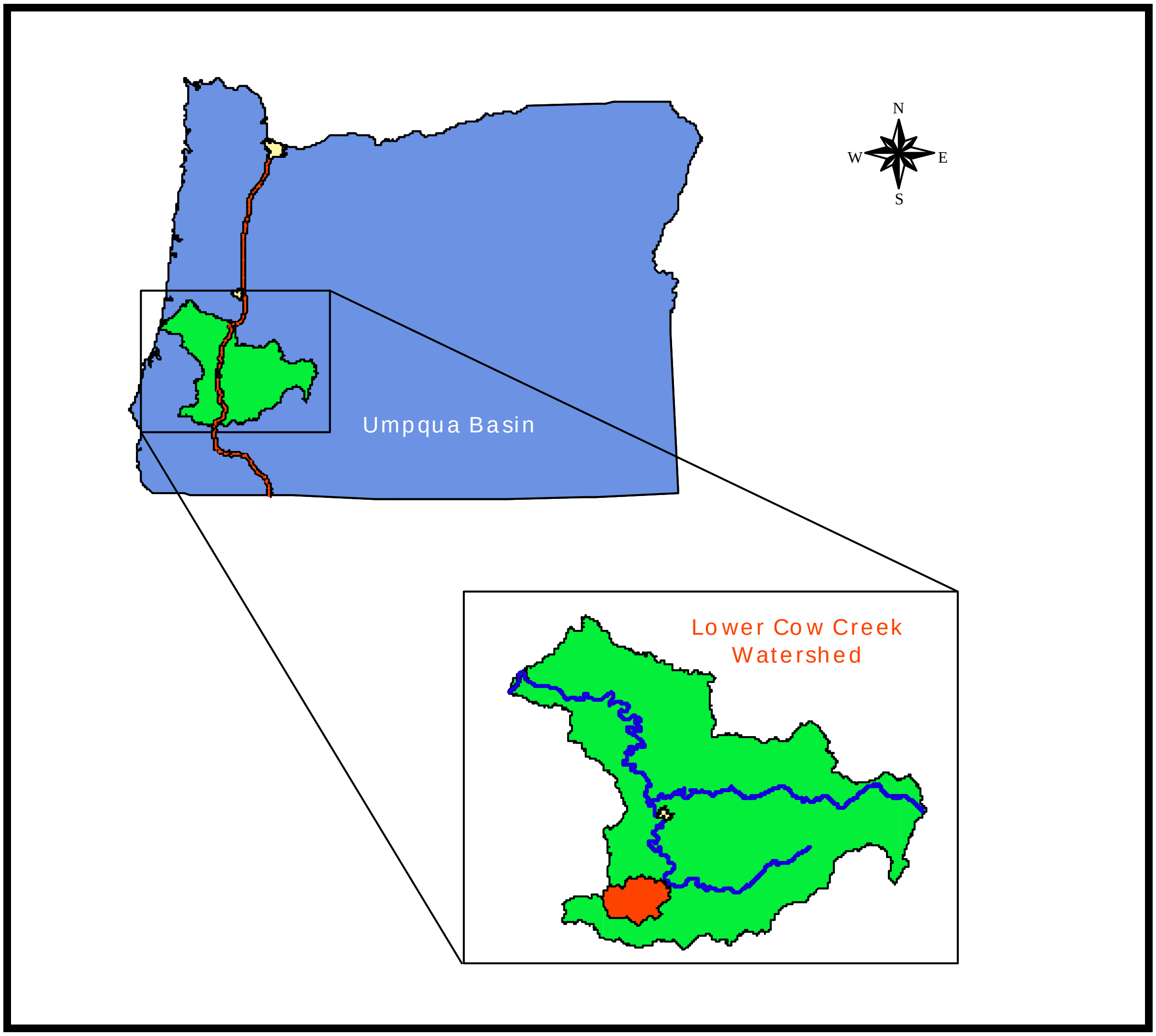
Lower Cow Creek

Watershed Assessment and Action Plan



Prepared by Nancy A. Geyer for the

Umpqua Basin Watershed Council

November, 2003

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Publication citation

This document should be referenced as Geyer, Nancy A. Lower Cow Creek Watershed Assessment and Action Plan. Roseburg, Oregon: Prepared for the Umpqua Basin Watershed Council; 2003 November.

This project has been funded in part by the United States Environmental Protection Agency under assistance agreement CO-000451-02 to the Oregon Department of Environmental Quality. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Acknowledgments

This assessment would not have been possible without the help of community volunteers. I am very grateful to the landowners, residents, and UBWC directors and members who attended the monthly watershed assessment meetings and offered their critical review and insight. Their input and participation was invaluable.

I am also grateful for the assistance of the following individuals and groups:

- Janice Green for reviewing the document and offering suggestions for improvement.
- The staff of the Douglas Soil and Water Conservation District, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, and Oregon Water Resources Department who answered many questions and provided much of the assessment's quantitative and qualitative data.
- The resource professionals who agreed to serve as guest speakers at our monthly watershed assessment meetings:
    - Bobbi Lindberg, ODEQ;
    - Dave Harris, ODFW;
    - Dave Williams, OWRD;
    - Frank Nielsen, Douglas County Natural Resources Department;
    - Kent Smith, InSight Consultants;
    - Sam Dunnavant, ODFW; and
    - Walter Barton, Douglas Soil and Water Conservation District.

I would also like to thank Eric Geyer for his unwavering support throughout the process.

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Acronym List

BLM	Bureau of Land Management
Cfs	Cubic feet per second
DFPA	Douglas Forest Protective Association
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
PSC	Pacific Salmon Commission
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 Lower 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, and the communities within the watershed. Information in sections 1.2 and 1.3 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 Lower Cow Creek Watershed and what are its defining characteristics?
- What are the demographic, educational, and economic characteristics of Lower Cow Creek Watershed residents?
- 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 Lower 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 Lower 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 Lower 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 Lower Cow Creek Watershed residents, landowners, and stakeholders. 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 Lower Cow Creek Watershed and offer comments and suggestions for improvement.

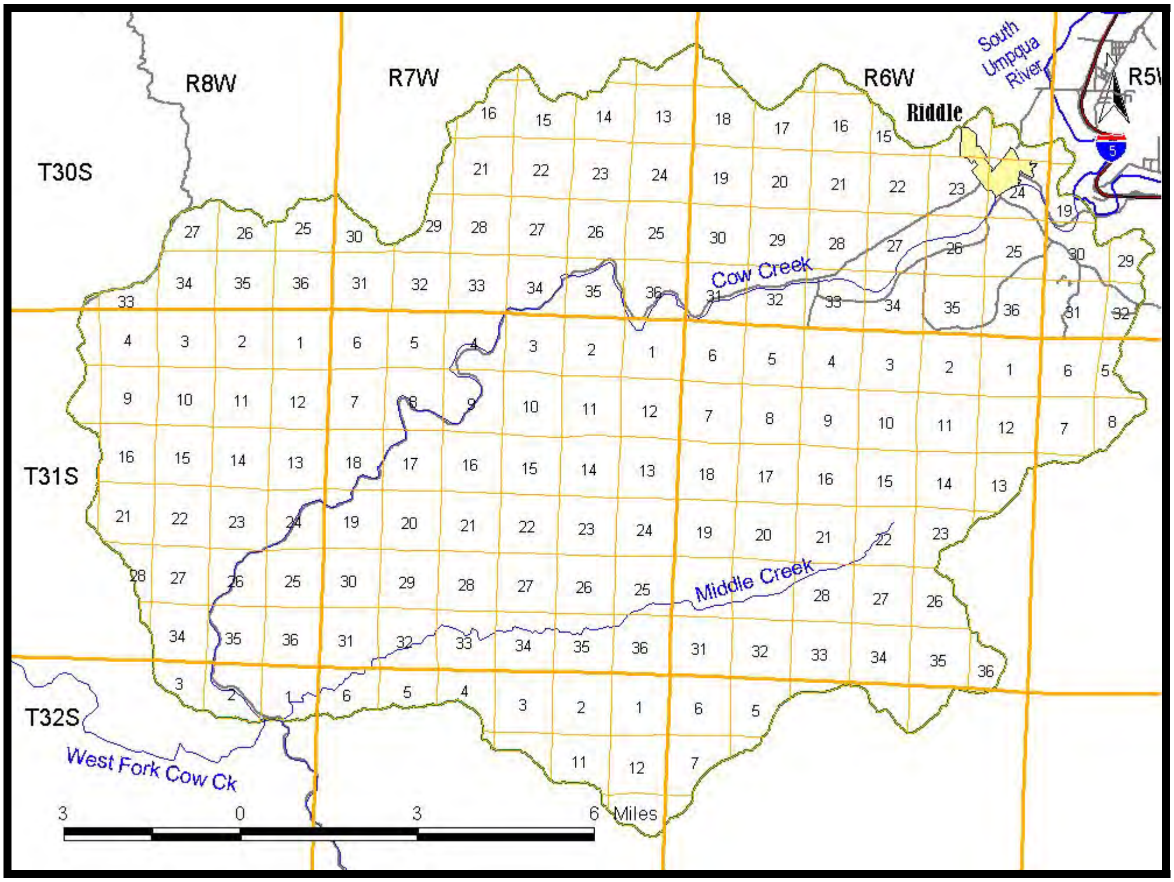
The Lower Cow Creek Watershed assessment meetings were held in conjunction with meetings for the South Umpqua River, West Fork Cow Creek, and Upper Cow Creek Watersheds. Landowners and residents met for 10 meetings and one field trip from October, 2002, through August, 2003. A total of 53 people attended 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 Lower Cow Creek fifth-field watershed is located in Douglas County, Oregon, and is approximately 102,536.7 acres. The watershed stretches a maximum of 13 miles north to south and 18 miles east to west (see Map 1-1). Riddle is the only incorporated city within the watershed. Cow Creek Road follows Cow Creek through the length of the watershed.

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



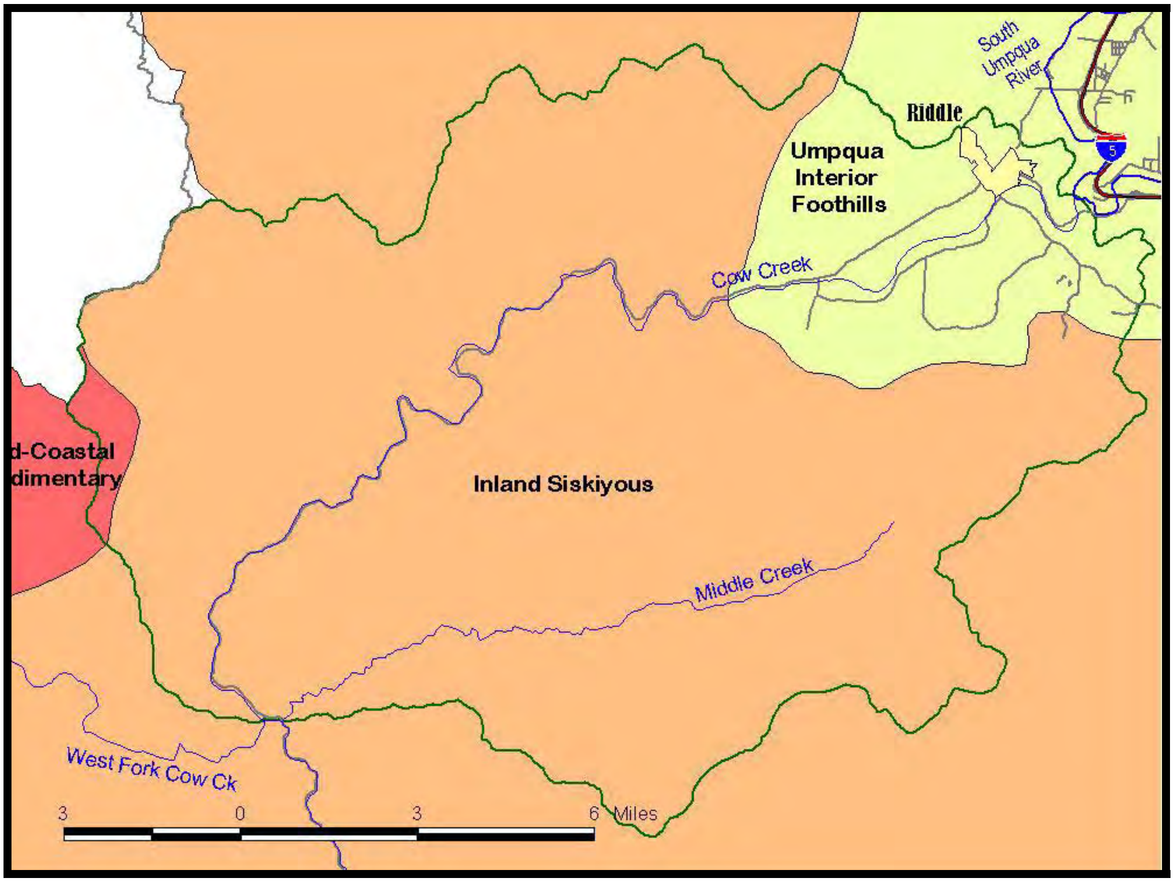
Map 1-1: Location of the Lower Cow Creek Watershed.

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 Lower Cow Creek Watershed. In some cases, ecoregion information is used to supplement other data.

Map 1-2 and Table 1-1 show the Lower Cow Creek Watershed's location, acres, and percent within each ecoregion. The majority of the watershed (84%) falls within the Inland Siskiyous Ecoregion. The western-most border of the watershed is part of the Mid-Coastal Sedimentary Ecoregion, while the northeast section is part of the Umpqua Interior Foothills.

[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 Lower Cow Creek Watershed.

Ecoregion	Acres	Percent of total[5]
Inland Siskiyous	86,386.5	84.2%
Mid-Coastal Sedimentary	1,063.6	1.0%
Umpqua Interior Foothills	15,086.6	14.7%
TOTAL	**102,536.7**	**100.0%**

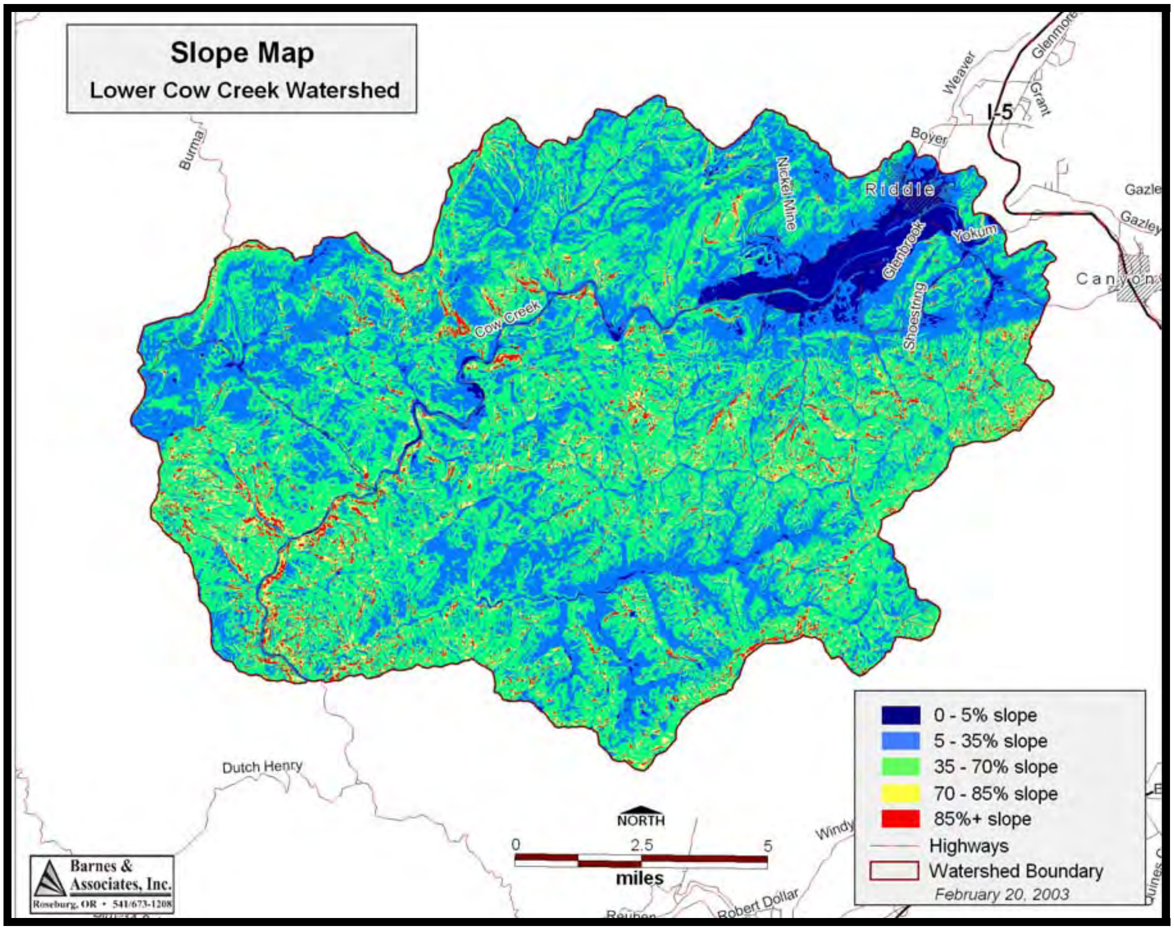
Table 1-1: Acres and percent of the Lower Cow Creek Watershed within each ecoregion.

1.2.3. Topography

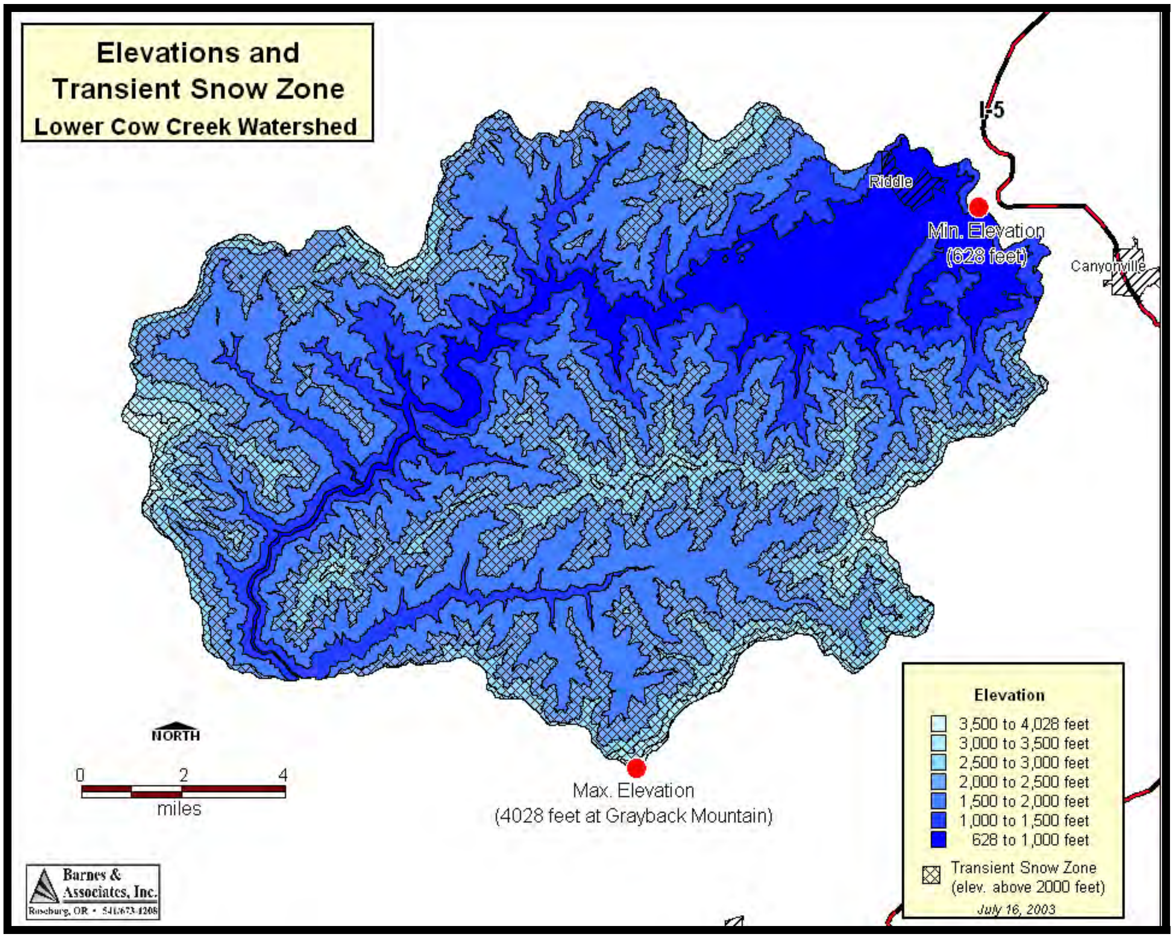
The Inland Siskiyous have mountains with deep, "V"-shaped valleys. Stream channels are usually moderate to high gradient. Narrow valleys, terraces, and steep foothills characterize the Umpqua Interior Foothills Ecoregion. Gentle to moderate slopes correspond with medium and large streams in the Mid-Coastal Sedimentary Ecoregion. Steep slopes often border smaller streams and stream headwaters (see Map 1-3). The lowest point in the watershed is 628 feet where Cow Creek meets the South Umpqua River. The highest point is 4,028 feet at Grayback Mountain on the southern tip of the watershed (see Map 1-4). In the Lower Cow Creek Watershed, 40.3% of the land base is

[5] Total does not add to 100 due to rounding.

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 Lower Cow Creek Watershed.



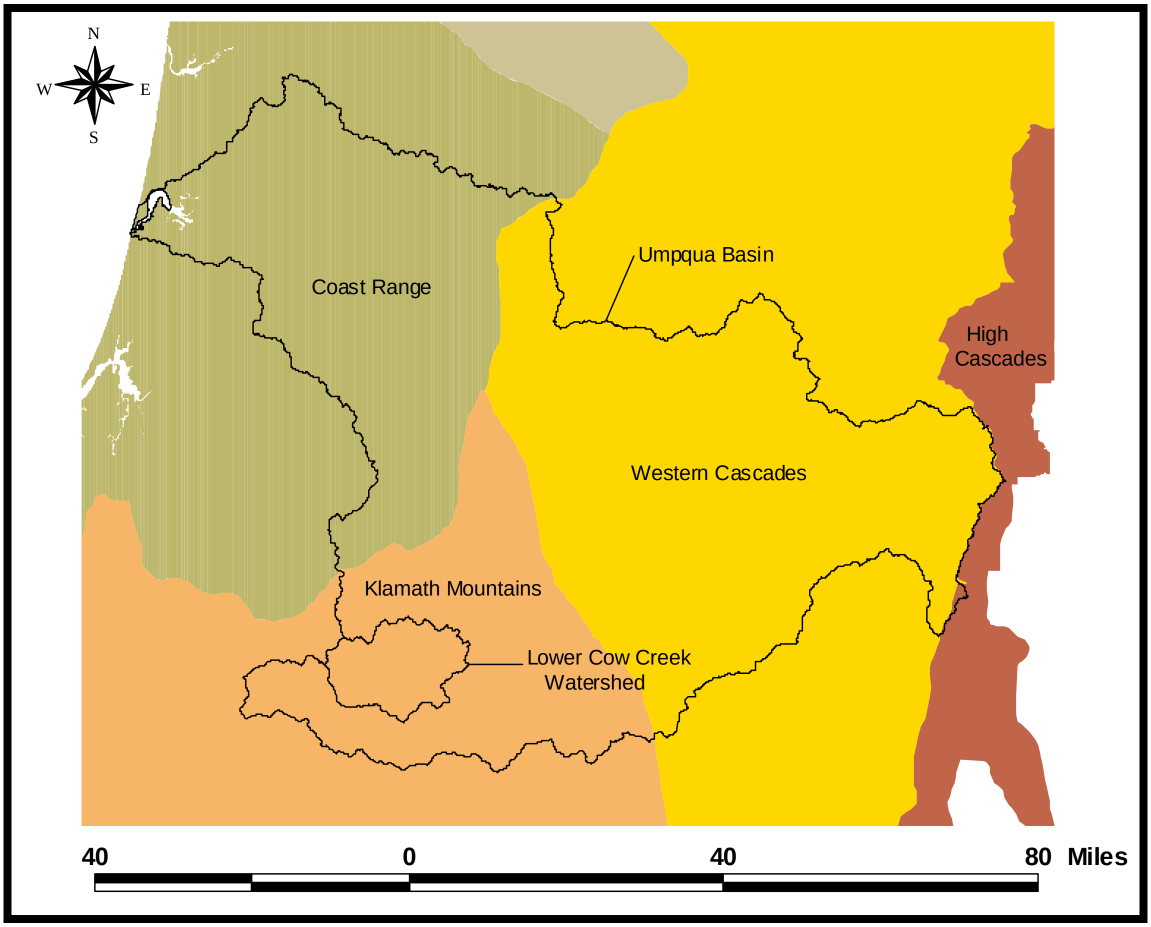
Map 1-4: Elevation of the Lower Cow Creek Watershed with highest and lowest points.

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 Lower 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, 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 (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. The Lower Cow Creek Watershed lies within the Klamath Mountains Province, though it has some geologic units typical of both the Oregon Coast Range and the Western Cascades. Map 1-5 illustrates the physiographic province distribution within the watershed.



Map 1-5: Physiographic provinces of the Lower 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 Western Cascades

The Western Cascades range in elevation from approximately 1,700 feet in the west to 5,800 feet above sea level on the eastern edge abutting the High Cascades. The Cascades run the entire north-south length of Oregon and divide the state into the wet western part and the dry eastern portion of the state. Deep erosion in the Western Cascades has occurred as a result of high rainfall. South of the Calapooya divide, streams draining the Cascades westward, including the Umpqua Basin, flow into the ocean rather than the Willamette.

The Lower Cow Creek Watershed

The Lower Cow Creek Watershed has fairly consistent high relief topography throughout the watershed; Rabbit Mountain, Dutchman Butte, and Iron Mountain are some examples. Streams within the watershed deeply dissect the landscape. The Cow Creek Valley opens up into a large floodplain downstream from the confluence with Council Creek until it joins with the South Umpqua River. This area is the only significant low relief feature within the watershed. Although the topography is fairly consistent throughout the Lower Cow Creek Watershed, some changes in slope are evident along contacts between geologic units.

Geologic units of the Lower Cow Creek Watershed

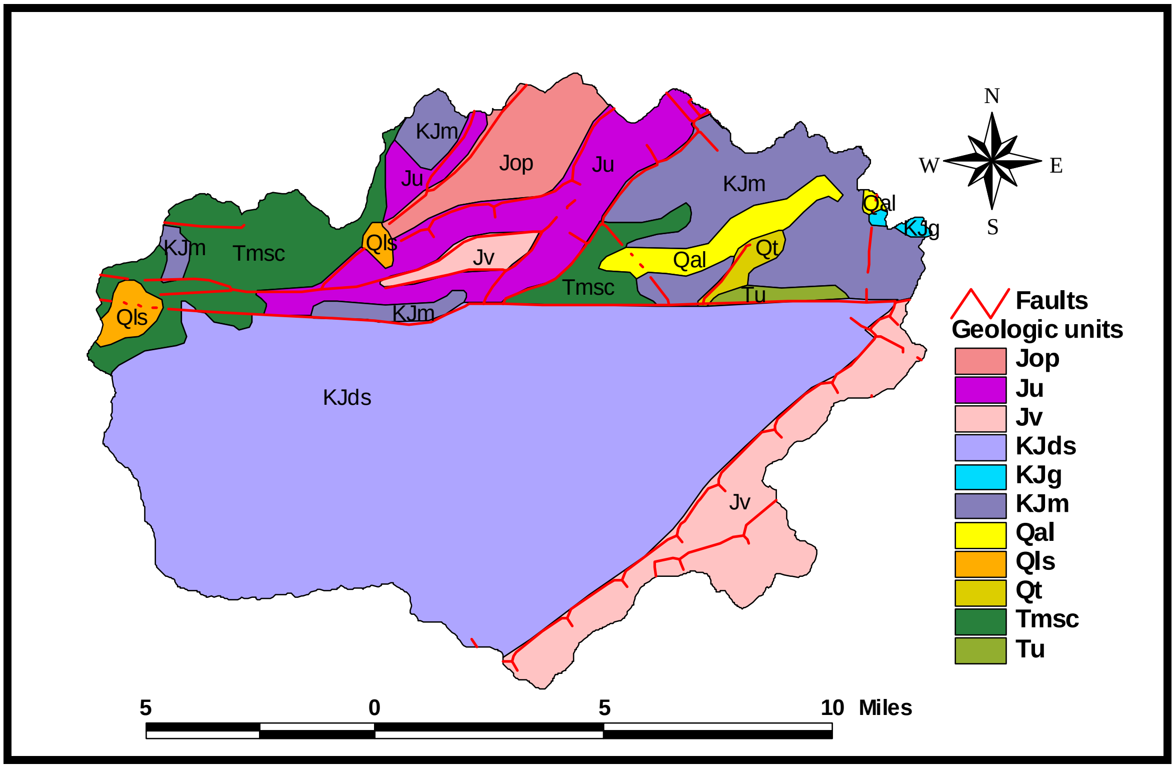
According to Walker and MacLeod (1991), there are ten geologic units within the Lower Cow Creek Watershed, ranging in age from Jurassic to Quaternary (see Table 1-2 and Map 1-6). Most of the geologic units within the watershed are characteristic of the Klamath Mountains. A detailed description of units and a glossary of terms can be found in Appendix 1.

Jurassic ophiolite sequences (Ju), or oceanic crust incorporated into the continent are found in the north central part of the watershed. Nickel Mountain, which was the only operating nickel mine in the United States until it recently closed down, is located within the ophiolite sequences in Lower Cow Creek Watershed. Peridotite, a mineral found within the ophiolite sequence, can weather to leave behind insoluble nickel (Orr and Orr, 2000). Nickel Mountain is located at the farthest north reach of the Ju unit in the watershed. Its full extent can be seen on Map 3-17 on page 116. The Jurassic Otter Point Formation (Jop) is also found in that same area, consisting of highly sheared graywacke, mudstone, siltstone, and shale with some greenstone, limestone, chert, blueschist, and serpentine. Jurassic volcanic rocks (Jv) are found mostly on the southeastern fringe of the watershed, but also in the north central region. Rocks of the late Jurassic and early Cretaceous constitute the majority of the watershed. The Myrtle Group (KJm) consists of conglomerate, sandstone, siltstone, and limestone, and the Dothan Formation sedimentary rocks (KJds) consist of sandstone, conglomerate, graywacke, and chert. Intrusive granite rocks (KJg) exist in a very small area in the northeast.

The Tertiary age units are found in the northern half 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 tuffaceous sedimentary rocks, tuffs, and basalt (Tu) typical of the Western Cascades. The youngest geologic units in the watershed are Quaternary in age. Alluvial (stream) deposits of sand, gravel, and silt are found in floodplains and channels (Qal), and older stream terrace deposits (Qt) lie above present-day floodplains. Landslide and debris flow deposits (Qls) are also found in the watershed.

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 Lower Cow Creek Watershed.

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 Lower Cow Creek Watershed has several major faults within its boundaries, most of which lie at the contacts between different geologic units. Most faults are in a southwest-northeast orientation (see Map 1-6), but some smaller faults fall in an orientation nearly perpendicular to this. One major fault lies in a west-east orientation at the contact of the Dothan Formation with the rocks north of it. 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 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 Lower Cow Creek Watershed, are naturally surface water dominated, with groundwater playing a relatively minor role.

In addition, 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 (see section 3.3 for more information on water quality).

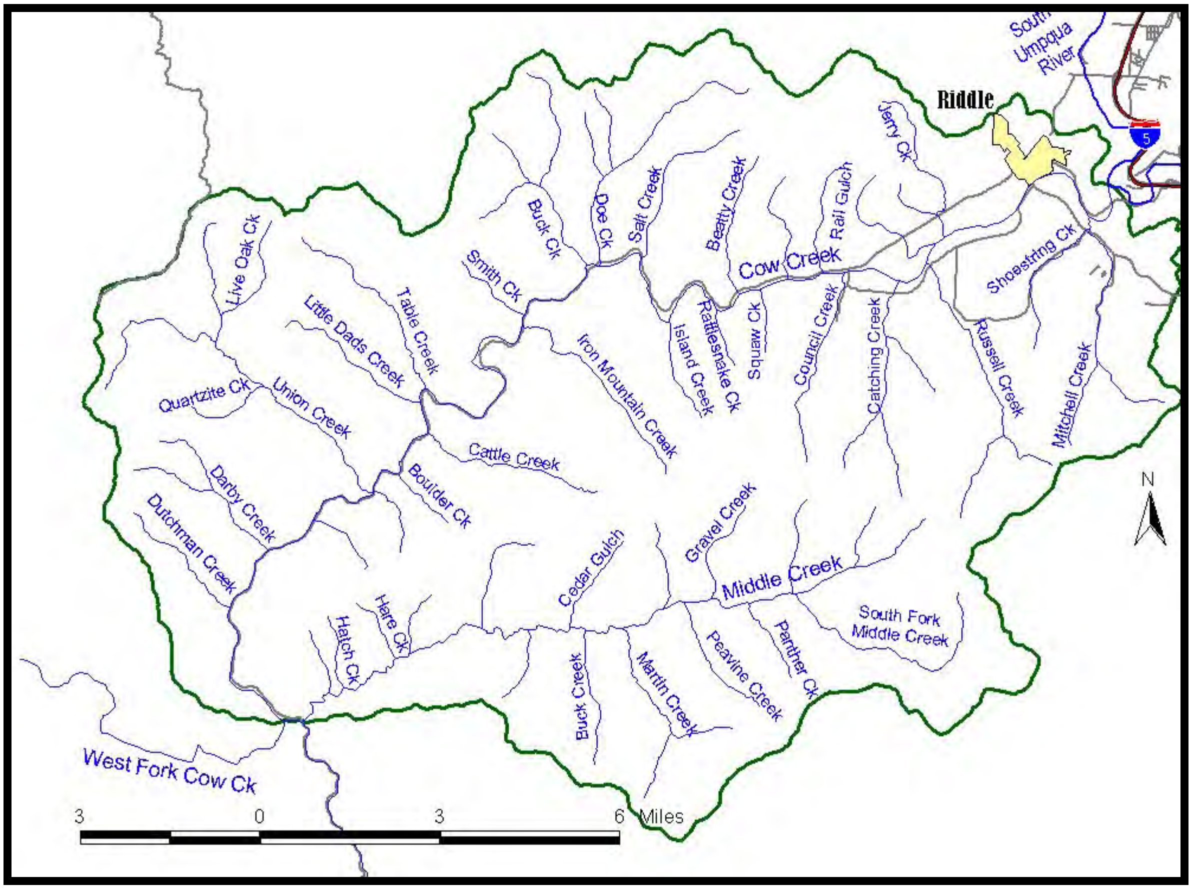
The topography that results from geologic processes helps to shape the steepness of slopes and their likelihood of failing. Topography also influences the local climate, causing, for instance, more rain on the western slopes of large hills than on the eastern slopes. This may influence runoff and sediment 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 3.3.7 for more information on stream sediment).

1.2.5. The Lower Cow Creek stream network

Lower Cow Creek is the final 26.3 stream miles of Cow Creek.[7] Map 1-7 shows all of Lower 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 169.1 stream miles in the Lower Cow Creek Watershed. The longest tributary to Lower Cow Creek is Middle Creek (12.8 stream miles). Cow Creek's average stream gradient is 0.5% (see Photo 1-1). The average stream gradient for Middle Creek is 1.8%, while other tributaries have an average gradient of 7.9%.

Stream density is fairly high in the Inland Siskiyous and Mid-Coastal Sedimentary Ecoregions. Umpqua Interior Foothills Ecoregion is characterized by lower stream density, even though this is not readily apparent in Map 1-7. Low precipitation can result in intermittent summer streamflow.

[7] 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 Lower Cow Creek Watershed.**

Photo 1-1: Cow Creek within the Lower Cow Creek Watershed.[8]

1.2.6. Climate

As is typical of southwest interior Oregon, the Inland Siskiyous Ecoregions and the Umpqua Interior Foothills Ecoregion are drier and colder than the northwest interior because much of the area is within the Coastal Mountain Range rain shadow. In the Inland Siskiyous Ecoregion, precipitation typically ranges from 35 to 70 inches, but can be up to 89 inches in higher elevations. The Umpqua Interior Foothills Ecoregion precipitation ranges from 30 to 50 inches. The Mid-Coastal Sedimentary Ecoregion typically has mild temperatures and between 60 and 130 inches of rain.

There is a climate station near Riddle (station #7169) that collects temperature and precipitation data within the watershed.[9] As the ecoregion information indicates, temperature is generally mild. Figure 1-1 shows the average daily minimum and maximum temperatures by month for Riddle. Maximum temperatures in the summer are generally in the 70s or low 80s. Minimum winter temperatures are usually above freezing.

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[8] Kristin Anderson and John Runyon of BioSystems, Inc., contributed this photograph. The photograph was taken from Universal Transverse Mercator coordinate 463041/4751777.

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

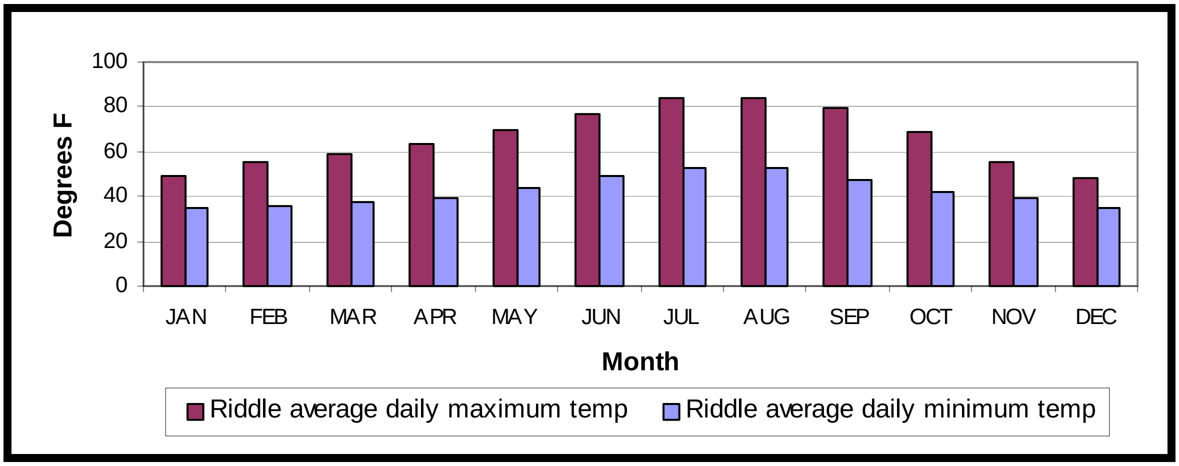


Figure 1-1: Average minimum and maximum temperature for Riddle (station #7169).

Rainfall averages 30.8 inches in Riddle, but can vary widely depending upon the year (see Figure 1-2). As is typical of southwest Oregon, most precipitation occurs in the winter months (see Figure 1-3). In Riddle, rainfall averages 4.8 inches for the months of November through February and 0.6 inches for June through September.

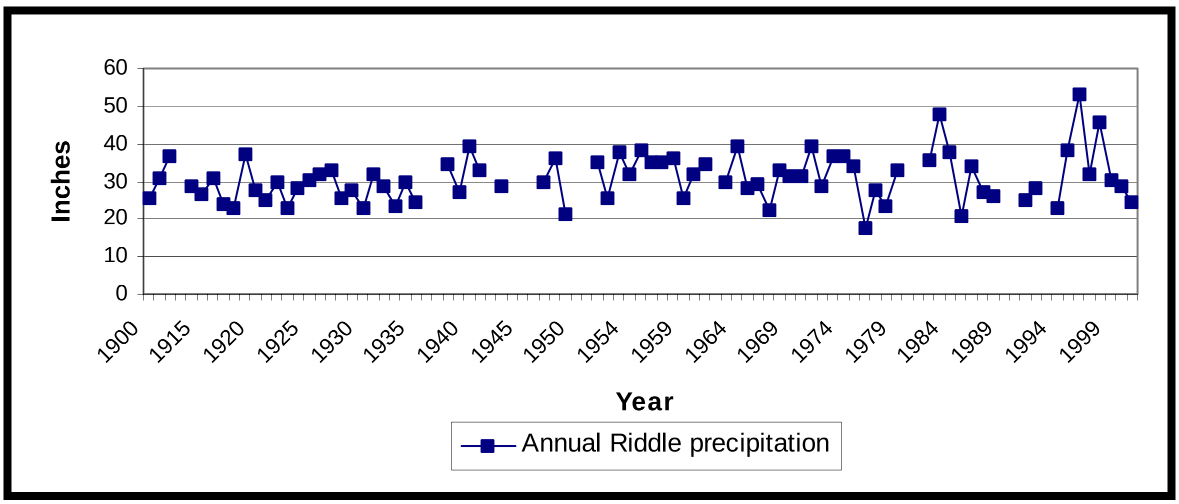


Figure 1-2: Annual precipitation for Riddle (station #7169).

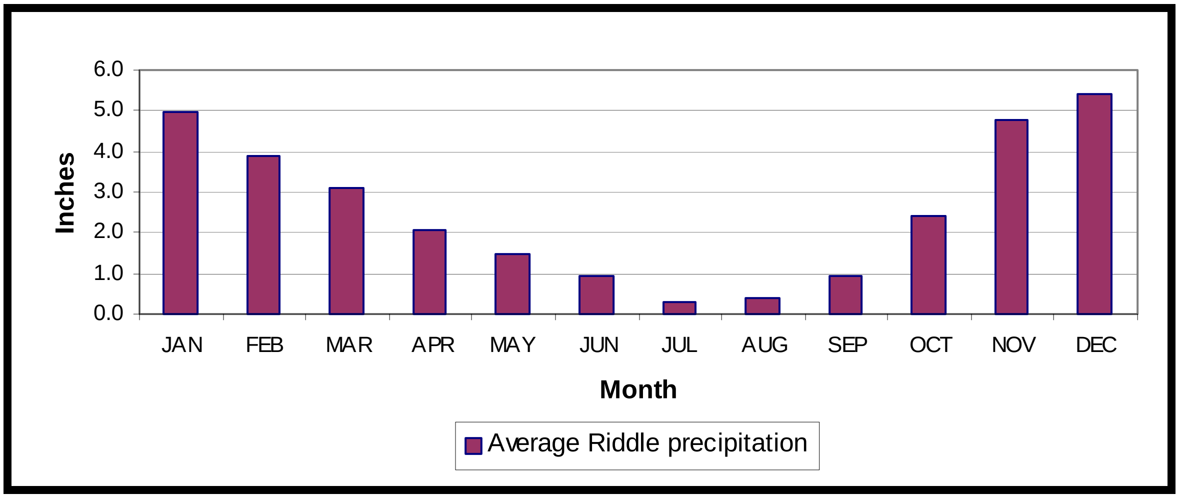


Figure 1-3: Mean monthly precipitation for Riddle (station #7169).

1.2.7. Vegetation

In the Umpqua Interior Foothills Ecoregion, valley bottoms have been converted from native prairie and savanna to urban and rural residential areas, agriculture lands, and grazing lands. Where conditions are favorable, uplands support coniferous forests of Douglas-fir intermixed with Pacific madrone, bigleaf maple, California black oak, ponderosa pine, incense cedar, and sometimes Oregon white oak. Dryer upland soils support hardwood-dominated stands of Pacific madrone, Oregon white oak, and some California black oak, with small amounts of Douglas-fir, ponderosa pine, and incense cedar. Where soils are shallow or rocky, scattered Oregon white oak, canyon live oak, and grass or shrubs characterize some hillsides. Bottomland vegetation varies. Areas with deep, sandy, gravelly floodplains often have black cottonwood while Oregon white oak and Oregon ash are more common in areas with poorly drained, clay soils.

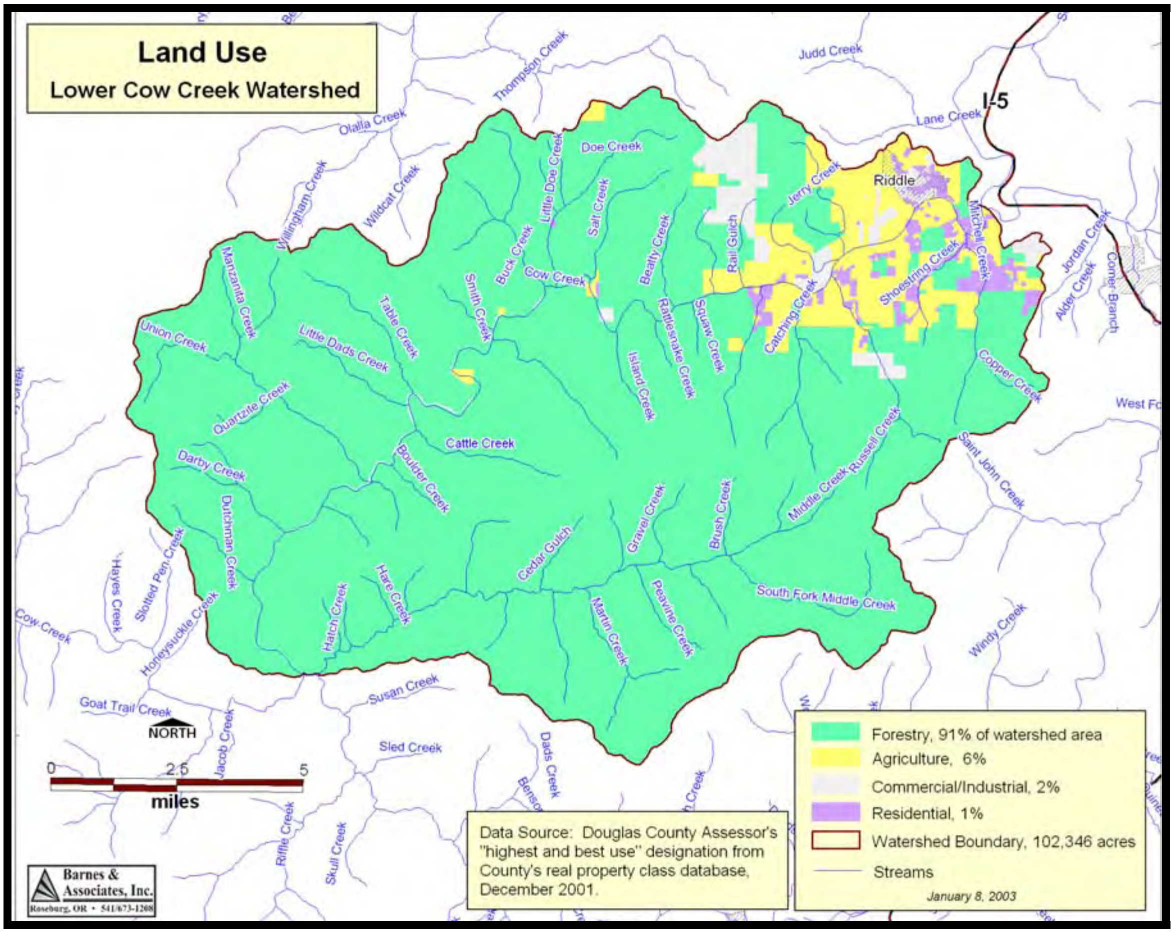
In the higher elevation Inland Siskiyous Ecoregion, Douglas-fir is dominant, with grand fir and white fir on northern aspects but minor or absent on southern aspects. Bigleaf maple, western redcedar, and incense cedar are also present. Hemlock and California black oak can be found where conditions are 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. Where serpentine soils are present, vegetation is often not consistent with other areas within the Inland Siskiyous Ecoregion.

The Mid-Coastal Sedimentary Ecoregion occupies a very small portion of the watershed (1%). Douglas-fir is the dominant species. 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, 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.

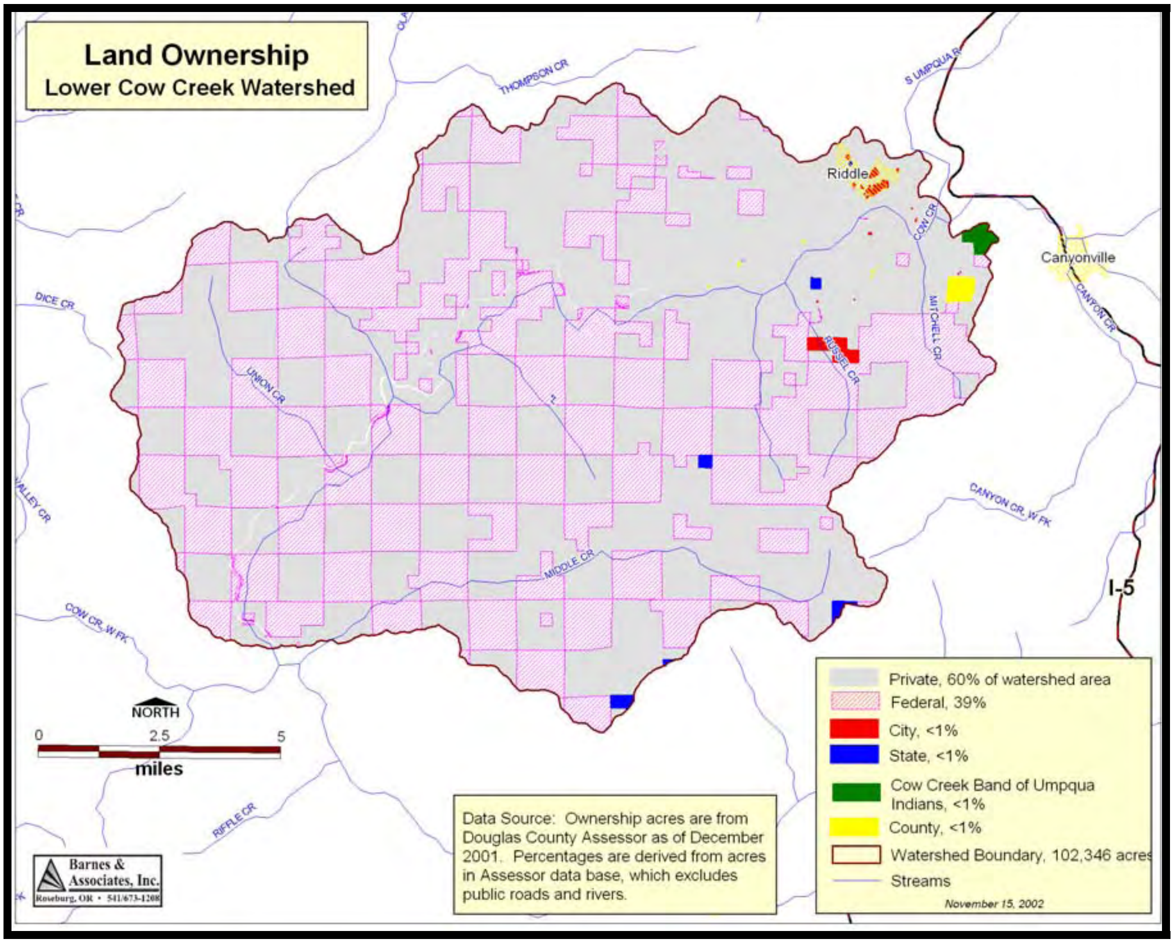
1.3. Land use, ownership, and population

1.3.1. Land use and ownership

The most common land use in the Lower Cow Creek Watershed is forestry, with 91% of the land base used for public or private forestry. Agriculture constitutes 6% of the land use, and mostly occurs around Riddle (see Map 1-8). Land ownership is primarily private (60%), with public ownership mostly administered by the Bureau of Land Management (see Map 1-9). Lands belonging to the Cow Creek Band of the Umpqua Tribe of Indians total less than 1% of the watershed.



Map 1-8: Land use in the Lower Cow Creek Watershed.

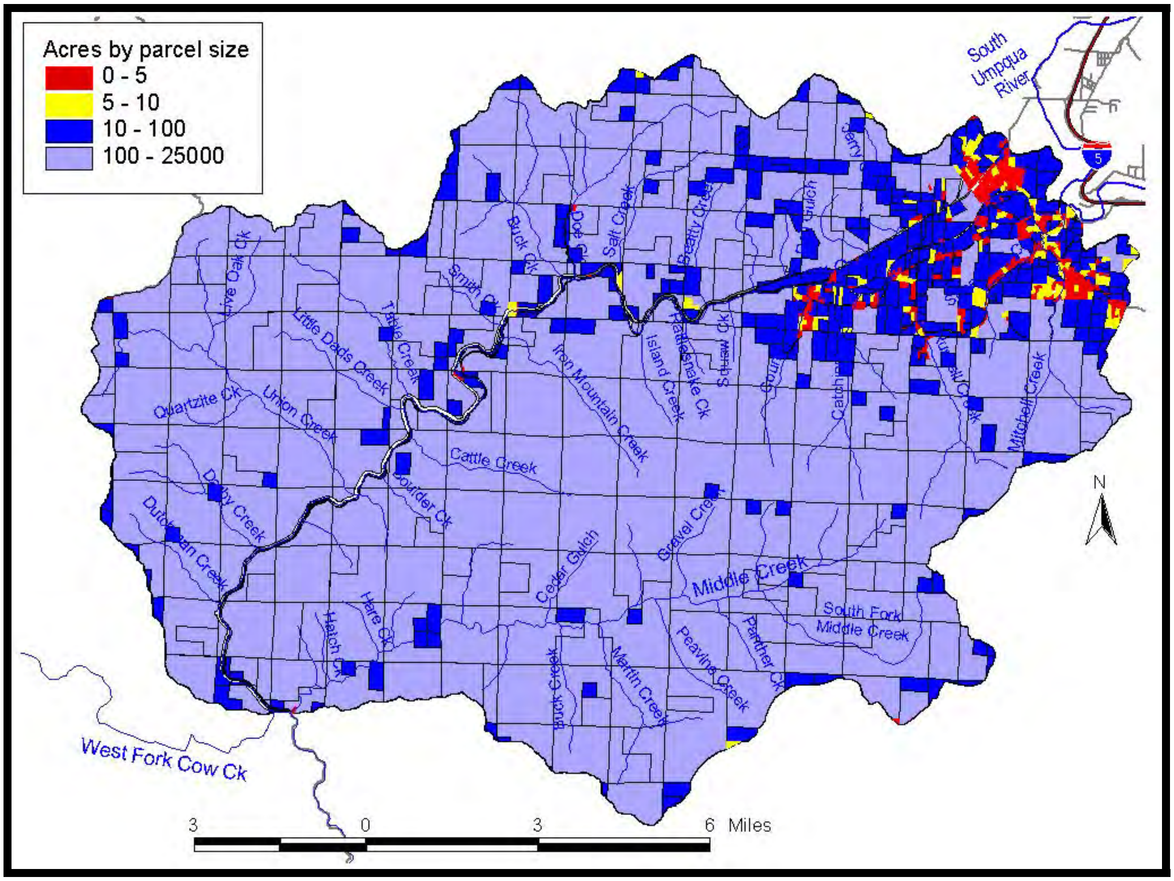


Map 1-9: Land ownership in the Lower Cow Creek Watershed.

Map 1-10 and Table 1-3 show parcel size distribution and percent by class for the Lower Cow Creek Watershed as of 2001. Most of the watershed (84.4%) consists of ownership parcels that are over 100 acres. Less than three percent of parcels are less than 10 acres. These are mostly located within and around the City of Riddle.

Parcel size	Percent
0-5	1.3%
5-10	1.1%
10-100	13.2%
100+	84.4%

Table 1-3: Percent of landholdings by parcel size for the Lower Cow Creek Watershed.



Map 1-10: **Parcel size distribution for the Lower Cow Creek Watershed.**

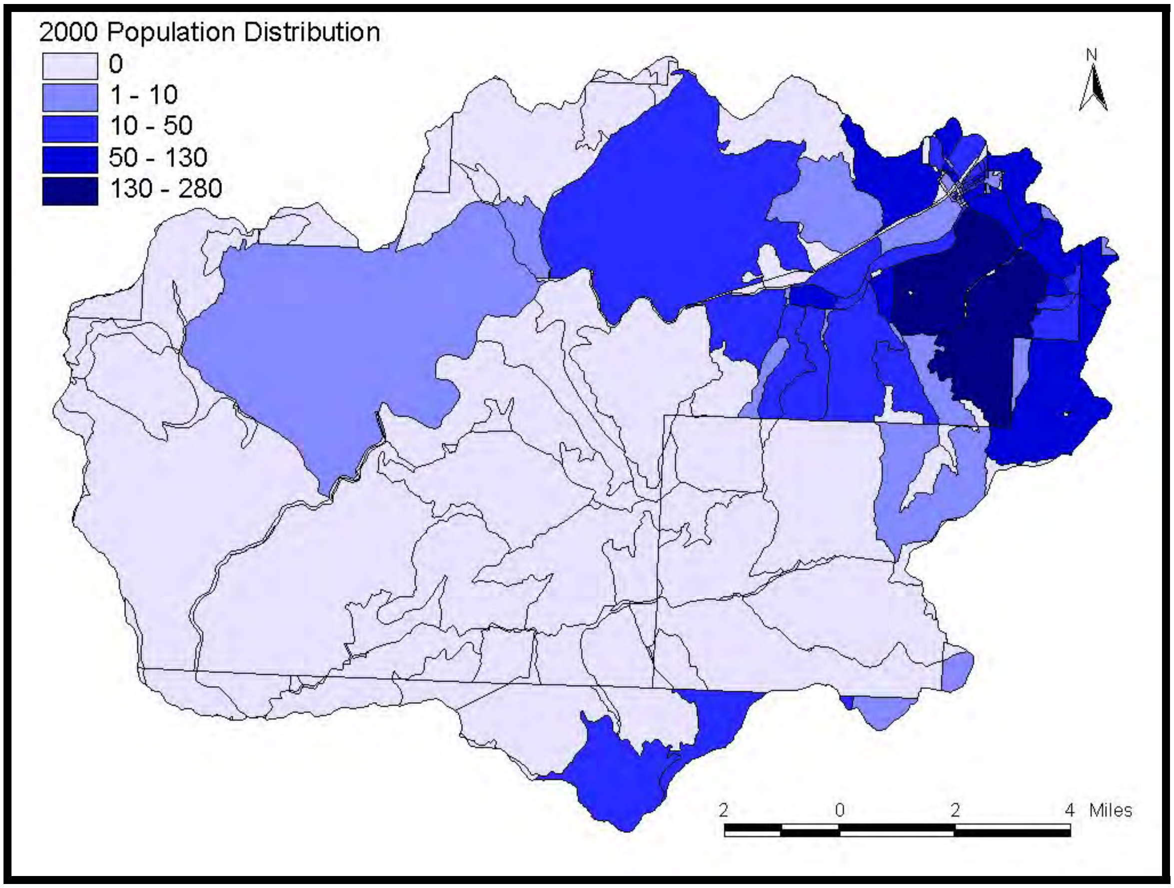
1.3.2. Population and demographics

Areas for which the US Census Bureau has population and demographic information do not correspond with the Lower Cow Creek Watershed boundary. Only data for the City of Riddle are entirely within the Lower Cow Creek Watershed. Parts of the South Umpqua census county division (CCD) and Myrtle Creek-Riddle CCD are within the watershed (see Appendix 2).[10] Data from all three areas are included in this section to provide an overview of the populations that live within the Lower Cow Creek Watershed.

[10] According to the US Census Bureau (http://factfinder.census.gov/servlet/BasicFactsServlet), a census county division (CCD) is "a subdivision of a county that is a relatively permanent statistical area established cooperatively by the Census Bureau and state and local government authorities. Used for presenting decennial census statistics in those states that do not have well-defined and stable minor civil divisions that serve as local governments."

Population

The only city within the Lower Cow Creek Watershed is Riddle. In 2000, the population of Riddle was 1,014 people. The population of the Lower Cow Creek Watershed is estimated to be no more than 2,680 people, or an average of 16.7 people per square mile. The relative distribution of people in the watershed is shown in Map 1-11.[11]



Map 1-11: Relative population density within the Lower Cow Creek Watershed.[12]

General demographic characteristics and housing

Table 1-4 provides Census 2000 information about general demographic characteristics and housing for the City of Riddle and for the South Umpqua CCD and Myrtle Creek-Riddle CCD. Douglas County data are provided for comparison in Appendix 2. The median age is much less in Riddle than in the South Umpqua CCD and Myrtle Creek-Riddle CCD. Census data show that Riddle has a larger percent of its population under the age of 25 and a smaller percent over 55 than the other two areas. The largest racial group for all areas is white, followed by Hispanic or Latino, two or more races, and American Indians and Alaskan Natives. Average household size and family size are

[11] US Census tracts and blocks do not follow watershed boundaries, so it is impossible to make a precise estimate of the watershed's population.
[12] The lines on Map 1-11 indicate US Census divisions.

comparable for the City of Riddle, the South Umpqua CCD, and the Myrtle Creek-Riddle CCD. Riddle has fewer owner-occupied housing than the South Umpqua and Myrtle Creek-Riddle CCD. The South Umpqua CCD has nearly double the housing vacancy rate as the other two areas.

Parameter	**Riddle City**	**South Umpqua CCD**	**Myrtle Creek-Riddle CCD**
Median age (years)	32.9	42.6	40.0
Race			
White	93.3%	89.2%	91.3%
Hispanic or Latino	2%	4.8%	2.9%
Asian	0.1%	0.4%	0.6%
American Indian/Alaskan Native	2.1%	2.1%	2.2%
African American	0	0.1%	0.1%
Native Hawaiian or Pacific Islander	0	0.2%	0.1%
Some other race	0	0.2%	0
Two or more races	2.6%	3.1%	2.9%
Households			
Avg. household size (#)	2.66	2.51	2.51
Avg. family size (#)	3.15	2.91	2.99
Owner-occupied housing	64%	71.5%	71.1%
Vacant housing units	6.2%	11.7%	6.4%

Table 1-4: 2000 Census general demographic characteristics and housing for the City of Riddle, the South Umpqua CCD, and the Myrtle Creek-Riddle CCD.

Social characteristics

Table 1-5 provides information from the 2000 Census for education, employment, and income. Appendix 2 has Douglas County information for comparison. The percent of people over 25 who are high school graduates and who are college graduates is lower in the City of Riddle than in the South Umpqua CCD and the Myrtle Creek-Riddle CCD; all three areas are below Douglas County's high school and college graduate levels. The percent of unemployed persons in the labor force is higher in Riddle than in the South Umpqua and Myrtle Creek-Riddle CCD. The top three occupations in Table 1-5 account for around 70% of the labor force in all three areas, and the top three industries employ over half of workers. Median income for all areas are lower than for Douglas County as a whole, while poverty levels are higher.

Riddle has a lower per capita income than the South Umpqua and Myrtle Creek-Riddle CCD but a higher median family income. The median income for women working full time in the South Umpqua and Myrtle Creek-Riddle CCD is $8,000 to $10,000 less than the median income for men. In Riddle, the median income for women is about $4000 less than the median income for men; this may contribute to the higher family median income in Riddle.

Parameter	**Riddle**	**South Umpqua CCD**	**Myrtle Creek-Riddle CCD**
Education – age 25+			
High school graduate or higher	73.2%	76.5%	75.1%
Bachelor's degree or higher	6.3%	10.0%	9.4%
Employment- age 16+			
In labor force	58.0%	52.0%	56.6%
Unemployed in labor force	15.5%	7.3%	9.9%
Top three occupations	Production, transportation, and material moving		
	Service; Sales and office	Management, professional, & related; Service	Service; Sales and office
Top three industries	Manufacturing; Educational, health, and social services; Arts, entertainment, recreation, accommodation, and food service		
Income			
Per capita income	$13,666	$15,036	$15,921
Median family income	$37,159	$34,559	$37,828
Families below poverty	16.1%	11.2%	11.8%

Table 1-5: 2000 Census information for education, employment, and income for the City of Riddle, the South Umpqua CCD, and the Myrtle Creek-Riddle CCD.

2. Past Conditions[13]

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 Lower 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 Lower 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

[13] 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.

Splash dams

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.[14] 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

<u>Mining at the Bonanza Mine in 1955</u>

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).

[14] 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.[15]

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

[15] 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.[16]

1970 to the present timeline

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).

[16] 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).

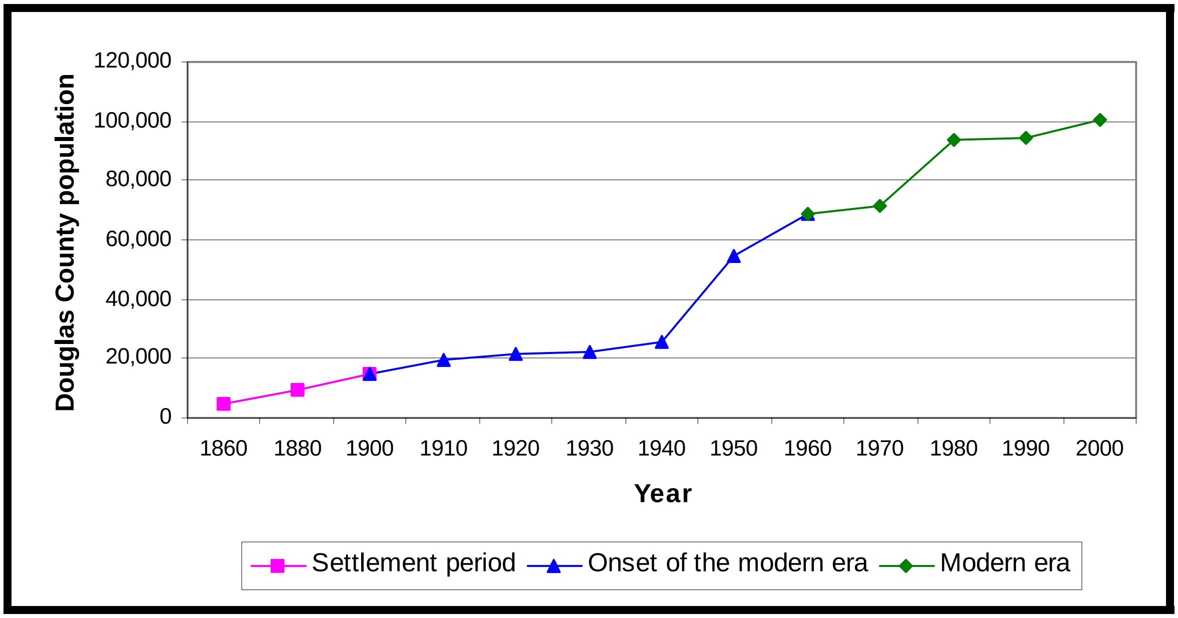


Figure 2-1: Population growth in Douglas County from 1860 through 2000.

2.6. *History of the Lower 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 Lower 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.[17]
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.[18]

[17] 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."

[18] Flood stage is 22.0 feet. Data have been recorded since 1950. See section 3.4 for more information about streamflow and flooding in the Lower Cow Creek Watershed.

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.

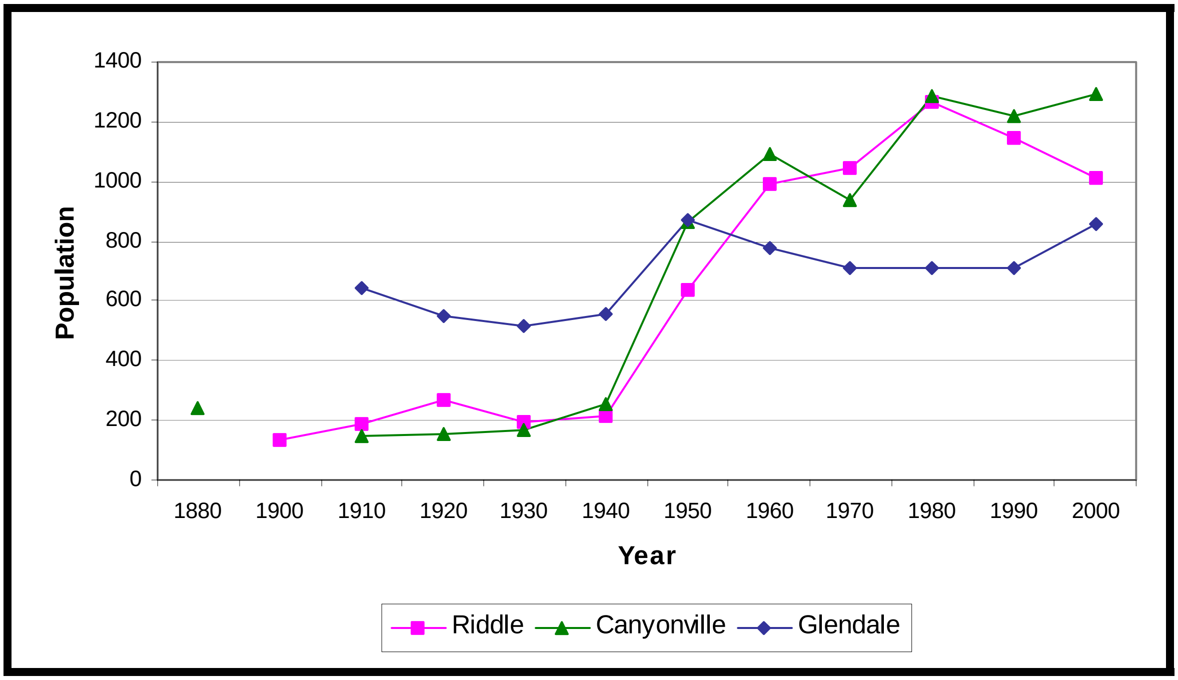


Figure 2-2: Population growth for Riddle, Canyonville, and Glendale from 1880 through 2000.[19]

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.

[19] 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 draining into the South Umpqua River. In 1937 the Umpqua National Forest surveyed portions of the South Umpqua 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 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.[20]

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.[21]

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.

[20] 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).
[21] 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.

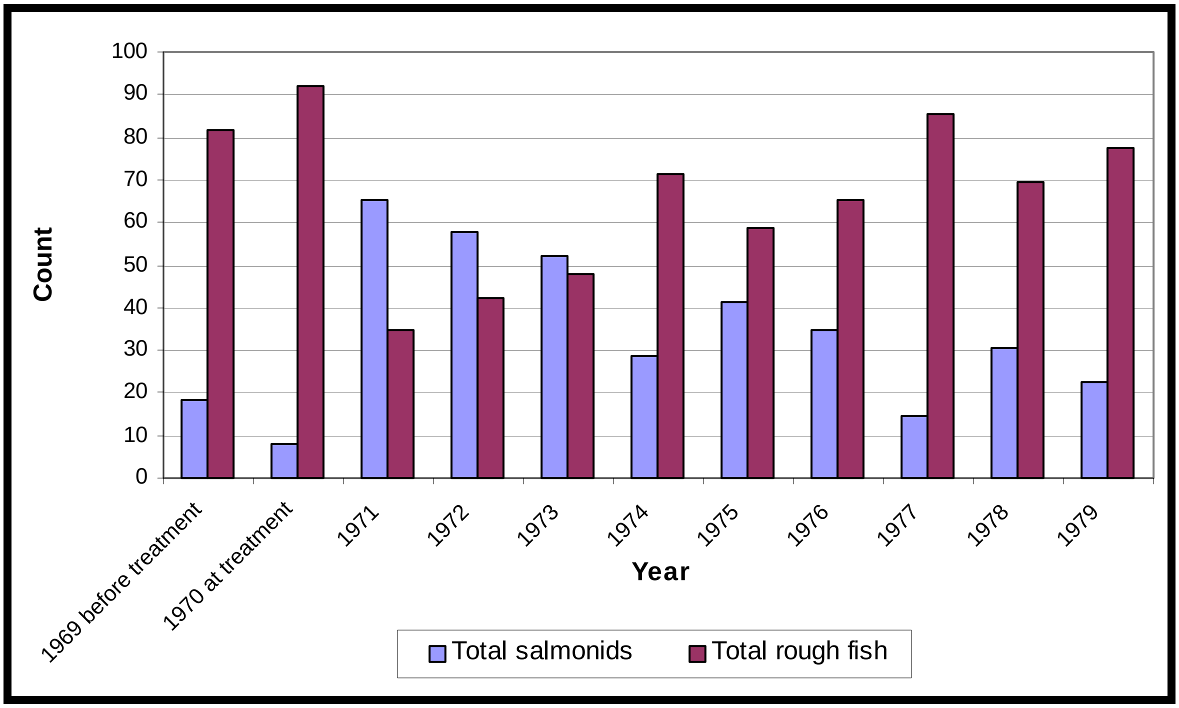


Figure 2-3: Percent occurrence of salmonids vs. rough fish in Cow Creek and tributaries, pre- and post-treatment with rotenone.

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.*

- *West Fork Cow Creek: 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.[22] 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.

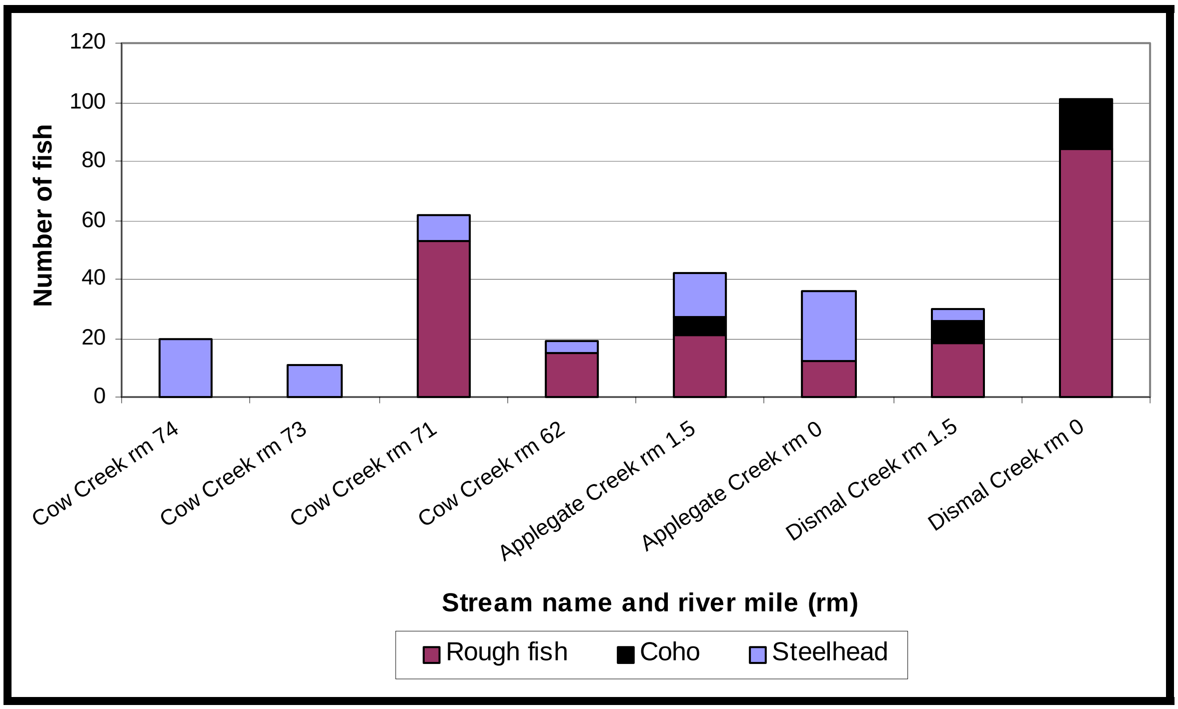


Figure 2-4: Number of electroshocked fish per 200 feet of stream, above Galesville Dam, 1980.[23]

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

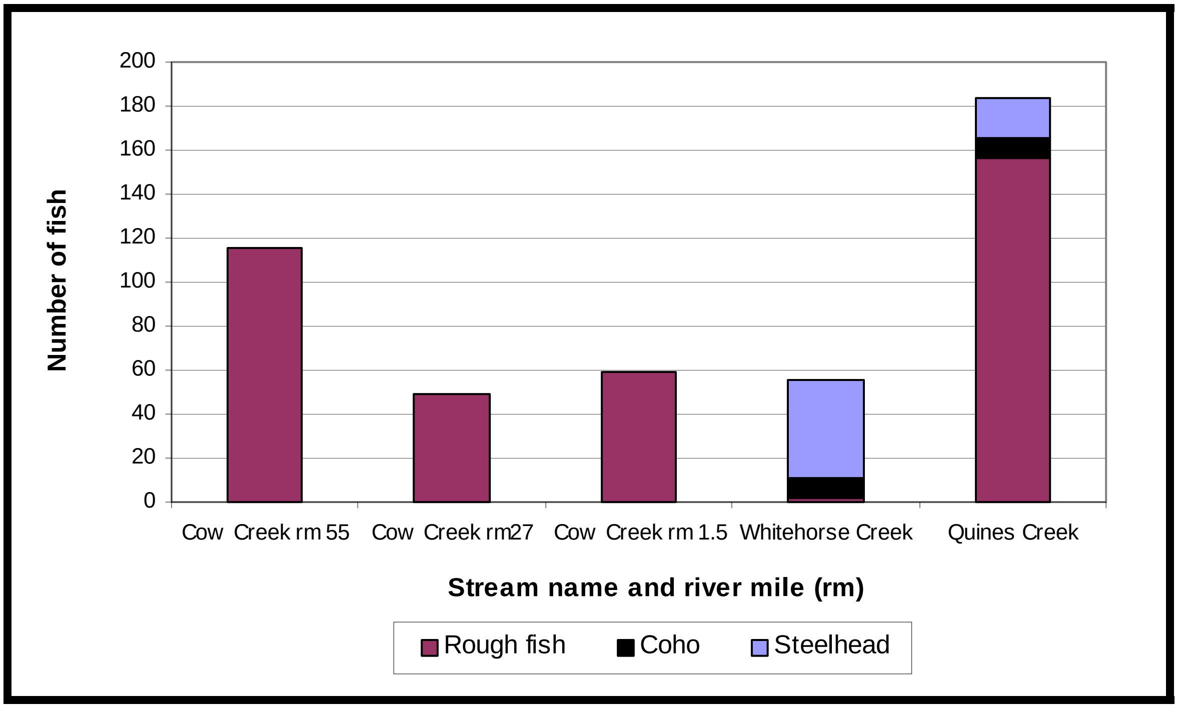

Figure 2-5: Number of electroshocked fish per 200 feet of stream, below Galesville Dam, 1980.

2.6.4. 1900 forest conditions

Figure 2-6 provides an indication of the forest cover at the turn of the last century.[24] Over half of the Lower Cow Creek Watershed was identified as timberless. Timberless would include grasslands, grazed land, cultivated and homestead areas. Twenty-eight percent of the watershed was designated as woodland. Woodland is categorized as scattered trees and open canopy, areas most likely altered by frequent fires. Only 16% of the watershed was estimated to contain merchantable timber and categorized as containing five to 10 thousand board feet per acre.

[24] Henry Gannet gathered the information for the map 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.

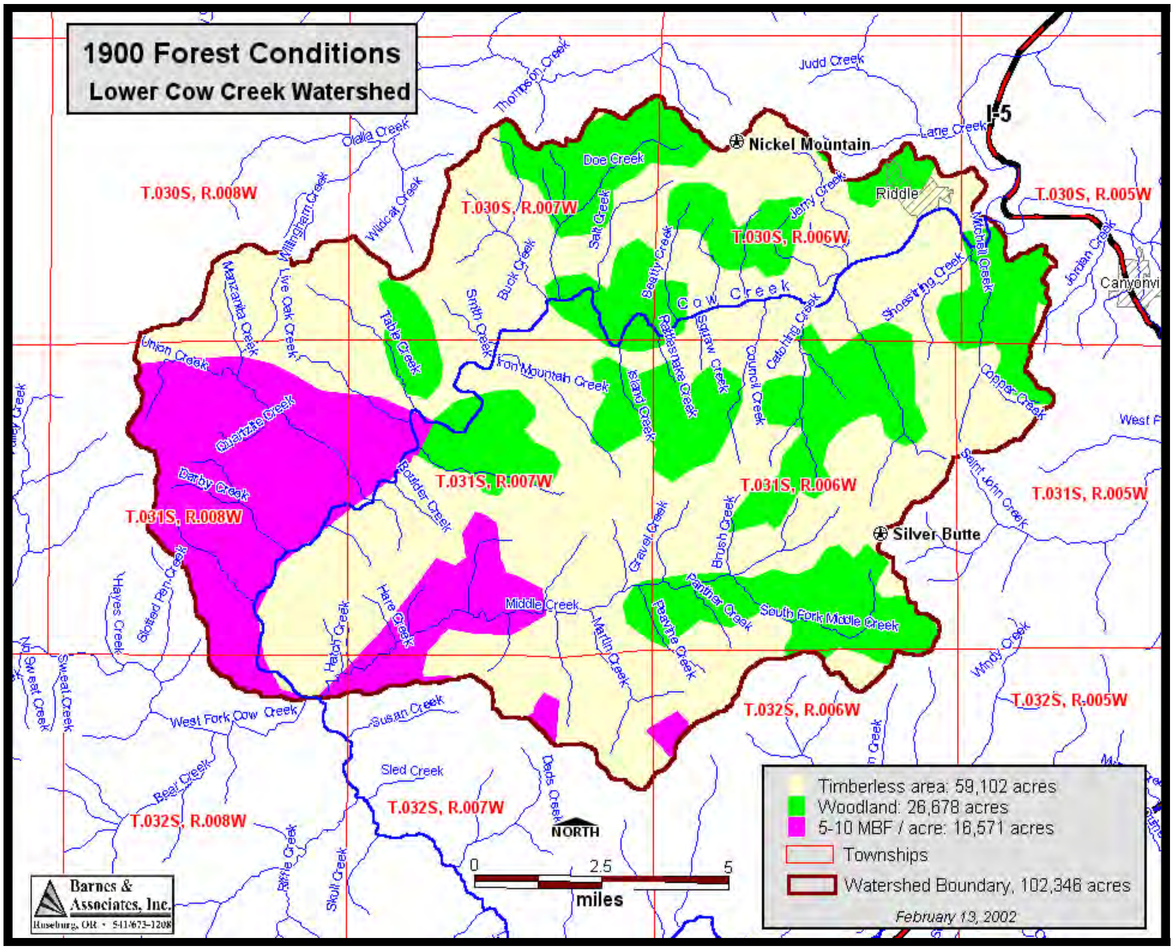

Figure 2-6: 1900 vegetation patterns for the Lower Cow Creek Watershed.

Historically, fire has played an important role in the Lower 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 relative to historic 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. From 1980 through 1994 there were 36 fires within the Lower Cow Creek Watershed that burned approximately 2,872 acres. The 1987 Buck Creek fire in the lower Middle Creek drainage burned approximately 1,486 acres. Lightning caused most of these fires.

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.

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3. Current Conditions

This chapter explores the current conditions of the Lower 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 Lower 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[25]

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 Lower 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*

[25] 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 Lower Cow Creek Watershed along with examples of streams that fall into each.

Channel Habitat Type	**Example within watershed**	**Restoration opportunities**
Low gradient large floodplain	Cow Creek from the confluence with Council Creek to the confluence with the South Umpqua River	Because of the migrating nature of these channels, restoration opportunities such as shade and bank stability projects on small side channels may be the best option for improvement.
Low gradient medium floodplain	Cow Creek at confluence with Council Creek	Because of the migrating nature of these channels, restoration opportunities such as shade and bank stability projects on small side channels may be the best option for improvement.
Low gradient small floodplain	Cow Creek between outlets of tributaries Table Creek and Iron Mountain Creek	Because of the migrating nature of these channels, restoration efforts may be challenging. However, because of their small size, projects at some locations would be successful.
Low gradient moderately confined	Middle Creek upstream of Buck Creek outlet	These channels can be very responsive to restoration efforts. Adding large wood to channels in forested areas may improve fish habitat, while stabilizing stream banks in non-forested areas may decrease erosion.
Low gradient confined	Doe Creek; Middle Creek downstream from Buck Creek outlet	Though these channels are not often responsive, riparian planting projects may improve water temperature and erosion issues.
Moderate gradient moderately confined	Downstream half of South Fork Middle 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	Union Creek	Though these channels are not often responsive, riparian planting projects may

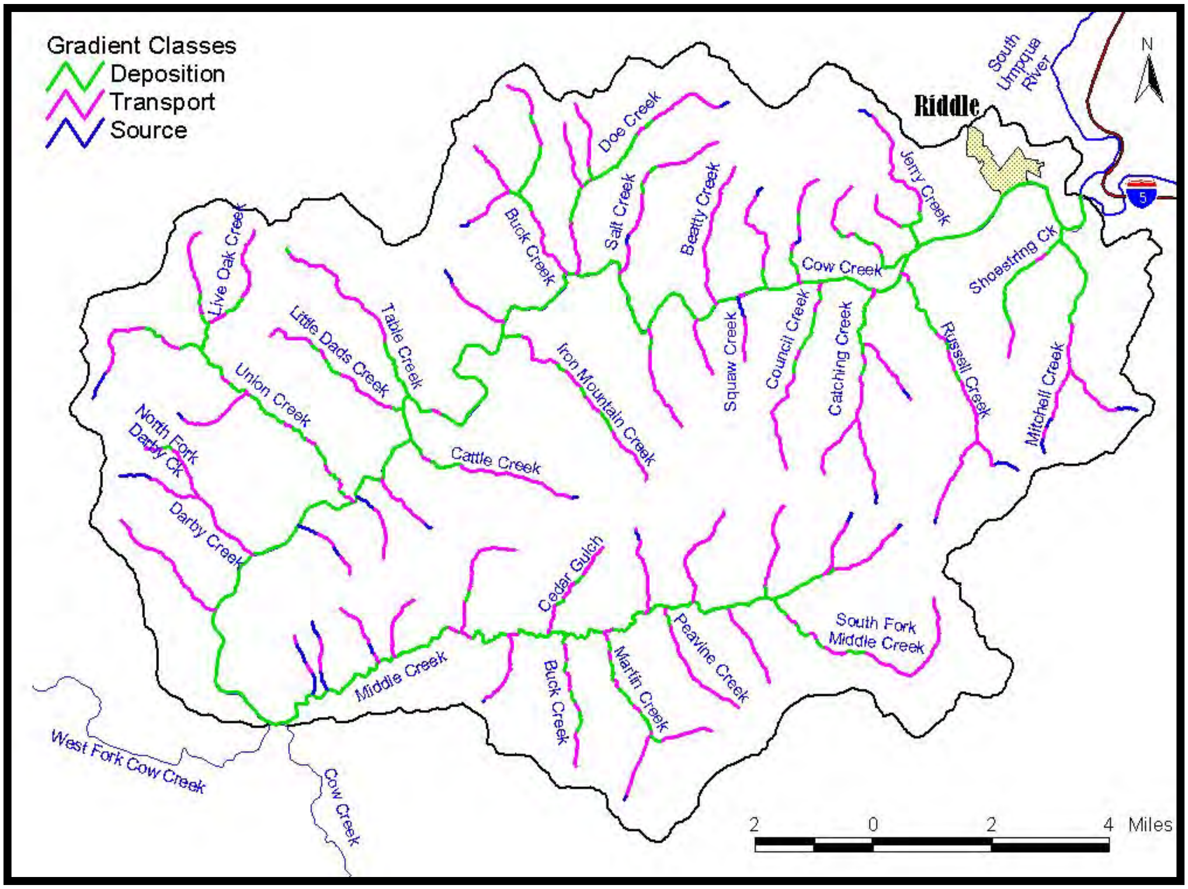
Channel Habitat Type	Example within watershed	Restoration opportunities
confined		improve water temperature and erosion issues.
Moderate gradient headwater	The headwaters of Union Creek	These channels are often moderately responsive to restoration. Riparian planting projects may improve water temperature and erosion issues.
Moderately steep narrow valley	Island Creek; Iron Mountain 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	The headwaters of Martin Creek and Peavine 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 Lower Cow Creek Watershed.

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 (see Photo 3-2). 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.

Photo 3-1: Looking across Lower Cow Creek at serpentine hills covered with Jeffrey pine and chemise brush. Cow Creek here is a low gradient medium floodplain stream.[26]

[26] This photograph was taken from Universal Transverse Mercator coordinate 4569903/4750802.



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

Gradient class	Stream miles in the watershed	% Total
Source	8.0	4.7%
Transport	93.9	55.5%
Deposition	67.2	39.7%
Total	169.1	100.0%

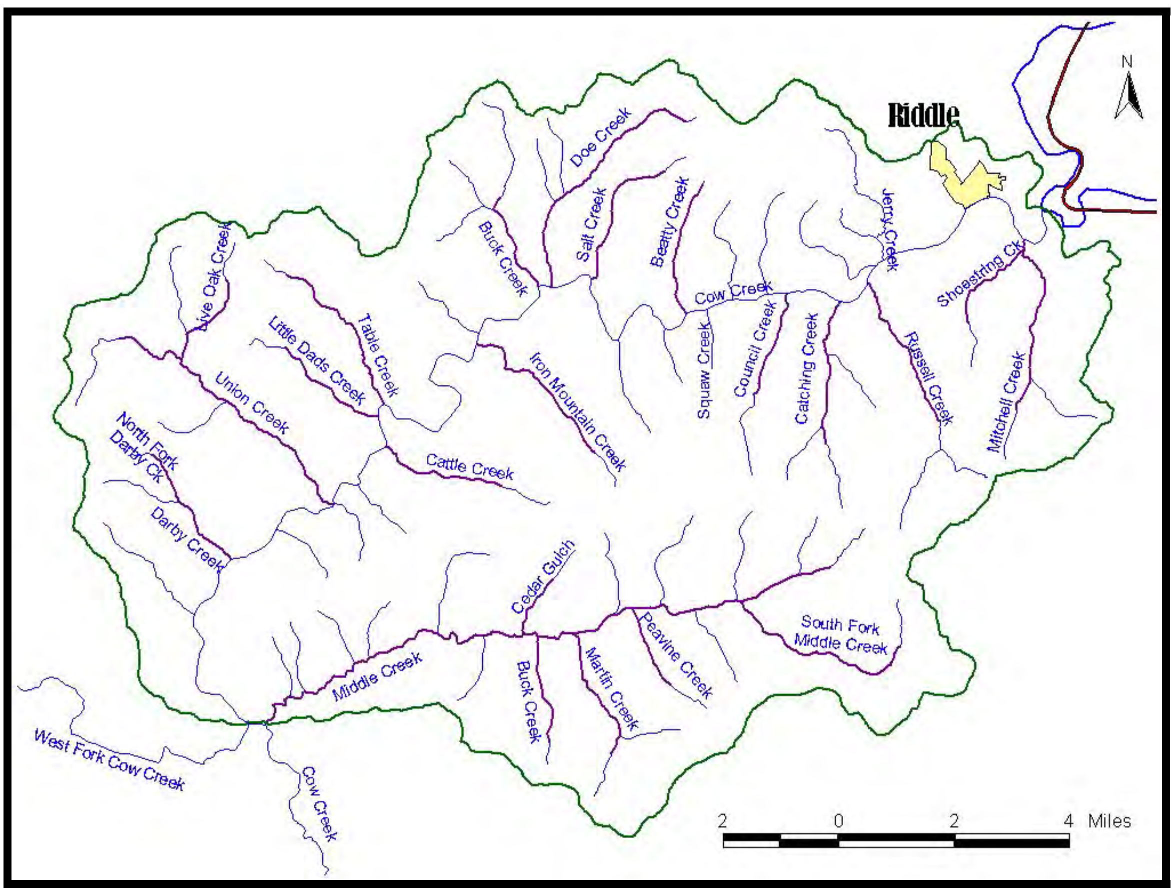
Table 3-2: Lower Cow Creek Watershed stream miles within each gradient class.

Most of the headwaters of the tributaries to Lower Cow Creek are fairly steep (8% to 16% slope). These are source streams, providing sediment and wood. Many of these sections of stream 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. Lower Cow Creek flowing east beyond the confluence with Council Creek opens up in a fairly wide floodplain stretching to its confluence with the South

Umpqua River. These broad, low-gradient reaches lend themselves to complex aquatic habitat with large wood, coarse sediment, pools, bars, and side channels. However, these reaches are difficult to enhance, as the meandering nature of the streams makes bank stability projects likely to fail, so special care should be given to project selection and planning.

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 1993, 1994, and 1995, approximately 65.5 stream miles were surveyed in the Lower Cow Creek Watershed (see Map 3-2). There are a total of 169.1 stream miles on Map 3-2; therefore, approximately 38.7% of Lower Cow Creek Watershed streams have been surveyed.[27] Each stream was divided into reaches based on channel and riparian habitat characteristics for a total of 60 reaches averaging 1.1 miles in length. Appendix 3 provides a map detailing the stream reaches.



Map 3-2: Streams surveyed in the Lower Cow Creek Watershed.

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

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.

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.

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**[28] 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

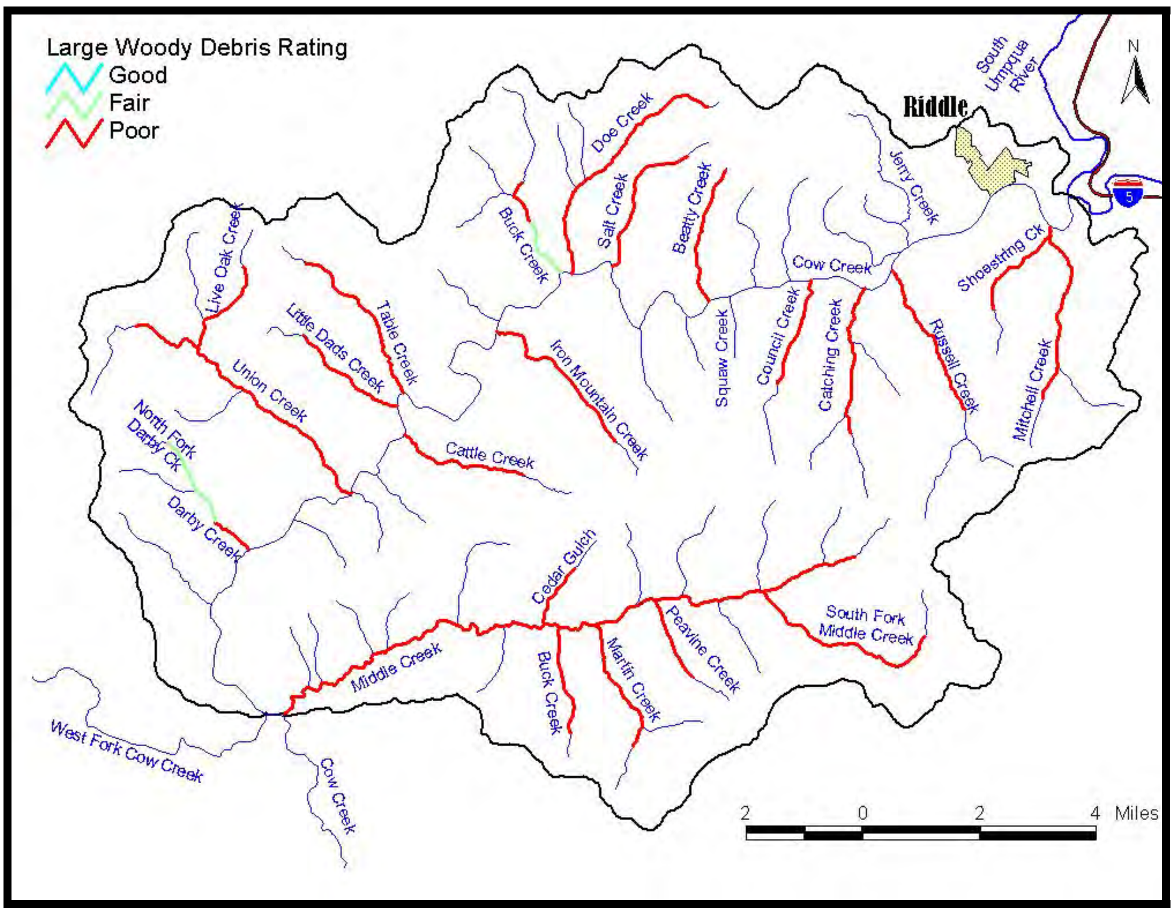
Table 3-3: Stream habitat survey benchmarks.

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

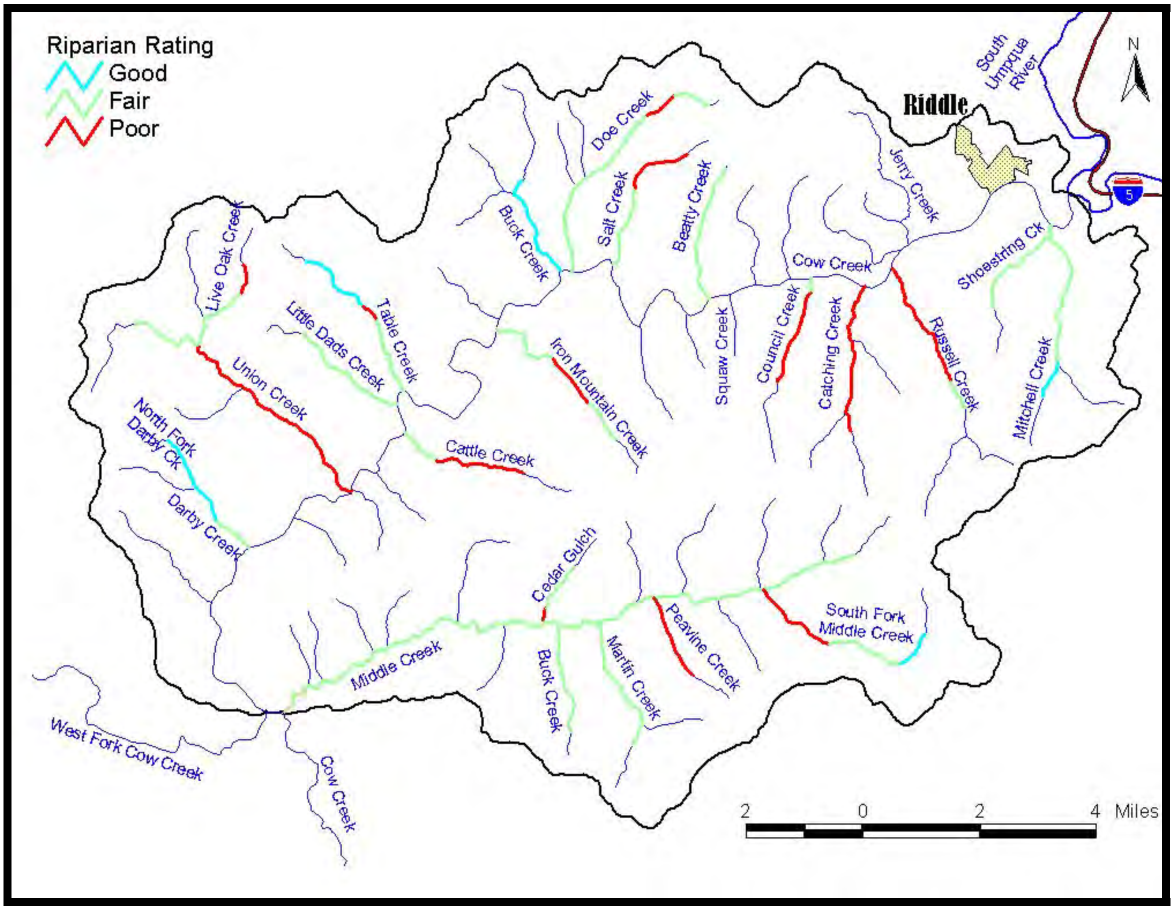
Overview of stream conditions

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 Lower 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.

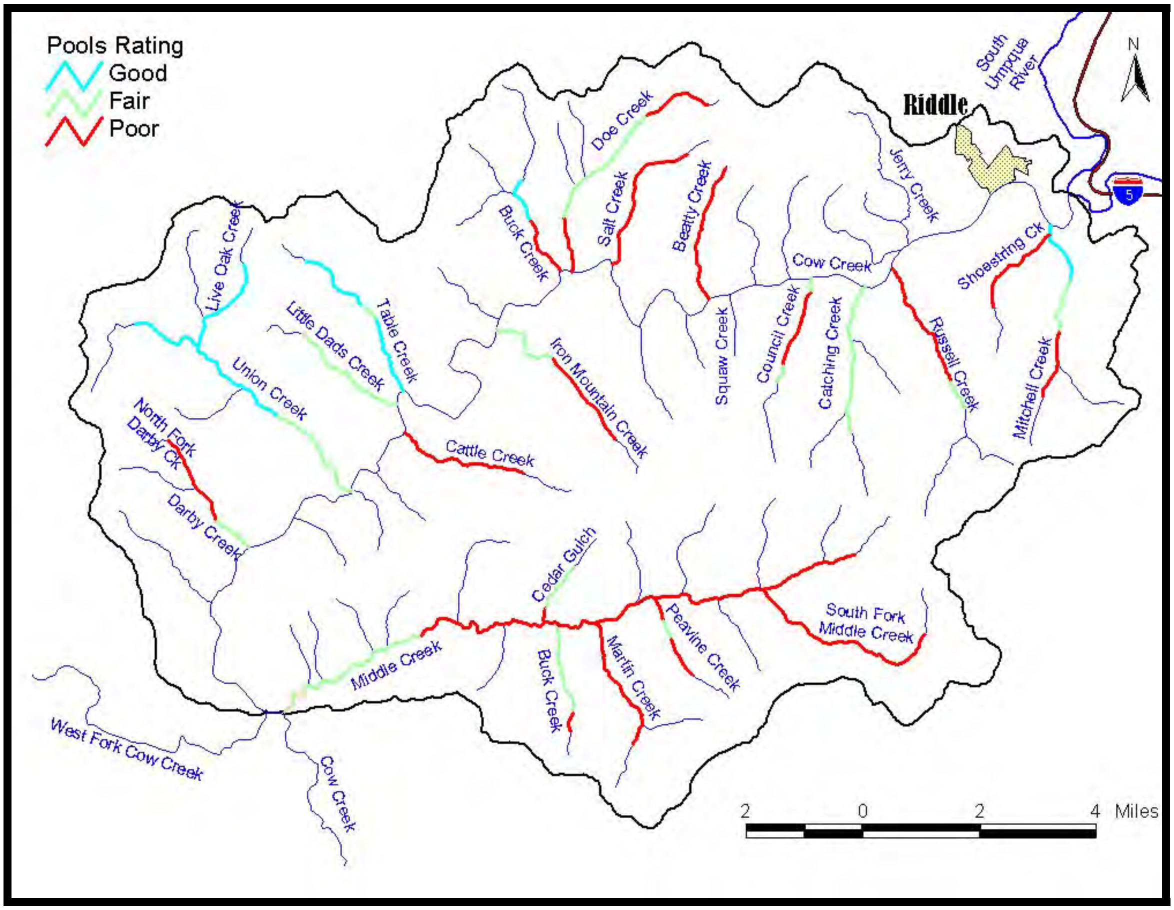
Within the Lower Cow Creek Watershed, ODFW surveyed 60 stream reaches. Of these reaches, none rate as fair or good in all four categories. Thirty-nine stream reaches (65%) had at least two categories rate as poor. Looking at Map 3-3, it is striking that all reaches rate as poor for large woody material except the first reach of Buck Creek on Cow Creek, Darby Creek's second reach, and North Fork Darby Creek, which rate as fair. Over a third of riparian areas and almost half of pools are poor (see Map 3-4 and Map 3-5). However, 31% of riffles are good (see Map 3-6). Ratings and land uses by stream reach are provided in Appendix 3 and Appendix 4.



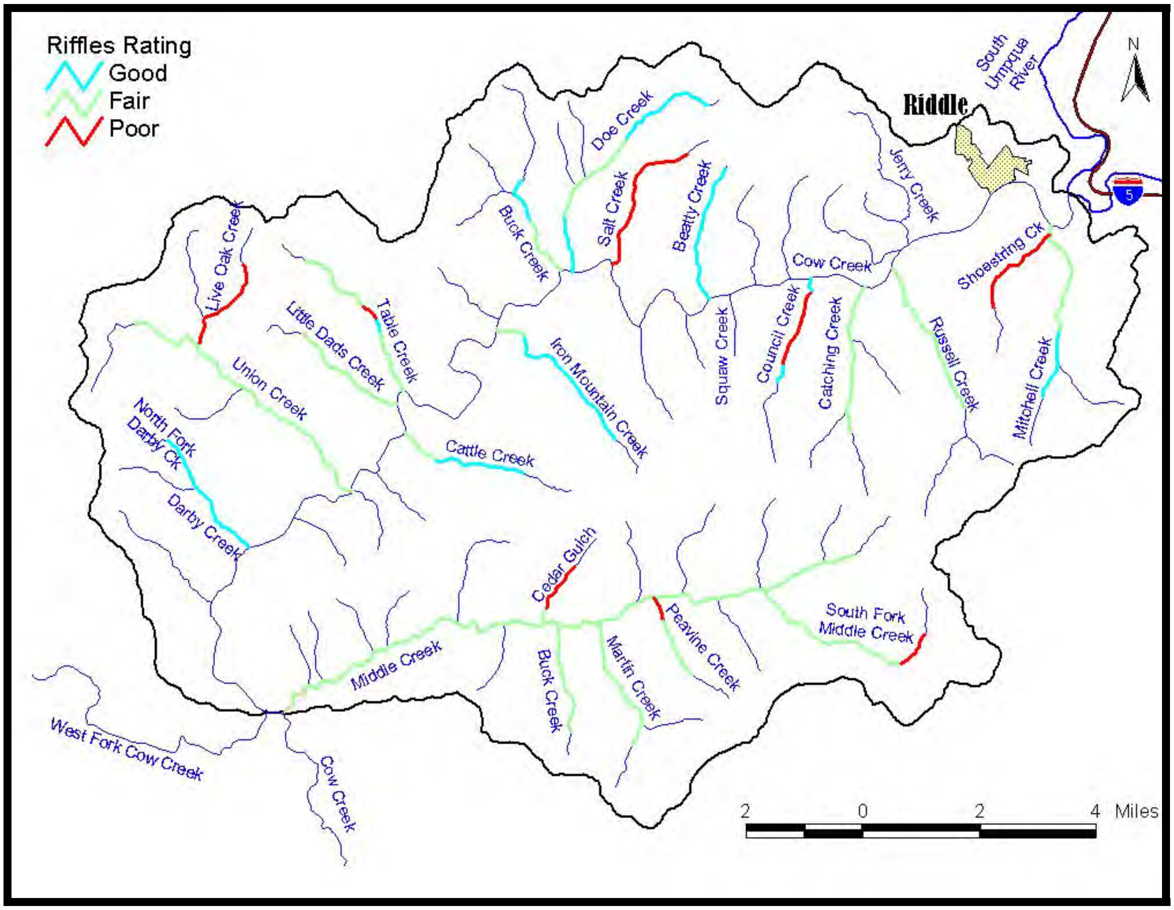
Map 3-3: Stream habitat large woody debris ratings for the Lower Cow Creek Watershed.



Map 3-4: **Stream habitat survey riparian ratings for the Lower Cow Creek Watershed.**



Map 3-5: Stream habitat survey pools ratings for the Lower Cow Creek Watershed.



Map 3-6: Stream habitat survey riffles ratings for the Lower 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.[29]

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

[29] 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 Lower Cow Creek Watershed.

Irrigation ditches
Irrigation ditches without fish wheel screens are primarily a problem for juvenile fish.[30] 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 Lower 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.[31] 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.

There is a dam on Iron Mountain Creek that is equipped with a fish passage wheel; this dam may be a barrier to juvenile fish passage. Another dam is on the lower half of Council Creek. The Oregon Water Resources Department and the UBWC are not aware of any other dams in the Lower Cow Creek Watershed that are barriers or obstacles to adult or juvenile fish passage.

Culverts
Culverts can be a barrier or obstacle 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 an additional velocity barrier at the upstream end of a culvert if it has been placed so that the stream flows sharply downward into the culvert

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

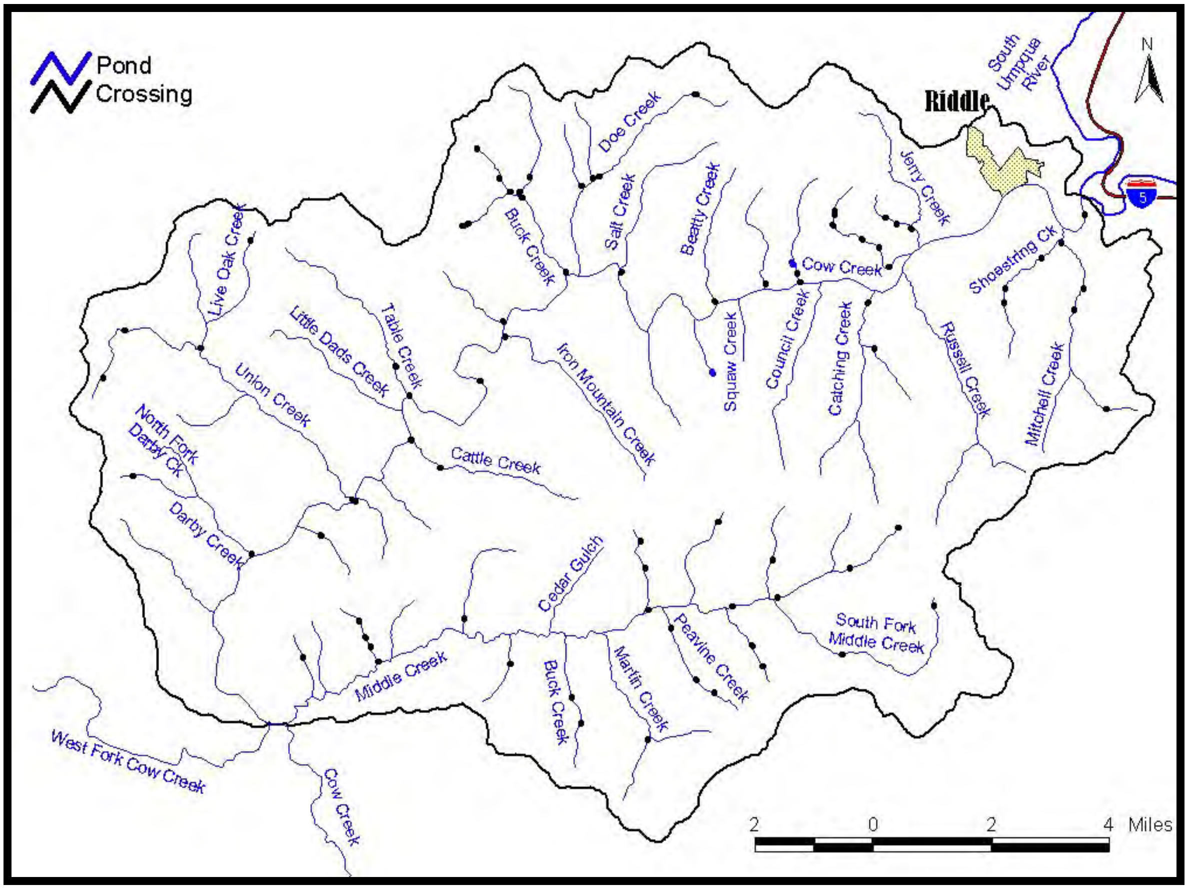
entrance. In general, smooth-bottomed culverts at a 1% gradient or more are obstacles to fish passage. Culverts that are partially buried underground or built to mimic a natural streambed provide greater protection and allow fish passage at steeper gradients and higher water velocities.

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.

Map 3-7 shows road/stream crossings within the Lower Cow Creek Watershed. Culverts are the most common method of passing a road over a stream; however, bridges and hardened crossings are used as well. Map 3-7 also shows instream “ponds” within the Lower Cow Creek Watershed. These ponds are areas within the stream channel where the flow is very wide in a localized area with a sudden narrowing in flow at the downstream end. These ponds are usually formed when something is blocking streamflow, such as an irrigation dam, beaver dam, clogged culvert, or log jam. It is unknown at this time how many of the road/stream crossings and ponds are fish passage barriers or obstacles. However, ODFW fish habitat biologist Sam Dunnavant believes that culverts block fish passage on Shoestring Creek, Mitchell Creek, and Buck Creek.

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. 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.[32] A document summarizing the results of this project will be available in 2004.

[32] See section 3.5.2 for information about anadromous and resident salmonid distribution within the Lower Cow Creek Watershed.



Map 3-7: Road/stream crossings and ponds in the Lower Cow Creek Watershed.

3.1.3. Channel modification[33]

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.[34] History has shown that channel

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

[34] 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

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 further downstream. Although channel modification projects can still be done with a permit, obtaining a permit can be 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.[35] 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 Lower 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 Lower Cow Creek Watershed, there are few stream miles in source areas, where most large woody material is recruited into the stream system. This may naturally limit instream large woody material abundance.

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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.

[35] In general, a gravel bar that has no grass or other vegetation is very unstable.

- Stream habitat surveys suggest that lack of large woody material, poor riparian area tree composition, and poor pools 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 Lower 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.[36]
- Encourage land use practices that enhance or protect riparian areas:
  - Protect riparian areas from livestock-caused browsing and bank erosion by providing stock water systems and shade trees outside of the stream channel and riparian zones. Fence riparian areas as appropriate.
  - 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 the purpose of this assessment, the vegetation immediately adjacent to a stream is the stream's 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.

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

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.

Riparian zone classification methodology
Digitized aerial photographs were used to determine riparian composition of the Lower Cow Creek Watershed. Right and left streambanks were divided into reaches based on vegetative changes.[37] The reaches were measured and classified using three vegetation composition parameters: dominant vegetation or feature, buffer width, and cover. Table 3-4 outlines the classifications for each parameter. Findings for each parameter for Cow Creek and tributaries within the watershed are discussed below. Appendix 5, Appendix 6, and Appendix 7 have data by percent for Cow Creek, Middle Creek, combined tributaries, potential anadromous salmonid streams, potential cutthroat streams, and non-salmonid streams.[38]

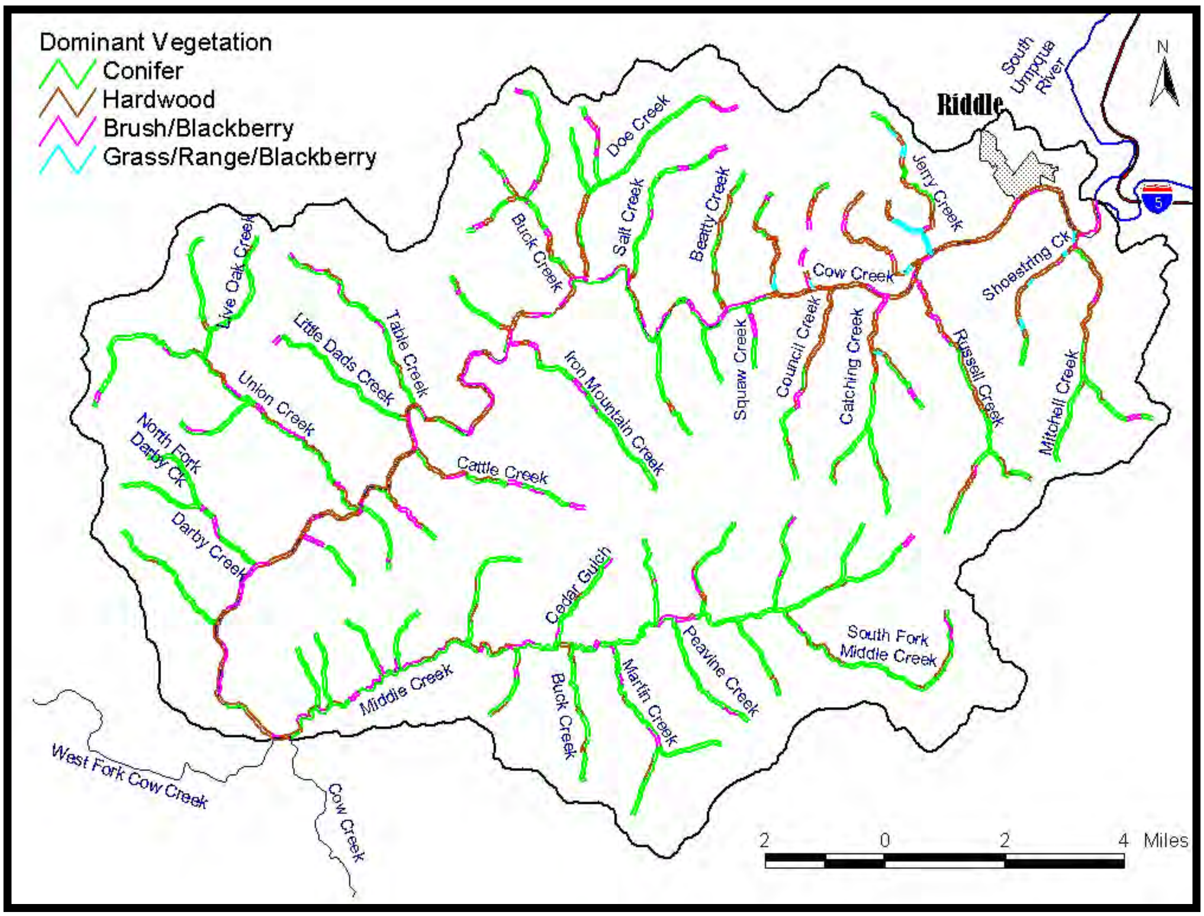
Riparian zone parameters	**Parameter attributes** Reaches are classified by the most dominant (>50% cover) characteristic
Dominant vegetation or feature	• Conifer trees • Hardwood trees • Brush/blackberry • Range/grass/blackberry • No vegetation (roads, bare ground, etc.) • Infrastructure (bridges and culverts)
Buffer width	• No trees • 1 tree width • 2+ tree widths
Cover	• No cover • <50% cover • >50% cover

Table 3-4: Riparian zone classification for the Lower Cow Creek Watershed.

Dominant vegetation or feature
The dominant streamside vegetation or features affect ecological functions by providing different levels of shade and bank stability as well as different types of nutrients and wildlife habitat. For this assessment, the dominant vegetation or feature is evaluated

[37] Stream banks were labeled as "left" or "right" from the perspective of standing in the middle of the creek looking downstream.
[38] See 3.5.2 for more information about salmonid distribution within the Lower Cow Creek Watershed.

using six attributes. Trees are split into two groups, conifers and hardwoods. Although all tree types provide shade and large woody debris, large conifers decompose very slowly and are less likely than hardwoods to wash downstream. Brush/blackberry constitutes short broad plants. Blackberry is not given a separate category because these plants are frequently intertwined with other shrubs and difficult to differentiate. Range and grass includes blackberries because in most cases a predominantly range or grass riparian zone has a thin strip of blackberries close to the stream bank. Areas of no vegetation include streamside roads and railroads and non-road related bare ground and rock. Infrastructure indicates areas where the stream passes under a bridge or culvert. Map 3-8 shows the three most common vegetation types for Lower Cow Creek Watershed streams. Appendix 5 has the percent of all vegetation or features for Cow Creek, Middle Creek, and combined tributaries, potential anadromous salmonid streams, potential cutthroat streams, and non-salmonid streams.



Map 3-8: **Dominant riparian vegetation or feature for the Lower Cow Creek Watershed.**

For Cow Creek, Middle Creek, and combined tributaries, conifers, hardwoods, and brush are the most common vegetation types (see Table 3-5). These are the most common vegetation types by salmonid habitat type as well (see Table 3-6). Cow Creek's riparian areas are predominantly hardwoods and brush/blackberry. Middle Creek and the combined tributaries are mostly conifers. Riparian areas along potential anadromous salmonid streams are mostly a mixture of conifers and hardwoods. Potential cutthroat streams have conifer-dominated riparian areas.

	Conifers		Hardwoods		Brush/blackberry	
Streams	%	Riparian miles[39]	%	Riparian miles	%	Riparian miles
Cow Creek	12.7%	6.8	59.6%	32.1	24.6%	13.2
Middle Creek	67.0%	18.0	14.6%	3.9	17.1%	4.6
Combined tributaries	65.7%	168.6	22.0%	56.5	9.3%	23.8

Table 3-5: Predominant vegetation types by stream in the Lower Cow Creek Watershed.

	Conifers		Hardwoods		Brush/blackberry	
Potential salmonid habitat	%	Riparian miles	%	Riparian miles	%	Riparian miles
Anadromous	49.3%	102.4	34.4%	71.5	13.6%	28.2
Cutthroat	75.2%	24.8	9.1%	3.0	12.1%	4.0
No salmonids	68.5%	66.2	18.6%	18.0	9.8%	9.5

Table 3-6: Predominant vegetation types by salmonid habitat in the Lower Cow Creek Watershed.

Buffer width

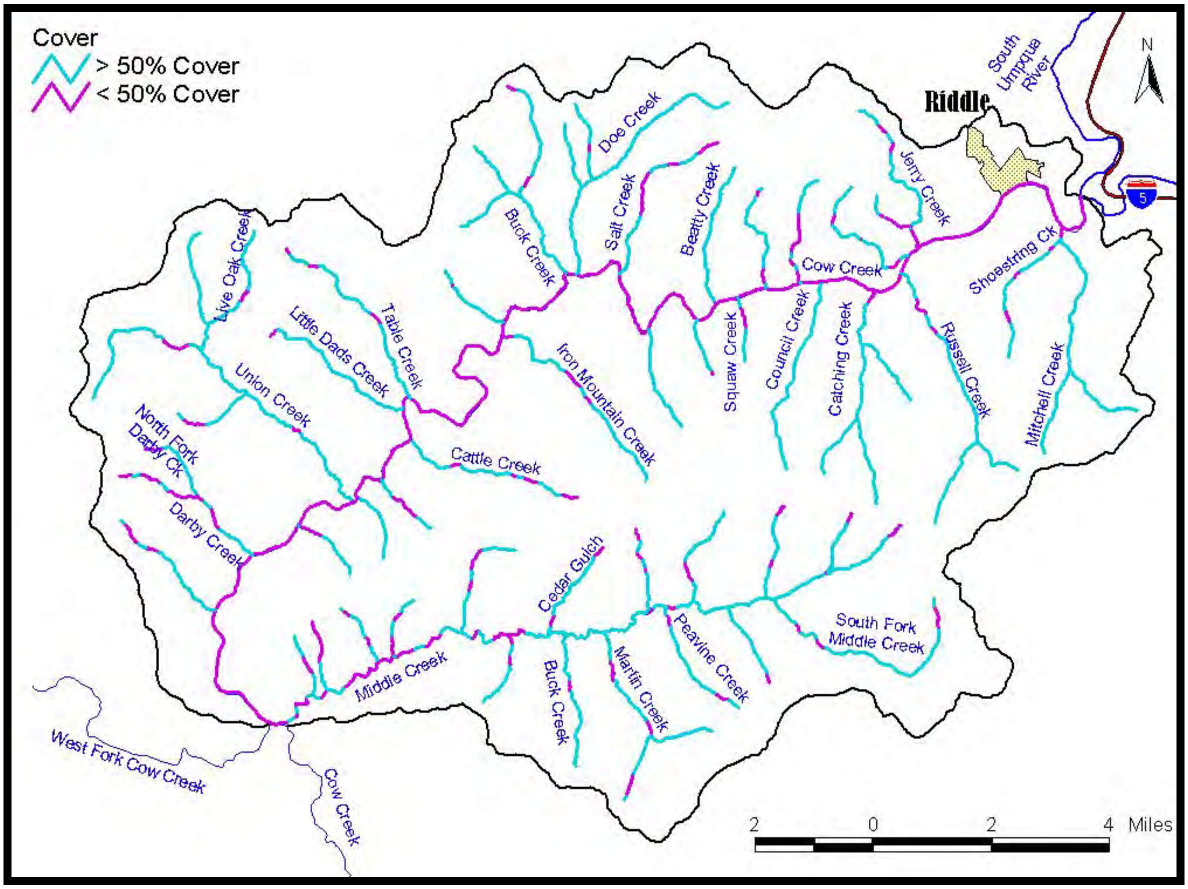
Riparian areas with wide bands of trees provide habitat and migration corridors for wildlife. As the number of trees in close proximity to the stream increases, so does the likelihood that some trees will fall into the stream, creating fish habitat and forming pools. Wide tree buffers also increase stream shading, creating a microclimate with cooler temperatures compared to other reaches within the same stream. Buffer width is classified as having no trees, one tree width, or a width of two or more trees. Map 3-9 shows buffer width findings for the Lower Cow Creek Watershed. Appendix 6 provides data for Cow Creek, Middle Creek, and combined tributaries, potential anadromous salmonid streams, potential cutthroat streams, and non-salmonid streams.

Over half of Cow Creek's riparian buffers are one tree wide (55.7%, 29.9 riparian miles). Over one-fourth of Cow Creek's riparian buffers have no trees (27.7%, 14.9 riparian miles). Buffers that are one tree wide and two or more trees wide constitute a similar amount of Middle Creek riparian zones (41.4%, 11.1 riparian miles and 39.5%, 10.6 riparian miles, respectively). Over two-thirds of Lower Cow Creek tributaries have riparian buffers that are two or more trees wide (66.1%, 169.8 riparian miles).

Riparian buffers within potential anadromous salmonid habitat are predominantly two or more trees wide (46.9%, 97.4 riparian miles) and one tree wide (36.7%, 76.3 riparian

[39] Riparian miles are the total measured distance for right and left streambanks.

miles). Riparian buffers within potential cutthroat habitat are mostly two or more trees wide (80.4%, 26.5 riparian miles). Areas with no salmonids are mostly two or more trees wide (67.7%, 65.4 riparian miles).



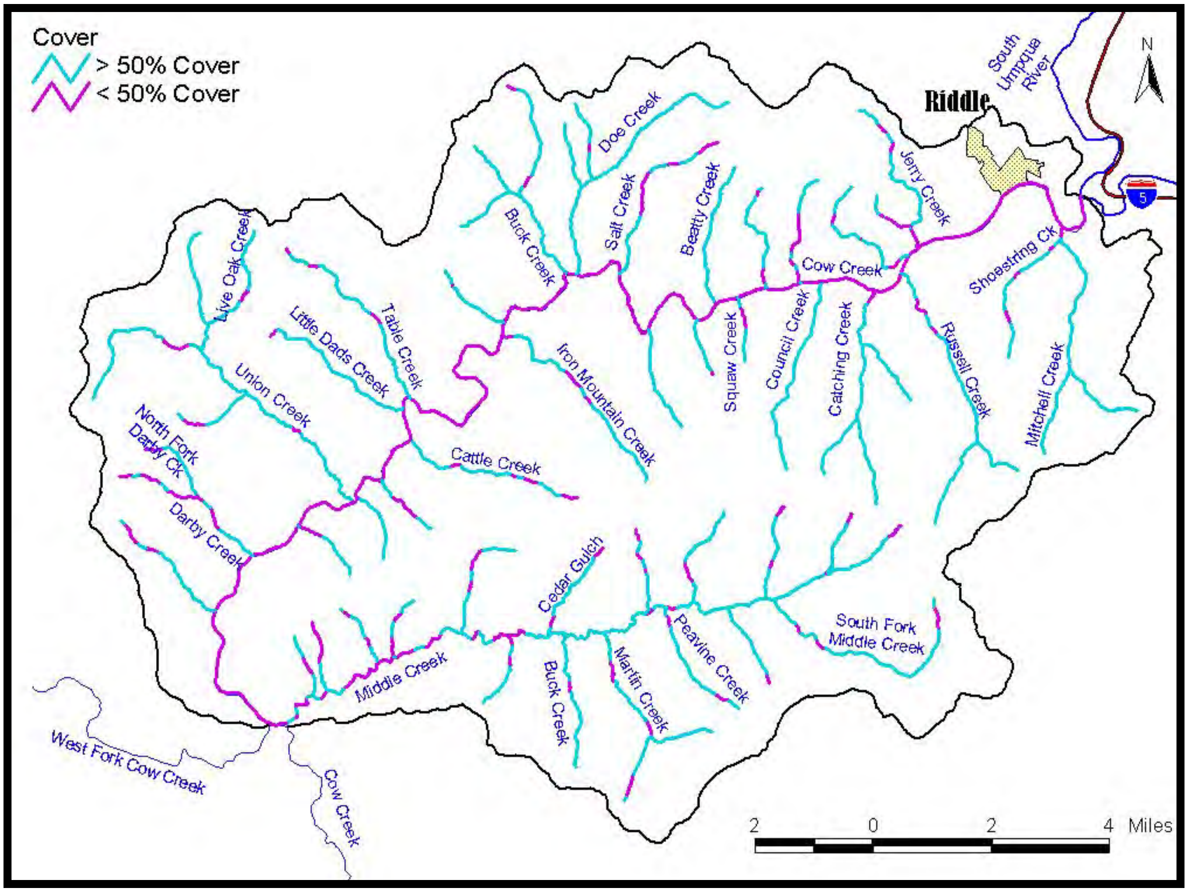
Map 3-9: Riparian buffer widths for the Lower Cow Creek Watershed.

Cover

The ultimate source of stream heat is the sun, either by direct solar radiation or by ambient air and ground temperature around the stream.[40] Blocking the amount of direct solar energy reaching the stream surface reduces warming rates. Streams with complete cover receive the least direct solar radiation, and are therefore preferred in the Umpqua Basin, where many streams are 303(d) listed for high temperature.[41] Cover is dependent on stream width and riparian vegetation. Shrubs and grasses can provide substantial cover for small, narrow streams. Larger streams can be partially shaded by vegetation and completely shaded by infrastructure. In very wide streams, only bridges provide complete coverage. This assessment looks at the percent of the total stream width that is covered by trees or infrastructure. Map 3-10 shows the stream reaches that have greater than 50% cover and less than 50% cover. Appendix 7 provides data for Cow Creek,

[40] See section 3.3.2 for more information about stream temperature.
[41] See section 3.3.1 and Table 3-9 for more information about 303(d) listed streams.

Middle Creek, and combined tributaries, potential anadromous salmonid streams, potential cutthroat streams, and non-salmonid streams.



Map 3-10: Percent cover for the Lower Cow Creek Watershed.

Due to the great width of Cow Creek, 99.0% of the river is less than half covered by vegetation or infrastructure (26.6 stream miles). The areas that are mostly covered are under bridges. Over two thirds of Middle Creek is mostly covered (69.2%, 9.3 stream miles). Tributaries are also mostly covered (83.7%, 107.4 stream miles). Non-salmonid-bearing streams have the highest percent of riparian zones that provide more than 50% cover (84.3%, 40.7 stream miles). Over three-fourths of potential cutthroat streams are mostly covered (76.1%, 12.5 stream miles). Only 61.1% (63.5 stream miles) of potential anadromous salmonid streams are mostly covered by vegetation or infrastructure. This is because Cow Creek is within the range of anadromous salmonids.

3.2.2. Wetlands[42]

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 section is to review current wetlands locations and attributes, historical wetlands, and opportunities for restoration.

[42] Jeanine Lum of Barnes and Associates, Inc., contributed section 3.2.2.

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, USDA Forest 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.

What is a wetland?

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; [43]
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; and
3. At least periodically, the land supports predominantly hydrophytic (water-loving) vegetation.

Function and values

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 function 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.
- 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.

[43] The growing season in Douglas County is from March 1 through October 31.

- 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.

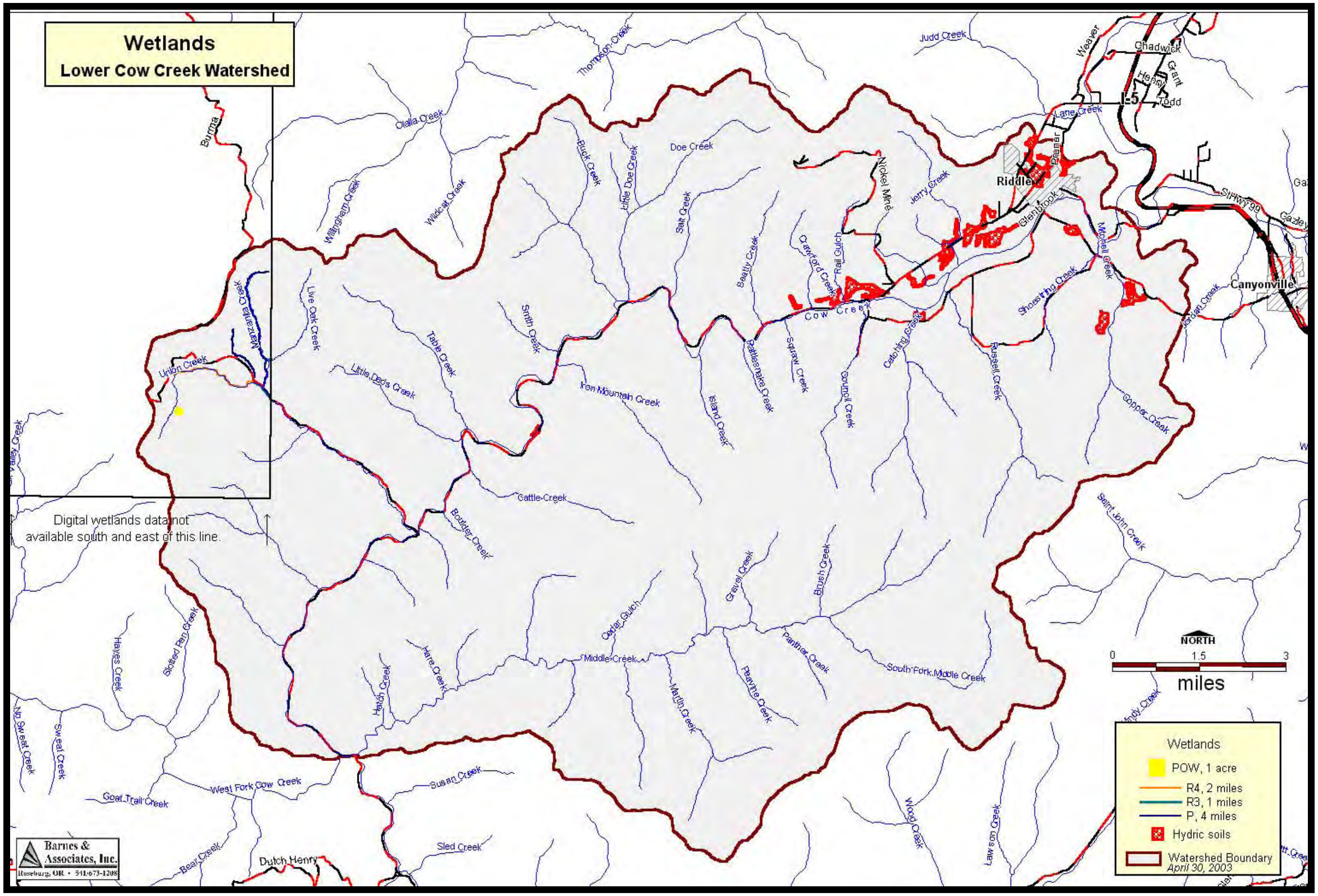
Types of wetlands
A wetland that holds water all year round is the easiest wetland to recognize and the one most people understand as a wetland. Another type of wetland is the ephemeral wetland, or a wetland that holds water for only a few days, weeks, or months during the year. The timing and duration 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 3-11 as line data labeled "P." Table 3-7 Table 3-7 is a summary of codes and descriptions used in the NWI. Data are displayed in Map 3-11.

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.
	OW	Open water. No vegetation evident at the water surface, or 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 3-7: National Wetlands Inventory wetlands codes and descriptions.



Map 3-11: **Lower Cow Creek Watershed wetlands.**

Description of current wetlands in the Lower Cow Creek Watershed

A review of the NWI data shows the main channels of Cow Creek and its major tributaries of Russell, Middle, Union, Table Mountain, Buck, and Doe Creeks are classified as riverine (stream-associated wetland) systems that periodically or continuously contain flowing water.[44] Portions of land adjacent to 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.

Within the palustrine system, palustrine wetlands with emergent vegetation (PEM), is found along the bottomlands of Cow Creek. Indicator plants of these wet pastures such as rushes (*Juncus spp.*) and sedges (*Carex spp*.) are typically found in this type of wetland. This area is primarily farmed as wet pasture and for hay production.

The PEM wetlands primarily occur in the areas zoned agricultural and residential. This is a common trend in rural valley bottoms as the fertile land was attractive to early settlers and subsequent landowners. Most of the agricultural practices extend right up to the edge of the stream bank or wetland.

Some landowners have fenced along the streambank to keep cattle out of the riparian area. However, they have complained that nutria, an introduced species, continues to cause problems with extensive foraging along the bank. In spite of their efforts to leave the brush and blackberry along the stream they still feel that the streambank is unstable.

The remaining palustrine wetlands are farm ponds, typically deep and constructed to hold water all year. These ponds are found scattered throughout the valleys where livestock are grazed. These ponds have been diked and dammed and, in some cases, have impacted the flow of water to and from wetlands.

One highly visible wetland is west of Rail Gulch along the north side of the Cow Creek By-Way and between the railroad tracks. This area is naturally dammed from beaver and muskrat. Occasionally railroad personnel break this dam as the water backs up onto the railroad tracks. Although the landowner (Green Diamond, formerly Glenbrook Nickel) has no plans for this wetland area, its high visibility and access has potential for wildlife viewing or wetland conservation education.

Historical wetlands and changes in the Lower Cow Creek Watershed

There is little specific reference in historical records to wetlands in the Lower Cow Creek Watershed. However, approximately 38% by area of Oregon's wetlands have been

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[44] Wetlands data for this watershed is available electronically only for the USGS 7.5 minute quadrangle of Chipmunk Ridge. This "digital" area falls in the western portion of the watershed. Approximately 4,460 acres, or 4% of the watershed area, were analyzed and mapped with this digital data. The balance of the Lower Cow Creek Watershed was analyzed using paper NWI maps from the Oregon Division of State Lands.

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. There are 463 acres of hydric soils in the watershed as displayed in Map 3-11. These soils are represented by four soil map units and occur on floodplains and terraces along Cooper Creek and Cow Creek from Rail Gulch downstream to its confluence with the South Umpqua River. In general, the soil units are described as clayey, poorly-drained, with low permeability and a high water table present during late fall, winter, and spring.

After review of the hydric soils as displayed in the Wetlands map and NWI data, it is apparent the NWI wetlands correspond with the hydric soils. However, these wetlands are only a fraction of the area designated as hydric soils. As mentioned earlier, wetland vegetation and certain hydrologic conditions must be present in order to meet the federal and state wetland definitions. Historical settlement and urban development of the Riddle area and long-term agricultural use of this land probably affected any original wetland hydrology.

Several wood processing facilities have been developed in the Riddle area along Cow Creek. Most were developed before wetland protection laws were established. It is unknown whether these facilities replaced any historical wetlands. However, a more recent facility, the Engineered Wood Products Plant owned by Roseburg Forest Products has led to a wetland mitigation project. This new wetland is in the establishment stage, and its maturation can provide valuable insight into the dynamic process of wetland creation.

Restoration opportunities in the Lower 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 non-native 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.

Some wetland projects are undertaken for the specific purpose of compensating for the damage or destruction to another wetland area. Recent reports shows that nearly two-thirds of all mitigation projects fail to meet performances standards (Mockler, 2003). Planning, monitoring, and long-term management, important for all wetland activities, are especially important for wetland mitigation projects. Lack of measurable goals, monitoring and corrective adaptive management have been identified as some problems with some mitigation wetlands in Douglas County.

Roseburg Forest Products has taken steps to try to create a successful wetland outside Riddle (Engineered Wood Product Mitigation Area). As part of the development of the wood processing facility that started in 1999, the firm began the process of creating 14 acres of wetlands to replace the seven acres of farmed wet pasture displaced by the facility. The creation of the "bio-swale" has included design, land shaping, vegetation planting, irrigation, maintenance and management of desired vegetation, and an annual monitoring program of permanent plots and transects. The services of a knowledgeable and experienced wetland consultant have been key in proceeding through the mitigation process.

Wetland projects really never end, as monitoring is crucial for measuring the success and functions of the wetland. Establishing reference wetlands in the watershed gives benchmarks for future wetland projects.

The primary agricultural use of wetlands is grazing of domestic animals that often congregate in stream-associated wetlands and other wetlands during dry and hot periods. Best management practices can reduce the impact of livestock in the wetlands and riparian areas. Off-channel watering, water gaps, irrigation, livestock exclusion (part or all of the year), and providing shade away from these areas are examples of improvements that can be implemented to minimize damage to the wetlands.

Opportunities exist for landowners to participate in incentive, cost-share, and/or grant awarding programs that encourage good land stewardship and benefit wetlands. Although each program varies with its incentives and eligibility, landowners share these common concerns:

- Lack of awareness of available programs.
- Overwhelming program choices: "which one is best for me?"
- Concern about hidden agendas and "fine print."
- Anxiety over bureaucracy and contracts: "not worth the effort."
- Fear of the loss of privacy on land or the discovery of threatened or endangered species on the property.

Most of the wetlands in the Lower Cow Creek Watershed are found on private land. Landowner "buy-in" and voluntary participation must be fostered if wetland conservation is to be successful in the watershed. The following recommendations can help realize this goal.

<u>Increase awareness of wetland conservation</u>
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.

<u>Address landowner concerns</u>
Establish an approachable "one-stop shop" or clearinghouse to assist landowners in enrolling in programs that can benefit wetlands and meet landowner goals. A friendly

and "non-governmental" atmosphere can reduce some of the previously identified landowner concerns. A central site can identify and coordinate partners, streamline landowner paperwork, and facilitate leveraging of money and in-kind services often needed for a successful project. Combining local programs with national programs gives flexibility and maximizes dollars. For example, a landowner could receive a tax exemption under the local Wildlife Habitat Conservation and Management Program, receive technical assistance in planning and cost share from the Natural Resources Conservation Service, and receive grant monies from Partners for Wildlife and Ducks Unlimited.

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Lew Howe, Silver Butte Timber Company
Carol Ireland, landowner

Scott Robbins, USDA Natural Resources Conservation Service
Art Schweitzer, Green Diamond
Mark Smalley, Roseburg Forest Products

3.2.3. Riparian zones and wetlands key findings and action recommendations

Riparian zones key findings

- Cow Creek's predominant vegetation types are hardwoods and brush/blackberry. Middle Creek is mostly conifers and hardwoods. Conifers dominate other Cow Creek tributaries.
- Over one-third of Lower Cow Creek anadromous salmonid streams have predominantly hardwood riparian areas; three-fourths of cutthroat streams have conifer-dominated riparian areas.
- Over half of Cow Creek's riparian buffers are one tree wide. Over one-fourth of Cow Creek's riparian buffers have no trees. Middle Creek's riparian zone buffers are mostly one tree wide or greater. Over two-thirds of Lower Cow Creek tributaries have riparian buffers that are two trees wide or greater.
- Riparian buffers within potential anadromous salmonid habitat are predominantly one tree wide or greater. Riparian buffers within potential cutthroat habitat are mostly two trees wide or greater.
- Due to the great width of Cow Creek, 99% of the river is less than half covered by vegetation or infrastructure. The areas that are mostly covered are under bridges. Over two-thirds of Middle Creek and the majority of other tributaries are mostly covered.
- Over 60% of potential anadromous salmonid streams are mostly covered by vegetation or infrastructure. This is because Cow Creek is within the range of anadromous salmonids. Over three-fourths of potential cutthroat streams are mostly covered.

Wetlands key findings

- Historical settlement and urban development of the Riddle area and long-term agricultural use of this land has probably affected the original wetland hydrology. Past wetland sites may have included Cooper Creek and Cow Creek from Rail Gulch downstream to its confluence with the South Umpqua River.
- Most of the remaining wetlands in the Lower Cow Creek Watershed are found on private land.
- 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

- Where canopy cover is less than 50%, establish wide buffers of native trees (preferably conifers) and/or shrubs, depending upon local conditions. Priority areas are fish-bearing streams for which more than 50% canopy cover is possible.
- Identify riparian zones dominated by grass, brush, and blackberry and convert these areas to native trees (preferably conifers) and/or shrubs, depending on local conditions.

- Where riparian buffers are one tree wide or less, encourage buffer expansion by planting native trees (preferably conifers) and/or shrubs, depending on local conditions.
- Maintain riparian zones that are two or more trees wide and provide more than 50% cover.
- Encourage best management practices that limit wetland damage, such as off-channel watering, hardened crossings, livestock exclusion (part or all of the year), and providing stream shade.
- 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.
- Establish an approachable "one-stop shop" or clearinghouse to assist landowners in enrolling in programs that can benefit wetlands and meet landowner goals.

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 3-8 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 3-8: 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."[45] The list of impaired streams is called the "303(d) list," after section 303(d) of the 1972 Clean

[45] ODEQ can also use data collected by other agencies and organizations to evaluate water quality.

Water Act. For each stream on the 303(d) list, ODEQ determines the total maximum daily load (TMDL) allowable for each parameter.[46] 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.

Table 3-9 shows the Lower Cow Creek Watershed streams included in the 2002 final 303(d) list that require TMDL plans.[47] This table is not a comprehensive evaluation of all water quality concerns in the Lower Cow Creek Watershed. There are many streams and stream segments that have not been monitored by ODEQ, or for which additional information is needed to make a listing determination.

Stream	**Parameter(s)**	**Year listed**	**Stream miles listed**	**Season**
Cow Creek	Temperature	2002	0 – 26.3	Sept 15 – May 31
		1998	0 – 26.3	Summer
	PH	1998	0 – 26.3	Summer
		1998	0 - 2	All year
Cattle Creek	Temperature	1998	0 – 3.2	Summer
		2002	0 – 3.2	Sept 15 – May 31
Iron Mt. Creek	Temperature	2002	0 – 3.8	Summer
		1998	0 – 3.8	Sep 15 – May 31
Martin Creek	Temperature	2002	0 – 2	Summer
				Sept 15 – May 31
			2 – 3.3	Sept 15 – May 31
Middle Creek	Temperature	1998	0 – 12.8	Summer
South Fork Middle Creek	Temperature	1998	0 – 4.4	Summer

Table 3-9: ODEQ water quality limited streams in the Lower Cow Creek Watershed.[48]

To evaluate water quality in the Lower Cow Creek Watershed, seven water quality parameters are reviewed in this section. These parameters are temperature, pH, dissolved oxygen, nutrients, bacteria, sedimentation and turbidity, and toxics. ODEQ monitoring data was used and evaluated using ODEQ water quality standards or OWEB recommended levels.

[46] 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.
[47] Streams that are water quality limited for habitat modification and flow modification do not require TMDL plans. In the Lower Cow Creek Watershed, these streams are: Middle Creek (habitat) and Cow Creek (habitat and flow).
[48] 303(d) listing information is from the ODEQ website http://www.deq.state.or.us. Select "water quality," "303(d)" list," "review the final 2002 303(d) list," and "search integrated report by waterbody name, parameter, and/or list date."

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 temperature exceeds tolerance levels, cold-water organisms such as salmonids become physically stressed and have difficulty obtaining enough oxygen.[49] 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 the Lower Cow Creek Watershed, Cow Creek, Iron Mountain Creek, Martin Creek, Middle Creek, and South Fork Middle Creek are 303(d) listed for temperature at various times of year (see Table 3-9).

In 2000, the Umpqua Basin Watershed Council (UBWC) undertook a study on stream temperature for Cow Creek and its tributaries, including streams in the Lower Cow Creek Watershed (the Smith report).[50] Continuously sampling sensors were placed at 89 locations within the Cow Creek system, of which 23 were within the Lower Cow Creek Watershed.[51] Sensors collected data from June through September. Table 3-10 and Map 3-12 show the locations of the monitoring sites within the watershed.

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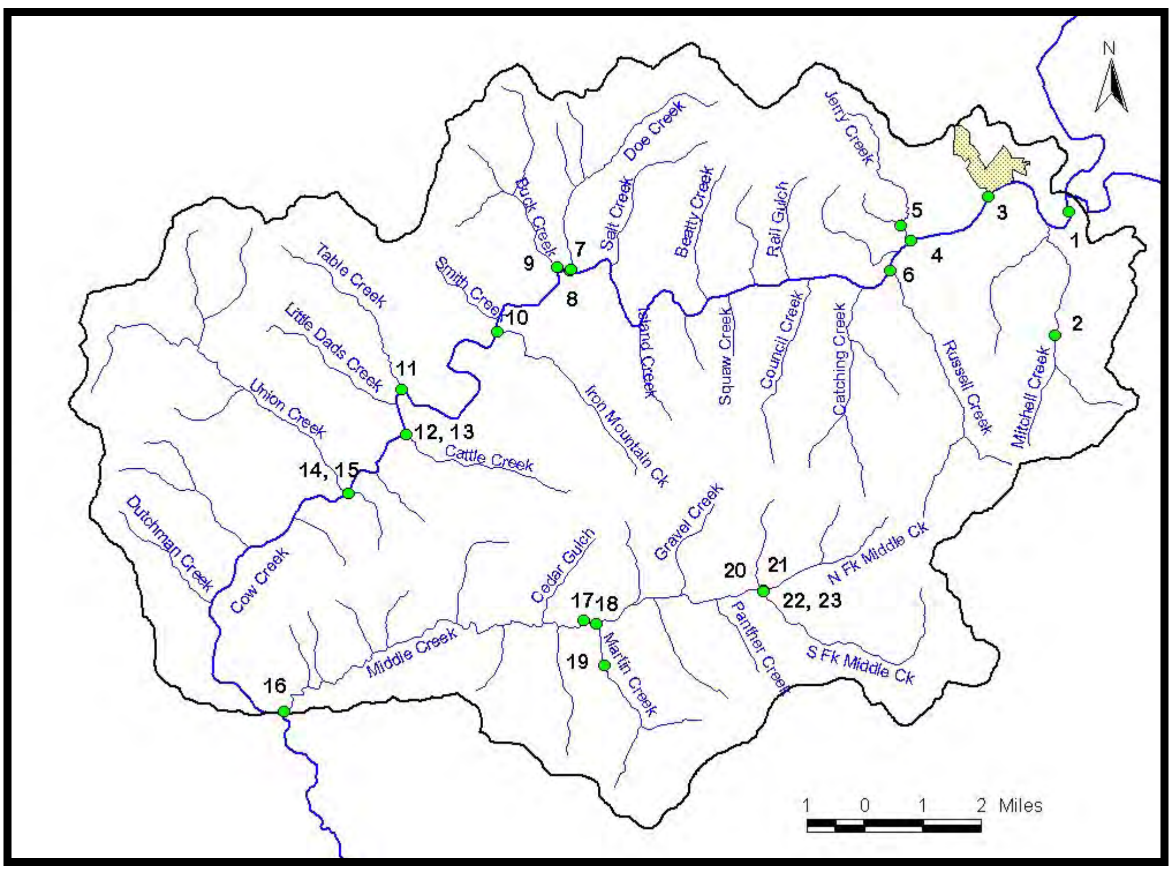
[49] Cold water holds more oxygen than warm water; as water becomes warmer, the concentration of oxygen decreases.

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

[51] Data from seven of the Lower Cow Creek monitoring sites were collected by the BLM-Roseburg.

Site name	Site #	Site name	Site #
Cow Ck near mouth	1	Cattle at BLM road 31-7-17	13
Mitchell Ck at section 6	2	Union Ck at mouth	14
Cow Ck above Canyonville Bridge	3	Union Ck near mouth	15
Cow Ck below Jerry Ck	4	Middle Ck at mouth	16
Jerry Ck below railroad	5	Middle Ck at section 35 bridge	17
Russell Ck at mouth	6	Martin Ck at BLM road 31-7-35	18
Doe Ck at mouth	7	Upper Martin Ck	19
Cow Ck above Doe Ck	8	Middle Ck at BLM road 31-6-29	20
Buck Ck near mouth	9	N Fork Middle Ck	21
Iron Mt Ck at mouth	10	S Fork Middle Ck	22
Table Ck at mouth	11	S Fork Middle Ck	23
Cattle Ck near mouth	12		

Table 3-10: Monitoring sites name and number in the Lower Cow Creek Watershed.



Map 3-12: Temperature monitoring sites within the Lower Cow Creek Watershed.

Figure 3-1 shows the seven-day moving average maximum temperatures for Cow Creek within the Lower Cow Creek Watershed.[52] Appendix 8 has the same data for tributaries. Table 3-11 has the number of days and percent of days for which seven-day moving average maximum temperatures exceeded 64°F. Results show that seven-day moving average maximum temperatures in Cow Creek were frequently above 64°F and have reached 81°F. Except for Upper Martin Creek, tributaries frequently had seven-day moving average maximums above 64° F in July and August; Upper Martin Creek was below 64°F every study day.

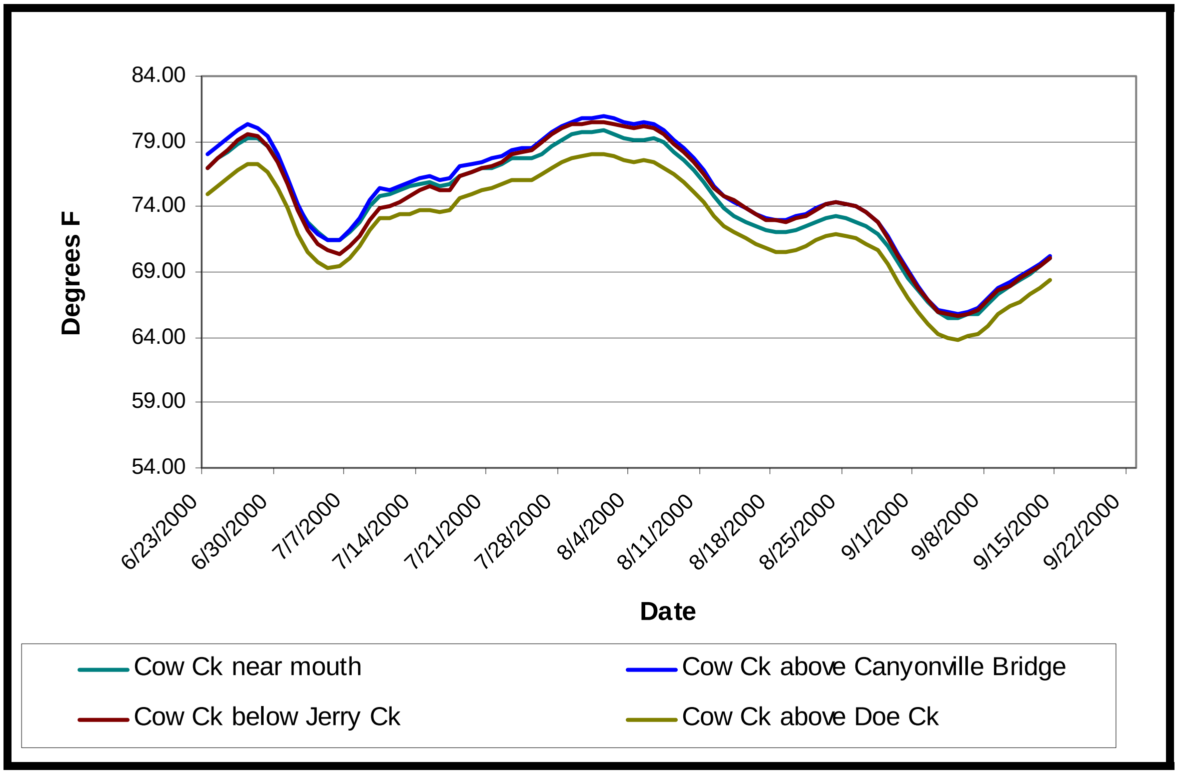


Figure 3-1: Summer temperature trends for Cow Creek within the Lower Cow Creek Watershed.

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

Site name	Site #	# days sampled	# days above 64ºF	% days >64ºF
Upper Martin Ck	19	84	0	0.0%
Iron Mt Ck at mouth	10	84	27	32.1%
Doe Ck at mouth	7	84	28	33.3%
Cattle at BLM road 31-7-17	13	84	32	38.1%
Martin Ck at BLM road 31-7-35	18	84	32	38.1%
Cattle Ck near mouth	12	84	33	39.3%
Mitchell Ck at section 6	2	84	38	45.2%
Buck Ck near mouth	9	84	40	47.6%
Middle Ck at BLM road 31-6-29	20	84	41	48.8%
S Fork Middle	22	84	41	48.8%
N Fork Middle Ck	21	84	41	48.8%
Union Ck near mouth	15	84	43	51.2%
Union Ck at mouth	14	84	43	51.2%
Middle Ck at section 35 bridge	17	80	43	53.8%
S Fork Middle Ck	23	83	45	54.2%
Table Ck at mouth	11	46	28	60.9%
Jerry Ck below railroad	5	84	64	76.2%
Russell Ck at mouth	6	84	69	82.1%
Middle Creek at mouth	16	84	72	85.7%
Cow Ck above Doe Ck	8	84	82	97.6%
Cow Ck near mouth	1	84	84	100.0%
Cow Ck above Canyonville Bridge	3	84	84	100.0%
Cow Ck below Jerry Ck	4	84	84	100.0%

Table 3-11: Number of days and percent of days for which seven-day average maximum temperatures exceeded 64°F in the Lower Cow Creek Watershed.

The Smith Report suggests that Cow Creek's temperature is dominated by Galesville reservoir releases. However, the effects of Galesville are less evident in the Lower Cow Creek Watershed:

> The temperature profile of the mainstem of Cow Creek is dominated by the effect of the Galesville Reservoir that introduces cold water and higher flows during summer releases and causes an abrupt decrease in stream temperature. This effect appears to diminish further downstream and, at the mouth of Cow Creek, the temperatures are similar to the South Umpqua directly above the confluence (p. 1).

Data also suggest that throughout the Cow Creek system, tributary streams have the potential to be at cooler temperatures:

> 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).

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.[53] 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 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.

Figure 3-2 shows stream temperature difference on July 31, 2000 (a very warm day), and September 04, 2000 (a very cool day). The lines are stream temperature, and the bars are the stream temperature difference between the warmest and coolest day. In general, locations with the greatest temperature difference have little or no shade.

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

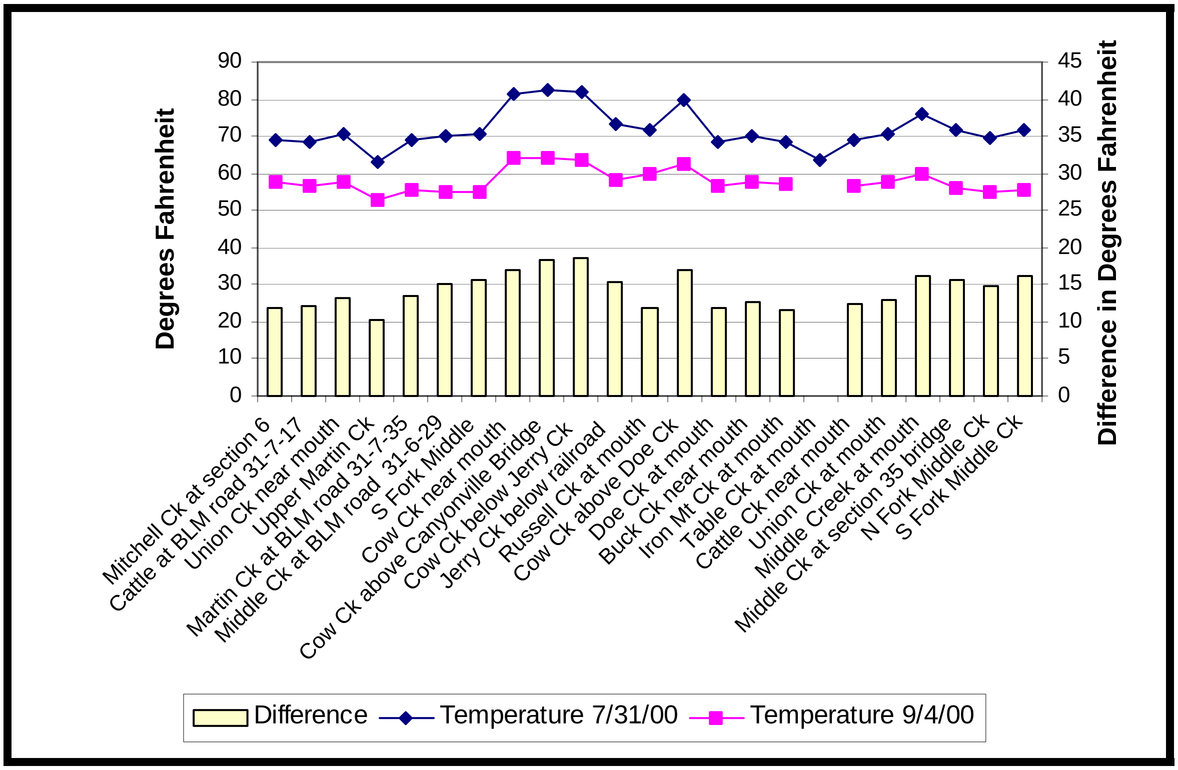


Figure 3-2: Temperature difference for monitoring sites in the Lower Cow Creek Watershed.

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" analysis 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.

Management implications

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.[54]

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

3.3.3. 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.

Between 1959 and 2002, pH was sampled 332 times in the Lower Cow Creek Watershed. Of these samples, 56 (16.9%) were outside the 6.5 to 8.5 range. Table 3-12 shows the sampling locations, the number of samples taken at each site, and the number and percent of samples exceeding water quality standards. Cow Creek pH levels exceed water quality standards at three sites: the mouth, 0.25 miles downstream of Riddle, and 150 yards upstream of the Riddle wastewater treatment plant outfall.[55] Cow Creek is 303(d) listed for pH from the mouth to stream mile 26.3 (the confluence with West Fork Cow Creek).

Location within the Lower Cow Creek Watershed	# of samples	# outside pH standards	%
Cow Ck 0.25 miles downstream of Riddle	34	5	14.7%
Cow Ck four miles upstream of Riddle at Cow Ck Road bridge	33	0	-
Cow Ck at the mouth	251	49	19.5%
Riddle wastewater treatment plant final effluent	4	0	-
Unnamed creek draining east of Riddle	1	0	-
Cow Ck 150 yards upstream of Riddle outfall	4	2	50.0%
Cow Ck 150 feet downstream of Riddle outfall	1	0	-
Cow Ck-Riddle Wastewater treatment plant	1	0	-
Tributary to Middle Ck at road mile 1.04	2	0	-
Middle Ck one mile upstream of mouth	1	0	-

Table 3-12: Lower Cow Creek Watershed pH levels.

In addition, water flowing out of the abandoned Formosa Mine site is acidic and contains toxic metal pollutants (see section 3.3.8). Water from the mine is entering Middle Creek and South Fork Middle Creek, contaminating 18 miles of the Middle Creek and South Fork Middle Creek stream systems. As of September, 2003, neither stream was 303(d) listed for pH or metal pollutants.

3.3.4. 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.

[55] 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."

Since oxygen content varies depending on many factors, ODEQ has many dissolved oxygen criteria. ODEQ's 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.

Table 3-13 shows dissolved oxygen sampling locations and results from July, 1959, through November, 2002, at 10 Lower Cow Creek sampling sites. Nine out of 431 samples (2.1%) did not meet water quality standards.[56] Although three sites failed to meet the dissolved oxygen standard, these sites were only sampled once or twice. There are no 303(d) listings for dissolved oxygen in the Lower Cow Creek Watershed.

Location within the Lower Cow Creek Watershed	**# of samples**	**# outside pH standards**	**%**
Cow Ck 0.25 miles downstream of Riddle	75	2	2.7%
Cow Ck four miles upstream of Riddle at Cow Ck Road bridge	75	0	-
Cow Ck at the Mouth	269	3	1.1%
Riddle wastewater treatment plant final effluent	2	2	100.0%
Unnamed creek draining east of Riddle	1	1	100.0%
Cow Ck 150 yards upstream of Riddle outfall	4	0	-
Cow Ck 150 feet downstream of Riddle outfall	1	0	-
Cow Ck-Riddle Wastewater treatment plant	1	1	100.0%
Tributary to Middle Ck at road mile 1.04	2	0	-
Middle Ck one mile upstream of mouth	1	0	-

Table 3-13: Dissolved oxygen levels for Lower Cow Creek monitoring sites.

3.3.5. Nutrients

The beneficial uses affected by nutrients are aesthetics or "uses identified under related parameters."[57] 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. As stated in section 3.3.3, 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,

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[56] Data are from ODEQ's Laboratory Analytical Storage and Retrievable (LASAR) database.
[57] From ODEQ's *Oregon's Approved 1998 303(d) Decision Matrix* (1998).

certain algae types produce by-products that are toxic to humans, wildlife, and livestock, as occurred in Diamond Lake in the summer of 2002.[58]

Currently, there are no Umpqua Basin-based ODEQ values for acceptable stream nutrient levels and no streams that are 303(d) listed for nutrients in the Lower Cow Creek Watershed. Therefore, this assessment used the OWEB recommended standards for evaluating nutrient levels in the watershed. OWEB recommends using 0.05 mg/l for total phosphorus, and 0.3 mg/l for total nitrate (including nitrites and nitrates).

Table 3-14 shows total nitrate sampling locations and results for monitoring sites within the Lower Cow Creek Watershed from October, 1976, through November, 2002. Table 3-15 shows the same information for total phosphorus from February, 1977, through November, 2002. Three out of 273 total nitrate samples (1.1%) exceeded 0.3 mg/l. Five of 194 phosphorus samples (2.6%) exceeded 0.05 mg/l. High nitrate values ranged from 0.85 to 2.8 mg/l. The highest phosphorus value was 3.1 mg/l at the Riddle wastewater treatment plant final effluent on August 28, 2002.[59] These data suggest that nutrient levels do not limit water quality in the Lower Cow Creek Watershed.

Location within the Lower Cow Creek Watershed	**# of samples**	**# outside pH standards**	**%**
Cow Ck 0.25 miles downstream of Riddle	1	0	-
Cow Ck four miles upstream of Riddle at Cow Ck Road bridge	3	0	-
Cow Ck at the Mouth	254	0	-
Riddle wastewater treatment plant final effluent	2	2	100.0%
Unnamed creek draining east of Riddle	1	0	-
Cow Ck 150 yards upstream of Riddle outfall	3	0	-
Cow Ck 150 feet downstream of Riddle outfall	1	0	-
Cow Ck 300 feet downstream of Riddle outfall	1	0	-
Cow Ck 600 feet downstream of Riddle outfall	1	0	-
Cow Ck 900 feet downstream of Riddle outfall	1	0	-
Cow Ck 1200 feet downstream of Riddle outfall	1	0	-
Cow Ck-Riddle Wastewater treatment plant	1	1	100.0%
Tributary to Middle Ck at road mile 1.04	2	0	-
Middle Ck one mile upstream of mouth	1	0	-

Table 3-14: Total nitrate levels for monitoring sites within the Lower Cow Creek Watershed.

[58] Diamond Lake is within the Umpqua National Forest in the extreme eastern portion of the Umpqua Basin.
[59] Data are from ODEQ's Laboratory Analytical Storage and Retrievable (LASAR) database.

Location within the Lower Cow Creek Watershed	# of samples	# outside pH standards	%
Cow Ck 0.25 miles downstream of Riddle	1	0	-
Cow Ck four miles upstream of Riddle at Cow Ck Road bridge	3	0	-
Cow Ck at the Mouth	174	1	0.6%
Riddle wastewater treatment plant final effluent	3	3	100.0%
Unnamed creek draining east of Riddle	1	0	-
Cow Ck 150 yards upstream of Riddle outfall	3	0	-
Cow Ck 150 feet downstream of Riddle outfall	1	0	-
Cow Ck 300 feet downstream of Riddle outfall	1	0	-
Cow Ck 600 feet downstream of Riddle outfall	1	0	-
Cow Ck 900 feet downstream of Riddle outfall	1	0	-
Cow Ck 1200 feet downstream of Riddle outfall	1	0	-
Cow Ck-Riddle Wastewater treatment plant	1	1	100.0%
Tributary to Middle Ck at road mile 1.04	2	0	-
Middle Ck one mile upstream of mouth	1	0	-

Table 3-15: Total phosphorus sampling locations and results for the Lower Cow Creek Watershed.

Landowner perspectives
A Lower Cow Creek Watershed meeting participant reported that some Cow Creek Valley landowners are concerned that fertilizers used on industrial timberlands contribute high nutrient levels to streams.

3.3.6. 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 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.

In the Lower Cow Creek Watershed, ODEQ has bacteria monitoring data from December, 1995, through November, 2002. Only one out of 66 samples from nine sites exceeds water quality standards. The most probable number of bacteria from the single high sample was 2,419 bacteria per 100 ml of water. Currently, no streams in the Lower Cow Creek Watershed are 303(d) listed for bacteria.[60] Additional monitoring is necessary to determine if Lower Cow Creek Watershed tributaries have water quality-limiting bacteria levels.

3.3.7. 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.

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. 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.

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

[60] Data are from ODEQ's Laboratory Analytical Storage and Retrievable (LASAR) database.

from non-ODEQ documents that use standardized protocols for evaluating aquatic habitat and fish population data. Currently, ODEQ monitors streams for total suspended solids, which indicates sedimentation. At the writing of this assessment, neither ODEQ nor OWEB has established criteria for these data. There are currently no streams in the Lower Cow Creek Watershed 303(d) listed for sedimentation. More data are needed to determine if sedimentation is a problem in the watershed.

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. To date, there are no streams in the Lower Cow Creek Watershed that are 303(d) listed for turbidity.

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. One out of 273 (0.4%) Lower Cow Creek Watershed turbidity samples exceeded 50 NTUs.[61] Additional monitoring is necessary to determine if turbidity levels are of concern in tributaries.

Sediment delivery processes[62]

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. All of these human modifications occur in the Lower Cow Creek Watershed. With good management, the impact of these practices can be minimized.

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 five potential sources of stream sedimentation and turbidity in the watershed: roads and culverts, slope and debris flow potential, soils, urban drainage, 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

[61] Data are from ODEQ's Laboratory Analytical Storage and Retrievable (LASAR) database.
[62] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the introductory text for this section.

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.[63]

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 836.0 miles of roads in the Lower Cow Creek Watershed. These are broken into nine classes (see Table 3-16).

Surface type	**Road miles**	**% total**
Surfaced		
• Federal roads (paved)	0.0	-
• State roads (paved)	0.0	-
• County/other (paved)	50.9	6.1%
• Major gravel	412.0	49.3%
• Minor gravel or spur	49.1	5.9%
Total surfaced	**512.0**	**61.2%**
Unsurfaced		
• Major dirt road	281.3	33.6%
• Minor dirt road	35.5	4.2%
Total unsurfaced	**316.8**	**37.9%**
Other		
• Unknown	0.2	>0.1%
• Closed	7.2	0.9%
Total other	**7.4**	**0.9%**

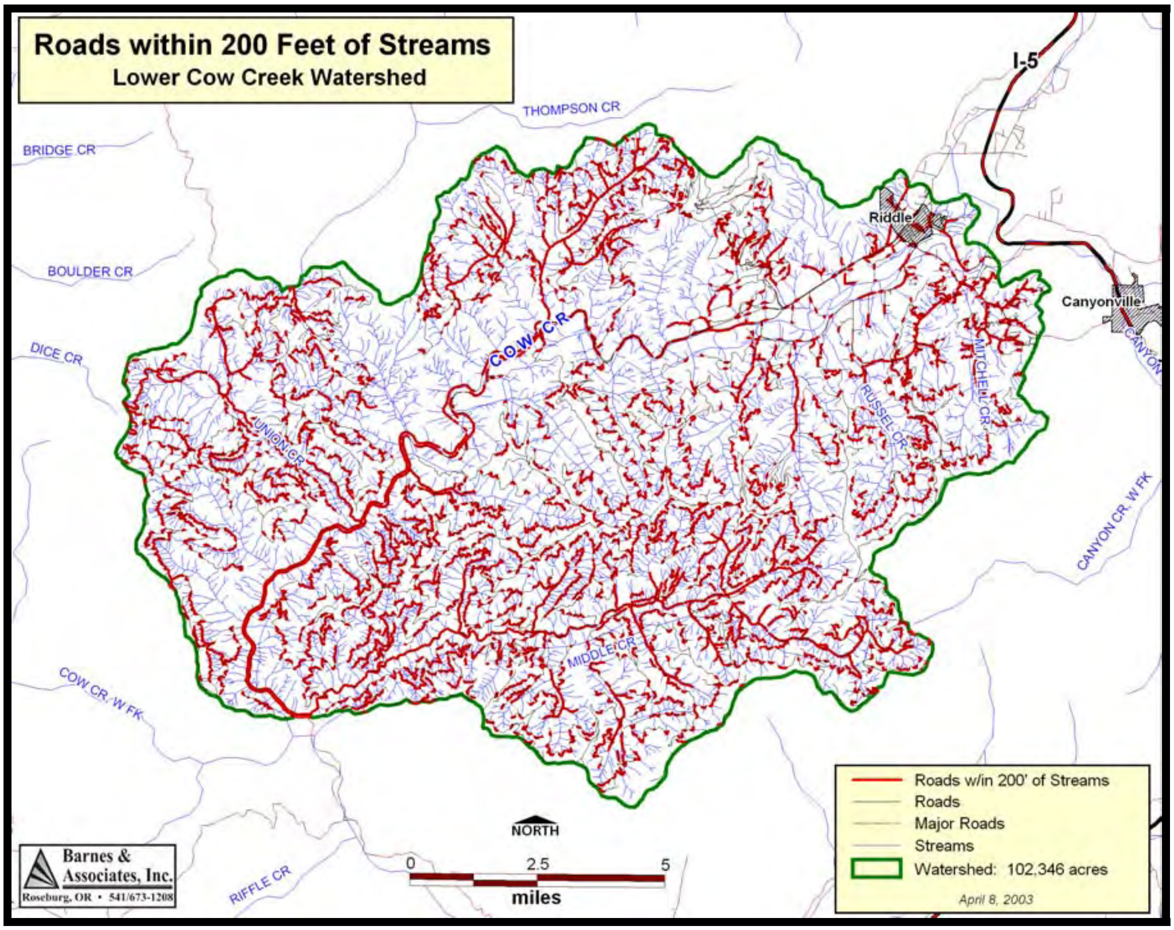
Table 3-16: Miles and percent of Lower Cow Creek Watershed roads by class.

The closer a road is to a stream, the greater the likelihood that road-related runoff contributes to sedimentation. In the Lower Cow Creek Watershed, there are 418.7 miles of roads (50.1% of 836.0 total miles) within 200 feet of streams (see Map 3-13). Of these, approximately 268.5 miles (64.1%) are surfaced roads, 146.9 miles (35.1%) are unsurfaced roads, and 3.4 miles (0.8%) are unknown or closed.

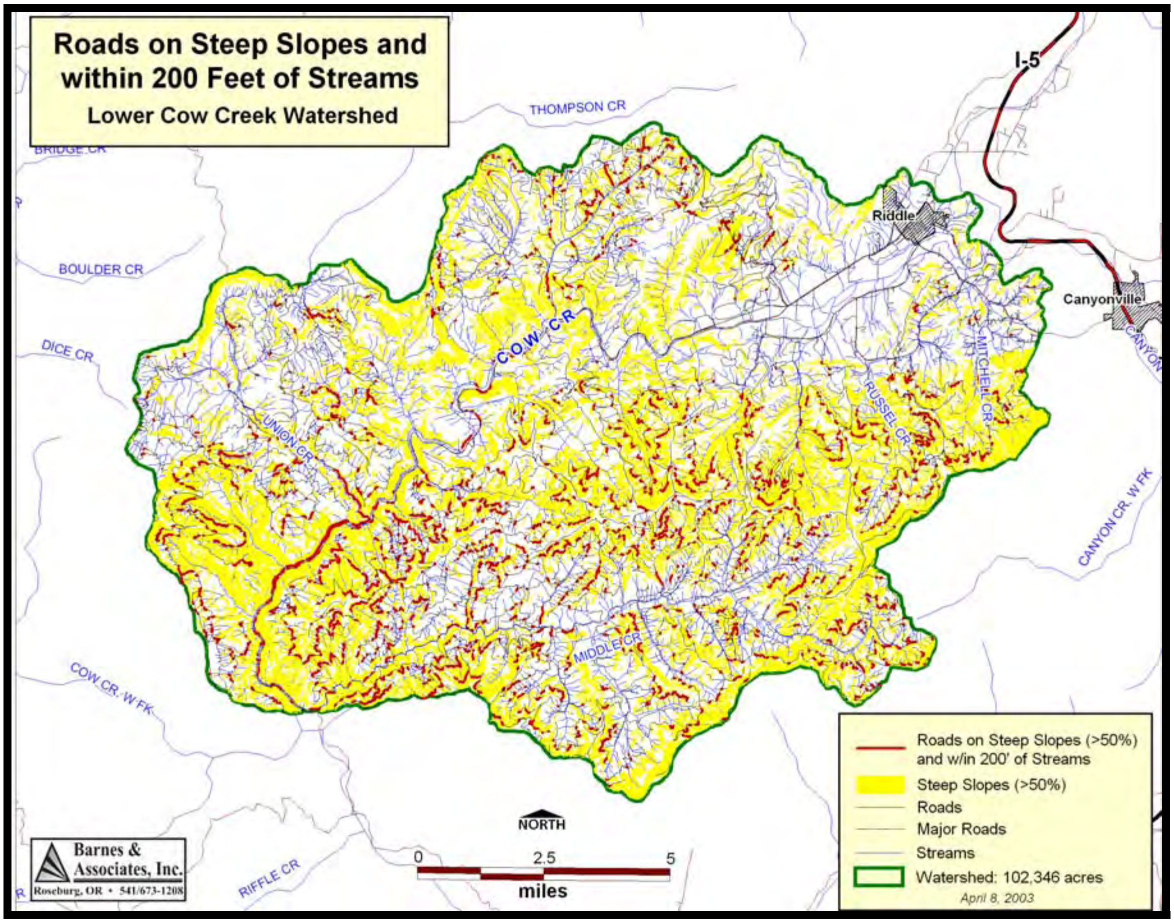
Roads on steep slopes have a greater potential for erosion and/or failure than roads on level ground. There are approximately 89.4 miles of roads (10.7% of 836.0 total miles) located on a 50% or greater slope and within 200 feet of a stream (see Map 3-14). Of these roads on steep slopes, 57.6 miles (64.4%) are surfaced, 31.2 miles (34.9%) are unsurfaced, and 0.7 miles (0.8%) are closed or unknown. An analysis of road conditions near streams is necessary to determine how much stream sedimentation is attributable to road conditions.

[63] Jenny Allen and Tim Grubert of BioSystems, Inc., contributed this paragraph.

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 3-13: Locations of Lower Cow Creek Watershed roads within 200 feet of a stream.

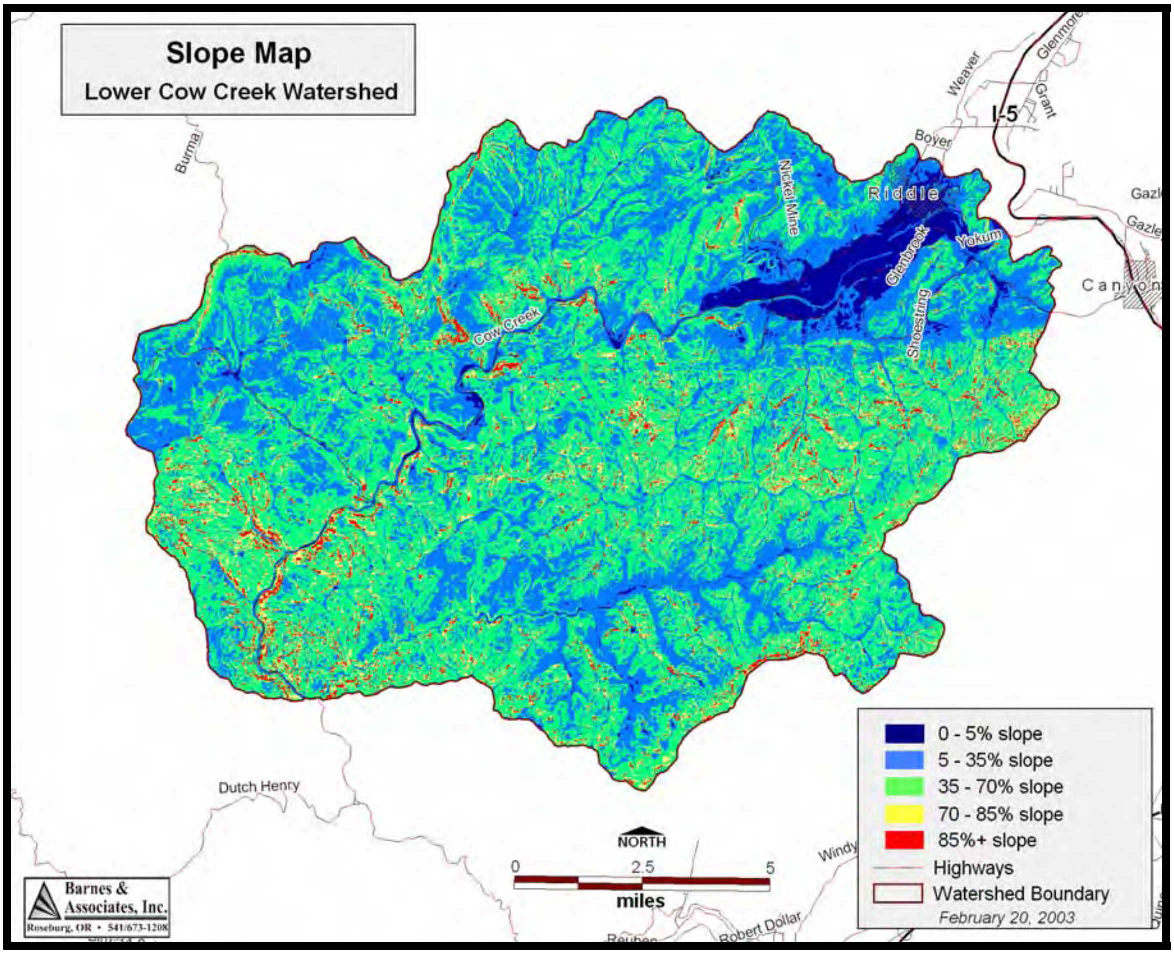


Map 3-14: Locations of Lower Cow Creek Watershed roads within 200 feet of a stream and on slopes that are greater than 50%.

Slope and debris flow potential[64]

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 3-15 shows Lower Cow Creek Watershed slope. Relatively steep slopes can be seen throughout the watershed. The southern portion of the watershed has consistently steeper sloped areas and fewer floodplains. The only large area of very low slope is the floodplain of Cow Creek near the confluence with the South Umpqua River.

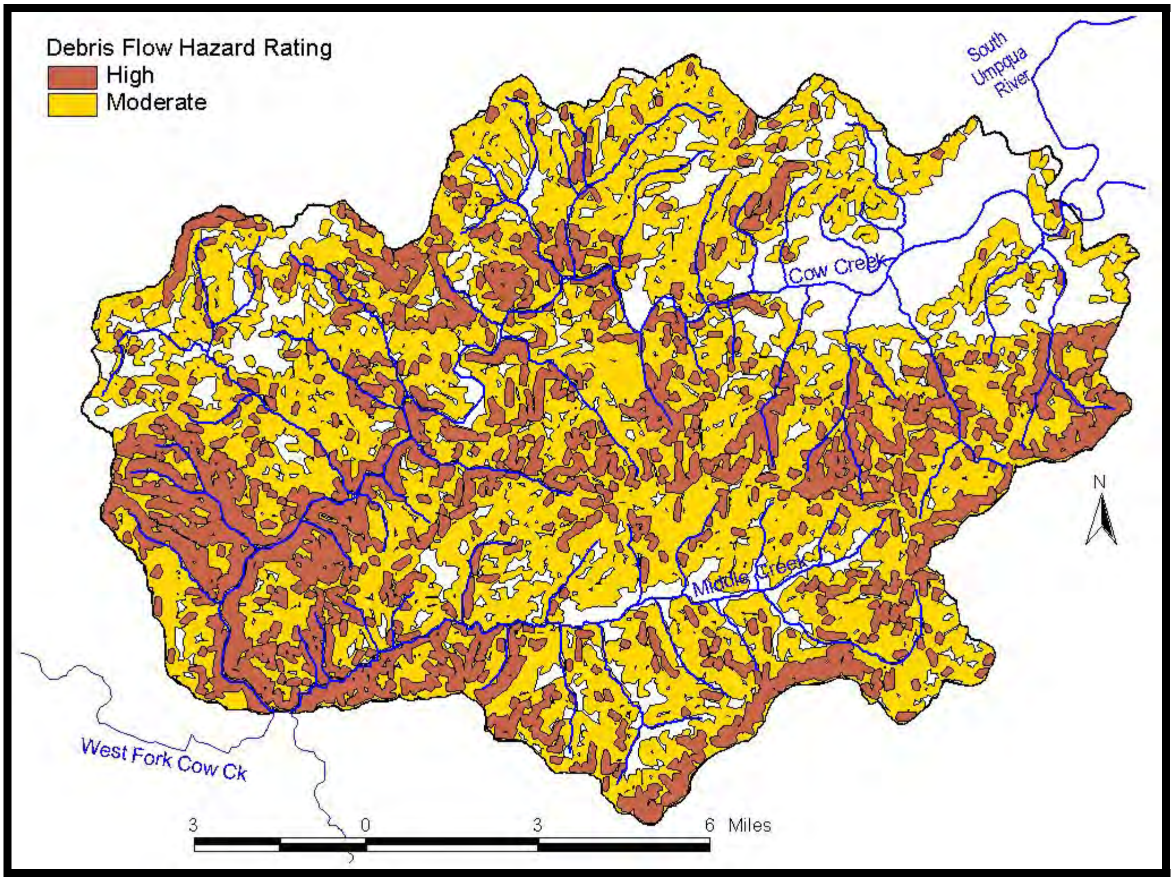
[64] Kristin Anderson and John Runyon of BioSystems, Inc., contributed this section's text and Photo 3-2.



Map 3-15: Percent slope for the Lower Cow Creek Watershed.

The slope of land will clearly influence the hazards for catastrophic slope failure and mass sediment delivery down slope. 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 be naturally prone to debris flows. ODF created coarse scale maps showing moderate, high, and extreme natural debris flow hazards using slope steepness, geologic units, stream channel confinement, geomorphology, and historical information on debris flows. 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 Lower Cow Creek Watershed are shown in Map 3-16. 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 (see Photo 3-2). An original, updated mapping study of landslide areas using aerial photos would provide valuable information about past and potential landslides in the watershed.[65]



Map 3-16: Natural debris flow hazard areas in the Lower Cow Creek Watershed as outlined in a coarse scale study by ODF.

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

Photo 3-2: Photograph looking across Lower Cow Creek at a hillside where mass wasting has recently occurred.[66]

[66] This photograph was taken from Universal Transverse Mercator coordinate 463041/4751777.

Soils[67]

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 hydrologic soils grouping and erosion potential 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 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 3-17 provides descriptions of the hydrologic soil groups.

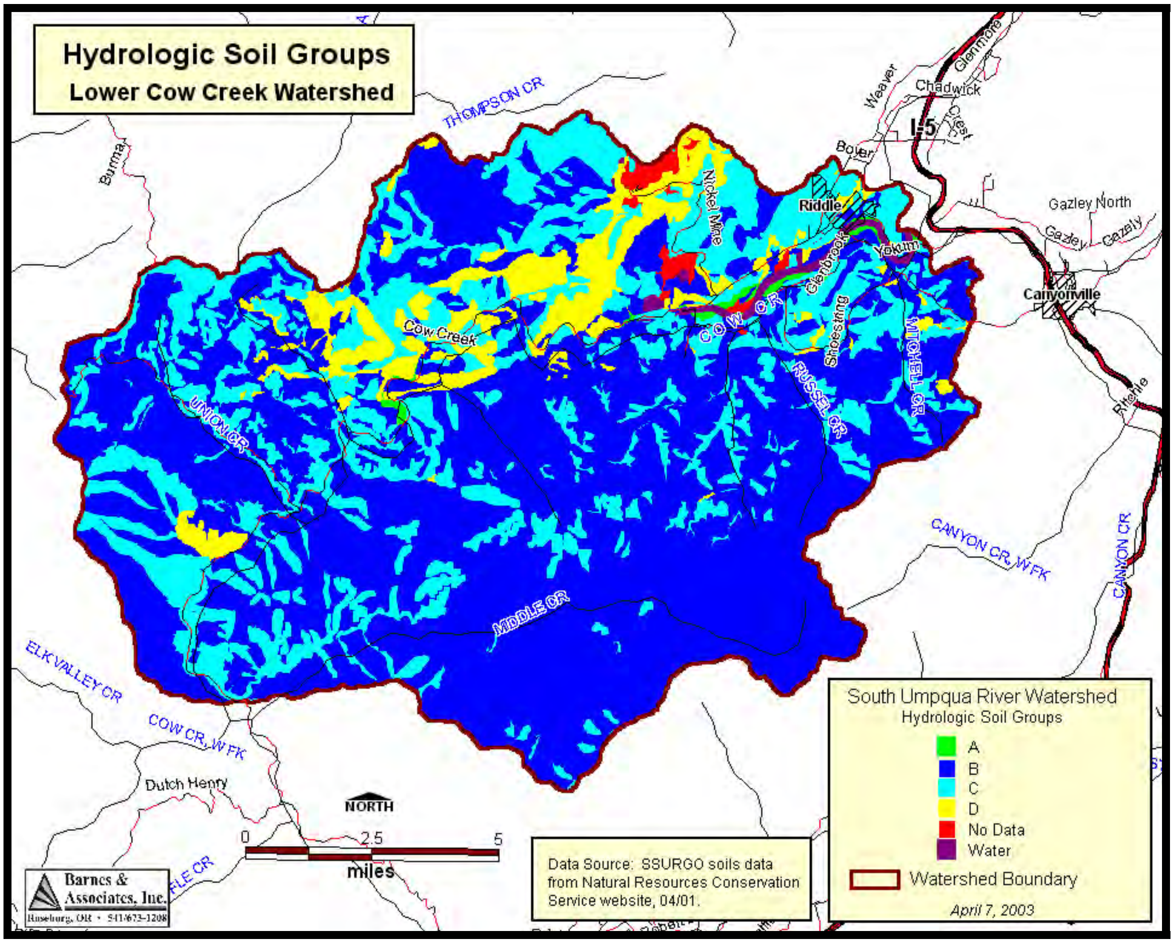
HSG	**Soil Description**
A	Have low runoff potential and high infiltration rates even when thoroughly wetted; consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).
B	Have moderate infiltration rates when thoroughly wetted 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 3-17: Hydrologic soil group descriptions.[68]

The northern half of the Lower Cow Creek Watershed has large areas of soils in the C and D hydrologic soils groups (see Map 3-17). These areas may be more prone to

[67] Kristin Anderson and John Runyon of BioSystems, Inc., contributed the text and table.
[68] From USDA Technical Release 55 (1986).

delivering sediment and faster runoff than other areas. The large area of D soils corresponds to the geologic units Ju, or the ophiolite sequences (see section 1.2.4 and Appendix 1 for more geologic information). Nickel Mountain mining within this unit can be seen in the color gray, indicating pits. Another noticeable area of soils in the D group, with high runoff and low infiltration capacity is located north and east of the confluence of Darby Creek with Cow Creek. Most of the southern part of the watershed falls into the B grouping, indicating a decreased tendency of those soil types to promote runoff. However, the slopes in the southern half of the watershed are still steep. As discussed earlier, slopes are also important to erosion and runoff processes.

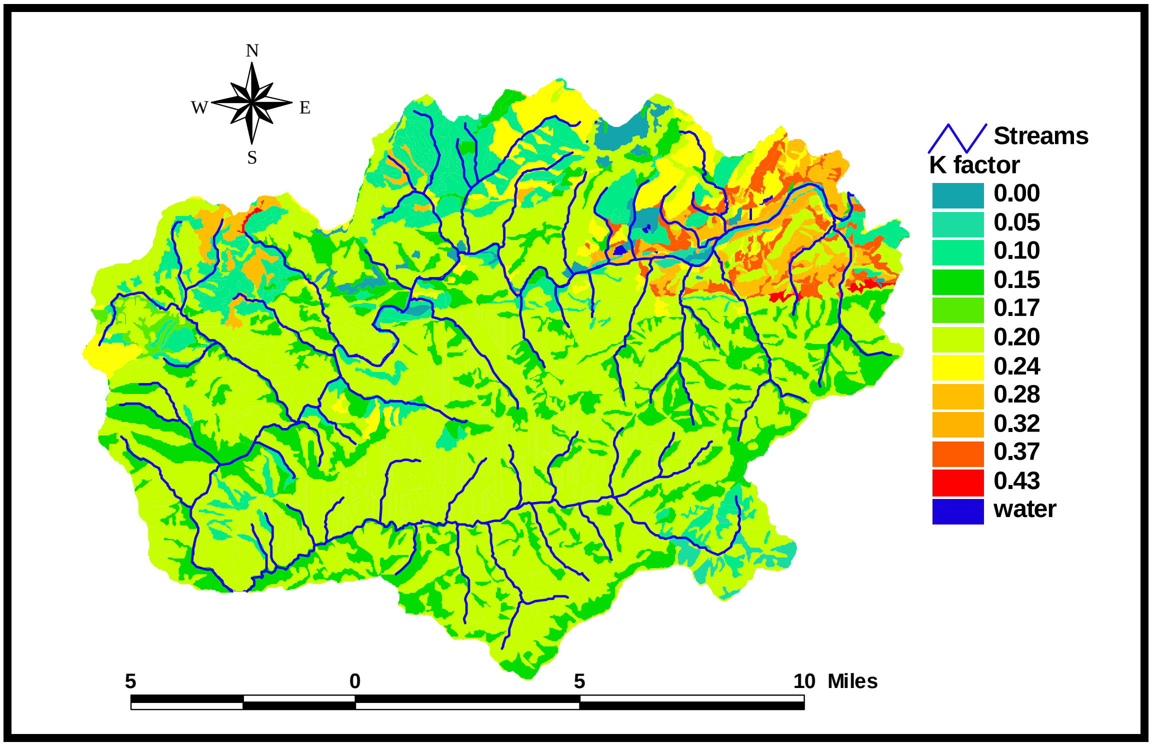


Map 3-17: Hydrologic soils map of the Lower Cow Creek Watershed.

Soil K factor

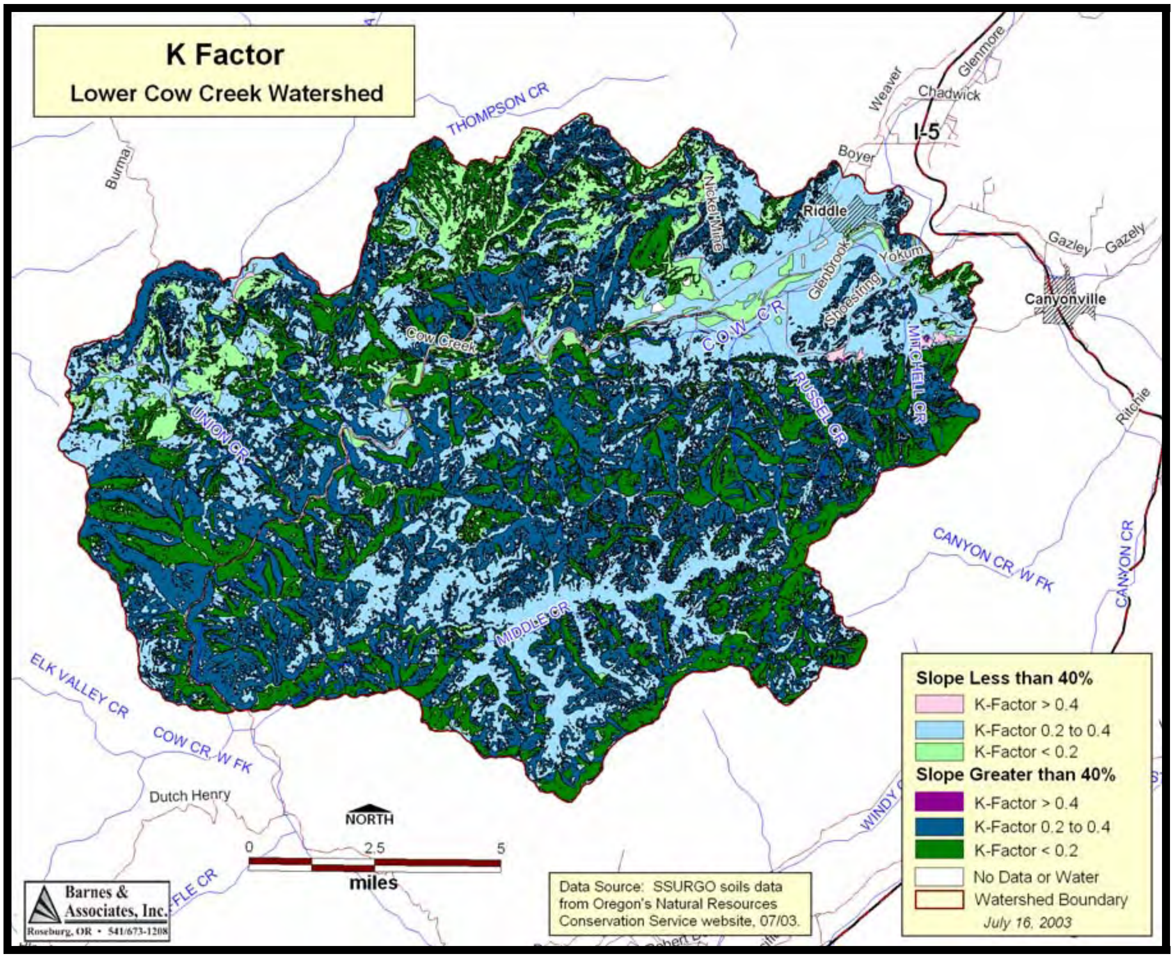
The K factor, or soil erodibility, is a measure of detachability of the soil, infiltration, runoff, and the transportability of sediment that has been eroded from the soil. Texture (the relative percentage of different grain sizes within the soil), organic matter, structure, and permeability of the soil 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 3-18 depicts the K factor adjusted for the effect of rock fragments of the surface layer of soil within the Lower Cow Creek Watershed. Map 3-19 depicts K factor and slope. Only a very small portion of the watershed has a high erodibility rate (>0.4); these areas are located in the headwaters of Table Creek and along the northeastern-most contact of the Dothan Formation (KJds) with Tertiary volcanics (Tu) and the Myrtle Group (KJm) along Shoestring Creek and Mitchell Creek, respectively. A concentration of soils with moderate erodibility rates exists within the large floodplain of Cow Creek in its downstream reaches. The bulk of the watershed has low to moderate erodibility values.



Map 3-18: K factor for the Lower Cow Creek Watershed.[69]

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



Map 3-19: K factor and slope for the Lower Cow Creek Watershed.

<u>Urban drainage</u>

In cities and towns, sediment enters streams from storm water systems. Urban development results in high amounts of impervious surfaces concentrated in a small area.[70] As a result, rainfall is no longer absorbed by the soil or stored in wetlands, leading to heightened peak streamflows and shortened lag times (time from rainfall to peak streamflow) following rain events. To prevent flooding, cities have extensive storm water systems that convey runoff from streets and other paved areas to nearby rivers, streams, and/or lakes; these storm water systems can be a source of stream sediment:

> Different types of land within an urban setting produce different amounts of sediment. Residential neighborhoods produce the least amount of sediment per square mile. Commercial areas produce moderate loads of sediment, and heavy industrial areas produce even higher amounts. The highest amounts occur in areas that are actively being developed. Earth disturbances and bared surfaces usually make sediment production the

[70] Impervious surfaces are ones that do not permit water infiltration, such as roads, roofs, and compacted soil.

highest within a town, albeit the sediment production usually decreases once the construction is complete (Oregon Watershed Assessment Manual, p. VI-27).

Table 3-18 shows the dominant land use and estimated percent of total impervious surfaces for 10 cities in the central Umpqua Basin. “Residential” is the dominant land use for all cities except Canyonville. Approximately 21% of the City of Riddle is impervious. The City of Glendale is located on Cow Creek upstream of the Lower Cow Creek Watershed and has a slightly higher percent impervious area (27%). More research is needed to determine the degree to which Riddle, Glendale, and other cities contribute to stream sediment.

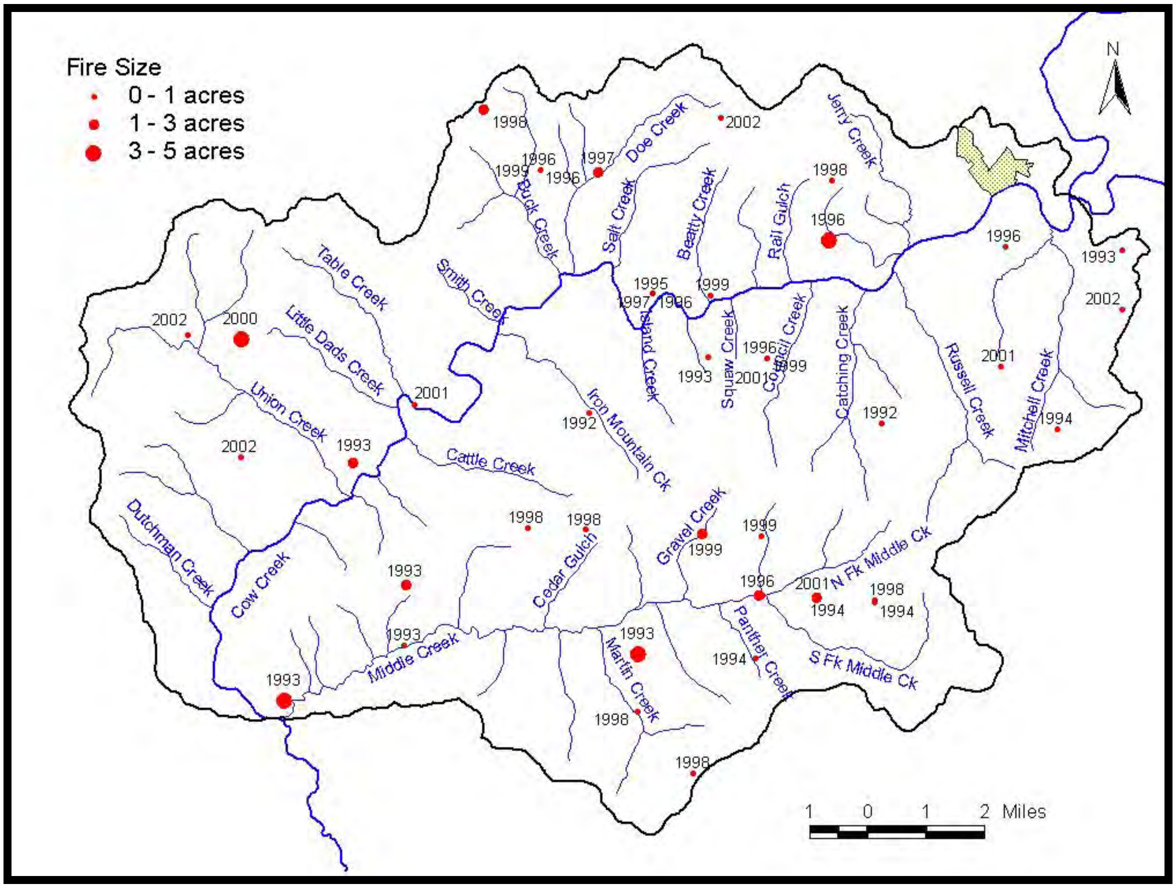
Urban Growth Boundary	**% commercial, industrial or residential area**	**Dominant type of land use**	**Estimate of % total impervious area**
Canyonville	78%	Urban	35%
Drain	76%	Residential	36%
Glendale	90%	Residential	27%
Myrtle Creek	74%	Residential	34%
Oakland	88%	Residential	38%
Riddle	67%	Residential	21%
Roseburg	75%	Residential	42%
Sutherlin	76%	Residential	38%
Winston	39%	Residential	18%
Yoncalla	93%	Residential	48%

Table 3-18: Dominant land use and estimated percent impervious area for seven cities in the central Umpqua Basin.[71]

Burns

Burned areas erode more easily than unburned areas because of the lack of vegetative cover and abundance of ash and charred material. Map 3-20 and Table 3-19 show the location, years, and size of non-permitted (accidental) fires in the Lower Cow Creek Watershed from 1991 through 2001.[72] 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.

[71] Barnes and Associates, Inc., provided the data in Table 3-18.
[72] Data are from the Douglas Forest Protective Association (DFPA).



Map 3-20: Wildfire location, year, and size in the Lower Cow Creek Watershed.

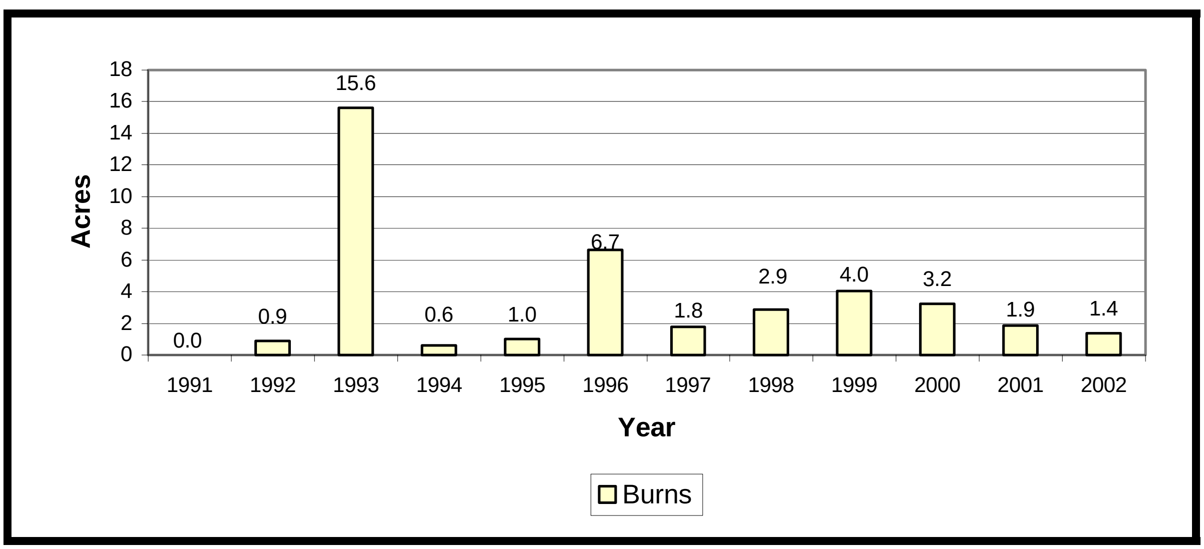


Table 3-19: Acres burned by year for the Lower Cow Creek Watershed.

3.3.8. 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).[73]

As shown in Table 3-9 on page 95, Cow Creek is 303(d) listed for chlorine. Ammonia is a potential concern. The abandoned Formosa Mine (also known as the Silver Butte Mine) located at the headwaters of Middle Creek is a source of metal contamination in Middle Creek and South Fork Middle Creek. A general description of these toxics and ODEQ's water quality monitoring findings are provided below.

Chlorine

In 1998, the final two stream miles of Cow Creek were 303(d) listed for chlorine. According to ODEQ, TMDL plan development for the stream showed chlorine toxicity associated with major discharges from Riddle. The beneficial uses affected by this toxicity are resident fish and aquatic life, anadromous fish passage, and drinking water. The Hach Corporation, which develops products for testing water quality, also provides educational information about various chemicals. Below is a description of chlorine from the Hach Corporation website (http://www.hach.com):[74]

> Chlorine is a greenish-yellow gas that dissolves easily in water. It has a pungent, noxious odor that some people can smell at concentrations above 0.3 parts per million. Because chlorine is an excellent disinfectant, it is commonly added to most drinking water supplies in the US…Chlorine is also used as a disinfectant in wastewater treatment plants and swimming pools. It is widely used as a bleaching agent in textile factories and paper mills, and it's an important ingredient in many laundry bleaches.

As shown in Table 3-20, chlorine is toxic to fish and aquatic life in very small concentrations. Chlorine becomes more toxic in low pH levels and in combination with other toxics, such as cyanide and ammonia.

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

[74] Select "visit H2OU," and then "educator resources," and "important water quality factors."

Amount of total chlorine (mg/l)	Effects on fish and aquatic life
0.006	Kills trout fry in two days.
0.01	Recommended maximum for all fish and aquatic life.
0.01	Kills chinook salmon and coho salmon.
0.01-0.05	Oysters have difficulty pumping water through their bodies.
0.02	Maximum brook and brown trout can withstand.
0.05	Maximum amount that can be tolerated by young Pacific salmon in the ocean.
0.1	Kills most marine plankton.
0.25	Only the hardiest fish can survive.
0.37	Maximum fish can tolerate.
1.0	Kills oysters.

Table 3-20: Effects of chlorine on fish and aquatic life.[75]

Ammonia

ODEQ TMDL plan development showed possible ammonia toxicity in the last two stream miles of Cow Creek. The toxicity is associated with discharges from Riddle. Ammonia can come from numerous sources. In nature, ammonia is formed by the action of bacteria on proteins and urea. The Kentucky Department of Natural Resources' River Assessment Monitoring Project summarizes ammonia sources and environmental impacts:

> About three-fourths of the ammonia produced in the United States is used in fertilizers either as the compound itself or as ammonium salts such as sulfate and nitrate. Large quantities of ammonia are used in the production of nitric acid, urea, and nitrogen compounds. It is used in the production of ice and in refrigerating plants. "Household ammonia" is an aqueous solution of ammonia. It is used to remove carbonate from hard water. Since ammonia is a decomposition product from urea and protein, it is found in domestic wastewater. Aquatic life and fish also contribute to ammonia levels in a stream.
>
> NH_3 is the principal form of toxic ammonia. It has been reported toxic to fresh water organisms at concentrations ranging from 0.53 to 22.8 mg/l. Plants are more tolerant of ammonia than animals, and invertebrates are more tolerant than fish. Hatching and growth rates of fishes may be affected. In the structural development, changes in tissues of gills, liver, and kidneys may also occur.[76]

[75] From the Hach Corporation website http://www.hach.com.

[76] From the website http://water.nr.state.ky.us/ww/ramp/default.htm. Select "what we are testing for" and "ammonia."

Like nitrates, ammonia may result in excessive plant growth, which in turn depletes oxygen levels. The danger ammonia poses for fish depends on the water temperature and pH along with the dissolved oxygen and carbon dioxide levels. In general, ammonia becomes more toxic as pH increases or water becomes warmer.

Contamination from the Formosa Mine
Since 1997, acidic water and metals from the Formosa Mine have been contaminating Middle Creek and South Fork Middle Creek.[77] Metal pollutants include arsenic, antimony, cadmium, copper, lead, manganese and nickel. These metals are reaching Middle Creek and South Fork Middle Creek through water flowing from the mine openings (adits) and from groundwater moving through the Formosa mine workings. The following information is from an ODEQ web site about the mine:

> The Formosa Abandoned Mine site near Riddle is a high priority for environmental investigation and cleanup. Toxic metals from this former mine site have contaminated about 18 miles of Middle Creek and South Fork Middle Creek. This contamination has severely harmed the ecosystem of these streams, including protected coho and steelhead salmon populations.
>
> Middle Creek is also a tributary of Cow Creek, which provides the City of Riddle with its drinking water supply. Fortunately, no adverse impacts from the mine have been observed in Cow Creek, indicating that the City of Riddle's drinking water supply is safe from Formosa Mine waste. DEQ declared the Formosa site a State Orphan site in March 2000, a designation that enabled DEQ to use Oregon's Orphan Account to fund short-term cleanup and follow-up environmental investigation work since late 2000.
>
> Money in the Orphan Site Account is reserved for high environmental priority sites when the party who is responsible for cleaning it up is either unknown, unable to pay, or unwilling to perform the work. In this case, the most recent owner of record is Formosa Explorations Inc., which declared bankruptcy in 1997.
>
> DEQ is also exploring grants and other funding sources to assist in funding the final cleanup action selected for the site. In the meantime, the upcoming work related to water quality monitoring, risk assessment, and final remedy selection will be paid from Oregon's Orphan Site Account, with technical support from [the] BLM.78

The upper reaches of Middle Creek and South Fork Middle Creek are toxic to fish and aquatic life. Figure 3-8 in section 3.5.2 shows that spawning coho have not been

[77] See sections 2.3.4, 2.4.2, and 2.6.1 for information on the history of the Formosa Mine.
[78] From the ODEQ website: http://www.deq.state.or.us/wr/LocalProjects/FormosaMine/Formosa.htm.

documented in the upper reaches of Middle Creek or South Fork Middle Creek since 1998. Despite substantial evidence of mine discharge contamination in Middle Creek and South Fork Middle Creek gathered over the last five years, neither stream is on the 2002 303(d) list for pH or metals. Greg Aitken with ODEQ expects both streams will be listed for one or both parameters in 2004.

Landowner perspectives
Galesville Reservoir, which is located in the headwaters of Cow Creek, is 303(d) listed for mercury. Watershed assessment meeting participants voiced concerns that Galesville Dam water releases will result in mercury contamination in Cow Creek below the dam. In addition, some landowners did not know that eating fish from the reservoir is a human health hazard.

3.3.9. Water quality key findings and action recommendations

Temperature key findings

- Results show that seven-day moving average maximum temperatures in Cow Creek were frequently above 64°F and have reached 81°F. Except for Upper Martin Creek, tributaries frequently had seven-day moving average maximums above 64° F in July and August. Consistently high stream temperatures would limit salmonid rearing in these reaches.
- 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

- Temperature and the levels of pH, nutrients, and dissolved oxygen are interrelated. In Cow Creek, pH levels violate water quality standards. Nutrient and dissolved oxygen levels do not appear to limit water quality in Cow Creek.
- Bacteria sampling does not consistently exceed water quality standards in Cow Creek. Additional monitoring is necessary to determine if Lower Cow Creek Watershed tributaries have water quality limiting bacteria levels.
- Chlorine levels exceed water quality standards in Cow Creek; ammonia levels are a potential concern.
- Acidic, heavy metal laden discharge and groundwater flow from the Formosa Mine site are causing 18 miles of Middle Creek and South Fork Middle Creek to be at least seasonally toxic to aquatic life. Formosa Mine pollutants have not been detected in Cow Creek.

Sedimentation and turbidity key findings

- Turbidity data indicate that usual turbidity levels in Lower Cow Creek should not affect 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

- Continue monitoring the Lower Cow Creek Watershed for all water quality conditions. Expand monitoring efforts to include small tributaries.
- Identify stream reaches 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.
- In very warm streams or where pH is a problem, increase shade by encouraging wide riparian buffers and managing for full canopies.
- Encourage landowner practices that will maintain the Lower Cow Creek Watershed’s low bacteria and nutrient levels:
  - Limit livestock stream access by providing stock water systems and shade trees outside of the stream channel and riparian zones. Fence riparian areas as appropriate.
  - Relocate structures and situations that concentrate domestic animals near streams, such as barns, feedlots, and kennels. Where these structures cannot be relocated, establish dense and wide riparian vegetation zones to filter fecal material.
  - Repair failing septic tanks and drain fields.
  - Use wastewater treatment plant effluent for irrigation.
  - Reduce chemical nutrient sources.
- Where data show that stream sediment or turbidity levels exceed established water quality standards, identify sediment sources such as urban runoff, failing culverts or roads, landside debris, construction, or burns. Take action to remedy the problem or seek assistance through organizations such as the UBWC, the Douglas Soil and Water Conservation District, and the Natural Resources Conservation Service (NRCS).
- Use the refined debris flow hazard data (soon 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.

- Cooperate with ODEQ as necessary to document and reduce contamination by toxics in Middle Creek and South Fork Middle Creek.

3.4. Water quantity

3.4.1. Water availability[79]

Data from the Oregon Water Resources Department (OWRD) has been used to determine water availability in the Lower 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 rights from streamflow. In most of the Umpqua Basin, including the Lower Cow Creek Watershed, there is no water available for new water rights from "natural" streamflow during the summer.[80] However, landowners with access to Cow Creek below Galesville Dam can purchase water rights from the reservoir.[81]

To analyze water availability, OWRD has divided the Umpqua Basin into water availability units, or WABs. The Lower Cow Creek Watershed consists of two WABs. WAB #300 encompasses all of Cow Creek and its tributaries within the watershed except Middle Creek. WAB #326 encompasses all of Middle Creek. Figure 3-3 shows surface water availability for the Cow Creek WAB. Appendix 9 shows surface water availability graphs for the Middle Creek WAB. The solid yellow area on Figure 3-3 is the 50% exceedence, or average, streamflow 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 streamflow, which is calculated by subtracting consumptive use from the average streamflow. In this WAB, instream water rights exceed average streamflow in October. Expected streamflow is less than average streamflow for the summer months and from January through April.

Oregon law provides a mechanism for temporarily changing the type and place of use for a certificated water right by leasing the right to an instream use. Leased water remains in-channel and benefits streamflows and aquatic species. The water right holder does not have to pay pumping costs, and, while leased, the instream use counts as use under the right for purposes of precluding forfeiture.

[79] 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 OWRD's Water Availability Report System database (http://www.wrd.state.or.us/).
[80] 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.
[81] Contact the Douglas County Natural Resources Department for more information on purchasing water from Galesville Reservoir.

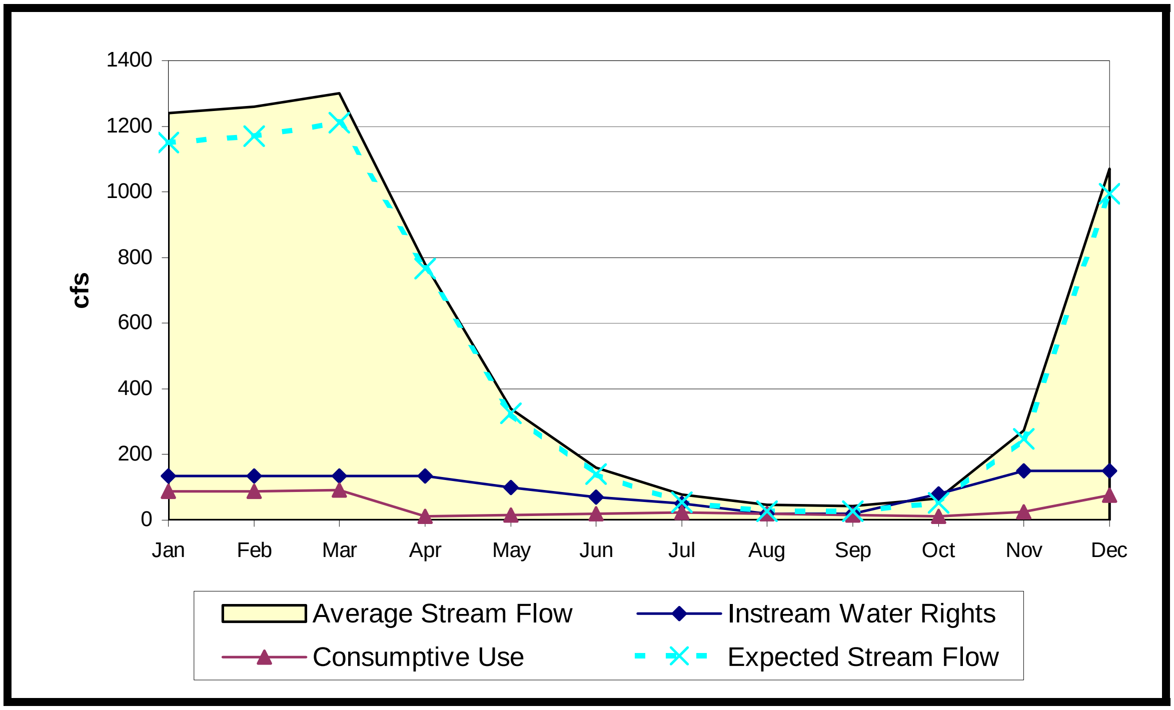


Figure 3-3: Water availability in the Cow Creek WAB (#300).

3.4.2. Water rights by use[82]

Table 3-21 shows consumptive use by category for the Lower Cow Creek Watershed. Appendix 10 lists the possible uses included in each category. Table 3-21 shows uncanceled water rights and does not indicate actual water consumption.[83]

For the Lower Cow Creek Watershed, the largest uses of water are "irrigation," "municipal," and "industrial." For the section of Cow Creek within the watershed, the largest uses are "irrigation," "industrial," and "municipal." The largest water uses for tributaries are "mining," "irrigation," and "miscellaneous." Many of the tributary mining rights are no longer active. All water secured for fish, agriculture, and mining are on tributaries. There are no rights secured for recreation, power, or wildlife uses in the Lower Cow Creek Watershed.

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

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

	TOTAL		**Cow Creek**		**Tributaries**	
Use	Cubic feet/sec	% Total	Cubic feet/sec	% of Cow Creek total	Cubic feet/sec	% of trib. total
Agriculture	0.02	0.1%	0	-	0.02	0.1%
Domestic	0.52	1.3%	0.06	0.3%	0.46	2.6%
Irrigation	13.48	34.9%	9.22	43.5%	4.26	24.5%
Industrial	5.88	15.2%	5.73	27.1%	0.15	0.9%
Fish	3.40	8.8%	0	-	3.4	19.5%
Livestock	0.14	0.4%	0.02	0.1%	0.12	0.7%
Municipal	6.41	16.6%	5.41	25.5%	1.00	5.7%
Mining	4.51	11.7%	0	-	4.51	25.9%
Misc. [84]	4.24	11.0%	0.75	3.5%	3.49	20.0%
Total	**38.60**	**100%**	**21.18**	**100%**	**17.42**	**100%**

Table 3-21: Water rights by use for the total Lower Cow Creek Watershed, Cow Creek, and tributaries.

3.4.3. Streamflow and flood potential

The US Geological Survey (USGS) stream gauge on Cow Creek near Riddle (gauge #14310000) has been active since 1954. Figure 3-4 charts the monthly historical mean flow for Cow Creek before Galesville Dam was in operation (1955 to 1985) and after the dam was active (1986 to 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. Figure 3-4 shows that since the construction of Galesville Dam, there has been greater streamflow in the months of June through September, but less streamflow from October through May.

[84] In Lower Cow Creek tributaries, the miscellaneous category includes water storage and forest management. For Cow Creek, the miscellaneous category includes fire protection and pollution abatement.

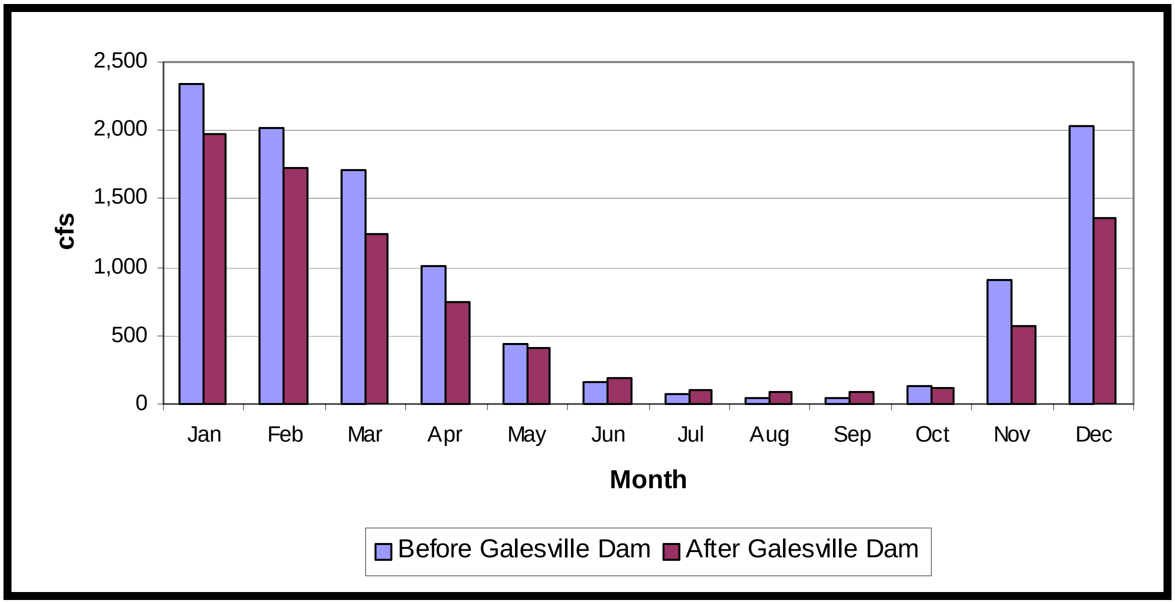


Figure 3-4: Mean monthly water flow for Cow Creek near Riddle (gauge #14310000).

Figure 3-5 shows peak flow data for Cow Creek near Riddle from water years 1951 through 2001, excluding 1952 and 1953.[85] Each point represents the highest recorded streamflow during the water year. Figure 3-6 shows the average annual streamflow since 1955. Average annual streamflow and peak flow events vary from year to year. Although in general, peak flow trends follow overall annual average streamflow trends, there are exceptions; 1996 had the highest average annual streamflow recorded to date (1,515 cfs) but a less-than-average peak flow (15,000 cfs).[86]

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[85] 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.

[86] Average peak flow for 1951 and 1955 through 2001 is 19,192 cfs.

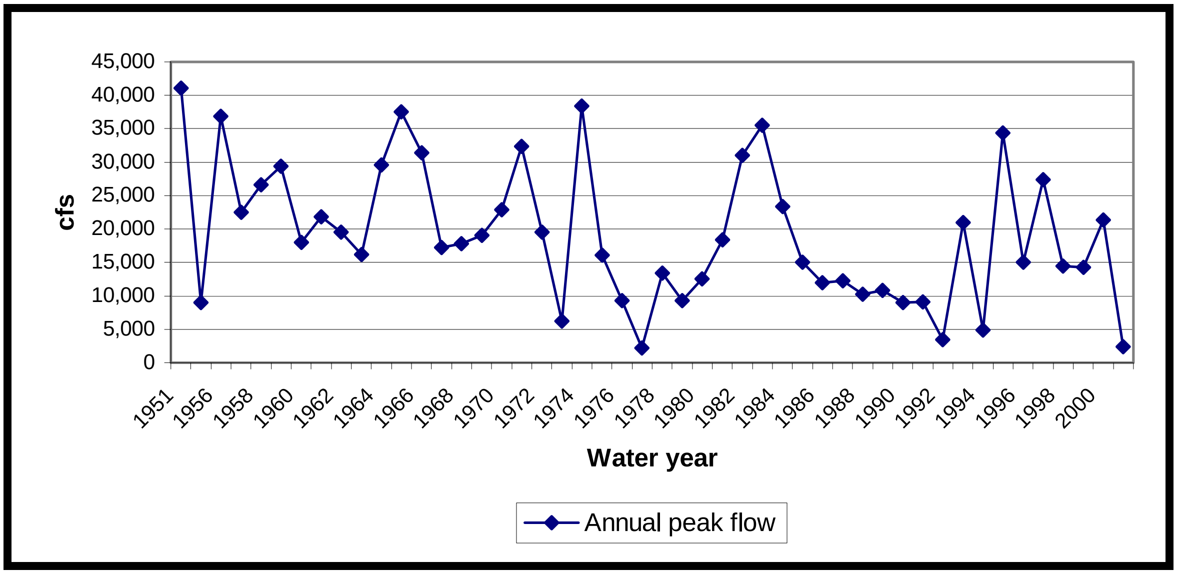


Figure 3-5: Peak flow for Cow Creek near Riddle (gauge #14310000).

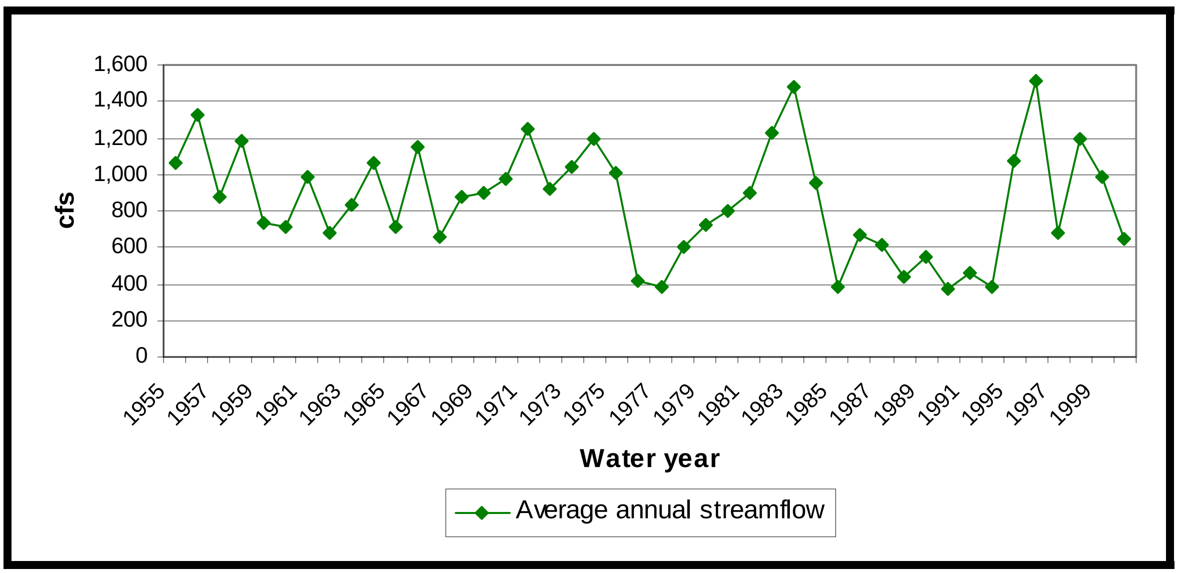


Figure 3-6: Average annual streamflow for Cow Creek near Riddle (gauge #14310000).

Influences on flood potential

Approximately 40% of the Lower 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 warmer 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, such as South Fork Middle Creek, are more susceptible to rain-on-snow events than lower elevation streams.

Road density can also influence peak flows. Table 3-22 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 streamflow and peak events is debatable.

Road type	Road miles/ square mile
Paved	0.3
Gravel	2.9
Dirt	2.0

Table 3-22: Miles of road per square mile for surfaced and unsurfaced roads in the Lower Cow Creek Watershed.

3.4.4. Water quantity key findings and action recommendations

Water availability and water rights by use key findings

- In both Lower Cow Creek Watershed WABs, instream water rights are close to or exceed average streamflow during one or more months of the year.
- During the summer, there is no “natural” streamflow available for new water rights. Landowners below Galesville Dam with access to Cow Creek can purchase water from Galesville Reservoir.
- The largest uses of water in the Lower Cow Creek Watershed are “irrigation,” “municipal,” and “industrial.” The largest water uses for tributaries are “mining,” “irrigation,” and “miscellaneous.”

Streamflow and flood potential key findings

- Since the construction of Galesville Dam, there has been greater streamflow in the months of June through September, but less streamflow from October to May.
- No flooding trends were determined from the records to date.
- The degree to which road density and the TSZ influence flood potential in the Lower Cow Creek Watershed is unknown at this time.

Water quantity action recommendations

- o Reduce summer water consumption through instream water leasing and by improving irrigation efficiency.
- o Educate landowners about proper irrigation methods and the benefits of improved irrigation efficiency.
- 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 3-23 lists the fish species in the Lower Cow Creek Watershed that have viable, reproducing populations or annual runs. Spring chinook have been documented in the watershed but their presence is intermittent and does not constitute a salmon run.[87] Largescale suckers and Umpqua pikeminnows are generally only found in the lower third of Cow Creek. Smallmouth bass have been found as far as Salt Creek. Other warm water fish, such as largemouth bass (*Micropterus salmoides)* and yellow perch (*Perca flavescens*) have also been reported in the watershed. These fish are most likely introduced to watershed streams through private ponds, or migrate into the watershed from the South Umpqua River. Lower Cow Creek Watershed stream temperatures are generally too cold for these species to establish reproducing populations.

Common Name	***Scientific Name***
Steelhead	*Oncorhynchus mykiss*
Coho salmon	*O. kisutch*
Chinook (fall)	*O. tshawytscha*
Cutthroat trout	*O. clarkii*
Western brook lamprey	*Lampetra richardsoni*
Pacific lamprey	*Lampetra tridentata*
Umpqua dace	*Rhinicthys cataractae*
Sculpin	*Cottus sp.*
Redside shiner	*Richardsonius balteatus*
Speckled dace	*Rhinicthys osculus*
Umpqua pikeminnow	*Ptychocheilus oregonensise*
Largescale sucker	*Catostomus macrocheilus*
Smallmouth bass	*Micropterus dolomieu*
Brown bullhead	*Ameiurus nebulosus*

Table 3-23: Fish species with established populations or runs within the Lower Cow Creek Watershed.

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 South Umpqua River 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.

3.5.2. Fish distribution and abundance

Information on fish distribution and abundance within the Lower 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

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

be included in the assessment. More information about non-salmonid fish may be available in the future.

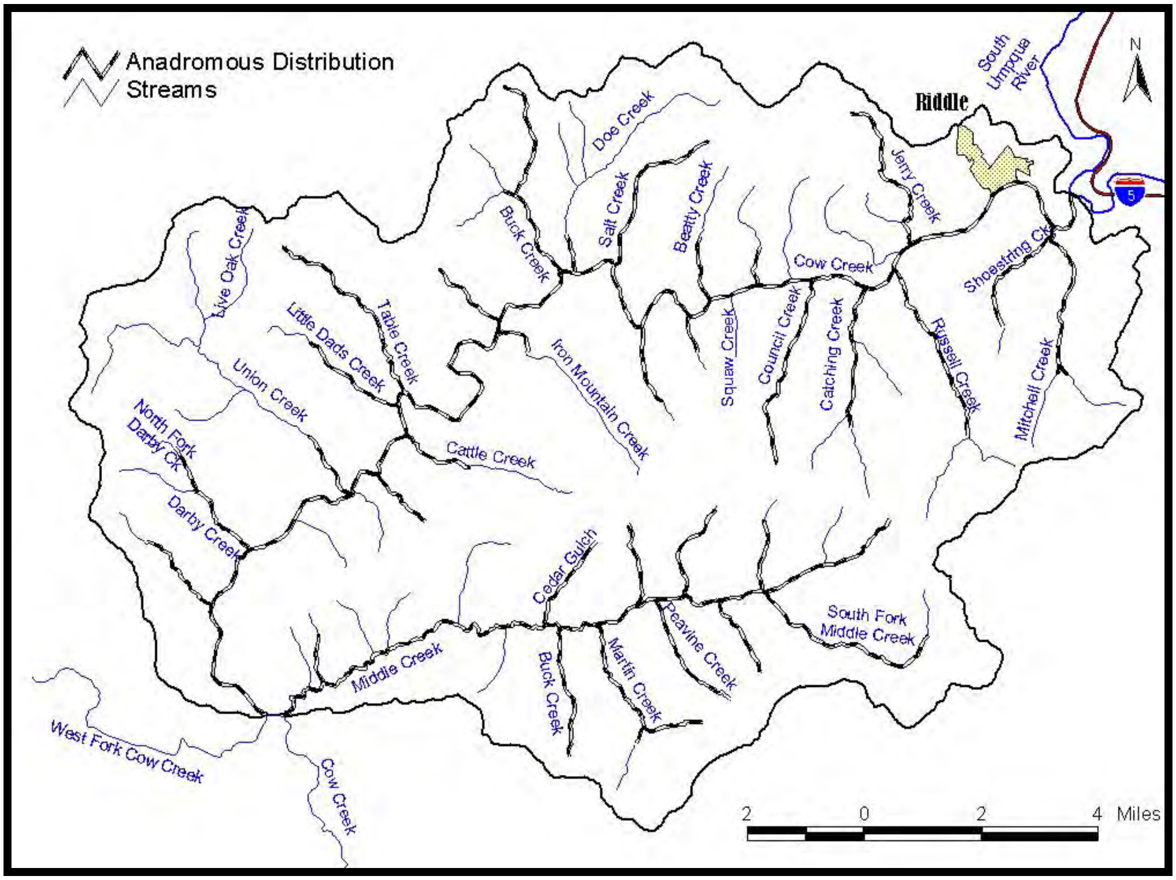
Anadromous salmonid distribution

The Oregon Department of Fish and Wildlife (ODFW) has developed anadromous salmonid distribution maps based on fish observations, assumed fish presence, and habitat conditions.[88] 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 adequate habitat for a given salmonid, even if there have been no fish sightings and the stream 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 105.3 stream miles within the Lower Cow Creek Watershed, or 62.2% of the total stream miles visible on the map below.[89] Map 3-21 shows the distribution of anadromous salmonids within the watershed and Table 3-24 lists the total stream miles used by each species. Total stream miles with anadromous salmonids does not equal the sum of miles used by species because many species distributions overlap (see Appendix 11). Salmonids will use many of the same stream reaches at different times of the year.

[88] Maps are available from the ODFW website http://www.streamnet.org/online-data/GISData.html.

[89] See section 1.2.5 on page 21 for more information about the stream map and total stream miles.



Map 3-21: Anadromous salmonid distribution within the Lower Cow Creek Watershed.

	Steelhead	Coho	Fall chinook
Stream miles	104.1	78.3	30.3
% of total stream miles	61.5%	46.3%	17.9%

Table 3-24: Miles of stream supporting anadromous salmonids in the Lower Cow Creek Watershed.

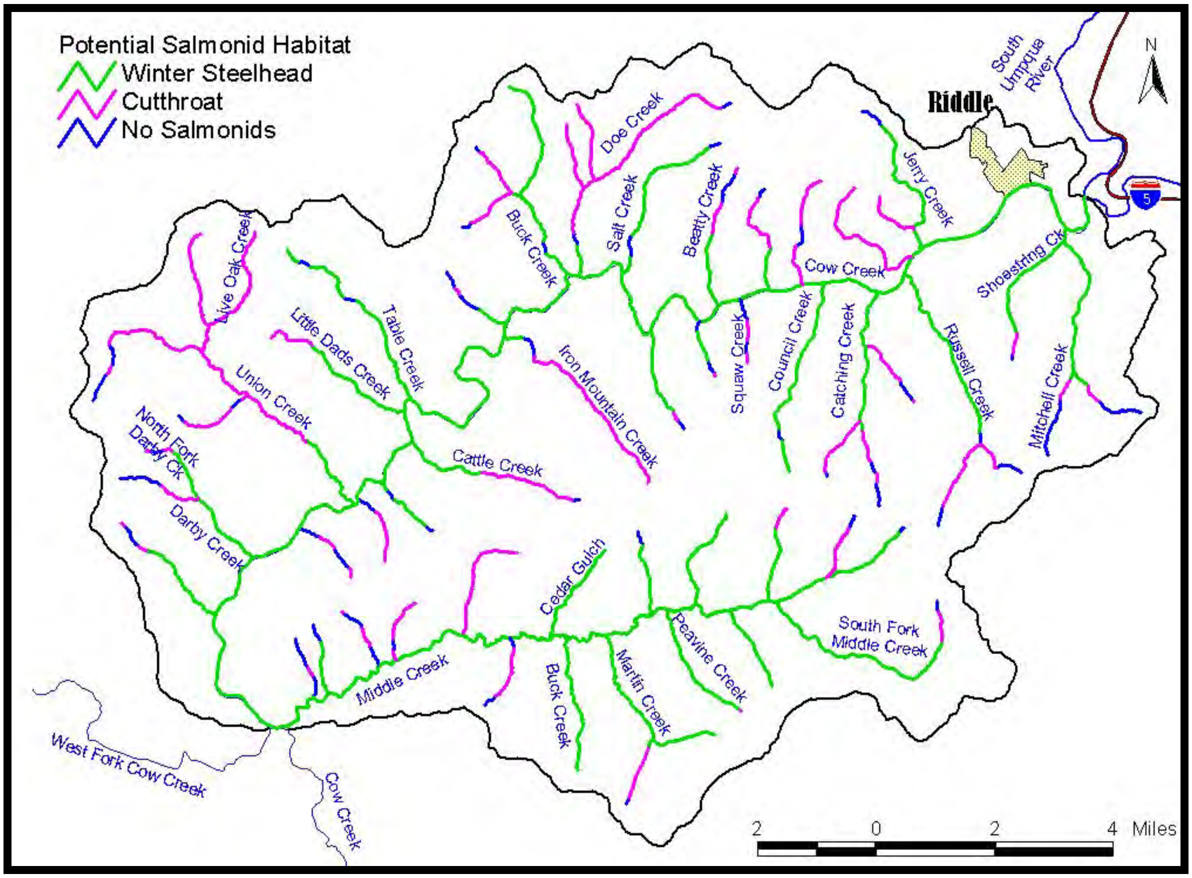
Resident cutthroat distribution

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.[90] Map 3-22 shows streams with gradients that are less than 15% and are

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

beyond winter steelhead distribution. Streams such as the upper reaches of Catching Creek may provide suitable habitat for cutthroat trout. However, there are many factors other than stream gradient that determine fish habitat suitability.

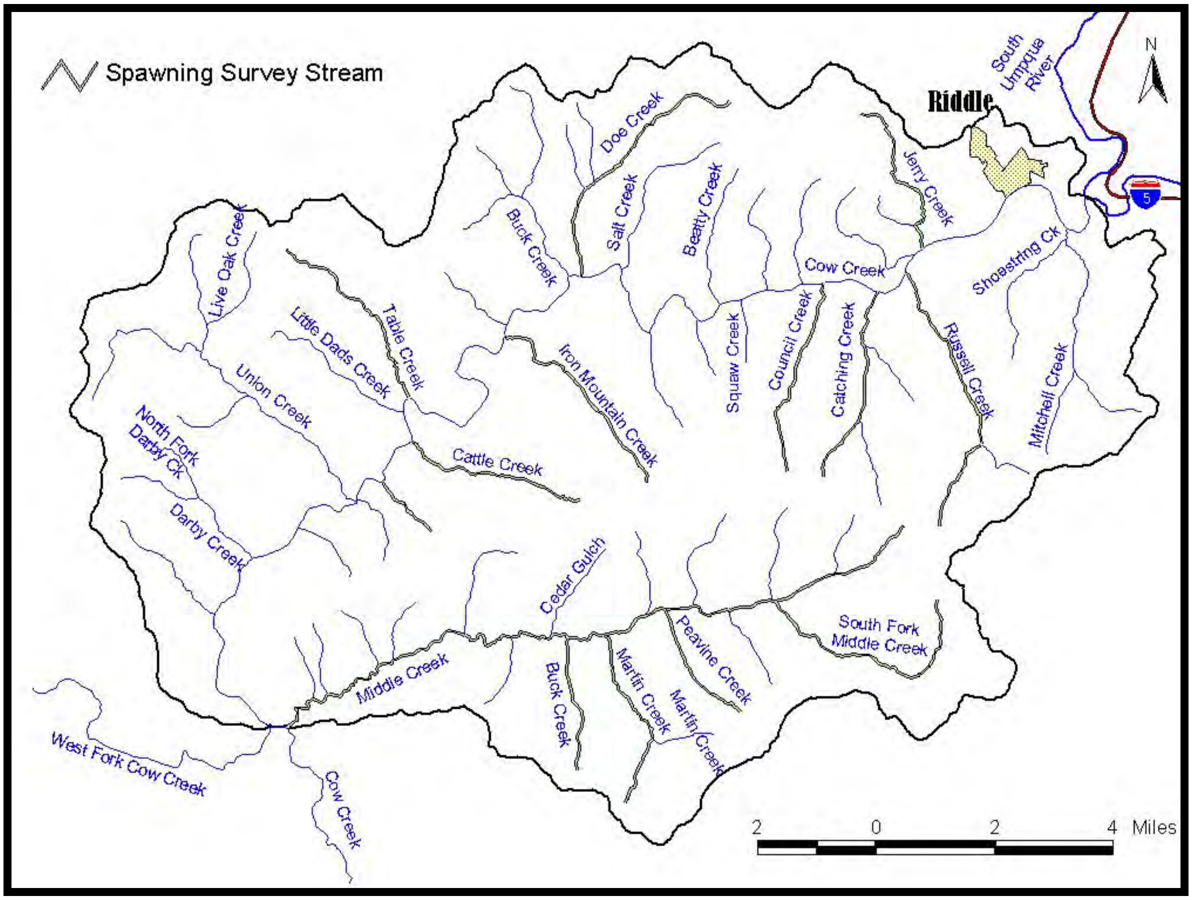


Map 3-22: Potential resident and anadromous salmonid habitat in the Lower Cow Creek Watershed.

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 Lower Cow Creek Watershed from 1992 through 2001.[91] Map 3-23 shows the surveyed streams and stream reaches.

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



Map 3-23: Lower Cow Creek Watershed coho spawning survey locations.

Figure 3-7 shows the maximum number of live and dead coho seen per mile on a given day for some mainstem Cow Creek 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 within individual streams fluctuates annually. Catching Creek had 15 coho per mile in 1996 and only one in 1997. More monitoring data are needed to draw conclusions about coho spawning in the watershed.

Figure 3-8 shows coho spawning data for Middle Creek and its tributaries. As discussed in section 3.3.8, 18 miles of Middle Creek and South Fork Middle Creek are at least seasonally toxic to fish and aquatic life because of heavy metal pollution from the Formosa Mine site. No coho have been documented in the fourth reach of Middle Creek or in the fifth reach of South Fork Middle Creek since 1998.

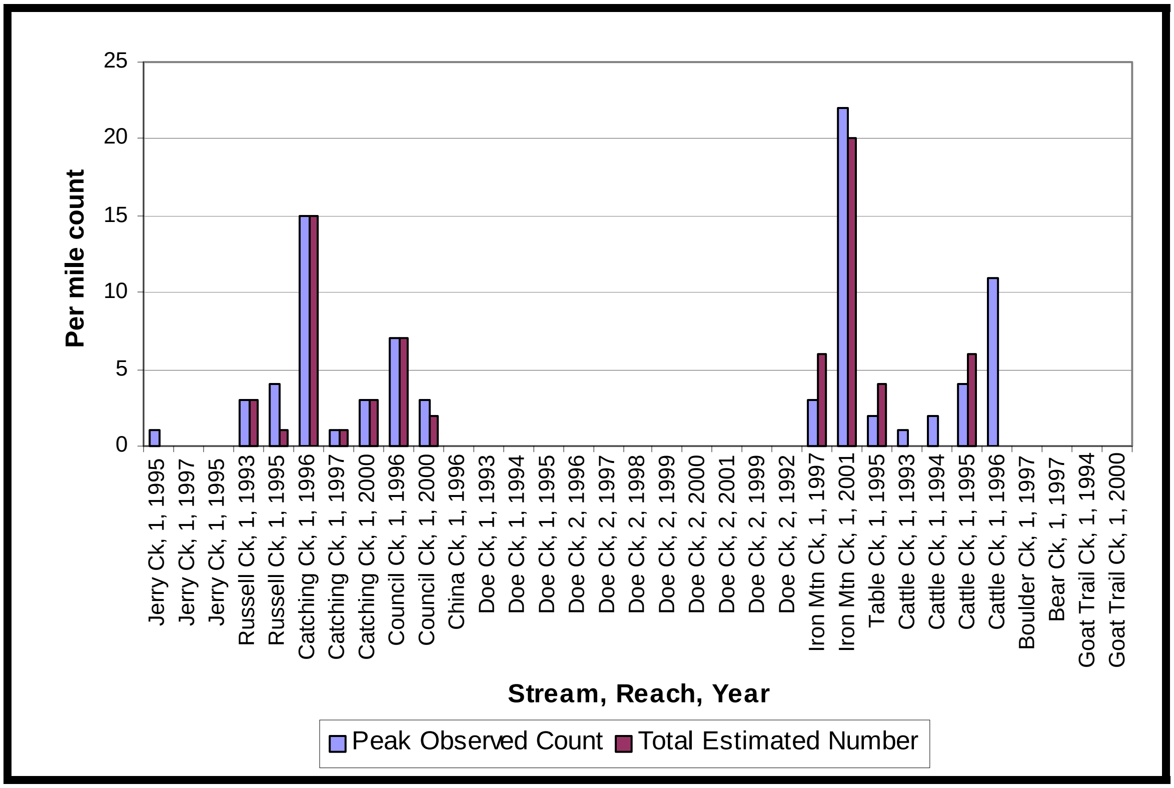


Figure 3-7: Coho spawning survey data for streams within the Lower Cow Creek Watershed excluding Middle Creek and its tributaries.

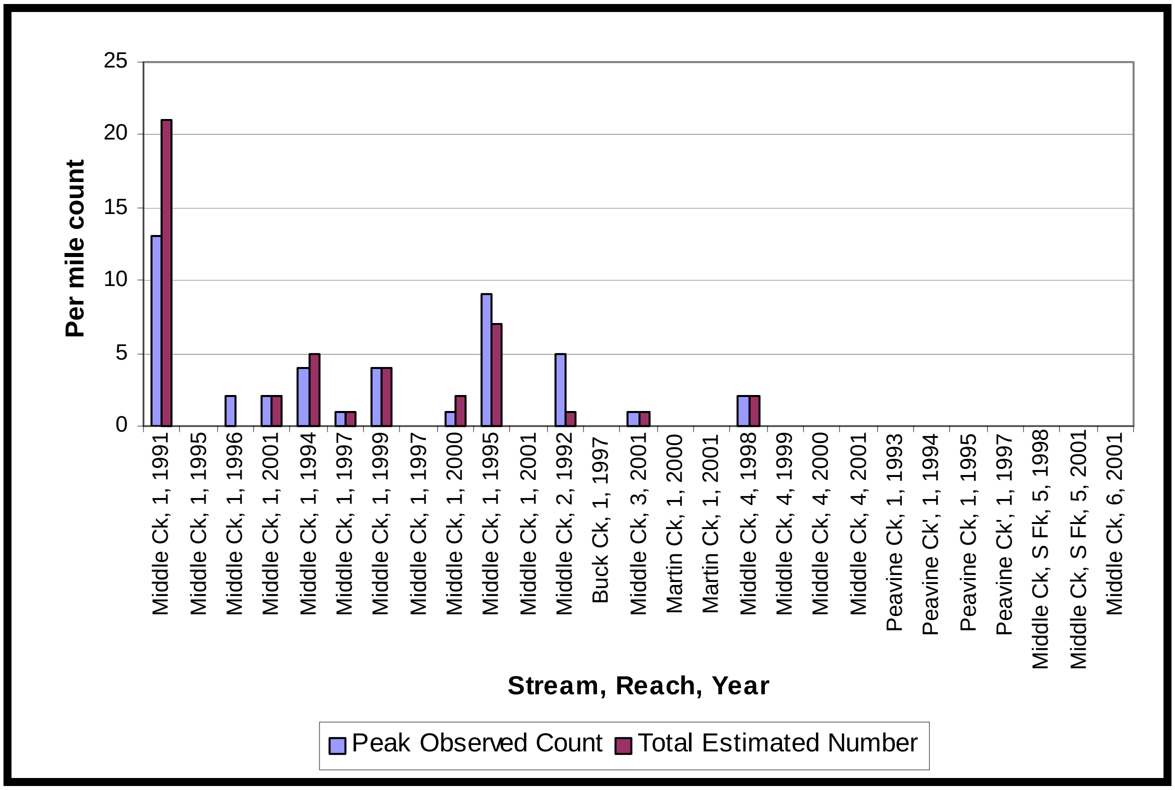


Figure 3-8: Coho spawning survey data for Middle Creek and its tributaries.

During coho spawning surveys, surveyors record the presence of other salmonid species. No steelhead or chum have been observed during the surveys. Table 3-25 shows the stream, year, and peak count for chinook.

Stream	Spawning year	Peak chinook count
Catching Creek	1996	19
Iron Mountain Creek	2001	1
Middle Creek	1996	2

Table 3-25: Chinook observed during coho spawning surveys.

Annual fall chinook counts

ODFW conducts annual aerial counts of fall chinook fish and fall chinook redds in the South Umpqua River and in Cow Creek.[92] Cow Creek is surveyed from the mouth to Galesville Dam. Flights are normally made twice a year, both before and after the height of the run. Counts are based on the average count for both flights.

Fall chinook adult fish have been surveyed since 1983. From 1983 through 1997, ODFW fish surveyors divided Cow Creek into reaches based on permanent features that are

[92] Annual fall chinook count data can be requested from the Oregon Department of Fish and Wildlife Roseburg District Office.

visible from a helicopter, such as the confluence with West Fork Cow Creek. Therefore, these counts can be used to estimate chinook spawning in the Lower South Umpqua Watershed.

Figure 3-9 shows annual fall chinook fish counts for the Lower Cow Creek Watershed and for all of Cow Creek below Galesville Dam from 1983 through 2000. There were no fish surveys conducted in 1985. Within the Cow Creek system, from 85% to 100% of fall chinook adult fish were documented within the Lower Cow Creek Watershed. The highest Lower Cow Creek fish count was 1,491 fish in 1996, and the lowest count was 130 fish in 1988. Figure 3-10 shows fall chinook counts by stream segment from 1983 through 1997, excluding 1985. Most of the fish in the Lower Cow Creek Watershed were documented between the mouth and Doe Creek.

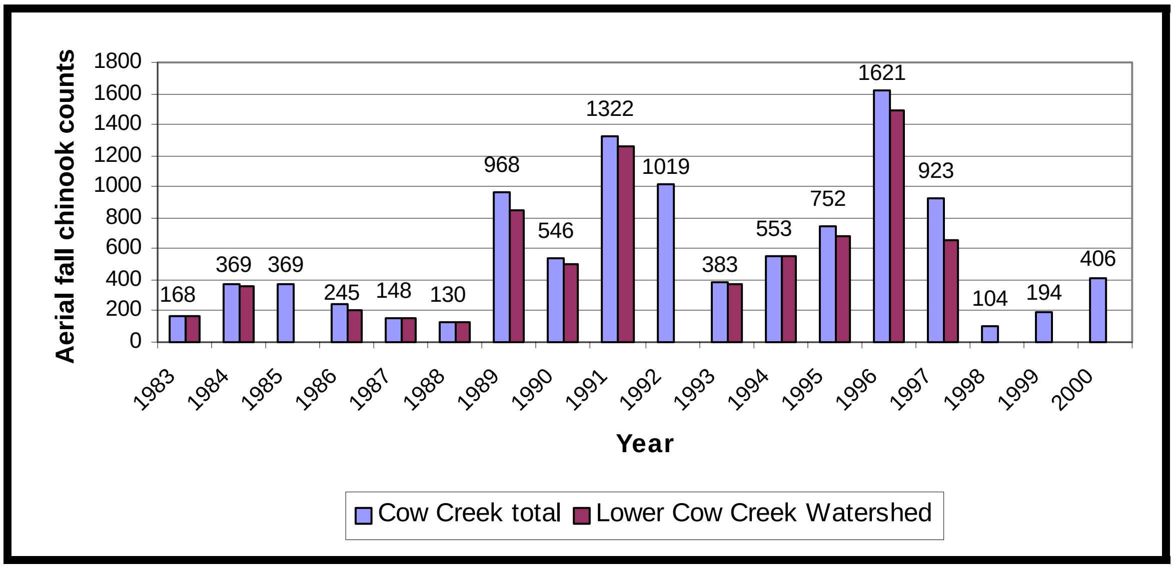


Figure 3-9: Total fall chinook fish counts for Cow Creek and for the Lower Cow Creek Watershed.

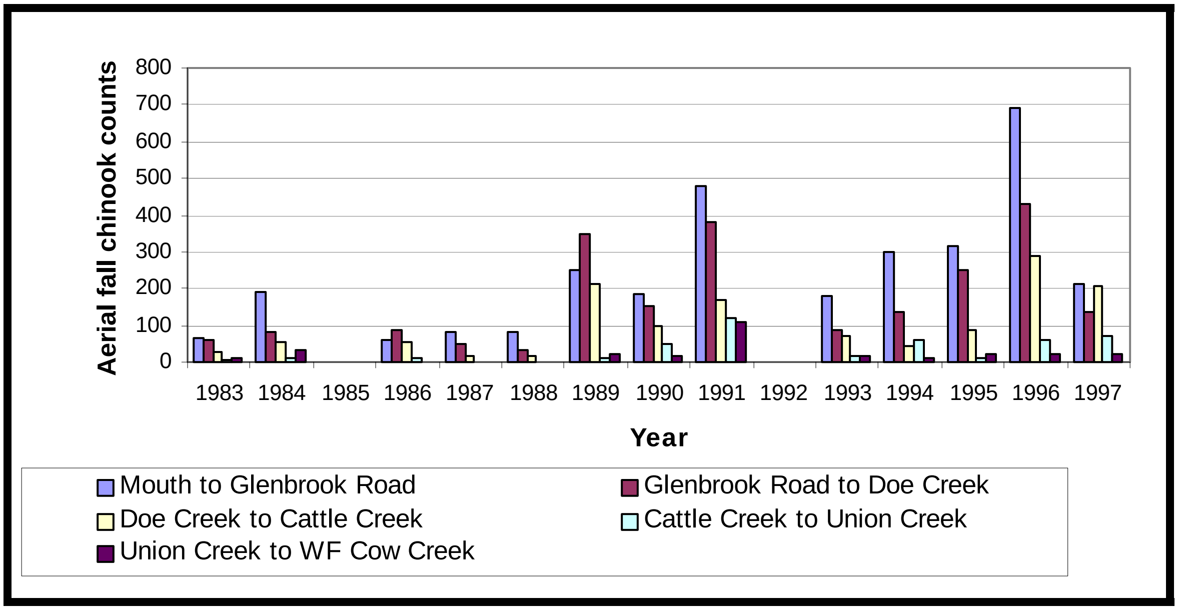


Figure 3-10: Fall chinook counts by stream segment in the Lower Cow Creek Watershed.[93]

Figure 3-11 shows annual fall chinook redd count data for Cow Creek from 1978 through 2001. Data for the South Umpqua River are included for comparison. Fall chinook redd data are not reported by watershed or stream segment, so the number of redds counted in the Lower Cow Creek Watershed is unknown.

The number of fall chinook redds counted in Cow Creek fluctuates each year. The highest count was 1,628 redds in 1996. The lowest count was zero redds in 1979. Overall, the number of redds appears to be increasing, as indicated by the black trend line in Figure 3-11.

[93] 1992 data were not reported by reach.

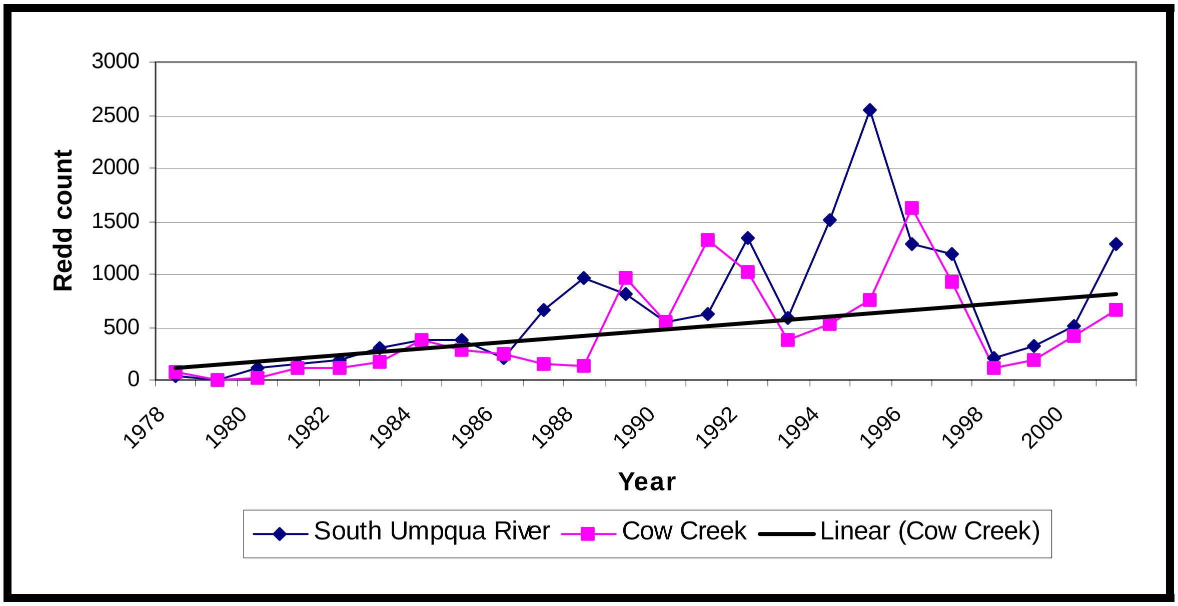


Figure 3-11: Annual fall chinook redd counts for Cow Creek and the South Umpqua River.

From 1998 through 1999, ODFW's Pacific Salmon Commission (PSC) undertook a study to calibrate fall chinook aerial redd counts to actual population levels using a mark-recapture experiment on the South Umpqua River. The study concluded that there are 3.86 adult fish for each counted redd. Figure 3-12 estimates the fall chinook run size in Cow Creek using the PSC 3.86 estimate. In 1996, there may have been over 6,000 fall chinook present in the river. ODFW fish biologists believe the ratio of redds to adult fish is higher in Cow Creek than the South Umpqua River.

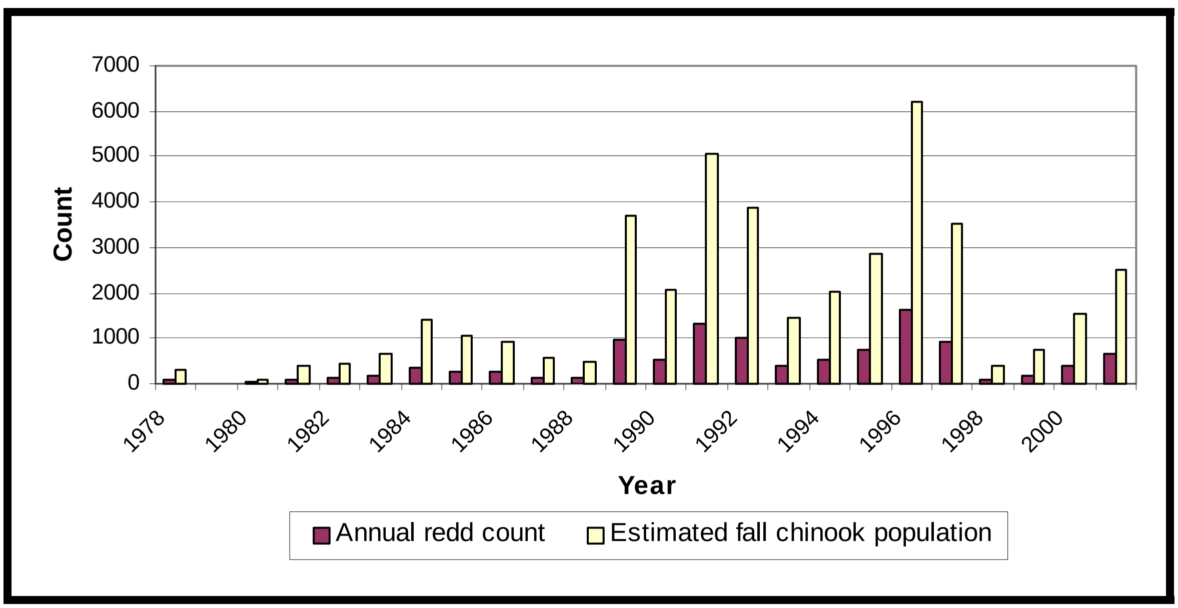


Figure 3-12: Estimated fall chinook population for Cow Creek.

Migrating juvenile salmonid populations

The US Forest Service (USFS), the Bureau of Land Management (BLM), and ODFW are working together to collect long-term information on the movements of juvenile salmonids out of their natal streams.[94] Juvenile salmonid data are primarily collected with five-foot rotary screw traps, which capture small fish. From data collected during trap operation, fisheries biologists estimate the number of juvenile fish passing by the trap during their outward migration.

In 2001, ODFW operated a screw trap in Cow Creek near the City of Riddle. The trap operated from March 26 through May 27, 2001. Figure 3-13 shows by species the estimated number juvenile of fish passing the rotary trap during the spring. In 2001, fall chinook smolts constitute the greatest number of migrating juvenile salmonids. More annual data are needed to determine any trends within the watershed.

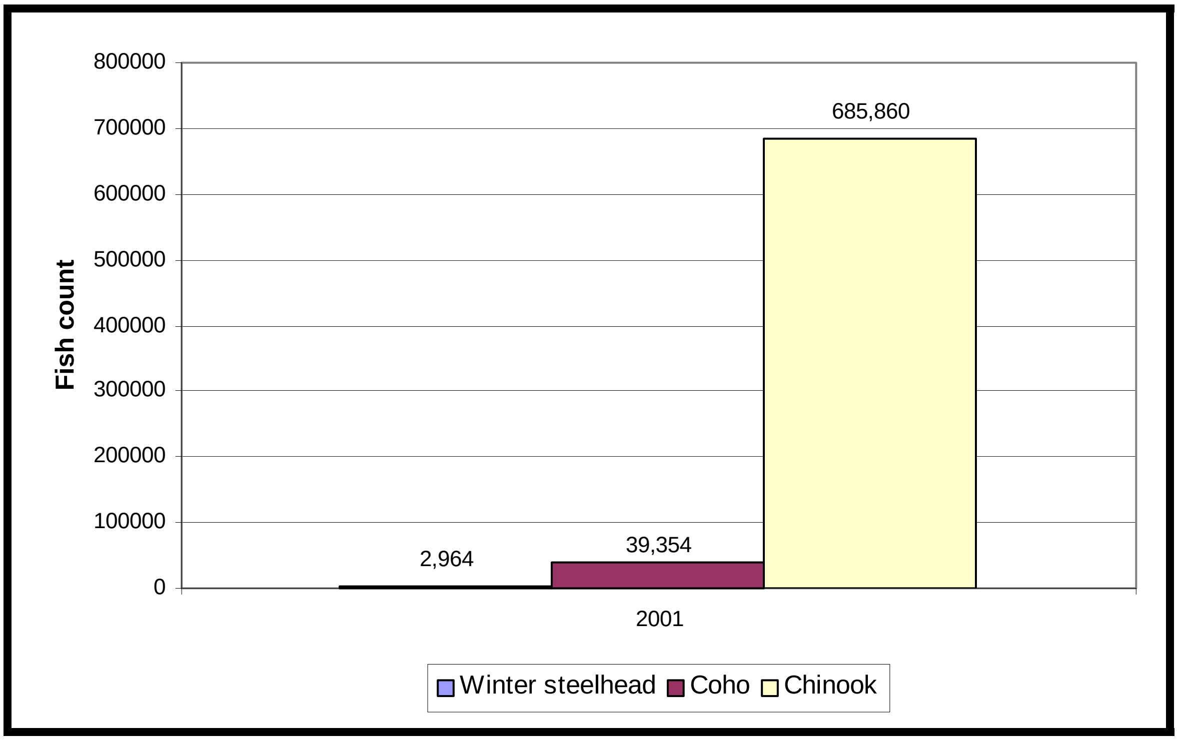


Figure 3-13: Estimated number of out-migrating juvenile chinook, coho, and steelhead.

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

[94] "Natal streams" refers to the streams where juvenile salmonids hatched.

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 Lower Cow Creek Watershed with annual runs are coho, steelhead, fall chinook, and Pacific lamprey. Cutthroat trout are the only resident salmonid.
- Although many Lower 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.
- Largemouth bass, smallmouth bass, and other non-native species have been reported in the lower reaches of Cow Creek. These fish are most likely introduced to watershed streams through private ponds, or migrate into Cow Creek from the South Umpqua River during the summer months. Stream temperatures are generally too cold for these species to establish reproducing populations throughout the watershed.
- More quantitative data are needed to evaluate salmonid abundance and the distribution and abundance of non-salmonid fish in the watershed.
- The majority of fall chinook in the Cow Creek system are found within the Lower Cow Creek Watershed.
- The number of redds in the Cow Creek system appears to be increasing.
- 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 and resident participation in fish monitoring activities.
- o Conduct landowner education programs about the potential problems associated with introducing non-native fish species into Umpqua Basin rivers and streams.
- o Encourage landowner participation in activities that improve freshwater salmonid habitat conditions.

4. Current Trends and Potential Future Conditions

This chapter evaluates the current trends and the potential future conditions that could affect important stakeholder groups in the watershed.

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. Overview

There are many commonalities among the identified stakeholder groups. All landowners are concerned that increasing regulations will affect profits, and all have to invest more time and energy in the battle against noxious weeds. The non-industrial private landowners are concerned about the global market's effect on the sale of local commodities. These groups also struggle with issues surrounding property inheritance. Some groups are changing strategies in similar ways; community outreach is becoming increasingly important for both the Oregon Department of Environmental Quality (ODEQ) and industrial timber companies. Overall, the future of fish habitat and water quality conditions in the Umpqua Basin is bright. According to ODEQ, basin-wide conditions are improving and have the potential to get better.

4.2. Stakeholder perspectives[95]

4.2.1. The City of Riddle[96]

City growth

In the Lower Cow Creek Watershed, the City of Riddle is the only incorporated city. Over the past 20 years, most growth in the Riddle area has occurred outside of the city limits and urban growth boundary (UGB).[97] This is because the city has been unable to expand its residential development because it has been "landlocked" by its UGB. State law permits changes to a city's UGB to accommodate growth when there is no developable land available within the current UGB or city limits. In the 1950s, approximately 126 lots plotted east of the city within the urban growth boundary were purchased for development. The original developer went bankrupt; land was sold to the county and eventually purchased by individual citizens. The new owners were unable to finance the land for residential expansion. As a result, the city has been unable to change its UGB to accommodate any new growth because, in the view of the State of Oregon, developable land was still available within the existing UGB.

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[95] 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 4.2.

[96] This information is primarily from an interview with Bill Duckett, Mayor, City of Riddle.

[97] The corporate city limit is the boundary where the city officially ends. The urban growth boundary delineates the area that sometime in the future could be annexed into the city to accommodate its 20-year projected population growth. Usually, areas within the UGB have access to city services like water, sewer, and electricity.

New owners purchased some of the lots two years ago, and the plans are for the area to be developed for residential homes. The area will target middle- and upper middle-income families and retirees. The city believes that Riddle's small-town atmosphere, low crime rate, and close-knit community, along with its mild weather and proximity to recreational opportunities, make it attractive to new residents. The city hopes that this new residential development will result in a 20% population increase over the next 10 years. If development plans fail, and the area remains as it was, the city expects a 10% increase over the next 10 years.

Business and industry

In 2003, the cities of Riddle, Myrtle Creek, Canyonville, Glendale, and Winston began working together to attract more tourism and industry to southern Douglas County. This group believes that the area's proximity to the Oregon Coast and Cascade Mountains makes the region attractive to visitors. By increasing visitors, the group hopes to also attract businesses and improve the economic viability of all five cities. This group is new and does not yet have a strategic plan in place. One consideration is to establish events, such as a renaissance festival, that would attract tourists from the Seven Feathers Hotel Casino and Resort outside Canyonville.

There is industrial land within and around the City of Riddle, and the city hopes to attract diverse industries to the area. Riddle is located approximately halfway between Seattle and Los Angeles, two of the West Coast's largest ports. Riddle and other south county cities believe that this geographical advantage, along with their proximity to I-5, makes the area suitable for industrial development.

The city also hopes to bring in smaller businesses, including shopping malls and grocery stores. Mayor Duckett does not favor attracting "mega-stores" such as Wal-Mart to Riddle; he believes mega-stores hurt small communities by out-competing small businesses that provide living wages. One difficulty faced by south county cities is that many businesses favor locating close to Roseburg. As the largest city in Douglas County, Roseburg is home to the area's hospital, state and federal offices, and shopping centers, making it very attractive to new businesses. South county cities hope to work together to change this trend.

Utilities

Cow Creek is the source of water for the City of Riddle. The city has one of the oldest rights on the river. The Cow Creek water right, along with water purchased from Galesville Reservoir, is sufficient to fulfill the city's current and projected future water needs. Two years ago, the City of Riddle completed a new water intake plant that is one of the best in the county. The plant can easily accommodate doubling the city's current water needs and provide water beyond that with moderate upgrades to the system. The system can also detect water contaminants and will shut down to prevent contaminated water from entering the city's water supply.

Plans are in place to upgrade the city's wastewater system. The city has just completed an assessment of its sewer lines. Once the findings are analyzed, the city will prioritize sewer lines for replacement and start upgrading the current system. The city also has plans to upgrade its wastewater treatment plant. The current plant has difficulties accommodating high winter flows. Once the sewer line analysis is complete, the city will turn its attention to the wastewater treatment plant and begin the upgrading process.

The future of Riddle

In the next 20 years, the City of Riddle hopes to have developed its business district into an attractive shopping area. Plans are in place to make this a reality; the city, high school, and local businesses are working together to establish a downtown park where visitors and shoppers can visit and rest. The city hopes to reestablish a local grocery store and bring more businesses to its downtown area. There are also plans to put signs along I-5 and the Riddle Bypass road directing visitors to the city; currently, some tourists believe the gas station and McDonald’s on exit 103 comprise the City of Riddle.

The cities of Riddle, Myrtle Creek, and Canyonville have discussed pooling their resources and establishing a large, south county police force. Myrtle Creek has its own force, while Canyonville and Riddle rely upon the Douglas County Sheriff. For a single small city, maintaining a police force is very costly. Combining resources would permit the cities to have a large, locally controlled police force. Currently, no plans are in place to develop a south county police force.

When asked to identify factors that could have a major impact on the City of Riddle, Mayor Duckett identified economic changes. Another event like the September 11, 2001 terrorist attacks would slow down the economy, making economic development extremely difficult. However, Mayor Duckett pointed out that in the event of a crisis, Riddle would be in better shape than many cities. Due to a reduction in the timber industry over the last 20 years, the City of Riddle and its citizens have become accustomed to working on a very tight budget. Currently, the city’s streets and water supply are in good shape. The wastewater system will be improved within the next five years. In the event of a crisis, Riddle would be very capable of “sitting tight” until hard times passed.

Should the economy pick up, Mayor Duckett believes that the future is bright for Riddle. Even if Riddle fails to attract more industry, the city’s location and proximity to other larger cities would make it a suitable “bedroom community.” Although this is not the preferred future for the city, it would be acceptable.

4.2.2. Agricultural landowners[98]

Farmers in the Umpqua Basin/Douglas County area produce a variety of agricultural goods, including corn, beans, alfalfa, peaches, strawberries, filberts, and grapes for wine. Livestock operations mostly raise beef cattle and sheep, with a small number of poultry

[98] The following information is primarily from interviews with Tom Hatfield, the Douglas County Farm Bureau representative for the Umpqua Basin Watershed Council, and Kathy Panner, a member of the Douglas County Livestock Association. Shelby Filley from the Douglas County Extension Service and Stan Thomas from the USDA Wildlife Services provided additional information.

operations.[99] Only 6% of the Lower Cow Creek Watershed is zoned for agriculture (see Map 1-8 on page 26). Most agricultural lands are privately held and located near the mouth of the river.[100] Barriers to farmer and rancher participation in fish habitat and water quality activities are limited time, limited money, and in many cases low awareness or understanding of restoration project requirements, benefits, and funding opportunities.

Agricultural producers

Local observation suggests that there are four types of agricultural producers in the Umpqua Basin/Douglas County area. The first group is people who have been very successful in purchasing or leasing large parcels of lands, sometimes thousands of acres, to run their operations. This group generates all their income from agricultural commodities by selling very large quantities of goods on the open market. The second group is medium- to large-sized operators who are able to support themselves by selling their products on the direct market (or “niche” market). This group is able to make a profit on a smaller quantity of goods by “cutting out the middlemen.” The third group is smaller operators who generate some income from their agricultural products, but are unable to support themselves and so must have another income as well. The last group is “hobby” farmers and ranchers who produce agricultural goods primarily for their own enjoyment and have no plans in place to make agricultural production their primary income source. Agricultural hobbyists often produce their goods to sell or share with family and friends. In many cases, members of this group do not identify themselves as part of the agricultural community. Observation suggests that in Douglas County the few very large operators are continuing to expand their land base. At the same time, smaller operators who hold outside jobs and agricultural hobbyists are becoming more common.

Factors influencing farmers and ranchers

Weeds

One concern for farmers and ranchers is weeds. There are a greater variety and distribution of weeds now than there were 20 years ago, including gorse, Himalayan blackberry, a variety of thistles, and Scotch broom.[101] Many of these species will never be eradicated; some, like Himalayan blackberries, are too widespread, and others, like Scotch broom, have seeds that can remain viable for at least 30 years.

Weeds are a constant battle for farmers and ranchers. These plants often favor disturbed areas and will compete with crops and pastures for water and nutrients. Many weeds grow faster and taller than crops and compete for sunlight. On pasturelands, weeds are a problem because they compete with grass and reduce the number of livestock that the land can support. Some species are poisonous; tansy ragwort is toxic to cattle, horses, and most other livestock except sheep. Whereas foresters must battle weeds only until the trees are “free to grow,” farmers and ranchers must constantly battle weeds every

[99] There are people who raise pigs, dairy cows, horses, llamas, and other animals, but few are commercial operators.

[100] Many farmers and ranchers are also forestland owners (see section 4.2.3).

[101] Tansy ragwort is less common today than ten years ago due to the introduction of successful biological control methods.

year. As a result, an enormous amount of time, effort, and money are invested for weed management, reducing profits and possibly driving smaller operators out of business.

Predators

Predators have always been a problem for ranchers. Cougar, coyote, and bear cause the most damage, but fox, bobcat, domestic dogs, and wolf/dog hybrids have also been documented killing and maiming livestock.[102] Prior to the 1960s, the US Department of Agriculture (USDA) handled all predator management in Douglas County. The county took over all predator control programs in the 1960s through 1999. Now, the USDA once again handles all predator management.

The populations of cougar and bear appear to be on the rise because of changes in predator control regulations.[103] These species are territorial animals. As populations increase, animals that are unable to establish territories in preferred habitat will establish themselves in less suitable areas, often around agricultural lands and rural residential developments. Some wildlife professionals believe that cougars are less shy than they have been in the past, and are becoming increasingly active in rural and residential areas. As cougar and bear populations continue to rise, so will predation by these species on livestock. It is also possible that incidents involving humans and predators will increase as well.

Contrary to popular belief, predators do not only kill for food. Local ranchers have lost dozens of sheep and cattle overnight to a single cougar. In these cases, only a few of the carcasses had evidence of feeding, indicating that the cougar was not killing livestock for food. Small animals like sheep are easy prey, so some ranchers are switching to cattle. However, local observation indicates that cougar, bears, and packs of coyote are quite capable of killing calves and adult cattle as well.

Loss of quality farmland

Due in part to the difficulties facing today's ranchers and farmers, many young people are favoring other careers over agriculture. As a result, many agricultural lands are sold out of the original families. In some cases, the land is purchased by other nearby farmers and ranchers, and remains in production.[104] Local observation suggests that new residents from outside of southwest Oregon purchase some of these agricultural lands. In the case of smaller operations, new owners are often unable to turn a profit. Some residents suggest this may be because the newcomers do not understand local conditions or the specific needs of the property and are therefore unable to manage it profitably. In other cases, family farms and ranches are purchased by developers and divided into smaller lots for hobby farms, or converted into residential developments and taken out of production entirely. Statewide, there were 18.1 million acres of farmland in 1980; this

[102] The last confirmed wild wolf sighting in Douglas County occurred in the late 1940s. Wolf/dog hybrids are brought to the Douglas County/Umpqua Basin area as pets or for breeding and escape or are intentionally released.
[103] Cougar populations have been increasing since protection laws were passed in the 1960s. Coyote, fox, bobcat, and other predator populations appear to be stable.
[104] The topography of the Umpqua Basin makes this area undesirable to large agricultural conglomerates.

number dropped to 17.2 million acres in 2000. This averages to be a loss of 45,000 acres of Oregon farmland per year.[105]

Regulations

Another concern for ranchers and farmers is the threat of increasing regulations. Since the 1970s, farmers and ranchers have had to change their land management practices to comply with stricter regulations and policies such as the Endangered Species Act, the Clean Water Act, and the Clean Air Act. The costs associated with farming and animal husbandry have increased substantially, partially attributable to increased standards and restricted use of pesticides, fertilizers, and other products. More regulations could further increase production costs and reduce profits.

Market trends

Perhaps the most important influence on agricultural industries is market trends. In the United States, there are around 10 food-marketing conglomerates that control most of the agricultural market through their immense influence on commodity prices. These conglomerates include the "mega" food chains like Wal-Mart and Costco. Also, trade has become globalized, and US farmers and ranchers are competing with farmers in countries that have lower production costs because they pay lower wages, have fewer environmental regulations, and/or have more subsidies. The conglomerates are in fierce competition with one another and rely on being able to sell food at the lowest possible price. These food giants have no allegiance to US agriculture, and the strength of the dollar makes purchasing overseas products very economical. On the open market, US farmers and ranchers must sell their goods at the same price as their foreign competitors or risk being unable to sell their products at all. In many cases, this means US producers must sell their goods at prices below production costs. As a result, it is very difficult for all but the very largest producers to compete with foreign agricultural goods, unless they are able to circumvent the open market by selling their goods directly to local or regional buyers ("niche" marketing).

The future of local agriculture

The future of farmers and ranchers depends a lot on the different facets of these groups' ability to work together. The agricultural community tends to be very independent, and farmers and ranchers have historically had limited success in combining forces to work towards a common goal. By working together, Oregon's agricultural community may be able to overcome the issues described above. If not, it is likely that in the Umpqua Basin hobby farms and residential developments will replace profitable family farms and ranches.

[105] Data are from the 2000-2001 Oregon Agriculture and Fisheries Statistics publication compiled by the US Department of Agriculture. A farm is defined as a place that sells or would normally sell $1,000 worth of agricultural products.

4.2.3. Family forestland owners[106]

The term "family forestland" is used to define forested properties owned by private individuals and/or families. Unlike the term "non-industrial private forestland," the definition of "family forestlands" excludes non-family corporations, clubs, and other associations. Of the 102,537 acres in the watershed, approximately 16% are non-industrial private forestlands. Family forestlands most likely constitute a slightly smaller percent of the private non-industrial forests.

Family forestlands differ from private industrial forests. Industrial timber companies favor expansive stands of even-aged Douglas-fir. Family forestlands are more often located in lower elevations, and collectively provide a mixture of young and medium-aged conifers, hardwood stands, and non-forested areas such as rangeland. Family forestland owners are more likely to manage their properties for both commercial and non-commercial interests such as merchantable timber, special forest products, biological diversity, and aesthetics.

Family forestland owners play a significant role in fish habitat and water quality restoration. Whereas most public and industrial timber forests are in upper elevations, family forestlands are concentrated in the lowlands and near cities and towns. Streams in these areas generally have low gradients providing critical spawning habitat for salmonids. As such, issues affecting family forestland property management may impact fish habitat and water quality restoration efforts.

Family forestland owners

Who are Douglas County's family forestland owners? In Oregon, most family forestland owners are older; nearly one in three is retired and another 25% will reach retirement age during this decade. Douglas County woodland owners seem to follow this general trend. Local observation suggests that many family forestland owners in Douglas County are either connected to the timber industry through their jobs or are recent arrivals to the area. The impression is that many of the latter group left higher-paying jobs in urban areas in favor of Douglas County's rural lifestyle. In general, few family forestland owners are under the age of 35. It is believed that most young forestland owners inherit their properties or have unusually large incomes, since the cost of forestland and its maintenance is beyond the means of people just beginning their careers.

Factors influencing family forestlands

<u>Changing markets</u>

There are very few small private mills still operating in Douglas County, so timber from family forests is sold to industrial timber mills. Timber companies are driven by the global market, which influences product demand, competition, and production locations. As markets change, so do the size and species of logs that mills will purchase. Family forestland owners must continually re-evaluate their timber management plans to meet the mills' requirements if they want to sell their timber. For example, mills are now

[106] The following information is from an interview with Bill Arsenault, President of the Douglas Small Woodland Owners Association and member of the Family Forestlands Advisory Committee, and from "Sustaining Oregon's Family Forestlands" (Committee for Family Forestlands, 2002).

favoring smaller diameter logs; hence family forestland owners have little financial incentive to grow large diameter trees.

Another aspect of globalization is a growing interest in certified wood products as derived from sustainably managed forests. Many family forestland owners follow the Oregon Forest Practices Act and consider their management systems sustainable. The Committee for Family Forestlands is concerned that wood certification parameters do not take into account small forest circumstances and management techniques. They fear that wood certification could exclude family-forest-grown timber from the expanding certified wood products market. However, the long-term effect of wood certification is still unclear.

Ultimately the key to continued family forestland productivity is a healthy timber market. Although globalization and certification may change the way family forestland owners manage their timber, foreign log imports have kept local mills in operation, providing a place for family forestland owners to sell their timber. The long-term impact of globalization on forestland will depend on how it affects local markets.

Indirectly, changes in the livestock industry also influence family forestland owners. The livestock market is down and many landowners are converting their ranchlands to forests. Douglas County supports these efforts through programs that offer landowners low-interest loans for afforestation projects.[107] Should the market for livestock remain low, it is likely that more pastureland will be converted to timber.

<u>Land management issues</u>

Exotic weeds are a problem for family forestland owners. Species like Scotch broom, gorse, and blackberries can out-compete seedlings and must be controlled. Unlike grass and most native hardwoods, these exotic species require multiple herbicide applications before seedlings are free to grow, which raises the cost of site maintenance by about $200 per acre. The cost is not enough to "break the bank" but can narrow family forestland owners' profit margins. The cost of weed control may increase if these exotic species and others such as Portuguese broom become more established in the Umpqua Basin.

<u>Regulations</u>

Many family forestland owners fear that increasing regulations will diminish forest management profitability. For example, some Douglas County forestland owners are unable to profitably manage their properties due to riparian buffer protection laws. Although most family forestland owners support sound management practices, laws that take more land out of timber production would further reduce the landowners' profits. This would likely discourage continued family forestland management.

[107] Afforestation is planting trees in areas that have few or no trees. Reforestation is planting trees in areas that recently had trees, such as timber harvest sites or burned forests. Contact the Douglas County Extension Forester for more information on this program.

Succession/inheritance

Succession is a concern of many family forestland owners. It appears that most forestland owners would prefer to keep the property in the family; however, an Oregon-wide survey indicates that only 12% of private forestland owners have owned their properties since the 1970s. Part of this failure to retain family forestlands within the family unit may result from complex inheritance laws. Inheritors may find themselves overwhelmed by confusing laws and burdensome taxes and choose to sell the property. Statewide, over 20,000 acres of timberland leave family forestland ownership every year. Private industrial timber companies are the primary buyers. Although the land remains forested, private industrial timber companies use different management prescriptions than do most family forestland owners. Other family forestlands have been converted to urban and residential development to accommodate population growth.

4.2.4. Industrial timber companies[108]

Most industrial timberlands are located in areas that favor Douglas-fir, tending to be hillsides and higher elevations.[109] 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 Lower Cow Creek Watershed, industrial timber companies own approximately 45% of the 102,537 total acres. 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.[110] 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. 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.

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[108] 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.

[109] Hillsides and higher elevations are often a checkerboard ownership of Bureau of Land Management administered lands (see section 4.2.5) and industrial timberlands.

[110] 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.

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; where it is feasible, failing culverts are replaced with ones that permit fish passage. 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

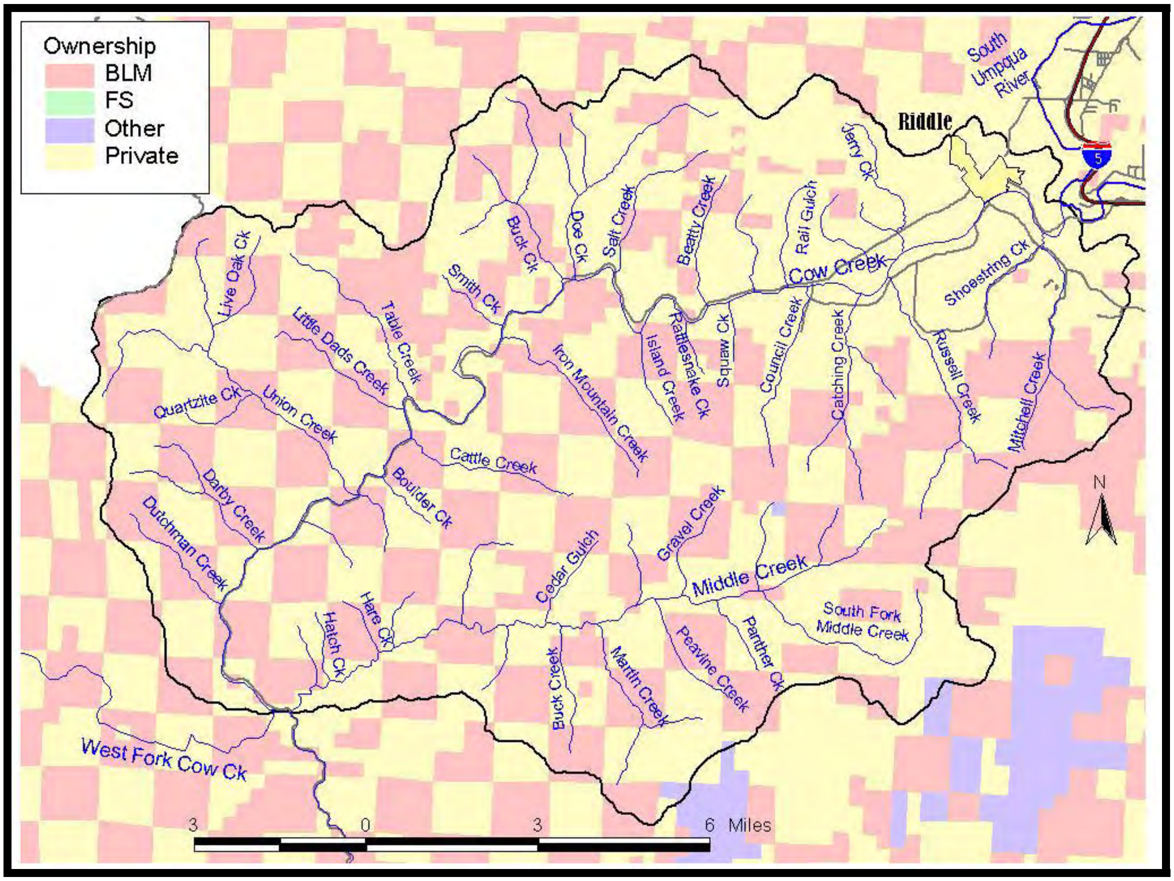
management systems sustainable. There is concern that the efforts and litigation that changed forest management methods on public lands will now be focused on private lands. Should forestry become unprofitable due to stricter regulations, industrial timber companies would be forced to move their businesses elsewhere, potentially converting their forestlands to other uses.

4.2.5. The Bureau of Land Management[111]

The Roseburg District Office of the Bureau of Land Management (BLM) administers a total of 425,588 acres of which most is within the Umpqua Basin and all is within Douglas County.[112] In the Lower Cow Creek Watershed, the BLM administers approximately 40% of the watershed (see Map 4-1).

The BLM and US Forest Service activities within the range of the Northern Spotted Owl follow the guidelines of the 1994 Northwest Forest Plan. In compliance with this policy, the Roseburg BLM's District Office developed a Record of Decision and Resource Management Plan in 1995.[113] The plan outlines the on-going resource management goals and objectives for lands administered by the BLM. All of the BLM's activities are guided by the resource management plan, the text below summarizes the main points of the document.

[111] The following information is from the Roseburg District of the Bureau of Land Management's 1995 Record of Decision and Resource Management Plan and the District's Annual Program Summary and Monitoring Report for fiscal year 2000 to 2001.
[112] Including 1,717 acres of non-federal land with federal subsurface mineral estate administered by the BLM.
[113] For copies of this document, contact the Bureau of Land Management Roseburg District Office at 777 Northwest Garden Valley Road, Roseburg, Oregon 97470.



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

General overview

The BLM Roseburg District Office's vision is that the "Bureau of Land Management will manage the natural resources under its jurisdiction in western Oregon to help enhance and maintain the ecological health of the environment and the social well-being of the human population." Ecosystem management is the strategy used by the Roseburg BLM to guide its vision:

> Ecosystem management involves the use of ecological, economic, social, and managerial principals to ensure the sustained condition of the whole. Ecosystem management emphasizes the complete ecosystem instead of individual components and looks at sustainable systems and products that people want and need. It seeks a balance between maintenance and restoration of natural systems and sustainable yield of resources (p. 18).

The BLM manages all its land using two primary management concepts outlined in the Northwest Forest Plan. The first is "Ecological Principles for Management of Late Successional Forests." One goal for this management concept is "to maintain late-successional and old-growth species habitat and ecosystems on federal lands." The second goal is "to maintain biological diversity associated with native species and ecosystems in accordance with laws and regulations."

The second management concept is the "Aquatic Conservation Strategy." This strategy was developed "to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands." A primary intent is to protect salmonid habitat on federal lands administered by the BLM through activities such as watershed restoration and protecting riparian areas.

Land use allocations and resource programs

As part of its strategy, the BLM has four land use allocations that are managed according to specific objectives and management actions/directions that contribute to the two primary management concepts. The first land use allocation is Riparian Reserves. These areas are managed to provide habitat for various wildlife species. The second is Late-Successional Reserves (LSR). These are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems that provide habitat for many species such as the northern spotted owl. Third, Matrix Areas have multiple objectives, which include providing a sustainable supply of timber and other forest commodities, connecting late successional reserves, and providing habitat for organisms associated with young, mature, and older forests. The last land use allocation is Adaptive Management Areas, where the agency develops and tests new management approaches to integrate ecological health with other social parameters, such as economic stability. In the Roseburg BLM District, the Adaptive Management Area is located in the Little River Watershed. The BLM also manages for 20 specific resource programs such as wilderness, timber resources, rural interface areas, and noxious weeds. As with the land use allocations, there are specific objectives and management actions/directions for each of the resource programs that are congruent with the Northwest Forest Plan management concepts.[114]

Current trends

A requirement of the Roseburg District BLM's Resource Management plan is to publish a report on its annual activities. This document is called the Annual Program Summary and Monitoring Report.[115] It describes the BLM's accomplishments during the fiscal year, provides information about its budget, timber receipt collections, and payments to Douglas County.

Overall, the Roseburg BLM District is implementing the Northwest Forest Plan. The BLM met its goals for its land use allocations and for many of its resource programs, such as "water and soils" and "fish habitat." However, uncertainty surrounding the Survey and Manage standard, as well as on-going litigation, has affected the BLM's

[114] For specific information about land use allocations and management, see the BLM Roseburg District's Resource Management Plan.
[115] Copies of the Roseburg District BLM's Annual Program Summary and Monitoring Report from fiscal year 2001 are available through the Roseburg District Office.

ability to implement some of its program elements.[116] For the third year in a row, the BLM's forest management and timber resource program did not come close to achieving its goal of sustainably harvesting 45 million board feet (MMBF) of timber. During fiscal years 1996 through 1998, the BLM came close to or exceeded its 45 MMBF goal. In 1999, harvests fell to 10 MMBF (22% of goal), and then dropped to 1.4 MMBF in 2000 (3% of goal). In 2001, harvest levels climbed slightly to 2.7 MMBF (6% of goal). Under the Resource Management Plan, more acres of BLM-administered forested lands are approaching late-successional stage than are being managed for timber.

Shortly after the completion of the Northwest Forest Plan, the American Forest Resource Council filed a lawsuit against the BLM. The major issues concerned the alleged inappropriate application of reserves and wildlife viability standards to Oregon and California Railroad lands (O&C lands).[117] In August, 2003, a settlement agreement was reached, including the following points:

- Within Northwest Forest Plan areas, the BLM and the US Forest Service will do their best efforts to annually offer 805 million board feet (MMBF) of timber from matrix lands.

- The BLM and USFS will offer thinning sales in Northwest Forest Plan Late Successional Reserve lands totaling 300 MMBF annually (100 MMBF for the BLM and 200 MMBF for the USFS).

- By 2008, the BLM will revise its land use plans in western Oregon. During this process, the BLM will develop alternatives that address a variety of issues, including at least one that will propose eliminating reserves on O&C lands, except where threatened or endangered species would be put at risk. This term is contingent upon funding.

Future of BLM management

The BLM's Resource Management Plan is the guide to all of the BLM's activities and is not subject to casual changes. There are three situations that may result in significant alterations to the current plan. First, major policy changes, such as modifying the Northwest Forest Plan, would require the BLM's Resource Management Plan to be updated so it corresponds with new policies. Second, landscape-wide ecological changes, such as a 60,000-acre fire or a landscape-wide tree disease outbreak, could require changes to the BLM's current plan. Finally, the Resource Management Plan is slated for evaluation in 2005. At that time, the current plan would be evaluated to ascertain if newer information or changed circumstances warranted an amendment or revision. In all cases, the public has the opportunity to review and comment on an amendment to or revision of the plan.

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[116] The Northwest Forest Plan's Survey and Manage standard requires that all agencies conduct surveys prior to any activities on public lands to identify resident species of which little is known (such as mosses, mollusks, and fungi) and develop appropriate management strategies. Depending on the specific species requirements, surveys for a project can take two years or more to complete.

[117] See footnote 17 on page 49 for more information on O&C lands.

4.2.6. Oregon Department of Environmental Quality[118]

The Oregon Department of Environmental Quality (ODEQ) plays an important and unique role in fish habitat and water quality restoration. ODEQ's primary responsibility is to support stream beneficial uses identified by the Oregon Water Resources Department by:

- Establishing research-based water quality standards;
- Monitoring to determine if beneficial uses are being impaired within a specific stream or stream segment; and
- Identifying factors that may be contributing to conditions that have led to water quality impairment.

Approximately every three years, ODEQ reassesses its water quality standards and streams that are 303(d) listed as impaired. Throughout the development and reassessment of water quality standards, ODEQ attempts to keep the public involved and informed about water quality standards and listings. All sectors of the public, including land managers, academics, and citizens-at-large, are encouraged to offer input into the process. Water quality standards and 303(d) listings may be revised if comments and research support the change.

Current and future efforts

To fulfill its responsibilities into the future, ODEQ will continue to prioritize areas that are important for the various beneficial uses through their own research and the research of other groups. When these areas have been identified and prioritized, ODEQ will examine current land use practices to determine what changes, if any, will benefit preserving and/or restoring resources. Also, ODEQ will continue its efforts to work with individuals, agencies, citizen groups, and businesses to encourage them to voluntarily improve fish habitat and water quality conditions.

ODEQ hopes that education and outreach will help residents understand that improving conditions for fish and wildlife also improves conditions for people. For example, well-established riparian buffers increase stream complexity by adding more wood to the stream channel. Increased stream complexity provides better habitat for fish. Buffers also helps downstream water quality by trapping nutrients and preventing stream warming, which can lead to excessive algae growth and interfere with water contact recreation.

Potential hindrances to water quality restoration

One hindrance to ODEQ's work is the financial reality of many water quality improvement activities. In some cases, the costs associated with meeting current standards are more than communities, businesses, or individual can easily absorb. For example, excessive nutrients from wastewater treatment plants can increase nitrate and phosphate levels and result in water quality impairments. The cost for upgrading a wastewater treatment plant can run into tens of millions of dollars, and is usually passed

[118] The following information is primarily from an interview with Paul Heberling, a water quality specialist for the Oregon Department of Environmental Quality in Roseburg.

on to the community through city taxes and higher utility rates. Upgrading septic systems to meet current standards can cost a single family in excess of $10,000, more than many low and middle-income rural residents can afford. People's interest in improving water quality often depends on the degree of financial hardship involved.

Another potential hindrance to ODEQ's work is budget cuts and staff reductions. There are two Healthy Stream Partnership positions assigned to the Umpqua Basin, which is approximately three million acres. Without sufficient funding or personnel, it is difficult for ODEQ to conduct its basin-wide monitoring activities and reassess current water quality standards and impaired streams.

Current and potential future water quality trends
In 1998, there were 1,067 streams or stream segments identified as failing to meet one or more of Oregon's water quality standards. Of these, approximately 10% were in the Umpqua Basin.[119] Table 4-1 shows by parameter the number of Umpqua Basin streams failing to meet water quality standards.

Parameter	**# of listed streams or reaches**	**Parameter**	**# of listed streams or reaches**
Ammonia	1	Iron	4
Aquatic weeds/algae	3	Lead	3
Arsenic	4	Manganese	2
Biological criteria	7	Mercury	4
Cadmium	1	pH	14
Chlorine	2	Phosphorus	1
Copper	2	Sediment	7
Dissolved oxygen	7	Temperature	180
E. coli and fecal coliform	14	Total dissolved gas	4

Table 4-1: Number of Umpqua Basin 303(d) listed streams by parameter.

Accordingly, the focus for preservation and restoration efforts is directed toward improving stream temperature and bacterial levels to support the various beneficial uses. Improving stream temperature may provide the greatest cost-benefit ratio because temperature is a major factor in impacting or exacerbating other water quality parameters, including dissolved oxygen, pH, bacteria, and ammonia. Land management activities that reduce the rate of stream warming, such as establishing functional riparian buffers, can also improve other water quality parameters, such as sedimentation. Reducing bacteria levels is also a focus because of the serious human health risks associated with fecal bacteria. There is a clear rationale for activities that reduce bacteria levels, such as fixing failing septic systems and reducing the amounts of fecal wastes reaching streams from livestock, pets, and other sources.

[119] See section 3.3.1 for 303(d) listed streams in the Lower Cow Creek Watershed.

Although many Umpqua Basin streams and reaches are water quality impaired, current trends indicate that conditions are improving. Data from ODEQ long term monitoring sites in the Umpqua Basin indicate that between 1989 and 1998, water quality conditions of many Umpqua Basin rivers and streams improved. The South Umpqua River at Melrose Road, Stewart Park Road, Winston, and Days Creek Cuttoff Road, as well as Cow Creek at the mouth, Calapooya Creek at Umpqua, and the North Umpqua at Garden Valley Road, are listed as sites that have shown significant improvement. From these data, ODEQ believes that continuing to support beneficial uses through water quality improvement activities will insure a bright future for fish habitat and water quality in the Umpqua Basin.

4.2.7. Galesville Dam[120]

Galesville Dam is located on Cow Creek upstream of the Lower Cow Creek Watershed. As described in section 3.4, dam releases impact streamflow levels in the watershed. Therefore, Galesville Dam information is included in this assessment.

Galesville Dam management is governed by the county's contractual agreements with the Bureau of Reclamation, legal requirements under the dam's license with the Federal Energy Regulatory Commission (FERC), and by state and federal laws. The Army Corps of Engineers has jurisdiction over the flood control functions as a result of those agreements and license. From November to February, the Army Corps of Engineers controls a large portion of the reservoir's capacity for flood control. Army Corps of Engineers regulations govern water releases and storage. From February through May, the Corps' regulations allow filling of the reservoir at a prescribed rate. The summer releases are predicated on state water laws and contractual obligations of the Douglas County Natural Resources Division.

The Galesville Dam license with FERC outlines other legal responsibilities, such as flow limitation, environmental conditions, and safety standards, and dam management is required by law to comply with the license agreement. The dam's management is also highly influenced by state and federal laws. As these laws and policies change, so does the dam's management. Consequently, Galesville Dam management has limited flexibility.

[120] This information is from Frank Nielsen, director of the Douglas County Natural Resources Department.

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 Lower 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.

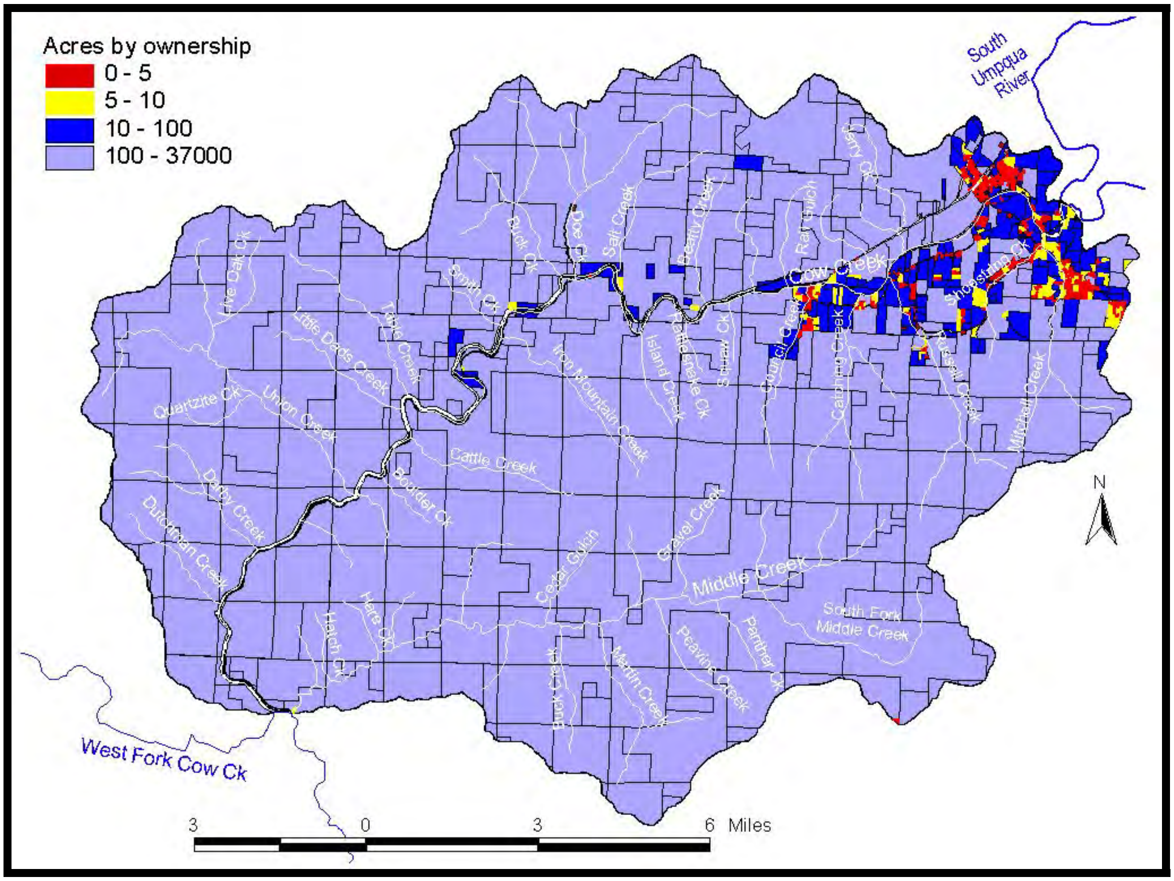
Key Questions

- 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 Lower Cow Creek Watershed. Unlike Map 1-10 in section 1.3, all parcels owned by the same person, family, agency, group, etc., are colored to reflect total ownership size. For example, if a single family 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 Lower Cow Creek Watershed, such as Cattle Creek, are good candidates for large-scale stream habitat restoration projects because they mostly run through large ownerships. Other streams that mostly consist of smaller ownerships, such as Mitchell Creek, should be considered for smaller-scale restoration and enhancement activities and for landowner education programs.



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

5.2. Lower 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 Lower Cow Creek Watershed, there are few stream miles in source areas, where most large woody material is recruited into the stream system. This may naturally limit instream large woody material abundance.
- Stream habitat surveys suggest that lack of large woody material, poor riparian area tree composition, and poor pools 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 Lower 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.[121]
- Encourage land use practices that enhance or protect riparian areas:
  - Protect riparian areas from livestock-caused browsing and bank erosion by providing stock water systems and shade trees outside of the stream channel and riparian zones. Fence riparian areas as appropriate.
  - 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

- Cow Creek's predominant vegetation types are hardwoods and brush/blackberry. Middle Creek is mostly conifers and hardwoods. Conifers dominate other Cow Creek tributaries.
- Over one-third of Lower Cow Creek anadromous salmonid streams have predominantly hardwood riparian areas; three-fourths of cutthroat streams have conifer-dominated riparian areas.
- Over half of Cow Creek's riparian buffers are one tree wide. Over one-fourth of Cow Creek's riparian buffers have no trees. Middle Creek's riparian zone buffers are mostly one tree wide or greater. Over two-thirds of Lower Cow Creek tributaries have riparian buffers that are two trees wide or greater.
- Riparian buffers within potential anadromous salmonid habitat are predominantly one tree wide or greater. Riparian buffers within potential cutthroat habitat are mostly two trees wide or greater.
- Due to the great width of Cow Creek, 99% of the river is less than half covered by vegetation or infrastructure. The areas that are mostly covered are under bridges. Over two-thirds of Middle Creek and the majority of other tributaries are mostly covered.

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

- Over 60% of potential anadromous salmonid streams are mostly covered by vegetation or infrastructure. This is because Cow Creek is within the range of anadromous salmonids. Over three-fourths of potential cutthroat streams are mostly covered.

Wetlands key findings[122]

- Historical settlement and urban development of the Riddle area and long-term agricultural use of this land has probably affected the original wetland hydrology. Past wetland sites may have included Cooper Creek and Cow Creek from Rail Gulch downstream to its confluence with the South Umpqua River.
- Most of the remaining wetlands in the Lower Cow Creek Watershed are found on private land.
- 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

- Where canopy cover is less than 50%, establish wide buffers of native trees (preferably conifers) and/or shrubs, depending upon local conditions. Priority areas are fish-bearing streams for which more than 50% canopy cover is possible.
- Identify riparian zones dominated by grass, brush, and blackberry and convert these areas to native trees (preferably conifers) and/or shrubs, depending on local conditions.
- Where riparian buffers are one tree wide or less, encourage buffer expansion by planting native trees (preferably conifers) and/or shrubs, depending on local conditions.
- Maintain riparian zones that are two or more trees wide and provide more than 50% cover.
- Encourage best management practices that limit wetland damage, such as off-channel watering, hardened crossings, livestock exclusion (part or all of the year), and providing stream shade.
- 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.
- Establish an approachable "one-stop shop" or clearinghouse to assist landowners in enrolling in programs that can benefit wetlands and meet landowner goals.

5.2.3. Water quality

Temperature key findings

- Results show that seven-day moving average maximum temperatures in Cow Creek were frequently above 64°F and have reached 81°F. Except for Upper Martin Creek, tributaries frequently had seven-day moving average maximums above 64° F in July

[122] Jeanine Lum of Barnes and Associates, Inc., contributed the wetlands key findings and action recommendations.

and August. Consistently high stream temperatures would limit salmonid rearing in these reaches.

- 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

- Temperature and the levels of pH, nutrients, and dissolved oxygen are interrelated. In Cow Creek, pH levels violate water quality standards. Nutrient and dissolved oxygen levels do not appear to limit water quality in Cow Creek.
- Bacteria sampling does not consistently exceed water quality standards in Cow Creek. Additional monitoring is necessary to determine if Lower Cow Creek Watershed tributaries have water quality limiting bacteria levels.
- Chlorine levels exceed water quality standards in Cow Creek; ammonia levels are a potential concern.
- Acidic, heavy metal laden discharge and groundwater flow from the Formosa Mine site are causing 18 miles of Middle Creek and South Fork Middle Creek to be at least seasonally toxic to aquatic life. Formosa Mine pollutants have not been detected in Cow Creek.

Sedimentation and turbidity key findings

- Turbidity data indicate that usual turbidity levels in Lower Cow Creek should not affect 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

- Continue monitoring the Lower Cow Creek Watershed for all water quality conditions. Expand monitoring efforts to include small tributaries.
- Identify stream reaches 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.

- In very warm streams or where pH is a problem, increase shade by encouraging wide riparian buffers and managing for full canopies.
- Encourage landowner practices that will maintain the Lower Cow Creek Watershed's low bacteria and nutrient levels:
  - Limit livestock stream access by providing stock water systems and shade trees outside of the stream channel and riparian zones. Fence riparian areas as appropriate.
  - Relocate structures and situations that concentrate domestic animals near streams, such as barns, feedlots, and kennels. Where these structures cannot be relocated, establish dense and wide riparian vegetation zones to filter fecal material.
  - Repair failing septic tanks and drain fields.
  - Use wastewater treatment plant effluent for irrigation.
  - Reduce chemical nutrient sources.
- Where data show that stream sediment or turbidity levels exceed established water quality standards, identify sediment sources such as urban runoff, failing culverts or roads, landside debris, construction, or burns. Take action to remedy the problem or seek assistance through organizations such as the UBWC, the Douglas Soil and Water Conservation District, and the Natural Resources Conservation Service (NRCS).
- Use the refined debris flow hazard data (soon 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.
- Cooperate with ODEQ as necessary to document and reduce contamination by toxics in Middle Creek and South Fork Middle Creek.

5.2.4. Water quantity

Water availability and water rights by use key findings

- In both Lower Cow Creek Watershed WABs, instream water rights are close to or exceed average streamflow during one or more months of the year.
- During the summer, there is no "natural" streamflow available for new water rights. Landowners below Galesville Dam with access to Cow Creek can purchase water from Galesville Reservoir.
- The largest uses of water in the Lower Cow Creek Watershed are "irrigation," "municipal," and "industrial." The largest water uses for tributaries are "mining," "irrigation," and "miscellaneous."

Streamflow and flood potential key findings

- Since the construction of Galesville Dam, there has been greater streamflow in the months of June through September, but less streamflow from October to May.
- No flooding trends were determined from the records to date.

- The degree to which road density and the TSZ influence flood potential in the Lower Cow Creek Watershed is unknown at this time.

Water quantity action recommendations

- o Reduce summer water consumption through instream water leasing and by improving irrigation efficiency.
- o Educate landowners about proper irrigation methods and the benefits of improved irrigation efficiency.
- 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.

5.2.5. Fish populations

Fish populations key findings

- The anadromous fish species in the Lower Cow Creek Watershed with annual runs are coho, steelhead, fall chinook, and Pacific lamprey. Cutthroat trout are the only resident salmonid.
- Although many Lower 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.
- Largemouth bass, smallmouth bass, and other non-native species have been reported in the lower reaches of Cow Creek. These fish are most likely introduced to watershed streams through private ponds, or migrate into Cow Creek from the South Umpqua River during the summer months. Stream temperatures are generally too cold for these species to establish reproducing populations throughout the watershed.
- More quantitative data are needed to evaluate salmonid abundance and the distribution and abundance of non-salmonid fish in the watershed.
- The majority of fall chinook in the Cow Creek system are found within the Lower Cow Creek Watershed.
- The number of redds in the Cow Creek system appears to be increasing.
- 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 and resident participation in fish monitoring activities.
- o Conduct landowner education programs about the potential problems associated with introducing non-native fish species into Umpqua Basin rivers and streams.
- o 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 Lower Cow Creek Watershed are good. UBWC staff members believe that within the Lower Cow Creek Watershed, Iron Mountain Creek and Table Creek are generally in the best condition. Shoestring Creek, Mitchell Creek, Russell Creek, Catching Creek, Council Creek, Cattle Creek, and Panther Creek are the UBWC's top priority streams for projects within the watershed. Listed below are specific UBWC enhancement opportunities within the Lower Cow Creek Watershed. These recommendations are based on the assessment findings as well as the professional experience of UBWC, DSWCD, and ODFW staff members.

1. Actively seek out opportunities with landowners, businesses, and resident groups in key areas to enlist participation in restoration projects and activities:
   - Remove/replace barriers to fish passage on Mitchell Creek, Shoestring Creek, and Buck Creek.
   - Install efficient irrigation systems and encourage instream water leasing on streams with irrigation rights, such as Cow Creek.
   - Place fish habitat improving logs and boulders in Russell Creek, Cattle Creek, and the lower reaches of Doe Creek.
   - Plant trees (especially conifers), remove blackberries, and fence riparian areas along Jerry Creek, Russell Creek, and Catching Creek, as well as at the mouth of other small tributaries flowing into Cow Creek. Install upland stock water systems as appropriate.

2. Work with landowners on a case-by-case basis on the following project types:
   - Improve instream fish habitat in areas with good riparian zones and an active channel that is less than 30 feet, especially Iron Mountain Creek, Beatty Creek, Salt Creek, Panther Creek, and Table Creek.
   - Assist landowners willing to create or improve wetlands, especially where evidence suggests historical wetlands may have been located, such as Cooper Creek and the lower reaches of Cow Creek.

3. Assist the Umpqua Basin Fish Access Team's evaluation of fish passage barriers and obstacles, especially on Council Creek, Cattle Creek, Salt Creek, and the upper third of Middle Creek and its tributaries.

4. Develop a page on the UBWC website that provides local information on wetlands and wetland conservation programs to help landowners enroll in programs that can benefit wetlands and meet landowner goals.

5. Develop educational materials and/or outreach programs to educate target audiences about fish habitat and water quality related issues:
   - Create educational brochures about bank erosion, the problems associated with channel modification, and the importance of riparian areas. These could be given to new landowners through real estate agents.

- Develop public service announcements about ways of improving or maintaining riparian and instream conditions, such as the benefits of riparian fencing and how to use fertilizers and pesticides in a stream-friendly fashion.
- Design engaging displays about fish passage barriers for community events, such as the Douglas County Fair.
- Give presentations at citizen groups about the benefits to landowners and to fish that result from upland stock water systems, off-channel shade trees, and instream water leasing.

6. Support local fish habitat and water quality research:
    - Train volunteers to conduct fish and water quality monitoring and research.
    - Provide equipment necessary for local water quality research and monitoring.
    - Survey long-term landowners and residents about historical and current fish distribution and abundance.
    - Encourage school and student participation in monitoring and research.
    - Collaborate with other organizations and agencies on monitoring projects, such as assisting ODEQ with monitoring pH and metals on Middle Creek.

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

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Appendices

Appendix 1: Additional geologic information[124]

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).

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

[124] 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.

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 Lower Cow Creek Watershed, metamorphic rocks, 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 large 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).

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 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 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 in which the floor of the ocean in currently subducting beneath the continent. 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 Lower Cow Creek Watershed, most of the geologic units are marine rocks formed by deposition in the forearc basin.

Western Cascades history

Starting around the beginning of the Oligocene epoch, the sinking of the oceanic crust beneath the continental margin began to spawn the Western Cascades. As the subducting slab sank to the hot mantle of the Earth, it began to heat up and melt, as well as melt rocks above it. Magma rose to the Earth’s surface in eruptions that built the Cascades (Alt and Hyndman, 2001). Between eruptions, volcanic materials were quickly eroded and washed into what was then a coastal plain to the west. Great thicknesses of deposits from volcanic eruptions and from erosion and subsequent deposition exist in the Western Cascades. The Western Cascades underwent significant periods of uplift during the Middle Miocene and more recently in the early Pliocene.

As more of the oceanic crust was consumed underneath the continent, the age of oceanic crust rocks that met the continent became progressively younger. Younger oceanic rocks are warmer, move more quickly, and are more buoyant. The popular theory for the shift of volcanic activity from the west to the east to later produce the High Cascades is that the more buoyant younger crust subducted at a lower angle, thus reaching a melting point farther inland (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
Qal	Holocene	**Alluvial deposits**: Sand, gravel, and silt forming floodplains and filling channels of present streams. In places includes talus and slope wash. Locally includes soils containing abundant organic material, and thin peat beds.
Qls	Holocene and Pleistocene	**Landslide and debris-flow deposits**: Unstratified mixtures of fragments of adjacent bedrock. Locally includes slope wash and colluvium. May include some deposits of late Pliocene age.
Qt	Pleistocene	**Terrace, pediment, and lag gravels**: Unconsolidated deposits of gravel, cobbles, and boulders intermixed and locally interlayered with clay, silt, and sand. Mostly on terraces and pediments above present flood plains.
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.
Tu	Miocene and Oligocene	**Undifferentiated tuffaceous sedimentary rocks, tuffs, and basalt**: Heterogeneous assemblage of continental, largely volcanogenic deposits of basalt and basaltic andesite, including flows of breccia, complexly interstratified with epiclastic and volcaniclastic deposits of basaltic to rhyodacitic composition. Includes extensive rhyodacitic to andesitic ash-flow and air-fall tuffs, abundant lapilli tuff and tuff breccia, andesitic to dacitic mudflow (lahar) deposits, poorly bedded to well bedded, fine- to coarse-grained tuffaceous sedimentary rocks, and volcanic conglomerate.
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.
KJg	Cretaceous and Jurassic	**Granitic rocks**: Mostly tonalite and quartz diorite but including lesser amounts of other granitoid rocks.

Jop	Upper Jurassic	**Otter Point Formation of Dott (1971) and related rocks**: Highly sheared greywacke, mudstone, siltstone, and shale with lenses and pods of sheared greenstone, limestone, chert, blueschist, and serpentine. Identified as mélange by some investigators.
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.
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[125]

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.

Blueschist: A metamorphic rock that has undergone regional metamorphism at low temperatures and high pressures; contains abundant blue amphibole (ferromagnesian silica minerals); usually associated with destructive plate boundary environments.

Breccia: A coarse-grained, clastic rock composed of angular and broken rock fragments in a finer-grained matrix. It is usually sedimentary in origin, but may also be igneous (volcanic breccia).

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.

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

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").

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.

Feldspar: The most important group of rock forming silicate minerals. Feldspar constitutes 60% of the Earth's crust.

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".

Greenstone: Compact dark green altered or metamorphosed basic igneous rocks.

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.

Landslide: The rapid downslope movement of soil and rock material, often lubricated by groundwater, over a basal shear zone or 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.

Mudstone: A hardened mud; a blocky or massive fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal.

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.

Peridotite: A coarse-grained ultramafice igneous rock very largely or entirely composed of olivine.

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.

Plagioclase: Soda-lime feldspar.

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.

Terrace: A step-like surface, bordering a valley floor or shoreline that represents the former position of a flood plain, or lake or sea shore.

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.

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Appendix 2: Census area locations and 2000 Douglas County data

Location of the South Umpqua CCD. [126]

[126] This map is from the US Census Bureau’s American FactFinder website: http://factfinder.census.gov.

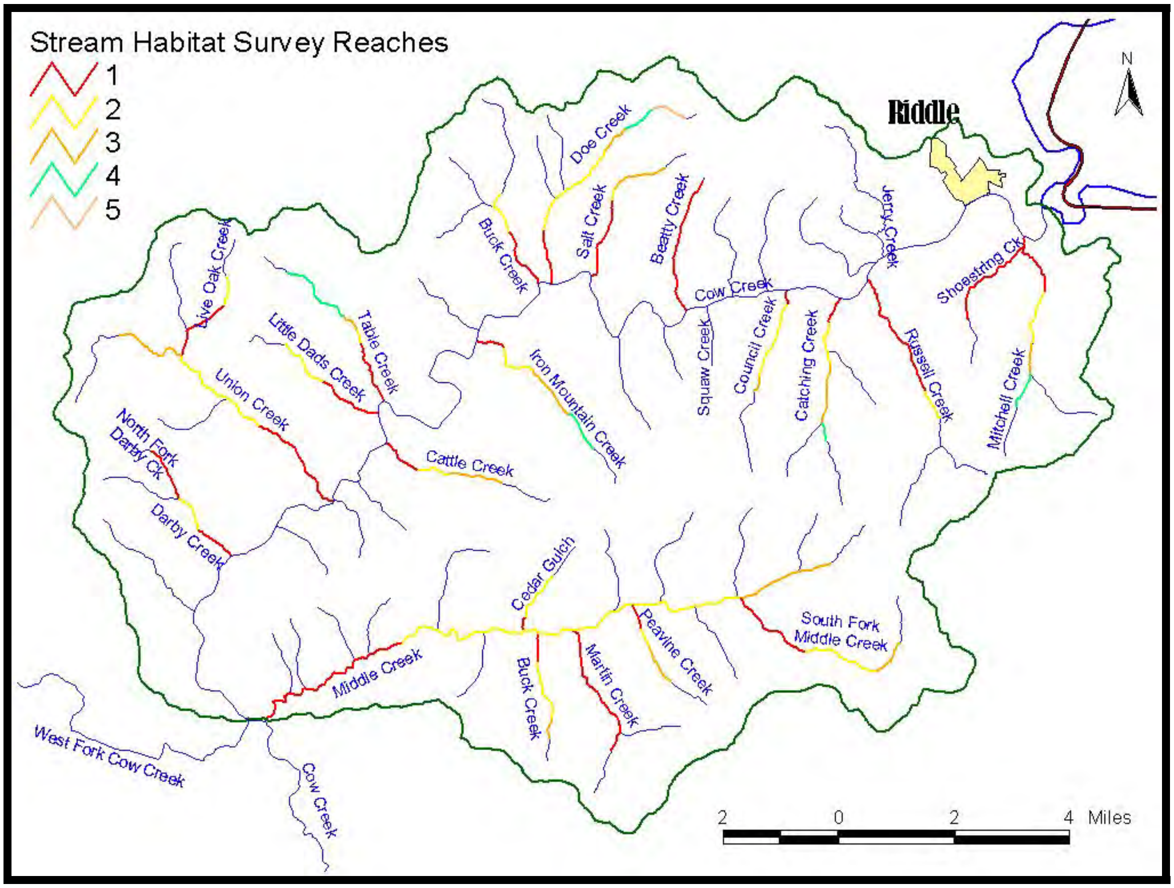
Location of the Myrtle Creek-Riddle CCD.

2000 Douglas County census information

Age, race, and housing	
Population	100,399
Median age (years)	41.2
Race	
White	91.9%
Hispanic or Latino	3.3%
Asian	0.6%
American Indian or Alaskan Native	1.4%
African American	0.2%
Native Hawaiian and Pacific islander	0.1%
Some other race	0.1%
Two or more races	2.4%
Housing	
Avg. household size (#)	2.48
Avg. family size (#)	2.90
Owner-occupied housing	71.7%
Vacant housing units	8.0%
Education, employment, and income	
Education – age 25 or older	
High school graduate or higher	81.0%
Bachelor's degree or higher	13.3%
Employment – age 16 or older	
In labor force	56.9%
Unemployed in labor force	7.5%
Top three occupations	Management, professional and related occupations; Sales and office; Production, transportation, and material moving.
Top three industries	Educational, health, and social services; Manufacturing; Retail
Income	
Per capita income	$16,581
Median family income	$39,364
Families below poverty	9.6%

Appendix 3: Stream habitat surveys

Stream reaches surveyed by the Oregon Department of Fish and Wildlife



Lower Cow Creek Watershed ●●● = Good; ●● = Fair; ● = Poor

Stream	Reach	Pools	Riffles	Riparian Area	Large Woody Material
BEATTY CREEK	1	●	●●●	●●	●
BUCK CREEK (COW)	1	●	●●	●●●	●●
BUCK CREEK (COW)	2	●●●	●●●	●●●	●
BUCK CREEK	1	●●	●●	●●	●
BUCK CREEK	2	●●	●●	●●	●
BUCK CREEK	3	●	●●	●●	●
CATCHING CREEK	1	●●	●●	●	●
CATCHING CREEK	2	●●	●●	●	●
CATCHING CREEK	3	●●	●●	●	●
CATCHING CREEK	4	●●	●●	●	●
CATTLE CREEK	1	●	●●	●●	●
CATTLE CREEK	2	●	●●●	●	●
CATTLE CREEK	3	●	●●●	●	●
CEDAR GULCH CREEK	1	●	●●	●	●

Stream	Reach	Pools	Riffles	Riparian Area	Large Woody Material
CEDAR GULCH CREEK	2	••	•	••	•
COUNCIL CREEK	1	••	•••	••	•
COUNCIL CREEK (UNSURVEYED)	2				
COUNCIL CREEK	3	••	•••	•	•
DARBY CREEK	1	••	•••	••	•
DARBY CREEK	2	•	•••	•••	••
DOE CREEK	1	•	•••	••	•
DOE CREEK	2	••	••	••	•
DOE CREEK	3	••	•••	••	•
DOE CREEK	4	•	•••	•	•
DOE CREEK	5	•	•••	••	•
IRON MTN CREEK	1	••	••	••	•
IRON MTN CREEK	2	••	•••	••	•
IRON MTN CREEK	3	•	•••	•	•
IRON MTN CREEK	4	•	•••	••	•
LITTLE DADS CREEK	1	••	••	••	•
LITTLE DADS CREEK	2	••	••	••	•
LIVE OAK CREEK	1	•••	•	••	•
LIVE OAK CREEK	2	•••	•	•	•
MARTIN CREEK	1	•	••	••	•
MIDDLE CREEK	1	••	••	••	•
MIDDLE CREEK	2	•	••	••	•
MIDDLE CREEK	3	•	••	••	•
ASH CREEK		•••	••	••	•
ASH CREEK	2	••	••	••	•
ASH CREEK	3	•	•••	••	•
ASH CREEK	4	•	•••	•••	•
NORTH FORK DARBY CREEK	1	•	•••	•••	••
PEAVINE CREEK	1	•	•	•	•
PEAVINE CREEK	2	••	••	•	•
PEAVINE CREEK	3	•	••	•	•
RUSSELL CREEK	1	•	••	•	•
RUSSELL CREEK	2	••	••	••	•
SALT CREEK (COW)	1	•	•	••	•
SALT CREEK (COW)	2	•	•	•	•
SALT CREEK (COW)	3	•	•	•	•
SHOESTRING CREEK	1	•	•	••	•
SOUTH FORK MIDDLE CREEK	1	•	••	•	•
SOUTH FORK MIDDLE CREEK	2	•	••	••	•
SOUTH FORK MIDDLE CREEK	3	•	•	•••	•
TABLE CREEK	1	•••	••	••	•
TABLE CREEK	2	•••	•••	••	•
TABLE CREEK	3	••	•	•	•
TABLE CREEK	4	•••	••	•••	•
UNION CREEK	1	••	••	•	•
UNION CREEK	2	•••	••	•	•
UNION CREEK	3	•••	••	••	•

Appendix 4: Land use classifications for the ODFW stream habitat surveys

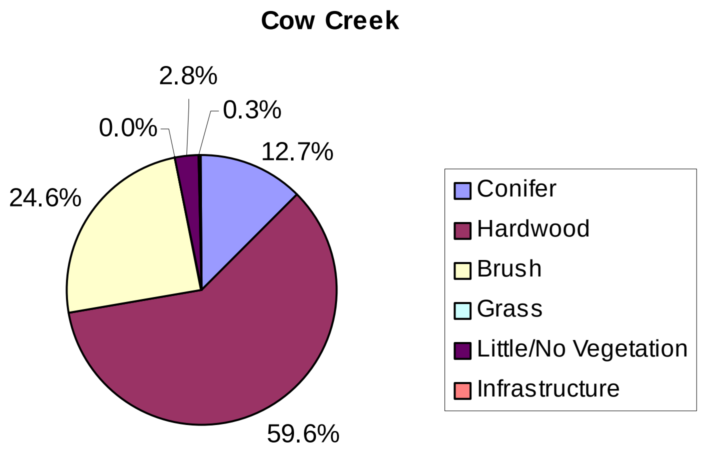
The Oregon Department of Fish and Wildlife classified the land use for each reach surveyed within the Lower Cow Creek Watershed. All categories have been included below, even those not applicable to the Lower Cow Creek Watershed.

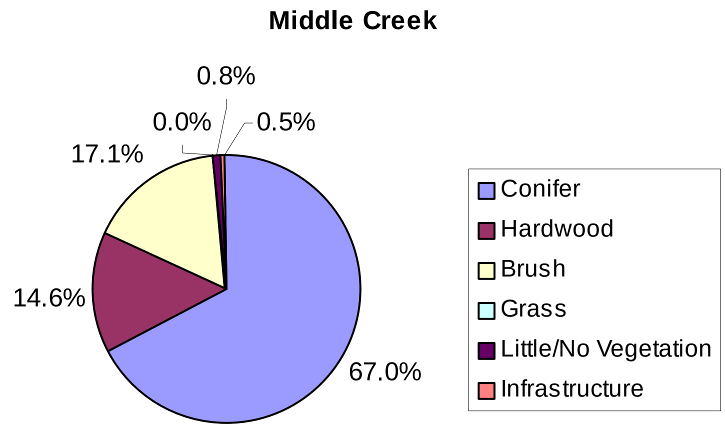
AG Agricultural crop or dairy land.
TH Timber harvest: active timber management including tree felling, logging, etc. Not yet replanted.
YT Young forest trees: can range from recently planted harvest units to stands with trees up to 15 cm dbh.
ST Second growth timber: trees 15-30 cm dbh within generally 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

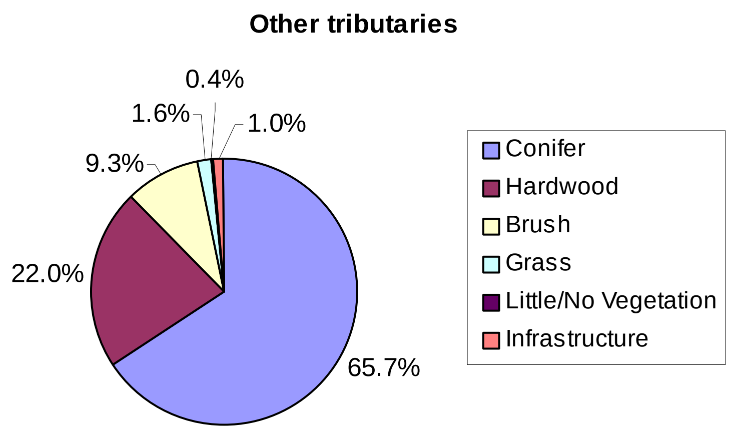
Stream	Reach	Primary Land Use	Secondary Land Use
BEATTY CREEK	1	MT	ST
BUCK CREEK (COW)	1	LT	
BUCK CREEK (COW)	2	LT	
BUCK CREEK	1	YT	OG
BUCK CREEK	2	YT	
BUCK CREEK	3	YT	
CATCHING CREEK	1	AG	
CATCHING CREEK	2	AG	
CATCHING CREEK	3	ST	TH
CATCHING CREEK	4	LT	ST

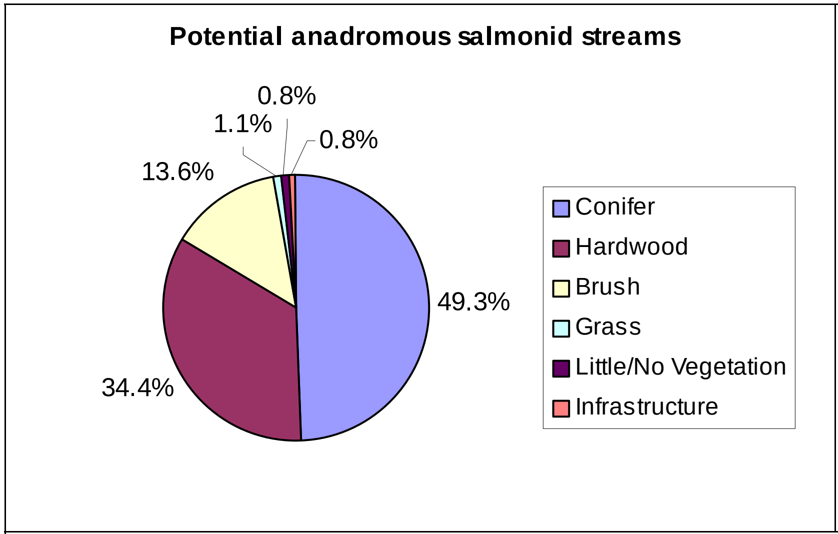
Stream	Reach	Primary Land Use	Secondary Land Use
CATTLE CREEK	1	ST	
CATTLE CREEK	2	YT	
CATTLE CREEK	3	YT	
CEDAR GULCH CREEK	1	YT	
CEDAR GULCH CREEK	2	YT	
COUNCIL CREEK	1	RR	
COUNCIL CREEK (UNSURVEYED)	2		
COUNCIL CREEK	3	ST	
DARBY CREEK	1	LT	
DARBY CREEK	2	TH	
DOE CREEK	1	ST	LT
DOE CREEK	2	ST	
DOE CREEK	3	YT	
DOE CREEK	4	ST	
DOE CREEK	5	LT	
IRON MTN CREEK	1	ST	YT
IRON MTN CREEK	2	LT	
IRON MTN CREEK	3	LT	TH
IRON MTN CREEK	4	LT	TH
LITTLE DADS CREEK	1	MT	ST
LITTLE DADS CREEK	2	ST	MT
LIVE OAK CREEK	1	LT	
LIVE OAK CREEK	2	ST	
MARTIN CREEK	1	YT	
MIDDLE CREEK	1	YT	ST
MIDDLE CREEK	2	ST	TH
MIDDLE CREEK	3	ST	MT
ASH CREEK	1	AG	
ASH CREEK	2	AG	RR
ASH CREEK	3	ST	MT
ASH CREEK	4	LT	MI
NORTH FORK DARBY CREEK	1	OG	ST
PEAVINE CREEK	1	YT	
PEAVINE CREEK	2	YT	
PEAVINE CREEK	3	YT	
RUSSELL CREEK	1	RR	TH
RUSSELL CREEK	2	ST	
SALT CREEK (COW)	1	MT	ST
SALT CREEK (COW)	2	YT	MT
SALT CREEK (COW)	3	YT	ST
SHOESTRING CREEK	1	RR	MT
SOUTH FORK MIDDLE CREEK	1	YT	
SOUTH FORK MIDDLE CREEK	2	YT	
SOUTH FORK MIDDLE CREEK	3	YT	
TABLE CREEK	1	MT	ST
TABLE CREEK	2	MT	ST
TABLE CREEK	3	YT	MT
TABLE CREEK	4	MT	ST
UNION CREEK	1	ST	
UNION CREEK	2	YT	
UNION CREEK	3	ST	

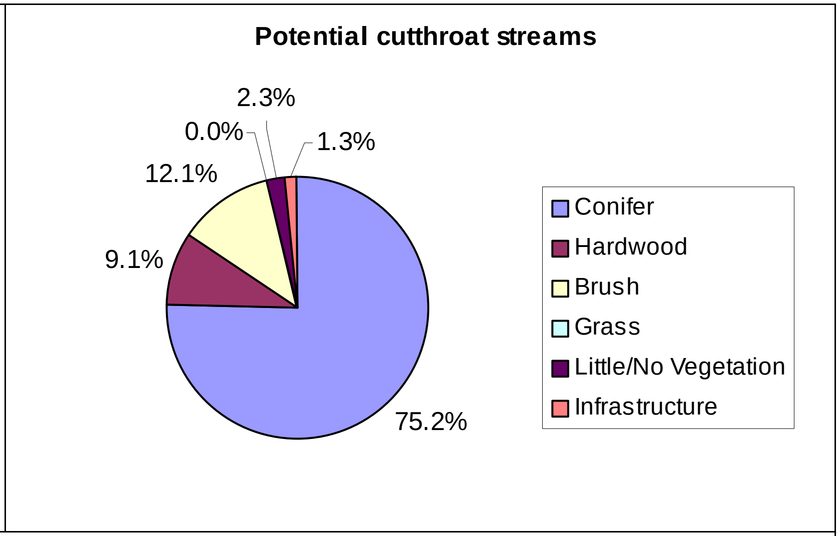
Appendix 5: Riparian vegetation and features

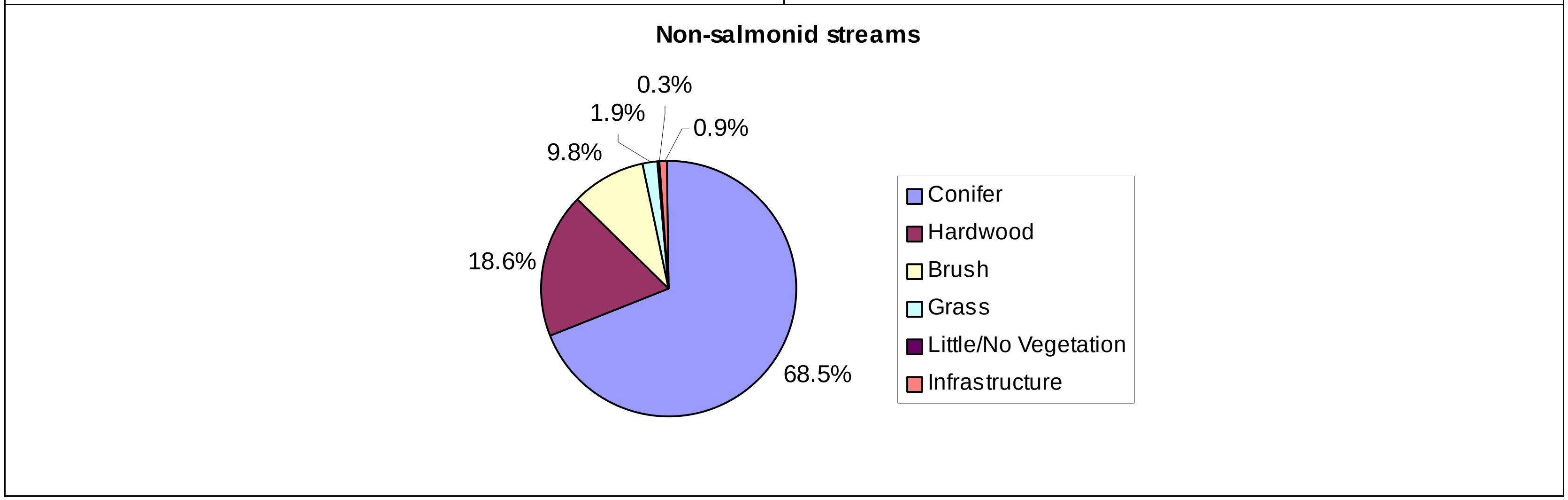




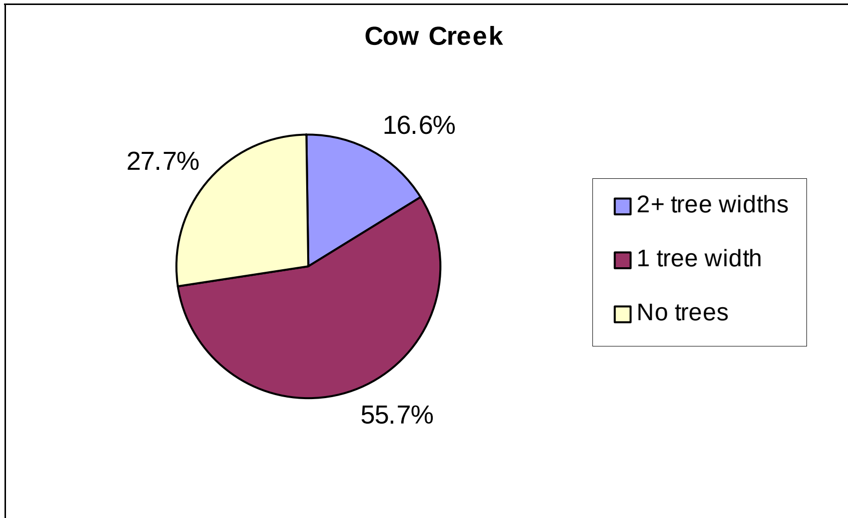


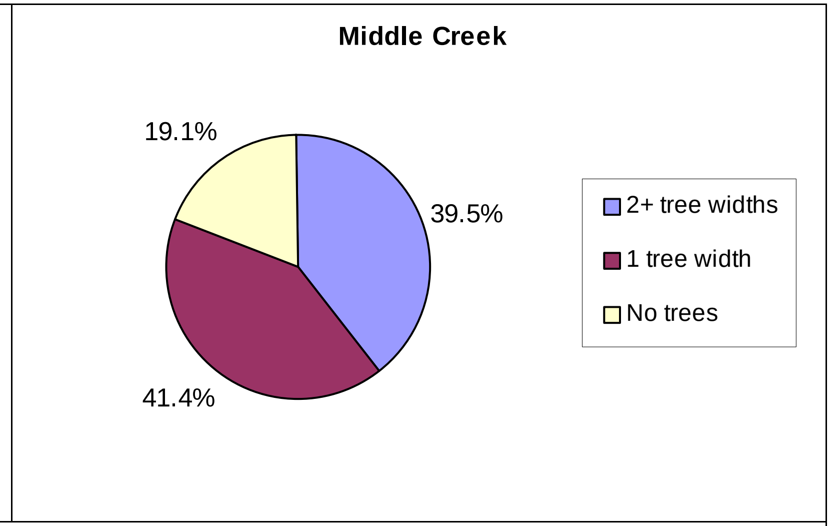

Potential anadromous salmonid streams
0.8%
1.1%
0.8%
13.6%
49.3%
34.4%
Conifer
Hardwood
Brush
Grass
Little/No Vegetation
Infrastructure

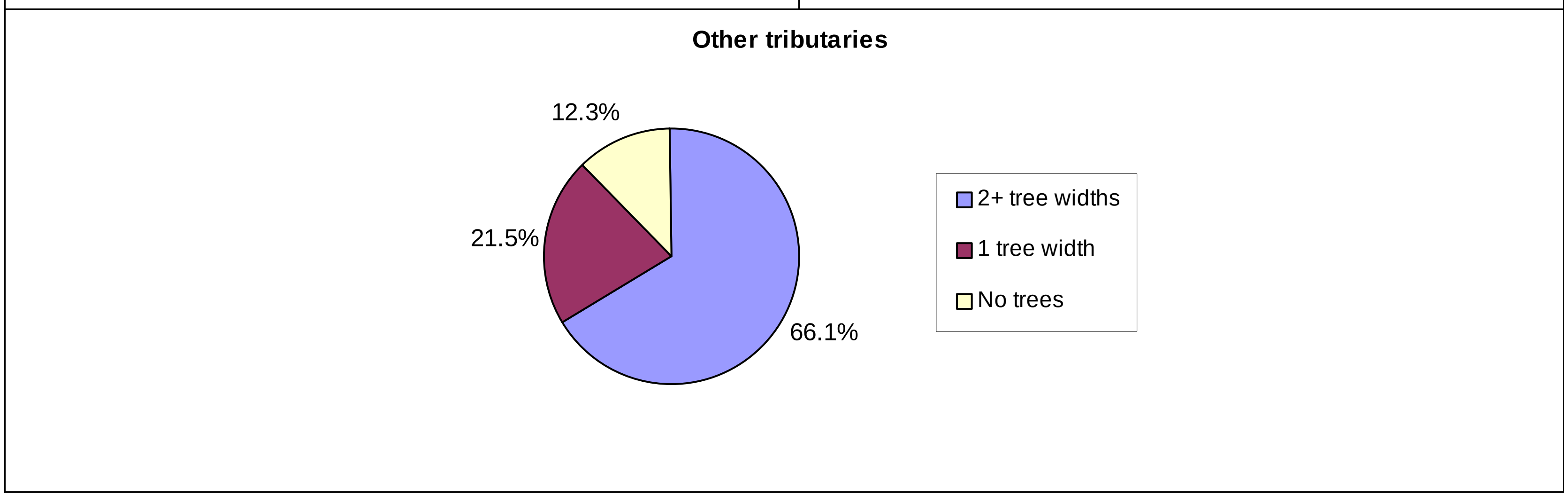

Potential cutthroat streams
2.3%
0.0%
1.3%
12.1%
9.1%
75.2%
Conifer
Hardwood
Brush
Grass
Little/No Vegetation
Infrastructure

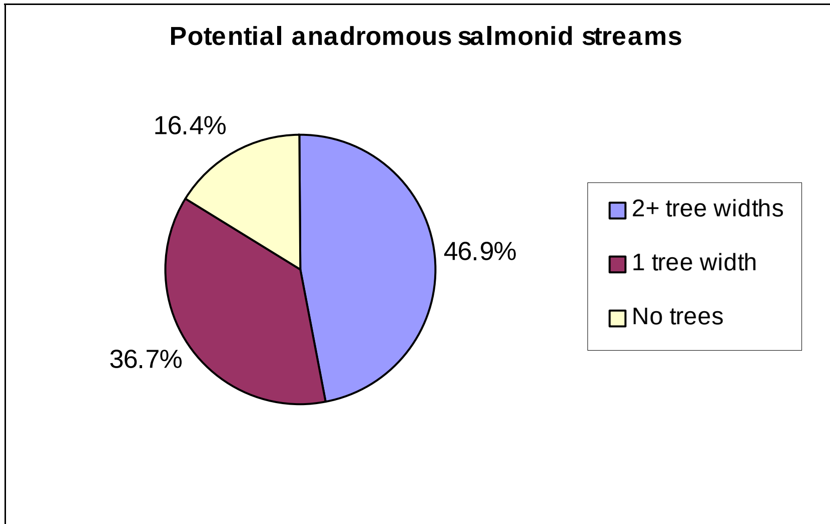

Non-salmonid streams
0.3%
1.9%
0.9%
9.8%
18.6%
68.5%
Conifer
Hardwood
Brush
Grass
Little/No Vegetation
Infrastructure

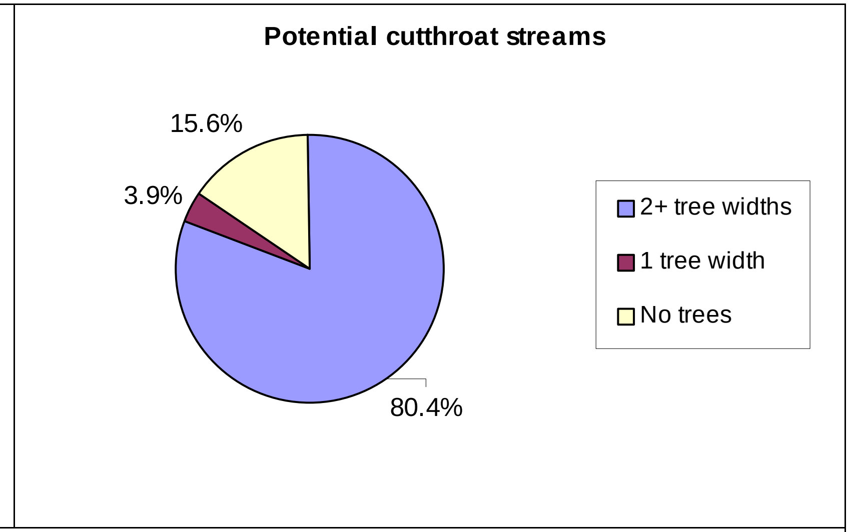
Appendix 6: Buffer width

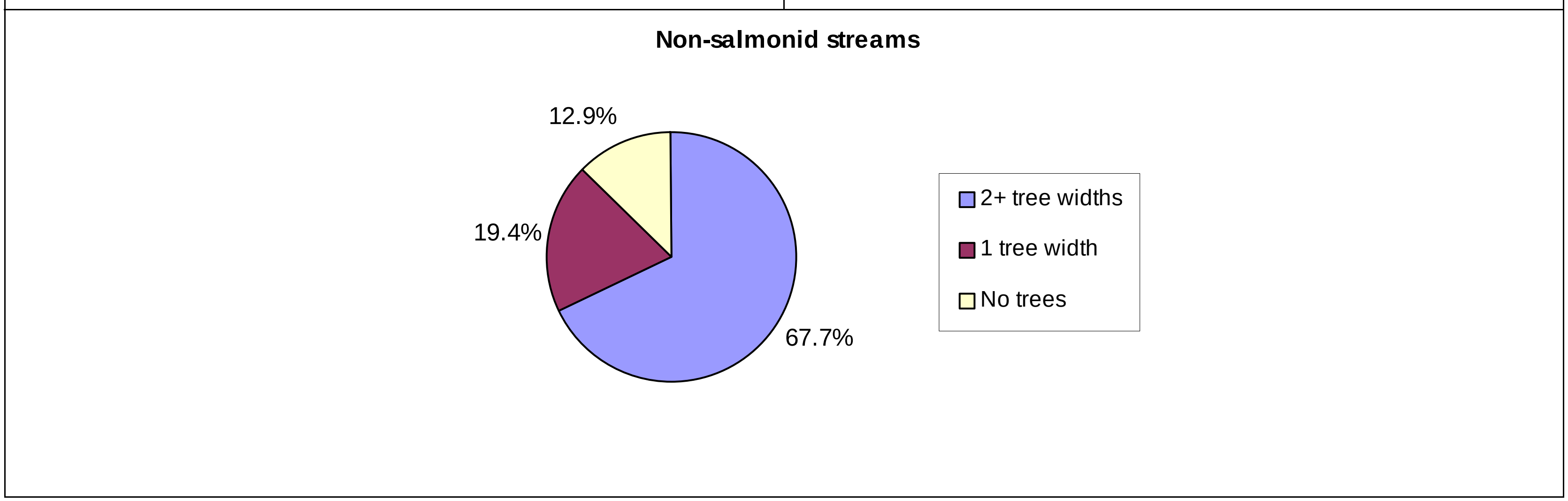




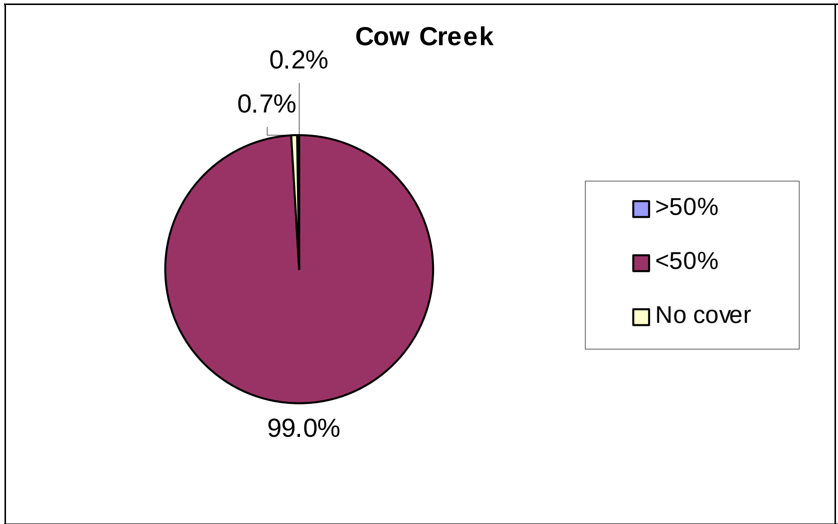


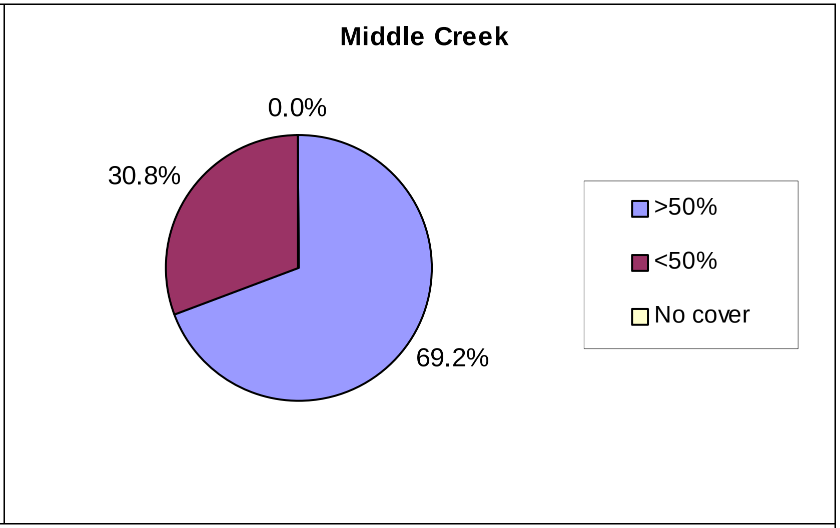

Potential anadromous salmonid streams
16.4%
46.9%
36.7%
2+ tree widths
1 tree width
No trees

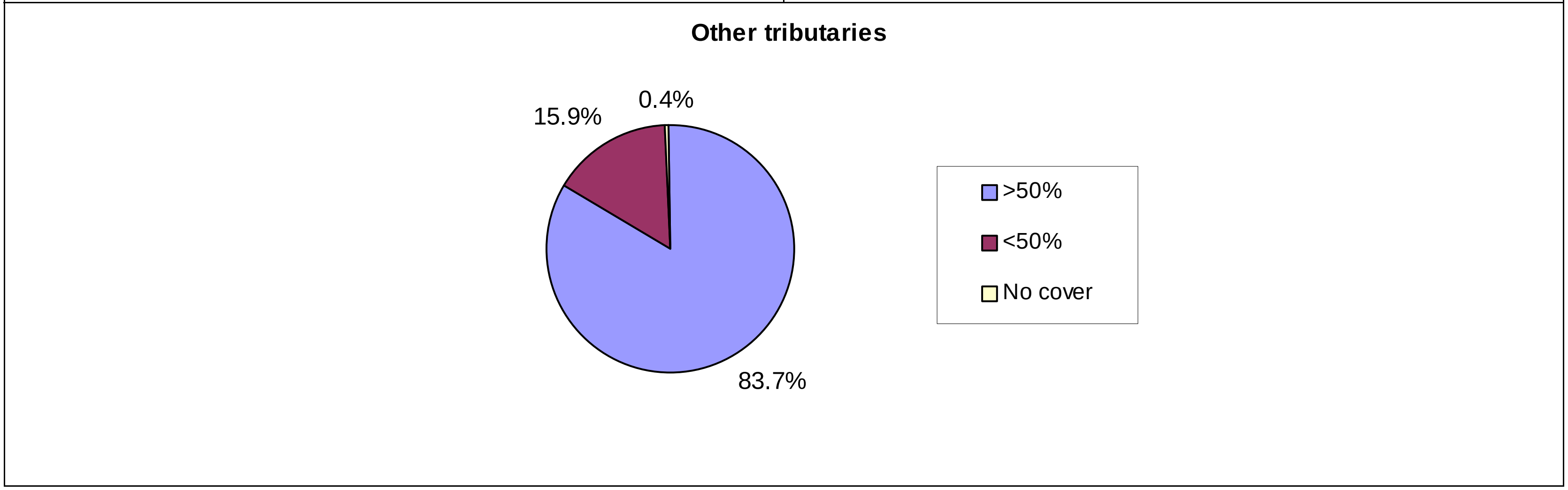

Potential cutthroat streams
15.6%
3.9%
80.4%
2+ tree widths
1 tree width
No trees

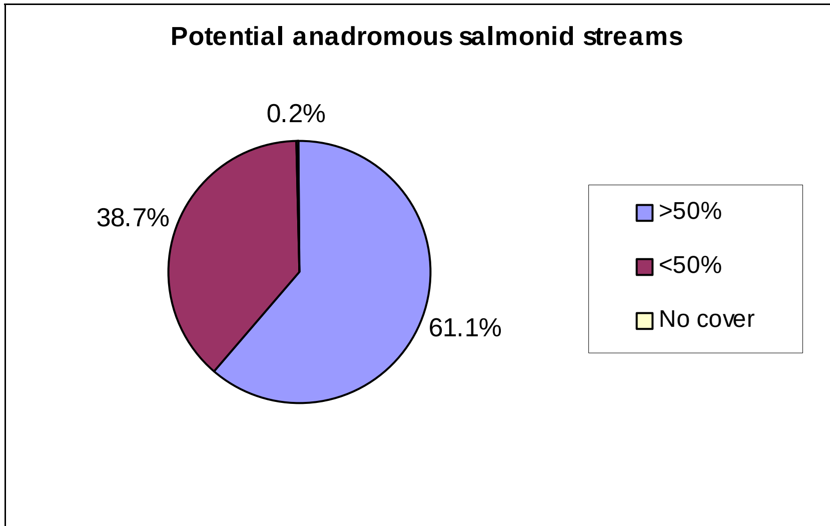

Non-salmonid streams
12.9%
19.4%
67.7%
2+ tree widths
1 tree width
No trees

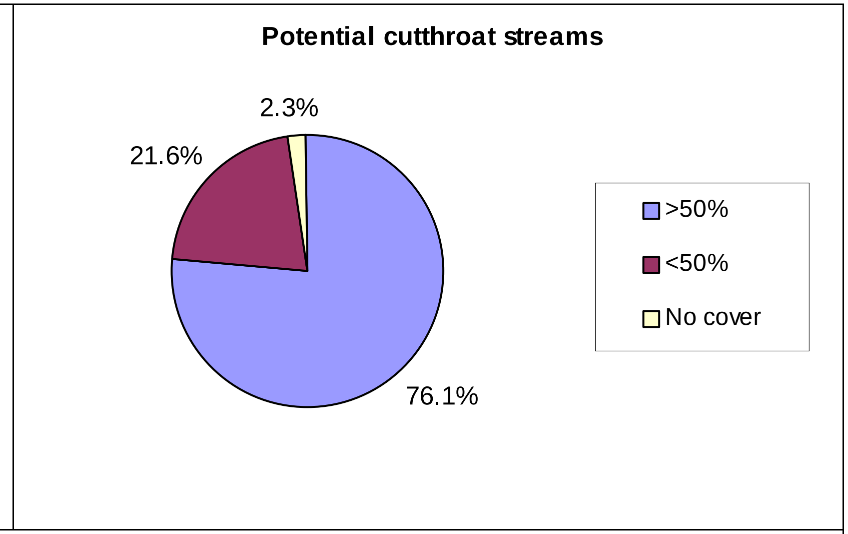
Appendix 7: Riparian cover

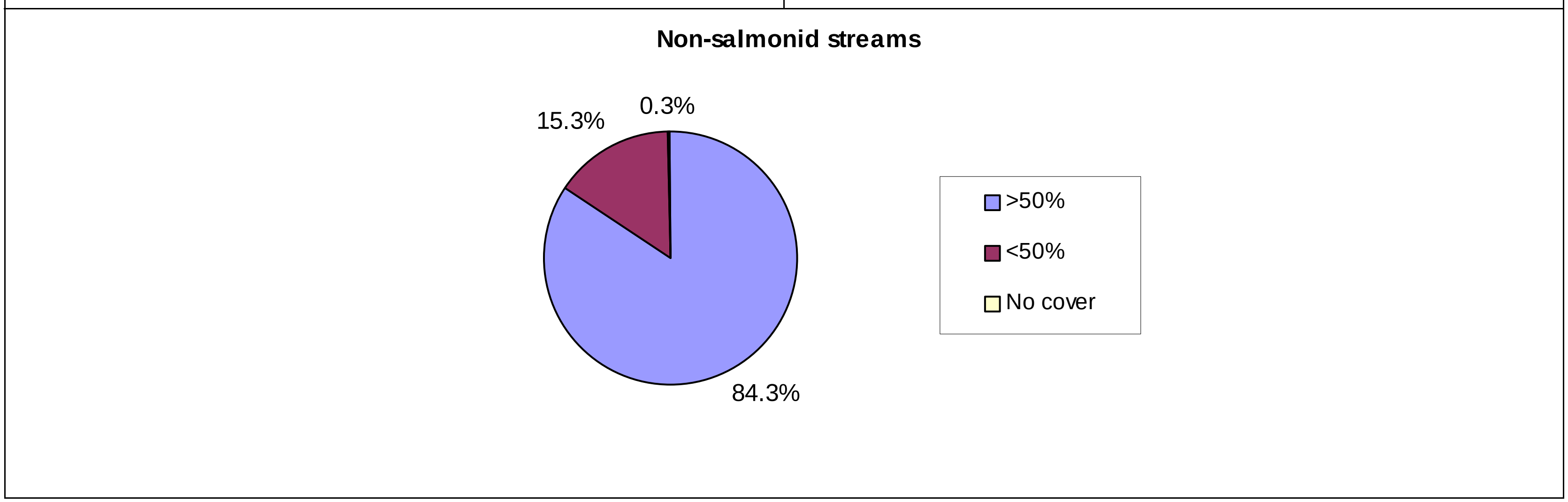







Potential anadromous salmonid streams
0.2%
38.7%
61.1%
>50%
<50%
No cover

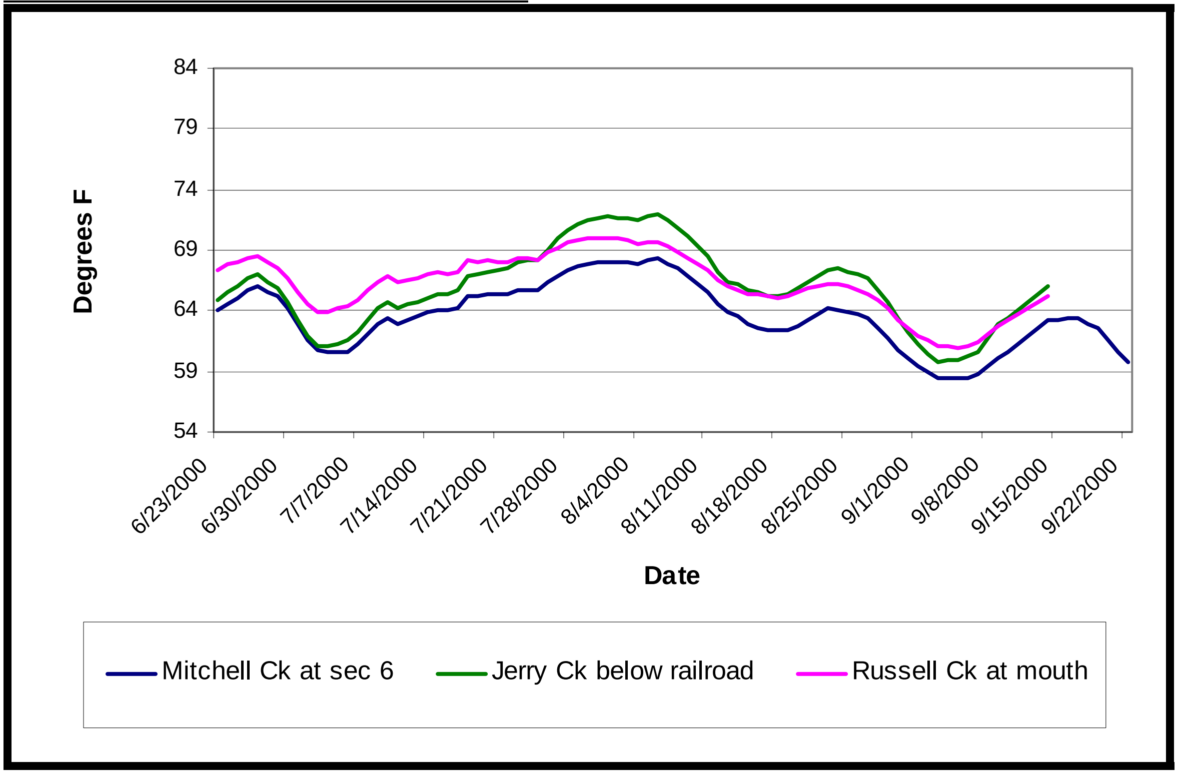

Potential cutthroat streams
2.3%
21.6%
76.1%
>50%
<50%
No cover


Non-salmonid streams
15.3%
0.3%
84.3%
>50%
<50%
No cover

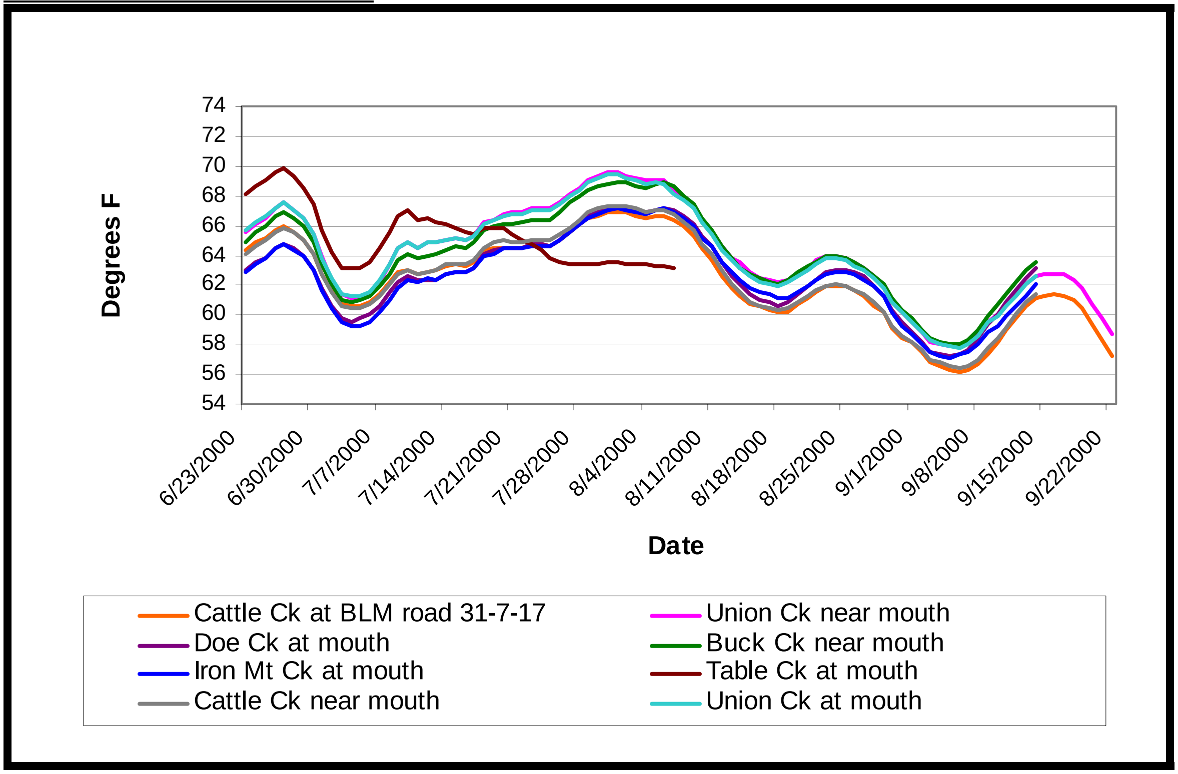
Appendix 8: Lower Cow Creek Watershed tributary temperature trends

(From K. Smith, 2000).

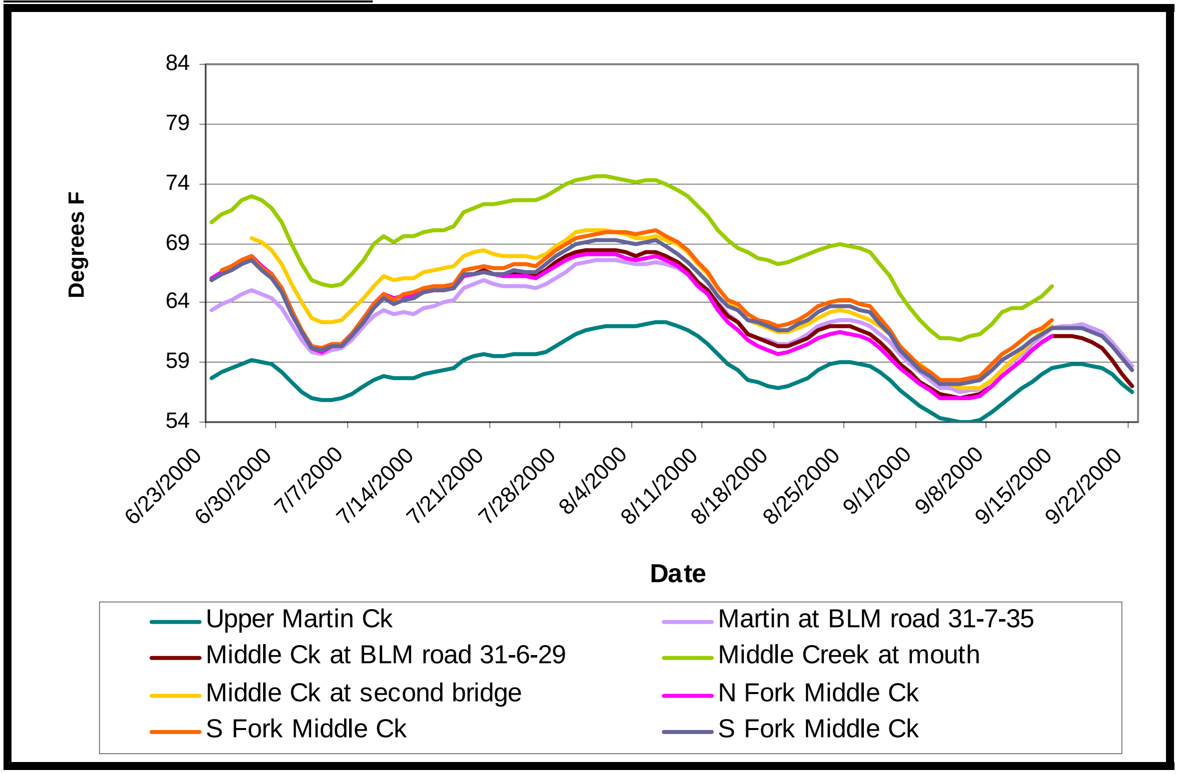
Tributaries near Cow Creek at the mouth



Central watershed tributaries

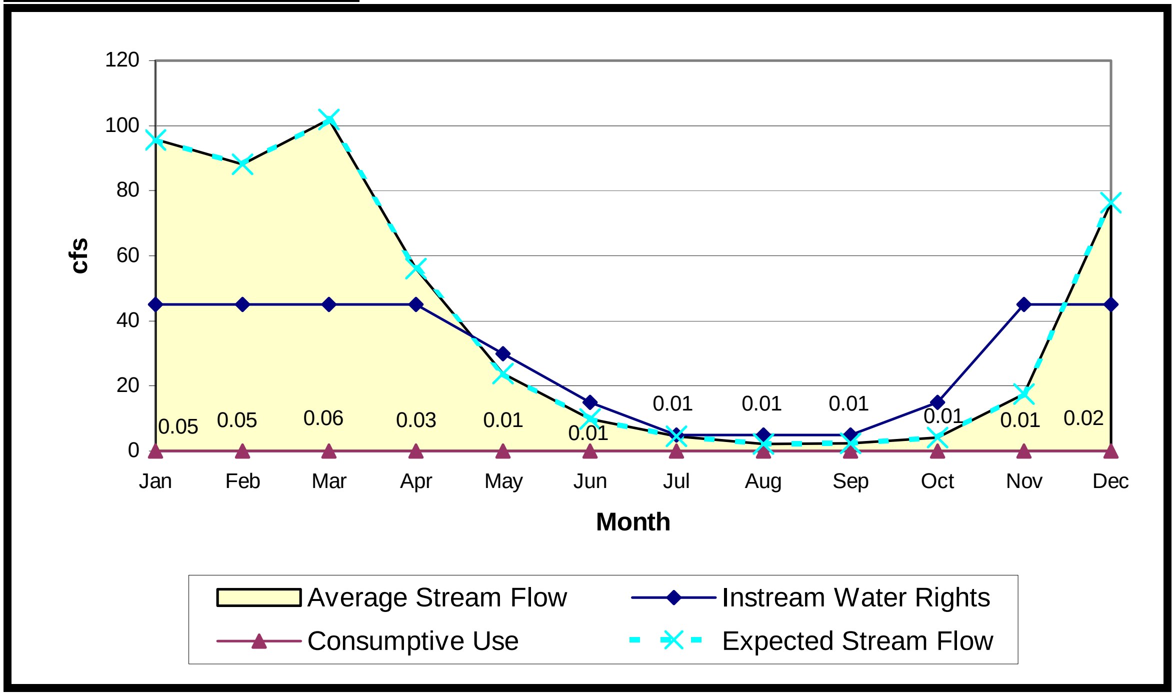


Middle Creek and tributaries



Appendix 9: Middle Creek water availability graph

WAB #326 – Middle Creek



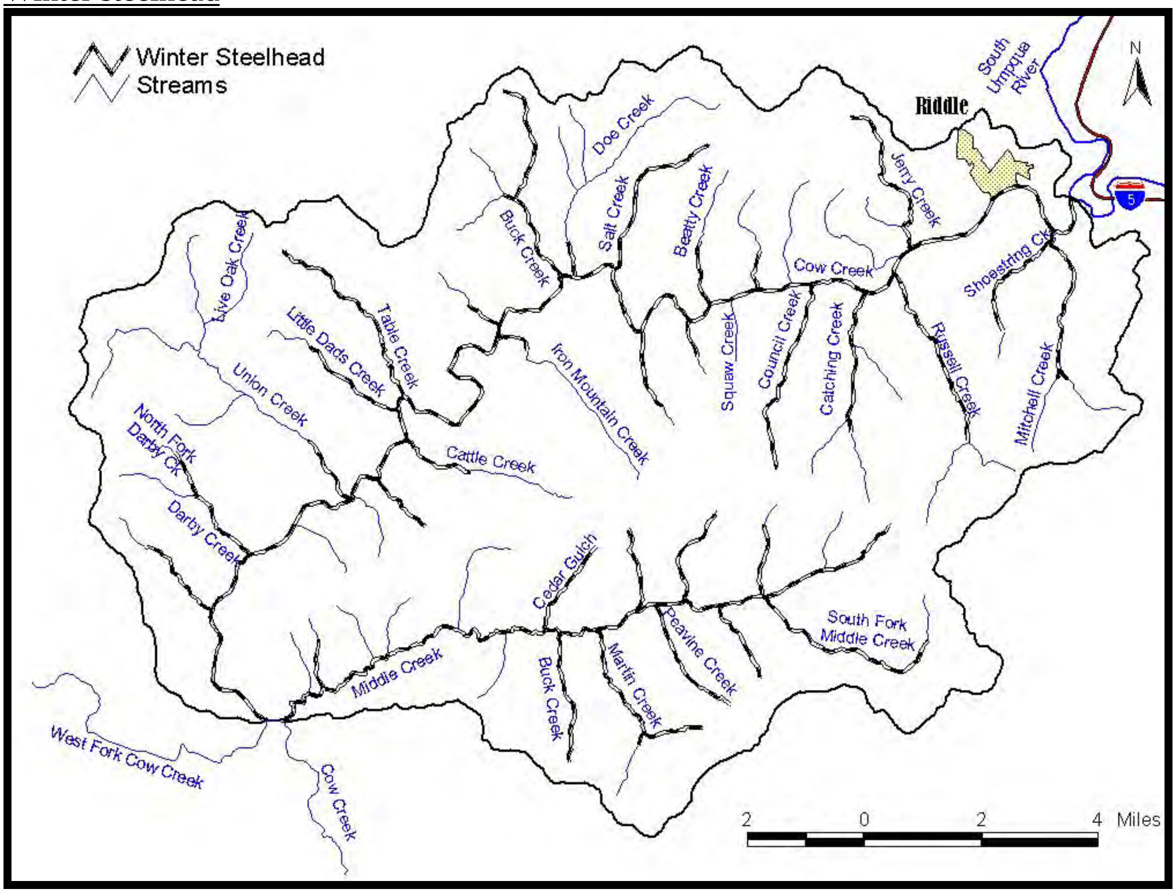
Appendix 10: Water use categories

There are eight general water use categories in the Lower 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 Lower Cow Creek Watershed.

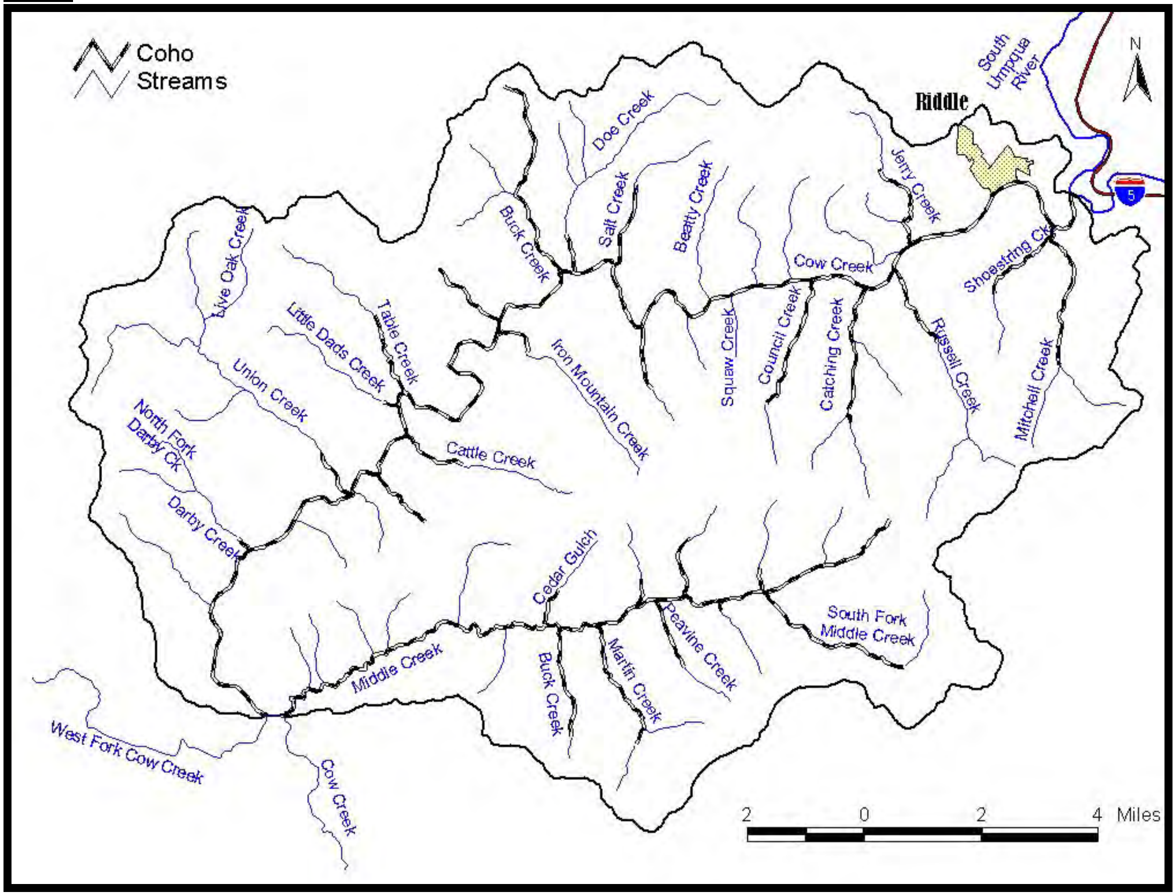
Irrigation	**Industrial**	**Domestic**
Primary and supplemental	Geothermal	Domestic
Irrigation	Manufacturing	Lawn and garden
Supplemental	Sawmill	Non-commercial
Cranberries	Shop	Stock
Irrigation, domestic & stock	Log deck	Group domestic
Irrigation & domestic	Commercial	Restroom
Irrigation & stock	Laboratory	School
Fish and Wildlife	**Municipal**	**Recreation**
Aquaculture	Municipal	Campground
Fish	Quasi-municipal	Recreation
Wildlife		School
Agriculture	**Miscellaneous**	
Agriculture	Air conditioning	
Cranberry harvest	Aesthetic	
Flood harvesting	Forest management	
All cranberry uses	Fire protection	
Temperature control	Groundwater recharge	
Dairy barn	Pollution abatement	
Frost protection	Road construction	
Greenhouse	Storage	
Mint still		
Nursery use		

Appendix 11: Anadromous salmonid distribution by species

Winter steelhead



Coho


Coho
Streams
Riddle
South Umpqua River
Doe Creek
Buck Creek
Salt Creek
Beatty Creek
Jerry Creek
Cow Creek
Shoestring Ck
Live Oak Creek
Table Creek
Little Dads Creek
Iron Mountain Creek
Squaw Creek
Council Creek
Catching Creek
Russell Creek
Mitchell Creek
Union Creek
North Fork Darby Ck
Cattle Creek
Darby Creek
Cedar Gulch
South Fork Middle Creek
Middle Creek
Buck Creek
Martin Creek
Peavine Creek
West Fork Cow Creek
Cow Creek
2
0
2
4
Miles
N
5

Fall chinook