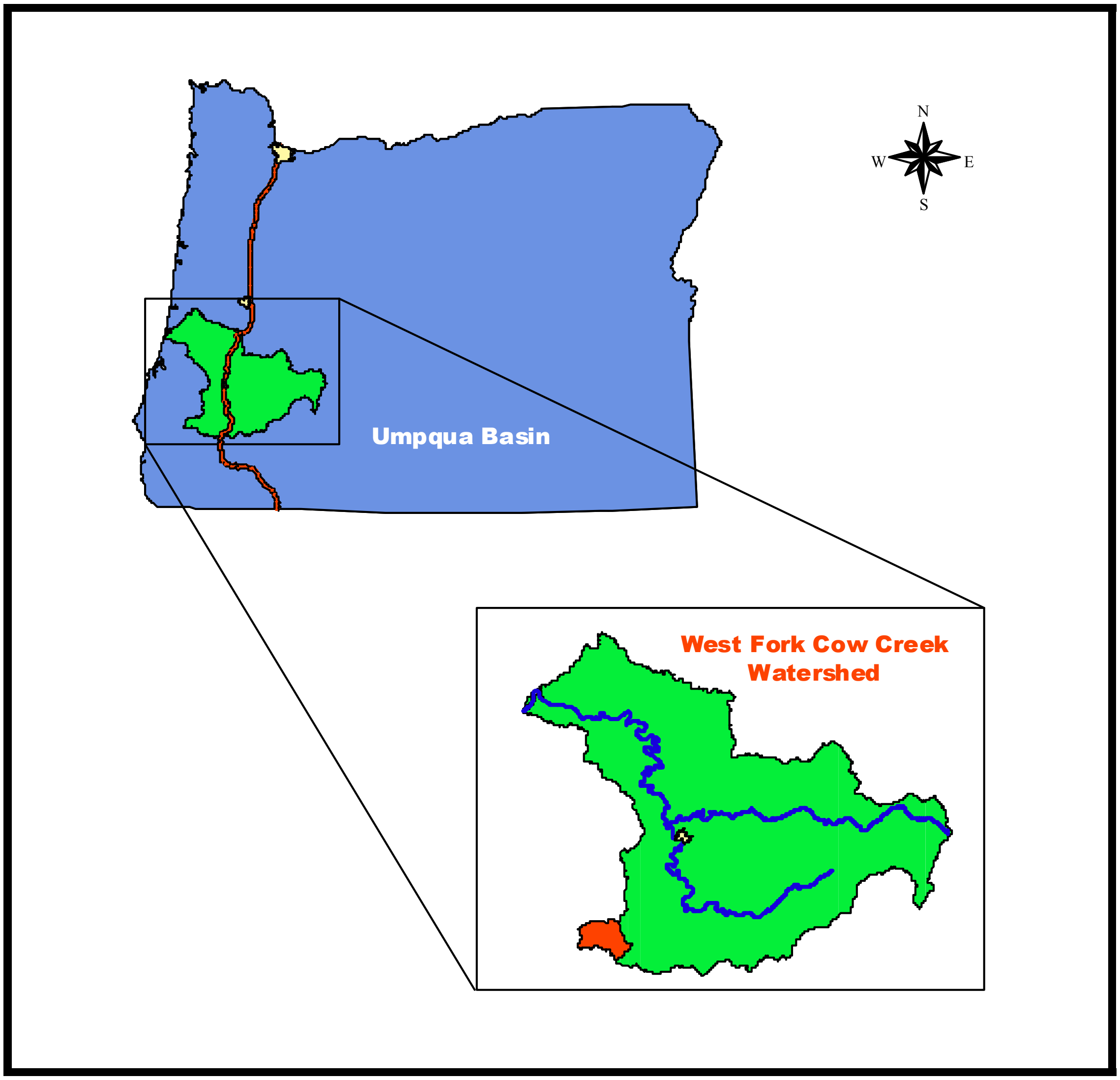
West Fork Cow Creek

Watershed Assessment and Action Plan



Prepared by Nancy A. Geyer for the

Umpqua Basin Watershed Council

November, 2003

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Prepared by

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November, 2003

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Acronym List

BLM	Bureau of Land Management
Cfs	Cubic feet per second
DSWCD	Douglas Soil and Water Conservation District
GIS	Geographic information system
NTU	Nephelometric turbidity units
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
TMDL	Total maximum daily load
TSZ	Transient snow zone
UBWC	Umpqua Basin Watershed Council
USDI	United States Department of the Interior
USGS	United States Geological Survey
WAB	Water availability basin

Forward

We often hear the term "watershed" these days. We all live within a watershed. Fish habitat and water quality can be affected by the watershed's condition and by the activities within it. All of us depend upon the water that flows from our watershed. But what exactly is a watershed?

A watershed is the area of land where all surface and groundwater drains into the same body of water, such as a river, wetland, or the ocean. Watersheds can be many millions of acres like the Colombia River Basin, or less than a dozen acres for a single small stream. Since the term "watershed" can be used for drainage areas of any size, the US Geological Survey (USGS) has divided watersheds into distinct units, or "fields," based on size. Sizes range from multi-million acre first-field watersheds to seventh-fields that can be less than 3,000 acres.

For this assessment, the most important fields are third-field and fifth-field watersheds.[1] Third-field watersheds are large river basins. The Umpqua River Basin includes the South, North, and main Umpqua Rivers, as well as Smith River, and has roughly the same boundary as Douglas County. Third-field watersheds are usually referred to as "basins," and in this document "basin" will be used to refer to the Umpqua Basin third-field watershed. Fifth-field watersheds have become the standard size used for research and projects by a variety of agencies and organizations. Therefore, it is convenient for fifth-field watershed to be the unit usually referred to herein by the term "watershed." Watersheds are around 40,000 to 120,000 acres, and there are 33 fifth-fields in the Umpqua Basin.

Although the borders of the watersheds are standardized, the names are not. Different organizations and agencies may call the watersheds by different names, but, in general, all watersheds are named for the creek or the section of stream into which all tributaries drain.[2] For example, the Calapooya Creek Watershed includes all land that drains into Calapooya Creek or its tributaries. A very large stream, such as the South Umpqua River, is usually separated into multiple fifth-field watersheds.

All watersheds have their own features, challenges, and potential. The conditions in one watershed may not reflect the conditions in a neighboring watershed. This assessment evaluates the unique past, present, and potential future conditions of the West Fork Cow Creek Watershed in terms of fish habitat and water quality.

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[1] Fourth-field watersheds refer to sub-basins. Just as there are three main rivers in the Umpqua Basin, there are also three fourth-field watersheds, or sub-basins: the Umpqua River fourth-field watershed, the North Umpqua River fourth-field watershed, and the South Umpqua River fourth-field watershed.

[2] When one watershed does not encompass the entire drainage area, such as with a river or large creek, names reflect the relative location of the watershed along the mainstem. Upper South Umpqua would be near the headwaters of the South Umpqua River, while Middle Cow Creek is somewhere in the middle of Cow Creek.

1. Introduction

The introduction provides a general description of the watershed in terms of its natural and human-made features, ownership, and current land uses. Information in section 1.2 was compiled from the *Oregon Watershed Assessment Manual* (Watershed Professionals Network, 1999), the *Lower Cow Creek Watershed Analysis* (USDI Bureau of Land Management, 2002), and the *Lower South Umpqua Watershed Analysis* (USDI Bureau of Land Management, 2000). Additional information is from the following sources' databases: The Oregon Climate Service, the US Census Bureau, and the Douglas County Assessor.

Key Questions

- What is the Umpqua Basin Watershed Council?
- What is the purpose of the watershed assessment and action plan document?
- How was the watershed assessment developed?
- Where is the West Fork Cow Creek Watershed and what are its defining characteristics?
- What is land ownership, use, and parcel size within the watershed?

1.1. Purpose and development of the watershed assessment

1.1.1. The Umpqua Basin Watershed Council

The Umpqua Basin Watershed Council (UBWC) is a non-profit, non-government, non-regulatory charitable organization that works with willing landowners on projects to enhance fish habitat and water quality in the Umpqua Basin. The council has its origins in 1992 as the Umpqua Basin Fisheries Restoration Initiative (UBFRI) and was changed to the UBWC in May of 1997. Three years later, the council was incorporated as a non-profit organization. The UBWC's 16-member Board of Directors represents resource stakeholders in the Umpqua Basin. The board develops localized and basin-wide fish habitat and water quality improvement strategies that are compatible with community goals and economic needs. Activities include enhancing salmon and trout spawning and rearing grounds, eliminating barriers to migratory fish, monitoring stream conditions and project impacts, and educating landowners and residents about fish habitat and water quality issues in their areas. Depending on the need, the UBWC will provide direct assistance to individuals and groups, or coordinate cooperative efforts between multiple partners over a large area.

1.1.2. The watershed assessment and action plan

The West Fork Cow Creek Watershed assessment has two goals:

1) To describe the past, present, and potential future conditions that affect water quality and fish habitat within the West Fork Cow Creek Watershed; and
2) To provide a research-based action plan that suggests voluntary activities to improve fish habitat and water quality within the watershed.

The action plan developed from findings in Chapter Three is a critical component of the assessment. The subchapters include a summary of each section's key findings and a list of action recommendations developed by UBWC staff, landowners, and restoration specialists. Chapter Five is a compilation of all key findings and action recommendations and includes a summary of potential UBWC West Fork Cow Creek Watershed enhancement opportunities. Activities within the action plan *are suggestions for voluntary projects and programs*. The action plan should not be interpreted as landowner requirements or as a comprehensive list of all possible restoration opportunities.

1.1.3. Assessment development

This document is the product of a collaborative effort between the UBWC and residents, landowners, and stakeholders in the Cow Creek and South Umpqua River areas. Members of the UBWC staff assembled information about each assessment topic and compiled the data into graphic and written form.[3] Landowners and other interested parties met with Nancy Geyer of the UBWC staff to review information about the West Fork Cow Creek Watershed and offer comments and suggestions for improvement.

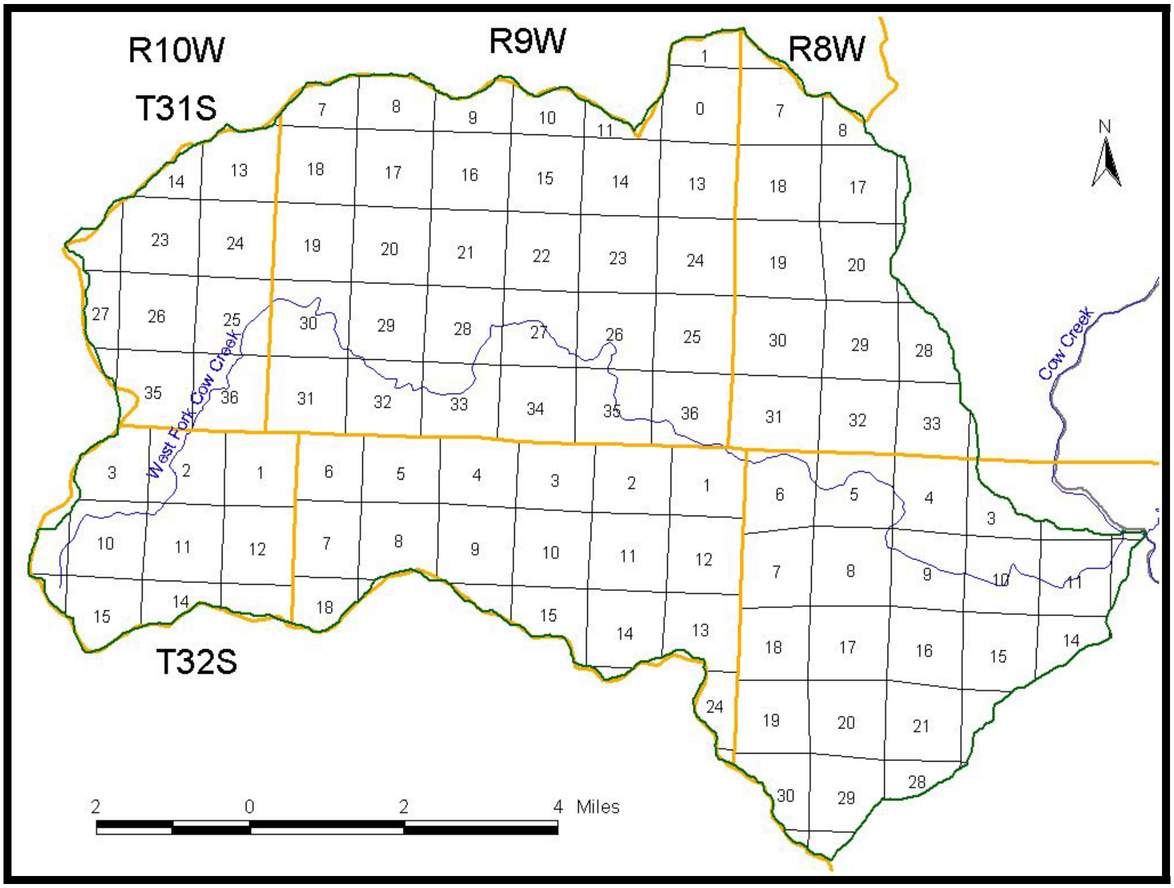
The West Fork Cow Creek Watershed assessment meetings were held in conjunction with meetings for the South Umpqua River, Lower Cow Creek, and Upper Cow Creek Watersheds. Landowners and residents met for 10 meetings and one field trip from October, 2002, through August, 2003. A total of 53 people attended one or more meetings and the field trip, with an average of 11.8 participants per meeting. Meeting participants included ranchers, family forestland owners, industrial timber company employees, city officials, city residents, and land management agency personnel.

1.2. Watershed description

1.2.1. Location, size, and major features

The West Fork Cow Creek fifth-field watershed is located in Douglas County, Oregon, and is 55,913.8 acres. The watershed stretches a maximum of 10 miles north to south and 14 miles east to west (see Map 1-1). There are no highways and no cities or population centers within the watershed. According to data from the 2000 US Census, the population of the West Fork Cow Creek Watershed is zero.

[3] Unless otherwise indicated, Nancy Geyer and Heidi Kincaid of the Umpqua Basin Watershed Council developed all text, tables, maps, and figures.



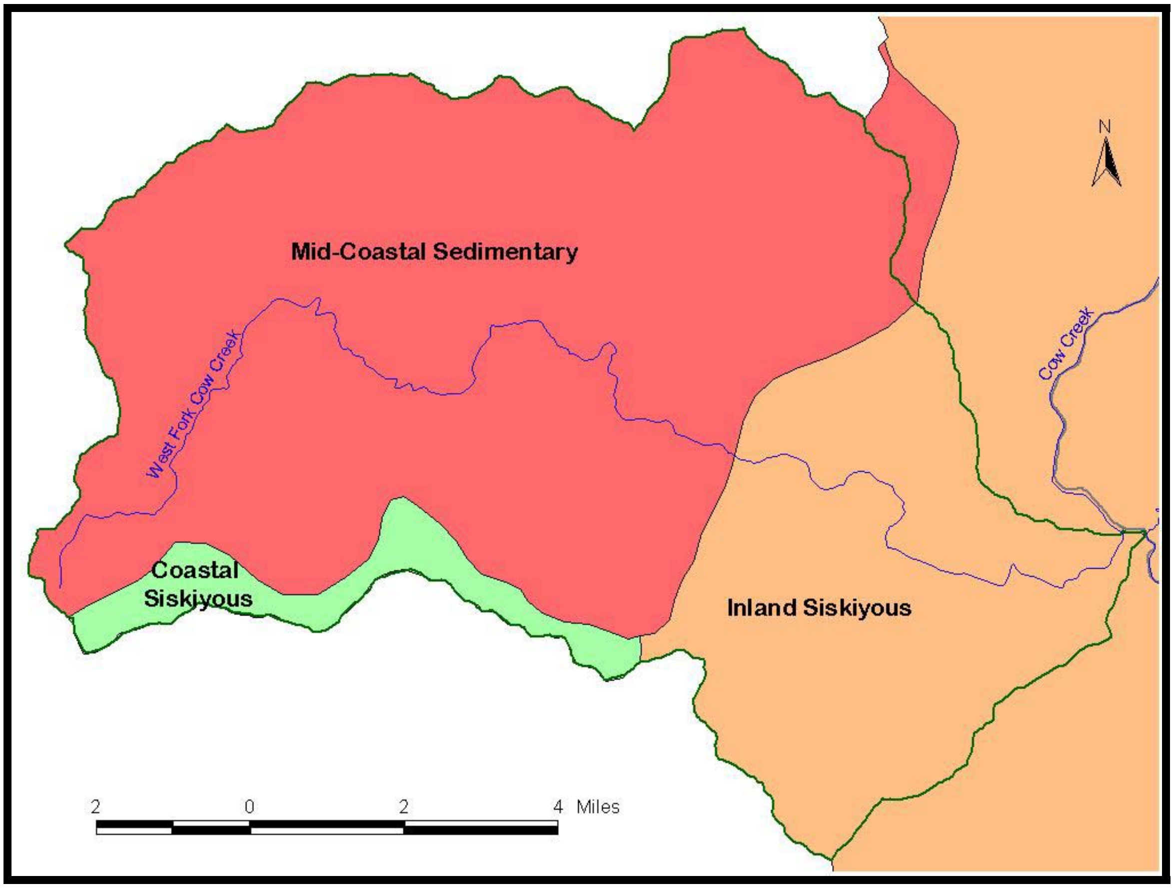
Map 1-1: Location of the West Fork Cow Creek Watershed.

1.2.2. Ecoregions

Ecoregions are areas with similar type, quality, and quantity of environmental resources, including landscape, climate, vegetation, and human use.[4] Ecoregion information is not specific to an individual watershed and is too general for the purposes of this assessment. However, ecoregions are useful because they divide the watershed into areas based on natural characteristics rather than on political boundaries or township, ranges, and sections. In this section, ecoregions are used to distinguish three unique areas in the West Fork Cow Creek Watershed. In some cases, ecoregion information is used to supplement other data.

Map 1-2 and Table 1-1 show the West Fork Cow Creek Watershed's location and percent within each ecoregion. The majority of the watershed (67%) falls within the Mid-Coastal Sedimentary Ecoregion. The eastern-most portion of the watershed is part of the Inland Siskiyous Ecoregion, while the southern border is within the Coastal Siskiyous Ecoregion.

[4] The Environmental Protection Agency (EPA) and the Oregon Natural Heritage Program (ONHP) developed ecoregion boundaries for the State of Oregon.



Map 1-2: Ecoregions of the West Fork Cow Creek Watershed.

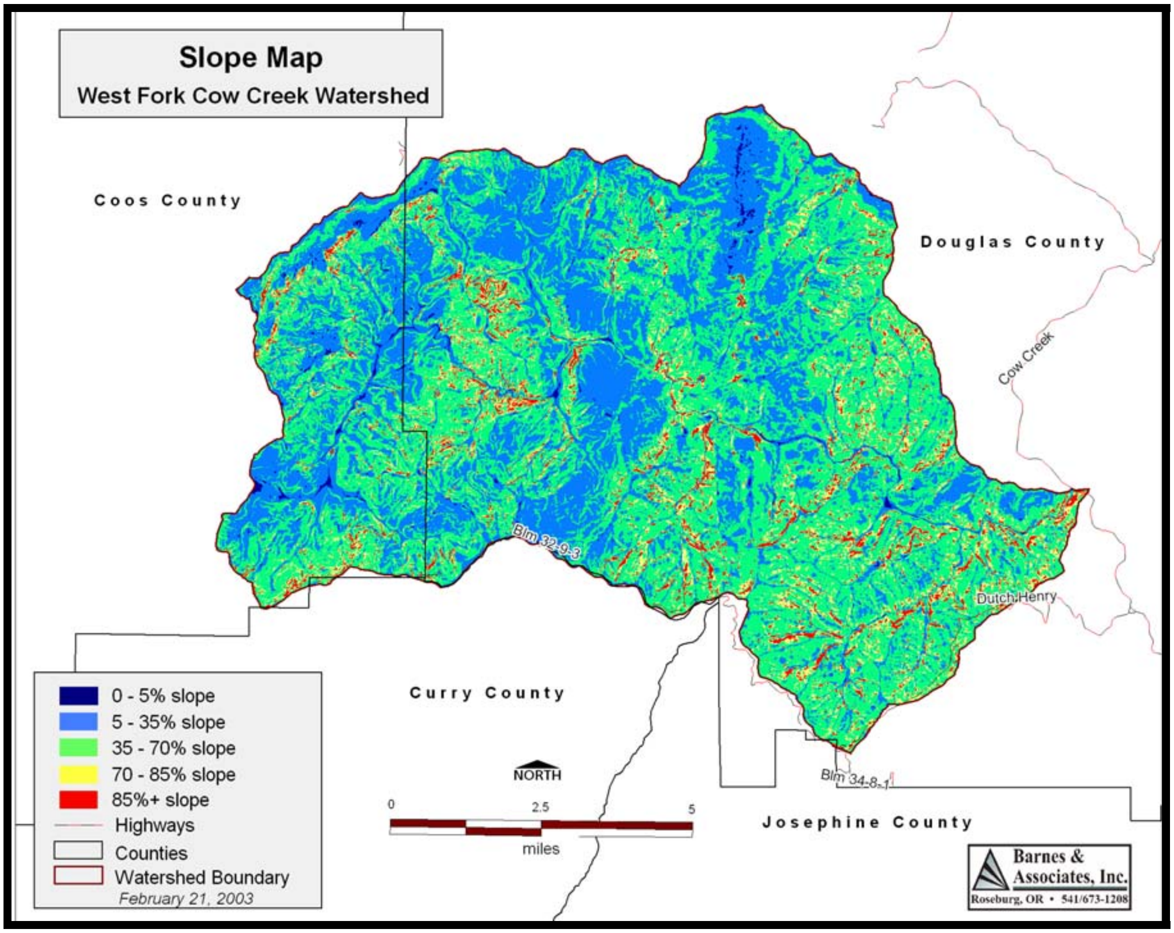
Ecoregion	Percent of total
Coastal Siskiyous	5%
Inland Siskiyous	28%
Mid-Coastal Sedimentary	67%
TOTAL	**100%**

Table 1-1: Percent of the West Fork Cow Creek Watershed within each ecoregion.

1.2.3. Topography

Gentle to moderate slopes correspond with medium and large streams in the Mid-Coastal Sedimentary Ecoregion. Steep slopes often border smaller streams and stream headwaters. The Inland Siskiyous Ecoregion and the Costal Siskiyous Ecoregion are generally mountainous with deep, "V"-shaped valleys, and usually have steeper slopes than the Mid-Costal Sedimentary Ecoregion (see Map 1-3).

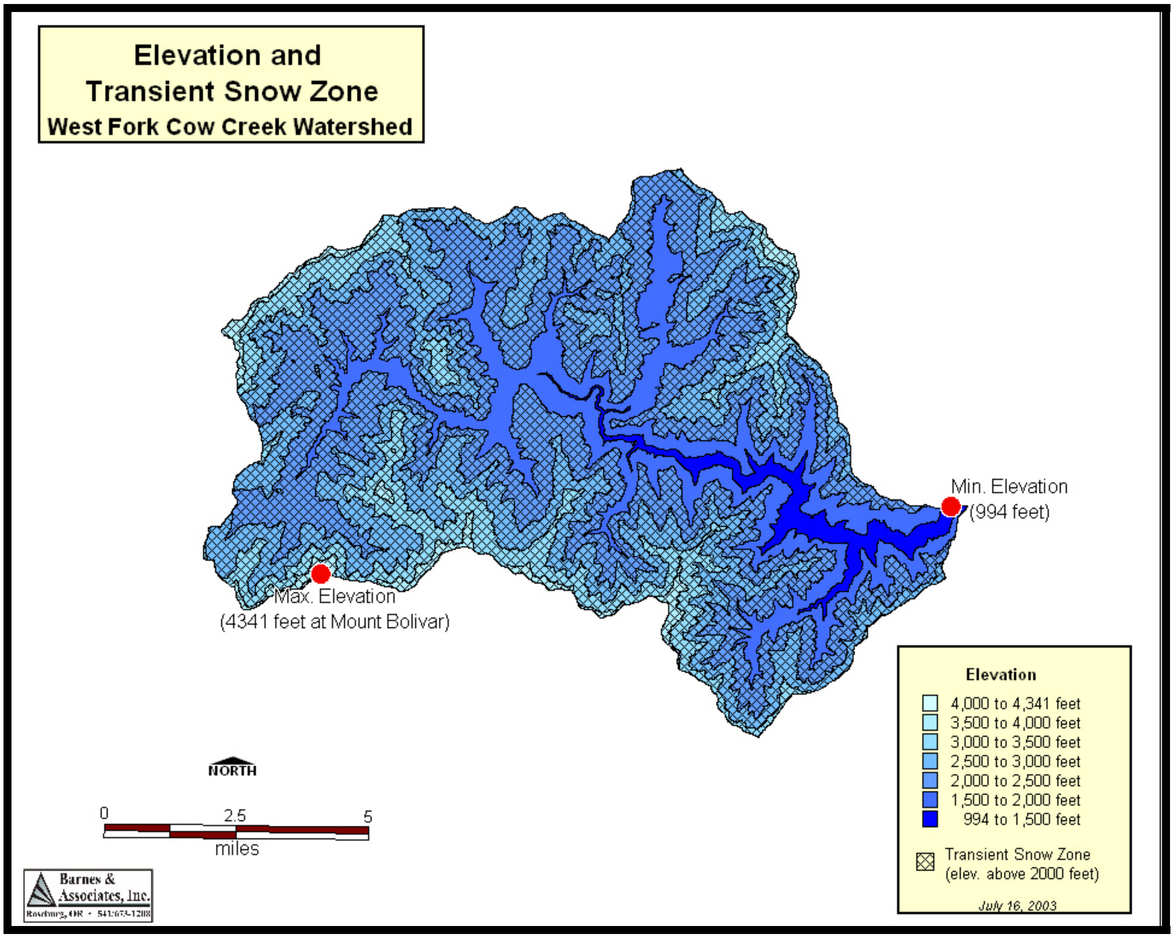
The lowest point in the watershed is 994 feet where West Fork Cow Creek meets Cow Creek (see Photo 1-1). The highest point is 4,641feet at Mount Bolivar on the eastern tip of the watershed (see Map 1-4). In the West Fork Cow Creek Watershed, 78.9% of the land base is above 2,000 feet. Areas between 2,000 and 5,000 feet in elevation are known as the transient snow zone (TSZ). Rain-on-snow events, in which rain falls on accumulated snow causing it to melt, may occur in these areas (see Map 1-4).



Map 1-3: Percent slope for the West Fork Cow Creek Watershed.

Photo 1-1: Photograph looking southeast at the confluence of West Fork Cow Creek (right) with the main channel of Cow Creek (left).[5]

[5] Kristin Anderson and John Runyon of BioSystems, Inc., contributed this photograph. The photograph was taken from Universal Transverse Mercator coordinate 450907/4739956.



Map 1-4: Elevation of the West Fork Cow Creek Watershed with highest and lowest points.

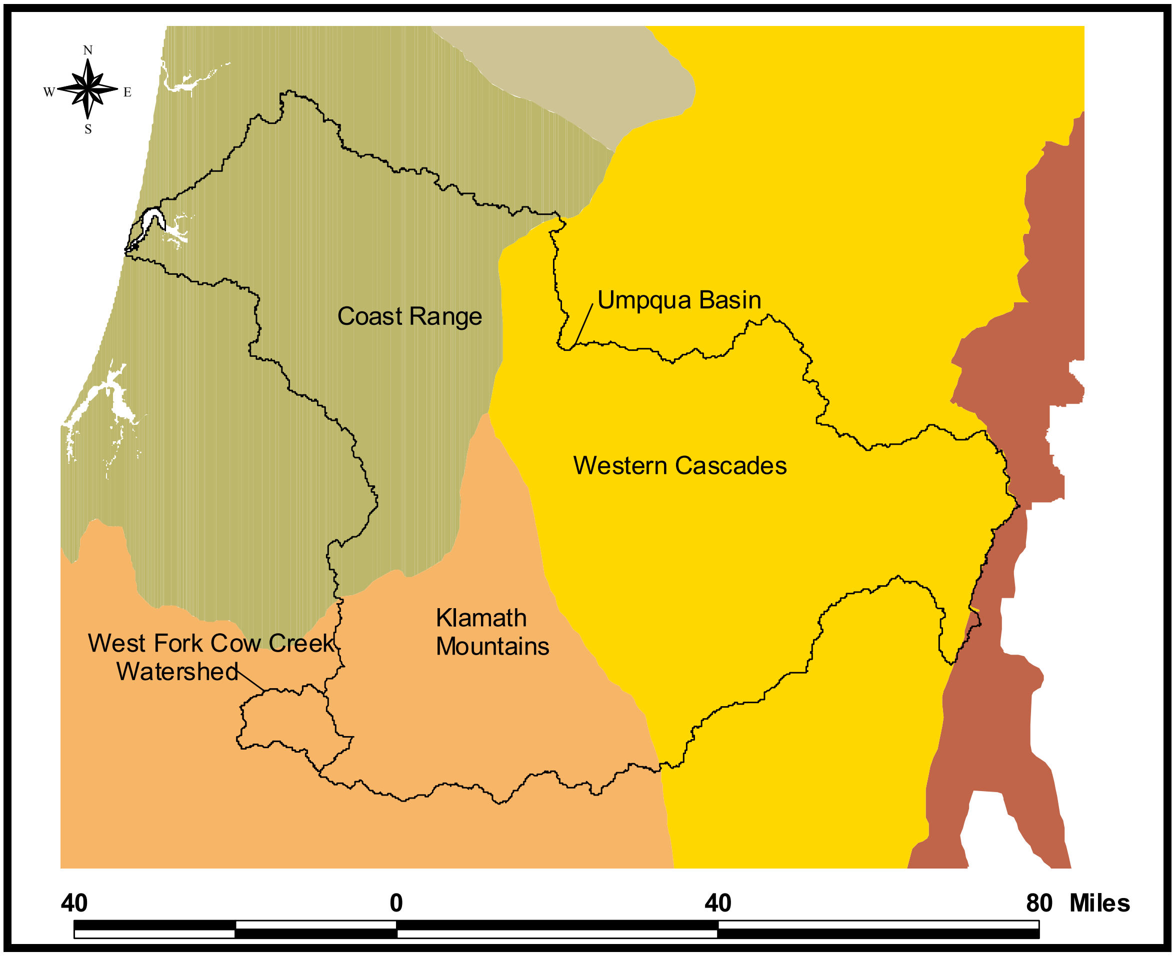
1.2.4. Geology[6]

The geologic history and current setting of any watershed is critical to understanding natural resource issues within it. In Oregon, geologic processes have created a unique and varied landscape throughout the state. In southwestern Oregon, the history of the landscape is dominated by the collision of western North America with the floor of the Pacific Ocean and fragments of earth crust lying on it. This report summarizes the geology and geomorphology of the West Fork Cow Creek Watershed. Appendix 1 provides more information about the geologic history of western Oregon and a glossary of terms. Information in this section has been summarized from the following documents: *Geology of Oregon* (Orr et al., 1992); *Northwest Exposures, A Geologic History of the Northwest* (Alt and Hyndman, 1995); *Earth* (Press and Siever, 1986); *Geologic Map of Oregon* (Walker and MacCleod, 1991); and *Atlas of Oregon* (Allen et al., 2001).

[6] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the text, table, photo, and maps for section 1.2.4. Terms such as "Jurassic" and "Cretaceous" refer to periods in the geologic/evolutionary timetable. However, the UBWC takes no position regarding the time periods with which these terms are associated and is using the terms to refer to natural processes and the relative order in which they occurred.

Physiography

Geologic processes have created many different physiographic provinces, or areas of similar geomorphology, within the state. According to the boundaries of these provinces as delineated by the Oregon/Washington Bureau of Land Management (USDI Bureau of Land Management, 1992), the Umpqua River Basin lies at the intersection of three physiographic provinces as follows: the Coast Range, the Klamath Mountains, and the Western Cascades (see Map 1-5). According to the BLM delineation, the West Fork Cow Creek Watershed lies within the Klamath Mountain Province. However, Orr and Orr (2000) show that an overlap of rocks typical to the Oregon Coast Range reach down into the northern part of the watershed.



Map 1-5: Physiographic provinces of the West Fork Cow Creek Watershed.

<u>The Klamath Mountains</u>

The Klamath Mountain Province lies in the southwestern corner of Oregon, and extends south into California as an elongate north-south lying province. The Klamath Mountain area has a varied landscape with some steep narrow canyons and high peaks; yet in most places, it has a fairly even relief. The Rogue River and its tributaries drain the majority of the province, but the South Umpqua River and its tributaries extend into the northeastern-most reach of this province. The Chetco and Pistol river systems also drain a portion of the province.

The Coast Range

The Coast Range, because of its location on the west coast of Oregon, receives the highest amount of rainfall in the state, is densely vegetated, and in most places has well-developed soils. The crest of the range has an average altitude of 1,500 feet above sea level, and the highest peaks are east of the middle of the range due to the more intense rainfall and consequent erosion on the western side. The Umpqua is one of three rivers (along with the Columbia and the Siuslaw) that cut entirely through the Oregon Coast Range.

The West Fork Cow Creek Watershed

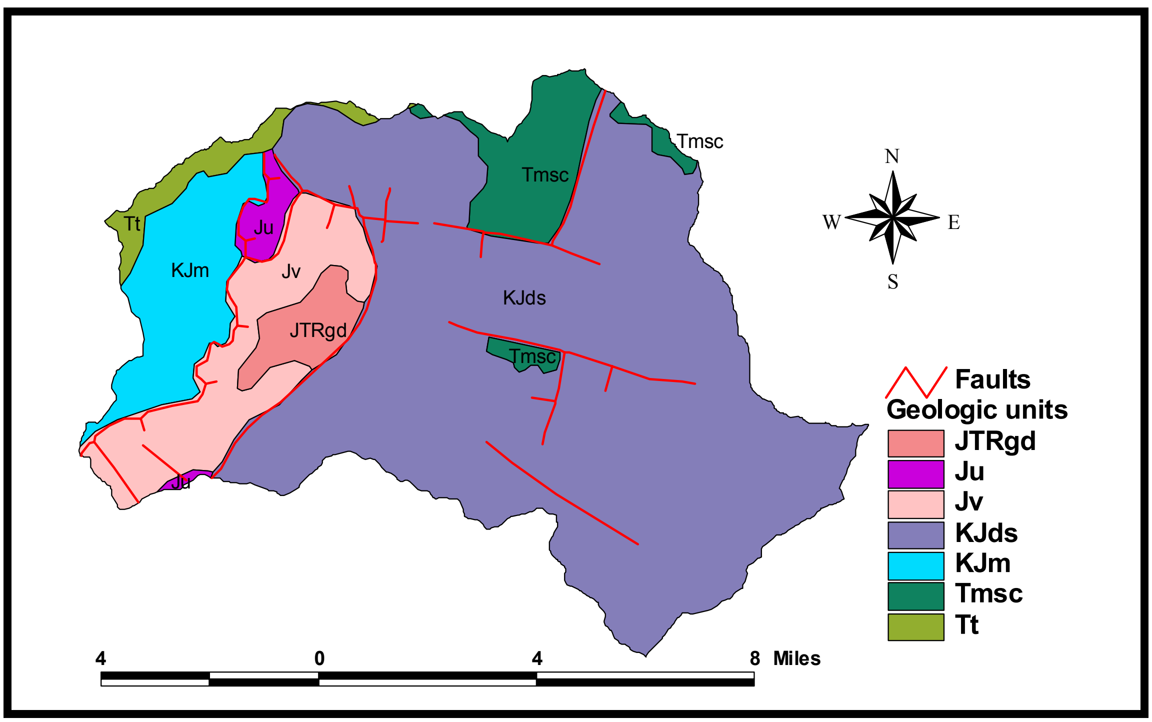
The West Fork Cow Creek Watershed exhibits fairly steep topography, with streams dissecting the landscape. Gold Mountain, Big Dutchman Butte, and Hayes Ridge are some prominent features within the watershed. There are no notable floodplain areas or other low relief features within the West Fork Cow Creek Watershed. Although the topography is fairly consistent throughout the watershed, some changes in slope are evident along contacts between geologic units.

Geologic units of the West Fork Cow Creek Watershed

According to Walker and MacLeod (1991), there are seven geologic units within the West Fork Cow Creek Watershed, ranging in age from Jurassic to Tertiary (see Table 1-2 and Map 1-6). Jurassic and Cretaceous geologic units within the watershed are characteristic of the Klamath Mountains, while the Tertiary units are characteristic of the Coast Range. Jurassic ophiolite sequences (Ju), or oceanic crust incorporated into the continent, are found in the northwestern part of the watershed. Jurassic volcanic rocks (Jv) are found in the western portion of the watershed. Intrusive granite and diorite rocks (JTRgd) of Jurassic and Triassic age lie in that same vicinity. Rocks of the late Jurassic and early Cretaceous constitute the majority of the watershed. Myrtle Group (KJm) consists of conglomerate, sandstone, siltstone, and limestone, and the Dothan Formation sedimentary rocks (KJds) consist of sandstone, conglomerate, graywacke, and chert (see Photo 1-2). The Tertiary age units are found mostly in the northern part of the watershed. Tertiary units include continental shelf and slope deposits of marine siltstone, sandstone, and conglomerate (Tmsc) typical of Oregon Coast Range rock formations and marine sandstones and siltstones of the Tyee Formation (Tt). A more detailed description of units and a glossary of terms can be found in Appendix 1.

Era	Period	Epoch
Cenozoic	Quaternary	Holocene
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
		Eocene
		Paleocene
Mesozoic	Cretaceous	
	Jurassic	
	Triassic	
Paleozoic	Permian	
	Pennsylvanian	
	Mississippian	
	Devonian	
	Silurian	
	Ordovician	
	Cambrian	
Precambrian		

Table 1-2: Relative geologic time scale (most recent to oldest – top to bottom).



Map 1-6: Geologic units and faults within the West Fork Cow Creek Watershed.

Photo 1-2: Photograph looking at road outcrop of the Dothan Formation, the predominant geologic unit found in the West Fork Cow Creek Watershed. [7]

Structural geology
The long history of tectonic subduction of the floor of the Pacific Ocean with the North American continent as well as a northward movement of the oceanic plate has left the landscape of Oregon riddled with faults. The West Fork Cow Creek Watershed has several major faults within its boundaries, many of which lie at the contacts between geologic units. Many faults are in a southwest-northeast orientation (see Map 1-6), but some faults fall in an orientation nearly perpendicular to this. Although recent earthquake activity has been focused mostly in the northwestern part of the state, the tectonic subduction zone that extends under the entire western part of the state poses an earthquake hazard in the entire area. The location of faults seen at the surface is not necessarily an indication of where crustal movement may occur in the future.

Impacts of geology on stream characteristics
As stated earlier, the geology of an area impacts the water resources of that area. Geologic processes govern the topography of an area, which in turn greatly influences the

[7] The photograph was taken from Universal Transverse Mercator coordinate 450602/4739241.

morphology of streams. The hydraulic conductivity, or permeability, of rock units plays a significant role in determining the groundwater inputs to streams, and groundwater can contribute to stream water quality. Generally, groundwater has a more consistently high quality than surface water. However, many streams in mountainous areas, such as the West Fork Cow Creek Watershed, are naturally surface water dominated, with groundwater playing a relatively minor role.

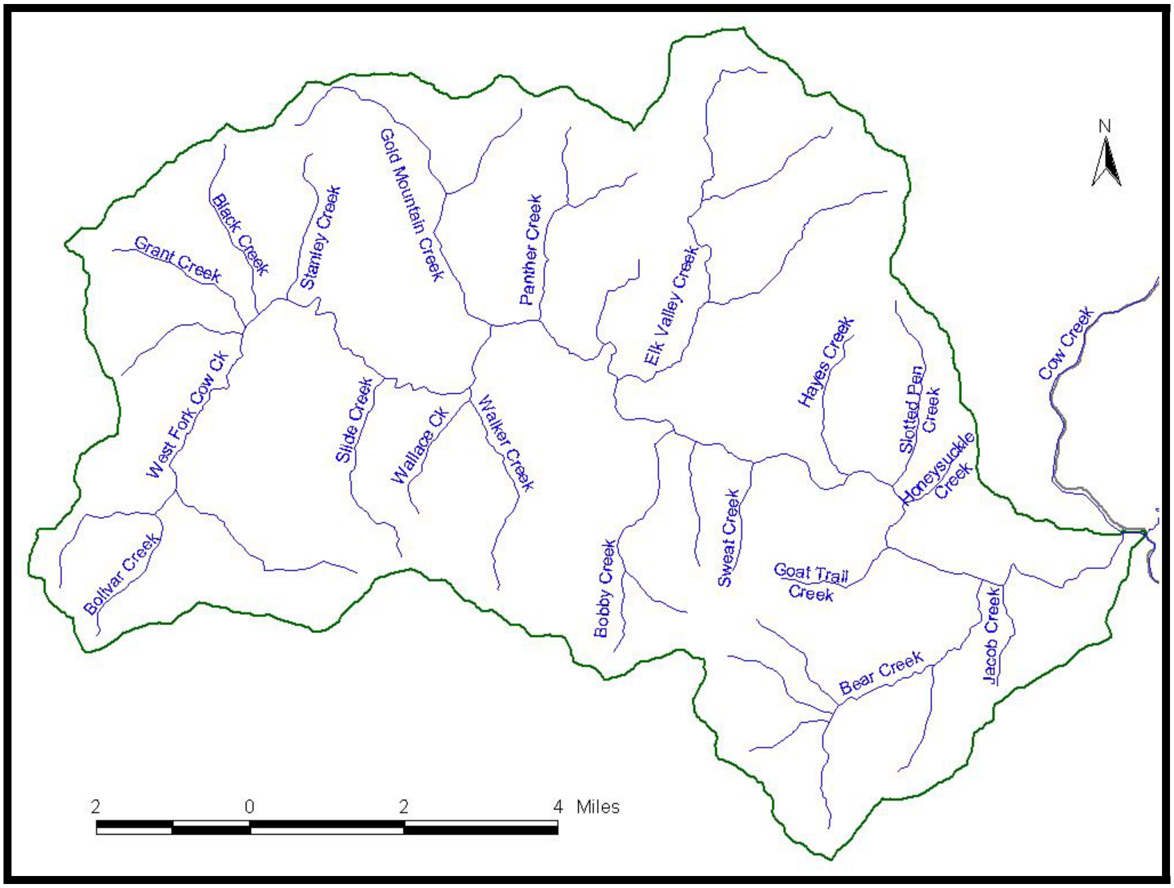
The composition of rocks can impact the quality of fish habitat and water quality. Generally, granitic rocks are more acidic, while calcareous rocks are more alkaline. Fish prefer neutral to alkaline conditions (Hastings et al., 2002). Erosion of rocks and subsequent delivery of sediments to streams as well as groundwater inputs delivered to streams through rock units influence the water chemistry of those streams.

The topography that results from geologic processes helps to shape the steepness of slopes and their likelihood of failing. Topography also influences the local climate, causing, for instance, more rain on the western slopes of large hills than on the eastern slopes. This may influence runoff and sediment inputs locally. Geology largely governs the process of soil formation. Rocks provide the parent material for soil development. The minerals within rocks also influence the organisms that grow and abide within the soil. Relief and climate, both influenced by geology, also impact soil genesis. The characteristics of the resulting soil impact the contribution of sediment to streams (see section 3.3.3 for more information on stream sediment).

1.2.5. The West Fork Cow Creek stream network

West Fork Cow Creek is a tributary of Cow Creek and is 22.2 stream miles long.[8] Map 1-7 shows all of West Fork Cow Creek's tributaries that are visible on a US Geological Survey 100,000 resolution map, where one inch equals 8,333.3 feet. According to this map, there are 110.6 stream miles in the West Fork Cow Creek Watershed. The longest tributary to West Fork Cow Creek is Elk Valley Creek (6.0 stream miles). West Fork Cow Creek's average stream gradient is 1.9%. Tributaries have an average gradient of 9.5%.

[8] Stream miles and river miles measure distance from the mouth following the center of the stream channel to a given point. "Total stream miles" is the length of a stream in miles from the mouth to the headwaters. "Stream mile zero" always refers to the mouth.



Map 1-7: Major streams of the West Fork Cow Creek Watershed.

1.2.6. Climate

The Mid-Coastal Sedimentary Ecoregion typically has wet winters, mostly dry summers, and mild temperatures throughout the year. During the winter months, heavy precipitation results from moist air masses moving off the Pacific Ocean on to land. Average annual precipitation ranges from 60 to 130 inches. Typical of southwest interior Oregon, the Coastal Siskiyous and Inland Siskiyous Ecoregions are drier and colder than the northwest interior because much of the area is within the Coastal Mountain Range rain shadow. Precipitation for the Inland Siskiyous Ecoregion typically ranges from 35 to 70 inches, but can be up to 89 inches in higher elevations. The Coastal Siskiyous Ecoregion receives between 70 and 130 inches of precipitation per year; higher elevations can receive up to 165 inches.

There is no climate station within the West Fork Cow Creek Watershed. The two nearest climate stations are in Powers (station #6820) and Riddle (station #7169)[9]. As per ecoregion information, temperatures are generally mild. Figure 1-1 and Figure 1-2 show the average daily minimum and maximum temperatures by month for Powers and Riddle.

[9] The National Oceanographic and Atmospheric Administration (NOAA) administer both stations. Data are available from the Oregon Climate Station website http://ocs.oce.orst.edu/.

For both climate stations, maximum temperatures in the summer are generally in the 70s or low 80s. Minimum winter temperatures are usually above freezing.

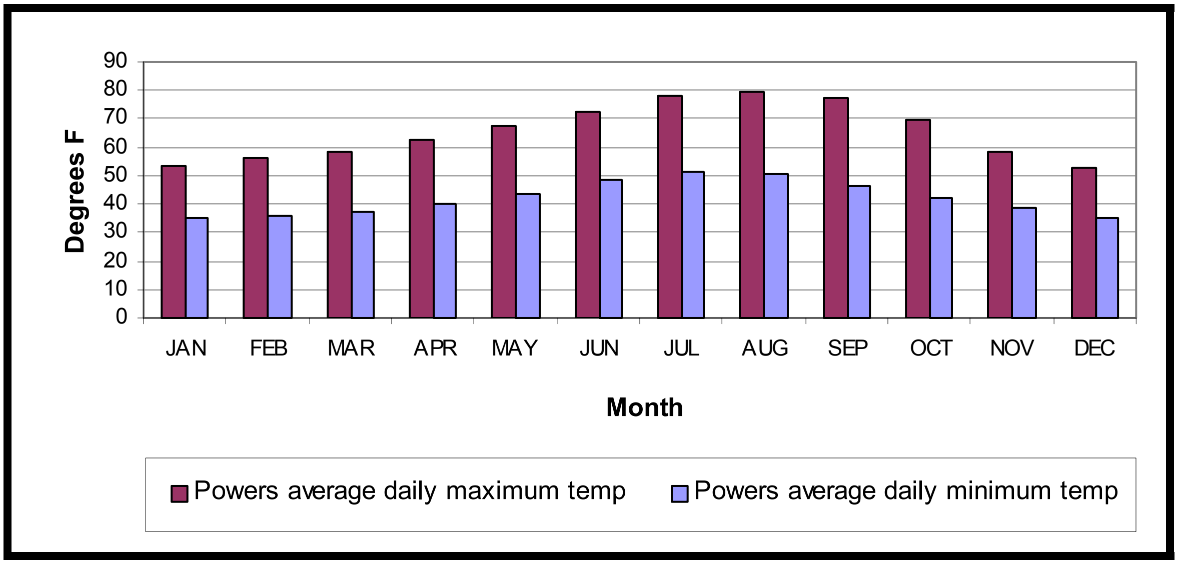


Figure 1-1: Average daily minimum and maximum temperatures for Powers (station #6820).

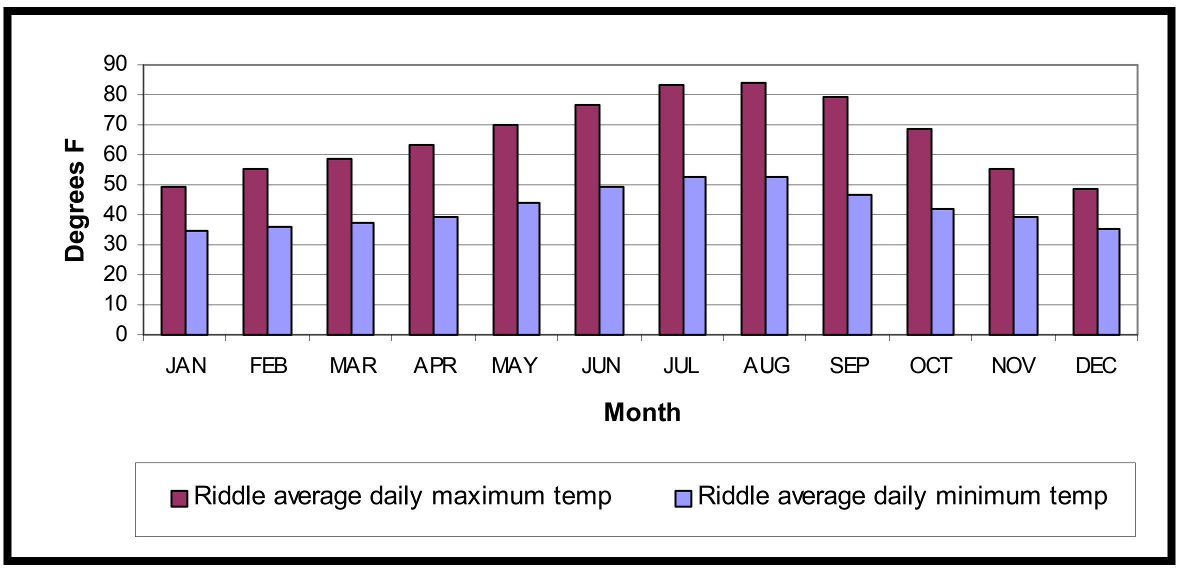


Figure 1-2: Average daily minimum and maximum temperatures for Riddle (station #7169).

Rainfall averages 60.0 inches annually in Powers and 30.8 inches annually in Riddle, but can vary widely depending upon the year (see Figure 1-3). As is typical of southwest Oregon, most precipitation occurs in the winter months (see Figure 1-4). In Powers, rainfall averages 9.3 inches for the months of November through February and 0.9 inches from June through September. Riddle averages 4.8 inches of precipitation from November through February and 0.6 inches from June through September.

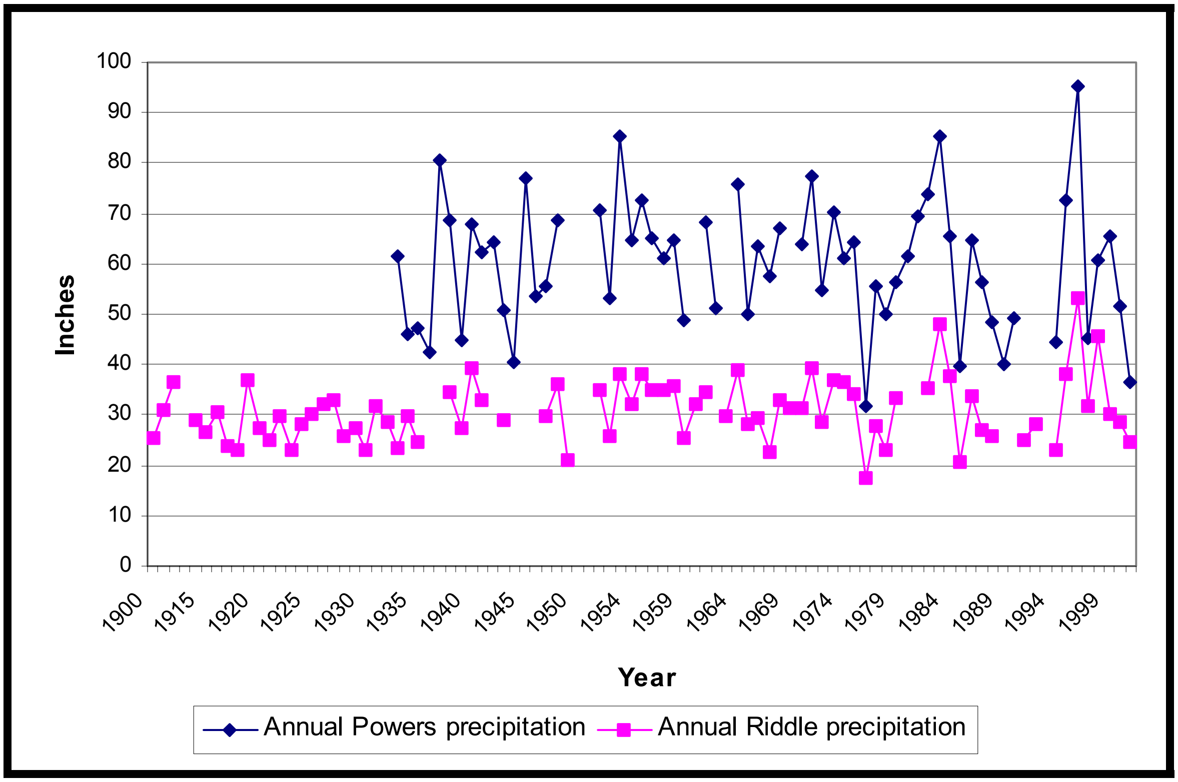


Figure 1-3: Annual precipitation for Powers (station #6820) and Riddle (station #7169).

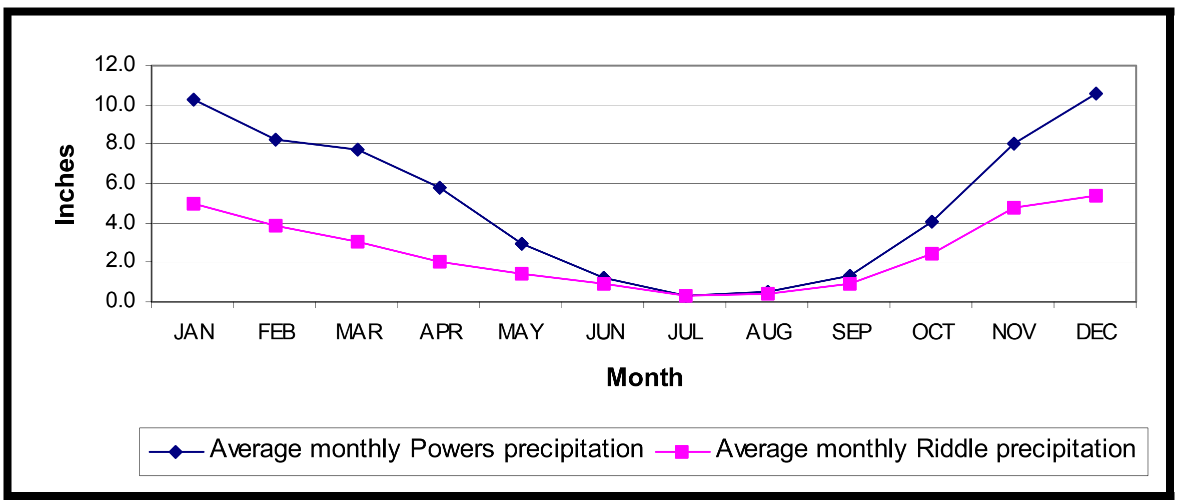


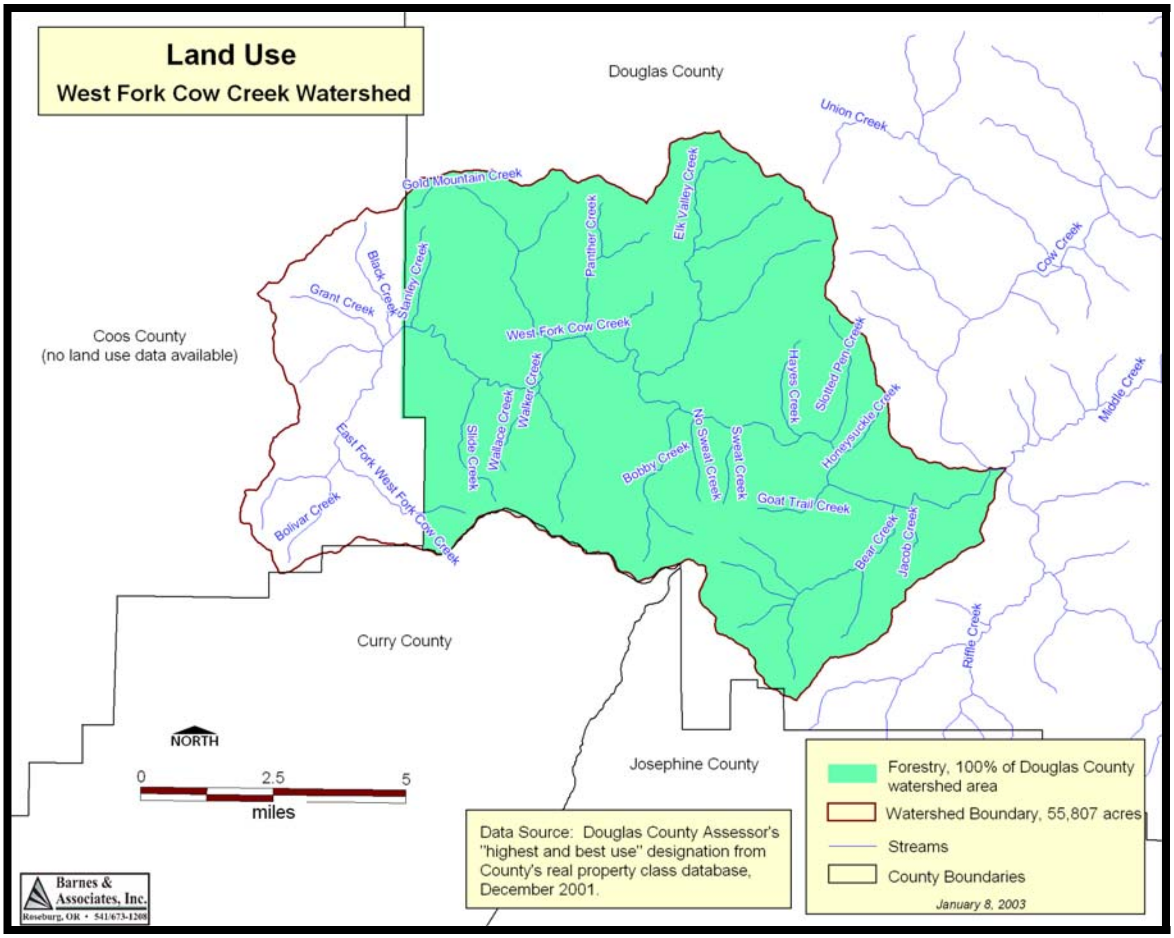
Figure 1-4: Average monthly precipitation for Powers (station #6820) and Riddle (station #7169).

Vegetation
Douglas-fir is the dominant tree species within the Mid-Coastal Sedimentary Ecoregion. Western hemlock is common in the understory and can be a dominant overstory species in older stands on northern aspects. On southern aspects, western hemlock is a minor overstory species. Grand fir, golden chinquapin, and western redcedar may also occur, while red alder, cascara buckthorn, and bigleaf maple can be found in favorable locations. Understory species include western swordfern, oxalis, vine maple, current, western hazel, creambush ocean spray, salal, red huckleberry, cascade Oregon grape, and evergreen huckleberry. Within the West Fork Cow Creek Watershed, the Coastal Siskiyous Ecoregion vegetation would be similar to Mid-Coastal Sedimentary Ecoregion vegetation.

Within the Inland Siskiyous Ecoregion, Douglas-fir is also dominant, with grand fir and white fir on northern aspects but minor or absent on southern aspects. Bigleaf maple, western redcedar, and incense cedar are also present. Hemlock and California black oak can be found where conditions are favorable. Northern aspects favor golden chinquapin, while madrone is prominent on south-facing slopes. For both aspects, the understory consists of salal, Oregon grape, western hazel, ocean spray, and red huckleberry; however, due to insufficient moisture, salal, Oregon grape, and red huckleberry are less common on southern slopes.

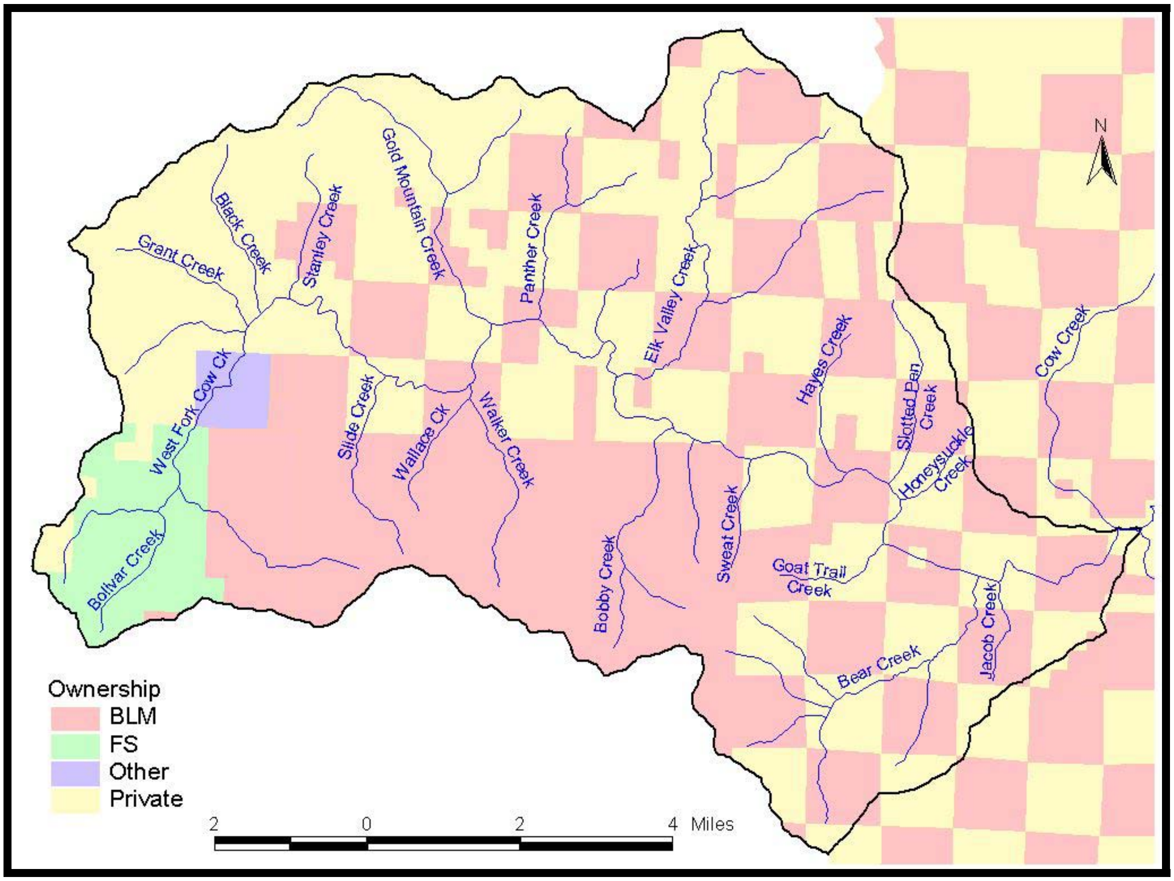
1.2.7. Land use and ownership

Forestry is the only land use within the West Fork Cow Creek Watershed (see Map 1-8). Land ownership is primarily federal (53%). The USDI Bureau of Land Management administers most of the federal lands within the watershed (see Map 1-9).



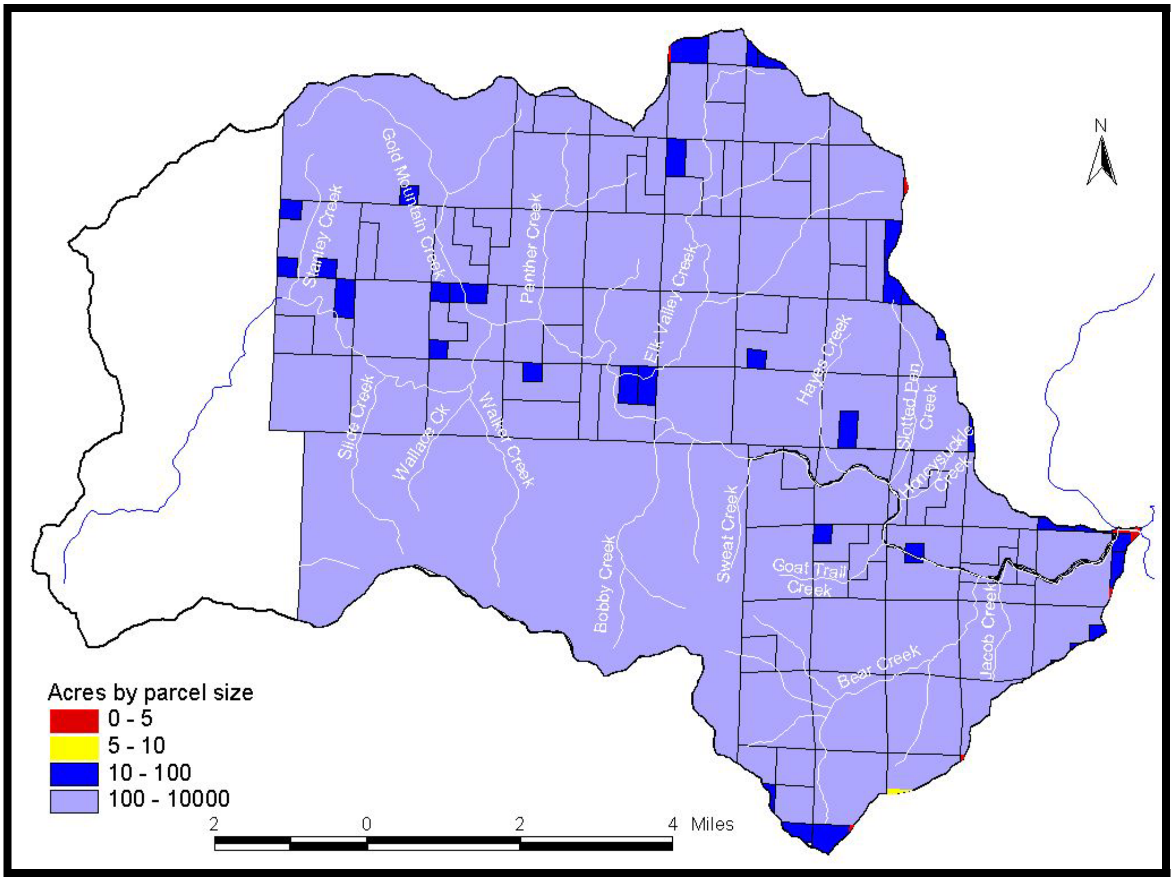
Map 1-8: Land use in the West Fork Cow Creek Watershed.[10]

[10] Digital land use information is only available for Douglas County. The portions of the watershed within Coos and Josephine Counties are also forestland.



Map 1-9: Land ownership in the West Fork Cow Creek Watershed.

Map 1-10 shows parcel size distribution by class for the West Cow Creek Watershed as of 2001. Data are only available for the portion of the watershed within Douglas County. Within Douglas County, most of the watershed (96.7%) consists of ownership parcels that are over 100 acres. There are few small ownerships within the West Fork Cow Creek Watershed.



Map 1-10: Parcel size distribution for the West Fork Cow Creek Watershed.

2. Past Conditions[11]

The past conditions section provides an overview of events since the early 1800s that have impacted land use, land management, population growth, and fish habitat in Douglas County and in the West Fork Cow Creek Watershed. Sections 2.1 through 2.5 describe the history of Douglas County. Section 2.6 provides information specific to the Cow Creek Valley and the West Fork Cow Creek Watershed. Most of sections 2.1 through 2.5 are based on S.D. Beckman's 1986 book *Land of the Umpqua: A History of Douglas County, Oregon.* Material obtained from other sources will be cited in the text and included in the reference list at the end of the section.

Key Questions

- What were the conditions of the Umpqua Basin watersheds before the arrival of the settlers?
- What events brought settlers to Douglas County?
- How did land management change over time and how did these changes impact fish habitat and water quality?
- What were the major socioeconomic changes in each period?
- When were laws and regulations implemented that impacted natural resource management?

2.1. Pre-Settlement: Early 1800s

The pre-settlement period was a time of exploration and inspiration. In 1804 President Thomas Jefferson directed William Clark and Meriwether Lewis to "secure data on geology, botany, zoology, ethnology, cartography, and the economic potentials of the region from the Mississippi Valley to the Pacific" (Beckham, 1986, p. 49). The two men successfully completed their journey in 1806 and returned with field collections, notes and diaries. The information they collected soon became an inspiration for others to follow their path. Fur trappers came first, reaching Douglas County in the 1820s. The pre-settlement period was an eye-opener for both the European explorers and the native Indians.

2.1.1. Indian lands

The Indians of Douglas County used fire to manipulate the local vegetation to improve their hunting success. George Hall, Sr., a settler of Douglas County in the 1850s, found the hills in the Oakland area with only a few large fir trees. In the draws were poison oak, small shrubs and abundant deer. "The Indians kept these hills burned off for good hunting" (Chenoweth, 1972, p. 66). In southern Douglas County early white men told of the Indian custom of burning during the late summer months. Burning stimulated the grasses and helped eliminate the undergrowth. "Reports from some of the first white men to see the Cow Creek Valley compared it to a giant wheat field" (Chandler, 1981, p. 2). Grass covering the rolling prairies often was waist high. An expedition in the fall of

[11] Robin Biesecker of Barnes and Associates, Inc., contributed sections 2.1 through 2.5. Jeanine Lum of Barnes and Associates, Inc., contributed section 2.6.

1841, funded by the federal government and led by Lt. George F. Emmons, met with dense, choking smoke as they traveled through the Umpqua Valley. Indians had created the smoky conditions by burning grasslands on the hillsides and along the river.

Accounts of the native Douglas County vegetation reveal extensive prairies and large trees. In June of 1826 David Douglas crossed the Calapooya Mountains and entered Yoncalla. His purpose was to collect specimens of native vegetation for the Royal Horticultural Society of London. Douglas was searching for stands of sugar pine. In the Umpqua Valley he was fortunate to meet and, with the help of beads and tobacco, make friends with an Indian. The Indian pointed to the south after Douglas drew pictures of the sugar pine and its huge cones. The pine stand was located and Douglas later described the largest pine windfall he had found: "57 feet nine inches in circumference; 134 feet from the ground, 17 feet five inches; extreme length, 215 feet" (Lavender, 1972, p. 148). Douglas was very fortunate to live through this experience. He was shooting up into the pine trees to clip cones when eight Indians, attracted by the noise, arrived armed with bows, arrows, and knives. Douglas cocked his gun, backed up and "as much as possible endeavored to preserve my coolness" (Lavender, 1972, p. 148). After an eight- to 10-minute staredown the Indian leader requested tobacco. Douglas complied, quickly retreated to his camp and, along with his three sugar pine cones, survived the encounter.

<u>Origin of the name "Umpqua"</u>

Many ideas exist about the origin of "Umpqua." An Indian chief searching for hunting grounds came to the area and said "umpqua" or "this is the place." Other natives refer to "unca" meaning "this stream." One full-blooded Umpqua Indian interviewed in 1960 believed the term originated when white men arrived across the river from their village and began shouting and gesturing their desire to cross. "Umpqua," she feels means "yelling," "calling," or a "loud noise" (Minter, 1967, p. 16). Another Indian when asked the meaning of "Umpqua" rubbed his stomach, smiled, and said, "Uuuuuump-kwa - full tummy!" (Bakken, 1970, p. 2).

Explorers and early settlers described the trees and other vegetation found in Douglas County. Large cedar trees were found along the South Umpqua River. In 1855 Herman and Charles Reinhart found yellow and red cedars clear of limbs for 30 to 50 feet. The Pacific Railroad Surveys passed through the Umpqua Valley in 1855. The oak groves found in the valleys were reported to grow both in groups and as single trees in the open. The oaks were described as reaching two to three foot diameters and to have a low and spreading form. Many early visitors describe the fields of camas. Hall Kelley traveled the Umpqua River in 1832. "The Umpqua raced in almost constant whitewater through prairies covered with blue camas flowers and then into dense forest" (Cantwell, 1972, p. 72). In the present-day Glide area, Lavola Bakken (1970) mentions the Umpqua Indian diet of sweet camas bulbs taken from the "great fields of camas" (p. 2). The Cow Creek Indians of southern Douglas County also ate the camas bulb (Chandler, 1981).

The diet of the native Indians also included fish and wildlife. The Cow Creek Indians built dams of sticks across stream channels to trap the fish. Venison was their main game meat that, prior to the use of guns, was taken with snares and bows and arrows (Chandler, 1981). Salmon was the fundamental food of the Indians along the main Umpqua River. The Lower Umpqua Indians fished with spears and by constructing barriers along the narrow channels. The large number of fish amazed a trapper working for the Hudson's Bay Company: "The immense quantities of these great fish caught might furnish all London with a breakfast" (Schlesser, 1973, p. 8). Wildlife was prevalent throughout Douglas County and included elk, deer, cougar, grizzly bear, beaver, muskrat, and coyotes.

2.1.2. European visitors

The Lewis and Clark Expedition gave glowing reports of the natural riches to be found and proved travel to Oregon was difficult but not impossible. Fur seekers, missionaries, and surveyors of the native geology, flora, and fauna were among the first European visitors to Douglas County. Methodist missionary Gustavus Hines preached to the Indians of the Umpqua in 1840. He concluded "the doom of extinction is suspended over this wretched race, and that the hand of Providence is removing them to give place to a people more worthy of this beautiful and fertile country" (Beckham, 1986, p.59).

Fur trading in Douglas County began in 1791 in the estuary of the Umpqua River. Captain James Baker traded with the Indians for about 10 days and obtained a few otter skins. The first land contact by fur traders in the Umpqua Valley was in 1818 by the Northwest Company of Canada. Trapping did not expand until Alexander Roderick McLeod – working for Hudson's Bay Company - explored the Umpqua Valley in 1826. The number of trappers steadily increased along the Umpqua River from 1828 to 1836. Hudson's Bay Company established Fort Umpqua first near the confluence of Calapooya Creek and the Umpqua in the 1820s and then, in 1836, near the present-day city of Elkton. Fort Umpqua was reduced in size in 1846 and finally destroyed in a fire in 1851. By 1855, the beaver were trapped out and fur trading had ended along the Umpqua River (Schlesser, 1973).

Pre-Settlement timeline

1804 - 1806	Lewis & Clark Expedition
1810	John Jacob Astor establishes Pacific Fur Company in Astoria
1818	Umpqua Massacre - North West Company fur seekers kill at least 14 Indians in northern Douglas County
1826	David Douglas (botanist) travels Douglas County
1828	Smith Massacre - Jedediah Smith's party attacked by Indians at the junction of the Smith and Umpqua Rivers; 14 killed

The travel routes of the trappers and early explorers closely parallel many of Douglas County's current roads. For example, Interstate Five (I-5) is located in the vicinity of an old trade route. The main difference is the original trail followed Calapooya Creek to its mouth and then up the Umpqua and South Umpqua rivers to Roseburg (Schlesser, 1973). Interstate Five uses a more direct route from Calapooya Creek to Roseburg via Winchester. The Umpqua Indian trails followed the major rivers and streams of the county including the main Umpqua and the North and South Umpqua Rivers, Little River, Rock Creek, and Steamboat Creek (Bakken, 1970).

The population of the Umpqua Valley is estimated to have been between 3,000 and 4,000 before the arrival of the white man (Schlesser, 1973). The Europeans brought diseases that reduced the population of Oregon Indians. Disease occurrences in Douglas County probably started between 1775 and the 1780s with the first smallpox outbreak. A smallpox or measles outbreak may have affected the far western part of the county in 1824 and 1825. The possibility of malaria in the central portion of the county occurred in 1830 through 1837. Smallpox was documented in the coastal portions of Douglas County in 1837 and 1838. Measles occurred in the western portions of the county in 1847 and 1848 (Allen, 2001). "The five bands of Athabascan speakers who lived along the Cow Creek were decreased to half their original number due to an epidemic during the severe winter of 1852-53" (Chandler, 1981, p. 9).

2.2. Settlement period: Late 1840s to the 1890s

2.2.1. Early settlement

California's Gold Rush was one factor in the early settlement of the county. First of all, the new miners demanded goods and services. "The California Gold Rush of 1849 suddenly created a market for Oregon crops and employment for Oregonians" (Allan, 2001). Secondly, travelers on their way to the gold fields passed through Douglas County. Many of these visitors observed the great potential for farming and raising stock and, after the trip to California, returned to Douglas County to take up permanent residence

The Donation Land Act of 1850 was a further impetus for the settlement of Douglas County. This act specified married couples arriving in Oregon prior to December 1850 could claim 640 acres; a single man could obtain

<u>Settlement period timeline</u>

1849	California Gold Rush
1850	Donation Land Act
1850s	Indian Wars; Douglas County Indians relocated to Grand Ronde Reservation
1860	Daily stages through Douglas County
1861	Flood
1870	*Swan* travels Umpqua River (Gardiner to Roseburg)
1872	Railroad to Roseburg
1873	Coos Bay Wagon Road completed
1887	Railroad connection to California
1893	Flood

320 acres. Men arriving after December 1850 were allowed to claim 320 acres if married and 160 acres if single. The patent to the land was secured with a four-year residency. The Donation Land Act was scheduled to end in December of 1853 but an extension increased this deadline to 1855. After 1855, settlers in Oregon were allowed to buy their land claims for $1.25 per acre following a one-year residency (Allan, 2001; Patton, 1976).

Large numbers of settlers entered Douglas County between 1849 and 1855. Lands were settled along Calapooya Creek, in Garden Valley, at Lookingglass, at the mouth of Deer Creek (Roseburg), in Winchester, and along Myrtle and Cow Creeks. For example, in Cow Creek Valley almost all open lands were claimed by 1855 (Chandler, 1981). The rich bottomland of the Umpqua Valley was very attractive to the emigrants looking for farmland. As the number of settlers increased, the Indian population of the county decreased. Diseases, as mentioned previously, took a toll, as did the Indian Wars of the 1850s. Douglas County Indians were relocated to the Grand Ronde Reservation in the 1850s.

2.2.2. Gold mining

One of the earliest mines in Douglas County was the Victory Mine close to Glendale. The Roseburg Review on November 6, 1893, reported the mine consisted of 800 acres of gold bearing gravel. In order to work the Victory Mine a dam was built across a canyon with a reservoir capable of holding millions of gallons of water.

The early 1850s brought placer mining to the South Umpqua near Canyonville and Riddle. The miners worked many different branches of Cow Creek. Coffee Creek, a tributary of the South Umpqua, was one of the most important mining areas. A minor rush occurred in the Steamboat area - east of Glide - in the 1870s.

In May of 1890 construction was begun on the "China Ditch." This ditch was to bring water from Little River to the Lower South Umpqua River area. The initial purpose was for use in hydraulic mining with future goals of floating logs and irrigating the local fruit orchards. In 1891, 200 Chinese laborers were hired, giving the ditch its name. About 18 miles of ditch were dug before the work was stopped in 1893 by a court order - employees had not been paid. The target destination of Little River was never reached (Tishendorf, 1981).

> <u>Mining techniques</u>
>
> Placer mining was commonly used to recover gold. Gravel deposits were washed away using water from ditches (often hand-dug) and side draws. The runoff was directed through flumes with riffles on the bottom. The gold settled out of the gravel and was collected by the riffles.
>
> Hydraulic mining was placer mining on a large scale. A nozzle or "giant" was used to direct huge amounts of water - under pressure - at a stream bank. The soil, gravel, and, hopefully, gold was washed away and captured downstream.

Gold mining affected the fish habitat of the streams and rivers. The drainage patterns were changed when miners diverted and redirected water flow. The removal of vegetation along the stream banks increased erosion and added sediment to the waterways. Salmon spawning grounds were destroyed when the gravels were washed away and the stream bottom was coated with mud. Placer and hydraulic mining may have created spawning areas by washing new gravels into the streams.

2.2.3. Mercury mining

The Bonanza and Nonpareil mines were located about eight miles east of Sutherlin. The Nonpareil mine was discovered in 1860 but was not developed until 1878. By 1880 the smelter was capable of handling 40 tons of ore per day. The Bonanza Mine had some early production in 1887 but the large-scale development did not occur until 1935. The Elkhead Mine, southeast of Yoncalla, began mercury mining and production around 1870.

2.2.4. Nickel mining

Sheepherders discovered nickel near Riddle on Old Piney (Nickel Mountain) in 1864 or 1865. Production was infrequent until 1882 when tunnels (some 320 feet long) and shafts were dug and a series of open cuts completed. Work slowed in the late 1890s and would not increase again until the late 1940s.

2.2.5. Agriculture

The early settlers brought livestock and plant seeds to use for food and for trade. Settler livestock included cattle, sheep, hogs, and horses. The early farmers sowed cereal crops of oats, wheat, corn, rye, and barley. Gristmills - used to grind the cereal crops into flour or feed - were first established in Douglas County in the 1850s and within 20 years almost every community in the county had one. Water was diverted from nearby streams and rivers to create power for the gristmills.

The early farmers reduced the indigenous food sources and changed the natural appearance of Douglas County. Hogs ate the acorns in the oak groves. The camas lilies were nipped by the livestock and diminished in number when the bottomlands were plowed to plant cereal crops. The deer and elk herds were decreased as the settler population increased. Indians were not allowed to burn the fields and hillsides in the fall because the settlers were concerned about their newly constructed log cabins and split rail fences.

2.2.6. Commercial fishing

The bountiful trout and salmon of the Umpqua were first sold commercially in the 1870s. William Rose caught trout and salmon at the confluence of the North and South Umpqua and sold them as far north as Portland. He caught the fish at night with nets and then shipped them out early the next morning. In 1877 the *Hera* – a boat with 100 Chinese workers and canning machinery – visited the lower Umpqua River. Local fishermen used gill nets stretched from the shore into the river to capture large numbers of fish as quickly as possible. Six-foot-long sturgeons were unwelcome captives. They were clubbed and thrown back in the river to rot on the shore. Yearly visits by the *Hera* and other cannery boats continued for three decades. Commercial fishing at a much smaller level occurred along the North Umpqua River. The fishermen constructed small dams and breakwaters. These obstructions created eddies and slow-moving water - ideal for capturing fish with gill nets.

2.2.7. Logging

The first wood product export was shipped from the Umpqua estuary in 1850. Trees were felled into the estuary, limbed, and loaded out for piling and spars on sailing ships. An additional market was found in San Francisco for piles for wharfing. The earliest sawmills in Douglas County appeared in the 1850s. The sawmills were water powered, often connected with a gristmill, and scattered throughout the county. Early sawmills were built on South Myrtle Creek, Pass Creek (north of Drain), the main Umpqua River (at Kellogg), Calapooya Creek, and in Canyonville. Dams were created to secure water to drive the mills.

<u>Splash dams</u>

Loggers created splash dams to transport logs to the mills. A dam was built across the stream creating a large reservoir. Logs were placed in the reservoir. The dam timbers were knocked out and the surge of water started the logs on their journey downstream

Log drives were used on many of the streams and rivers of Douglas County to deliver logs to the mill. The most common form of log drive included loading up the drainages with logs in the drier part of the year and then waiting for a winter freshet. When the rains came and the logs began to float, the “drive” would begin. Loggers would be positioned along the banks and at times would jump on and ride the logs. They used long poles to push and prod the logs downstream. Stubborn log jams would be blasted apart with dynamite. Log drives were often aided by the use of splash dams (see box). During these log drives, the stream channels were gouged, spawning gravels were removed or muddied, and fish passage may have been affected (Markers, 2000).

2.2.8. Transportation

Improvements in transportation were key to the economic development and population growth during this time period. The period began with limited transportation options into and through Douglas County. Ships came into the Umpqua estuary and delivered goods destined for the gold mines of California and the remainder of Douglas County. Goods moved from the estuary inland along the Scottsburg-Camp Stuart Wagon Road. Camp Stuart was a temporary military post occupied in 1851 in the Rogue River Valley. This route passed through Winchester and then into California following the Applegate Trail. Congress funded improvements to the Scottsburg-Camp Stuart Wagon Road and to the old Oregon-California Trail (Portland to Winchester) from 1853 through 1879. These road improvements led to the beginning of stage travel from Portland to Sacramento in 1860. The Oregon and California Stage Company began offering daily stages through Douglas County in July of 1860. A daily stage came through the Cow Creek area starting in 1862 (Chandler, 1981). The Coos Bay Wagon Road opened in 1873 allowing stage travel from Roseburg to Coos Bay.

Another form of transportation was attempted in 1870. A group of hopeful investors, *Merchants and Farmers Navigation Company*, financed a small sternwheel steamer, *Swan*, to navigate the Umpqua and South Umpqua Rivers from Gardiner to Roseburg. The voyage began February 10, 1870, and became a great social event as whole communities lined the riverbanks to watch the *Swan's* progress. Witness accounts recall the slowness of the trip upriver and the swiftness of the downriver journey. The *Swan* safely arrived in Roseburg with the captain, Nicholas Haun, very optimistic about vessel travel on the Umpqua. Captain Haun thought a minor clearing of the channel would allow a ship the size of the *Swan* to pass the rapids except in periods of very low water (Minter, 1967).

The U.S. Corps of Engineers surveyed the river and reported that it could be made navigable seven months of the year. Congress appropriated money for the removal of obstructions and W.B. Clarke was awarded the job. Reports are sketchy about how much channel modification was actually carried out. One witness remembered some blasting in the Umpqua River channel near Tyee. In February, 1871, the *Enterprise* began a maiden voyage upriver but, because of low water, only reached Sawyers Rapids - downstream of Elkton. The cargo was subsequently dumped at the rapids, and no further attempt was made to navigate the upper Umpqua (Minter, 1967).

River travel on the Umpqua was soon forgotten when the Oregon California Railroad reached Roseburg in 1872. Financial problems stalled the southerly extension of the railroad for 10 years. Those 10 years proved to be an economic boon for Roseburg. Travelers heading south took the train to Roseburg and then rode the stage into California. Travelers poured in and out of Roseburg creating a need for new hotels and warehouses and leading to rapid population growth. Finally, in 1887, the tracks were completed, extending the railroad into California.

2.3. Onset of the modern era: Early 1900s to the 1960s

2.3.1. Transportation

The first automobiles arrived in Oregon in 1899 and in Douglas County in the early 1900s. After 1910 automobile travel in western Oregon became a key motivation for road construction and improvements in Douglas County. One of the first major road construction projects in the state was the Pacific Highway (Highway 99) running from Portland to Sacramento and Los Angeles. Construction began in 1915 and by 1923 Oregon had a paved highway running the entire length of the state. In Douglas County the Pacific Highway passed through Drain, Yoncalla, Oakland, Sutherlin, Roseburg, Myrtle Creek, Canyonville, and Galesville for a total length of 97.7 miles.

Other major road construction projects completed before 1925 include routes between Roseburg and Coos Bay, Dixonville to Glide, Drain to Elkton, and Elkton to Reedsport. These roads were built to meet the expanding numbers of vehicles in the state. Registered vehicles in Oregon rose from 48,632 in 1917 to 193,000 in 1924. World War II slowed the road construction projects in the early 1940s but when the soldiers returned in 1945 road construction accelerated. The most important road-building project in the 1950s was Interstate Five (I-5), a four-lane, nonstop freeway, completed in 1966. I-5 was a windfall for cities along its path - Roseburg for example - but difficult for the bypassed cities of Yoncalla, Riddle, and Glendale.

2.3.2. Logging

Logging expanded in Douglas County in the early 1900s for two main reasons: the invention of the steam donkey engine and the use of logging railroads. The steam donkey engine was a power-driven spool with a rope or cable attached for yarding logs. It could be mounted on a log sled and yard itself, as well as logs, up and down extremely steep slopes. The logs were yarded with the steam donkey engine and then hauled to the sawmill on logging railroads. In Douglas County more than 150 miles of logging railroads were used between 1905 and 1947.

Gyppo loggers came into prevalence in the 1920s. These were loggers and mill owners with limited capital trying to break into the market. The term “gyppo” related to the real possibility that these loggers would “gyp” or not pay their workers. Many of the gyppos operated on the edge, cutting corners and costs whenever possible. Equipment breakdowns, fuel leaks, and accidents were common occurrences. The gyppo loggers searched for valuable logs, such as cedar, left after the initial logging.

1890s to the 1960s timeline

1900	Fish hatchery established near Glide
1903	Prunes major agricultural crop
1909	Flood
1923	Pacific Highway (Highway 99) completed
1927	Flood
1929	Northwest Turkey Show in Oakland (Douglas County ranked 6th in U.S. turkey production)
1936	Kenneth Ford establishes Roseburg Lumber Company
1945	Returning soldiers (WW II) create a housing - and timber - boom
1947 - 1956	Eight dams are built in the headwaters of the North Umpqua River as part of the North Umpqua Hydroelectric Project
1950	Flood
1953	Hanna Nickel production
1955	Flood
1962	Columbus Day Storm
1964	Flood
1966	Interstate Five completed

Splash dams and log drives were still used in Douglas County into the 1940s (Markers, 2000). Log drives were phased out as more roads were built into the woods. In 1957 log drives in Oregon were made illegal; sport fishermen led the campaign against this form of log transport (Beckham, 1990). Waterways used to transport logs were scoured to bedrock, widened, and channelized. The large woody debris was removed and fish holding pools lost. As more logging roads were built in the 1950s, fish habitat was affected. Landslides associated with logging roads added sediment to the waterways. Logging next to streams removed riparian vegetation and the possibilities for elevated summer water temperatures and stream bank erosion were increased. Fewer old growth conifers were available as a new wood source in many Douglas County streams (Oregon Department of Fish and Wildlife, 1995).

Following World War II larger sawmills with increased capacity began to operate - just in time to take advantage of the housing boom. Kenneth Ford established Roseburg Lumber Company in 1936 by taking over the operation of an existing sawmill in Roseburg. He built his own mill at Dillard in 1944.

2.3.3. Mercury mining

H.C. Wilmot purchased the Bonanza Mine, approximately eight miles east of Sutherlin, in 1935 and began extensive development. The demand for mercury (quicksilver) for war purposes (World War II) led to a surge in prices to more than $200 a flask.[12] Flasks were made of cast iron and resembled the size and shape of a fruit jar (Oberst, 1985). A vast new deposit discovered in 1939 together with the high mercury demand, resulted in a production of 5,733 flasks by 1940, second highest in the nation. Some of the mineshafts extended more than 1,000 feet deep (Libbey, 1951; Oberst, 1985).

As with many other natural resources, mercury production followed the prices received. Prices fell to $150 per flask in 1949 and then to $70 in 1950, causing the first shutdown since 1936. A price surge in

> Mining at the Bonanza Mine in 1955
>
> *The mine is well-equipped with modern automatic machinery. The trains of cars which bring the ore to the reduction plant, perched on the side of the hill, are powered with electric batteries.*
>
> *The reduction plant, in principle, is just one giant still. Ore from the mine is fed into a long, revolving kiln, where heat from an oil-fired furnace practically melts the small bits of ore. The mercury vaporizes and is carried into a battery of 24 3-story-high condensers.*
>
> *The mercury is recovered in rubber buckets at the base of the condensers. The buckets are kept beneath water as a safeguard against escaping mercury vapor which is extremely poisonous.*
>
> *Dust collects in the form of mud with the mercury. The final step in the recovery process is to allow the "mud" to dry on a sloping tray. Then, the mud is stirred and chopped with a garden hoe and the mercury trickles to a lower corner where it is collected and later stored in squat, 76-pound flasks* (Wyant, 1955, p. 1).

[12] A flask is 76 pounds of mercury.

the mid-1950s to $300 a flask reopened the mine. The Bonanza Mine had produced 39,488 flasks by 1960, its final year of operation (Libbey, 1951; Oberst, 1985; Wyant, 1955).

Other mercury mines were also active in the 1900s in Douglas County. The Elkhead Mine, southwest of Yoncalla, operated on and off into the 1960s. The Nonpareil Mine, next to the Bonanza Mine, was active from 1928 to 1932. The Tiller area had two mines, the Buena Vista and the Maud S, both active for short periods in the in the 1920s and 1930s. The Red Cloud Mine in upper Cow Creek was worked between 1908 and 1911 and then sporadically in the 1930s and 1940s.

The Oregon Department of Environmental Quality (DEQ) currently rates the Bonanza Mine as a high priority for further investigation and cleanup. High levels of mercury and arsenic have been found in the area of the old mine. Possibilities exist for movement of mercury into Foster Creek, which flows directly into Calapooya Creek. The site is a considerable risk to aquatic organisms in nearby drainages receiving runoff (Oregon Department of Environmental Quality, 2002).

2.3.4. Nickel mining / copper and zinc mining

M.A. Hanna Company obtained a lease in 1947 and contracted with U.S. government in 1953 to produce nickel. A tramway running almost to the top of Nickel Mountain was completed in 1954. By 1958, 21 million pounds of nickel had been produced. Production continued on Nickel Mountain into the 1990s.

The Formosa Mine is located about seven miles south of Riddle. This copper and zinc mine first opened in the early 1900s with the highest production occurring between 1927 and 1933. Formosa Explorations, Inc. reopened the mine in 1990 (Oregon Department of Environmental Quality, 2002).

2.3.5. Hatcheries

Douglas County's first fish hatchery was located northeast of Glide on the North Umpqua River near the mouth of Hatchery Creek. Built in 1900, the hatchery had an initial capacity for 1,000,000 eggs. In its first year of operations 200,000 salmon eggs were harvested. Another 600,000 chinook salmon eggs were brought in from a federal hatchery on Little White Salmon. These eggs produced approximately 700,000 fry that were released in the Umpqua river system. In 1901 a hatchery was constructed at the mouth of Steamboat Creek. A hatchery on Little Mill Creek at Scottsburg began operation in 1927 and operated for eight years (Bakken, 1970; Markers, 2000). The single remaining hatchery in Douglas County was established in 1937 northeast of Glide on Rock Creek.

In the 1910s large amounts of fish eggs were taken from the Umpqua river system. "In 1910 the State took four million chinook eggs from the Umpqua; the harvest mounted to seven million eggs in 1914. Over the next five years the State collected and shipped an estimated 24 million more eggs to hatcheries on other river systems" (Beckham, 1986, p. 208). The early hatcheries were focused on increasing salmon production for harvest.

"Hatcheries have been essential in maintaining supplies of salmon, whose natural spawning grounds and migration routes have been severely disrupted in many areas by dams, agricultural reclamation and irrigation, and by timber operations" (Patton, 1976, p. 168). In recent years the effect of hatchery fish on the natural fish population has been examined. Flagg et al. (2000) concluded that salmonids raised in an artificial hatchery environment do not respond the same as fish reared in a natural setting. However, they also felt current information was not sufficient to make concrete conclusions about how hatchery fish affect the survival of wild fish.

2.3.6. Agriculture

Crop irrigation was introduced to Douglas County farmers in 1928. J.C. Leady, Douglas County Agent (predecessor of County Extension Agent) gave a demonstration of ditch blasting in 1928. In the demonstration one ditch in Melrose and one ditch in Smith River was created by blasting. The dimension of the resulting ditch was four feet deep by six feet wide. The report recommended this method of ditch creation in the low lands adjoining the Umpqua and Smith Rivers (Leedy, 1929).

In 1935 Douglas County Agent J. Roland Parker introduced crop irrigation using gas and electric pumps. "The lift necessary to place irrigation water upon most land, laying along the numerous streams throughout the county, ranges from 15 to 30 feet. Only in exceptional cases will a higher lift be necessary" (Parker, 1936, p.15). Parker predicted the applications for water rights and the installation of irrigation systems would double in 1936. In his 1935 Annual Report, Parker listed 21 farms and their proposed irrigation projects. The water sources included the South Umpqua River, Calapooya Creek, Little River, North Umpqua River, Tenmile Creek, Myrtle Creek, Hubbard Creek, and Cow Creek (Parker, 1936).

The appropriation of water rights for agriculture left less water in the streams for fish, especially in the critical late months of summer. In Oregon water law follows the "prior appropriation" doctrine that is often described as "first come, first served." The first person to obtain a water right on a stream will be the last user shut off when the streamflows are low. Junior users have water rights obtained at a later date than higher priority users. In periods of low water, the water right holder with the oldest priority date is entitled to the water specified in the senior water right regardless of the needs of junior users.[13]

2.4. Modern era: 1970s to the present

2.4.1. Logging

In 1972 the Oregon Forest Practices Act became effective. Standards were set for road construction and maintenance, reforestation, and streamside buffer strips. New rules were added in 1974 to prevent soil, silt, and petroleum products from entering streams. Starting in 1978, forest operators were required to give a 15-day notification prior to a

[13] The water rights information was obtained on January 7, 2003, from the Oregon Water Resources Department website http://www.wrd.state.or.us/.

forest operation. New rules were also added relating to stream channel changes. In 1987 riparian protection was increased - specific numbers and sizes of trees to be left in the riparian areas were specified. New rules in 1994 were added to create the desired future condition of mature streamside stands. Landowner incentives were provided for stream enhancement and for hardwood conversion to conifer along certain streams (Oregon Department of Forestry, 2002).

In the 1970s, Roseburg Lumber's plant in Dillard became the world's largest wood products manufacturing facility. Key to the development of this facility was the availability of federal timber from both the U.S. Forest Service and the Bureau of Land Management. A housing slump in the early 1980s and a decline in federal timber in the 1990s resulted in the closure or reduced the size of many other manufacturing companies in the 1980s and 1990s (Oregon Labor Market Information System, 2002). In 2002 and 2003, increased wood products imports from foreign producers such as Canada and New Zealand resulted in a surplus of timber-based products in the US. This caused a depression in the local forest products manufacturing industry. In April, 2003, Roseburg Forest Products, the largest private employer in Douglas County, laid off approximately 400 workers.[14]

<u>1970 to the present timeline</u>

1971	Flood
1972	Clean Water Act
1972	Oregon Forest Practices Act
1973	Endangered Species Act
1974, 1981, 1983	Floods
1987	Hanna nickel mine in Riddle closed
1988	Glenbrook Nickel in Riddle begins production
1994	Northwest Forest Plan results in reduced federal log supplies
1996	Flood
1998	Glenbrook Nickel in Riddle closed
1999	International Paper Mill in Gardiner closed

2.4.2. Mining

The M.A. Hanna Company permanently closed the mine and smelter on Nickel Mountain (near Riddle) in January, 1987. Nickel prices had fallen to below $2 per pound. By March of 1988 average prices rose to between $5 and $6 per pound allowing Glenbrook Nickel to start production. Glenbrook Nickel closed in April, 1998. The M. A. Hanna Company followed by Glenbrook Nickel diligently strived to reclaim Nickel Mountain and to maintain good water quality from the discharge points. Walter Matschkowsky of Glenbrook Nickel Company was named Reclamationist of the Year in 1998 for his career of responsible mining and reclamation. He supervised the Thompson Creek Reclamation project and was successful in converting an area affected by mining into a green, healthy forest (Oregon Department of Geology and Mineral Industries, 2002).

[14] This information is based on conversations between Nancy Geyer, Society of American Foresters president and president-elect Jake Gibbs and Eric Geyer, and Dick Beeby of Roseburg Forest Products.

Formosa Explorations Inc. was not as successful in reclamation efforts in the mine south of Riddle. Formosa reopened the Silver Butte Mine in 1990 and produced copper and zinc ore until 1993. Formosa closed the mine in 1994, completed reclamation activities, and filed for bankruptcy. In the winter of 1995-96, acidic wastes were detected in Middle Creek and the South Fork of Middle Creek. Middle Creek is a tributary of Cow Creek. Bureau of Land Management fish surveys in the Middle Creek watershed in 1984 indicated the presence of coho salmon and steelhead. These fish have not been observed in upper Middle Creek for several years. The Oregon Department of Environmental Quality and the Bureau of Land Management are working together to clean up the site (Oregon Department of Environmental Quality, 2002).

2.4.3. Dam construction

During the late 1960s through 1980s several dams were constructed in Douglas County. The largest ones are included in Table 2-1 obtained from the Oregon Water Resources Department.

Year completed	Dam name	Creek	Storage (acre feet)
1967	Plat I Dam	Sutherlin	870
1971	Cooper Creek Dam	Cooper	3,900
1980	Berry Creek Dam	Berry	11,250
1985	Galesville Dam	Cow	42,225

Table 2-1: Name, location, and storage capacity of Umpqua Basin dams built since 1960.

Dams have both beneficial and detrimental influences on fish. Water release during periods of low flow in the late summer can assist fish survival. However, Galesville Dam and Berry Creek Dam are complete barriers to fish movement. Cooper Creek Dam and Plat I Dam may be barriers to juvenile fish (see section 3.1.2).

2.4.4. Tourism

The rapid expansion of tourism in Douglas County came after World War II. The improving economy left Americans with an increased standard of living and the mobility of automobile travel. The Umpqua Valley offers scenic attractions and good access roads. Interstate Five and the connecting State Highways 38, 42, and 138, provide access to Umpqua Valley's excellent tourist areas. Tourist destination points include Crater Lake National Park, Wildlife Safari, Salmon Harbor, and the Oregon Dunes National Recreation Area. Tourism is a growing industry in Douglas County.

2.4.5. Settlement patterns and urbanization

Unlike many other Oregon counties, over 50 percent of Douglas County residents lived outside incorporated cities in 1980. The settlement pattern was mostly linear. Population density in 1980 was greatest in the central valley from Riddle to Roseburg to Sutherlin and lowest in the eastern and northwestern areas of the county (Cubic, 1987).

The population of Douglas County in 2000 was 100,399, which is an increase of almost 32,000 since 1960 (see Figure 2-1). Major urban areas have developed along the South Umpqua River to the confluence with the North Umpqua River and around the Umpqua estuary. Water quality along these streams gained protection with the passage of the Clean Water Act in 1972. The Clean Water Act established pollution discharge levels on point sources such as sewage treatment and wood processing plants.

2.5. Douglas County population growth

Figure 2-1 shows population growth data for Douglas County during the settlement period (1840s-1890s), the onset of the modern era (1900-1960s), and the modern era (1970s-present).

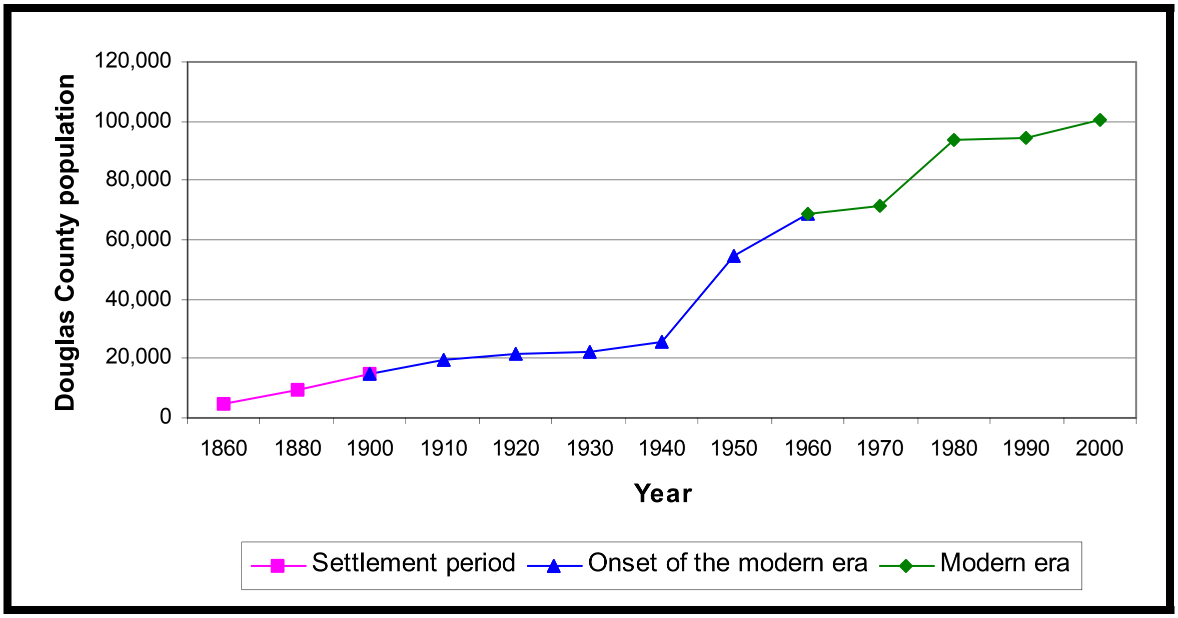


Figure 2-1: Population growth in Douglas County from 1860 through 2000.

2.6. History of the West Fork Cow Creek Watershed

2.6.1. Cow Creek Valley historical timeline

This section includes significant historical events that most likely had an impact on the Cow Creek Valley, including the West Fork Cow Creek Watershed. Background information for this section was compiled from the following groups' documents, websites, and specialists: the USDI Bureau of Land Management (BLM), Douglas County, the Oregon Department of Environmental Quality, the Oregon Department of Fish and Wildlife (ODFW), the Oregon Water Resources Department, the Secretary of State, and the USDA Forest Service (USFS). Additional information was compiled from the following books: *Land of the Umpqua: A History of Douglas County, Oregon* (Beckham, 1986); *History of Southern Oregon* (Walling, 1884); *Cow Creek Valley* (Chandler, 1981); *and Cow Creek Valley Memories* (Cornutt, 1971).

Date	Event
1820-1840	Hudson's Bay Company fur trappers and other explorers penetrated the interior of southwestern Oregon. Trappers were instructed to "trap out" beaver in the remote streams of southwest Oregon.
1828	Sponsored by the Hudson's Bay Company, Alexander McLeod and his party passed through Cow Creek Valley on their way to California to hunt and trap.
1837	Ewing Young and his entourage led the first cattle drive through Cow Creek Valley on his way to the Willamette Valley from California with seven hundred head of cattle.
1846	Lindsay Applegate along with others surveyed for a new emigrant trail through Canyon Creek into the Willamette Valley from the south.
1849-1855	Initial period of settlement in the Cow Creek Valley.
1850	The Donation Land Claim Act passed, attracting more settlers to the area.
1851	William H. and Maximilla Riddle selected a land claim site about two miles from the present-day town of Riddle.
1852	The gold rush moved into Oregon. Herman and Charles Reinhart found placer gold near their land claim in the region of Canyonville and Riddle, which attracted gold miners to the Cow Creek area.
1852-53	A fever affected Cow Creek Indians and an estimated one-half to two-thirds of the Indians died within a couple of weeks. Contact and tension between miners and Indians increased, creating conflict and wars with Indians.
1855	Almost all open lands of the Cow Creek Valley were claimed.
1856	The government removed over 2,000 Indians from southwestern Oregon.

1862	A stagecoach began daily service in the Cow Creek Valley. Twenty years later two stages a day traveled through Cow Creek.
1864	Nickel deposits were first discovered on Nickel Mountain (also known as Old Piney).
1866	Oregon and California Land Grant Act was established to finance railroad construction.
1880-1890s	Prune trees were planted on thousands of acres throughout Cow Creek and the Umpqua Valley.
1882	The Oregon and California (O&C) Railroad reached Riddle and was temporarily terminated before resuming construction to the south. This provided a new means of transportation and commerce to the north for Riddle and other communities such as Canyonville, Perdue (Milo), Days Creek, Tiller, and Drew.
1882	"Riddles" post office was established with James Johnson as postmaster. Post office was renamed to Riddle in 1910.
1887	The railroad was completed in California after diverting around Canyon Creek and following Cow Creek south to Glendale. This opened access for commerce to southern Oregon and California.
1893	The town of Riddle was incorporated.
1897	A lumber mill at Doe Creek produced railroad ties and fuel. Judge Riddle operated the mill. A store and post office were established on site.
1899	At Union Creek, Frank Cain's flume for his gold placer mine clogged with logs and debris after a heavy rain, spilling over onto the train track. A southbound train hit the debris, derailed and rolled into Cow Creek. Note: see another derailment in this area 100 years later.
1900s	Fire suppression efforts began in earnest.
1901	Canyonville and Glendale were incorporated in 1901.

1906	Small-scale mills including Dunbar and Ross, and Sto-man began operations in Riddle. Dunbar and Ross produced 600,000 board feet and 160,000 shingles annually.
1910	Silver Butte Mine was established on Silver Butte and commercially mined for copper, gold, and silver until 1936.
1916	The Chamberlain-Ferris Act of 1916 revested to the federal government 2.3 million O&C acres with an estimated 50 billion board feet of timber. Land was administered by the General Land Office and later the Bureau of Land Management.[15]
1920s	The Pacific Highway (Highway 99) paved road bypassed Riddle and was routed through Canyonville to Galesville.
1930s	Prune production declined and was replaced with sheep and cattle grazing.
1940	A large fire burned in the Panther Creek drainage of West Fork Cow Creek.
1944	The Sustained-Yield Management Act of 1944 provided the momentum in shifting the role of the USFS from caretaker to administering the sale of timber.
1948-1953	Hanna Nickel Company constructed a nickel smelter and tramways for the processing of ore.
1950s	Interstate Five was constructed through the South Umpqua Valley and for the most part paralleled Highway 99. This major thoroughfare bypassed Riddle and Glendale.
1950	Cow Creek flooded near Riddle, cresting at 28.5 feet.[16]

[15] According to the Oregon State University Forest Sciences Laboratory (1998): "The Oregon and California Railroad Act of 1866 provided for 3,700,000 acres in Oregon in alternate sections to go to the builder of a railroad line down the Willamette Valley to California (12,800 acres for each mile of track laid)…. The land grant was made on condition that the company sell the land in small tracts (no more than 160 acres each) to bonafide settlers, at a price of no more than $2.50 per acre….[The] railroad had deferred the taking of title to unsold grant lands until there was a market for the property, thus avoiding taxes. This kept those lands unavailable for acquisition by anyone else. On the request of the Oregon legislature, the federal government investigated and discovered that the terms of the O&C land grant had been violated. Litigated before the Supreme Court in 1915, the remaining unsold O&C grant lands, over 2,800,000 acres, were revested by Congress to the United States in 1916."

[16] Flood stage is 22.0 feet. Data have been recorded since 1950.

1950s-1960s	Timber harvesting, construction of access roads and rock quarries became major influences on the Cow Creek landscape.
1955	Cow Creek flooded near Riddle, cresting at 27.35 feet.
1958-1967	The Cow Creek road was asphalted and Council Creek and Middle Creek roads were built.
1962	A Columbus Day storm with hurricane-force winds impacted the Walker Creek drainage, causing extensive windthrow. Subsequently, a large-scale timber salvage took place in this drainage in the West Fork Cow Creek Watershed.
1964	Cow Creek flooded near Riddle, cresting at 27.67 feet.
1971	Cow Creek flooded near Riddle, cresting at 25.01 feet.
1974	Cow Creek flooded near Riddle, cresting at 28.17 feet.
1981	Cow Creek flooded near Riddle, cresting at 24.42 feet.
1983	Cow Creek flooded near Riddle, cresting at 26.79 feet.
1985	Galesville Reservoir was completed to provide current and future water storage for municipal, industrial, irrigation and fisheries water needs for southern Douglas County.
1987	Buck Creek Fire was started by lightning and burned approximately 1,486 acres in the lower Middle Creek drainage of the Lower Cow Creek Watershed.
1988	The shift in management emphasis on federal land from timber production to protecting habitat for endangered species resulted in the beginning of a steady decline in timber harvest on federal forestland.
1989	Glenbrook Nickel Company purchased the Hanna Mine and operated it intermittently from 1991 to 1998.
1990	Formosa Exploration, Inc. received an operating permit for the Silver Butte Mine (also referred to as Formosa Mine) from the Oregon Department of Geology and Mineral Industries (DOGAMI) to mine gold, silver, copper, and zinc. The mine produced 350 to 400 tons of copper and zinc ore per day.

1993	Formosa Exploration, Inc. received a Closure Order from DOGAMI and a Notice of Noncompliance from Oregon Department of Environmental Quality (ODEQ). Production at the Silver Butte Mine ceased.
1995	An acid mine drainage control system installed at Silver Butte Mine failed and began to discharge acidic and metal-laden water into Middle Creek.
1997	Formosa Explorations, Inc. declared bankruptcy.
1999	A train carrying a cargo of urea fertilizer derailed near Union Creek and spilled into Cow Creek.
2000s	Approximately 40,000 cubic yards of soil contaminated with metals and petroleum hydrocarbons were removed from the Glenbrook Nickel site and disposed at the Valley Landfill in Corvallis, Oregon.
2000-2003	ODEQ lists the Silver Butte Mine under the Oregon Orphan Site program. ODEQ and the BLM begin developing a remediation plan for the site.

2.6.2. Cow Creek Valley population

Riddle and Glendale are the primary town developments within the Cow Creek Valley. The town of Canyonville is found in the adjacent South Umpqua River Watershed. The historical events and close proximity of these three towns to one another often impacted each community. Figure 2-2 shows the population growth of these three cities since 1880.

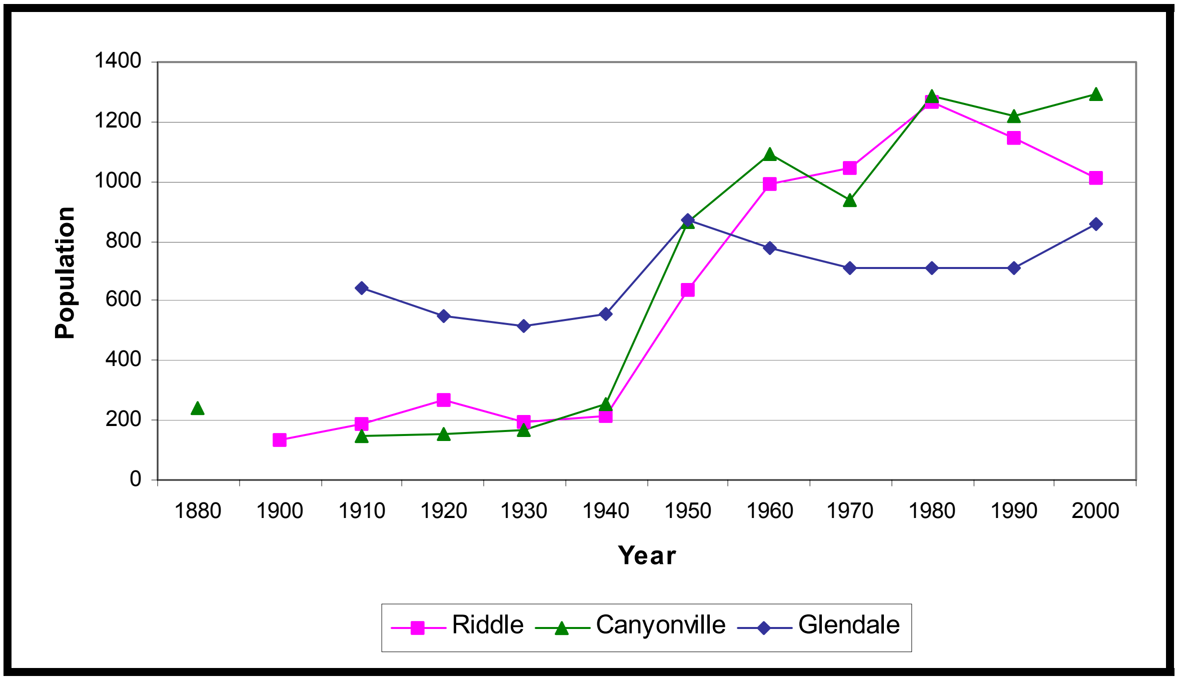


Figure 2-2: Population growth for Riddle, Canyonville, and Glendale from 1880 through 2000.[17]

Many towns and rural communities evolved and faded as a lifestyle of subsistence grew to one of commerce. The towns provided goods and services for the demands of settlers, miners, loggers, and the labor force to construct railroads and roads. Often the placement of the railroad, stagecoach corridors, and highways "made" or "broke" a town and its entrepreneurs. The railroad through Riddle boosted its growth and later attracted lumber mills. However, the Pacific Highway and Interstate Five bypassed Riddle and instead Canyonville became the "visible" town. It continues to be a "gasoline stop" today.

The increase in population growth between the 1940s and 1950s in these towns is attributed to the booming logging industry and the associated sawmills and plywood mills as well as the development of mining on Nickel Mountain. It has been suggested by local residents that the decline in the 1960s was related to the consolidation of some forest product mills and abandonment of several communes in the area. The shift in management emphasis on federal land from timber production to protecting habitat for endangered species resulted in the beginning of a steady decline in timber harvest on federal forestland. The impact from this shift affected the two communities and is probably reflected in the downward trend in population. The author was unable to find an apparent explanation for the population decline in Riddle from 1920 through 1930.

[17] The information in Figure 2-2 is extracted from the *Cultural Resource Overview* and the *Oregon Blue Book* [website].

2.6.3. Historical fish use

The information in this section is primarily compiled from historical files from the ODFW field office in Roseburg, *Fish and Wildlife Resources of the Umpqua Basin, Oregon, and Their Water Requirements* (Lauman et al., 1972) and resources from the following groups' documents, websites, and specialists: the USDI Bureau of Land Management and the USDA Forest Service.

There is little standardized data on historical fish use of the streams in the Cow Creek Valley watersheds. The purpose of the data provided in this section is to show a historical "snapshot" in time of fish species presence and use of various streams in the watershed. It is not intended for comparative analysis. References to previous management activities and observations from biologists are included.

The Cow Creek Valley is located within the South Umpqua River sub-basin with all streams of the watershed draining into the South Umpqua River. In 1937 the Umpqua National Forest surveyed portions of the South Umpqua River sub-basin for fish use. An abundance of salmon, steelhead, and cutthroat trout were found throughout the South Umpqua River and its tributaries.

From 1880 to 1946, there was a dam on the South Umpqua River in the vicinity of the current Douglas County Fairgrounds. The dam was considered a major barrier for anadromous fish at low water conditions and a partial barrier even after modifications were made to the dam. In 1946, the Oregon Game Commission (the precursor to the Oregon Department of Fish and Wildlife) recommended that the Umpqua River and its tributaries be closed for spring chinook salmon fishing for five years and fishing be curtailed for coho due to significant declining catch rates.

Prior to the 1960s, fish runs in the South Umpqua River sub-basin were estimated to be as high as 30,000 winter steelhead, 5,000 spring chinook, and 70,000 coho. In 1972, the Oregon State Game Commission estimated that 10,000 sea-run cutthroat, 10,000 winter steelhead, 4,000 coho, and 1,500 fall chinook used the South Umpqua River (Table 2-2). These anadromous fish used an estimated 39 tributaries to the South Umpqua at that time. In addition to the South Umpqua River estimates, 1,000 sea-run cutthroat, 4,050 winter steelhead, 1,450 coho and 300 fall chinook are estimated to have used the Cow Creek and its tributaries.

Non-game fish such as squawfish, suckers, redside shiners, dace, and cottids are often referred to as "rough" fish. These fish readily inhabit the Umpqua Basin streams. In 1969, a rehabilitation effort was made to reduce the numbers of rough fish that were thought to be competing with salmonids by performing a rotenone treatment in Cow Creek. Table 2-3 provides an indication of the types and numbers of fish found in Cow Creek before treatment.

Stream system	Chinook		Coho	Steelhead		Sea-run
	Spring	Fall		Winter	Summer	Cutthroat
S. Umpqua River (total)	600	1,500	4,000	10,000	-	10,000
Myrtle Creek	-	-	750	1,000	-	1,500
Lookingglass Creek	-	-	300	600	-	800
Cow Creek	-	300	1,450	4,050	-	1,000

Table 2-2: Estimated number of adult anadromous salmonids spawning in Umpqua Basin river systems in 1972.[18]

Station (rm=river mile)	Number of fish collected by species								
	Sq	Su	ReS	D	Cot	St	ChF	Co	Ct
Cow Ck rm 2.0	11	-	188	25	3	-	-	-	-
Cow Ck rm 27	17	23	29	17	4	1	-	-	-
Cow Ck rm 43	18	8	172	41	6	8	-	-	1
Cow Ck rm 55	7	17	96	11	5	7	-	-	-
Cow Ck rm 71	-	14	-	58	17	3	-	1	-
W. Fork Cow rm 3.0	7	-	50	40	7	2	-	-	-
W. Fork Cow rm 15	-	7	-	23	24	35	4	28	-
Middle Ck rm 1.0	5	12	103	137	23	17	-	3	-
Middle Ck rm 6	12	21	31	44	5	12	3	9	8
Windy Ck rm 3.0	-	-	2	13	25	7	-	28	5
Quines Ck rm 1.0	-	-	-	18	27	30	-	18	13
Whitehorse Ck rm 1.0	-	-	8	50	17	26	-	24	14

Table 2-3: Results of fish collections by electroshocking in 100 foot sections of Cow Creek and tributaries, July 1969.[19]

Figure 2-3 displays the percent occurrence of salmonids versus rough fish over the nine years after treatment. There appears to be an initial benefit to the salmonids in the first several years after treatment but a steady decline thereafter. The seventh year after treatment (1977) was a drought year.

[18] Estimates include hatchery contributions. These data were extracted from *Fish and Wildlife Resources of the Umpqua Basin, Oregon, and Their Water Requirements* by Jim E. Lauman et al. of the Oregon State Game Commission (1972).
[19] Sq=squawfish, Su=suckers, ReS=redside shiners, D=dace, Cot=cottids, St=steelhead, ChF=fall chinook, Co=coho, Ct=cutthroat. Data are from ODFW files, Roseburg District, Eighth progress report, July 20-August 19, 1979.

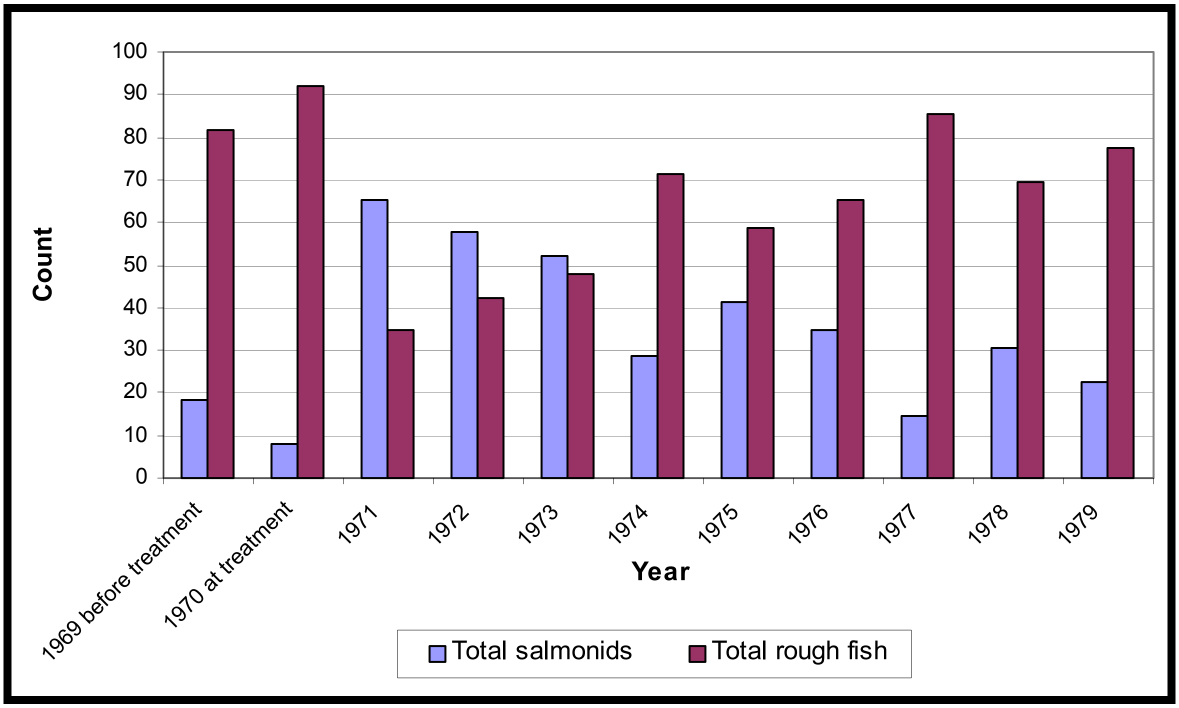


Figure 2-3: Percent occurrence of salmonids vs. rough fish in Cow Creek and tributaries, pre- and post-treatment with rotenone.

In 1977, Jerry Bauer with ODFW conducted a stream habitat inventory. It was unlikely that all of the streams were walked, but estimates of fish were made with biologist expertise and local knowledge of other streams with similar habitat structures. Of special interest were the following comments found on file.

- *South Umpqua River at 0-50 miles between confluence with N. Umpqua and Canyonville. Polluted by sewage-industrial effluents, lack of water, high temperatures etc. Stream bank habitat lost to road and railroad rights-of-ways, pasture development and gravel removal operations. Over 1/2 of streambed is silted in because of poor land use practices in headwaters and tributaries in earlier years.*

- *Panther Creek: The log jams number at least 8 in the lower 2 miles. Some are passable but all are obstacles and take up spawning area.*

- *Darby Creek: Five log jams within 3/4 miles of mouth should be removed to improve fish passage.*

- *Applegate Creek: Prime spawning and rearing area is in need of habitat protection. Estimate 20 Coho and 20 Winter Steelhead in stream.*

- *<u>West Fork Cow Creek</u>: Log jams 1/4 mile up (impassable) 15 feet high and 40 feet long, 200 yards above this another huge jam approximately 100 yd long. Fish present are Silver salmon=below jam, Steelhead = below jam, Cutthroat = above first jam. Watershed cover types = logged area w/no shade. Comments = blasting caps and wire found in pool below 1st impassable jam. This jam could be removed cheaply but the one 200 yards (log jam) is quite extensive. Likely only a mile of available stream for spawning above these jams.*

In 1980, additional electroshocking was conducted by ODFW at 13 representative sites above and below the then-proposed Galesville Dam.[20] Results from the samples above the proposed dam are displayed in Figure 2-4. Data from below the dam can be found in Figure 2-5. Coho were observed in the tributaries but not in the mainstream of Cow Creek. Steelhead were found in all upper reaches of the tributaries sampled. The 42,225 acre-feet Galesville Reservoir was completed in 1985.

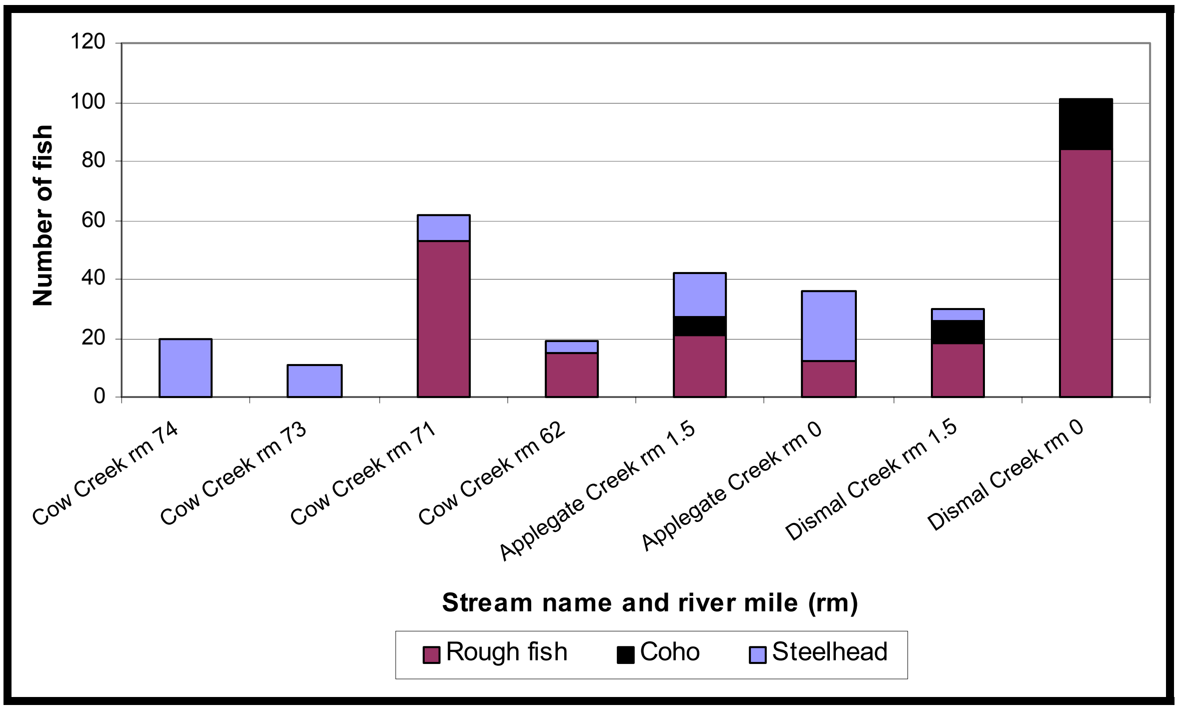


Figure 2-4: Number of electroshocked fish per 200 feet of stream, above Galesville Dam, 1980.[21]

[20] Galesville Dam is at river mile 60.
[21] Data are from ODFW files, Roseburg District, Ninth Monthly Report, Aug 20-Sep 19, 1980.

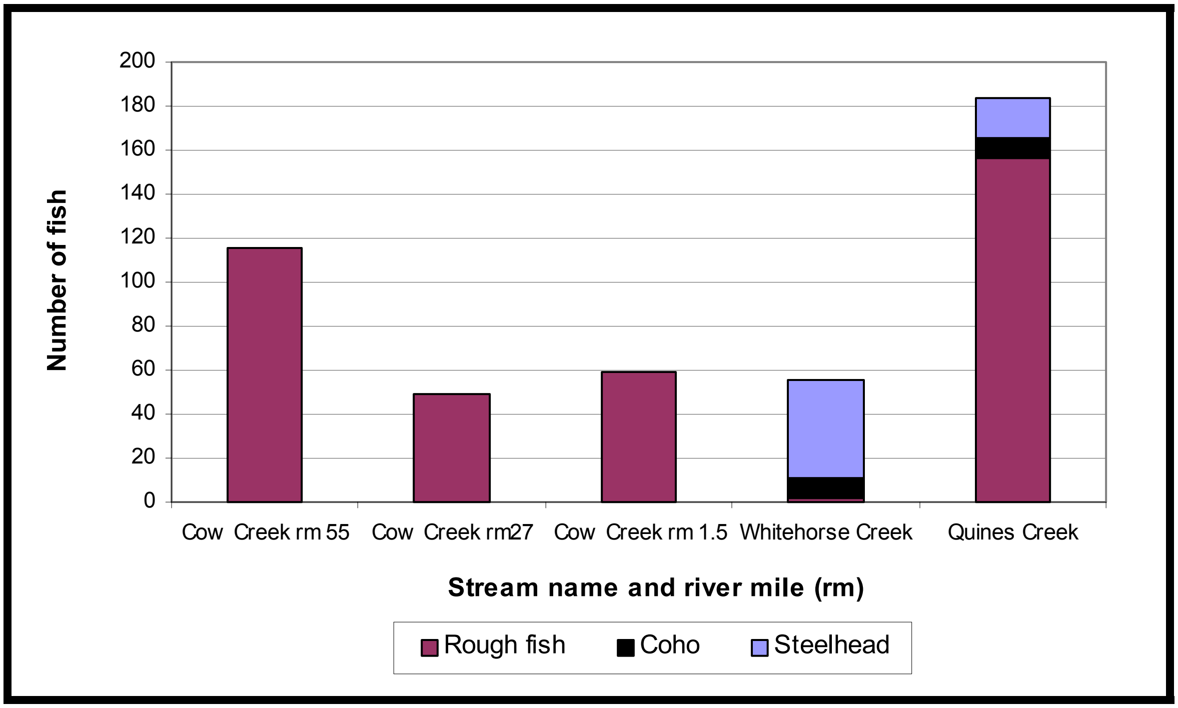
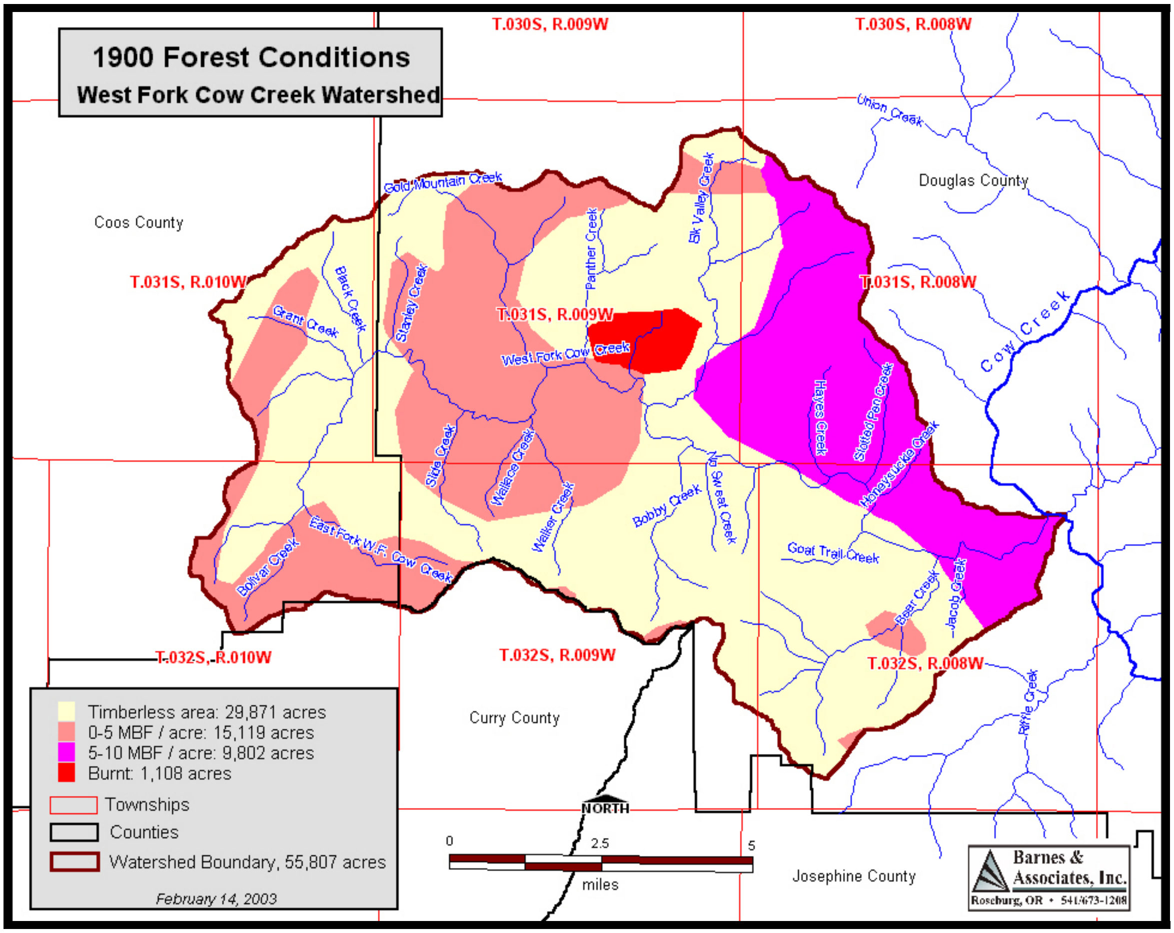


Figure 2-5: Number of electroshocked fish per 200 feet of stream, below Galesville Dam, 1980.

2.6.4. 1900 forest conditions

Error! Reference source not found. provides an indication of the forest cover at the turn of the century.[22] Over half of the West Fork Cow Creek Watershed was identified as timberless. Timberless would have included grasslands, grazed land, cultivated and homestead areas. Only 45% of the watershed was considered in merchantable timber, of which 61% was categorized as having less than five thousand board feet per acre and the remainder was categorized as five to 10 thousand board feet per acre.

[22] The information for the map was gathered by Henry Gannet from 1898 through 1902. The map was compiled by A.J. Johnson and produced by Gilbert Thompson in 1902. The BLM enlarged the map and then digitized it in 1995.



Map 2-1: 1900 vegetation patterns for the West Fork Cow Creek Watershed.

The five to 10 thousand board feet per acre category were located primarily in the areas of Union Creek, Darby Creek, and the northeastern slopes of Hayes Ridge. Herman Reinhart, a gold miner who arrived in the region in 1851, made reference to the trees as the finest yellow and red cedar he had ever seen, with logs thirty to fifty feet without a limb.

Historically, fire has played an important role in the West Fork Cow Creek Watershed. Large stand replacement fires caused by lightning and humans created a mosaic of age classes, even before any extensive logging began. Effective fire suppression began in the early 1900s and altered the fire regime compared to historical time. For example, fire suppression has most likely reduced the frequency of large fires. Prescribed burning practices today target specific areas such as post-logging slash cleanup and fuels reduction under standing timber and are controlled at delineated boundaries relative to the more general burning of pre-settlement times.

The 1916 revestment surveys document the occurrence of major burns in the watershed. BLM personnel have interpreted a pronounced mosaic of burned and unburned stands from 1953 aerial photographs. There was a large fire in the Panther Creek area in the

1940s. The 1900 Forest Conditions map for West Fork Cow Creek Watershed designates another burned area in the Panther Creek area of approximately 1,100 acres in size.

Early settlers into Cow Creek Valley indicated that the valley bottoms needed minimal clearing. This was most likely due to cultural practices of the indigenous people who annually burned the valleys during the summer and fall months. Some even described the valley as a giant wheat field, as in this narrative by George Riddle:

> It was near the first of November 1851 that we settled upon the land now known as Glenbrook Farms. At that time cow creek valley looked like a great wheat field. The Indians, according to their custom, had burned the grass during the summer, and early rains had caused a luxuriant crop of grass on which our immigrant cattle were fat by Christmas time… fortunately in our case the land was ready for the plow. There was no grubbing to do.

Bob Zybach, a forester and former owner of a logging business, in a 1994 interview with *Evergreen Magazine* states,

> We also have accounts describing the interior valleys, including the… Umpqua…Here the Indians burned hundred of thousand of acres annually, and the result was a nearly contiguous series of great prairies and oak savannas extending almost the entire length of the Cascade Mountains… I am not a proponent of the idea that fires came and went in cycles. Keep in mind that cultural fire was a daily occurrence in this region for thousands of years. Indians cooked on these fires, and they warmed themselves with fire. They also burned seasonally, in the spring and fall, to clear away trees and underbrush and to stimulate the growth of wildlife forage. It is reasonable to assume many of the catastrophic forest fires for which we find evidence were probably set by Indians intent on clearing land, controlling the spread of Douglas-fir, and creating habitat for wildlife.

2.7. Historical references

Allen, S; Buckley, A. R., and Mecham, J. E. Atlas of Oregon. Eugene, Oregon: University of Oregon Press; 2001.

Bakken, L.J. Lone Rock Free State. Myrtle Creek, Oregon: The Mail Printers; 1970.

Beckham, D. Swift flows the river: Log Driving in Oregon. Coos Bay, Oregon: Arago Books; 1990.

Beckham, S.D. Land of the Umpqua: A History of Douglas County, Oregon. Roseburg, Oregon: Douglas County Commissioners; 1986.

Cantwell, R. The Hidden Northwest. New York, New York: J.B. Lippincott Company; 1972.

Chandler, S.L. Cow Creek Valley: From Mi-wa-leta to New Odessa. Drain, Oregon: The Drain Enterprise; 1981.

Chenoweth, J.V. Douglas County's Golden Age. Oakland, Oregon: Oakland Printing Company; 1972.

Cornutt, John M. Cow Creek Valley Memories. Eugene, Oregon: Industrial Publishing Company; 1971

Cubic, K.L. A Place Called Douglas County. Roseburg, Oregon: Douglas County Planning Department; 1987.

Cubic, K.L. Historic Gold Mining in Douglas County, Oregon. Roseburg, Oregon: Douglas County Planning Department.

Douglas County Oregon. Flood Crest History [Website]. Accessed February 18, 2003. Available at: http://www.co.douglas.or.us/flood_crest.asp.

Flagg T.A., Berejikian, B.A., Colt, J.E., Dickhoff, W.W., Harrell, L.W., D.J. Maynard, Nash, C.E., Strom, M.S., Iwamoto, R.N., & Mahnken, C.V.W. Ecological and Behavioral Impacts of Artificial Production Strategies on the Abundance of Wild Salmon Populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC- 41; 2000.

Lauman, J.E., K.E. Thompson, and J.D. Fortune, Jr. Fish and Wildlife Resources of the Umpqua Basin, Oregon, and Their Water Requirements. Portland, Oregon: Oregon State Game Commission; 1972.

Lavender, D. (Ed). The Oregon Journals of David Douglas – During the Years 1825, 1826, & 1827. Ashland, Oregon: The Oregon Book Society; 1972.

Leedy, J.C. 1928 Annual Report - Douglas County. Corvallis, Oregon: Oregon State Agricultural College; 1929.

Libbey, F.W. Geology and Mineral Resources of Douglas County, Oregon. The Ore. – Bin, 13:2, 9-13; 1951.

Markers, A.G. Footsteps on the Umpqua. Lebanon, Oregon: Dalton Press; 2000.

Minter, H.A. Umpqua Valley Oregon and Its Pioneers: The History of a River and Its People. Portland, Oregon: Binfords & Mort, Publishers; 1967.

Oberst, G. For Sale: Quicksilver Mine. The News Review, January 13, 1985, pp. c1,c2.

Oregon Department of Environmental Quality. Formosa mine: Project status report. Accessed November 14, 2002. Available at: http://www.deq.state.or.us.

Oregon Department of Environmental Quality. Land Quality [Website]. Accessed March 10, 2003. Available at: http://www.deq.state.or.us/news/publicnotices/uploaded/021115_2831_glenbrooksecpn.pdf.

Oregon Department of Environmental Quality. Land Quality [Website]. Accessed March 10, 2003. Available at: http://www.deq.state.or.us/wmc/cleanup/sbm-qsr.htm.

Oregon Department of Fish and Wildlife. 1995 Biennial Report in the Status of Wild Fish in Oregon. Accessed November 7, 2002. Available at: http://www.dfw.state.or.us.

Oregon Department of Forestry. A Brief History of the Oregon Forest Practices Act. Accessed November 13, 2002. Available at: http://www.odf.state.or.us/.

Oregon Department of Geology and Mineral Industries. Recognizing Environmentally Conscious Miners. Accessed November 14, 2002. Available at: http://sarvis.dogami.state.or.us/.

Oregon Labor Market Information System. The Lumber and Wood Products Industry: Recent Trends. Accessed November 13, 2002. Available at: http://www.qualityinfo.org/olmisj/OlmisZine.

Oregon Secretary of State. Oregon Blue Book City Populations [Website]. Accessed February 24, 2003. Available at: http://www.sos.state.or.us/bbook/local/populations/pop04.htm.

Oregon Water Resources Department: Dam Information [Website]. Accessed February 18, 2003. Available at: http://www.wrd.state.or.us/cgi-bin/dams.pl?basin-16.

Parker, J.R. 1935 Annual Report - Douglas County. Corvallis, Oregon: Oregon State Agricultural College; 1936.

Patton, C.P. 1976. Atlas of Oregon. University of Oregon: Eugene, Oregon; 1976.

Riddle, George W. Early Days in Oregon. Canyonville, Oregon: South Umpqua Historical Society, Inc; 1993.

Schlesser, H.D. Fort Umpqua: Bastion of Empire. Oakland, Oregon: Oakland Printing Company; 1973.

Tishendorf, D. China Ditch: The Lost Course of Dreams. The News-Review, May 3, 1981, c1, c10.

USDI Bureau of Land Management. Cow Creek Watershed Analysis. Roseburg, Oregon: USDI Bureau of Land Management, Roseburg District Office; 1997 Sep.

[Website] Accessed March 2003. Available at: http://www.or.blm.gov/roseburg/Info/WA.htm.

---. West Fork of Cow Creek Watershed Analysis Document. Medford, Oregon: USDI Bureau of Land Management, Medford District Office; 1997 Jun. [Website] Accessed March 2003. Available at: http://www.or.blm.gov/Medford/docs/wfc_wa.pdf.

US Forest Service. Cultural Resource Overview. Roseburg, Oregon: Umpqua National Forest and Bureau of Land Management, Roseburg District Office; 1980 Jul.

---. Jackson Creek Watershed Analysis. Tiller, Oregon: Umpqua National Forest, Tiller Ranger District; 1995 Mar.

Walling, A.G. History of Southern Oregon. Portland, Oregon: A.G. Walling Publishing Company; 1884.

Wyant, D. Ore Search Goes on Deep Inside Mountain. Eugene Register-Guard, September 5, 1955.

Zybach, Bob. Evergreen Magazine. Medford, Oregon: Evergreen Foundation; 1994 Mar-Apr. Pages 18-19.

3. Current Conditions

This chapter explores the current conditions of the West Fork Cow Creek Watershed in terms of instream, riparian, and wetland habitats, water quality, water quantity, and fish populations. Background information for this chapter was compiled from the following sources: the *Oregon Watershed Assessment Manual* (Watershed Professionals Network, 1999), the *Watershed Stewardship Handbook* (Oregon State University Extension Service, 2002), and the *Fish Passage Short Course Handbook* (Oregon State University Extension Service, 2000). Additional information and data are from the following groups' documents, websites, and specialists: the USDI Bureau of Land Management, the Oregon Department of Environmental Quality, the Oregon Department of Fish and Wildlife, the Douglas Soil and Water Conservation District, the US Geological Survey, and the Oregon Water Resources Department.

Key Questions

- In general how are the streams, riparian areas, and wetlands within the West Fork Cow Creek Watershed functioning?
- How is water quality in terms of temperature, surface water pH, dissolved oxygen, and other parameters?
- What are the consumptive uses and instream water rights in the watershed, and what are their impacts on water availability?
- What are the flood trends within the watershed?
- What is the distribution and abundance of various fish species, what are the habitat conditions, and where are fish passage barriers?

3.1. Stream function

3.1.1. Stream morphology

Channel morphology[23]

Large disturbance events, such as floods, typically dominate stream channel morphology processes. The stream gradient and channel confinement govern the behavior of water flow through the channel in these peak flow events. These characteristics most significantly influence the character of the stream substrate, the stream's ability to maintain fish populations, and the effectiveness of riparian enhancement projects. Narrow valleys and steep slopes force water through channels at high velocities, in which only large particles like gravel, cobbles, and boulders can be deposited. However, confined channels, though they have faster peak flows, maintain a more stable stream position than, for instance, the migrating meandering streams of a large floodplain. This section discusses the channel morphology of the West Fork Cow Creek Watershed. Information in this section has been summarized from the following documents: *Oregon Watershed Assessment Manual* (Watershed Professional Network, 1999) and *Going with*

[23] Kristin Anderson and John Runyon of BioSystems, Inc., provided the text, photograph, and Table 3-1 for this section.

the Flow: Understanding Effects of Land Management on Rivers, Floods, and Floodplains (Ellis-Sugai and Godwin, 2002).

The Oregon Watershed Enhancement Board (OWEB) has developed a system for classifying streams based on their physical attributes that has implications for the ecology of these streams. This system, called the Channel Habitat Type system, uses features of stream gradient, valley shape, channel pattern, channel confinement, stream size, position in drainage, and substrate. Table 3-1 lists the channel habitat types that are found in the West Fork Cow Creek Watershed along with examples of streams that fall into each.

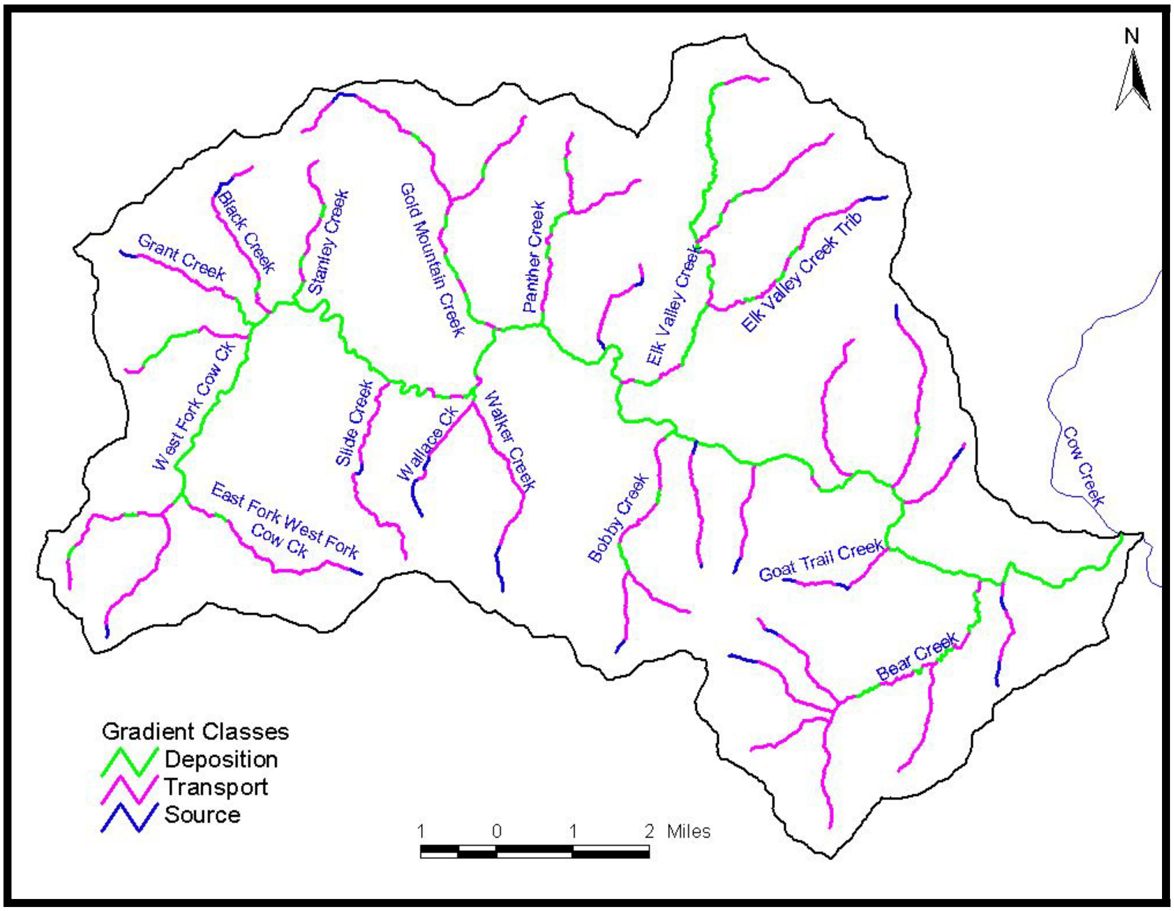
Channel Habitat Type	**Example within watershed**	**Restoration opportunities**
Low gradient confined	West Fork Cow Creek (see Photo 3-1)	Though these channels are not often responsive, riparian planting projects may improve water temperature and erosion issues.
Moderate gradient moderately confined	Bolivar Creek, Gold Mountain Creek	These channels are among the most responsive to restoration projects. Adding large wood to channels in forested areas may improve fish habitat, while stabilizing stream banks in non-forested areas may decrease erosion.
Moderate gradient confined	Panther Creek	Though these channels are not often responsive, riparian planting projects may improve water temperature and erosion issues.
Moderately steep narrow valley	Slide Creek, Bobby Creek	Though these channels are not often responsive, riparian planting projects may improve water temperature and erosion issues.
Steep narrow valley and very steep headwater	Hayes Creek	Though these channels are not often highly responsive, the establishment of riparian vegetation along stable banks may address water temperature problems.

Table 3-1: Channel habitat types and examples within the West Fork Cow Creek Watershed.

Photo 3-1: Photograph looking west (upstream) at West Fork Cow Creek, a low gradient confined stream.[24]

[24] The photograph was taken from Universal Transverse Mercator coordinate 448240/4738807.

Ellis-Sugai and Godwin (2002) also look at streams in terms of their position in the watershed. Streams in steep headwaters (often 20% slope or greater) are source streams, adding sediment and wood to the stream system. They have high-energy flows, no floodplain, and are prone to landslides. Transport streams have medium gradients, often between 3% and 20% slopes. They often have small meanders and floodplains. They carry sediment and wood during times of large flows and store them during low flows. In the downstream reaches of watersheds lie depositional streams. The low gradients, large floodplains, and meanders of these streams dissipate the energy of flows and allow sediments and wood to settle out of low flows and be stored in these reaches of the streams for long periods. These depositional streams are the most sensitive to changes in the watershed. For instance, changes to sediment supply make the biggest impact in these lower reaches. Map 3-1 and Table 3-2 show the total stream miles and percent of streams within each gradient class.



Map 3-1: Stream gradients in the West Fork Cow Creek Watershed.

Gradient class	Stream miles in the watershed	% Total
Source	8.9	8.0%
Transport	64.1	58.0%
Deposition	37.6	34.0%
Total	110.6	100.0%

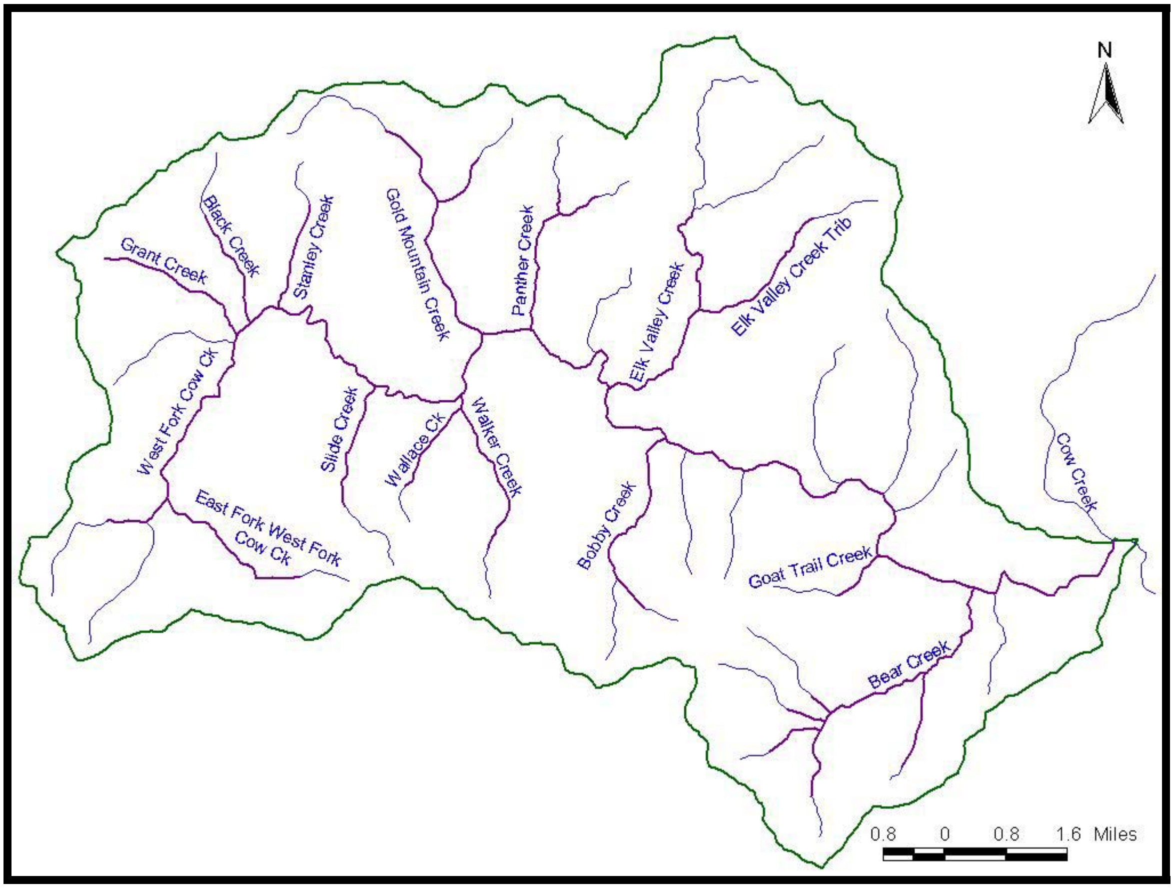
Table 3-2: West Fork Cow Creek Watershed stream miles within each gradient class.

The channel morphology of streams in the West Fork Cow Creek Watershed is fairly uniform throughout the watershed. The headwaters of most tributaries to West Fork Cow Creek are often fairly steep (8% to 16% slope). These are source streams, providing sediment and wood. Many of these streams are above the anadromous fish zone. Shade and other riparian projects may help improve those stream reaches. Most of these headwater streams quickly become moderately sloped (4% to 8% slope) shortly downstream with confined to moderately confined conditions. These reaches function as transport streams, both storing and delivering sediment and wood downstream. Adding large wood, stabilizing banks by planting trees, and improving shade in these reaches may be helpful for the stream system. There is no prominent floodplain or low gradient areas are found within the West Fork Cow Creek Watershed.

Stream habitat surveys

Since 1992, the Oregon Department of Fish and Wildlife (ODFW) has conducted stream habitat surveys throughout the Umpqua Basin. The purpose of these surveys is to gather basic data about Umpqua Basin streams, and to compare current stream conditions to the habitat needs of salmonids and other fish. During the summers of 1994, 1995, and 1997, approximately 56.5 stream miles were surveyed in the West Fork Cow Creek Watershed (see Map 3-2). There are a total of 110.6 stream miles on Map 3-2; therefore, 51.1% of West Fork Cow Creek Watershed streams have been surveyed.[25] Each stream was divided into reaches based on channel and riparian habitat characteristics for a total of 38 reaches averaging 1.5 miles in length. Appendix 2 provides a map detailing the stream reaches.

[25] See section 1.2.5 for more information about the stream map.



Map 3-2: ODFW surveyed streams in the West Fork Cow Creek Watershed.

For each stream, surveyors measured a variety of pre-determined habitat variables. Since a primary purpose of the stream habitat surveys was to evaluate the stream's current condition compared to fish habitat needs, ODFW developed habitat benchmarks to interpret stream measurements that pertain to fish habitat. This assessment includes nine measurements that have been grouped into four categories: pools, riffles, riparian areas and large instream woody material. Table 3-3 provides the habitat measurements included in each category.

Stream habitat benchmarks rate the values of the components of the survey in four categories: excellent, good, fair, and poor. For the purpose of this watershed assessment, "excellent" and "good" have been combined into one "good" category. Table 3-3 provides parameters used to develop the benchmark values.

For this assessment, UBWC and ODFW staff simplified the stream data by rating the habitat categories by their most limiting factors. For example, there are two components that determine the pools rating: percent area in pools and residual pool depth. If a reach of a small stream had 50% of its area in pools, then according to Table 3-3, it would be classified as good for percent area in pools. If average pool depth on the same reach were 0.4 meters in depth, this reach would have fair residual pool depth. This reach's classification for the pools habitat category would be fair. Most habitat categories need a combination of components to be effective, and therefore are rated by the most limiting factor, which is pool depth in this example.

Habitat characteristic	Measurements used for rating habitat quality	Benchmark values		
		Good	**Fair**	**Poor**
Pools	1. **Percent area in pools:** percentage of the creek area that has pools 2. **Residual pool depth:** depth of the pool (m), from the bottom of the pool to the bottom of the streambed below the pool a) small streams b) large streams	1. > 30 2a. > 0.5 2b. > 0.8	1. 16-30 2a. 0.5 - 0.3 2b. 0.8 - 0.5	1. <16 2a. < 0.3 2b. < 0.5
Riffles	1. **Width to depth ratio:** width of the active stream channel divided by the depth at that width 2. **Percent gravel in the riffles:** percentage of creek substrate in the riffle sections of the stream that are gravel 3. **Percent sediments** (silt, sand, and organics) **in the riffles:** percentage of creek substrate in the riffle sections of the stream that are sediments	1. ≤ 20.4 2. ≥ 30 3. ≤ 7	1. 20.5-29.4 2. 16-29 3. 8-14	1. ≥ 29.5 2. ≤ 15 3. ≥ 15
Riparian	1. **Dominant riparian species:** hardwoods or conifers 2. **Percent of the creek that is shaded** a) for a stream with width < 12m (39 feet) b) for a stream with width > 12m	1. large diameter conifers 2a. > 70 2b. > 60	1. medium diameter conifers & hardwoods 2a. 60 – 70 2b. 50 – 60	1. small diameter hardwoods 2a. < 60 2b. < 50
Large Woody Material in the Creek	1. **Number of wood pieces**[26] per 100m (328 feet) of stream length 2. **Volume of wood** (cubic meters) per 100m of stream length	1. > 19.5 2. > 29.5	1. 10.5-19.5 2. 20.5-29.5	1. < 10.5 2. < 20.5

Table 3-3: Stream habitat survey benchmarks.

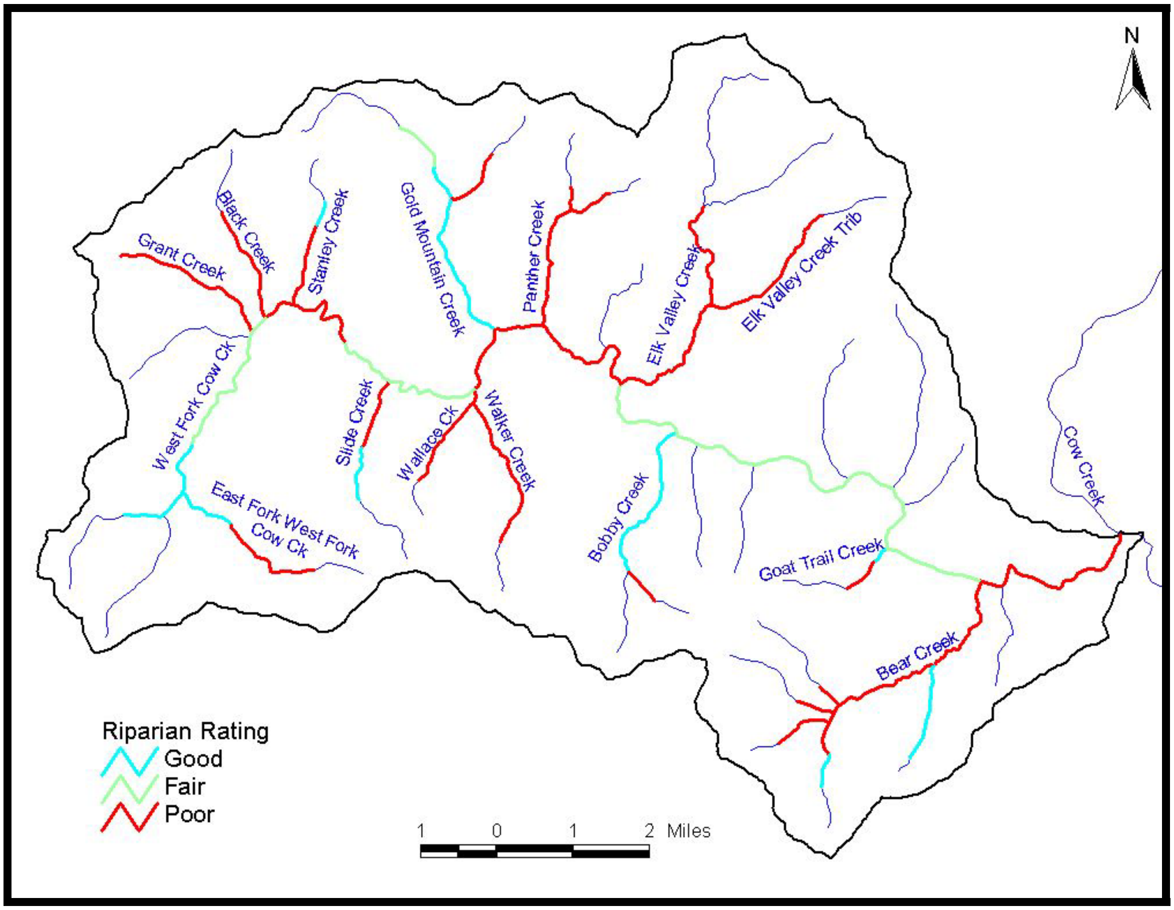
[26] Minimum size is six-inch diameter by 10 ft length or a root wad that has a diameter of six inches or more.

The benchmark ratings should not be viewed as performance values, but as guides for interpretation and further investigation. Streams are dynamic systems that change over time, and the stream habitat surveys provide only a single picture of the stream. For each habitat variable, historical and current events must be considered to understand the significance of the benchmark rating. Take, for example, a stream reach with a poor rating for instream large wood. Closer investigation could uncover that this stream is located in an area that historically never had any large riparian trees. Failing to meet the benchmark for instream large wood might not be a concern because low instream wood levels might be the stream's normal condition. On the other hand, meeting a benchmark might not mean all is well. A stream reach in an historically wooded area could meet its benchmark for large instream wood because a logging truck lost control and dumped its load in the stream. In this example, meeting the large wood benchmark is not sufficient if that stream reach has no natural sources of woody material other than logging truck accidents.

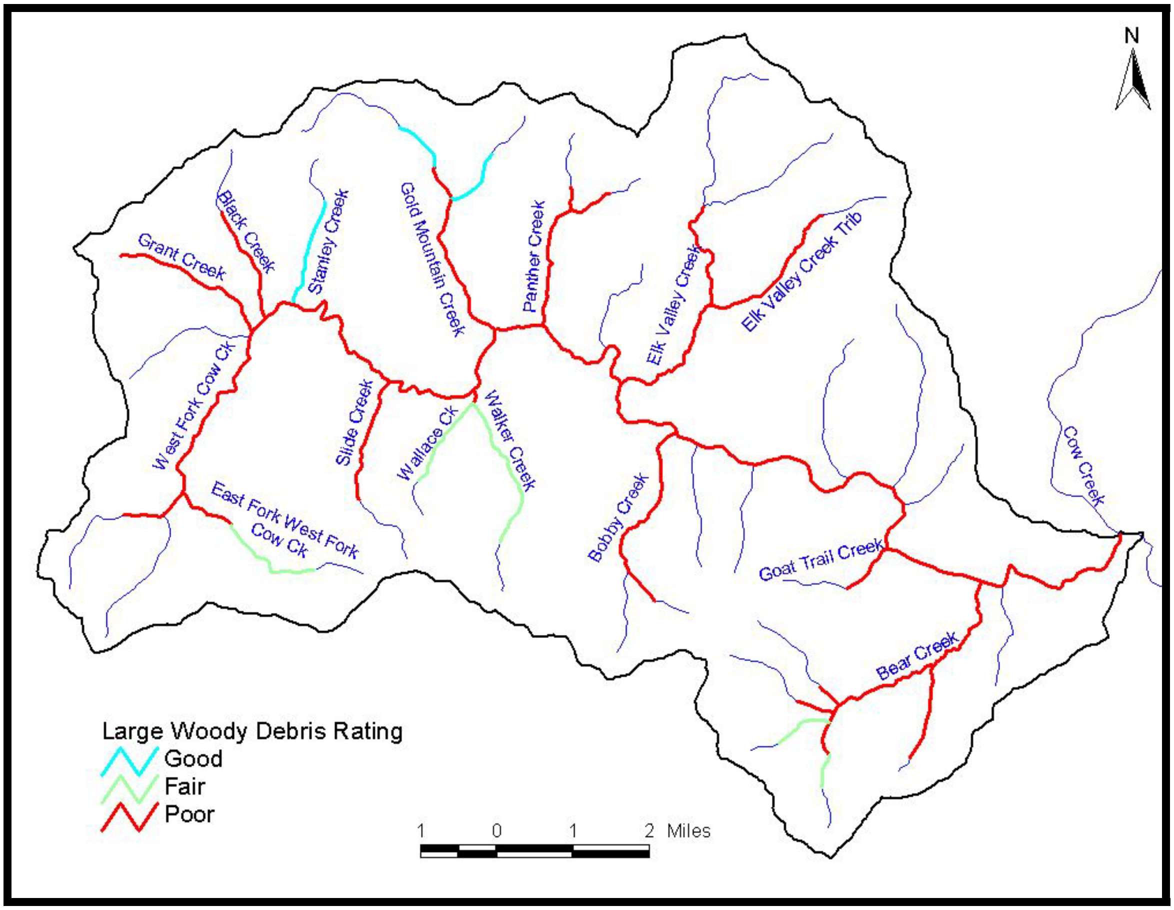
Overview of stream conditions

Looking at the historical and the recent conditions is necessary to fully understand the value of each reach's benchmark rating. Conducting this type of study for every reach within the West Fork Cow Creek Watershed is beyond the scope of this assessment. Instead, it looks for patterns within the whole watershed and along the stream length to provide a broad view and help determine trends that might be of concern.

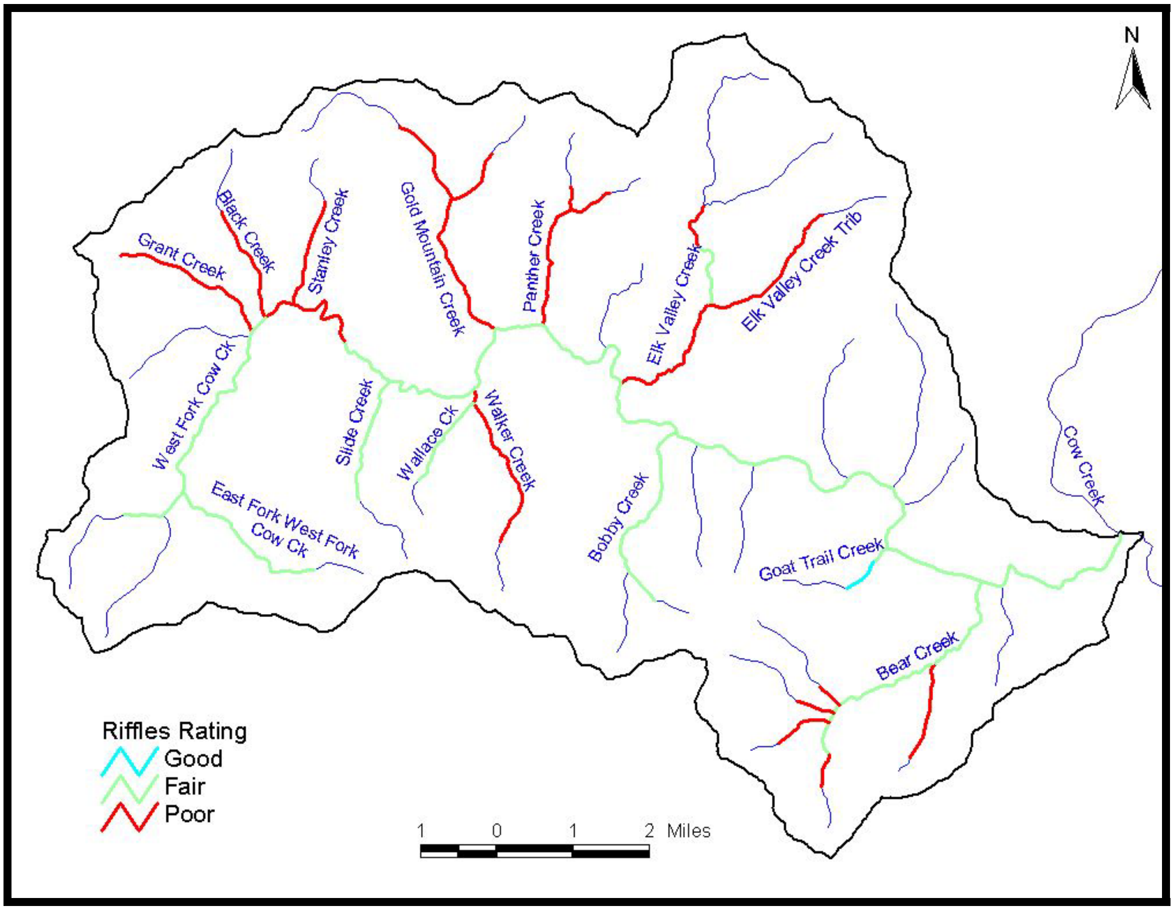
Of the 38 stream reaches surveyed by ODFW in the West Fork Cow Creek Watershed, none rate as fair or good in all four categories. Twenty-eight stream reaches (74%) have at least two categories rate as poor. Looking at Map 3-3 and Map 3-4, it is striking that more than two-thirds of reaches rate as poor for riparian areas and large woody material. Only reach two of Gold Mountain Creek has good riffles (see Map 3-5). However, 71% of stream reaches have fair or good pools (Map 3-6). Ratings and land uses by stream reach are provided in Appendix 2 and Appendix 3.



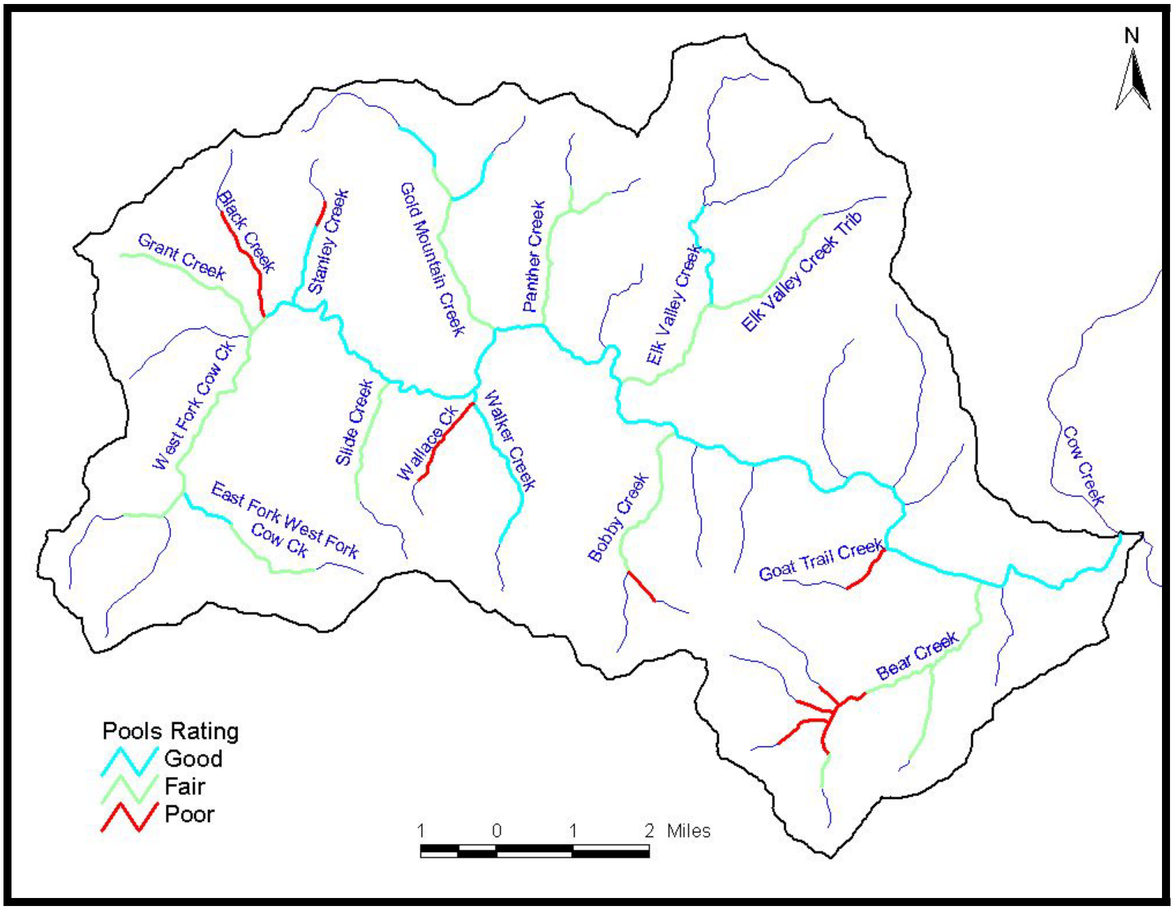
Map 3-3: Stream habitat survey riparian ratings for the West Fork Cow Creek Watershed.



Map 3-4: Stream habitat survey large woody debris ratings for the West Fork Cow Creek Watershed.



Map 3-5: Stream habitat survey riffles ratings for the West Fork Cow Creek Watershed.



Map 3-6: Stream habitat survey pools ratings for the West Fork Cow Creek Watershed.

3.1.2. Stream connectivity

Stream connectivity refers to the ability of resident and anadromous fish, as well as other aquatic organisms, to navigate the stream network. The stream system becomes disconnected when natural and human-made structures such as waterfalls, log jams, and dams, inhibit fish passage. Although some stream disconnect is normal, a high degree of disconnect can reduce the amount of suitable spawning habitat available to salmonids. This, in turn, reduces the stream system's salmonid productivity potential. Poor stream connectivity can increase juvenile and resident fish mortality by blocking access to other critical habitat, such as rearing grounds and cool tributaries during the summer months.[27]

For this assessment, fish passage barriers are structures that completely block all fish passage. A juvenile fish passage barrier permits adult passage but blocks all young fish. Structures that allow some adults or some juvenile fish to pass are referred to as obstacles. Although a single obstacle does not prevent passage, when there are multiple obstacles, fish can expend so much energy in their passage efforts that they may die or be

[27] See section 3.3.2 for more information about stream temperature.

unable to spawn or feed. This assessment reviews the known locations of human-caused fish passage barriers and obstacles within the West Fork Cow Creek Watershed.

Irrigation ditches

Irrigation ditches without fish wheel screens are primarily a problem for juvenile fish.[28] When the water diversion is in place, young fish swim into the ditches in search of food. When the diversion to the ditch is removed, the young fish left in the ditch cannot return to the stream network and will eventually die. At the writing of this assessment, no unscreened irrigation ditches in the West Fork Cow Creek Watershed had been identified as significant juvenile fish passage barriers.

Dams

In the central Umpqua Basin, most dams on larger streams are push-up dams used to create pools to pump irrigation water.[29] These dams are only used during the summer months, and pose no passage barrier to fish during the winter. Dams can be barriers or obstacles to fish passage if the distance from the downstream water surface to the top of the dam (the "drop") is too far for fish to jump. Whether or not a fish can overcome this distance depends on three factors: the size of the fish, the height of the drop, and the size of the pool at the base of the dam, which is where fish gain momentum to jump. If the pool is two feet deep, it is generally believed that adult fish can surmount a two-foot high dam or less, while juvenile fish can overcome a height of 0.5 feet or less. As pool depth decreases or height increases, fish have difficulty jumping high enough to pass over. Staff members from the Oregon Water Resources Department, the Douglas Soil and Water Conservation District, and the Umpqua Basin Watershed Council are not aware of any dams in the West Fork Cow Creek Watershed that are barriers or obstacles to adult or juvenile fish passage.

Culverts

Culverts can be barriers or obstacles to fish passage if the distance from the downstream water surface to the culvert outfall is too far for fish to jump. Just as with dams, it is generally believed that adult fish can reach a culvert outlet that is two feet or less from the downstream water, while juvenile fish overcome a height of 0.5 feet or less, if there is a two-foot deep pool at the outfall.

Unlike dams, water velocity within the culvert poses another potential fish passage barrier. In natural stream systems, fish are able to navigate high velocity waters by periodically resting behind rocks and logs or in pools. Smooth-bottomed culverts offer no such protection, and water velocities can prevent some or all fish from passing through the pipe. Fish may face additional velocity barriers at the upstream end of a culvert if it has been placed so that the stream flows sharply downward into the culvert entrance. In general, smooth-bottomed culverts at a 1% gradient or more are obstacles to fish passage. Culverts that are partially buried underground or built to mimic a natural

[28] Fish wheel screens are self-cleaning screens that prevent fish from entering an irrigation ditch while passing floating debris that may prevent water flow.
[29] Some landowners may have dams on small tributaries to provide water for wildfire control, provide water for livestock, or for landscape aesthetics.

streambed provide greater protection and allow fish passage at steeper gradients and higher water velocities.

It is important to note that culverts may be fish passage obstacles or barriers for only part of the year. As water levels change, so do pool depth, drop distance, and water velocity. A culvert with a five-foot drop in the summer may be easily navigated in the winter. High winter water flows can increase pool size and reduce jumping distance. However, high flows can also increase water velocities, making culverts impassable.

It is unknown how many culverts are barriers or obstacles to fish passage in the West Fork Cow Creek Watershed. Currently, the Umpqua Basin Fish Access Team (UBFAT) is working on identifying and prioritizing fish passage-limiting culverts, as well as other fish passage barriers and obstacles, on public and private land throughout the Umpqua Basin. This project is in the information gathering stage and does not yet have a list of fish passage-limiting culverts in the Umpqua Basin. Future prioritization will focus on identifying the fish passage barriers that will give the highest cost-to-benefit ratio, such as culverts blocking fish access near the mouths of streams that are within the distribution of salmonids.[30] A document summarizing the results of this project will be available in 2004.

3.1.3. Channel modification[31]

For the purpose of this assessment, "channel modification" is defined as any human activity designed to alter a stream's flow or its movement within the floodplain, such as building riprap, dredging, or vegetative bank stabilization. Although placing structures like boulders or logs in a stream alters the channel, this type of work is done to improve aquatic habitat conditions and is not intended to alter the stream's path. As such, instream structure placement projects are not considered channel modification activities for this assessment.

In Oregon, the state has the authority to regulate all activities that modify a stream's active channel. The active channel is all the area along a stream that is submerged during normal high waters. Even if the entire stream is within a landowner's property, the active channel, like the water within it, is regulated by public agencies, and channel modification projects can only be done with a permit.[32] History has shown that channel modification activities are often detrimental to aquatic ecosystems and to other reaches of the same stream. Streams naturally meander; attempts to halt meandering can alter aquatic habitats in localized areas and cause serious erosion or sedimentation problems

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[30] See section 3.5.2 for information about anadromous and resident salmonid distribution within the West Fork Cow Creek Watershed.

[31] Information in section 3.1.3 is primarily from interviews by the author with Douglas Soil and Water Conservation District staff.

[32] Under the Oregon Removal/Fill Law (ORS 196.800-196.990), removing, filling, or altering 50 cubic yards or more of material within the bed or banks of the waters of the state or any amount of material within Essential Habitat streams or State Scenic Waterways requires a permit from the Division of State Lands. Waters of the state include the Pacific Ocean, rivers, lakes, most ponds and wetlands, and other natural bodies of water. Tree planting in the active stream channel, and timber harvesting in some circumstances, can be done without a permit.

further downstream. Although channel modification projects can still be done with a permit, obtaining a permit is a lengthy process.

Historical channel modification projects
Quantifying historical channel modification activities is difficult because no permits were issued, and the evidence is hidden or non-existent. According to the Douglas Soil and Water Conservation District staff, the majority of past channel modification activities were removing gravel bars from the stream and bank stabilization. Property owners removed gravel bars to sell the gravel as aggregate, to reduce water velocities, and "to put the creek where it belongs." Gravel bars are not stationary, and during every flood event gravel is washed away and replaced by upstream materials. Consequently, a gravel bar in the same location was often removed every year.

Bank stabilization concerns any material added to the stream's bank to prevent erosion and stream meandering. The term "riprap" refers to bank stabilization done with any handy material including tires, car bodies, railroad ties, rocks, and cement. Frequently, riprap becomes buried by sediment only to be exposed years later when a stream alters its path. During the 1996 Douglas County area floods, many past bank stabilization projects were exposed as sediment was washed away. In some cases, entire car bodies used for riprap were found stranded in the middle of streams that had drastically changed course.

Current channel modification projects
Staff members from the Douglas Soil and Water Conservation District, the Oregon Water Resources Department, and the Umpqua Basin Watershed Council are not aware of any permitted channel modification projects within the West Fork Cow Creek Watershed. Landowners and stream restoration professionals report that non-permitted channel modification activities still occur throughout the Umpqua Basin. In many cases, the people involved are unaware of the regulations and fines associated with non-permitted channel modification projects and the effects on aquatic systems.

3.1.4. Stream function key findings and action recommendations

Stream morphology key findings
- A wide variety of stream channel habitat types are found in the watershed, offering different enhancement opportunities.
- In the West Fork Cow Creek Watershed, there are few stream miles in source areas, where most large woody material is recruited into the stream system.
- Stream habitat surveys suggest that poor large woody material, poor riparian area tree composition, and poor to fair riffles limit fish habitat in most surveyed streams.

Stream connectivity key findings
- Culverts that are barriers and/or obstacles to fish may reduce stream connectivity, affecting anadromous and resident fish productivity in the West Fork Cow Creek Watershed. More information about fish passage barriers will be available from UBFAT in 2004.

Channel modification key findings

- Many landowners may not understand the detrimental impacts of channel modification activities or may be unaware of active stream channel regulations.

Stream function action recommendations

- Where appropriate, improve pools and increase instream large woody material by placing large wood and/or boulders in streams with channel types that are responsive to restoration activities and have an active channel less than 30 feet wide.[33]
- Encourage land use practices that enhance or protect riparian areas:
  - Plant native riparian trees, shrubs, and understory vegetation in areas with poor or fair riparian areas.
  - Manage riparian zones for uneven-aged stands with large diameter trees and younger understory trees.
- Maintain areas with good native riparian vegetation.
- Encourage landowner participation in restoring stream connectivity by eliminating barriers and obstacles to fish passage. Restoration projects should focus on barriers that, when removed or repaired, create access to the greatest amount of fish habitat.
- Increase landowner awareness and understanding of the effects and implications of channel modification activities through public outreach and education.

3.2. Riparian zones and wetlands

3.2.1. Riparian zones

For this assessment, the vegetation immediately adjacent to a stream is its riparian zone. Riparian zones influence stream conditions in many ways. Aboveground vegetation can provide shade, reduce flood velocities, and add nutrients to the stream. Roots help prevent bank erosion and stream meandering. Trees and limbs that fall into streams can increase fish habitat complexity and can create pools. Insects that thrive in streamside vegetation are an important food source for fish.

What constitutes a “healthy” riparian area, however, is dependent on many factors. Although many large-diameter conifers and hardwoods provide the greatest amount of shade and woody debris, many streams flow through areas that do not support large trees or forests. In some areas, current land uses may not permit the growth of “ideal” vegetation types. Conclusions about stream riparian zone conditions should take into consideration location, known historical conditions, and current land uses. Therefore, this assessment’s riparian zone findings should be viewed as a guide for interpretation and further investigation and not as an attempt to qualify riparian conditions.

Riparian zone classification methodology

In this watershed, riparian vegetation data are available for West Fork Cow Creek. No data area available for tributaries. UBWC staff members were unable to locate data

[33] Thirty feet is the maximum stream width for which instream log and boulder placement projects are permitted.

about other riparian parameters for the West Fork Cow Creek Watershed, such as riparian buffer width and percent shade.

West Fork Cow Creek's vegetation percent by class and distribution are shown in Figure 3-1 and Map 3-7. Trees are split into two groups: conifers and hardwoods. In general, trees are the preferred vegetation type for riparian areas in western Oregon because they provide shade and add large woody debris to streams. Conifers are preferred over hardwoods because they decompose very slowly and are less likely than hardwoods to wash downstream. "Brush" constitutes short broad plants, and "grass" describes areas that are primarily non-woody plants. Areas of no vegetation include streamside roads and railroads and non-road related bare ground and rock.

West Fork Cow Creek's riparian vegetation consists primarily of conifers. Areas of little or no vegetation are scattered along the entire stream length. A large patch of grass is located between Panther Creek and Elk Valley Creek. A brushy patch and a group of hardwoods are located downstream of Elk Valley Creek.

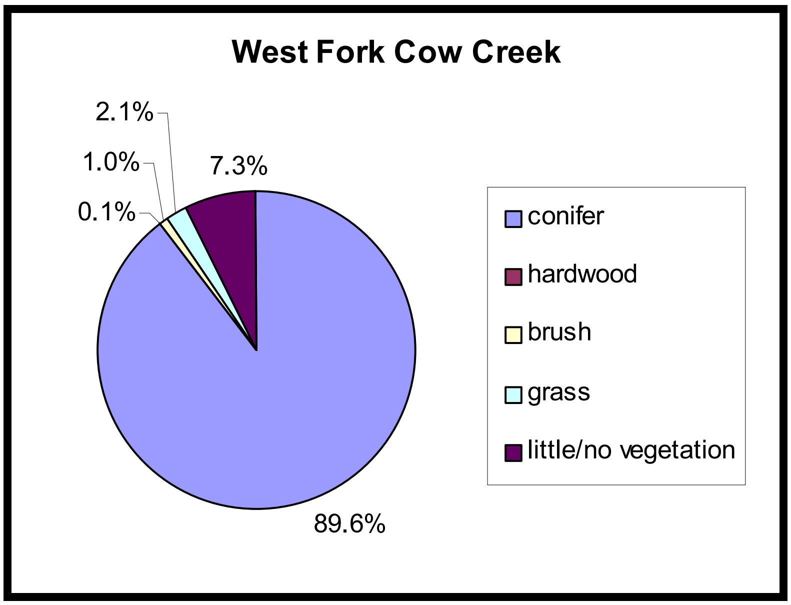
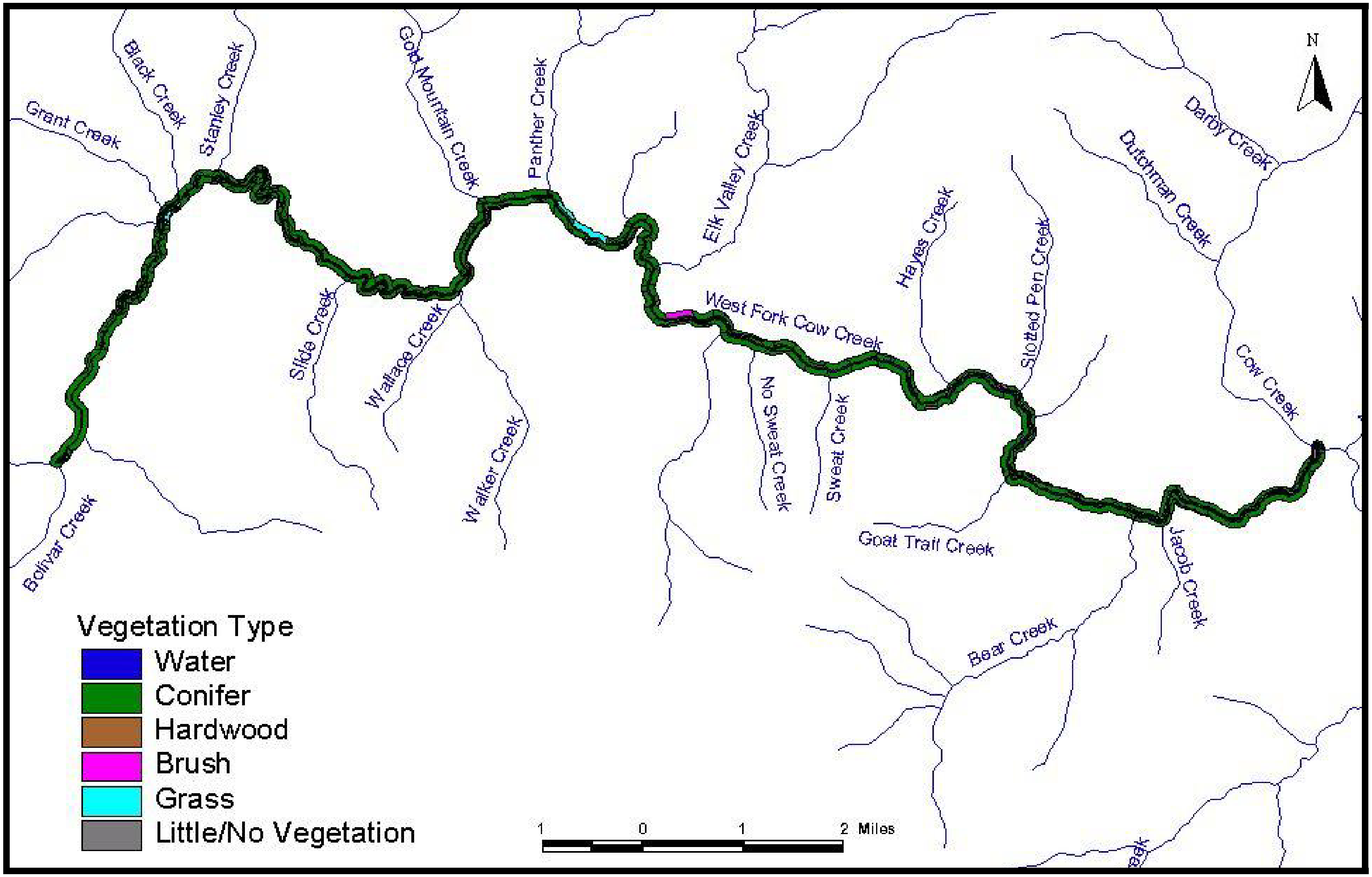


Figure 3-1: Percent riparian vegetation by class for West Fork Cow Creek.



Map 3-7: **Riparian vegetation distribution for West Fork Cow Creek.**

3.2.2. Wetlands[34]

The hydrology of wetlands and stream-associated wetlands is often complex and interconnected. A watershed-based approach to wetlands assessment is critical to ensure that the whole ecosystem is reviewed. The purpose of this assessment is to review current wetlands locations and attributes, historical wetlands, and opportunities for restoration. Background information for this section was compiled from the following groups' documents, websites, and specialists: the Oregon Division of State Lands, US Environmental Protection Agency, US Fish and Wildlife Service, and Wetlands Conservancy. Additional information was compiled from *Wetland Plants of Oregon and Washington* (Guard, 1995).

Overview of wetland ecology

When discussing wetlands, it is helpful to clarify terms and review ecological functions in order to facilitate a mutual understanding. The following section provides a brief description of wetland ecology.

<u>What is a wetland?</u>

In general, wetlands are a transitional area between terrestrial and aquatic ecosystems, where the water table is usually at or near the surface of the land, or the land is covered by shallow water. The following three attributes must be found together to establish the existence of a regulated wetland:

1. Under normal circumstances there is inundation or saturation with water for two weeks or more during the growing season;[35]
2. The substrate is predominantly undrained hydric soil as indicated by the presence of features such as dull colored or gleyed (gray colors) soils, soft iron masses, oxidized root channels, or manganese dioxide nodules;
3. At least periodically, the land supports predominantly hydrophytic (water-loving) vegetation.

<u>Function and values</u>

In the past, wetlands were regarded as wastelands and considered nuisances. As early as 1849 with the enactment of the Swamp Act, wetlands removal was encouraged. Wetlands were feared as the cause of malaria and malignant fever. However, research over the years has led to a greater appreciation of the many important ecological functions that wetlands perform.

Of the many functions and benefits of wetlands, different ones will be important to different communities depending upon their goals for wetland protection and restoration. Some of the many functions and benefits of wetlands include:

- Flood prevention - wetlands are able to absorb water from runoff during storms and gradually release the water that would otherwise flow quickly downstream.

[34] Jeanine Lum of Barnes and Associates, Inc., contributed section 3.2.2.
[35] The growing season in Douglas County is from March 1 through October 31.

- Water filtration - wetlands improve water quality by acting as sediment basins. Wetland vegetation is able to filter and reduce excess nutrients such as phosphorous and nitrogen.
- Ground water recharge - water that is held in wetlands can move into the subsurface soil, thus recharging the groundwater.
- Stream bank stabilization - wetlands and associated vegetation slow the movement of water and help slow erosion of stream banks.
- Fish and wildlife habitat - many species depend on wetlands for food, spawning and rearing.

Background on the Clean Water Act and National Wetlands Inventory

Section 404 of the federal Clean Water Act requires that anyone planning to place dredged or fill material into waters of the United States, including wetlands, must first obtain a permit from the U.S. Army Corp of Engineers. Established (ongoing) and normal farming, ranching, and forestry activities are exempt. The Emergency Wetlands Resources Act of 1986 requires the U.S. Fish and Wildlife Service (USFWS) to inventory and map wetlands in the United States. This mapped inventory is called the National Wetlands Inventory (NWI).

Nationally, an estimated 46 million acres, or 50% of the original wetlands area, have been lost to clearing, filling, draining and flood control since the 1600s. In 1997, the USFWS reported an 80% reduction in wetlands loss during the period 1986 to 1996, as compared to the decade prior. Although the nation has not met the goal of no net loss of wetlands, it has slowed the rate of wetlands loss.

Types of wetlands

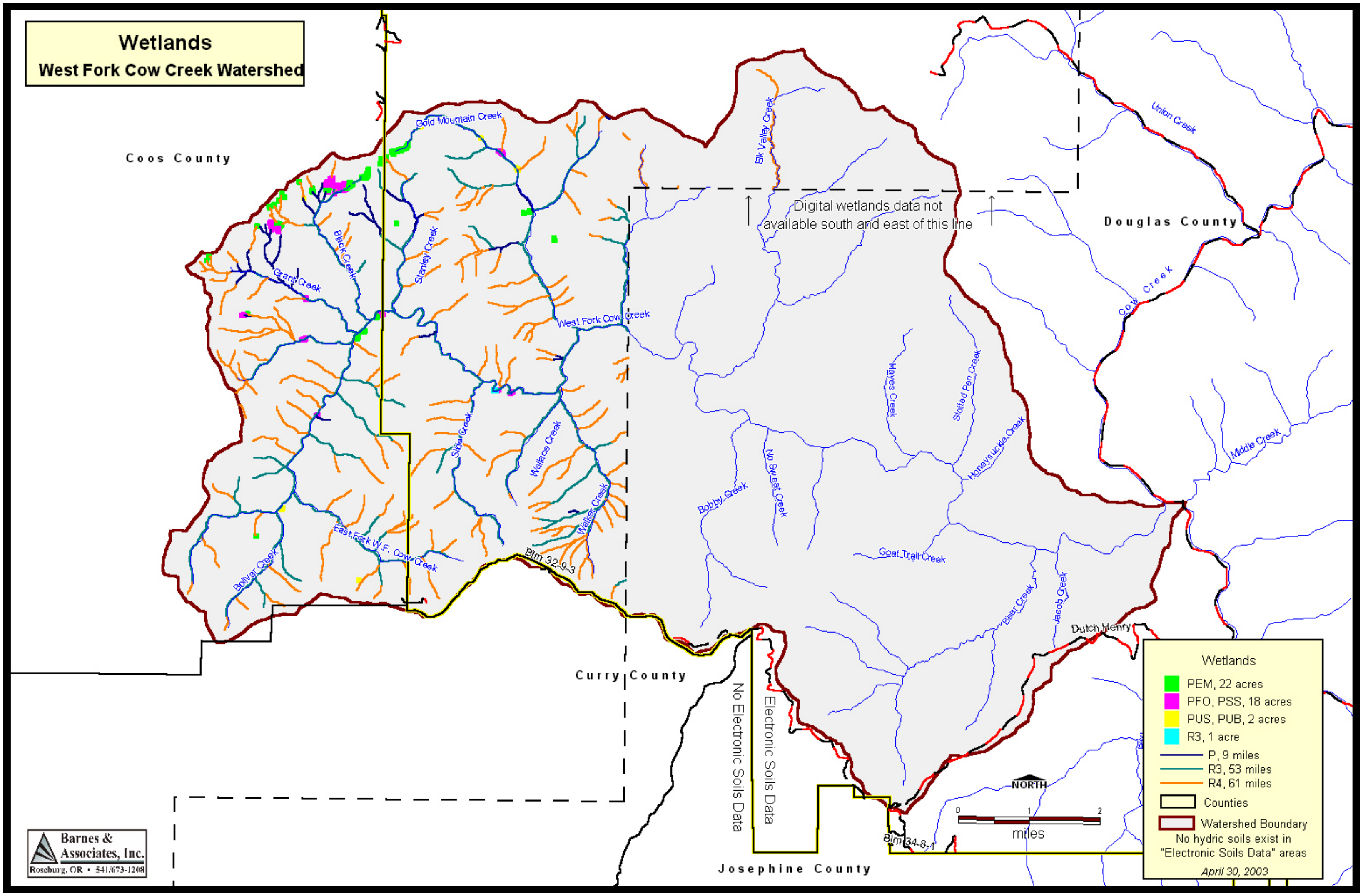
A wetland that holds water all year round is the easiest wetland to recognize and the one most people understand as a wetland. Another type of wetland is the ephemeral wetland, or a wetland that holds water for only a few days, weeks, or months during the year. The timing and duration of water are important factors that dictate which plants and wildlife will use a particular wetland.

NWI classifies wetlands based on guidelines established by Cowardin and others (1979). The “palustrine” system classification includes all nontidal wetlands dominated by trees, shrubs, emergents (erect, rooted, non-woody plants), mosses or lichens. It groups the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie potholes. The palustrine wetland also includes the small, shallow, permanent or intermittent water bodies often called ponds. Bodies of water that are lacking such vegetation and are less than 20 acres in size are included in this category.

The “riverine” system classification includes wetlands within a channel, except those dominated by trees, shrubs, and persistent emergents. Wetlands within a channel that are dominated by vegetation are classified as “palustrine” and appear on Map 3-8 as line data labeled “P.” Table 3-4 is a summary of codes and descriptions used in the NWI. Data are displayed in Map 3-8.

System	Class	Brief description
P=Palustrine	EM=emergent	Dominated by rooted herbaceous plants, such as cattails and grass.
	SS=scrub-shrub	Dominated by shrubs and saplings less than 20 feet in height.
	FO=forested	Dominated by trees taller than 20 feet in height.
	UB=unconsolidated bottom	No vegetation evident at the water surface with mud or exposed soils.
R=Riverine	R3=upper perennial	Channels that flow throughout the year, characterized by high gradient and fast water velocity.
	R4=intermittent	Channels that contain flowing water only part of the year.

Table 3-4: National Wetlands Inventory wetlands codes and descriptions.



Map 3-8: West Fork Cow Creek Watershed wetlands.

Description of current wetlands in the West Fork Cow Creek Watershed
A review of the NWI data shows the main channel of West Fork Cow Creek and its tributaries including Bear, Bobby, Elk Valley, Hayes, No Sweat, and Slotted Pen Creeks are classified as riverine (stream-associated wetland) systems that periodically or continuously contain flowing water.[36] Portions of land adjacent to West Fork Cow Creek are seasonally flooded. Here surface water is present for an extended period, especially early in the growing season, but is absent by the end of the growing season in most years. The water table can vary from saturation at the surface to well below the ground surface after flooding ceases.

Palustrine wetland is the primary type of wetland in the watershed, with 54 occurrences totaling 42 inventoried acres. Palustrine with emergent vegetation (PEM) represents more that half of the palustrine system. Indicator plants such as rushes (*Juncus spp.*) and sedges (*Carex spp*.) are typically found in this type of wetland.

Most of the palustrine wetlands are found in the northwest section of the watershed at the headwaters of Grant, Black, and Stanley Creeks. This area, owned by Plum Creek Timber Company, consists primarily of small areas (less than one acre each) of shrubs such as willow and a few grass openings. The wetlands are found along a narrow plateau below the watershed ridgeline and most appear to be stream-associated wetlands. Some may have even been affected or created by road placement. The area around the small wetlands was logged in the early 1970s and then aerially seeded with Douglas fir. Any future timber harvesting activity in the area would conform to the Oregon Forest Practices Act.

Historical wetlands and changes in the West Fork Cow Creek Watershed
There is little specific reference in historical records to wetlands in the West Fork Cow Creek Watershed. However, approximately 38% by area of Oregon's wetlands have been drained, diked or filled since European settlement. In western Oregon specifically, 53% of the original wetlands acreage has been lost to development or converted to other uses (Wetlands Conservancy, 2003).

One indicator of possible historical wetlands is the area of hydric soils adjacent to existing wetlands. Hydric soils are formed under conditions of saturation, flooding or ponding of sufficient duration during the growing season to develop anaerobic conditions in the upper part of the soil profile. Typically, the soil units are described as clayey, poorly-drained, with low permeability and a high water table present during late fall, winter, and spring. There is no indication of hydric soils in the Douglas County portion of the watershed, which encompasses approximately 82% of the watershed (see Map 3-8).

[36] Wetlands data for this watershed is available electronically for only the USGS 7.5 minute quadrangles of Bone Mountain, Chipmunk ridge, and Mount Bolivar. This "digital" area falls in the western portion of the watershed. Approximately 28,122 acres, or 50% of the watershed area, were analyzed and mapped with this digital data. The balance of the West Fork Cow Creek Watershed was analyzed using paper NWI maps from the Oregon Division of State Lands.

Restoration opportunities in the West Fork Cow Creek Watershed
Wetland loss and degradation is caused by human activities that change wetland water quality, quantity, and flow rates, increase pollutant inputs, and change species composition as a result of disturbance and introduction of nonnative species. Although one of the functions of wetlands is to absorb pollutants and sediments from the water, there is a limit to their capacity to do so.

The wetlands designated by NWI on Plum Creek Timber Company land are small and enhancement activities are unlikely to provide significant benefit. There is one specific PEM wetland that is larger than most but still less than the eight acres designated as a significant wetland by the Oregon Forestry Practices Act. This site has maintained its integrity since the high water table limit encroachment from the adjacent Douglas-fir forest. A prescribed burn or manual removal of the occasional Douglas-fir in this open grassy wetland after the next harvest cycle, in conjunction with the maintenance of the site would help keep this area open through future rotations.

Recommendations
Wetland conservation awareness must be fostered if wetland conservation is to be successful in any watershed. Increasing awareness of what defines a wetland, its functions and benefits is a fundamental step in creating interest and appreciation of wetlands conservation by landowners and their contractors. Identifying or establishing peer-related wetland demonstration projects in this watershed or nearby watersheds are good opportunities to educate stakeholders.

Wetlands references

Cowardin, L.M., V. Carter, F. Goblet, E.T. LaRoe. Classification of Wetlands and Deepwater Habitats of the United States. Washington, D.C.: U.S. Fish and Wildlife Service, FWS/OBS-79/31; 1979.

Guard, B. Jennifer. Wetland Plants of Oregon and Washington. Redmond, Washington: Lone Pine Publishing; 1995.

Oregon Division of State Lands. How to Identify Wetlands [Website]. Accessed May 8, 2003. Available at: http://statelands.dsl.state.or.us/fact4.htm.

U.S. Environmental Protection Agency. Wetlands Fact Sheet [Website]. Accessed March 16, 2003. Available at: http://www.epa.gov/owow/wetlands/facts/.

U.S. Fish and Wildlife Service. National Wetlands Status and Trends Reports [Website]. Accessed March 16, 2003. Available at: http://www.nwi.fws.gov/bha/SandT/index.html.

Wetlands Conservancy. Conserving Oregon's Wetlands [Website]. Accessed March 16, 2003. Available at: http://www.wetlandsconservancy.org/oregons_greatest.html.

Other sources
John Moore, Plum Creek Timber Company, Coos Bay, Oregon
Scott Robbins, USDA Natural Resources Conservation Service, Roseburg, Oregon
Steve Wickham, Plum Creek Timber Company, Coos Bay, Oregon

3.2.3. Riparian zones and wetlands key findings and action recommendations

Riparian zones key findings

- BLM data indicate that conifers dominate most of West Fork Cow Creek's riparian vegetation, with small patches of brush, grass, and hardwoods.
- The UBWC could not located stream specific riparian information for the West Fork Cow Creek Watershed tributaries. .

Wetlands key findings

- West Fork Cow Creek and many of its tributaries have stream-associated wetland that periodically or continuously contain flowing water.
- There are 42 inventoried acres of palustrine wetland in the West Fork Cow Creek Watershed. These small wetlands are mostly found in the northwest section of the watershed at the headwaters of Grant, Black, and Stanley Creeks.
- Landowner "buy-in" and voluntary participation must be fostered if wetland conservation is to be successful in the watershed.

Riparian zones and wetlands action recommendations

- Identify the following riparian conditions from digital aerial photographs or from stream surveys:
  - Streams segments where canopy cover is less than 50%. In these areas, establish wide buffers of native trees (preferably conifers) and/or shrubs, depending upon local conditions. Priority areas are fish-bearing streams which more than 50% canopy cover is possible.
  - Riparian zones dominated by brush/blackberry. Convert these areas to native trees (preferably conifers) and/or shrubs, depending on local conditions.
  - Riparian buffers that are one tree wide or less. In these areas, encourage buffer expansion by planting native trees (preferably conifers) and/or shrubs, depending on local conditions.
- Develop opportunities to increase awareness of what defines a wetland, its functions and benefits. This is a fundamental step in creating landowner interest and developing landowner appreciation for wetland conservation.
- Identify or establish various peer-related demonstration projects as opportunities to educate stakeholders.

3.3. Water quality

3.3.1. Stream beneficial uses and water quality impairments

The Oregon Water Resources Department (OWRD) has established a list of designated beneficial uses for surface waters, including streams, rivers, ponds, and lakes. Beneficial uses are based on human, fish, and wildlife activities associated with water. This assessment focuses on the designated beneficial uses for flowing water, i.e. streams and rivers. Table 3-5 lists all beneficial uses for streams and rivers within the Umpqua Basin.

Beneficial Uses	
Public domestic water supply	Private domestic water supply
Industrial water supply	Irrigation
Livestock watering	Boating
Aesthetic quality	Anadromous fish passage
Commercial navigation and transportation	Resident fish and aquatic life
Salmonid fish spawning	Salmonid fish rearing
Wildlife and hunting	Fishing
Water contact recreation	Hydroelectric power

Table 3-5: Beneficial uses for surface water in the Umpqua Basin.

The Oregon Department of Environmental Quality (ODEQ) has established water quality standards for the designated beneficial uses. These standards determine the acceptable levels or ranges for water quality parameters, including temperature, dissolved oxygen, and pH. Water quality standards set by ODEQ are reviewed and updated every three years. ODEQ monitors streams and stream reaches throughout Oregon, and streams or reaches that are not within the standards are listed as "water quality impaired."[37] The list of impaired streams is called the "303(d) list," after section 303(d) of the 1972 Clean Water Act. For each stream on the 303(d) list, ODEQ determines the total maximum daily load (TMDL) allowable for each parameter.[38] Streams can be de-listed once TMDL plans are complete, when monitoring shows that the stream is meeting water quality standards, or if evidence suggests that a 303(d) listing was in error.

Watershed assessments by the UBWC explore seven water quality parameters: temperature, pH, dissolved oxygen, nutrients, bacteria, sedimentation and turbidity, and toxics. In 2002, West Fork Cow Creek from the mouth to stream mile 17.9 was 303(d) listed for temperature during the summer. The West Fork Cow Creek Watershed has only been sampled once for pH, dissolved oxygen, nutrients, bacteria, and turbidity; the samples were taken on August 28, 2002. The pH sample exceeded water quality standards. Dissolved oxygen, nutrient, bacteria, and turbidity samples were within water quality parameters. No conclusions can be made about these water quality parameters in the West Fork Cow Creek Watershed. UBWC staff members could not locate watershed-specific data about toxics or stream sediment levels.[39]

[37] ODEQ can also use data collected by other agencies and organizations to evaluate water quality.
[38] Total maximum daily load plans are limits on pollution developed when streams and other water bodies do not meet water quality standards. TMDL plans consider both human-related and natural pollution sources. 303(d) listings for habitat and flow modification do not require TMDL plans. West Fork Cow Creek is 303(d) listed for both habitat and flow modification from the mouth to stream mile 22.0.
[39] Data are from ODEQ's Laboratory Analytical Storage and Retrievable (LASAR) database. All ODEQ data are available via the website www.deq.state.or.us. Select "water quality" and "Laboratory Analytical Storage and Retrievable Database – Monitoring Data."

Sections 3.3.2 provides a detailed discussion about stream temperature. Section 3.3.3 provides more information about potential sediment and turbidity sources in the West Fork Cow Creek Watershed. General information about the impacts pH, dissolved oxygen, nutrients, bacteria, and toxics have on water quality is provided in Appendix 4.

3.3.2. Temperature

Importance of stream temperature

Aquatic life is temperature-sensitive and requires water that is within certain temperature ranges. The Umpqua Basin provides important habitat for many cold-water species, including salmonids. When temperatures exceed tolerance levels, cold-water organisms such as salmonids become physically stressed and have difficulty obtaining enough oxygen.[40] Stressed fish are more susceptible to predation, disease, and competition by temperature tolerant species, which in the case of salmonids might be bass. For all aquatic life, prolonged exposure to temperatures outside tolerance ranges will cause death. Therefore, the beneficial uses affected by temperature are resident fish and aquatic life, and salmonid spawning and rearing.

Temperature limits vary depending upon species and life cycle stage. Salmonids are among the most sensitive fish, and so ODEQ standards have been set based on salmonid temperature tolerance levels. From the time of spawning until fry emerge, 55°F (12.8°C) is the maximum temperature criterion. For all other life stages, the criterion is set at 64°F (17.8°C). Temperatures 77°F (25°C) or higher are considered lethal.

Stream temperature fluctuates by time of year and time of day. In general, water temperature during the winter and most of spring (between November and May) is well below both the 55°F and 64°F standards, and is not an issue. In the summer and fall months, water temperature can exceed the 64°F standard and cause streams to be water quality limited

In 2000, the Umpqua Basin Watershed Council (UBWC) undertook a study on stream temperature for Cow Creek and its tributaries (the Smith report).[41] One temperature sensor was placed at the mouth of West Fork Cow Creek. Temperature was monitored at this site from June 20 through September 17, 2000. Figure 3-2 shows the daily maximum temperatures and the seven-day moving average maximum temperatures for West Fork Cow Creek at the mouth.[42] Seven-day moving average maximum temperatures at this site exceeded ODEQ's 64°F standard 90.5% of monitoring days. According the Smith Report, tributary streams have the potential to be at cooler temperatures throughout the Cow Creek system:

[40] Cold water holds more oxygen than warm water; as water becomes warmer, the concentration of oxygen decreases.

[41] Copies of this study, "Cow Creek Watershed Temperature Study 2000," by Kent Smith are available at the UBWC office.

[42] The seven-day moving average maximum temperature is an average of the maximum temperatures of a given day, the three preceding days, and the three days that follow.

> Analysis of the data with respect to the location in the watershed indicate that the tributary streams tended to be [approximately] 10°F cooler than Cow Creek, with smaller streams typically cooler than larger streams. Charting the data with respect to the distance from the source ridge of each stream indicated that the maximum temperatures of the coldest streams tended to increase on a logarithmic scale at the rate of 10°F for every multiple of 10 miles. [This] suggests that many of the similarly sized tributary streams have the potential to be at cooler temperatures (p. 1).

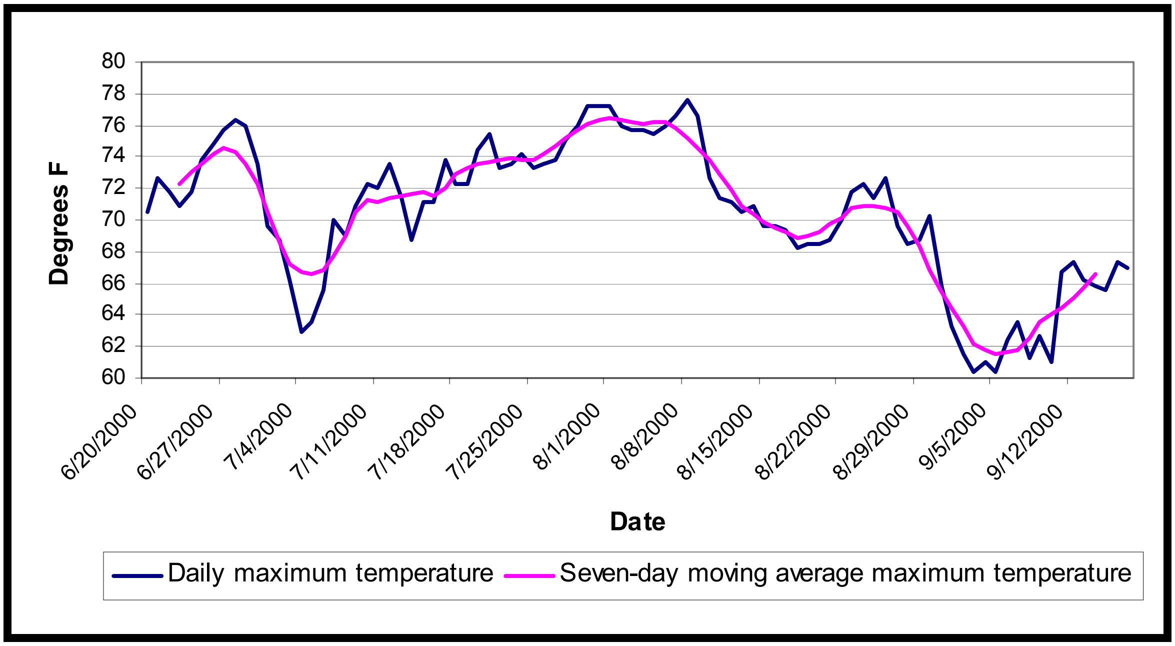


Figure 3-2: Daily maximum temperature and seven-day moving average maximum temperature for West Fork Cow Creek at the mouth.

Influences on stream temperature

The ultimate source of stream heat is the sun, either by direct solar radiation or by ambient air and ground temperature around the stream, which are also a result of solar energy.[43] Groundwater has the least exposure to solar energy, and therefore is at the coolest temperature (52°F in the Umpqua Basin). Since groundwater accounts for a large proportion of a stream's flow at the headwaters, streamflow is generally coolest at the headwaters. When groundwater enters a stream and become surface water, it is exposed to solar energy and will become warmer until it reaches equilibrium with ambient temperatures and direct solar radiation levels. As solar energy inputs change, such as at night, so do the ambient and stream temperatures.

If solar energy were the only influence on stream warming, it would be expected that stream temperature would increase at a smooth and steady rate until the stream was in

[43] Friction adds a very small amount of heat to streams. Geothermal heat is a minor factor in the Umpqua Basin.

equilibrium with solar energy inputs. However, stream temperature at a given location is influenced by two factors: the temperature of the upstream flow and local conditions. As upstream flow reaches a given stream location, factors such as stream morphology and riparian buffer conditions can affect warming rates. For example, data from the Smith Report indicate that when upstream flow enters a reach that is highly exposed to direct solar radiation, the flow in that reach is usually warmer than would be expected from the upstream flow's temperature.

Localized groundwater influx and tributary flow can reduce stream temperatures. When groundwater enters a stream, it mixes with the warmer upstream surface flow until temperature equilibrium is reached. As the proportion of groundwater increases, so will the cooling effect. Groundwater has the greatest influence on small and medium-sized streams. This is partially because groundwater constitutes a greater proportion of small streams' flow. As a result, cooler flow from small tributaries entering larger streams can, like groundwater influx, reduce stream temperature at that location. In some cases, this may also occur when a tributary is practically dry. Evidence from the Smith Report and from Smith's "Thermal Transition in Small Streams Under Low Flow Conditions" suggest that in some cases tributaries with gravel-dominated streambeds permit cooler subsurface water to pass into the mainstem, even when the stream has little or no surface flow. Smith suggests that the lower reaches and mouths of small and medium-sized tributaries, and reaches within warm streams that have high groundwater influx and shade, may provide important shelter for fish during the summer months. An important implication of Smith's studies is that prevailing stream temperatures on small streams can be strongly influenced by local conditions. Local stream temperature management restoration projects may be very effective in improving stream temperature conditions in many small streams in the Umpqua Basin.[44]

3.3.3. Sedimentation and turbidity

Sediment is any organic or inorganic material that enters the stream and settles to the bottom. When considering water quality, this assessment is specifically referring to very fine particles of organic or inorganic material that have the potential of forming streambed "sludge." The beneficial uses affected by sedimentation are resident fish and aquatic life, and salmonid fish spawning and rearing. Salmonids need gravel beds for spawning. Eggs are laid in a gravel-covered nest called a "redd." Water is able to circulate through the gravel, bringing oxygen to the eggs. The sludge layer resulting from stream sedimentation does not allow water circulation through the redd and will suffocate salmonid eggs. Although there are many aquatic organisms that require gravel beds, others, such as the larvae of the Pacific lamprey, thrive in sludgy streams.

Sediment is considered to be water quality limiting if beneficial uses are impaired. ODEQ determines impairment by monitoring changes in aquatic communities (especially macroinvertebrates, such as insects), changes in fish populations, or by using information from non-ODEQ documents that use standardized protocols for evaluating aquatic habitat and fish population data. Currently, ODEQ monitors streams for total suspended solids,

[44] From Kent Smith's "Thermal Transition in Small Streams Under Low Flow Conditions" (2002).

which indicates sedimentation. At the writing of this assessment, there are no established criteria for these data.

Turbidity is closely related to sediment because it is a measurement of water clarity. In many cases, high turbidity indicates a large amount of suspended sediment in a stream. Small particles such as silt and clay will stay suspended in solution for the longest amount of time. Therefore, areas with soils comprised of silt and clay are more likely to be turbid than streams in areas with coarser soil types. Also, turbidity levels can rise during a storm event. This is because rapidly moving water has greater energy than slower water. During storms, upland material is washed into the stream from surface flow, which adds sediment to the system.

The beneficial uses affected by turbidity are resident fish and aquatic life, public and private domestic water supply, and aesthetic quality. As turbidity increases, it becomes more difficult for sight-feeding aquatic organisms to see, impacting their ability to search for food. High levels of suspended sediment can clog water filters and the respiratory structures in fish and other aquatic life. According to OWEB, suspended sediment is a carrier of other pollutants, such as bacteria and toxins, which is a concern for water quality in general. Finally, clear water is simply more pleasant than cloudy water for outdoor recreation and enjoyment.

Turbidity is measured by passing a light beam through a water sample. As suspended sediment increases, less light penetrates the water. Turbidity is recorded in NTUs (nephelometric turbidity units), and high NTU values reflect high turbidity. According to ODEQ, turbidity is water quality limiting when NTU levels have increased by more than 10% due to an on-going operation or activity, such as dam releases or irrigation. OWEB recommends using 50 NTUs as the turbidity evaluation criteria for watershed assessments. At this level, turbidity interferes with sight-feeding aquatic organisms and provides an indication of the biological effect of suspended sediment.

Sediment delivery processes[45]

Erosion is a natural process, but it can become a problem in watersheds when it is accelerated by human activities. An increased amount of erosion that fish are not adapted to can be harmful to their populations by decreasing dissolved oxygen levels through the introduction of nutrients to water, decreasing sunlight penetration leading to degraded plant growth, and filling in spawning gravels. Certain human manipulations of the landscape are common causes of increased erosion. These include the construction of roads and their subsequent modification of fluvial (stream) processes, the removal of vegetation, such as timber harvesting, crop and range agriculture, and residential development. Because the West Fork Cow Creek Watershed is unpopulated, many of these influences are minimal. However, timber harvesting may modify the landscape and affect stream systems. With good management, the impact of these practices can be reduced.

[45] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the introductory text for this section.

Without further field verification and analysis using GIS, a more in-depth and detailed report on sediment processes within the watershed is beyond the scope of this screening-level assessment. This assessment reviews four potential sources of stream sedimentation and turbidity in the watershed: roads and culverts, slope and debris flow potential, soils, and burns.

<u>Roads and culverts</u>
As is the case in many watersheds, sediment delivery from dirt and gravel roads is a leading cause of increased sediment in stream systems. Road sediment production and delivery involves many factors and processes such as road surface type, ditch infeed lengths, proximity to nearest stream channel, condition of road, and level and type of use the road system receives. Since complete road data for the watershed are not available, specific values for sediment delivery from the road system are not included in this assessment. Rather, this assessment looks at the current state of road types, road to stream proximity and slope, and culverts.[46]

Roads can be divided into two types: surfaced and unsurfaced. Surfaced roads are ones that have been paved or rocked. Unsurfaced roads are dirt roads. Unsurfaced roads are much more likely to erode and fail than surfaced roads. There are 398.6 miles of roads in the West Fork Cow Creek Watershed. These are broken into seven classes (see Table 3-6).

Surface type	**Road miles**	**% total**
Surfaced		
• Paved	27.5	6.9%
• Gravel, 3” minus rock	37.2	9.3%
• Gravel, 1-½” minus rock	31.4	7.9%
• Pit run rock, rolled[47]	21.5	5.4%
• Pit run rock, not rolled	60.3	15.1%
Total surfaced	**177.9**	**44.6%**
Unsurfaced	78.1	19.6%
Unknown	142.6	35.8%

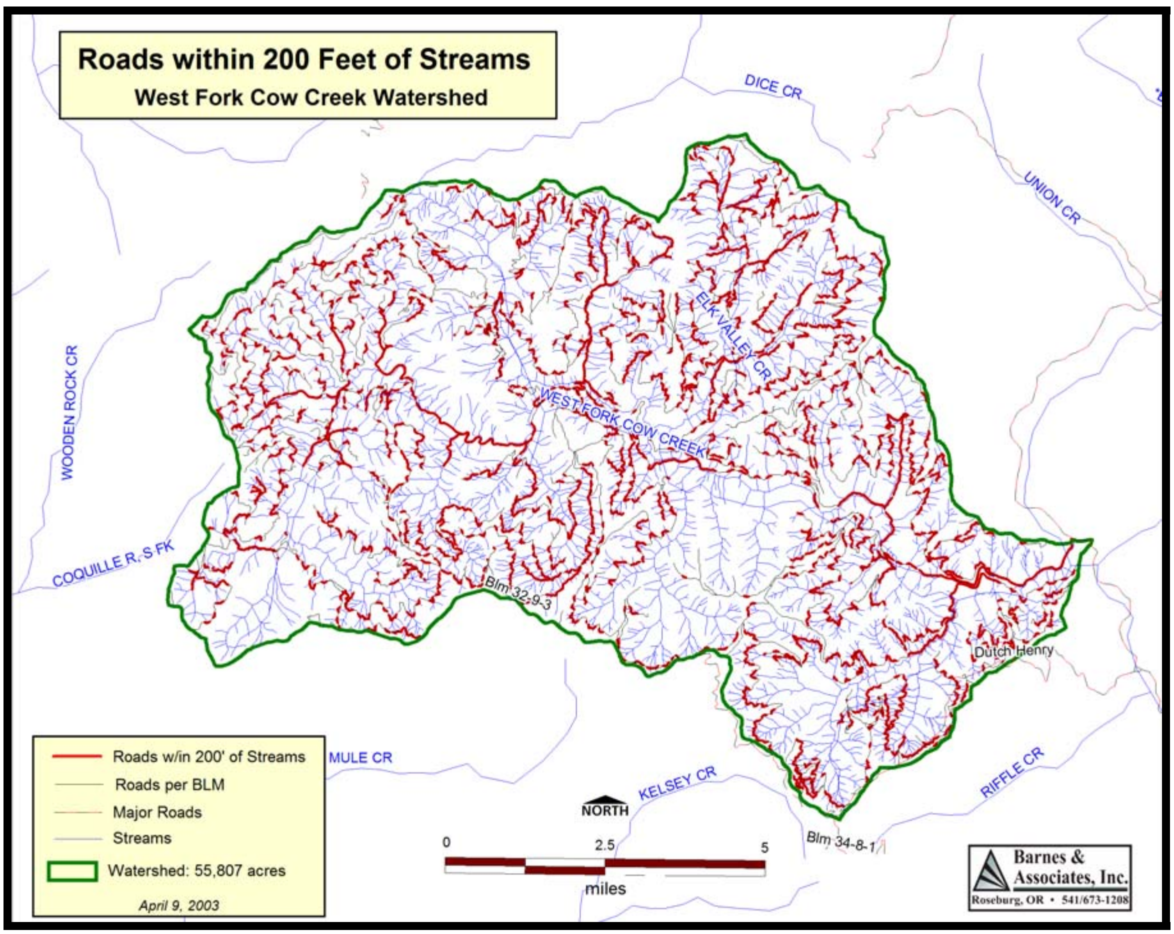
Table 3-6: Miles and percent of West Fork Cow Creek Watershed roads by class.

The closer a road is to a stream, the greater the likelihood that road-related runoff contributes to sedimentation. In the West Fork Cow Creek Watershed, there are 184.8 miles of roads (46.4% of 398.6 total miles) within 200 feet of streams (see Map 3-9). Of these, approximately 91.5 miles (49.5%) are surfaced roads, 37.7 miles (20.4%) are unsurfaced roads, and 55.6 miles (30.1%) are unknown.

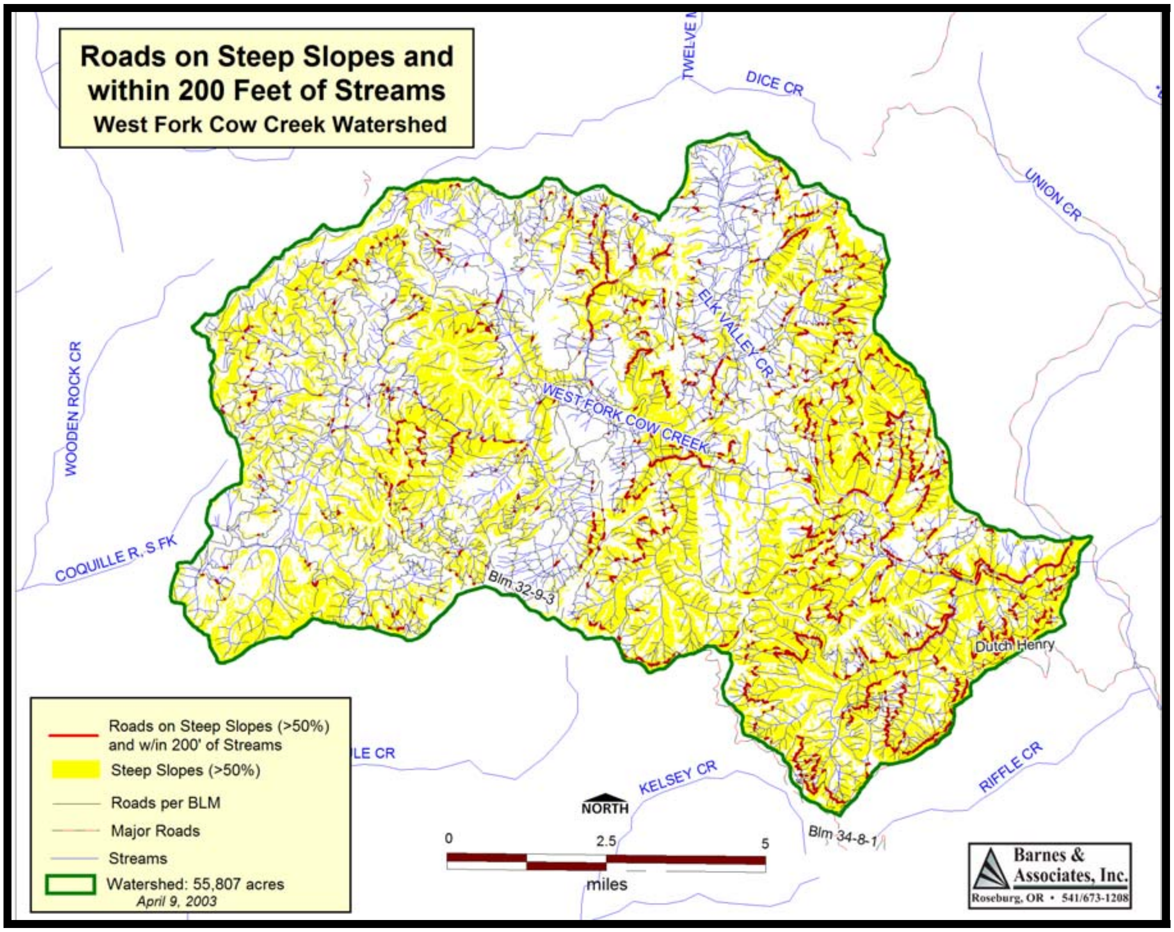
[46] Jenny Allen and Tim Grubert of BioSystems, Inc., contributed this paragraph.
[47] “Pit run rock” is rock of various sizes, much of which is large.

Roads on steep slopes have a greater potential for erosion and/or failure than roads on level ground. There are approximately 49.6 miles of roads (12.4% of 398.6 total miles) located on a 50% or greater slope and within 200 feet of a stream (see Map 3-10). Of these roads on steep slopes, 23.0 miles (46.4%) are surfaced, 16.5 miles (33.3%) are unsurfaced, and 10.1 miles (20.4%) are closed or unknown. An analysis of road conditions near streams is necessary to determine how much stream sedimentation is attributable to road conditions.

Like roads, culverts can contribute to stream sedimentation when they are failing. Culverts often fail when the pipe is too narrow to accommodate high stream flows, or when the pipe is placed too high or too low in relation to the surface of a stream. In the latter cases, the amount of flow overwhelms the culvert's drainage capacity, and water floods around and over the culvert, eroding the culvert fill, road, and streambank. At this time, it is unknown how many of these crossing are culverts and how many culverts are failing. Section 3.1.2 provides more information about current culvert identification and restoration efforts in the Umpqua Basin.



Map 3-9: Locations of West Fork Cow Creek Watershed roads within 200 feet of a stream.

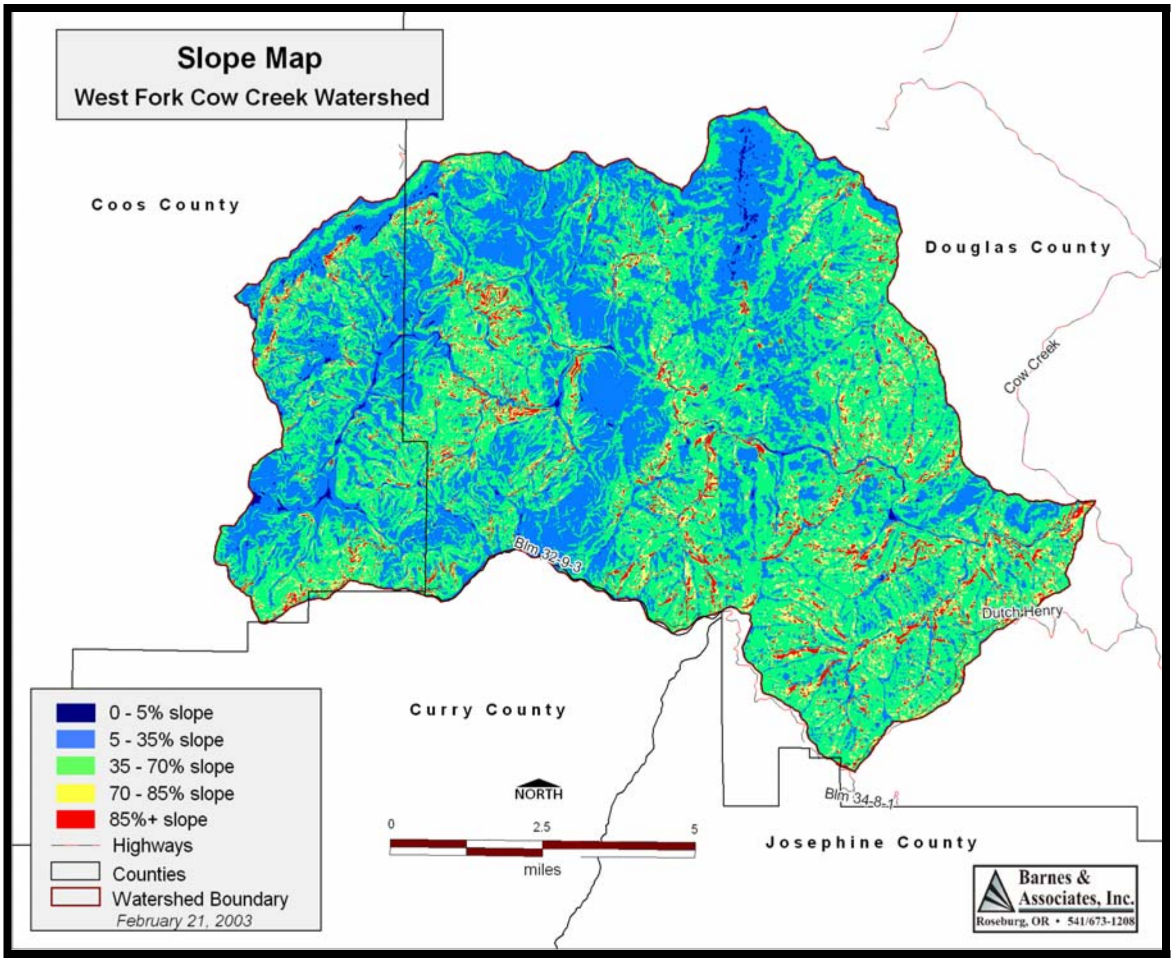


Map 3-10: Locations of West Fork Cow Creek Watershed roads within 200 feet of a stream and on slopes that are greater than 50%.

Slope and debris flow potential[48]

Steep slopes provide greater energy to runoff and therefore have more power to deliver sediment to streams. Slope is an important consideration to sediment delivery, both in long-term erosion processes and in catastrophic events. Map 3-11 shows the slope throughout the watershed. Relatively steep slopes can be seen throughout the watershed. A particularly abrupt slope change can be seen near the northwestern edge of the watershed at the contact between the Tyee Formation and the Myrtle Group (see section 1.2.4 and Appendix 1 for more geologic information).

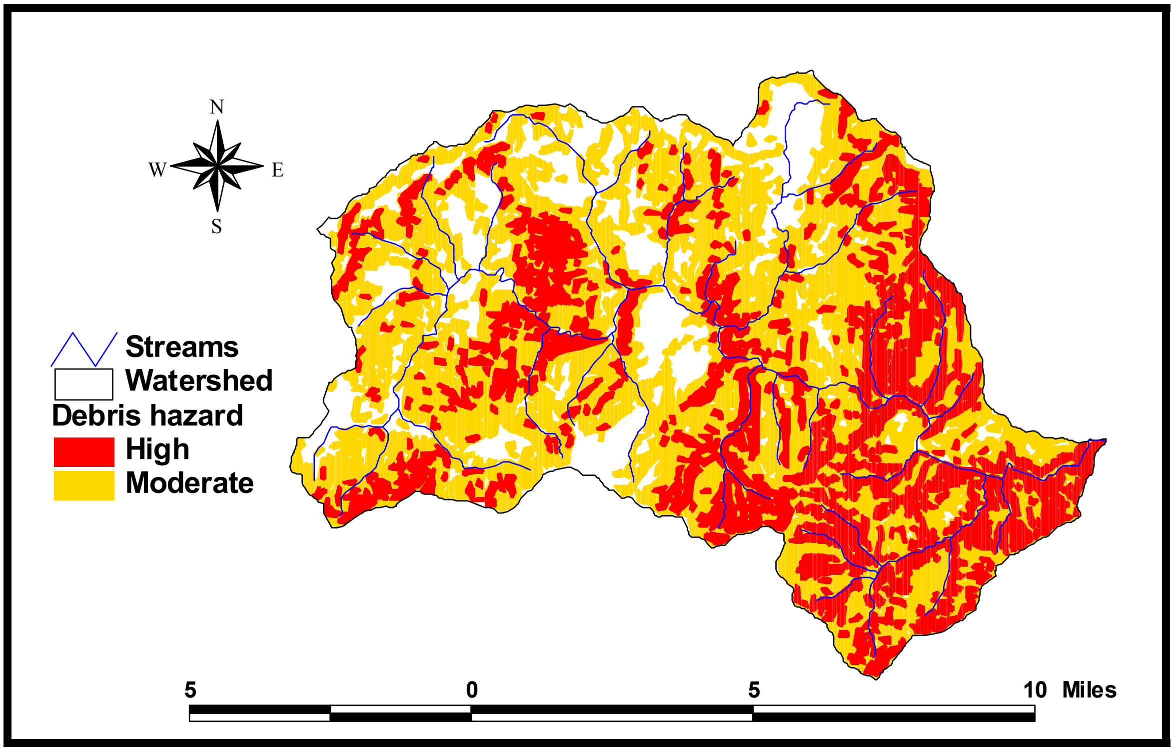
[48] Kristin Anderson and John Runyon of BioSystems, Inc., contributed this section's text, table, and Map 3-12, Map 3-13, and Map 3-14.



Map 3-11: Percent slope for the West Fork Cow Creek Watershed.

The slope of land will clearly influence the hazards for catastrophic slope failure and mass sediment delivery downslope. Physical characteristics of geologic units have also been shown to influence the occurrence of debris flows (e.g., Graham, 1985, and Lane, 1987). The Oregon Department of Forestry (ODF, 2000) identified areas that may naturally be prone to debris flows. Using slope steepness, geologic units, stream channel confinement, geomorphology, and historical information on debris flows, they created coarse scale maps of moderate, high, and extreme natural debris flow hazards. While this information is not intended for localized management decisions, it is a tool to locate areas where further field investigations may be pertinent when determining management plans. Natural debris flow hazards as determined by ODF in the West Fork Cow Creek Watershed are shown in Map 3-12. This ODF study will very soon be superceded by a much more refined debris hazard mapping effort. For purposes of planning and localized hazard identification, this forthcoming study will be much more valuable. Information regarding this new data will be available at Nature of the Northwest in Portland, Oregon.

Mass wasting, or the downslope movement of materials, causes significant and sometimes catastrophic sediment delivery to streams. An original, updated mapping study of landslide areas using aerial photos would provide valuable information about past and potential landslides in the watershed.[49]



Map 3-12: Natural debris flow hazard areas in the West Fork Cow Creek Watershed as outlined in a coarse scale study by ODF.

Soils[50]

Certain characteristics of soils within a watershed play an important role in erosion and storm runoff, both of which impact watersheds. Rapid runoff from rain events can cause pulses of concentrated pollutants and sediment throughout stream systems, ultimately impacting fish populations and the overall health and function of stream systems. Both erosion potential and hydrologic soils grouping are qualities of soils that can give some indication of areas prone to experiencing hydrologic processes that may negatively impact stream characteristics. Information in this section has been summarized from the following documents: *Oregon Watershed Assessment Manual* (Watershed Professional Network, 1999); and *Technical Release 55* (USDA, 1986).

Hydrologic soils groups

Hydrologic soil groupings (HSG) are a categorization of soils by their runoff potential and infiltration capacity. In these groupings, group A represents soils with the lowest runoff potential and the highest infiltration rate, while group D is on the opposite end of the spectrum, having high runoff potential and a low infiltration rate. The runoff

[49] Information on upcoming data and landslide mapping provided by R. J. Hofmeister (Oregon Department of Geology and Mineral Industries, verbal communication, 2003).

[50] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the text and table for this section.

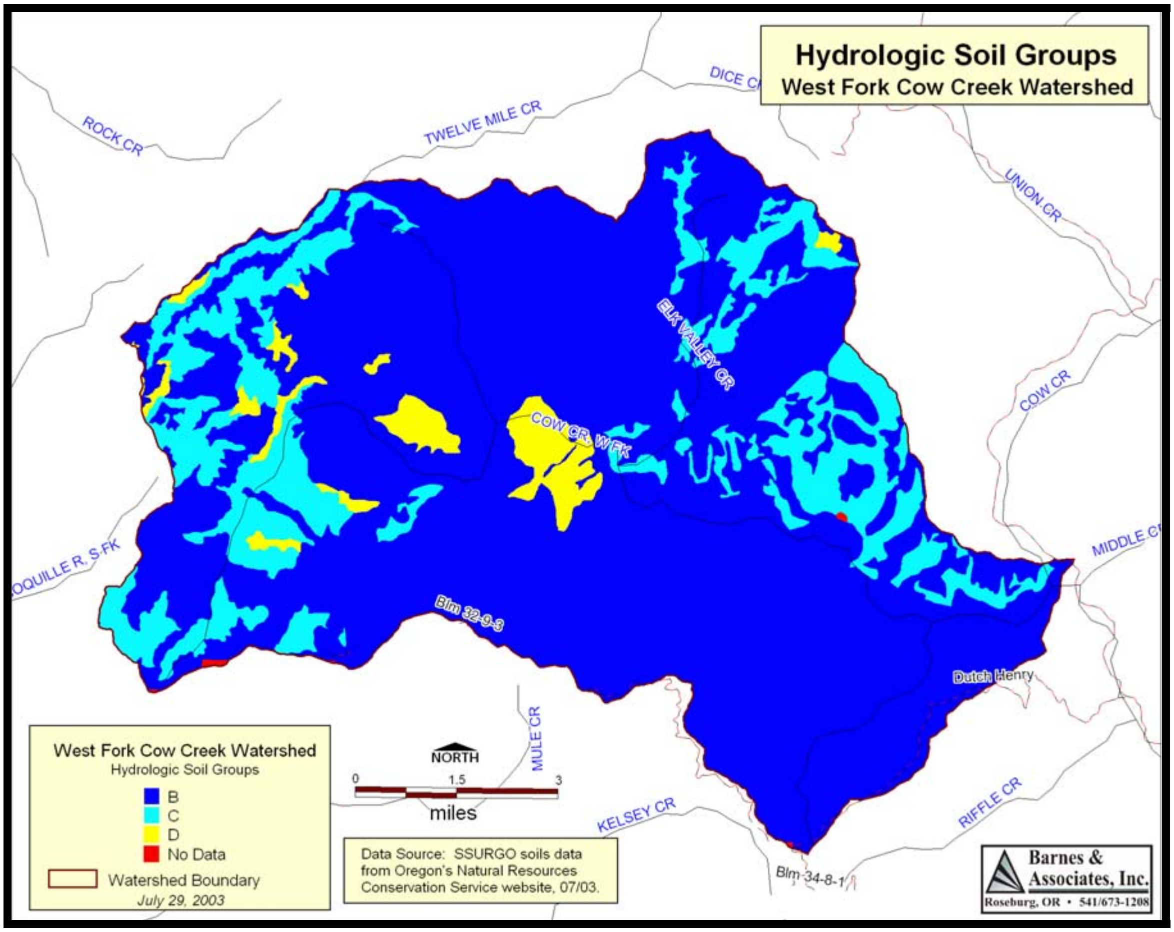
potential and infiltration rate of soils influence runoff from precipitation. With greater amounts of runoff, more erosion and higher peak flows are likely to occur, with the possibility of large pulses of sediment to streams. Table 3-7 provides descriptions of the hydrologic soil groups.

The majority of the West Fork Cow Creek Watershed has soils within the B hydrologic group, having moderate infiltration rates and moderate drainage (see Map 3-13). Soils within the C and D hydrologic groups are found mostly in the western and eastern reaches of the watershed. These areas may be more prone to delivering sediment and faster runoff than other areas. Two noticeable areas of D-group soils are seen near the center of the watershed. The southwestern side of Gold Mountain across West Fork Cow Creek from the outlet of Slide Creek and the area northeast of Walker Creek are prone to high runoff. Despite the watershed's generally moderate infiltration and runoff soil characteristics, the landscape is fairly steeply sloped. Slopes are also important to erosion and runoff processes.

HSG	Soil Description
A	Have low runoff potential and high infiltration rates even when thoroughly wetted; consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).
B	Have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures; have a moderate rate of water transmission (0.15-0.30 in/hr).
C	Have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture; have a low rate of water transmission (0.05-0.15 in/hr).
D	Have high runoff potential; have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material; have a very low rate of water transmission (0-0.05 in/hr).

Table 3-7: Hydrologic soil group descriptions.[51]

[51] From USDA Technical Release 55 (1986).

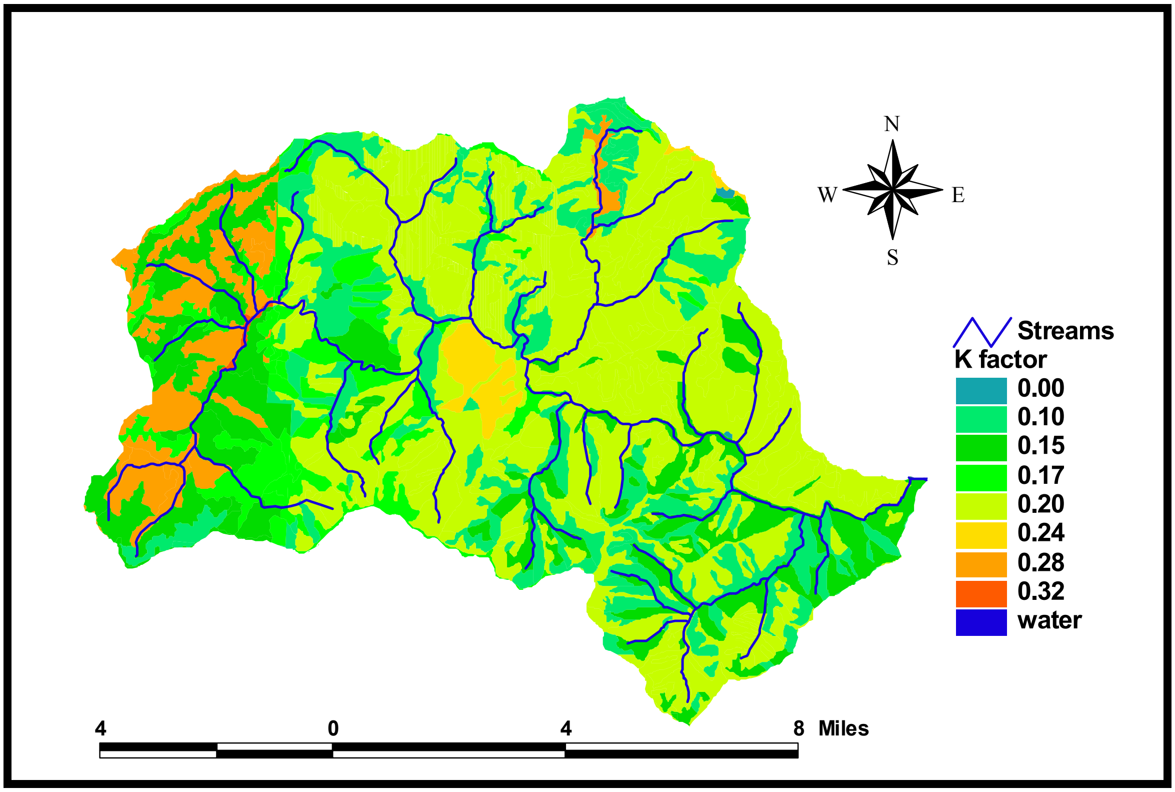


Map 3-13: Hydrologic soils map of the West Fork Cow Creek Watershed.

Soil K factor

The K factor, or soil erodibility, is a measure of detachability of the soil, infiltration, runoff, and the transportability of sediment that has been eroded from the soil. Texture (the relative percentage of different grain sizes within the soil), organic matter, structure, and permeability of the soil determine the K factor value assigned to a soil. In general, soils with high infiltration rates (and thus low runoff rates), low detachability, and low transportability are least likely to erode, and are given low K factor values (USDA Agriculture Research Service National Sedimentation Laboratory, 2003). K factor values typically range from 0 to 0.6 (Pacific Northwest National Laboratory, 2003).

Map 3-14 depicts the K factor adjusted for the effect of rock fragments of the surface layer of soil within the West Fork Cow Creek Watershed. No areas of high erodibility rates (>0.4) are found within the watershed. Areas with moderate erodibility rates are found primarily in the western portion of the watershed in the Cretaceous and Jurassic geologic units. The majority of the watershed is in areas with low or moderate to low soils erodibility.

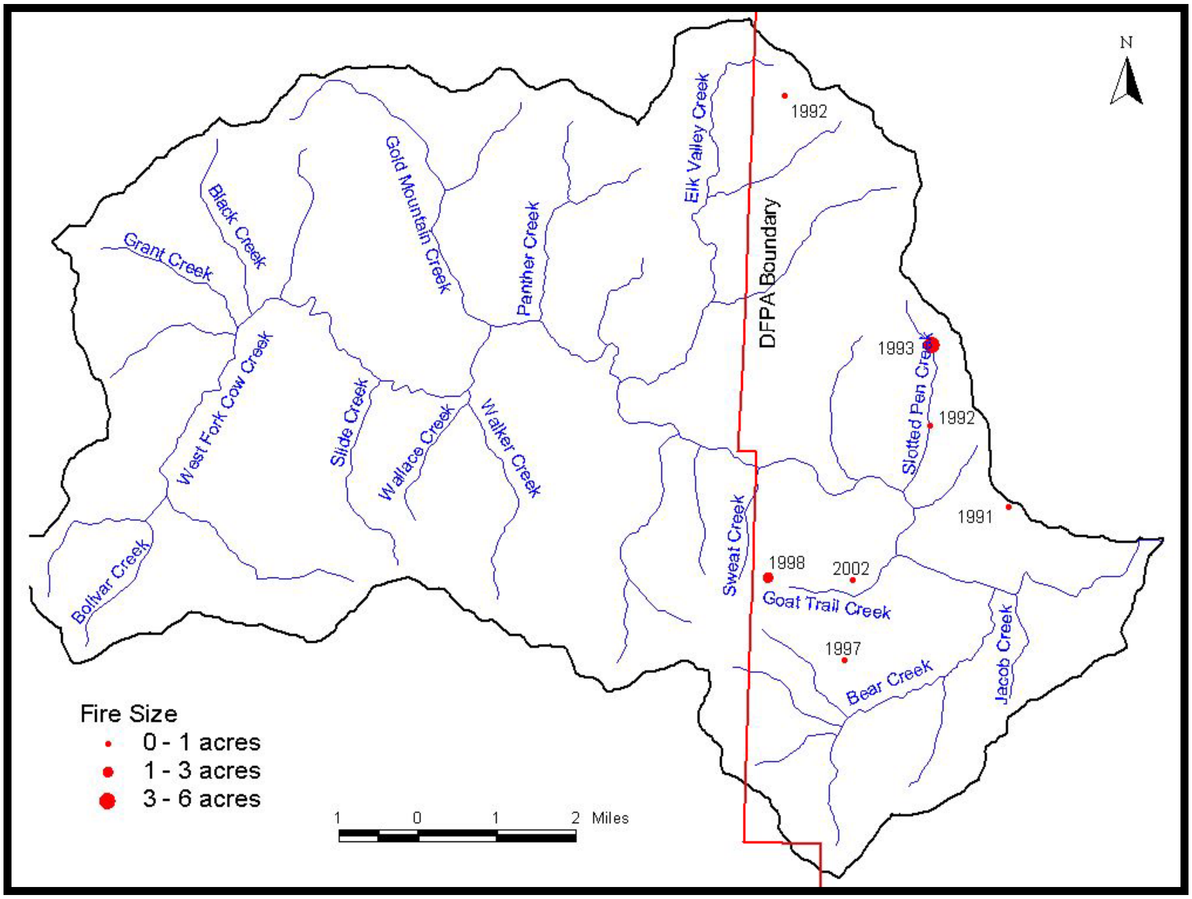


Map 3-14: K factor for the West Fork Cow Creek Watershed.[52]

<u>Burns</u>

Burned areas erode more easily than unburned areas because of the lack of vegetative cover and abundance of fine material. Map 3-15 and Table 3-8 show the location, years, and size of non-permitted (accidental) fires in the West Fork Cow Creek Watershed from 1991 through 2001. Burn data are only available for the portion of the watershed within the Douglas Forest Protective Association's jurisdiction. UBWC staff members were unable to locate quantitative data on burn/stream proximity and therefore the potential for stream sedimentation from burns cannot be evaluated.

[52] Kristin Anderson and John Runyon of BioSystems, Inc., contributed this map.



Map 3-15: Wildfire location, year, and size in the West Fork Cow Creek Watershed.

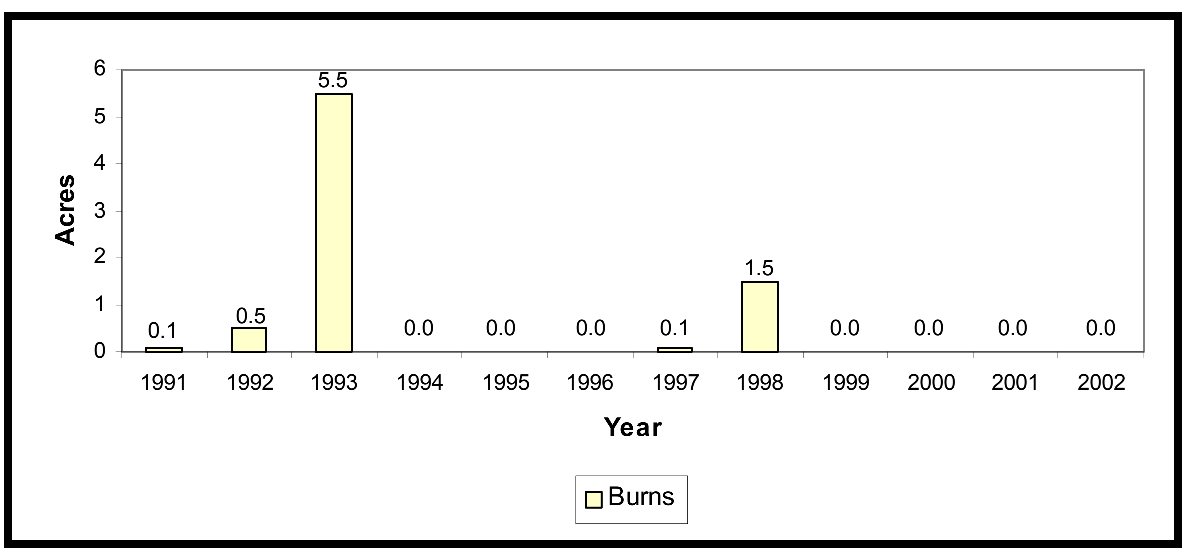


Table 3-8: Acres burned by year for the West Fork Cow Creek Watershed.

3.3.4. Water quality key findings and action recommendations

Temperature key findings

- Seven-day moving average maximum temperatures in for West Fork Cow Creek at the mouth were frequently above 64°F. Consistently high stream temperatures would limit salmonid rearing at this location.
- The UBWC was unable to locate stream temperature data for West Fork Cow Creek tributaries.
- The following findings for the general Cow Creek system might also apply to the West Fork Cow Creek Watershed:
  - ➢ Warmer sites often lack shade. Increasing shade on small and medium-sized streams will reduce stream warming rates and improve habitat for salmonids.
  - ➢ Groundwater and tributary flows can contribute to stream cooling. Gravel-dominated tributaries may permit cooler subsurface flows when surface flows are low.
- Fish may find shelter from high summer temperatures in the lower reaches and mouths of small and medium-sized tributaries and in reaches within warm streams that have proportionately high groundwater influx and shade.

Surface water pH, dissolved oxygen, nutrients, bacteria, and toxics key findings

- There are insufficient data to draw conclusions about pH, dissolved oxygen, nutrients, bacteria, and toxics in the West Fork Cow Creek Watershed.

Sedimentation and turbidity key findings

- Turbidity data indicate that usual turbidity levels in Lower Cow Creek do not impair sight-feeding fish like salmonids.
- Areas of moderate to high soil erodibility and runoff potential lie in the large floodplain area of Cow Creek near Riddle and west of the floodplain where the Otter Point Formation lies.
- Steep to moderately steep slopes dominate the topography of the watershed. The combination of steep slope along with poorly managed, erosion-inducing human modifications such as roads, timber harvesting, agriculture, and residential development can make areas prone to greatly increased erosion.
- In the Umpqua Basin, more studies are needed to determine the impacts of roads, culverts, landslides, burns, soil type, and urban conditions on sedimentation and turbidity.

Water quality action recommendations

- o Increase the frequency and locations of water quality monitoring in the West Fork Cow Creek Watershed for all water quality parameters that can be affected by timber management activities.
- o Along West Fork Cow Creek, identify areas that may serve as “oases” for fish during the summer months, such as at the mouth of small or medium-sized tributaries. Protect or enhance these streams’ riparian buffers and, when appropriate, improve instream conditions by placing logs and boulders within the active stream channel to create pools and collect gravel.

- Where stream temperature is a concern, increase shade by encouraging wide riparian buffers and managing for full canopies.
- Use the refined debris flow hazard data, which will soon be available at Nature of the Northwest in Portland, to identify landslide-sensitive areas.
- Complete an original, detailed landslide identification study using aerial photography to identify sensitive and disturbed areas.
- In areas that have high K factor values or with high concentrations of group C or D hydrologic soils, encourage landowners to identify the specific soil types on their properties and include soils information in their land management plans.
- Use proper management practices (such as controlling road runoff from improper drainage) to control erosion in sensitive areas of the watershed.

3.4. Water quantity

3.4.1. Water availability[53]

Data from the Oregon Water Resources Department (OWRD) has been used to determine water availability in the West Fork Cow Creek Watershed. Availability is based on streamflow, consumptive use, and instream water rights. The amount of water available for issuance of new water rights is determined by subtracting consumptive use and the instream water right from streamflow. In most of the Umpqua Basin, including the West Fork Cow Creek Watershed, there is no water available for new water rights from "natural" streamflow during the summer.[54]

To analyze water availability, OWRD has divided the Umpqua Basin into water availability units, or WABs. The West Fork Cow Creek Watershed consists one WAB (#31630216) that encompasses the entire watershed. The solid yellow area on Figure 3-3 is the 50% exceedence, or average, stream flow in cubic feet per second (cfs). The dark blue line represents the cfs for instream water rights, and the red line is the estimated consumptive use. The light blue line represents the expected stream flow, which is calculated by subtracting consumptive use from the average stream flow. In this WAB, instream water rights exceed average streamflow in October.

[53] David Williams, the Oregon Water Resources Department Watermaster for the Umpqua Basin, contributed the background text for section 3.4.1. Water availability data are from the OWRD's Water Availability Report System database (http://www.wrd.state.or.us/).

[54] In some circumstances, domestic water rights can be obtained if there is no other source of water on a property. Contact the Water Resources Department for more information.

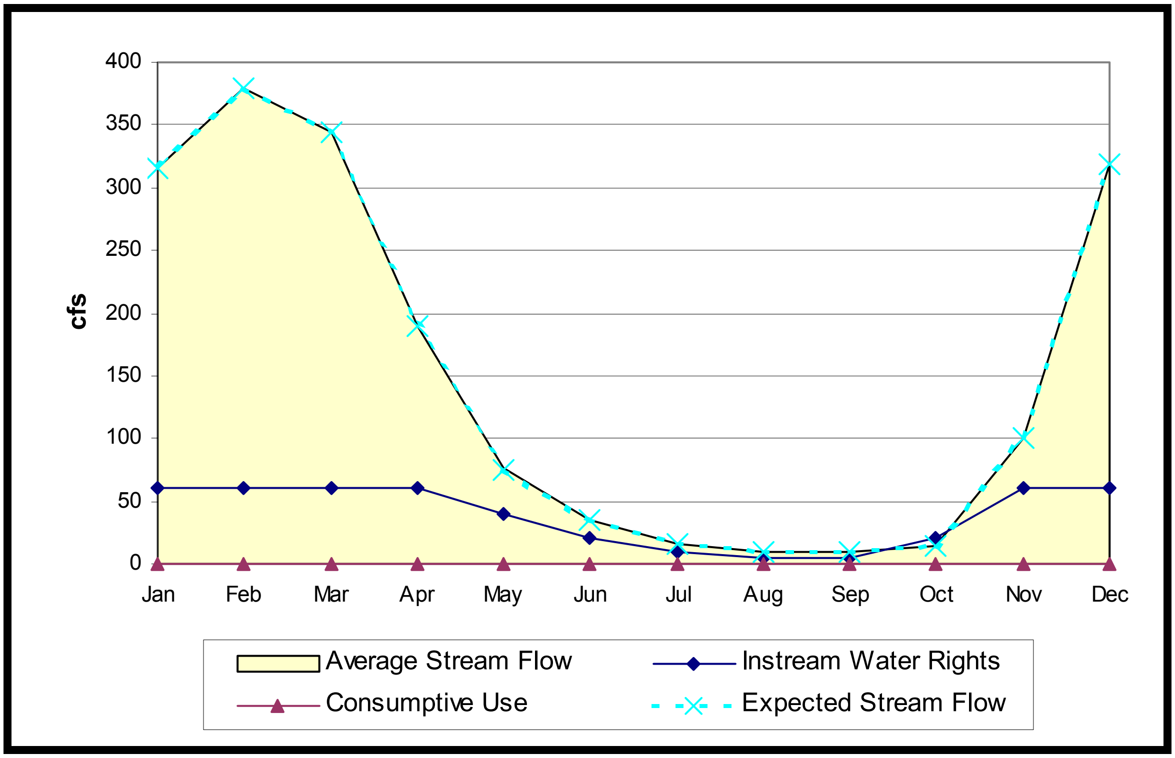


Figure 3-3: Water availability in the West Fork Cow Creek WAB (#31630216).

3.4.2. Water rights by use[55]

Table 3-9 shows consumptive use by category for the West Fork Cow Creek Watershed. Appendix 5 lists the possible uses included in each category. Table 3-9 shows uncanceled water rights and do not indicate actual water consumption. Uncanceled water rights include: 1) valid rights, which are ones that have not been intentionally canceled and the beneficial use of the water has been continued without a lapse of five or more consecutive years in the past 15 years; and 2) rights that are subject to cancellation due to non-use.[56]

In the West Fork Cow Creek Watershed, the "miscellaneous" category is the largest water use for the total watershed. All miscellaneous uses are on tributaries; this category includes forest management, fire protection, road construction, and storage. On West Fork Cow Creek, the largest water use is "industrial" followed by "domestic." Since there is no resident population in this watershed, it can be assumed that many of the water rights listed in Table 3-9 are no longer active.

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[55] Water rights data are available from the OWRD's Water Rights Information System database available at http://www.wrd.state.or.us/.

[56] For more information about water rights, contact the Oregon Water Resources Department.

	TOTAL		West Fork Cow Creek		Tributaries	
Use	Cubic feet/sec	% Total	Cubic feet/sec	% of Cow Creek total	Cubic feet/sec	% of trib. total
Domestic	0.15	12.8%	0.15	37.5%	0.00	-
Irrigation	0.02	1.7%	0.00	-	0.02	2.6%
Industrial	0.25	21.4%	0.25	62.5%	0.00	-
Misc.	0.75	64.1%	0.00	-	0.75	97.4%
Total	**1.17**	**100.0%**	**0.40**	**100.0**	**0.77**	**100.0**

Table 3-9: Water rights by use for the total West Fork Cow Creek Watershed, West Fork Cow Creek, and tributaries.

3.4.3. Stream flow and flood potential

The US Geological Survey (USGS) stream gauge on West Fork Cow Creek near Glendale (gauge #14310000) has been active since 1955. Figure 3-4 charts the monthly historical average flow for West Fork Cow Creek through 2001. As would be expected from climate information in section 1.2.6, the winter months have the greatest average flow due to higher precipitation levels. Summer average flows during the summer can drop below 10 cfs.

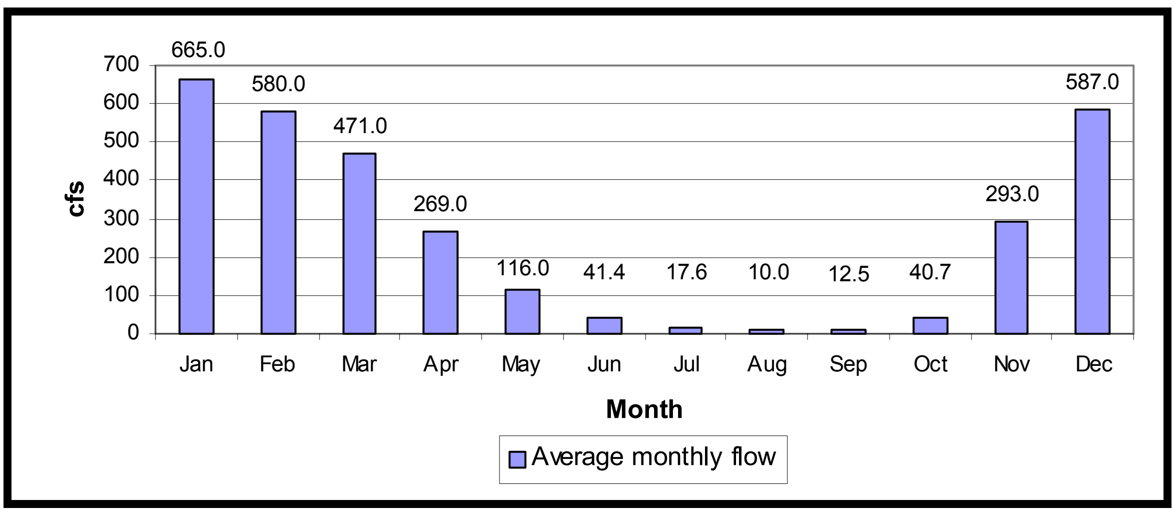


Figure 3-4: Average monthly water flow for West Fork Cow Creek (gauge #14309500).

Figure 3-5 shows peak flow data for West Fork Cow Creek from water years 1956 through 2001.[57] Figure 3-6 shows the average annual streamflow from 1956 through 2000. Each point represents the highest recorded streamflow during the water year.

57 Data are shown by water year. Water years begin October 1 and end September 30. Therefore, a flood event in December, 2001 will be recorded in the 2002 water year.

Average annual streamflow and peak flow events vary from year to year. A year with a high peak flow event, such as 1965, does not necessarily correspond with a high average annual streamflow year. Overall, it appears that peak flows and annual average flows are declining in West Fork Cow Creek as indicated by the black trend lines in Figure 3-5 and Figure 3-6.

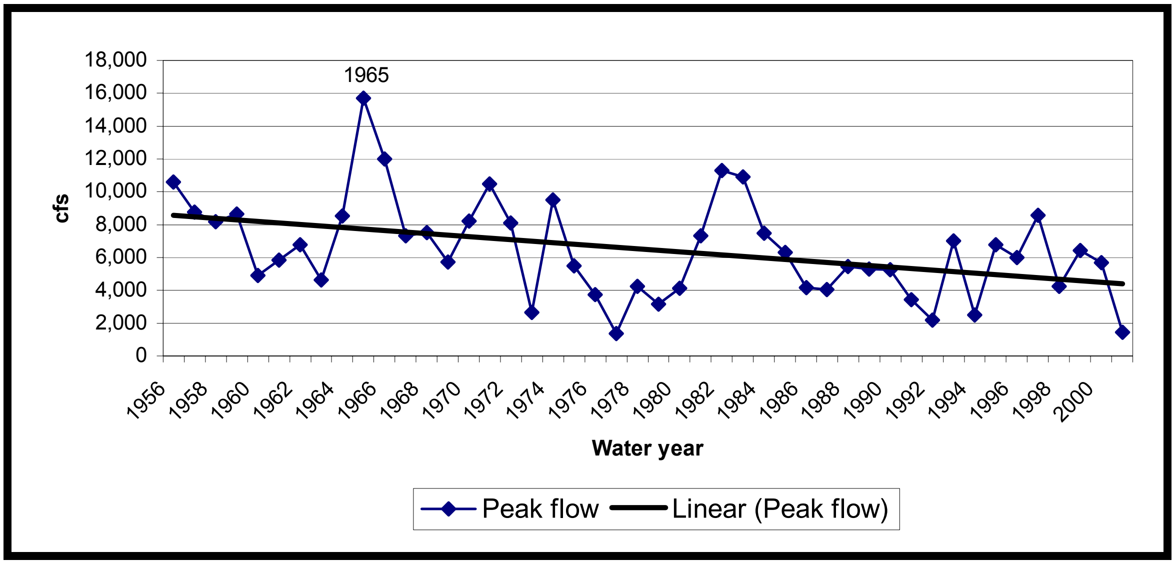


Figure 3-5: Peak flow for West Fork Cow Creek (gauge #14309500).

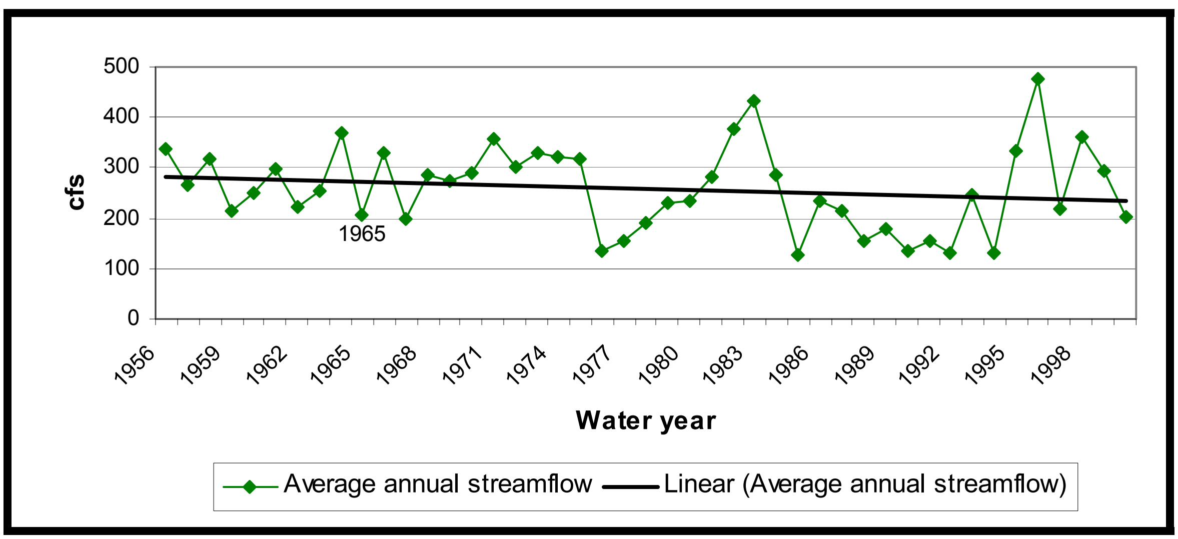


Figure 3-6: Average annual streamflow for West Fork Cow Creek (gauge #14309500).

Influences on flood potential

Approximately 80% of the West Fork Cow Creek Watershed is within the transient snow zone (TSZ) (see section 1.2.3). In the TSZ, snow can accumulate in areas with open canopies such as meadows, burned areas, or timber harvest units. When rain falls on the accumulated snow, the snow quickly melts and can result in high runoff levels and peak streamflows. Streams with headwaters in the TSZ zone are more susceptible to rain-on-snow events than lower elevation streams.

Road density can also influence peak flows. Table 3-10 shows the miles of road per square mile for paved, gravel, and dirt roads. Paved roads are impermeable to water, and rock or dirt roads are somewhat permeable. When it rains or accumulated snow on road surfaces melts, water that is not absorbed will flow off the road. The soil and vegetation surrounding the road may absorb the runoff. If the surrounding area is unable to absorb the excess water, and if the road is close to a stream, then the excess water flows into the stream, resulting in high peak flows. The relationship between roads, streams, and peak flows is dependent on many factors, and the influence of roads on stream flow and peak events is debatable.

Road type	Road miles/ square mile
Paved	0.3
Gravel	1.7
Dirt	0.9

Table 3-10: Miles of road per square mile for surfaced and unsurfaced roads in the West Fork Cow Creek Watershed.

3.4.4. Water quantity key findings and action recommendations

Water availability and water rights by use key findings

- In the West Fork Cow Creek Watershed WAB, there is no resident population and so consumptive use is very low. Instream water rights exceed average streamflow in October.
- During the summer, there is no “natural” streamflow available for new water rights.
- “Miscellaneous uses,” which are forest management, fire protection, road construction, and storage, are the largest water uses for the West Fork Cow Creek Watershed. “Industrial” is the largest use of water on mainstem West Fork Cow Creek; this water right is probably no longer active.

Stream flow and flood potential key findings

- Data suggest that peak flows and annual streamflow for the West Fork Cow Creek Watershed are decreasing.
- The degree to which road density and the TSZ influence flood potential in the West Fork Cow Creek Watershed is unknown at this time.

Water quantity action recommendations

- o Continue monitoring peak flow trends in the watershed. Try to determine the role of vegetative cover, flooding, road density, and the TSZ on water volume.

3.5. Fish populations

3.5.1. Fish presence

Table 3-11 lists the fish species in the West Fork Cow Creek Watershed that have viable, reproducing populations or annual runs. Although fall chinook (*Oncorhynchus tshawytscha*) have been documented in West Fork Cow Creek, their presence is intermittent and does not constitute a salmon run.[58] Redside shiners (*Richardsonius balteatus*) have been observed in the watershed; it is unclear whether or not these fish have reproducing populations.

The Oregon Coast coho salmon was listed as a threatened species in 1998 under the Endangered Species Act of 1973. Currently, there are no other threatened or endangered aquatic species in the West Fork Cow Creek Watershed. In January, 2003, various groups petitioned to protect the Pacific lamprey and western brook lamprey, as well as two other lamprey species, under the Endangered Species Act.

Common Name	***Scientific Name***
Steelhead (winter)	*Oncorhynchus mykiss*
Coho salmon	*O. kisutch*
Cutthroat trout	*O. clarkii*
Western brook lamprey	*Lampetra richardsoni*
Pacific lamprey	*Lampetra tridentata*
Umpqua dace	*Rhinicthys cataractae*
Sculpin	*Cottus sp.*
Speckled dace	*Rhinicthys osculus*

Table 3-11: Fish with established populations or runs within the West Fork Cow Creek Watershed.

3.5.2. Fish distribution and abundance

Information on fish distribution and abundance within the West Fork Cow Creek Watershed is limited to salmonids. Although non-salmonid fish species are important as well, there are insufficient accessible data on the location of these types of fish, and they could not be included in the assessment. More information about non-salmonid fish may be available in the future.

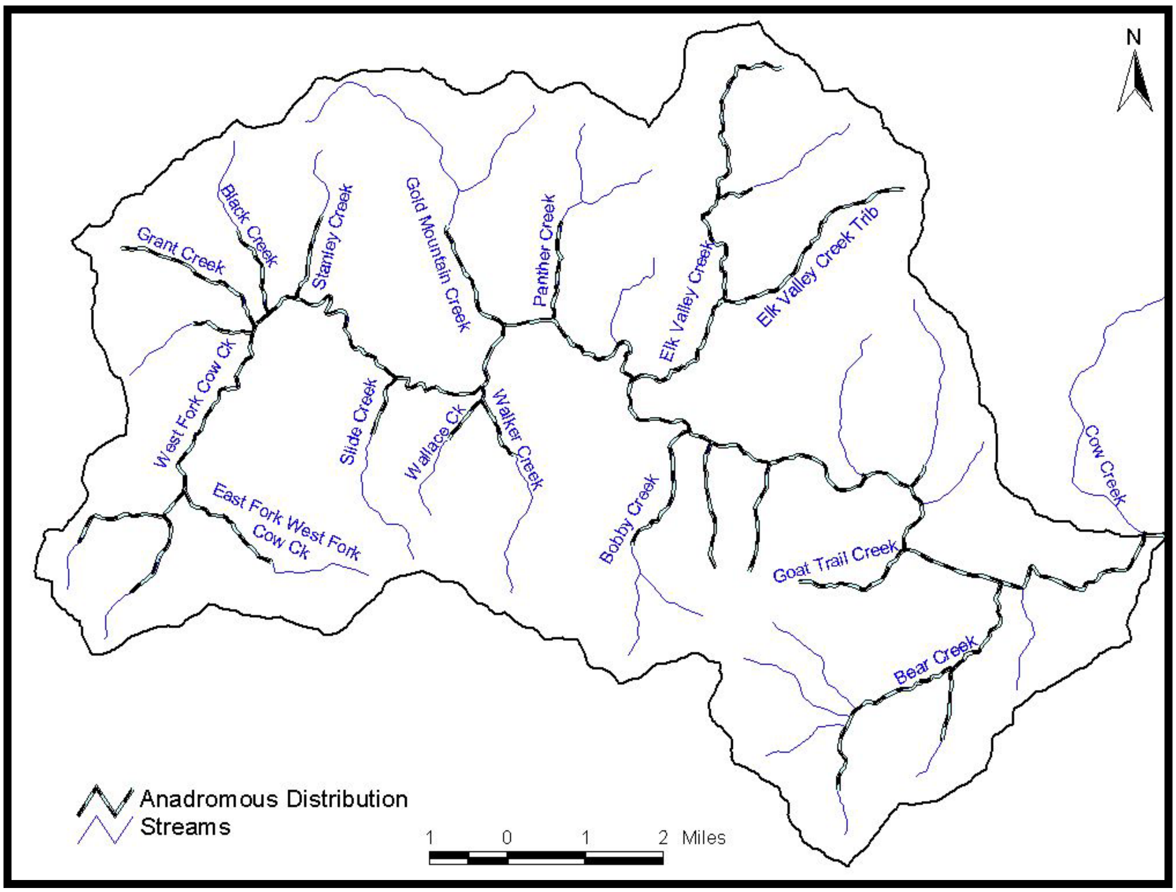
Anadromous salmonid distribution

The Oregon Department of Fish and Wildlife (ODFW) has developed anadromous salmonid distribution maps based on fish observations, assumed fish presence, and habitat conditions.[59] Fish observations are the most accurate because ODFW personnel have seen live or dead fish in the stream. With assumed fish presence, streams or reaches are included in the distribution map because of their proximity to fish-bearing streams or reaches and adequate habitat. Also included on the map are streams that appear to have

[58] From Dave Harris, fish biologist, Oregon Department of Fish and Wildlife, Roseburg District Office.
[59] Maps are available from the ODFW website http://www.streamnet.org/online-data/GISData.html.

adequate habitat for a given salmonid, even if there have been no fish sightings and the stream or reach is not near a fish-bearing stream. As of January, 2003, ODFW was in the process of revising the salmonid distribution maps to distinguish observed fish-bearing streams from the others. It is possible that some streams have been included in the distribution maps that do not have salmonid presence.

According to ODFW, anadromous salmonid distribution includes 57.0 stream miles within the West Fork Cow Creek Watershed, or 60.8% of the total stream miles visible on the map below.[60] Map 3-17 shows the distribution of these anadromous salmonids within the watershed and Table 3-12 lists the stream miles used by each species.[61] Total stream miles with anadromous salmonids does not equal the sum of miles used by species because many species distributions overlap (see Appendix 6). Different salmonid species will use many of the same stream reaches at different times of the year.



Map 3-16: Anadromous salmonid distribution within the West Fork Cow Creek Watershed.

[60] See section 1.2.5 on page 20 for more information about the stream map and total stream miles.
[61] Maps are available from the ODFW website http://www.streamnet.org/online-data/GISData.html.

	Steelhead	Coho
Stream miles	53.0	32.9
% total stream miles	56.5%	35.1%

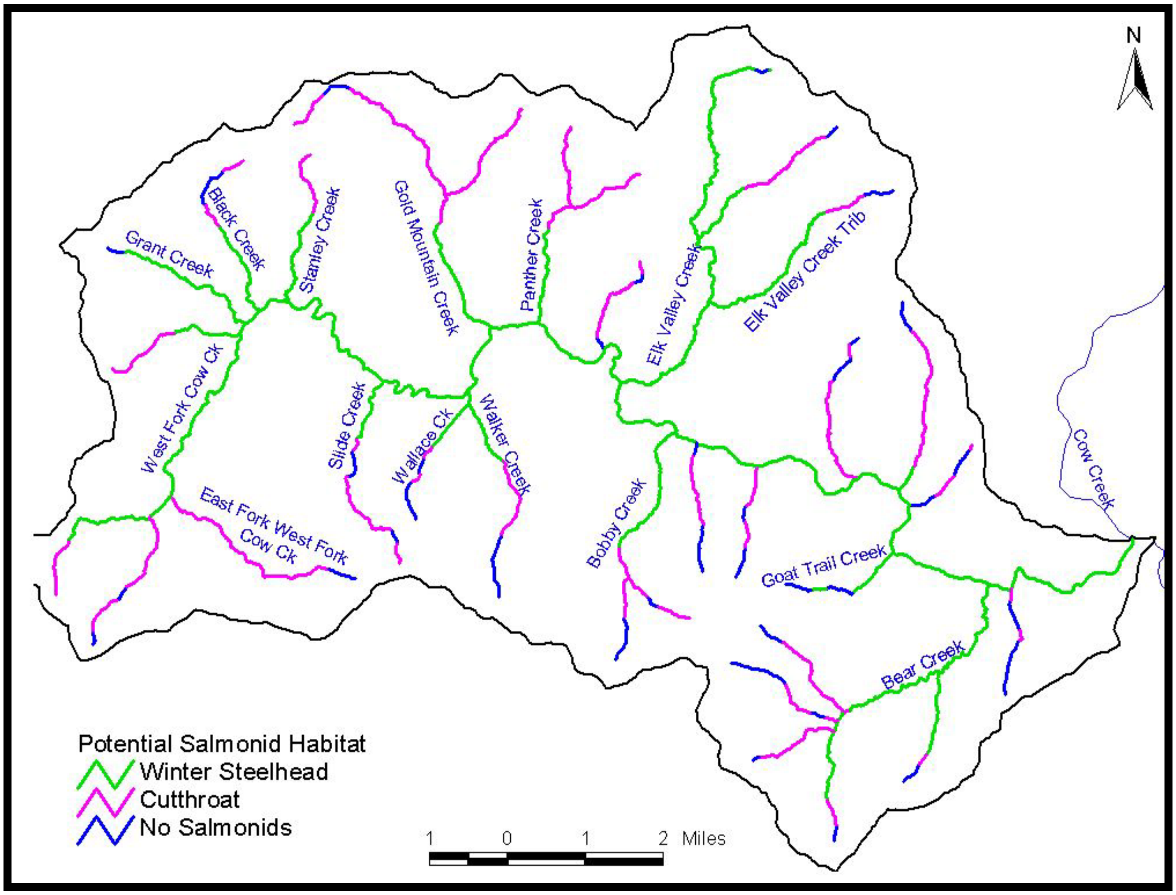
Table 3-12: Miles of stream supporting anadromous salmonids in the West Fork Cow Creek Watershed.

Resident cutthroat distribution

There are no comprehensive data about resident cutthroat distribution in the Umpqua Basin. ODFW is compiling regional data and will develop maps indicating fish presence by stream. However, the project will not be completed until after this assessment is complete.

Although there is much overlap, anadromous salmonids generally prefer streams with a 0% to 4% gradient, whereas resident cutthroat trout prefer streams with a 4% to 15% gradient. Also, cutthroat trout are generally found beyond the range of winter steelhead.[62] Map 3-17 shows streams with gradients that are less than 15% and are beyond winter steelhead distribution. Streams such as the upper reaches of Gold Mountain Creek may provide suitable habitat for cutthroat trout. However, there are many factors other than stream gradient that determine fish habitat suitability.

[62] From Dave Harris, fish biologist, Oregon Department of Fish and Wildlife, Roseburg District Office.

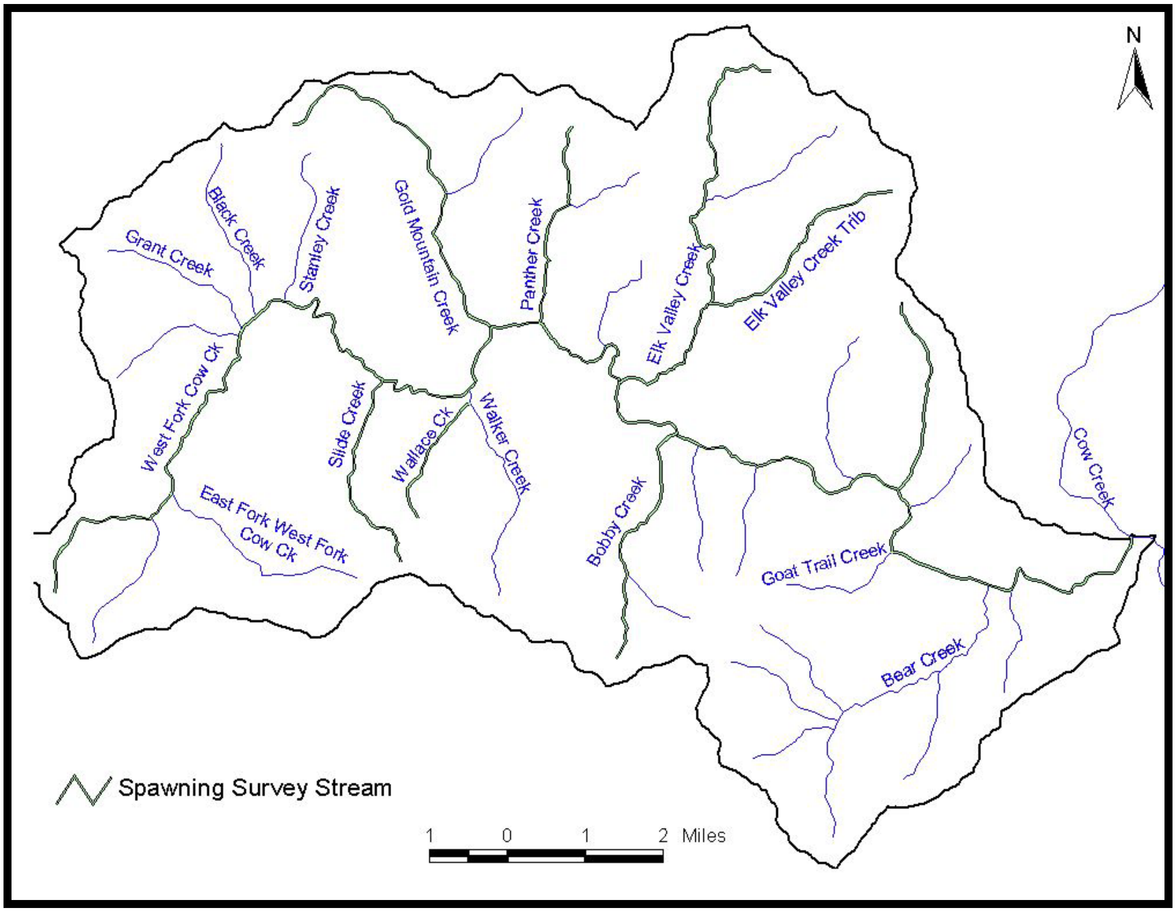


Map 3-17: Potential resident and anadromous salmonid habitat in the West Fork Cow Creek Watershed.

Coho abundance

ODFW conducts coho spawning surveys throughout the Umpqua Basin. Volunteers and ODFW personnel survey pre-determined stream reaches and count the number of live and dead coho. The same person or team usually does surveys every 10 days for two or three months. There are coho spawning data for the West Fork Cow Creek Watershed from 1992 through 2001.[63] Map 3-18 shows the surveyed stream reaches.

[63] Coho spawning survey data can be requested from the Oregon Department of Fish and Wildlife Corvallis Research Station.



Map 3-18: West Fork Cow Creek Watershed coho spawning survey locations.

Figure 3-7 and Figure 3-8 show the maximum number of live and dead coho seen per mile on a given day for mainstem West Fork Cow Creek and some tributaries. In some cases, the estimated total number of coho per mile is included as a red bar next to peak per mile count. Coho spawning fluctuates by stream and by year. Reach three of West Fork Cow Creek had a peak count of nine fish in 1999, 19 fish in 2000, and two fish in 2001. Peak count for the first reach of Elk Valley Creek was 14 fish in 1999, seven fish in 2000, and 37 fish in 2001. More monitoring data are needed to draw conclusions about coho spawning in the watershed.

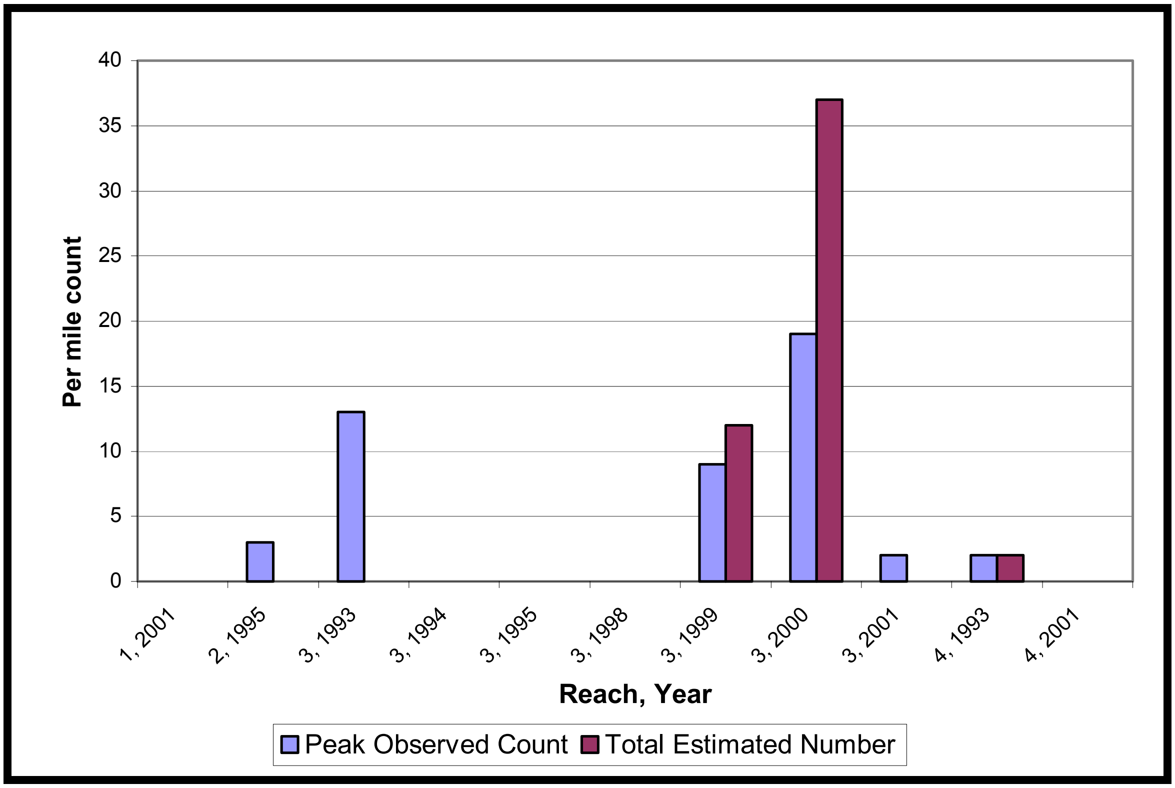


Figure 3-7: West Fork Cow Creek coho spawning surveys results.

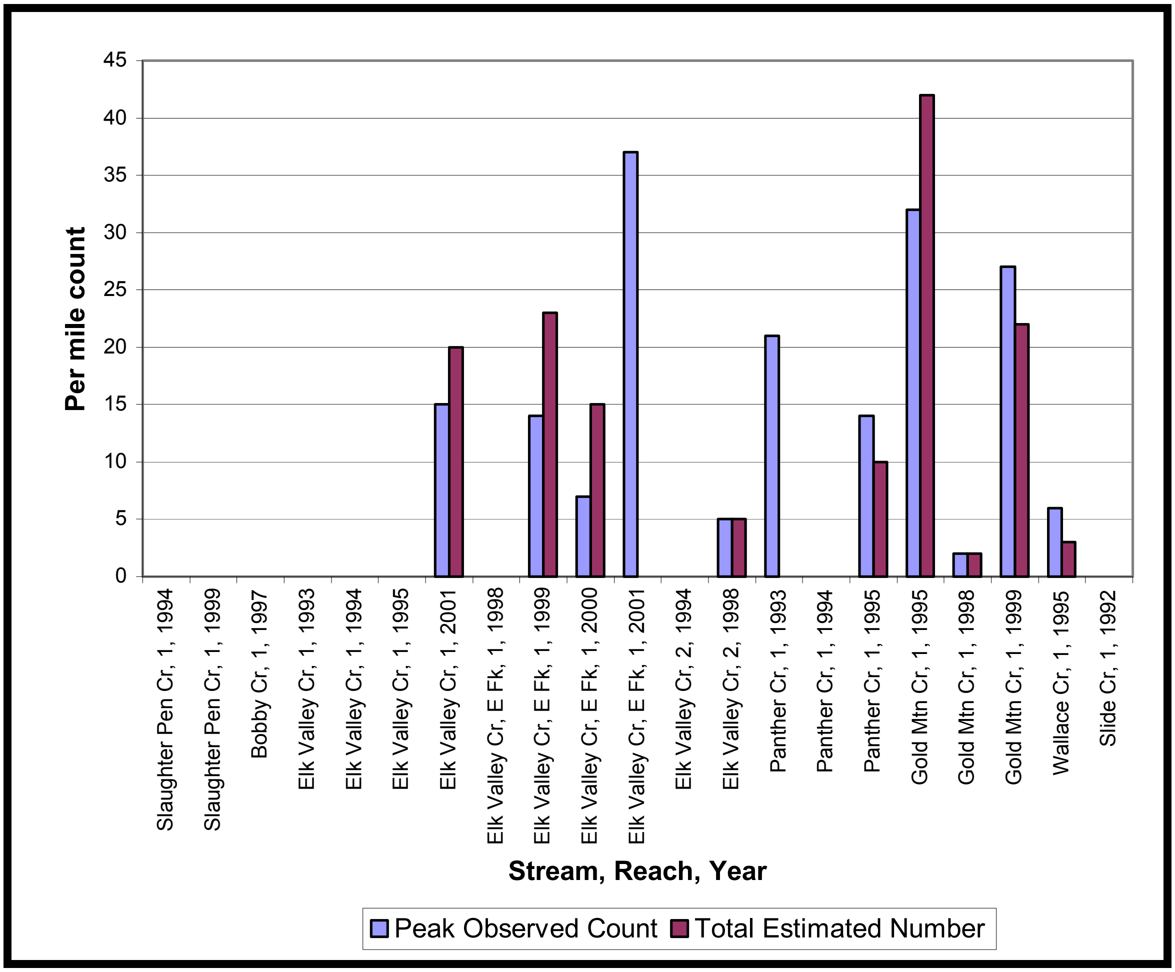


Figure 3-8 West Fork Cow Creek tributaries coho spawning survey results.

During coho spawning surveys, surveyors record the presence of other salmonid species. No steelhead or chum have been observed during the survey. Table 3-13 shows the number and location of chinook peak counts.

Stream	Spawning year	Peak chinook count
West Fork Cow Creek	1995	2
Gold Mountain Creek	1995	1

Table 3-13: Chinook observed during coho spawning surveys.

3.5.3. Salmonid population trends

According to Dave Harris of the Oregon Department of Fish and Wildlife, adult salmonid returns throughout the Umpqua Basin increased from 1998 through 2002. This trend is due to greater numbers of wild and hatchery fish surviving to adulthood because of normal winter storm events (i.e. no major floods or landslides) and ocean conditions that favor survival and growth. When both of these limiting factors are favorable over several years or fish generations, the result is an increase in adult run sizes. This trend is expected to continue until there is a change in ocean conditions or winter freshwater events.

Activities that improve freshwater conditions for salmonids will also help increase fish runs. These activities include removing barriers to fish passage, increasing instream flows, and improving critical habitat in streams and estuaries. It is also important to continue gathering data about salmonids and educating the public.

3.5.4. Fish populations key findings and action recommendations

Fish populations key findings

- The anadromous fish species in the West Fork Cow Creek Watershed with annual runs are coho, winter steelhead, and Pacific lamprey. Cutthroat trout are the only resident salmonid.
- Although fall chinook have been reported spawning in the West Fork Cow Creek Watershed, their presence is intermittent and does not constitute a run.
- Although many West Fork Cow Creek Watershed medium and large tributaries are within the distribution of one or more salmonid species, salmonid ranges have not been verified for each tributary.
- More quantitative data are needed to evaluate salmonid abundance and the distribution and abundance of non-salmonid fish in the watershed.
- Although watershed-specific data show tremendous fluctuation in annual salmonid abundance, Umpqua Basin-wide data indicate that salmonid returns have improved. Ocean conditions are a strong determinant of salmonid run size; however, improving freshwater conditions will help increase salmonid fish populations.

Fish populations action recommendations

- o Work with local specialists and landowners to verify the current and historical distribution of salmonids in tributaries.
- o Support salmonid and non-salmonid distribution and abundance research activities in the watershed, especially at the local level.
- o Encourage landowner participation in activities that improve freshwater salmonid habitat conditions.

4. Current Trends and Potential Future Conditions[64]

This chapter evaluates the current trends and the potential future conditions that could affect important stakeholder groups in the watershed. Because the West Fork Cow Creek Watershed does not have a resident population, stakeholder groups are limited to industrial timber companies and the Bureau of Land Management

Key Questions

- What are the important issues currently facing the various stakeholder groups?
- How can these issues affect the future of each group

4.1. Stakeholder perspectives

4.1.1. Industrial timber companies[65]

Most industrial timberlands are located in areas that favor Douglas-fir, tending to be hillsides and higher elevations.[66] Higher gradient streams provide important habitat for cutthroat trout. Riparian buffer zones in stream headwater areas may influence stream temperatures in lower gradients.

In the West Fork Cow Creek Watershed, industrial timber companies own approximately 45% of the land base. These lands are intensively managed for timber production. For all holdings, timber companies develop general 10-year harvest and thinning schedules based on 45 to 60 year timber rotations, depending upon site indices.[67] The purpose of these tentative harvest plans is to look into the future to develop sustained yield harvest schedules. These harvest and thinning plans are very general, modified over time depending on market conditions, fires, regulatory changes, and other factors, but are always developed to maintain sustained timber yield within the parameters outlined by the Oregon Forest Practices Act.

Current land management trends

Land acquisition

Most industrial timber companies in the Umpqua Basin have an active land acquisition program. When assessing land for purchase, industrial timber companies consider site index along with the land's proximity to a manufacturing plant, accessibility, and other factors. The sale of large private forestlands is not predictable, and it would be difficult for timber companies to try to consolidate their holdings to a specific geographic area.

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[64] It was not possible to develop a comprehensive viewpoint of the current trends and potential future conditions for the conservationist and environmentalist community in the Umpqua Basin. Therefore, this perspective is not included in section 4.1.

[65] The following information is primarily from an interview with Dick Beeby, Chief Forester for Roseburg Forest Product's Umpqua District, and Jake Gibbs, Forester for Lone Rock Timber and President of the Umpqua Chapter of the Society of American Foresters.

[66] Hillsides and higher elevations are often a checkerboard ownership of Bureau of Land Management administered lands (see section 4.1.2) and industrial timberlands.

[67] Site index is a term used to describe a specific location's productivity for growing trees. Specifically, it relates a tree's height relative to its age, which indicates the potential productivity for that site.

However, most land holdings and acquisitions by timber companies tend to be where conditions favor Douglas-fir production. While purchasing and selling land is commonplace, land exchanges are rare.

Weeds

Noxious weeds are a concern for industrial timber managers. As with family forestlands, species such as Scotch broom, hawthorn, and gorse increase site maintenance costs. Weeds can block roads, adding additional costs to road maintenance. Some weeds are fire hazards; dense growth creates dangerous flash and ladder fuels capable of spreading fire quickly. To help combat noxious weeds, some industrial timber companies are working with research cooperatives to find ways of controlling these species.

Fire management

Fires are always a concern for industrial timber companies. The areas at greatest risk are recently harvested and thinned units, because of the flammable undecayed slash (debris) left behind. Timber companies believe that the fire risk is minimized once slash begins to decay. Although many timber companies still use prescribed burning as a site management technique, it is becoming less common due to regulations and the associated cost versus risk factors.

Road maintenance

Although a good road system is critical to forest management, poorly maintained roads can be a source of stream sediment, and undersized or damaged culverts can be fish passage barriers. Roads on industrial timberlands are inventoried and monitored routinely. Problems are prioritized and improvements scheduled either in conjunction with planned management activities or independently based on priority. Currently, most industrial timber companies repair roads so they do not negatively affect fish habitat and water quality, such as replacing failing culverts with ones that are fish-passage friendly. Road decommissioning is not common, but is occasionally done on old roads. When a road is decommissioned, it is first stabilized to prevent erosion problems, and then nature is allowed to take its course. Although these roads are not tilled or plowed to blend in with the surrounding landscape, over time vegetation is re-established. New roads are built utilizing the latest technology and science to meet forest management objectives while protecting streams and other resources.

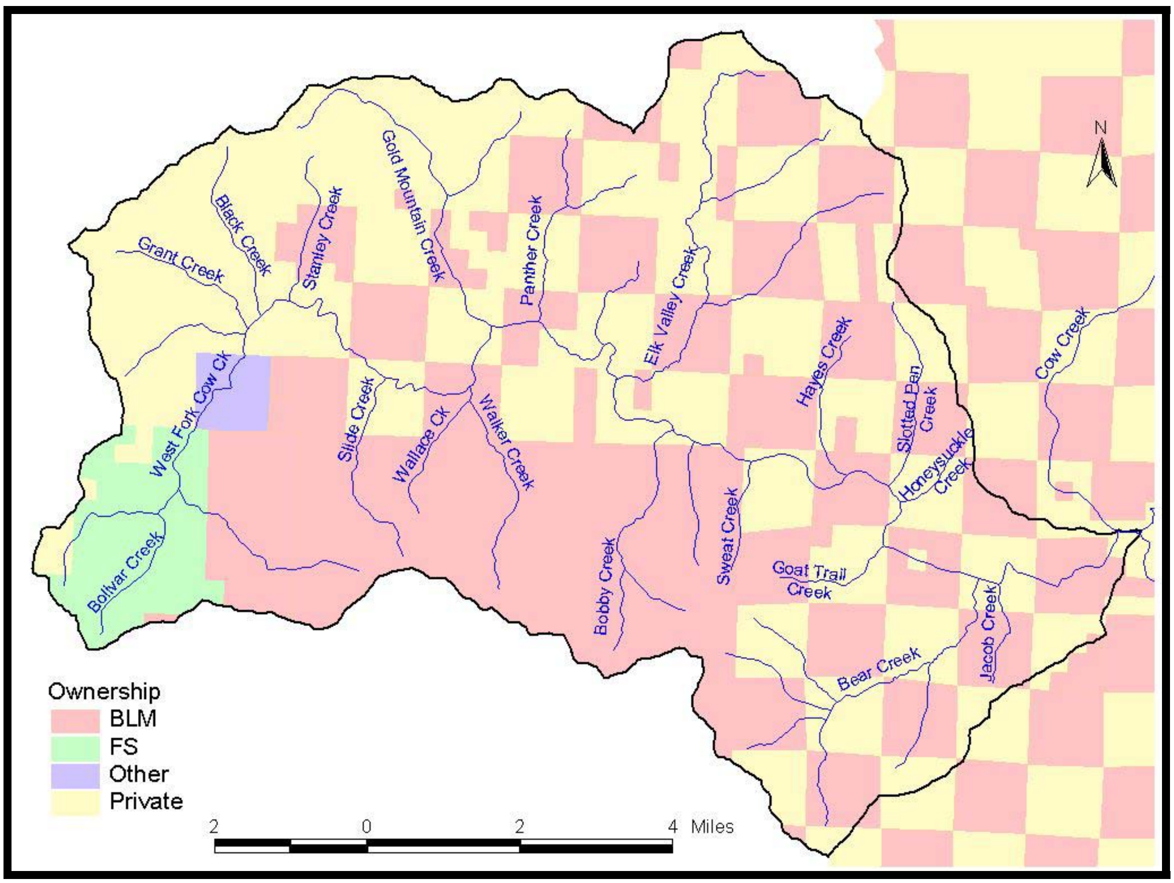
Community outreach

The population of Douglas County is growing. Local observation suggests that many new residents are retirees or transfer incomes from urban areas. Many of these new residents moved to the area for its “livability” and are not familiar with the land management methods employed by industrial timber companies. As a result, establishing and maintaining neighbor relations is becoming increasingly important. Many timber companies will go door-to-door to discuss upcoming land management operations with neighboring owners and address any questions or concerns that the owners may have. These efforts will continue as the rural population within the Umpqua Basin grows.

Regulations
Increased regulations will probably have the greatest impact on the future of industrial timber companies. Like family forestland owners, most industrial timber companies believe in following sound forest management principles and consider their current management systems sustainable. There is concern that the efforts and litigation that changed forest management methods on public lands will now be focused on private lands. Should forestry become unprofitable due to stricter regulations, industrial timber companies would be forced to move their businesses elsewhere, potentially converting their forestlands to other uses.

4.1.2. The USDI Bureau of Land Management[68]

The Medford District of the USDI Bureau of Land Management (BLM) administers approximately half of the West Fork Cow Creek Watershed (see Map 4-1). The following text describes some of the BLM's planned and potential future activities.



Map 4-1: Location of BLM administered lands in the West Fork Cow Creek Watershed.

[68] The following information is derived from information provided by the Medford District of the Bureau of Land Management for the draft Upper Cow Creek Watershed Assessment and Action Plan (Geyer, 2003).

Timber harvesting
Within late successional reserves (LSR), the BLM's objective for timber harvesting is to maintain older forest stands. Where there are younger stands, the emphasis is placed on accelerating stand development to characteristics common to old growth stands and improving habitat for old growth dependent species. As a result of the Northwest Forest Plan (NFP), timber harvest on general forest management area (GFMA) lands in the Medford District has changed. The number of board feet that the BLM is expected to harvest has been reduced from 213 million board feet in the 1980s and 1990s to the present 57 million board feet. Harvest prescriptions also have changed. "Regeneration cuts" that leave a minimum of six to eight trees per acre have replaced traditional clearcuts that removed all merchantable trees. There is now a greater emphasis on commercial thinning and density management that remove only portions of the stand, generally the smaller and less vigorous trees. The stands in GFMA in this watershed are generally managed under a 100-year rotation.

Land acquisition/land exchanges
The BLM consider all reasonable requests for land exchanges if it is advantageous to the government and funds allow for it.

Replanting
Restocking matrix lands harvested for timber, or possible fire rehabilitation, would occur with use of mixed conifers appropriate for the site. Three to five larger hardwoods (greater than 20 inches in diameter) per acre would be retained within regeneration harvests to protect the diversity of species composition.

Pest and invasive organism control
The BLM anticipates continued support and expansion of its noxious weed control program with increased emphasis in partnerships with private and other public agencies.

Fire/fuels control and prescribed burning
The primary objective of fire and fuels management in the LSR is to minimize loss of late-successional habitat to high intensity, stand replacement fires. Wildfires would be suppressed. Also of high importance is the reduction of wildland fire risk through management of fuels and ignition sources. This will be accomplished through reduction of slash from management activities and reduction of fuel hazards through hand piling and burning and broadcast burning. At this time, fuels projects within LSR would treat activity fuels (trees less than three inches in diameter). In addition to the treatment of activity fuels, matrix land projects would be designed to reduce fuels such as shaded fuel breaks.

Habitat protection
The BLM will continue to implement provisions of the NFP as related to the LSR and the Aquatic Conservation Strategy. All provisions of the Endangered Species Act would be adhered to. The BLM will continue to place emphasis on restoration of old growth habitat within the LSR. Some of these activities would include thinning small diameter trees around established trees so they may grow larger, reduce overstocked areas to

minimize the risk of habitat loss through wildland fire, retain natural species composition, provide wildlife habitat by creating large down woody structures and snags.

Roads and culverts

The BLM continues efforts to decommission roads where they are redundant or no longer needed. Other roads will be maintained by the installation of water dips and outsloping to manage water runoff. The BLM will continue to identify stream barriers to fish passage and as budget warrants improve or replace these structures. Culverts that prevent fish passage will continue to be a priority, as will stabilization projects to continue to reduce sediment from entering streams.

The future of the Medford BLM

Budgets for the Medford BLM will continue to shrink. Greater emphasis is being placed, and funded, in collaborative approaches to land management. Partnerships with other agencies and private organizations will be put in place to fund the management of public lands; Secure Rural School Act Title II is an example of this. The BLM also expects that the federal work force will be reduced with greater emphasis being placed on contracting work and services previously provided by the BLM.

5. Action Plan

The action plan summarizes key findings and action recommendations from Chapter Three and identifies specific and general restoration opportunities and locations within the watershed. The Umpqua Basin Watershed Council, the Oregon Department of Fish and Wildlife, and the Douglas Soil and Water Conservation District developed the action plan for the West Fork Cow Creek Watershed. Activities within the action plan *are suggestions for voluntary projects and programs*. The action plan should not be interpreted as landowner requirements or as a comprehensive list of all possible restoration opportunities.

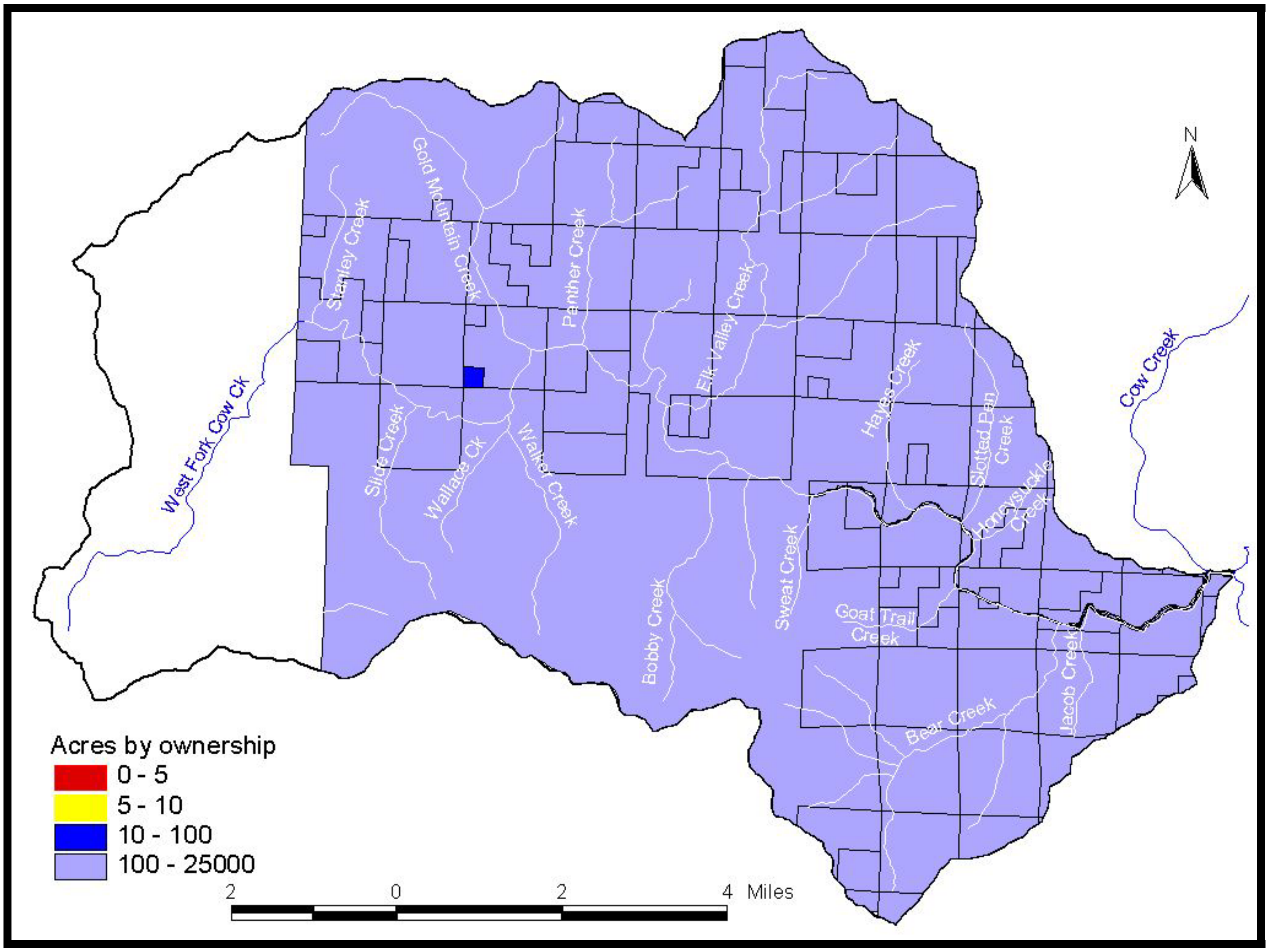
Key Questions

- Where are potential project location sites and activities in the watershed?
- How does property ownership affect restoration potential?

5.1. Property ownership and restoration potential

For some projects, such as eliminating fish passage barriers, the actual length of stream involved in implementing the project is very small. If only one culvert needs to be replaced, it doesn't make any difference if the participating landowner has 50 feet or a half-mile of stream on the property. The benefits of other activities, such as riparian fencing and tree planting, increase with the length of the stream included in the project. Experience has shown that for the UBWC, conducting projects with one landowner, or a very small group of landowners, is the most efficient approach to watershed restoration and enhancement. Although working with a large group is sometimes feasible, as the number of landowners cooperating on a single project increases, so do the complexities and difficulties associated with coordinating among all the participants and facets of the project. For large-scale enhancement activities, working with one or a few landowners on a very long length of stream is generally preferred to working with many landowners who each own only a short segment of streambank.

Map 5-1 shows parcel size in acres by ownership in the West Fork Cow Creek Watershed. Unlike Map 1-10 in section 1.2.7, all parcels owned by the same person, family, agency, group, etc., are colored to reflect total ownership size. For example, if a single group owns three five-acre parcels, all parcels will be colored dark blue to reflect the total ownership of 15 acres. This map indicates that many streams and stream segment in the West Fork Cow Creek Watershed are good candidates for large-scale stream habitat restoration projects because they mostly run through large ownerships.



Map 5-1: Ownership size by acre for the West Fork Cow Creek Watershed.

5.2. West Fork Cow Creek Watershed key findings and action recommendations

5.2.1. Stream function

Stream morphology key findings

- A wide variety of stream channel habitat types are found in the watershed, offering different enhancement opportunities.
- In the West Fork Cow Creek Watershed, there are few stream miles in source areas, where most large woody material is recruited into the stream system.
- Stream habitat surveys suggest that poor large woody material, poor riparian area tree composition, and poor to fair riffles limit fish habitat in most surveyed streams.

Stream connectivity key findings

- Culverts that are barriers and/or obstacles to fish may reduce stream connectivity, affecting anadromous and resident fish productivity in the West Fork Cow Creek Watershed. More information about fish passage barriers will be available from UBFAT in 2004.

Channel modification key findings

- Many landowners may not understand the detrimental impacts of channel modification activities or may be unaware of active stream channel regulations.

Stream function action recommendations

- Where appropriate, improve pools and increase instream large woody material by placing large wood and/or boulders in streams with channel types that are responsive to restoration activities and have an active channel less than 30 feet wide.[69]
- Encourage land use practices that enhance or protect riparian areas:
  - Plant native riparian trees, shrubs, and understory vegetation in areas with poor or fair riparian areas.
  - Manage riparian zones for uneven-aged stands with large diameter trees and younger understory trees.
- Maintain areas with good native riparian vegetation.
- Encourage landowner participation in restoring stream connectivity by eliminating barriers and obstacles to fish passage. Restoration projects should focus on barriers that, when removed or repaired, create access to the greatest amount of fish habitat.
- Increase landowner awareness and understanding of the effects and implications of channel modification activities through public outreach and education.

5.2.2. Riparian zones and wetlands

Riparian zones key findings

- BLM data indicate that conifers dominate most of West Fork Cow Creek's riparian vegetation, with small patches of brush, grass, and hardwoods.
- The UBWC could not located stream specific riparian information for the West Fork Cow Creek Watershed tributaries.

Wetlands key findings

- West Fork Cow Creek and many of its tributaries have stream-associated wetland that periodically or continuously contain flowing water.
- There are 42 inventoried acres of palustrine wetland in the West Fork Cow Creek Watershed. These small wetlands are mostly found in the northwest section of the watershed at the headwaters of Grant, Black, and Stanley Creeks.
- Landowner "buy-in" and voluntary participation must be fostered if wetland conservation is to be successful in the watershed.

Riparian zones and wetlands action recommendations

- Identify the following riparian conditions from digital aerial photographs or from stream surveys:
  - Streams segments where canopy cover is less than 50%. In these areas, establish wide buffers of native trees (preferably conifers) and/or shrubs, depending upon

[69] Thirty feet is the maximum stream width for which instream log and boulder placement projects are permitted.

local conditions. Priority areas are fish-bearing streams which more than 50% canopy cover is possible.
- ➢ Riparian zones dominated by brush/blackberry. Convert these areas to native trees (preferably conifers) and/or shrubs, depending on local conditions.
- ➢ Riparian buffers that are one tree wide or less. In these areas, encourage buffer expansion by planting native trees (preferably conifers) and/or shrubs, depending on local conditions.

- o Develop opportunities to increase awareness of what defines a wetland, its functions and benefits. This is a fundamental step in creating landowner interest and developing landowner appreciation for wetland conservation.
- o Identify or establish various peer-related demonstration projects as opportunities to educate stakeholders.

5.2.3. Water quality

Temperature key findings

- Seven-day moving average maximum temperatures in for West Fork Cow Creek at the mouth were frequently above 64°F. Consistently high stream temperatures would limit salmonid rearing at this location.
- The UBWC was unable to locate stream temperature data for West Fork Cow Creek tributaries.
- The following findings for the general Cow Creek system might also apply to the West Fork Cow Creek Watershed:
  - ➢ Warmer sites often lack shade. Increasing shade on small and medium-sized streams will reduce stream warming rates and improve habitat for salmonids.
  - ➢ Groundwater and tributary flows can contribute to stream cooling. Gravel-dominated tributaries may permit cooler subsurface flows when surface flows are low.
- Fish may find shelter from high summer temperatures in the lower reaches and mouths of small and medium-sized tributaries and in reaches within warm streams that have proportionately high groundwater influx and shade.

Surface water pH, dissolved oxygen, nutrients, bacteria, and toxics key findings

- There are insufficient data to draw conclusions about pH, dissolved oxygen, nutrients, bacteria, and toxics in the West Fork Cow Creek Watershed.

Sedimentation and turbidity key findings

- There are insufficient turbidity data to draw conclusions about the effects of West Fork Cow Creek turbidity levels on sight-feeding fish like salmonids.
- Areas of moderate to high soil erodibility and runoff potential are not widespread in the West Fork Cow Creek Watershed; however, there are pockets in the western and central portions of the watershed.
- Steep to moderately steep slopes dominate the topography of the watershed. As a result, there are landslide hazards in large portions of the watershed.
- The combination of steep slope along with poorly managed, erosion-inducing human modifications such as roads or timber harvesting can make areas prone to greatly increased erosion.

- In the Umpqua Basin, more studies are needed to determine the impacts of roads, culverts, landslides, burns, and soil type on sedimentation and turbidity.

Water quality action recommendations

- Increase the frequency and locations of water quality monitoring in the West Fork Cow Creek Watershed for all water quality parameters that can be affected by timber management activities.
- Along West Fork Cow Creek, identify areas that may serve as "oases" for fish during the summer months, such as at the mouth of small or medium-sized tributaries. Protect or enhance these streams' riparian buffers and, when appropriate, improve instream conditions by placing logs and boulders within the active stream channel to create pools and collect gravel.
- Where stream temperature is a concern, increase shade by encouraging wide riparian buffers and managing for full canopies.
- Use the refined debris flow hazard data, which will soon be available at Nature of the Northwest in Portland, to identify landslide-sensitive areas.
- Complete an original, detailed landslide identification study using aerial photography to identify sensitive and disturbed areas.
- In areas that have high K factor values or with high concentrations of group C or D hydrologic soils, encourage landowners to identify the specific soil types on their properties and include soils information in their land management plans.
- Use proper management practices (such as controlling road runoff from improper drainage) to control erosion in sensitive areas of the watershed.

5.2.4. Water quantity

Water availability and water rights by use key findings

- In the West Fork Cow Creek Watershed WAB, there is no resident population and so consumptive use is very low. Instream water rights exceed average streamflow in October.
- During the summer, there is no "natural" streamflow available for new water rights.
- "Miscellaneous uses," which are forest management, fire protection, road construction, and storage, are the largest water uses for the West Fork Cow Creek Watershed. "Industrial" is the largest use of water on mainstem West Fork Cow Creek; this water right is probably no longer active.

Stream flow and flood potential key findings

- Data suggest that peak flows and annual streamflow for the West Fork Cow Creek Watershed are decreasing.
- The degree to which road density and the TSZ influence flood potential in the West Fork Cow Creek Watershed is unknown at this time.

Water quantity action recommendations

- Continue monitoring peak flow trends in the watershed. Try to determine the role of vegetative cover, flooding, road density, and the TSZ on water volume.

5.2.5. Fish populations

Fish populations key findings

- The anadromous fish species in the West Fork Cow Creek Watershed with annual runs are coho, winter steelhead, and Pacific lamprey. Cutthroat trout are the only resident salmonid.
- Although fall chinook have been reported spawning in the West Fork Cow Creek Watershed, their presence is intermittent and does not constitute a run.
- Although many West Fork Cow Creek Watershed medium and large tributaries are within the distribution of one or more salmonid species, salmonid ranges have not been verified for each tributary.
- More quantitative data are needed to evaluate salmonid abundance and the distribution and abundance of non-salmonid fish in the watershed.
- Although watershed-specific data show tremendous fluctuation in annual salmonid abundance, Umpqua Basin-wide data indicate that salmonid returns have improved. Ocean conditions are a strong determinant of salmonid run size, however, improving freshwater conditions will help increase salmonid fish populations.

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- Support salmonid and non-salmonid distribution and abundance research activities in the watershed, especially at the local level.
- Encourage landowner participation in activities that improve freshwater salmonid habitat conditions.

5.3. Specific UBWC enhancement opportunities

Compared to other watersheds in the Umpqua Basin, stream conditions in the West Fork Cow Creek Watershed are good. Listed below are specific UBWC enhancement opportunities within the West Fork Cow Creek Watershed.

1. Assist the Umpqua Basin Fish Access Team's evaluation of fish passage barriers and obstacles throughout the watershed.

2. Investigate instream restoration project opportunities for Elk Valley Creek, Grant Creek, Black Creek, Panther Creek, and Slide Creek.

3. Use volunteer watershed monitors to increase fish distribution and water quality monitoring in the watershed. This could be done in collaboration with agencies and other organizations, such as ODEQ and ODFW.

4. Educate policy makers about the obstacles preventing greater landowner participation in voluntary fish habitat and water quality improvement methods.

References[70]

Allen, S; Buckley, A. R., and Mecham, J. E. Atlas of Oregon. Eugene, Oregon: University of Oregon Press; 2001.

Alt, David and Hyndman, Donald W. Northwest Exposures: A Geologic History of the Northwest. Mountain Press Publishing Company; 2001.

Douglas County Assessor. Microfiche CD of Assessment Data, 2000-2001: Douglas County, Oregon; 2001 Apr.

Ellis-Sugai, Barbara and Godwin, Derek C. Going With the Flow: Understanding Effects of Land Management on Rivers, Floods, and Floodplains. Corvallis, Oregon: Oregon Sea Grant/Oregon State University; 2002.

Geyer, Nancy A. Upper Cow Creek Watershed Assessment and Action Plan (Draft). Roseburg, Oregon: Prepared for the Umpqua Basin Watershed Council; 2003 Nov.

Graham, James D. Mass Movement Dynamics, Geomorphology, and Their Relationship to Geology in the North Fork Siuslaw River Drainage Basin, Oregon Coast Range. MS Thesis. Department of Geosciences: Oregon State University; 1985.

Hastings, N. et al. Geoscape Fort Fraser, British Columbia, Geological Survey of Canada Miscellaneous Report 66 [Web Page]. 2002; Accessed 2003 Apr. Available at: http://geoscape.nrcan.gc.ca/fortfraser_pdf/fish.pdf.

Lane, Jeffery W. Relations Between Geology and Mass Movement Features in a Part of the East Fork Coquille River Watershed, Southern Coast Range, Oregon. MS Thesis. Department of Geosciences: Oregon State University; 1987.

Oregon Climate Service. Climate Data [Web Page]. Accessed 2002 Nov. Available at: http://ocs.oce.orst.edu/.

Oregon Department of Environmental Quality. Final 2002 303(d) Database Search Choices Page [Web Page]. Accessed 2003 Mar. Available at: http://www.deq.state.or.us/wq/WQLData/SearchChoice02.htm.

---. Laboratory Analytical Storage and Retrievable Database. Accessed 2003 Mar. Available at: www.deq.state.or.us.

---. Oregon's Approved 1998 Section 303(d) Decision Matrix. 1998 Nov.

Oregon Department of Fish and Wildlife. Fish Data: Streamnet GIS Data [Web Page].

[70] References for Chapter Two, "Past Conditions," the "Wetlands" subsection of Chapter Three, and Appendix 1, "Additional geological information," are not included in this list.

Accessed 2003 Jan. Available at http://www.streamnet.org/online-data/GISData.html.

Oregon Department of Forestry. Western Oregon Debris Flow Hazard Maps [Web Page]. 2000; Accessed 2003 Apr. Available at: http://www.odf.state.or.us/gis/debris.html.

Oregon State University Extension Service. Fish Passage Short Course. Oregon State University; 2000 Jun.

---. Watershed Stewardship: A Learning Guide. Oregon State University; 1998 Jul.

Oregon State University Forest Science Laboratory. Northern Coast Range Adaptive Management Area - Chapter 2: Past and Current Conditions in the AMA. 1998 Feb 19; Accessed 2003 August. Available at: http://www.fsl.orst.edu/ncama/guidcon.htm#CONT.

Oregon Water Resources Department. Water Availability Report System database. Accessed 2002 Dec. Available at: http://www.wrd.state.or.us/.

---. Water Rights Information System database. Accessed 2002 Dec. Available at: http://www.wrd.state.or.us/.

Orr, Elizabeth L. and Orr, William N. Geology of Oregon. Kendall/Hunt Publishing Company; 2000.

Pacific Northwest National Laboratory. Soil Erodiblity Factor [Web Page]. Accessed 2003 Apr. Available at: http://mepas.pnl.gov:2080/earth/formulations/source_term/5_0/5_32/5_32.html.

Press, F. and Siever, R. Earth. Fourth ed. San Francisco: W.H. Freeman and Company; 1986.

Smith, Kent. Cow Creek Temperature Study, 2000: Procedure, Results, and Preliminary Analysis. Yoncalla, Oregon: Umpqua Basin Watershed Council; 2001.

---. Thermal Transition in Small Streams Under Low Flow Conditions. Yoncalla, Oregon: Umpqua Basin Watershed Council.

US Census Bureau. American Factfinder [Web Page]. Accessed 2002 Nov. Available at: http://factfinder.census.gov/servlet/BasicFactsServlet.

US Geological Survey. NWISWeb Data for Oregon [Web Page]. Accessed 2003 Feb. Available at: http://or.waterdata.usgs.gov.

USDA Agriculture Research Service National Sedimentation Laboratory. Revised Universal Soil Loss Equation [Web Page]. Accessed 2003 Apr. Available at: http://www.sedlab.olemiss.edu/rusle/description.html.

USDA Natural Resources Conservation Service. Technical Release 55. Conservation Engineering Division; 1986.

USDI Bureau of Land Management. Lower Cow Creek Watershed Analysis. Roseburg, Oregon: USDI Bureau of Land Management, Roseburg District Office; 2002 Nov.

---. Lower South Umpqua Watershed Analysis. Roseburg, Oregon: USDI Bureau of Land Management, Roseburg District Office; 2000 May.

---. Physiographic Province Boundaries [Web Page]. Accessed 2003 Apr. Available at: http://www.or.blm.gov/gis/data/catalog/dataset.asp?cid=10.

---. Record of Decision and Resource Management Plan. Roseburg, Oregon: USDI Bureau of Land Management, Roseburg District Office; 1995 Jun.

---. Roseburg District Annual Program Summary and Monitoring Report: Fiscal Year 2001. Roseburg, Oregon: USDI Bureau of Land Management, Roseburg District Office; 2002 Jul.

Walker, G. W. and MacCleod, N. S. Geologic Map of Oregon. US Geological Survey; 1991.

Watershed Professionals Network. Oregon Watershed Assessment Manual. Salem, Oregon: Prepared for the Governor's Watershed Enhancement Board; 1999 Jun.

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Appendix 1: Additional geologic information[71]

Geologic history

Overview of plate tectonics

The geologic history of southwestern Oregon is dominated by plate tectonics. The crust of the earth is a thin veneer of solid rock material that rides on partially molten rocks (the mantle) beneath it that flow as a result of convection heat cycles caused by the radiation of heat from the core of the earth. The crust is composed of continental crust and oceanic crust. Continental crust is relatively lighter than oceanic crust due to its mineralogical characteristics, and thus floats higher on the mantle relative to oceanic crust, resulting in its position above sea level. The crust is broken up into plates, and these plates can move apart, collide, or shear against one another at their borders (Press and Siever, 1994). As one could imagine, the movement of such large plates of earth often results in many local-scale complexities that are difficult to understand without an appreciation for the large-scale processes. Geologic processes that occur at the boundaries of crustal plates result in certain characteristic geologic formation types. At colliding boundaries like that along the northwest coast of the United States, geologic processes result in the rise of coastal mountains, the formation of a volcanic chain approximately 100 miles inland, and accretion of islands to the edge of the continent (Alt and Hyndman, 2001; see glossary for definitions of terms). These processes result in a varied landscape and an often highly deformed and sometimes confounding set of rock formations. The geologic story of the Umpqua Basin follows the plot of a typical collision of the ocean floor with a continent, with its own unique elements.

Setting the stage for continental collision

In the late Triassic and early Jurassic (see Appendix table I for relative time scale), the North American continent started moving westward across the earth, and in doing so, collided with the oceanic crust underlying the Pacific Ocean. This began the long process of subduction that has been occurring ever since. As oceanic crust collides with a continent, the oceanic crust descends, or subducts, beneath the continental crust due to its greater density. At the collision point, a trench forms, creating the setting for a great deal of deformation of sediments. As the ocean floor subducts, continental shelf and slope sediments that had been deposited off the shore of the continent are scraped off the underlying ocean crust and shoved into the edge of the continent. Islands or other belts of rocks that were associated with the oceanic plate collide into the continent and, because they will not sink, accrete to the edge of the continent (Alt and Hyndman, 2001).

Coast Range history

The Coast Range began with a core of volcanic rocks that had likely formed as a volcanic island chain, and then collided with the continent. The accretion of these volcanics with

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[71] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the text and tables for Appendix 1. Terms such as “Jurassic” and “Cretaceous” refer to periods in the geologic/evolutionary timetable. However, the UBWC takes no position regarding the time periods with which these terms are associated and is using the terms to refer to natural processes and the relative order in which they occurred.

North America added about a 50 mile width of land to the continent, and created a forearc basin between the volcanic chain an the continent that received vast amounts of sediment deposited in a marine setting during the Eocene and Oligocene epochs. Ash from the forming volcanic Cascades to the east was also deposited in the basin. The subduction of the ocean floor beneath the continent was displaced westward, where a new trench was created after the old one was abandoned; this new trench is the modern trench today. In the Miocene, the sea retreated and the coastal mountains uplifted, as a large thickness of lighter sediments had accumulated (Orr and Orr, 2000). In the West Fork Cow Creek Watershed, the geologic units are marine rocks formed by deposition in the forearc basin.

Klamath Mountains history

The Klamath Mountains of Oregon were formed by the collision of many different belts of rocks, or terranes, into the continent over time ranging from the late Triassic to the late Cretaceous. Some of these rocks formed in an open oceanic environment, while others formed in a coastal environment. Volcanic islands crashed into the continent. Sediment that was constantly being deposited by rivers onto the continental shelf and slope were just as constantly being shoved onto the edge of the continent as they rode east on top of the oceanic floor. This accretion of many terranes and the intense faulting that occurs at the plate collision boundary makes the geology of the Klamath Mountains highly complex. Each terrane has distinct rocks and fossils. In the West Fork Cow Creek Watershed, volcanic rocks and a chunk of oceanic crust of Jurassic age were incorporated in the landscape. Younger marine sedimentary rocks of Jurassic/Cretaceous age were later accreted onto the edge of the continent and now lie in a part of the watershed. In the beginning stages of the formation of the Klamath Mountains, the province was located much further east than it is today. It rotated into its current position by the early Cretaceous, and has been relatively stable since. Today, the contacts between the terranes are orientated in a southwest-northeast trend (Orr and Orr, 2000).

Era	**Period**	**Epoch**
Cenozoic	Quaternary	Holocene
		Pleistocene
	Tertiary	Pliocene
		Miocene
		Oligocene
		Eocene
		Paleocene
Mesozoic	Cretaceous	
	Jurassic	
	Triassic	
Paleozoic	Permian	
	Pennsylvanian	
	Mississippian	
	Devonian	
	Silurian	
	Ordovician	
	Cambrian	
Precambrian		

Appendix table I: Geologic time scale (most recent to oldest – top to bottom).

Descriptions of geologic units from Walker and MacLeod (1991).
For explanation of terms within this table, refer to Jackson (1997).

Map symbol	Age	Geologic Unit Description
Tt	middle Eocene	**Tyee Formation**: Very thick sequence of rhythmically bedded, medium- to fine-grained micaceous, feldspathic, lithic, or arkosic marine sandstone and micaceous carbonaceous siltstone; contains minor interbeds of dacite tuff in upper part.
Tmsc	lower Eocene	**Marine siltstone, sandstone, and conglomerate**: Cobble and pebble conglomerate, pebbly sandstone, lithic sandstone, siltstone, and mudstone; massive to thin-bedded; shelf and slope depositional setting. Contains foraminiferal faunas referred to the Penutian Stages of early Eocene age.
KJds	Lower Cretaceous and Upper Jurassic	**Dothan Formation and related rocks**: sedimentary rock: Sandstone, conglomerate, greywacke, rhythmically banded chert lenses.
KJm	Lower Cretaceous and Upper Jurassic	**Myrtle Group**: Conglomerate, sandstone, siltstone, and limestone. Locally fossiliferous.
Jv	Jurassic	**Volcanic rocks**: Lava flows, flow breccia, and agglomerate dominantly of plagioclase, pyroxene, and hornblende porphyritic and aphyric andesite. Includes flow rocks that range in composition from basalt to rhyolite as well as some interlayered tuff and tuffaceous sedimentary rocks. Commonly metamorphosed to greenschist facies; locally foliated, schistose or gneissic. Considered to be accreted island-arc terrane.
JTRgd	Jurassic and Triassic	**Granite and diorite**: Felsic to intermediate, granitoid intrusive rocks. Includes Jurassic muscovite granodiorite, hornblende gabbro, tonalite, and quartz diorite of southwest Oregon (Smith and others, 1982).
Ju	Jurassic	**Ultramafic and related rocks of ophiolite sequences**: Predominantly harzburgite and dunite with both cumulate and tectonic fabrics. Locally altered to serpentinite. Includes gabbroic rocks and sheeted diabasic dike complexes. In southwest Oregon, locally includes small bodies of early Mesozoic or Late Paleozoic serpentinized and sheared ultramafic rocks, mostly in shear zones. Locally, volcanic and sedimentary rocks shown separately.

Glossary of terms[72]

Accretion: The addition of continental material to a pre-existing continent, usually at its edge and by the processes of convergent and transform motion.

Alluvial: Pertaining to the environments, actions, and products of rivers or streams.

Alluvium: An unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that had been deposited by water.

Banding: Bedding produced by deposition of different materials in alternating layers.

Basalt: A fine-grained, dark, mafic, extrusive igneous rock composed largely of plagioclase feldspar and pyroxene. It is the major rock of ocean basins.

Bedding: The arrangement of sedimentary rocks in layers of varying thickness and character.

Calcareous: Any rock that has enough carbonate material so that it reacts with hydrochloric (or any other strong) acid, producing bubbles of carbon dioxide. Usually, the carbonate material is calcite.

Chert: A sedimentary form of amorphous or extremely fine-grained silica, partially hydrous, found in concretions and beds.

Clay: Mineral particles less than 4 micrometers in diameter.

Conglomerate: A coarse-grained clastic sedimentary rock composed of rounded or sub-rounded fragments larger than two millimeters in diameter and cemented together.

Continental shelf: That part of the continental margin that is between the shoreline and the continental slope. Usually it extends vertically to a depth of about 600 feet. It is the zone where sunlight penetrates and is the most productive area of marine life in the ocean. It is characterized by its very gentle slope.

Continental slope: That part of the continental margin that lies between the continental shelf and the bottom of the ocean. Sunlight does not penetrate this area, and mostly it is home to scavengers. It is characterized by a relatively steep slope.

Convection: Bodily movement of material from one place (usually hotter) to another (usually colder). Often in sub-circular patterns called "convection cells."

Crust: The outermost layer of the earth. It includes the oceanic crust (about 5-10 miles thick) and the continental crust (50-75 miles thick). The bottom of the crust is the Mohorovicic Discontinuity ("Moho").

[72] These terms are mostly compiled from Allaby and Allaby (1999), Challinor (1978), Jackson (1997), and Orr and Orr (2000).

Debris avalanche: A fast downhill mass movement of soil and rock.

Deformation: Any change in shape or structure of a rock unit as a result of earth forces, on any scale.

Drainage basin: A region of land surrounded by divides and crossed by streams that eventually converge to one river or lake.

Epoch: One subdivision of a geologic period, often chosen to correspond to a stratigraphic series.

Era: A time period including several periods, but smaller than an eon. Commonly recognized eras are Precambrian, Paleozoic, Mesozoic, and Cenozoic.

Erosion: The set of all processes by which soil and rock are loosened and moved downhill or downwind.

Fault: A crack or fracture in the earth's surface across which there has been relative displacement. Movement along the fault can cause earthquakes or--in the process of mountain-building--can release underlying magma and permit it to rise to the surface.

Flood plain: A level plain of stratified alluvium on either side of a stream; submerged during floods.

Fluvial: Pertaining to streams and river deposits; produced by the action of flowing water.

Forearc basin: A sedimentary basin, usually elongate, lying between the volcanic arc and the shelf break in a convergent plate boundary zone.

Formation: A body of rock identified by lithic characteristics and stratigraphic position and is mappable at the earth's surface or traceable in the subsurface.

Geomorphology: The science of surface landforms and their interpretation on the basis of geology and climate.

Granite: A coarse-grained, intrusive igneous rock composed of quartz, orthoclase feldspar, sodic plagioclase feldspar, and micas. Also sometimes a metamorphic product.

Gravel: Sediment grains with diameters between 2 and 60 millimeters.

Graywacke: A quartz sandstone that includes noticeable amounts of mud and/or mica. Sometimes called a "dirty sandstone".

Group: Two or more formations in a stratigraphic column that formed by similar events or processes.

Hydraulic conductivity: A measure of the ability of a rock, sediment, or soil to permit fluids to flow through it.

Igneous: Rock or mineral crystallized from partly molten material, i.e. magma.

Intrusion: The process of emplacement of magma in pre-existing rock. Also, the term refers to igneous rock mass so formed within the surrounding rock.

Intrusive: Applied to a body of rock, usually igneous, that is emplaced within preexisting rocks.

Landslide: The rapid downslope movement of soil and rock material, often lubricated by groundwater, over a basal shear zone or along a sedimentary contact; also the tongue of stationary material deposited by such an event.

Lava: Magma that has reached the surface through a volcanic eruption. The term is most commonly applied to streams of liquid rock that flow from a crater or fissure. It also refers to cooled and solidified rock.

Limestone: A sedimentary rock composed principally of calcium carbonate (CaCO2), usually as the mineral calcite.

Lithology: The systematic description of rocks, in terms of mineral composition and texture.

Lithosphere: The zone of brittle rock between the earth's surface and the asthenosphere (a zone of ductile deformation about 200 km below the surface). The lithosphere consists of the entire crust and a small portion of the uppermost mantle. It has an ultramafic igneous composition (mostly magnesium, silicon, and oxygen). The lithosphere forms the "plates" of plate tectonics.

Mafic: An igneous rock composed chiefly of one or more dark-colored minerals.

Magma: Molten rock material that forms igneous rocks upon cooling. Magma that reaches the surface is referred to as lava.

Mantle: The main bulk of the Earth, between the crust and core, ranging from depths of about 40 to 3480 kilometers. It is composed of dense mafic silicates and divided into concentric layers by phase changes that are caused by the increase in pressure with depth.

Mass movement: A downhill movement of soil or fractured rock under the force of gravity.

Metamorphic rocks: Rocks altered by heat and pressure causing recrystallization and loss of original characteristics.

Ophiolite suite: An assemblage of mafic and ultra-mafic igneous rocks with deep-sea sediments supposedly associated with divergent zones and the sea-floor environment.

Period: A major, worldwide, geologic time unit corresponding to a system such as the Cambrian Period.

Pillow lava: A general term for those lavas displaying pillow structures (globs of lava with curved tops and "pinched" bottoms) and considered to have formed under water.

Plate tectonics: The theory that the earth's crust is broken into about 10 fragments (plates), which move in relation to one another, shifting continents, forming new ocean crust, and stimulating volcanic eruptions.

Relief: The vertical difference between the summit of a mountain and the adjacent valley or plain.

Rhythmic sedimentation: Cyclic deposition of sediments involving a circuitous sequence of conditions.

Runoff: The amount of rain water directly leaving an area in surface drainage, as opposed to the amount that seeps out as groundwater.

Sand: Mineral particles between 1/16 mm and 2 mm in diameter.

Sandstone: A detrital sedimentary rock composed of grains from 1/16 mm to 2 mm in diameter, dominated in most sandstones by quartz, feldspar, and rock fragments, bound together by a cement of silica, carbonate, or other minerals or a matrix of clay minerals.

Schist: A medium- to coarse-grained, foliated (layered) metamorphic rock created by regional metamorphism to medium or high temperatures and shearing pressures. Commonly, schists include quartz, feldspars, and micas, but mineral composition is not an essential factor in its definition. Schists are strongly foliated, with well-developed parallelism of more than 50% of the minerals present.

Sedimentary rock: A rock formed by the accumulation and cementation of mineral grains transported by wind, water, or ice to the site of deposition or chemically precipitated at the depositional site.

Sedimentation: The process of deposition of mineral grains or precipitates in beds or other accumulations.

Serpentine: Rock-forming minerals derived from alteration of magnesium-rich silica minerals; have a greasy or silky luster, a slightly soapy feel, are usually compact, and are commonly greenish in color.

Shale: A very fine-grained, thinly layered sedimentary rock composed of clay and/or silt grains. Shales break easily along their layering, especially along weathered surfaces. They feel smooth to the touch, not gritty.

Shearing: The motion of surfaces sliding past one another.

Silt: Mineral particles between 4 and 62 micrometers in diameter.

Siltstone: A fine-grained, layered sedimentary rock composed primarily of grains between 1/256 mm and 1/16 mm in size. Siltstones contain hard thin layers. They feel grittier than shales or mudstones.

Subduction: The process of consumption of a crustal plate at a convergent plate margin with one crustal plate descending beneath another.

Subduction zone: A dipping planar zone descending away from a trench and defined by high seismicity, interpreted as the shear zone between a sinking oceanic plate and an overriding plate.

Terrane: A suite of rocks bounded by fault surfaces that has been displaced from its point of origin.

Topography: The shape of the Earth's surface, above and below sea level; the set of landforms in a region; the distribution of elevations.

Trench: A narrow, elongate depression of the deep-sea floor, having steep sides and oriented parallel to the trend of an adjacent continent. It lies between the continental margin and the abyssal plain. Usually it forms the surficial trace of a subduction zone.

Tuff: A consolidated rock composed of pyroclastic (from a volcanic explosion) fragments and fine ash. If particles are melted slightly together from their own heat, it is a "welded tuff."

Tuffaceous: Composed by large amounts of tuff.

Ultramafic: A magnesium-rich igneous rock with less than 45% silica (silicon dioxide); typical composition of the Earth's mantle.

Volcanic arc (also island arc): A curved chain of volcanic islands rising from the deep-sea floor and near to a continent caused by subduction processes and occurring on the continent side of the subduction zone. Its curve generally is convex toward the open ocean.

Volcano: A vent in the surface of the Earth through which magma and associated gases and ash erupt; also, the form or structure (usually conical) that is produced by the ejected material.

Appendix 1 references

Allaby, Ailsa, and Allaby, Michael. A Dictionary of Earth Sciences, Second Ed. Oxford University Press; 1999.

Alt, David, and Hyndman, Donald W. Northwest Exposures: A Geologic Story of the Northwest. Mountain Press Publishing Company; 2001.

Challinor, John. A Dictionary of Geology, Fifth Ed. University of Wales Press; 1978.

Jackson, Julia A., ed. Glossary of Geology, Fourth Ed. America Geological Institute; 1997.

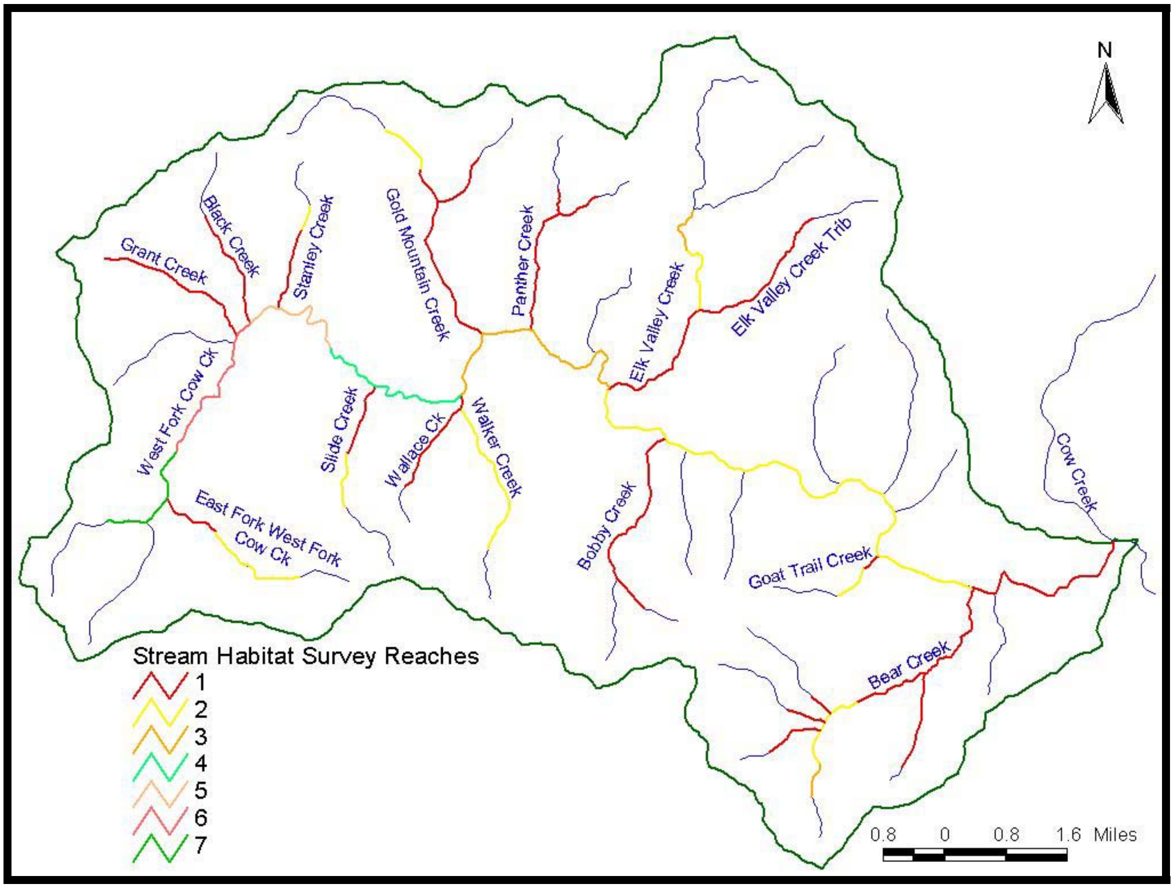
Orr, Elizabeth L., and Orr, William N. Geology of Oregon, Fifth Ed. Kendall/Hunt Publishing Company; 2000.

Press, Frank and Siever, Raymond. Earth. Fourth ed. San Francisco: W.H. Freeman and Company; 1986.

Walker, George W. and MacCleod, Norman S. Geologic Map of Oregon. US Geological Survey; 1991.

Appendix 2: Stream habitat surveys

Stream reaches surveyed by the Oregon Department of Fish and Wildlife



West Fork Cow Creek Watershed ●●● = Good; ●● = Fair; ● = Poor

Stream	Reach	Pools	Riffles	Riparian Area	Large Woody Material
BEAR CREEK	1	●●	●●	●	●
BEAR CREEK	2	●	●●	●	●
BEAR CREEK	3	●●	●	●●●	●●
BLACK CREEK	1	●	●	●	●
BOBBY CREEK	1	●●	●●	●●●	●
WILSON CREEK	1	●●●	●●	●●●	●
WILSON CREEK	2	●●	●●	●	●●
ELK VALLEY CREEK	1	●●	●	●	●
ELK VALLEY CREEK	2	●●●	●●	●	●
ELK VALLEY CREEK	3	●●●	●	●	●
EAST FORK. ELK VALLEY CREEK	1	●●	●	●	●
GOAT TRAIL CREEK	1	●	●●	●●●	●
GOAT TRAIL CREEK	2	●	●●●	●	●
GOLD MOUNTAIN CREEK	1	●●	●	●●●	●
GOLD MOUNTAIN CREEK	2	●●●	●	●●	●●●
GRANT CREEK	1	●●	●	●	●
PANTHER CREEK	1	●●	●	●	●
SLIDE CREEK	1	●●	●●	●	●
SLIDE CREEK	2	●●	●●	●●●	●
STANLEY CREEK	1	●●●	●	●	●●●
STANLEY CREEK	2	●	●	●●●	●●●
WALKER CREEK	1	●●●	●	●	●
WALKER CREEK	2	●●●	●	●	●●
WALLACE CREEK	1	●	●●	●	●●
WEST FORK COW CREEK	1	●●●	●●	●	●
WEST FORK COW CREEK	2	●●●	●●	●●	●
WEST FORK COW CREEK	3	●●●	●●	●	●
WEST FORK COW CREEK	4	●●●	●●	●●	●
WEST FORK COW CREEK	5	●●●	●	●	●
WEST FORK COW CREEK	6	●●	●●	●●	●
GOLD MOUNTAIN CREEK TRIB 1	1	●●●	●	●	●●●
PANTHER CREEK TRIBUTARY 1	1	●●	●	●	●
BOBBY CREEK TRIB 2	1	●	●●	●	●
BEAR CREEK TRIBUTARY 1	1	●●	●	●●●	●
BEAR CREEK TRIBUTARY 2	1	●	●	●	●
BEAR CREEK TRIBUTARY 3	1	●	●	●	●
BEAR CREEK TRIBUTARY 4	1	●	●	●	●●

Appendix 3: Land use classifications for the ODFW stream habitat surveys

The Oregon Department of Fish and Wildlife classified the land use for each reach surveyed within the West Fork Cow Creek Watershed. All categories have been included below, even those not applicable to the West Fork Cow Creek Watershed.

AG	Agricultural crop or dairy land.
TH	Timber harvest: active timber management including tree felling, logging, etc. Not yet replanted.
YT	Young forest trees: can range from recently planted harvest units to stands with trees up to 15 cm dbh.
ST	Second growth timber: trees 15-30 cm dbh within generally dense, rapidly growing, uniform stands.
LT	Large timber: 30 to 50 cm dbh.
MT	Mature timber: 50 to 90 cm dbh.
OG	Old growth forest: many trees with 90+ cm dbh and plant community with old growth characteristics.
PT	Partial cut timber: selection cut or shelterwood cut with partial removal of large trees. Combination of stumps and standing timber.
FF	Forest fire: evidence of recent charring and tree mortality.
BK	Bug kill: eastside forests with >60% mortality from pests and diseases.
LG	Light grazing pressure: grasses, forbs, and shrubs present. Banks not broken down, animal presence obvious only at limited points such as water crossing. Cow pies evident.
HG	Heavy grazing pressure: broken banks, well established cow paths. Primarily bare earth or early successional stages of grasses and forbs present.
EX	Exclosure: fenced area that excludes cattle from a portion of rangeland.
UR	Urban
RR	Rural residential
IN	Industrial
MI	Mining
WL	Wetland
NU	No use identified

Stream	Reach	Primary Land Use	Secondary Land Use
BEAR CREEK	1	ST	
BEAR CREEK	2	YT	
BEAR CREEK	3	LT	
BLACK CREEK	1	YT	
BOBBY CREEK	1	LT	
WILSON CREEK	1	MT	
WILSON CREEK	2	YT	LT
ELK VALLEY CREEK	1	ST	LT
ELK VALLEY CREEK	2	ST	
ELK VALLEY CREEK	3	ST	
E. FK. ELK VALLEY CREEK	1	ST	
GOAT TRAIL CREEK	1	LT	
GOAT TRAIL CREEK	2	YT	
GOLD MOUNTAIN CREEK	1	LT	
GOLD MOUNTAIN CREEK	2	ST	PT
GRANT CREEK	1	YT	
PANTHER CREEK	1	ST	
SLIDE CREEK	1	ST	
SLIDE CREEK	2	MT	
STANLEY CREEK	1	ST	
STANLEY CREEK	2	ST	YT
WALKER CREEK	1	LT	MT
WALKER CREEK	2	LT	MT
WALLACE CREEK	1	LT	MT
W. FK. COW CREEK	1	ST	
W. FK. COW CREEK	2	MT	ST
W. FK. COW CREEK	3	ST	
W. FK. COW CREEK	4	MT	
W. FK. COW CREEK	5	ST	
W. FK. COW CREEK	6	ST	
GOLD MOUNTAIN CREEK TRIB 1	1	ST	PT
PANTHER CREEK TRIBUTARY 1	1	ST	
BOBBY CREEK TRIB 2	1	LT	
BEAR CREEK TRIBUTARY 1	1	LT	
BEAR CREEK TRIBUTARY 2	1	YT	
BEAR CREEK TRIBUTARY 3	1	YT	
BEAR CREEK TRIBUTARY 4	1	LT	

Appendix 4: Water quality parameter descriptions

Surface water pH
The hydrogen ion concentration of a liquid, which determines acidity or alkalinity, is expressed using pH. A logarithmic scale that ranges from one to 14 measures pH. On this scale, a pH of seven is neutral, more than seven is alkaline, and less than seven is acidic.

The beneficial uses affected by high or low pH levels are resident fish and aquatic life, and water contact recreation. When pH levels exceed the stream's normal range, water can dissolve the protective mucous layer on aquatic organisms such as fish, amphibians, and mollusks. Without a healthy protective layer, fish and other animals become more susceptible to diseases. Also, pH affects nutrients, toxics, and metals within the stream. Changes in pH can alter the chemical form and affect availability of nutrients and toxic chemicals, which can harm resident aquatic life and be a human health risk. In mining areas, there is the potential for both low pH levels and the presence of heavy metals. This is an issue because metal ions shift to more toxic forms in acidic water, which is a concern for both wildlife and humans.

Physical and biological factors cause surface and groundwater pH to normally be slightly alkaline or acidic. The chemical composition of rocks and rainfall will influence pH. Respiration and photosynthesis are normal metabolic processes of aquatic organisms that change pH. Carbon dioxide (CO_2) is produced during respiration and used for photosynthesis. The level of dissolved CO_2 in a stream raises and lowers pH. Normally, there is a balance between instream metabolic processes and a natural chemical buffering system that prevents streams from becoming too acidic or alkaline from changes in CO_2 levels. However, stream inputs that increase or decrease respiration and photosynthesis by aquatic organisms can indirectly shift pH by changing CO_2 levels. For example, nitrogen and phosphorus from organic matter such as feces and urine, or from inorganic chemicals such as fertilizers, encourage algae growth in the summer and can result in algae "blooms." When a stream's algae population grows, so does the degree to which CO_2 is produced and used. When CO_2 levels in water are high, carbonic acid is produced resulting in pH levels that are harmful to aquatic life.

In an attempt to differentiate between the natural variability of surface water pH and the changes caused by other factors, ODEQ established a range of acceptable pH levels for river basins or for specific bodies of water. In the Umpqua Basin, the acceptable pH range is 6.5 to 8.5. When 10% or more of pH measurements from the same stream are outside of the 6.5 to 8.5 range, the stream is designated water quality limited.

Dissolved oxygen
In the Umpqua Basin, cold-water aquatic organisms are adapted to waters with high amounts of dissolved oxygen. Salmonid eggs and smolts are especially sensitive to dissolved oxygen levels. If levels drop too low for even a short period of time, eggs, smolts, and other aquatic organisms will die. Therefore, the beneficial uses most affected

by dissolved oxygen are resident fish and aquatic life, salmonid fish spawning, and salmonid fish rearing.

The amount of oxygen that is dissolved in water will vary depending upon temperature, barometric pressure, flow, and time of day. Cold water dissolves more oxygen than warm water. As barometric pressure increases, so does the amount of oxygen that can dissolve in water. Flowing water has more dissolved oxygen than still water. Aquatic organisms produce oxygen through photosynthesis and use oxygen during respiration. As a result, dissolved oxygen levels tend to be highest in the afternoon when algal photosynthesis is at a peak, and lowest before dawn after organisms have used oxygen for respiration.

Since oxygen content varies depending on many factors, ODEQ has many dissolved oxygen criteria. The standards specify oxygen content during different stages of salmonid life cycles and for gravel beds. Standards change based on differences in elevation and stream temperature. During months when salmon are spawning, ODEQ uses 11.0 mg/l as the dissolved oxygen standard for the Umpqua Basin. For the rest of the year, the standard is 8.0 mg/l.

Nutrients
The beneficial uses affected by nutrients are aesthetics or "uses identified under related parameters."[73] This means that a stream may be considered water quality limited for nutrients if nutrient levels adversely affect related parameters, such as dissolved oxygen, that then negatively impact one or more beneficial uses, such as resident fish and aquatic life.

Possible nutrient sources include feces and urine from domestic and wild animals, wastewater treatment plant effluent, failing septic system waste, and fertilizers. High nutrient levels during the summer encourage the growth of algae and aquatic plants. Excessive algal and vegetative growth can result in little or no dissolved oxygen, and interfere with water contact recreation, such as swimming. Also, certain algae types produce by-products that are toxic to humans, wildlife, and livestock, as occurred in Diamond Lake in the summer of 2002.[74] Currently, there are no Umpqua Basin-based ODEQ values for acceptable stream nutrient levels. The Oregon Watershed Enhancement Board recommends using 0.05 mg/l for total phosphorus, and 0.3 mg/l for total nitrate (including nitrites and nitrates).

Bacteria
Bacteria are present in all surface water. In general, resident bacteria are not harmful to the overall aquatic environment or to most human uses. However, ingestion of fecal bacteria such as *Escherichia coli* (*E. coli*) can cause serious illness or death in humans. The presence of fecal bacteria indicates a potential vector for other human diseases, such as cholera and giardiasis ("beaver fever"). Water contact recreation is the beneficial use

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[73] From ODEQ's *Oregon's Approved 1998 303(d) Decision Matrix* (1998).
[74] Diamond Lake is within the Umpqua National Forest in the extreme eastern portion of the Umpqua Basin.

most affected by bacteria. Private and public drinking water supplies are not affected because water filtration systems are able to remove harmful microorganisms.

There are many possible sources of *E. coli* and other fecal bacteria in water. Common sources include failing septic systems and aquatic warm-blooded animals, such as waterfowl and beaver. Upland areas with concentrated fecal waste, such as stockyards and kennels, are also bacteria sources; during rain events, high levels of bacteria may be washed down into streams.

According to ODEQ, a stream is considered water quality limited for bacteria when one of two events occurs: 1) 10% of two or more samples taken from the same stream have *E. coli* concentrations exceeding 406 bacteria per 100 ml of water; and 2) the average *E. coli* concentration of five samples taken within a 30-day period exceeds 126 bacteria per 100 ml of water.

Toxics

Toxics are a concern for residential fish and aquatic life and for drinking water. A variety of substances can be toxic, including metals, organic chemicals, and inorganic chemicals. Toxics are not defined by substance type, but rather by their effects on humans, fish, wildlife, and the environment. According to ODEQ:

> Toxic substances shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations [that] may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare, [or are detrimental to] aquatic life, wildlife, or other designated beneficial uses (p. 22).[75]

[75] From ODEQ's *Oregon's Approved 1998 303(d) Decision Matrix* (1998).

Appendix 5: Water use categories

There are eight general water use categories in the West Fork Cow Creek Watershed. The table below lists the Oregon Water Resources Department uses that are included in each category. Not all uses occur in the West Fork Cow Creek Watershed.

Irrigation
Primary and supplemental
Irrigation
Supplemental
Cranberries
Irrigation, domestic & stock
Irrigation & domestic
Irrigation & stock

Industrial
Geothermal
Manufacturing
Sawmill
Shop
Log deck
Commercial
Laboratory

Domestic
Domestic
Lawn and garden
Non-commercial
Stock
Group domestic
Restroom
School

Fish and Wildlife
Aquaculture
Fish
Wildlife

Municipal
Municipal
Quasi-municipal

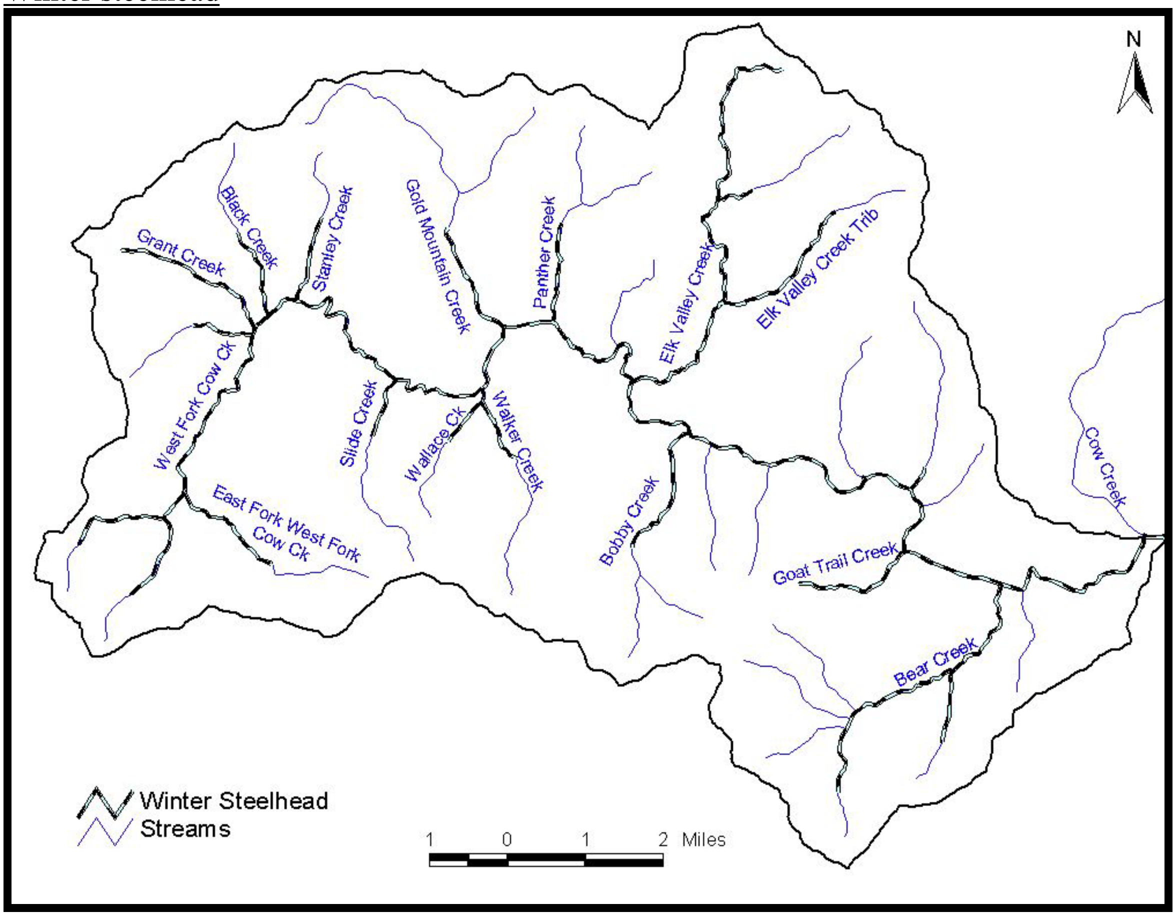
Recreation
Campground
Recreation
School

Agriculture
Agriculture
Cranberry harvest
Flood harvesting
All cranberry uses
Temperature control
Dairy barn
Frost protection
Greenhouse
Mint still
Nursery use

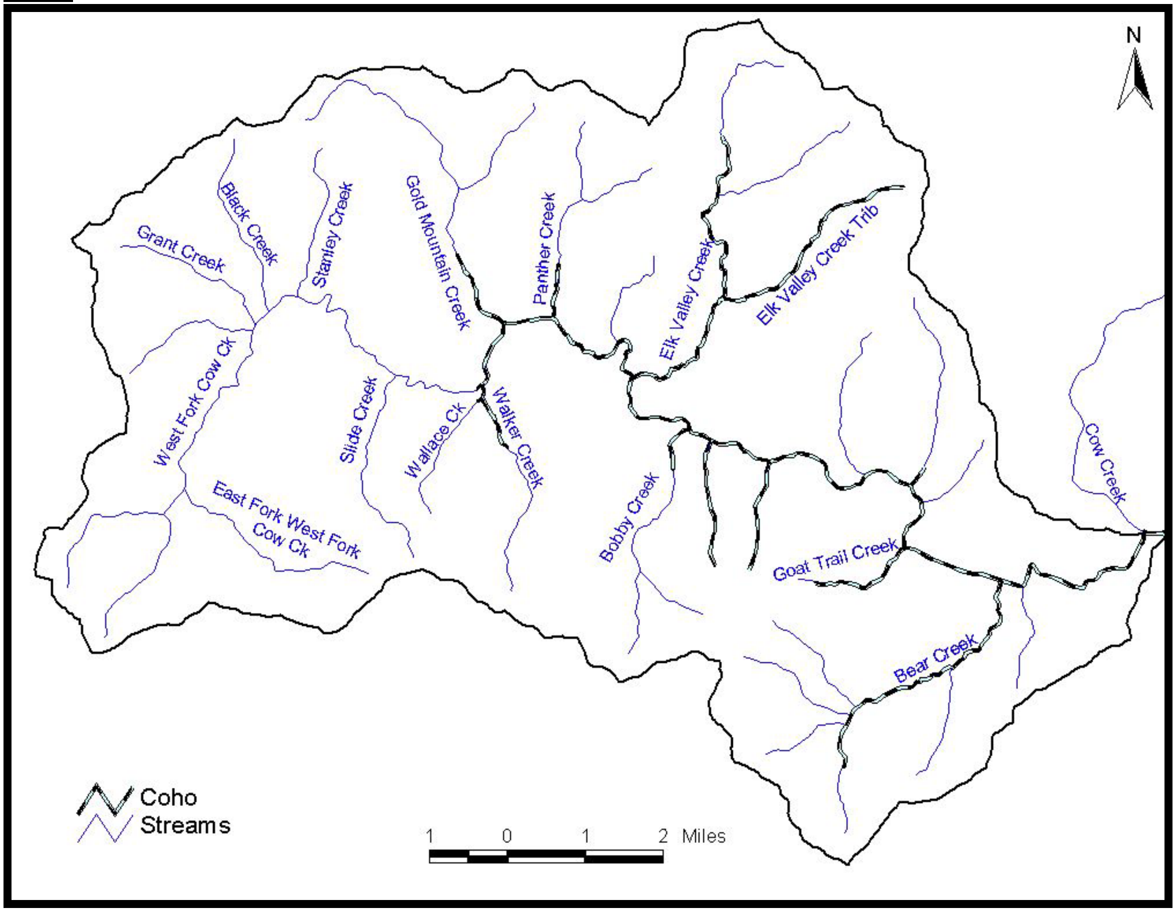
Miscellaneous
Air conditioning
Aesthetic
Forest management
Fire protection
Groundwater recharge
Pollution abatement
Road construction
Storage

Appendix 6: Anadromous salmonid distribution by species

<u>Winter steelhead</u>



Coho


N
Grant Creek
Black Creek
Stanley Creek
Gold Mountain Creek
Panther Creek
Elk Valley Creek
Elk Valley Creek Trib
West Fork Cow Ck
Slide Creek
Wallace Ck
Walker Creek
East Fork West Fork
Cow Ck
Bobby Creek
Goat Trail Creek
Bear Creek
Cow Creek
Coho
Streams
1 0 1 2 Miles

Fall chinook

Fall chinook spawning in the West Fork Cow Creek Watershed is intermittent and does not constitute a run.