Salt Creek Watershed Assessment

The Yamhill Basin Council • (503)472-6403
Yamhill and Polk Counties, Oregon
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Above photo: A tributary of Ash Swale flowing north from the McCoy area.

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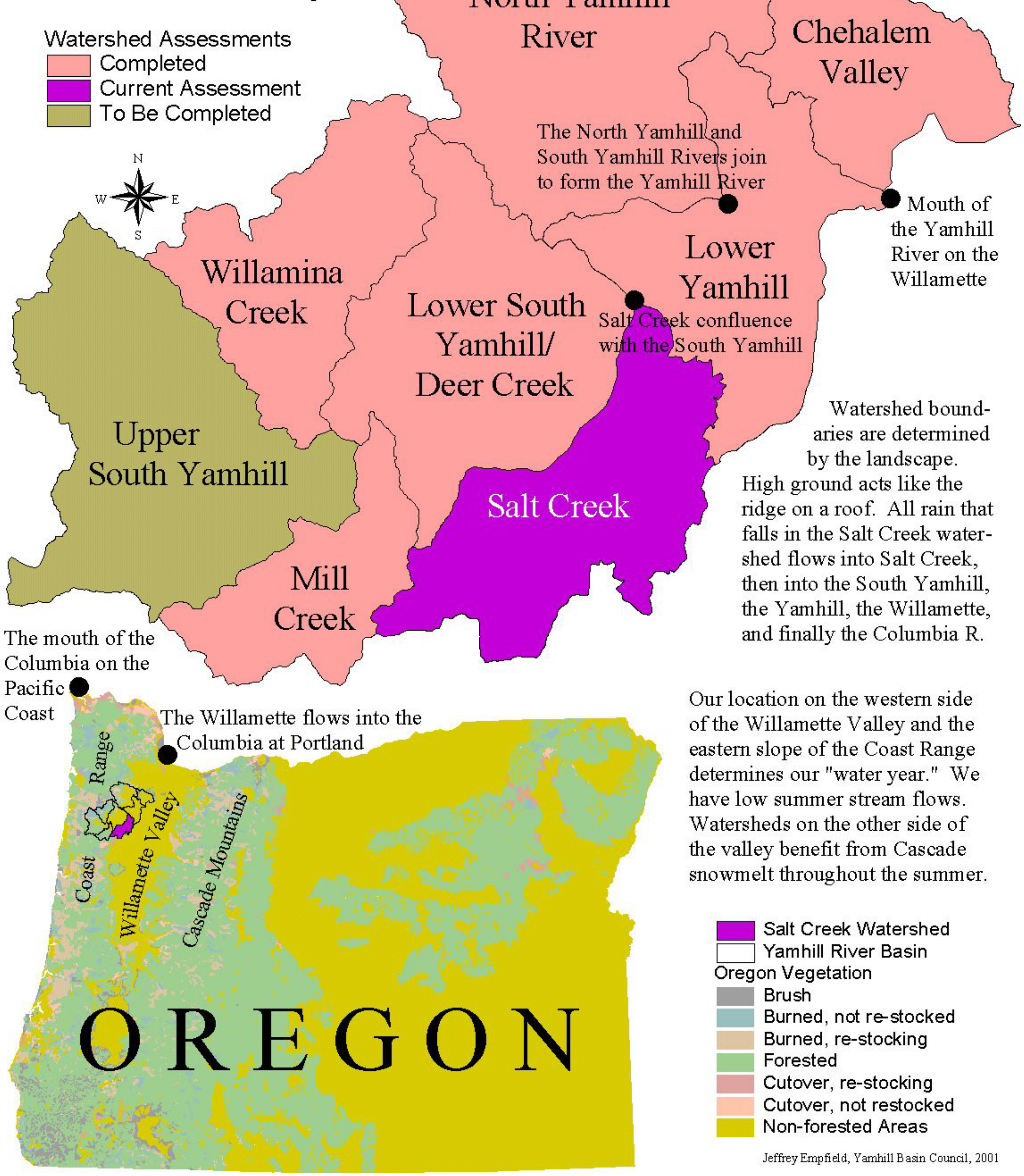
Abbreviations and Acronyms

BLM	Bureau of Land Management
CHT	Channel Habitat Types
CFS	Cubic Feet per Second
CREP	Conservation Reserve Enhancement Program
DBH	Diameter at Breast Height
DEQ	Department of Environmental Quality
DOGAMI	Department of Geology and Mining Industries
DO	Dissolved Oxygen
DSL	Division of State Lands
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information Systems
ISWR	Instream Water Rights
LCDC	Land Conservation and Development Commission
LWD	Large Woody Debris
LWI	Local Wetland Inventory
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service (was the SCS)
NTU	Nephelometric Turbidity Units
NWHI	Northwest Habitat Institute
NWI	National Wetland Inventory
ODFW	Oregon Dept. of Fish and Wildlife
ODF	Oregon Department of Forestry
OSUES	Oregon State University Extension Service
OWAM	Oregon Watershed Enhancement Board
RM	River Mile
SCS	Soil Conservation Service (now the NRCS)
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WRD	Water Resources Department
WRF	Water Reclamation Facility
WRP	Wetland Reserve Program
YBC	Yamhill Basin Council

Map 1. The Yamhill River Basin & the Chehalem Valley



"You just can't fight mother nature"—Eugene Villwock, lifelong Salt Creek resident and farmer

"Polk County will use drainage basin lines to delineate boundaries for studies relating to or affecting the carrying capacity of the County's land resources…
"Polk County shall recognize the significance of municipal watershed areas and, in the course of decision making, recognize the important natural values of the watershed and prohibit any use which could potentially degrade water quality or contaminate municipal drinking waters."—Polk County Comprehensive Plan

CHAPTER 1

Introduction and Watershed Overview

The Salt Creek watershed assessment is a publication of the Yamhill Basin Council (YBC) and is a reference tool for landowners, watershed residents, and council members. It contains factual and interpretive information about the condition of the watershed, both past and present. The overriding purpose of the assessment is to evaluate the watershed in terms of quality of life for basin residents. More specifically, it looks at how natural and human processes are influencing the watershed's capacity to produce clean water. It may serve as a baseline for designing restoration projects and will aid the Council and community members in developing monitoring plans. It is also tied to an ongoing process of community-based land use planning; the information contained will need to be updated as needs and objectives evolve.

The guidance for the assessment came from a manual developed specifically for Oregon. The Oregon Watershed Assessment Manual (OWAM) provides information on the resources available for completing a local assessment, information on watershed functions in Oregon, and suggestions for approaching each aspect of the assessment. The authors were trying to give us as many tools as they could in terms of a broad working knowledge of water's role in your surroundings. Reading and further investigating any portion of an assessment is valuable.

In our scientific age we rely heavily on data analysis. This is because we're looking for direction in a complex world of public policy, local politics, economic forces, diminishing resources, religious and cultural traditions, rapid changes in technology, and our natural surroundings—all of which we understand imperfectly.

Data used in preparing this document came from a wide variety of sources. The Bureau of Land Management's Geographic Information System (GIS) "base layers" provided data for many of the maps on which the document is hinged. The Oregon Water Resources Department, the Northwest Habitat Institute, the Oregon Department of Forestry, The Nature Conservancy, and the Federal Emergency Management Administration also provided "projections" used in the maps. Additional field work and interviews with local residents and officials was also helpful.

In contrast to the personal knowledge many residents have of the area, specific scientific data is limited for the Salt Creek area. The Yamhill River basin (including most of Yamhill County and the northern part of Polk County) has not been studied much by natural science researchers. This is noteworthy because our society has adopted scientific (and increasingly, ecological) management for our institutions, public lands, and natural surroundings. This approach demands statistics to serve as a basis for acceptable air and water pollution levels, wildlife habitat, and use of our natural resources. So it may surprise some readers that there is little documentation on historic and current fish populations, for example, or even on species surveys in the area. Only regional generalizations and some scattered stream and water quality data are available.

That doesn't mean there isn't any useful information available. The assessment contains a number of interesting insights and many surprising facts. It is just that a lot of the information comes from general databases for the Willamette Valley or for the state. Needless to say, there are opportunities for further investigation locally. The Yamhill Basin Council (YBC) began collecting stream temperature data in a number of locations in the basin during the summer of 1999. Please contact the YBC at (503) 472-6403 if you are interested in water quality monitoring or forming a community group to do so.

It is difficult to draw accurate conclusions on the condition of one's watershed without information of this kind. We can still draw meaningful conclusions based on what we know and more importantly we can determine what level of health we want to set as a goal for our watershed and work towards that goal.

Geographic Information Systems

Computer software called ArcView provided the tools for producing the maps and many of the statistics included in this document. ArcView is one of several commercial software packages available using Geographic Information System (GIS) technology. GIS allows maps to be produced from digitized information based on geographic coordinates—the map image is broken down into thousands of individual points and the computer remembers what each point represents. With this system, instead of drawing a line to represent a river the computer draws a number of dots that appear to form a line.

The significance of this technology is similar to the difference between a traditional camera and a digital camera. With a traditional camera (or map) we produce images that are somewhat inflexible; one can add to the image using various techniques but selecting, removing, or manipulating information from a film negative (or a traditional map) is difficult. The advantage of digitized information is that with a relatively simple personal computer, geographic information can be manipulated (selected, combined, removed, highlighted, differentiated, or correlated with other information) for specific, local purposes. For example, the wetlands, streams, and soils can all be displayed simultaneously to provide a better picture of the watershed's hydrologic conditions. Calculations and measurements can also be made using GIS. This versatility helps us answer many questions about the watershed and its features that otherwise might be prohibitively complex, expensive, or time consuming.

The assessment draws information from many sources in an effort to do preliminary footwork for interested residents. Additional data, maps, and explanations of water issues are available from public agencies, the library, and fellow residents. If you're interested in learning more about any of the topics in the assessment, talk to your neighbors or try a simple search on the internet (available free at the public library) to get you started.

Like all technological advances, GIS also contains weaknesses and represents a tradeoff with the advantages of the system it replaces. For example, the most basic limitation of GIS maps is the imperfect nature of the data on which they're based. The data comes from many sources of varying accuracy and should be read as interpretive in most cases. What you see on the map is an approximation of the actual conditions on the ground or in the water of your local surroundings. This is the case with all maps, satellite images, and even photographs.

Table 1. Examples of GIS Data Layers

- Watershed boundaries
- Streams
- Roads
- Land-use
- Land ownership
- Urban Growth Boundaries (UGB)
- Historic vegetation
- Current vegetation
- Geology
- Irrigation rights
- Wells
- Floodplain
- Debris flow risk
- Township, range, section lines
- Soil erodibility
- Wetlands, hydric soils

A second limitation of the maps included here is the scale of presentation. You'd be surprised at how much more you can see in GIS when you look at a large format wall map or use a computer to zoom in on a specific area in ArcView. Unlike these larger formats, our watershed of approximately 63,000 acres is represented here on 8.5" x 11" pages. So even though we're looking at a relatively local area, a lot of detail is lost. The significance for residents is that these maps are useful for gaining an understanding of the big picture of your immediate surroundings. Further investigation on the part of citizens is needed to determine locations and strategies for water-related issues.

Think of the information you find in this assessment as a new look at your surroundings rather than as the last word on things. Decide for yourself whether the neighborhood or countryside where you live is as healthy as you'd like it to be. Consider what you would like to see improve in your community or surroundings and how that might happen.

What is the Salt Creek Watershed?

The Salt Creek watershed is part of the Willamette River basin in the northwestern Willamette Valley. When referring to the Willamette, we can use "basin" and "watershed" interchangeably (but not synonymously) with "valley" because the size and shape of the Willamette watershed approximates the boundaries of one recognizable valley. Other large-scale watersheds contain thousands of distinct valleys. For instance the Columbia River basin is a huge watershed including much of the Pacific Northwest all the way to the western slope of the Northern Rockies and a portion of Canada. It is often more useful to use the word "watershed" in terms of the stream or river that is closest to your house. The area drained by each stream you see constitutes a watershed. The 63,000-acre Salt Creek watershed is on the eastern side of the Coast Range. Approximately 78% of the drainage lies in Polk County while the remaining 22% is in Yamhill County.

The major streams of the watershed include Salt Creek and Ash Swale. There are many other perennial or "blue line" streams in the watershed that are tributaries of these two; some have official names while other's do not.[1] The Salt Creek watershed can be further divided into sub-watersheds based on the guidelines set forth in the Oregon Watershed Assessment Manual (OWAM). Sub-watersheds can be identified using major drainages such as Ash Swale, lower Salt Creek, and upper Salt Creek; this helps neighbors address local issues they share. **See Map 2**. Elevations in the watershed range from 98 feet above sea level at Salt Creek's confluence with the South Yamhill River to about 2000 feet at Salt Creek's headwaters in the Coast Range. Other high points are found along the Amity and Eola Hills forming the eastern boundary of the watershed. A small tributary of Salt Creek drains a portion of the Amity Hills rising to 863 feet. Tributaries of Ash Swale drain the Eola Hills peaking at about 1160 feet.

Population

Polk County has a population listed at 62,380 while Yamhill County has 83,992 residents. Nearly all areas of the countryside are occupied in the Salt Creek watershed.

Table 2. Population and Rate of Growth with Projections for Coming Decades

Year	Polk County		Yamhill County	
1900	9,923	**Increase**	13,400	**Increase**
1910	13,469	35.74%	18,285	36.46%
1920	14,181	5.29%	20,529	12.27%
1930	16,858	18.87%	22,036	7.34%
1940	19,989	18.57%	26,336	19.51%
1950	26,317	31.66%	33,484	27.14%
1960	26,523	0.78%	32,478	-3.00%
1970	35,349	33.28%	40,213	23.82%
1980	45,203	27.88%	55,332	37.60%
1990	49,541	9.60%	65,551	18.47%
2000	62,380	25.92%	83,992	28.13%
2010	69,402†	11.26%	101,152†	20.43%
2020	78,502	13.11%	119,589	18.23%
2030	87,307	11.22%	138,095	15.47%
2040	95,479	9.36%	155,779	12.81%

Figures for 1900-2000 are from the U.S. Census Bureau.
† Projections for future decades come from the Oregon Office of Economic Analysis, Dept. of Administrative Services

[1] Blue line refers to the streams recorded in blue on USGS topographical maps

Amity is the only incorporated town in the watershed and has the only urban growth boundary. It has 1,478 residents as of the 2000 census. This represents a 25.8% increase from 1990, about the same rate of increase as Polk County (25.9%) but lower than Yamhill County's growth (28.1%) over the past decade. The annual state population growth rate is 2%, Portland's is 2.3%, Polk County is at 2.63%, while Yamhill County is at 2.7%.

Local planners use slightly different projections than those shown in Table 2. Polk County Planners accept figures from the Portland State University Center for Population Research. These place the future Polk County population at 80,048 in 2010 and 101,588 in 2020. Yamhill County Planners accept numbers from a private research firm that project 99,925 residents in 2010 and 116,975 by 2014.

Urban Growth Boundary (UGB)

Thirty years ago, statewide concern about accelerating and haphazard growth. Senate Bill 100 created the Land Conservation and Development Commission (LCDC) to improve state planning and to help municipalities with their local planning. Another boost for comprehensive planning came in the early 1970s when the Oregon Supreme Court found in two cases that when conflict existed between zoning and comprehensive plans, that the latter took precedence. Urban Growth Boundaries (UGB) were established statewide in response to the 1980 Oregon Statewide Planning Act. This was part of an effort to set goals and guidelines for urban growth including plans for adequate infrastructure.

Amity's current UGB—the hopeful limit of short-term urban growth—includes 219.15 acres and is the same as the city limits. Of those acres, 174.89 are developed and the remaining 44.26 acres are vacant and buildable. Amity Planner Walt Wendolowski anticipates the town will need to add about 25 acres to the UGB in the next few years. Any additions to the acreage should also account for amenities such as parks and schools. There are also some partially vacant residential acres that already have residences on them but that are large enough to accommodate additional development. Check with the planning department if you are interested in learning more about residential options such as "granny flats."

One of the issues facing planners is the question of how many additional dwelling units—houses and apartments—will be needed over the next 20 years. Creative solutions are needed. According to area planners, the challenge is to establish residential needs through data analysis, public planning workshops, and public hearings. The solution will likely include a combination of expanding area UGBs and adopting appropriate growth management measures such as revising zoning to allow additional residential options.

Climate and Topography

The Salt Creek climate is marine-influenced with extended winter rainy seasons and hot, dry summers. Snow and ice do not accumulate often, even at the higher elevations of the watershed. As a result “rain on snow events”—where heavy snow accumulation is followed by intensive rains—are rare. Rain on snow greatly increases the speed of runoff resulting in flooding. In 1964 and 1996, Coast Range rain on snow contributed to the record flooding in the area.

Average annual precipitation estimates are available from the Oregon Climate Service. Rainfall amounts vary in the watershed depending on location; the higher elevations receive up to 80 inches of precipitation annually while the bottomlands receive about 40 inches annually.

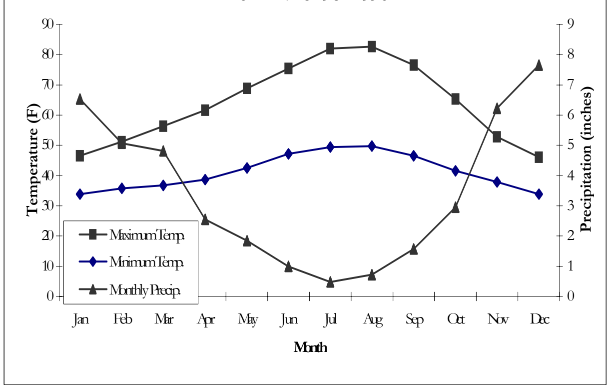


Figure 1. Average Monthly Temperatures and Precipitation McMinnville 1961-1990

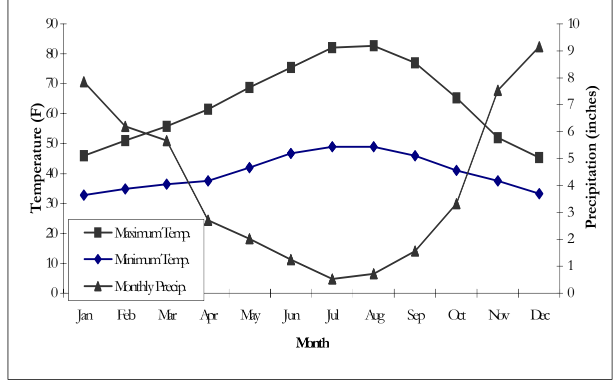


Figure 2. Average Monthly Temperatures and Precipitation Dallas 1961-1990

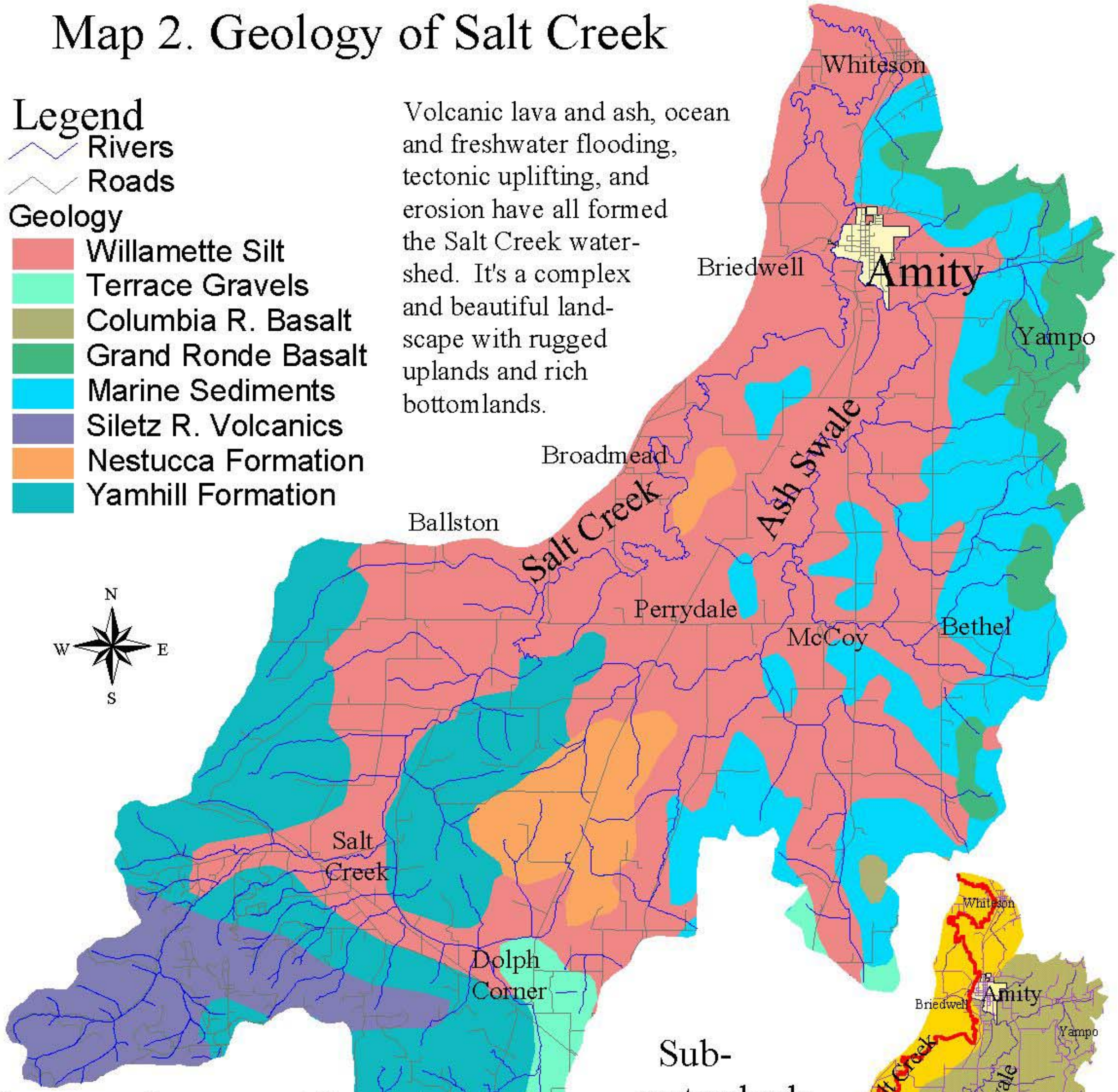
As is typical for the west side of the Cascades, precipitation is not spread evenly over the calendar year but falls during the fall, winter, and spring months from October to June. Figure 1 shows the average monthly temperatures and precipitation figures for McMinnville, just a few miles to the north of the Salt Creek watershed. Figure 2 shows data for Dallas located just to the south of the watershed. Average temperatures are nearly identical for the two cities with Dallas averages only slightly (two or three tenths of a degree Fahrenheit) cooler. Interestingly, Dallas precipitation averages are significantly higher (15%) than McMinnville during winter months, especially from November to February. During each of these wettest months, Dallas averages at least an inch more of precipitation than McMinnville. At an elevation of 290 feet, Dallas’ annual average precipitation is 49.1 inches while at 161 feet, McMinnville’s is 41.86 inches.

Geology and Soils

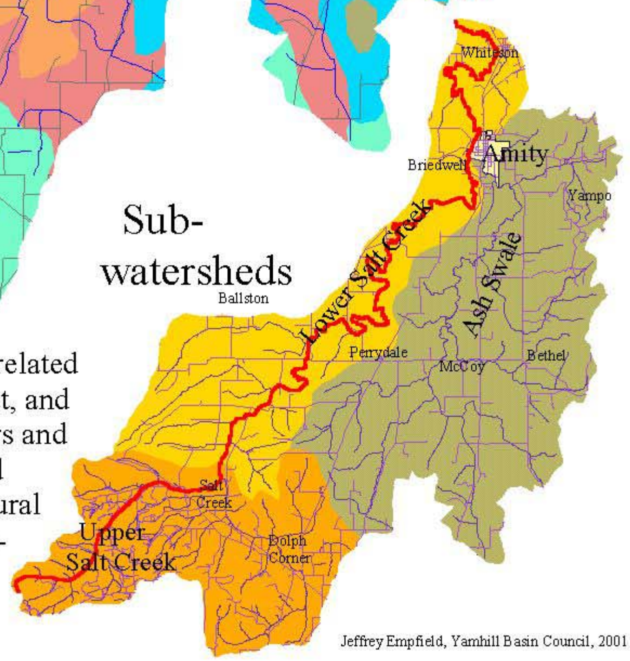
The geology of Salt Creek watershed helps us understand the topography and history of the landscape as well as the nature of the parent material that forms the soils. It also helps us understand how stream channels formed in our area and how changes in the landscape may lead to further stream bank erosion.

Salt Creek soils have both volcanic and sedimentary parent material—or raw material out of which the soils form. A variety of volcanic basalts intermingle with marine sediments resulting in a complex geology in the Coast Range and the Amity-Eola Hills. The valley

Map 2. Geology of Salt Creek



Volcanic lava and ash, ocean and freshwater flooding, tectonic uplifting, and erosion have all formed the Salt Creek watershed. It's a complex and beautiful landscape with rugged uplands and rich bottomlands.



Subwatersheds help us understand local water-related issues such as demand, supply, flooding, habitat, and pollution. In recent years, groups of landowners and residents in many parts of the U.S. have formed watershed groups to secure local control of natural resource decisions. The Oregon Watershed Enhancement Board (which funds the Yamhill Basin Council) gives the people of Oregon an opportunity to address problems locally.

Jeffrey Empfield, Yamhill Basin Council, 2001

floor has sedimentary rock with deep alluvial deposits overlaying it. The geology of the watershed is illustrated in Map 2 and described in more detail in Table 3, below.

Soils with similar profiles make up a *series* or an *association*. These are useful for understanding the content and major *horizons* (thickness and arrangement) of soils. The Soil Survey of Polk County lists five main soil associations for the Salt Creek watershed. The Soil Survey of Yamhill County lists three more. In-depth information on the soils and their characteristics and locations can be found in these and other publications of the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service, SCS).

The soils along the lower reaches of Salt Creek and Ash Swale (covering most of the low-lying parts of the watershed including Amity, Perrydale, and McCoy) are Woodburn-Willamette association soils. These are moderately well drained and nearly level silt loams and silty clay loams.

The tops of the Eola Hills have Jory-Nekia soils. These are usually well-drained, deep, gently sloping to very steep clay loams over clay. They may also be silt loams over silty clay. They're typically formed in basaltic colluvium. The Willakenzie-Hazelair association soils on the western slopes of the Amity and Eola Hills are gently sloping to steep silty clay loams formed over clay and siltstone. At the western base of the Eola Hills are Amity-Dayton association soils that are poorly drained, nearly level silt loams over silty clay loam and clay. The western slopes of the Eola Hills to the south are characterized by Helmick-Steiwer-Hazelair association soils. These are deep and moderately deep, well drained to somewhat poorly drained silt loams.

Helmick-Steiwer-Hazelair soils also cap the rolling hills south of Perrydale. On the southwestern side of this dome-shaped upland and further west in the foothills of the Coast
Range are Bellpine-Suver-Rickreall soils. These are both moderately deep and shallow, well drained to somewhat poorly drained silty clay loams. In the narrow valley between these two uplands, the upper Salt Creek and Hoekstre Slough flood plain has formed Cove-Bashaw soils that are poorly drained silty clay loams.

Further to the west, higher up in the foothills of the Coast Range are more Jory-Nekia soils and then finally at the headwaters are Peavine-Honeygrove-McDuff soils. These are deep and moderately deep, well-drained silty clay loams.

Table 3. Geology of the Salt Creek Watershed

Geologic Name	Description by P-types	Location
Columbia River basalts	**Tc** (Miocene) A group of succeeding volcanic flows high in glass content. Subaerial basalt and minor andesite lava flows and flow breccia; submarine palagonic tuff and pillow complexes. Locally includes invasive basalt flows. Occurs principally in the Willamette Valley from Salem north to the Columbia and in the northern Coast Range.	Isolated tops of Eola Hills
	Tcg Grande Ronde basalt (Middle and lower Miocene) Flows of dark-gray to black aphyric tholeiitic basalt. Potassium-argon ages mostly in the range of 15 to 17 Ma.	Tops of Amity-Eola Hills
Terrace, Pediment, and Lag Gravels	**Qt** (Holocene, Pleistocene) 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.	Rolling hills on the southern boundary of the watershed
Willamette silt	**Qs** (Pleistocene) Lacustrine and fluvial light-brown silt up to 75 feet thick throughout the Willamette Valley. Unconsolidated and semi-consolidated clay, silt, sand, and gravel; in places includes mudflow and fluvial deposits and discontinuous layers of peat. Includes older alluvium and related deposits of Willamette silt, alluvial silt, sand, and gravel that form terrace deposits.	Most of the level urban, agriculture, and industrial land in the valley
Nestucca formation	**Tss** (Upper and middle Eocene) Very mixed: volcanic flows, tuffs, marine siltstone, and sandstone. Thick to thin bedded. Fine to coarse grained.	Isolated mid-valley hills
Marine Sedimentary rocks	**Tsd** (Oligocene and upper Eocene) Sedimentary marine shale, siltstone, sandstone, and conglomerate, in places partly composed of tuffaceous and basaltic debris; interbeds of arkosic, glauconitic, and quartzose sandstone.	Lower elevations of Amity and Eola Hills
Siletz River Volcanics	**Tsr** (Middle and Lower Eocene and Paleocene) Aphitic to Porphyritic, vescular pillow flows, tuff-breccias, massive lava flows and sills of tholeiitic and alkalitic basalt. Upper part of sequence contains numerous interbeds of basaltic siltstone and sandstone, basaltic tuff, and locally derived basalt conglomerate. Rocks of unit pervasively zeolitized and veined with calcite. Most of these rocks are of marine origin and have been interpreted as oceanic crusts and seamounts. Foraminiferal assemblages referred to the ulitisian and penutian stages. Potassium-argon ages range from 50.7 ± 3.1 to 58.1 ± 1.5 Ma.	Middle elevations of the Coast Range
Yamhill Formation and related rocks	**Ty** (Upper and Middle Eocene) Massive to thin-bedded concretionary marine siltstone and thin interbeds of arkosic, glauconitic, and basaltic lava flows and lapilli tuff. Foraminiferal assemblages in siltstone referred to the ulatisian and lower narizian stages.	Lower foothills of the Coast Range

Surprisingly well correlated to geology is vegetation in the Salt Creek watershed. It varies a great deal depending on the location. In general, the hilly areas in the east and south are forested but in recent years increasing acreages have been converted to vineyards. Meanwhile the more level valley bottoms are dominated by an impressive variety of agricultural crops ranging from nurseries and annual and perennial grasses to row crops, berries, and orchards. For a more detailed outline of the area's vegetation, including current and historic conditions and noxious weeds, see Chapter 3.

Fire History

For at least the past four thousand years and possibly as long as ten thousand years prior to Euro-American settlement, humans systematically burned large sections of the Willamette Valley including Salt Creek. Biological and anthropological researchers agree that this long-established practice played a major role in the evolution of valley ecosystems.

The indigenous Che-ahm-ill people of the "Yam Hills" area were a sub-group of the Kalapuyan culture. They occupied the Salt Creek valley at the time of Euro-American contact and for several decades afterward until their numbers dwindled and the few survivors were removed with other tribes to reservations, primarily the Grand Ronde reservation several miles to the west. In the 1820s, the first white explorers in the valley reported large prairies, oak savannas, and thick smoke from widespread burning during the late summer. The newcomers reported that natives intentionally torched large portions of the landscape annually to hunt and encourage certain plant communities. Natives had developed a system of land management to help maintain favorable conditions for meeting their food and other needs. Many of these areas otherwise would have supported Douglas-fir forests if native burning had not occurred.

Natural and human-caused wildfires continued to shape the landscape after Euro-American settlement, but in different ways. In the 1850s, Coast Range forests burned more than they had in previous decades while valley prairies and savannas had less fire and were either turned to field and pasture or grew into forests. There were many fires in 1902 and 1910. In 1933 the infamous Tillamook burn covered nearly a quarter of a million acres. Since the 30s, fire suppression crews have become better trained and organized. Despite our extensive efforts, wildfires continue. In 1949, 18,000 acres of logged forestland burned in Yamhill County. In the 1950s a public education campaign through area newspapers urged residents to prevent forest fires. Through the later decades of the 20th century and currently, large fires continue to burn most years in various parts of the West.

Residential development located in forested areas will likely experience fires at some point. A lack of fire-breaks surrounding buildings, limited water availability during the high-risk summer months, and fire suppression over the last 100 or more years contribute to a fire hazard in the forested areas of the watershed. Suppression of fire has contributed as much to the current vegetation pattern as historically intentional burning did. The most obvious difference is that the region has more Douglas-fir-dominated acres and much less oak savanna and prairie than it did in the middle of the 19th century. See Maps 3 and 4 for the area's historic and current vegetation.

Land Ownership and Land Use

The overwhelming majority of the watershed's 63,143 acres are privately owned. Land use reflects this in a varied mosaic of agriculture, forestry, industry, residential, and commercial development. The headwater areas (upper Salt Creek) are similar to much of the surrounding mountains where conifer forest dominates. North of Highway 22 the land is a patchwork of relatively small, intensively managed parcels with a highly developed infrastructure. Agriculture accounts for most of the land in the watershed. Table 4 shows the acreage for various land use categories.

Table 4. Land Use of the Salt Creek Watershed

Land Use	Acres	Percentage
Agriculture	44,006	69.69%
Forested	18,007	28.52%
Urban	452	0.72%
Water, gravel, sand	356	0.56%
Reed canarygrass	322	0.51%
Total	63,143	100%

ArcView analysis of land use data from 1998.

Mining

Area quarries mine rock and gravel for road construction, fill, asphalt paving, or ready mix concrete. They are required to obtain permits from the Department of Geology and Mining Industries (DOGAMI). The Grant of Total Exemption Rule states that person(s) disturbing less than 5,000 cubic yards and/or less than one acre in a 12-month period need not apply for a permit with the state. That means that small amounts of earth can be moved legally without a permit unless one is near a wetland or body of water. In that case, the Division of State Lands would need to be contacted for a permit.

Table 5. Current Quarry Permits held in the Salt Creek Watershed

Number	Status	Name of Quarry and/or Permit Holder	Type	Location
36-0010	Permitted	Stephens Quarry, C.C. Meisel Company, Inc.	Basalt	5S 4W sec. 23
36-0036	Permitted	Larry L. Turner	Basalt	5S 4W sec. 23, 26
36-0002	Permitted	Anderson, Old McMinnville Rock Quarry, Western Aggregate Resources Inc.	Basalt	5S 4W sec. 23, 26

(From DOGAMI records office in Albany, Oregon, 2001)

If more than 5,000 cubic yards are being disturbed, a permit must be filed with the DOGAMI office in Albany, Oregon. This permitting process became law in 1974, making records of mines and quarries before that date unknown or anecdotal. Three quarries (two "Borrow Pit" and one "Gravel Pit") are shown on the USGS topographical maps of the watershed. These were updated most recently in the 60s and 70s. For further information on quarries, contact the USGS office in Portland: USGS, 10615 SE Cherryblossom Dr., Portland, OR 97216, (503)251-3200.

Agriculture

Historically and prehistorically, agriculture has been an important part of the culture and economy in the Yamhill basin. In 1947 there were 276,000 farmer-owned acres in Yamhill County. By 1959, this had dropped to 229,137 acres—87.9% of the county. The dominant land use (about 70%) in the Salt Creek watershed today is agriculture. Any approach to addressing the area's landscape-related issues must address the importance of agriculture.

Agriculture has great significance for the area's streams and rivers. Much of the area under cultivation in the watershed has been tiled and drained. The land has enough topography to provide outlets for drainage systems, unlike the central Willamette Valley, which is too flat to provide adequate drainage. Outlets for drainage systems allow water to be channeled off the surface and into streams making cultivation possible during the wetter part of the year. A side effect is that the area's hydrology is altered. Because agricultural issues pervade the landscape we will return often to them throughout the assessment.

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CHAPTER 2

Historical Conditions

Introduction

This chapter is an overview of historical events that have helped shape the Yamhill River basin. By looking at the environmental history of the area—the mutual influence of nature and human activity over time—one can understand something about human interaction with the landscape. The area's history has bearing both for the area's growth and for efforts to maintain or restore natural functions essential for water quality.

Timeline:

Before Europeans arrived, thousands of Native Kalapuyan people occupied the Yamhill Valley and used small, controlled, low temperature fires as a land-management tool. The Upper South Yamhill River was predominantly forested with significant areas of wetland, upland prairie, and oak savanna.

1775 First impact of Europeans reaching the region was the smallpox epidemic of 1775 that struck coastal and lower Columbia Native populations.

1782 Smallpox entered the Willamette Valley and the Native population severely declined. Intentional burns subsequently decreased.

1812 Pacific Fur Company traders entered the Willamette Valley under the leadership of Donald McKenzie—first documented contact between Kalapuyan and European people.

1830s Severe malaria epidemic plagued Kalapuyan people.

1834 Jason Lee established a mission at Wheatland on the east bank of the Willamette. Early settlers to the Yamhill basin crossed here from French Prairie.

1843 Provisional Government established at Champoeg began regulating land claims.

1845 The Champoeg Fire swept from the Willamette Valley to the Pacific Ocean burning large parts of the Yamhill basin. It encompassed an estimated 1,500,000 acres and is believed to be the largest area of old growth destroyed by a fire in the U.S. Polk County was created from the Yamhill District. At that time, Polk County stretched to the Pacific Ocean and far to the south.

1846 The United States gained Great Britain's claim of the Oregon Territory through a treaty. Natives still have claims to traditional ancestral homelands.

1848 Last large-scale Native-set fires recorded. Nestucca fire burned area forestlands.

1850 Cynthian (Dallas) became the Polk County seat. Census indicates 243 houses in Yamhill County.

1855 Congress ratified treaty with Confederated bands of Grand Ronde.

1856 Kalapuya, Umpqua, and Takelma peoples moved to the Grand Ronde reservation.

1859 Oregon gained statehood.

1861 Large flood estimated to be comparable to 1964 flood levels.

1887 The Southern Pacific Railroad began service through the Yamhill Valley shipping a high diversity of agricultural products. Prior to this only grains could be grown for distant markets; they were shipped by steamboat down the Willamette River.

1908 Grand Ronde Reservation Agency closed. Reservation land divided among remaining tribal members. Native children began attending public schools.

1911 First tractors began to replace animals for farming and gentle slope logging.

1923 Hydraulic sheave mounted to rear of tractors, allowed line logging on steep hillsides.

1929 Southern Pacific Railroad discontinued passenger service through Polk and Yamhill Counties.

1930s The Depression greatly affected agriculture and ended the production of prunes as a major crop. Hops farmers lost their market due to prohibition.

1947 Area forests reported by the Bonneville Power Administration to be "seriously depleted."

1948 Tansy ragwort, an invasive and aggressive plant introduced from Europe, took root in the area; it quickly colonizes areas of disturbance such as cut-over areas, ditches, and overgrazed pastures.

1954 Grand Ronde Reservation officially terminated by federal government. State officials began releasing hatchery coho salmon to area streams.

1856 BIA census report for each tribe at Grand Ronde estimates Kalapuya population at 748.

1964 A large flood damaged agricultural lands. An estimated 20 million tons of loose soil washed into streams. Bridges damaged or destroyed when logjams brought the full force of the water against them.

1980s Stocking of hatchery coho salmon and rainbow trout discontinued after biologists began to question detrimental interactions between wild (native) and stocked populations.

1983 Grand Ronde Reservation re-established.

1996 Large-scale flooding throughout the Willamette basin.

1998 Winter steelhead in the upper Willamette basin listed as threatened under the Endangered Species Act. The Confederated Tribes of Grand Ronde and the Yamhill Basin Council begin stream temperature monitoring on local streams. The Confederated Tribes of Grand Ronde also begin conducting habitat surveys and collecting macro-invertebrate samples on local streams.

Natives

Natives settled in a much colder and drier steppe environment with alpine forests covering uplands. The conditions under which these first Oregonians survived underwent drastic changes over time. During the period from 10,000 to 7,000 years ago, the climate warmed. Local conditions were still quite dry compared with today and fire-resistant ferns proliferated under spruce and oak forests. Today's cool, wet climate has characterized the region for only the past three or four thousand years.

Historian Joseph Taylor points out that Natives "[L]iving in the Willamette Valley above Willamette Falls adapted to a variable environment as the numbers of salmon and other migratory fish dropped off during most of the year." As a result, local Natives began to develop a plant-based subsistence strategy by 3,300 years ago that resembled the Kalapuya of the nineteenth century. As early as 1,800 years ago, Natives relied primarily on local camas roots and also consumed fish.

Warmer conditions following the last Ice Age resulted in a trend from migratory to semi-sedentary settlement patterns. With increasingly specialized bands becoming settled in their own territories, Natives began to rely more on food storage and preservation, household-based subsistence economies, and land management for food resources. This required sophisticated knowledge about when, where, and how often to burn and harvest foods. Despite specialization and settlement, Native food consumption remained flexible. As Taylor points out, historical salmon use by Natives mirrored salmon availability. When salmon populations were low, Natives used other natural supplies.

Anthropologists believe Northwestern Natives' respect for other species, particularly food species, was important for developing careful, knowledgeable use of plants and animals. Their stories and beliefs reflect this orientation.

Natives at the time of Contact

When Lewis and Clark passed through the Columbia Gorge in 1805 they encountered a settled landscape of varied and interconnected Native cultures. They noted a lively trade network across the region in spite of population losses to smallpox that had swept through decades earlier. Many of its victims had not even seen a European person. A well-established system of trade, communication, and social organization evolved here over millennia.

Along the Columbia lived the Chinook tribes whose activity and iconography focused on the river and the bounty of food it provided. Just south of the Chinook villages were the Tualatin people—the northernmost of the Kalapuya tribes living north of the Yamhill basin. They dwelt on the cultural fringe between the Willamette Valley and the Columbia River culture groups. As Kalapuyans, the Tualatins were one of the Penutian-speaking peoples that occupied the Willamette Valley at the time of European contact. The Kalapuya were an inland people whose territory included the Willamette Valley as far north as Willamette Falls (at Oregon City) and south including the headwaters of the Willamette and a small portion of the upper Umpqua River drainage.

Each of the 13 or so Kalapuyan tribes lived as an autonomous group within their own territory—better defined as an area of influence that possibly followed watershed boundaries. Within their area the group had access to most of what they needed in plants, animals, and other resources. Oral histories have indicated that natives shared access to resources and hunting areas, and individual clans and/or families maintained certain harvest areas.

South of Chehalem Mountain, another valley of grass-covered hills was occupied by the Che-ahm-ill Kalapuyans. Here in "Yamhill" country, population density was perhaps lower than along the Columbia or the coast, but still relatively high for western Natives. The economy was less centralized and relied more on plants and seasonal migration in contrast to the settled economy of salmon fishing along the Columbia and lower Willamette.

A significant amount of cultural debris from pre-historic cultures has been collected in the Yamhill basin. More can be learned from the Oregon Museum of Anthropology in Eugene. Interpretations of their significance rely mainly on informed speculation. Basic conclusions include that of a deeply complex culture developed over a time period lasting much longer than the current historic period. More significantly, the prehistoric system co-evolved with the local ecology, relied overwhelmingly on local, renewable resources, supported a large, relatively healthy population, and was rich in leisure time, craft, and both utilitarian and non-utilitarian art.

Willamette Valley people developed Plateau-like subsistence patterns for summer months because local resources were dispersed over a wide area. They migrated during the dry half of the year, possessed less property, and celebrated fewer ceremonies than people in neighboring areas. The relative scarcity of salmon above Willamette Falls and the seasonal nature of subsistence hunter-gathering led to trading as the main strategy for procuring fish. As staple foods, camas and wapato were valuable trade items at centers located at Willamette Falls and on the coast.

Plants accounted for a significant portion of Kalapuyan nutritional intake in addition to meat. Camas was the most important of all plants; they roasted it in pit-type ovens. Other nutritionally important plants were wapato, tarweed seeds, hazelnuts, and various berry species. Natives also cultivated tobacco (*Nicotiana sp*.). They used White oak acorns but these do not seem to have been a major part of their diet. Abundant wildlife was also utilized by the Kalapuya including deer, elk, Canada geese, ground squirrels, jack rabbits, black bear, birds, fish, clams, lamprey, and grasshoppers. After countless generations of harvesting these plants and animals, Natives had learned how to benefit from them without overharvesting.

In *Steelhead's Mother was his Father, Salmon,* Joseph Taylor writes that prior to European contact, Natives "were aware of the limits of exploitation [of natural resources], and in response developed a sophisticated set of social practices and cultural beliefs to moderate their impact." So, in spite of natural fluctuations both from year to year and over long periods of time, Natives established villages and settled economies based largely on salmon and semi-wild root crops without heavy reliance on what one thinks of today as agriculture.

European Contact

When European diseases arrived, crowded winter villages proved a perfect breeding ground for diseases like smallpox and malaria. A severe epidemic plagued area Natives throughout the 1830s especially during the first three years of the decade. At the time known as the "Internment Fever," malaria was the disease that would most reduce Native populations throughout western Oregon. "Between 1830 and 1841," Taylor reports, "losses exceeded eighty-five percent." By the 1840s, when immigrant farmers brought thousands of cattle into the valley, there was little to keep them from over-running and ruining traditional Native food sources. Many Natives hid in the woods and hills to avoid contact with Europeans.

After thousands of years of settlement, the land appeared pristine to European eyes and supported more biodiversity than remains today. When Commodore Charles Wilkes visited the area in 1841 he found a well-cared-for landscape, although the significance of that was likely lost on him. Europeans had trouble seeing the value of Native ways. Like 19^{th} century Yamhill County resident J.C. Cooper, many Europeans regarded the Natives as "neither crafty nor cunning…a quiet, indolent people." Wilkes instead focused on the land, describing the "Yam Hills" as moderate, "the tops are easily reached on horseback, and every part of them which I saw was deemed susceptible of cultivation. The soil is a reddish clay, and bears few marks of any wash from the rains"—a telling observation by someone familiar with the effects of plowing and overgrazing. "These hills are clothed to the very top with grass, and afford excellent pasturage for cattle," Wilkes concluded, and soon they would be put to that purpose. Already in 1841 on the "route through the Yam Hills," Wilkes reported, "we passed many settlers' establishments."

Grand Ronde Reservation

During the early 1850s, various Native groups from around Oregon negotiated treaties to secure small reservations that would have allowed them to remain on their ancestral land. Before ratification took place, however, a large gold rush occurred in southern Oregon leading to the Rogue River wars. Fear swept over the territory. Back in Yamhill County, Joel Palmer hastily set up the Grand Ronde reservation on a narrow prairie in the Coast Range. In July 1855, the remaining Kalapuyans ceded their traditional ancestral homelands, the Willamette Valley, and were moved to the Grand Ronde reservation the following year. By 1857, many of them had died of disease—health conditions were possibly made worse by the damper environment of the Coast Range.

Kalapuyans blended with other Native groups at the Grand Ronde reservation in a mixed society that relied on basic trade words more than their tribal languages. The 1860 census counted 9,000 Natives and 52,288 non-Natives in Oregon. By 1900, the Native population had dropped to 4,951 and non-Native numbers had increased to 417,585. These numbers do not include Natives who were hiding from the Europeans.

On the reservation, the process of cultural replacement continued. The federal agent at Grand Ronde Agency reported that Europeans tried to scare Natives into giving up and leaving by claiming that Natives' land titles were worthless. At the same time, the agent's job was to keep Natives on the new reservation. Historian Joseph Taylor said that Natives from southern Oregon were not familiar with local species and thus relied on annuities promised in the treaties in exchange for the land that they ceded. Molalas, Clackamases, Clowellas and other groups still migrated in the spring and fall to Willamette Falls to fish for salmon. The agent provided some Natives with supplies to fish the Salmon River to prevent them from migrating to and fighting with the Europeans at Willamette Falls.

Under the reservation system, the U.S. President awarded agency posts to those who had served in political parties, civic, or military service. Agents enjoyed wide powers: they hired their own employees, managed financial affairs, and reportedly enjoyed large personal profits through their position. The 1870s brought reform to the system and greater influence by missionary churches. At Grand Ronde, the Irish Catholic agent Patrick Sinnott served from 1872-85. During this period, family farms became the mainstay of the economy, many Natives became citizens, tribal loyalty gave way to reservation loyalty, and leadership shifted from chiefs to elected councils.

In terms of transforming Natives into farmers, Grand Ronde proved to be the Office of Indian Affairs' greatest success story in Oregon. Through a combination of accommodation and strategic access to markets, the Natives were "actively engaged" in agriculture by 1867. That year Grand Ronde farmers earned over $23,000 from plant crops, livestock, and poultry. Part of the acculturation strategy was the privatization of tribal land. In 1873, Natives at Grand Ronde were the first in Oregon to receive individual allotments for farming. By 1879, the agent claimed "as a rule" Natives were living by agriculture.

They accomplished this despite their old seed stock and the fact that both the agent and neighboring settlers considered reservation land "foul" for agricultural purposes. Natives compensated by focusing on the strengths of their land. The high, cool valley was excellent for growing grass so they increased their reliance on livestock. By 1881, most Natives in Grand Ronde reportedly resided on their own land and by the turn of the century the agent claimed they were virtually all independent farmers selling hay, wood, and other items further down the valley.

These reports may be somewhat overstated. Other reports suggest that a mixture of agriculture and traditional hunter-gathering continued through the 19th century. In 1882, officials reported that of 3,448 Natives at Grand Ronde, Siletz, Umatilla, and Warm Springs Reservations, only 824 were actively pursuing farming. The rest "supported themselves by either laboring or subsisting by traditional means." Dennis Werth believes that work off the reservation was common by the 1870s when large numbers of Natives were absent seasonally. He explains that this was necessary "to avoid starvation because of the poor soils, the lousy weather, and the general unsuitability to make it farming in the area."

Attempts to characterize cultural practices likely oversimplify what must have been an ongoing process of compromise between the old ways and the new. In 1875, the agent at Grand Ronde reported that only a few of the oldest members clung to traditional ways. Yet two years later, access to the salmon fishery at Salmon River, game hunting, and berry gathering were listed as important elements of subsistence. Despite efforts to limit their movements, many Natives continued to travel to traditional food harvesting locations such as Willamette Falls. Other traditional practices blended well with the new market economy. In 1899, women at Grand Ronde were harvesting hazel sprouts to produce intricately woven baskets. They sold these to merchants in Portland to help support their families.

European Settlers

The area that now includes Yamhill and Polk Counties was home to many of Oregon's earliest European settlers who began arriving in significant numbers in the 1840s. The greatest proportion were Europeans from eastern states that had already moved to the Midwestern frontier. In many cases, pioneers spent a few years in places such as Kentucky or Ohio before embarking on the Oregon trail. Many were enticed by lavish descriptions of Oregon and the promise of free or cheap land.

There were various rules of the provisional government aimed at limiting single family holdings to a reasonable acreage. Limits were needed due to land speculation. Indeed, some settlers came to Oregon specifically to get rich by speculating on land, a process they believed would take no more than ten years. University of Oregon geographer Jerry Charles Towle writes that "[w]hatever the intention of Congress, there is little doubt that the settlers themselves intended to sell a portion of their grants, and hoped for extremely high returns." Unfortunately for the speculators, a high demand for these excess acres never developed in the 19th century. As late as 1899, for example, some 40,000 arable acres were not in production in Yamhill and Polk Counties.

By 1850, Oregon had an official population of 11,952—nearly all of those counted were residing in the Willamette Valley. Many of these were Natives but undoubtedly not all Natives were counted. Significant numbers of settlers came from all regions of the United States. Consequently, no single agricultural tradition was transplanted to the Willamette Valley. This resulted in a unique system where each farmer held unprecedented numbers of cattle and horses. The relatively large land claims of prairie and savanna made this possible. Area farms of the 19th century were typically over 200 or 300 acres. This was dedicated mostly to woodlots with some field cropping and pasture for cattle, sheep, hogs, and horses. The valleys filled up rapidly with cattle herds pushing into the hills of the Upper South Yamhill River.

Soon after pioneers arrived, they began traveling up the South Yamhill River to cross over into the Nestucca drainage. In 1837, missionaries Jason Lee and Cyrus Shepard and their brides used the Old Elk Creek trail to visit the coast from their mission near present day Wheatland. James Quick and his family were the first Europeans to take this route for the purpose of homesteading. They settled in the Tillamook area in 1852 and were soon followed by others. The Tillamook pioneers initiated an effort to improve the trail; settlers worked on it from both ends.

Use of the trail increased in 1856 as a result of the establishment of the Grand Ronde and Siletz reservations; the U.S. military used the trail—now called "The Road to the Coast"—for patrolling the area and for traveling between the reservations. In 1864, Yamhill, Polk, and Tillamook counties improved the trail and started charging for its use as a toll-road. Even so, the route remained only marginally passable through the early decades of the 20th century. Just west of the Upper South Yamhill River watershed is an area called Boyer Flat, the site of an overnight hotel and toll-gate operated by John and Julia Boyer from 1908 to 1920. In 1930, Oregon completed Highway 18 following the historic trail.

The Forest

Jane Claire Dirks-Edmunds recounts her decades-long research in the headwater forests of the Coast Range in *Not Just Trees: The Legacy of a Douglas-fir Forest.* Dirks-Edmunds first saw the area surrounding her study site on Saddleback Mountain as a sophomore at Linfield College.

> "On that day December 30, 1933, the only visible breaks in all that expanse were tiny clusters of buildings that formed the towns…We had scrambled from the trail nearby to reach this promontory near the top of 3,200-foot Saddleback Mountain and now stood in awed silence, hearing only the sighing of wind-stirred trees."

James Macnab, a research biologist from Linfield College, explained to his students that the coastal forest stretched from San Francisco to Alaska and contained ancient Douglas-firs, hemlocks, spruces, cedars, true firs, and redwoods. "It's a living being," he explained, "sheltering and sustaining a vast array of unknown animals and plants." Though she had been to the forest many times, Jane Claire had never seen such an endless display of huge conifers.

The researchers' earliest observations consisted of ecological inventories in old growth and burnt areas. They tracked where fires had occurred by noting the smaller trees that were only 50 to 100 years old. "The Tillamook fire of last August destroyed a lot of trees like these," Professor Macnab explained, "and studies have shown that similar burns, probably caused by lightning, have long been occurring in these forests." Periodic fires, landslides, windstorms and other natural disturbances are partly responsible for the survival of Douglas-fir-dominated forests of the Coast Range. Douglas-firs often live for hundred of years but their saplings do not do well in the shade of closed-canopy forests.

In 1940, the research site on Saddleback Mountain was clear-cut; over the following decades Jane Claire and others chronicled successive stages of re-vegetation. Their observations are summarized in Chapter 3 on Vegetation. In 1998 there was a new clear-cut on the site, once again favoring pioneer species that thrive on disturbance.

Area forests have improved over the past fifty years. According to a 1947 Department of the Interior report, the forests of the area were "seriously depleted" and the number of jobs in forestry and wood products was expected to drop due to "reduced lumber production resulting from exhaustion of local timber supplies." In 1942 the Forest Service classed 51% of the area as forestland, 48% as agricultural, and 1% as waste. Nearly half of the forestland contained immature conifers in 1947 while only one-fifth represented saw-timber; the rest was cut over or deforested by fire.

Recreation

Historically, Yamhill and Polk Counties have not emphasized establishment of parkland. In 1966, Yamhill had 13 parks totaling less than 60 acres with a budget of $12,000. That's less than 40 cents per resident at a time when other counties in Oregon were spending over $3 per capita on parks. Since then, the Yamhill County Parks acreage has increased to over 81 acres. The budget has increased to an estimated $110,000 annually through an arrangement between the Parks department and the County Corrections department. In 1990, the Polk County Comprehensive Plan reported 16 parks totaling 208 acres. Increasing urbanization and the growth in popularity of recreation have resulted in a growing demand for facilities. Robin DeForest of the Polk County Parks Department explains that the county now manages 17 parks with over 700 acres. Twelve are operational for day use by the public.

Interest in improving the quality of life in the area has increased through recent decades. Designated recreational opportunities remain rare, however, by Oregon standards. Hiking and horse riding trails remain scarce. Recognizing that opportunities exist in the growing outdoor recreation industry, area leaders have established rest areas and parks along roads adjacent to streams.

Basin residents can look forward to having additional recreation outlets in coming years. The Oregon Parks and Recreation Department (OPRD), in cooperation with the Confederated Tribes of Grand Ronde (CTGR), is currently developing historic Fort Yamhill near Valley Junction as a

State Park interpretive center. Completion is slated for 2006 in time for the fort's sesquicentennial celebration. Established in 1856, Fort Yamhill was one of four military posts whose purpose was to both contain and protect Natives at the newly formed reservations. OPRD, the Tribal Council, and casino staff are working together to develop the Fort Yamhill site in the context of ancestral Natives. The site is located approximately 2 miles north of the Spirit Mountain Casino. Over the past decade, OPRD has been developing plans for the state-owned portion (52 acres) of the site. Recently, the Confederated Tribes of Grand Ronde acquired a key parcel (113 acres) that will provide parking and other staging for public access. For more information, contact Kristen Stallman, Oregon Parks and Recreation Department, Master Planning Coordinator, 1115 Commercial St NE, Suite 1, Salem OR 97301, 503-378-4168 x328, kristen.stallman@state.or.us

According to Yamhill County Parks Coordinator David Primozich, efforts are underway for establishing a campground and trail facility just west of McMinnville. The Coast Range Equestrian Trail Association (CREST), a local citizen group, is seeking input from interested parties. Next, an environmental assessment will need to be completed and then the design will need to make its way through the BLM approval process. This process may take as much as five years. If successful, it will mean the first public camping sites in the county and a new 10-mile loop trail.

Each county's share of the Oregon State Parks fund is based on the number of recreational vehicles registered and the number of public campsites available in the county. As a result of having campsites, several counties in western Oregon have parks budgets running up to several million dollars. Not only do they collect fees from campers, but their share of the State Park Fund increases for every campsite in the county. Polk and Yamhill Counties do not currently have any campsites.

With the opening of Spirit Mountain Casino in 1995, much-needed economic benefits of tourism came to the area along with new challenges related to development, traffic, storm water run-off, and water quality. The mission of the Spirit Mountain Development Corporation is "to establish economic self-sufficiency, develop the local economy, and to create resources for future prosperity of the CTGR, while preserving both the environment and its members heritage and customs." In support of this, future development will need to include measures to sustain watershed health. Transportation is a prominent issue, as the casino receives millions of visits annually.

Additional outdoor-oriented destinations would contribute to a more diverse economy. The area is well-suited to this due to its natural beauty—the dozens of waterfalls for instance—and the burgeoning population of outdoor enthusiasts living in Oregon.

Conclusion

The Native Che-ahm-ill group of Kalapuyan people were part of a distinct upper Willamette Valley culture that had close ties to the people along the Columbia and some contact with coastal and southern Oregon cultures. They relied heavily on plant foods, secondarily on meat, and very little on salmon. Natives managed the watershed, in part, with late summer burning. The majority of the Upper South Yamhill River watershed—nearly 87%—was forested in pioneer times. The remaining 13% was savanna, prairie grassland, and brush.

European settlement brought an end to intentional burns resulting in bottomland areas becoming more heavily forested, mostly by Oregon white oak and Douglas-fir-dominated woodlands. Forestry has been important to the area throughout recent history and will continue to be an important source of jobs. Tourism is increasingly important and should be guided by far-sighted goals to maximize benefits while avoiding the pitfalls of development and economic booms.

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CHAPTER 3
Vegetation

Introduction

This chapter covers the variety and function of historic and current vegetation in the region. About three-quarters of the watershed is non-forested and was so historically. The composition of species and plant communities has changed significantly following pioneer settlement. Native plants growing in association with one another contribute to water quality. Riparian vegetation is lacking in many areas of Salt Creek watershed; this is a major area of concern and also provides one of the best opportunities for quick improvement.

Historic Vegetation

Much of what we know about the native vegetation of the Willamette Valley comes from accounts by explorers, early newspapers, and the personal letters and diaries of settlers. We know that most of the Willamette Valley was prairie and savanna but that the Willamette River floodplain was covered with a rather dense forest that included many Douglas-fir. We also know that Indian-set fires were important since at least 1647 but ceased after 1848, according to tree ring analysis.

Early botanical analysis helps to illustrate historical vegetation patterns. Writing in 1902, J. E. Kirkwood explained that in the 50 years since pioneer settlement, most of the lowland forest had been cleared with the exception of riparian areas. Kirkwood notes that a "remnant of the forest remains along the banks of streams whose location and course may by this means be determined from a distance." Oak forests had already taken on the appearance they have today. "*Quercus* [oak] usually forms groves by itself," Kirkwood reported, "and does not grow so well in the open forest of *Psudotsuga* ["false fir," or Douglas-fir, what Kirkwood called a Douglas spruce] as do some other deciduous trees." The swale areas "possess some peculiarities worth noticing"such as "a luxuriant undergrowth of *Fraxinus* [ash], *Crataegus* [hawthorn], *Spiraea* [hardhack], *Amelanchier* [saskatoon], *Acer* [maple], *Salix* [willow], etc."

Kirkwood went on to recount the rapid reforestation that occurred after burning ended:

> "It is said by the older inhabitants that before much immigration had taken place, considerable areas of land in the Willamette valley were covered only by large isolated trees and a luxuriant growth of grass, a condition, as they say, maintained by the Indians. As parts were fenced off by the settlers for cultivation, the rest was neglected and soon sprang up to undergrowth which one sees today as a forest of young trees fifty feet or more in height.
>
> "A tract of land which was under the writer's own observation in 1884, was then almost entirely devoid of undergrowth, the growth having been cleared off and burned a few years previous. In the summer of 1901, however, this tract was…covered with an almost impenetrable growth mostly of *Psudotsuga*, about twenty feet in height."

Similarly, Kirkwood suggested that small streams such as those in the Salt Creek watershed may have previously had less dense riparian vegetation. "The valleys of streams tributary to the Willamette which head in the Coast Mountains," he wrote, "are flanked in their upper parts by forests." The significant thing is that although riparian forests had dense undergrowth they were dominated by large Douglas-firs with widely spread branches. This growth pattern confirms that there was an open canopy or savanna present in the time prior to pioneer settlement.

Another indication of pre-settlement vegetation comes from Government Land Office surveys conducted in the 1850s. At that time surveyors were establishing section lines and took notes on the landscape and vegetation they encountered as they crisscrossed the valley. Although some areas were homesteaded with fields planted to crops before the surveys began, most areas were surveyed before or concurrently with settlement. At the end of each mile, the surveyor provided a summary of the vegetation, soil, and geography. When they completed examining each township (36 sections), they wrote an overall description of the area. Douglas-fir was the most common "witness tree" marking corners oak, pine, and maple were also used.

Although surveyors' botanical knowledge was imperfect and note taking was not standardized, their descriptions allow us to reconstruct historic patterns. Map 3 is based on these original survey descriptions now kept at the BLM office in Portland. The map shows the approximate vegetation of the watershed prior to Euro-American settlement. Since basic patterns are often meaningful for understanding complexity, similar descriptions of historic vegetation were combined for the Natural Patterns inset on Map 4. These natural patterns and grouped descriptions are outlined in Table 6.

Table 6. Salt Creek Watershed Natural Vegetation Patterns

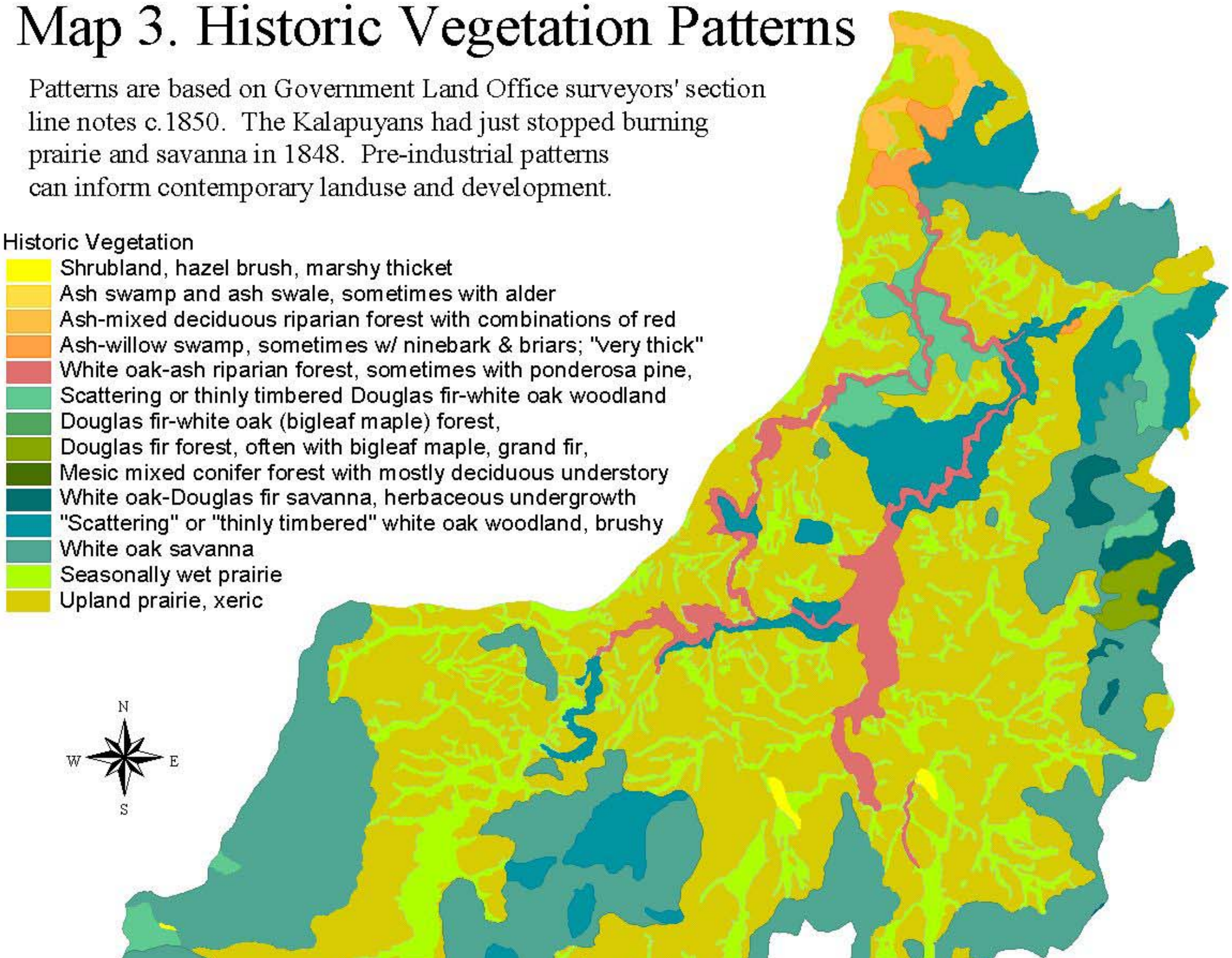
Natural Patterns Acres & Percent	**Historic Vegetation Database Categories Combined for use in Map of "Natural Patterns" of the Salt Creek Valley c.1850**
Water 83 acres, 0.13%	• Water
Riparian Forest 2,711 acres, 4.3%	• Ash swamp and ash swale, sometimes with alder. • Ash-mixed deciduous riparian forest with combinations of red alder and willow. • Ash-willow swamp, sometimes with ninebark and briars, "very thick." • White oak-ash riparian forest, sometimes with ponderosa pine.
Prairie 32,202 acres, 51%	• Upland prairie, xeric • Seasonally wet prairie. • Emergent wetland.
White Oak Savanna 15,804 acres, 25.02%	• White oak savanna. • White oak-Douglas-fir savanna, mostly herbaceous undergrowth.
Oak and Fir Woodland 9,554 acres, 15.13%	• "Scattering" or "thinly timbered" white oak woodland, brushy. • Scattering or thinly timbered Douglas-fir-white oak woodland. • White oak forest, oak brush, or oak and hazel brush.
Closed Forest, upland 2,789 acres, 4.42%	• Douglas-fir forest, often with big-leaf maple, grand fir. • Douglas-fir woodland or "timber" often with big-leaf maple, alder. • Mesic (moderately moist), mixed conifer forest.
Total: 63,143 acres	

There are four main types of natural habitat in the Willamette Valley[1]—riparian forest, prairie (wet and dry), oak savanna, and woodlands. These habitats evolved in response to both natural conditions and human presence and are currently evolving in response to fire suppression and heavy development over the last century.

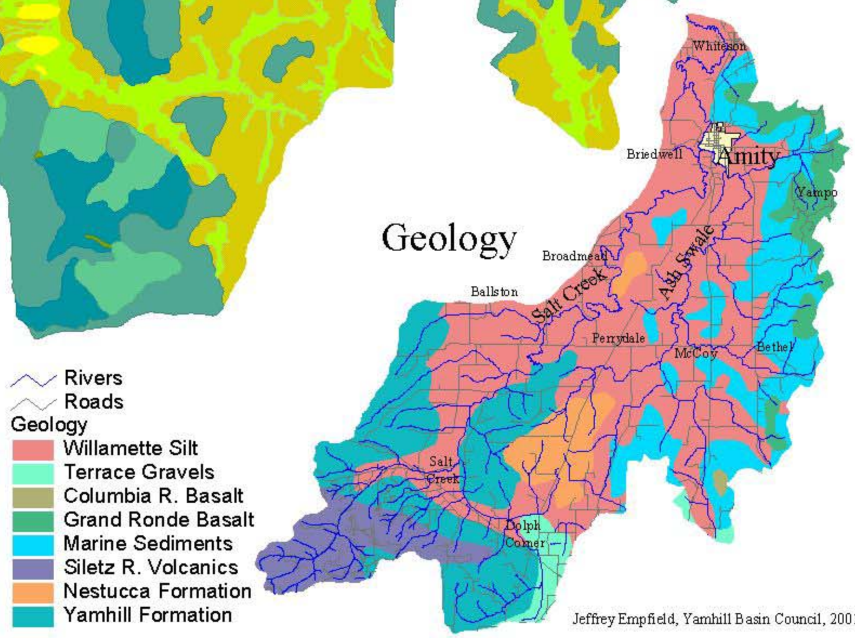
[1] The Willamette Valley is a distinct "ecoregion" according to current thinking in the biological sciences. There are nine such regions in Oregon. They are useful for extrapolating knowledge and best management practices to areas with similar ecology or conversely for understanding how conditions differ from one region to another.

Map 3. Historic Vegetation Patterns

Patterns are based on Government Land Office surveyors' section line notes c.1850. The Kalapuyans had just stopped burning prairie and savanna in 1848. Pre-industrial patterns can inform contemporary landuse and development.



Native vegetation follows patterns of soil. Note upland prairie was found on Willamette silt. Also, oak savanna and woodlands corresponded remarkably with well-drained marine sediments and volcanics.



Jeffrey Empfield, Yamhill Basin Council, 2001

Riparian Forests

Nearly all bottomlands in the Salt Creek watershed are valuable agricultural lands. Draining these more level lands are the major creeks of the watershed. The creeks are important natural open spaces. Although these areas no longer contain their full diversity of species, they are the major habitats remaining for fish and wildlife. Riparian vegetation is also important for returning oxygen to the air. Vegetation reduces the velocity of surface runoff and filters water before it enters streams. Drainageways create continuous, narrow strips of open space running considerable distances through residential and agricultural areas. "They create natural buffer zones between uses," local officials wrote in 1981, "and would be capable of supporting simple trails and bikeways as well as parks in some of the wider areas."

In the past, area streams and rivers had extensive floodplains with closed-canopy forests of deciduous Oregon ash, alder, black cottonwood, big-leaf maple, and conifers such as Douglas-fir, grand fir, and ponderosa pine. Western red-cedar may have been present occasionally but since it is a fire sensitive species, it would not have been common. Regular burning by natural and human-set fires would have affected riparian forests but the higher levels of soil and plant moisture likely made them resistant to intense burning. Generally these forests extended over large parts of the floodplain and transitioned into wet prairies.

Bottomland areas have been intensively managed for agriculture. These forests are now typically only narrow strips along streams and increasingly rare hedgerows. In many areas, non-native blackberry dominates, exacerbating the problems of diminished biodiversity, habitat, and understory growth. Where large woody plants are present, the dominant species are usually red alder, big-leaf maple, and willow intermixed with second or third-growth conifers.

Under natural conditions, streams in relatively flat valley bottoms develop a meandering pattern that changes from year to year and includes sections of complex braided channels. Where beavers are present, their dams slow the water and trap sediment. As beaver ponds fill, new channels typically form carrying the current around the obstructing dam. This also leads to the creation of multiple side-channels and a variety of habitats. Other obstructions such as fallen trees slow and reroute the water forming multiple shallow channels. Log jams and dense riparian vegetation slow and dissipate floodwaters over the adjacent floodplain. Sediments then have time to settle out and accumulate, enriching floodplains. The seasonal inundation of the floodplain also serves to recharge groundwater levels. This is beneficial because groundwater is the main source for summer flows on the western side of the Willamette Valley where we lack snowmelt. These conditions are prevented in much of the Yamhill basin due to downcutting, straightening, and dike building.

Historically in the hilly parts of the watershed, riparian tree species included alder, maple, and Douglas-fir. Bottomland riparian forests included species such as Oregon ash, black cottonwood, Douglas-fir, and big-leaf maple. Steeper stream gradient and less frequent fires characterized the hilly areas where mixed-forest riparian corridors have been logged or cleared. These areas are now primarily red alder and other pioneer species that thrive on disturbance. Non-native vegetation dominates many stream banks in the watershed. Once non-native invasives such as Himalayan blackberry become established, it is very difficult to remove them and re-establish native vegetation. Even native species such as Reed canarygrass can become invasive when they have been altered through breeding programs.

Forested riparian areas, especially those with large conifers, provide shade to keep stream temperatures cooler as well as large woody debris for slowing flow and increasing habitat complexity. Unfortunately, these forests are absent from large portions of the watershed and the trees that now fill riparian corridors are often too small for creating adequate woody debris in stream channels. Animals such as the Columbia white-tailed deer have also been affected. White-tailed deer depended heavily on the original riparian forests but have been forced out of the area or *extirpated* and have remained absent since the 1800s.

Prairie, Wet and Dry

Prairies dominated the Willamette Valley in prehistoric times. Approximately one third of the prairie was described as "wet prairie" in surveyors' notes. The tall perennial grass, tufted hairgrass (*Deschampsia cespitosa),* is a good example of a native prairie species; it is well adapted to both periodic fires and wetland or "hydric" soils—soils that are inundated for a significant part of the year. Hairgrass was an important source of forage for animals when it was more common. Today it remains only in isolated remnants of prairie and where it has been reintroduced in restoration projects.

Numerous species in the lily family co-evolved with Native Americans in the valley who cultivated them in semi-wild settings for centuries. In addition to benefiting from periodic weeding and selection, the lilies became well adapted to the annual burning practices of the Kalapuyan people. The fires knocked back the more competitive grasses and released nutrients allowing the lilies to flourish. Although many members of the lily family were utilized, the primary edible species was camas (*Camassia quamash*). Camas forms bulbs that Native Americans harvested and stored through the winter.

A 1919 study of grasses in the Salem area reported 106 species; 55 were introduced while 51 were considered native. A good example of one of the dominant grasses of the valley's native dry prairies was red fescue (*Festuca rubra rommerii*).

The Kalapuya burned prairies throughout the valley and into the foothills of the Coast Range to elevations of 1000 feet. Author Robert Boyd has reconstructed a likely scenario for burning:
In late spring and early summer the Indians were probably concentrated at "primary flood plain" sites in the wet prairies, where root crops such as camas were collected and processed. There was no burning at this time. During midsummer (July and August) the focus shifted to the dry prairies, and "narrow valley plain" sites were more intensively occupied. Burning in July and August was apparently sporadic, most likely occurring after the harvesting of seasonally and locally available wild foods (grass seeds, sunflower seeds, hazelnuts and blackberries), in limited areas. The intermediate effect of the early burns would be a "cleaning up" process; the long-term result would be to facilitate the re-growth, in future seasons, of the plants involved. In late summer fire was used, on the high prairies, as a direct tool in the gathering of tarweed and insects. This was followed, in October, by firing of the oak openings after acorns had been collected. Finally, from the "valley edge" sites, the Kalapuya initiated large-scale communal drives for deer, which provided a winter's supply of venison. The sequence ended as they returned to their sheltered winter villages along the river banks. (Robert Boyd, *Strategies of Indian Burning in the Willamette Valley*.)

In both wet and dry prairies, shrubs and small trees such as hazel, serviceberry, and cascara were present. Again, they're well adapted to burning which consumes the woody, above-ground parts of the plant encouraging a burst of sprouts the following spring. This re-growth was likely a major source of fiber for Native American clothing, shelter, and baskets.

Oak Forests and Oak Savanna

The Oregon white oak (*Quercus garryana*) is found everywhere in the Willamette Valley (covering about one million acres) and on drier soils throughout western Washington and Oregon. It is found from the coastal mountains to the western slopes of the Cascade Mountains. It is slow-growing compared to other deciduous trees and thrives where conifers are limited by low soil moisture. You can see clear evidence of this by comparing the geology of the Salt Creek watershed with its historic vegetation patterns. White oak dominated (and in many areas still dominates) hilly areas with well-drained volcanic and marine rocks. See Maps 3 and 4.

Oregon white oak occurs in two forms: forest and savanna. The majority of existing trees developed under forest conditions. These "forest-form" trees are relatively tall, seldom exceed 60 centimeters in diameter measured at breast height (dbh), and have ascending branches clustered near the crown. Their crowns form a closed canopy. The average age of mature forest-form trees (in 1968) was 90 years with an age range of 47—135 years.

Scattered through the forest and remaining in some fields are a few large relict *Quercus garryana* apparently developed under non-forest conditions. These "savanna-form" trees generally exceed 1 meter dbh and their boles are short in relation to the total height of the tree. They have massive branches and spreading crowns and are usually spaced so the crowns do not touch. There is an average of 17 savanna-form *Quercus garryana* per hectare (2.471 acres) in remnant oak savanna forests of the region. In 1968, their annual growth rings indicated an age range of about 260—310 years. Other studies indicate Oregon white oak may live over 500 years and reach 90cm dbh at only 250 years of age.

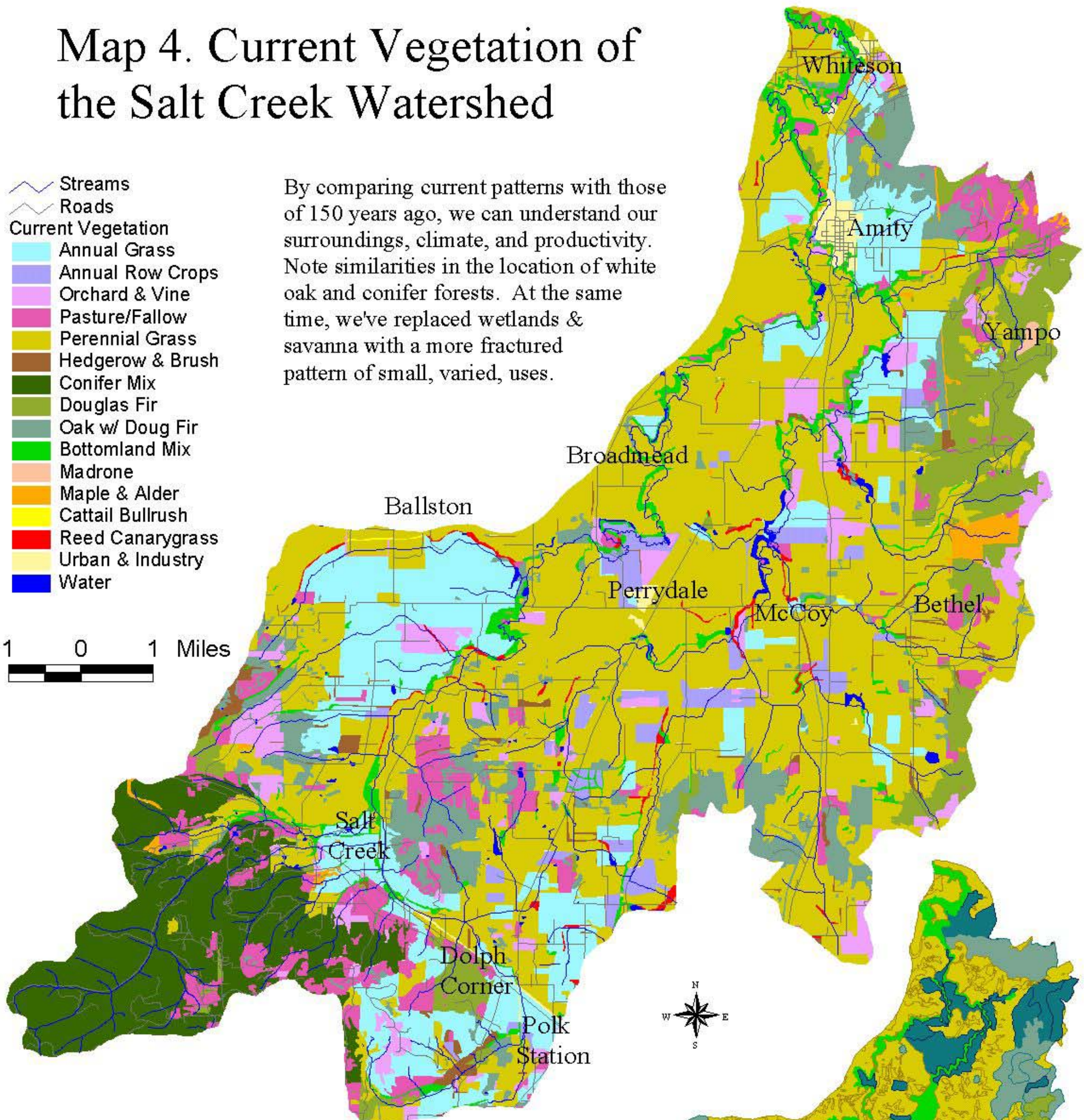
Many areas of the Salt Creek watershed currently have forests dominated by both oak and Douglas-fir forming a patchwork. Pacific madrone, another dry-soil tree, often occurs in large stands within oak-dominated forests. Western poisonoak is also common in the understory. The sub-basin has a higher ratio of Oregon white oak than other parts of the Willamette Valley. Typical oak forest animals include acorn-loving western scrub jays and western gray squirrels.

Historically, oak savanna covered a large portion of the Willamette Valley and at least a quarter of the Salt Creek watershed. It remains today primarily in isolated remnants on wildlife refuges or in thin bands where more dense oak woodlands transition into agricultural and residential areas. Savanna is characterized by mixed grasslands covering rolling hills with large, spreading white oaks as the dominant tree. Black cottonwood, red alder and Oregon ash are also sometimes present. The open canopy has since closed in to create oak woodlands because contemporary management suppresses periodic wildfires.

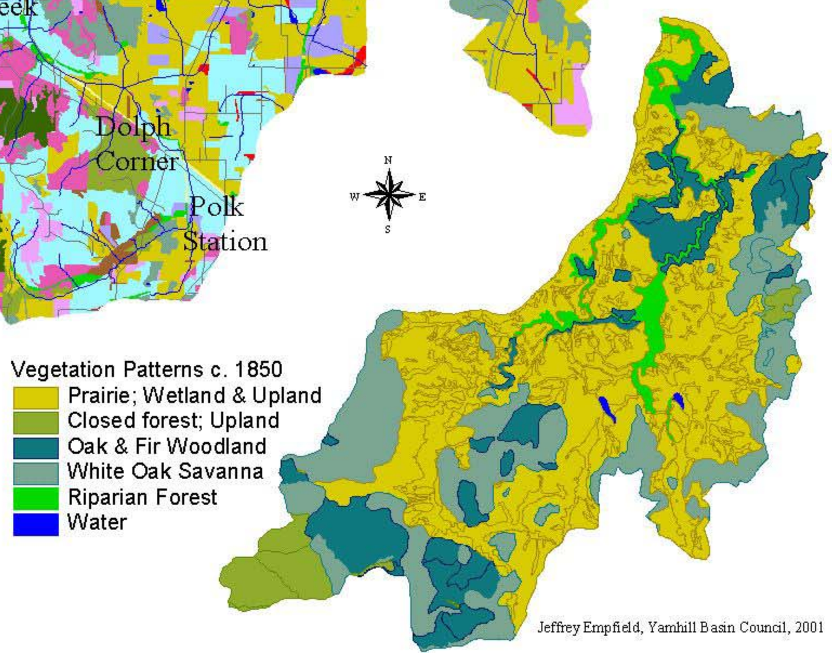
Older, dead, or dying Oregon white oak trees provide more "cavity" habitat than any other vegetation in the area. Twenty-eight bird species, including the white-breasted nuthatch and the black-capped chickadee, seek out these cavities. Small mammals are also more common in oaks and do not seem as well adapted to Douglas-fir dominated woods.

Map 4. Current Vegetation of the Salt Creek Watershed

By comparing current patterns with those of 150 years ago, we can understand our surroundings, climate, and productivity. Note similarities in the location of white oak and conifer forests. At the same time, we've replaced wetlands & savanna with a more fractured pattern of small, varied, uses.



The current map is based on a 1998 study. Small changes have already occurred in some areas. Most are incidental as development pressure is relatively low in the Salt Creek watershed. The map of historic patterns is based on survey notes from the mid-19th century, just prior to pioneer settlement.



A newly discovered oak disease called "sudden oak death" has been gaining attention for attacking a variety of oak species in northern California and southern Oregon. University of California—Davis plant pathologist David Rizzo believes a fungus with an appetite for oak bark is probably to blame. Rizzo's investigation points to a novel fungus related to the organism that caused the Irish potato famine of 1845-50 and the recent deaths of Port Orford cedar trees in the Northwest. Contrary to some reports, the pathogen is not related to the oak wilt fungus (*Ceratocystis fagacearum*), a disease of oaks in the eastern United States.

Once in the tree, the fungus produces enzymes that dissolve the dead outer and living inner layers of bark. Oozing sores result as the cell walls break down. As the disease progresses past the bark and into the wood, the tree becomes so weak that it is vulnerable to bark beetles, which burrow into the tree and kill it by blocking its circulatory system. The fungi move around by spores that can easily travel in infected wood and soil, on bicycle and car tires, on hikers' shoes, and on animals' feet. "Preventing the movement of soil and wood will be critical to slowing the spread of the fungus to other oak woodlands," Rizzo says. "In particular, firewood and soil should not be moved from [potentially infected] areas." Any wood already moved elsewhere should be burned.

Conifer Forest

In prehistoric times, there was relatively little conifer forest in the Salt Creek watershed. Cone bearing trees in pure stands accounted for less than 5% of the watershed and were in mixed forests covering another 20% of the watershed. Map 3 indicates that dense conifer forest was in the Salt Creek headwaters in the Coast Range, on the Eola Hills, and in the riparian forest near where Ash Swale joins Salt Creek. One of the more surprising historical patterns is that Douglas-fir was common in bottomland stands intermixed with broadleaf trees along rivers and streams. Today, conifers are still found in riparian areas but we associate them more with uplands as they have spread into more of the hilly areas of the watershed. Conifers now account for over 16% of the vegetation cover of the Salt Creek watershed in upland stands and in another 7% of the watershed where oak dominates. While Douglas-fir remains intermixed with deciduous trees in riparian forests, its presence is drastically reduced from historic conditions and now covers only about 2% of the watershed.

In upland conifer stands, common understory plants include sword fern, salal, Oregon grape, and red huckleberry. These areas generally support less understory vegetation than oak-dominated forests because of the closed canopy of larger conifers and the high density of young trees established after cutting or other disturbance.

Laminated root rot may be a factor in the conifer areas of the watershed. *Phellinus weirii* is a native root fungus and causes laminated root rot in Douglas-fir trees, eventually killing them. Infected trees are vulnerable to "windthrow" or blowdowns due to weakened roots. This is a bigger problem in the more mountainous and heavily forested areas in the Coast Range.

Gaps in the canopy provide light and moisture for understory species such as shrubs, hardwoods, and herbaceous ground cover. Standing dead trees provide habitat for many plants and animals as well as coarse woody debris for streams. This is important in many of the larger bottomland riparian forests where more conifers are needed.

Current Vegetation

Map 4 shows the current vegetation of the watershed. The basis for this map is a 1998 study conducted by the Oregon Department of Fish and Wildlife (ODFW) Ecological Analysis Center and the Northwest Habitat Institute (NWHI). They mapped 90% of the landscape through field surveys and the remaining 10% using aerial photos. They estimate their accuracy at 85% for Polk County and at 83% for Yamhill County. Some uncertainty is due to the difficulty in differentiating between annual and perennial grasses. This is significant due to the loss of soil accompanying cultivation for annual grasses.

Like all maps, this one represents a moment in time. Any changes in land use since the late 1990s are not reflected here. For our purposes there has been little significant change in the vegetation pattern in the watershed in the past three years. Approximately 45,000 acres or 71% of the watershed is non-forested—lands under cultivation or development. The Yamhill basin proportion of hardwoods is about 20% of the total land coverage compared to the northwest Oregon average of only 7%.

Table 7. Current Vegetation and Land Use in the Salt Creek Watershed

Vegetation/Land use	Acres	Percent of Watershed	Explanation of vegetation and land use classes
Row crops	1,478	2.34%	Farmland could be vegetables or herbs.
Annual grass	8,304	13.15%	Farmland for production of wheat, oats, barley, and rye. Generally, without irrigation.
Perennial grass	27,837	44.09%	Farmland for production of perennial grass especially grass seed and hay. Also without irrigation.
Orchards, berry farms, nurseries	2,660	4.21%	Farmland used for fruit trees, berries, Christmas trees, and nursery stock usually requiring a high volume of water for irrigation.
Unmanaged pasture	3,728	5.9%	Farmland that appears to have no active management such as fertilizer application, irrigation or weed control. Might be grazed. Land usually has been cleared and farmed intensively for some time.
Urban & industrial zones	452	0.72%	Includes current areas of industry and housing in towns and subdivisions, not urban growth boundaries. It depicts actual land use at the time of mapping.
Water	334	0.53%	Only areas of water that have enough surface area to be seen at this scale are shown on the map.
Black hawthorn, riparian, hedgerows	789	1.25%	Many of these areas are too small to be seen clearly on the map at this scale.
Reed canarygrass	322	0.51%	Promoted as a forage grass, it now overwhelms many wetlands and riparian areas as an unwanted invasive. Native but altered through breeding.
Cattail	22	0.04%	Typically irrigation reservoirs.
Ash, cottonwood, maple bottomland	1,870	2.96%	This habitat is usually a seasonal wetland, bordering streams and standing water. These areas are sometimes too thin to be seen on the map at this scale. Expect trees, willow, and emergent wetland species.
Oak mostly w/ Douglas-fir	4,608	7.3%	Usually very diverse habitat with many species of forbs and grasses in the understory.

Oak, madrone	45	0.07%	Not easy to see at this scale.
Maple, alder, fir Hardwoods dominant	491	0.78%	Along streams typically in response to logging or fire where conifers weren't actively planted.
Douglas-fir, other conifers	10,203	16.15%	In many areas in planted pure stands. Christmas tree plantings likely fall under this classification .
Total	63,143	100%	

The current and historic vegetation maps are revealing when compared with one another. It is interesting to locate an area with which you are familiar to see how accurate the current map is and what vegetation was likely there a hundred and fifty years ago. You may enjoy theorizing about what caused the changes and why. What is desirable about the current pattern of vegetation and what, if anything, is undesirable?

The value of knowing historic ecological conditions is that they provide a benchmark for the scale of change resulting from modern land management. "Wet prairie" or wetlands, for example, are increasingly rare in the area now. Much of the valley's wetlands were found on what is now cultivated land and have been tiled, ditched, and drained over the past century and a half. Conversely, the amount of forested land has increased about 5% overall even with the loss of hundreds of acres of riparian forest. The lack of fire has allowed Douglas-fir to expand its range. Compare the vegetation maps with Map 11 that shows areas under irrigation.

Native and Non-native Plants

Native plants are valuable and important because they have evolved to fit local conditions and because they contribute to systems that support all life. Not only are native species locally adapted, but communities or groups of native plants have co-evolved in relation to one another. Evolution is the result of interactions between many environmental factors including soil, aspect, slope, elevation, moisture, temperature, and competition.

For more information on plants and seed stock contact your Soil and Water Conservation District. The local chapter of the Native Plant Society of Oregon (NPSO) can be contacted at (503)843-4338.

Yamhill SWCD: (503) 472-6403
2200 SW 2nd Street
McMinnville, OR 97128

Polk SWCD: (503) 623-5534
289 E. Ellendale Rd., Suite 504
Dallas, OR 97338

Non-native species (also called "exotics") are species that have been introduced from other regions of North America or, in many cases, from the other continents. Often exotics do not grow well because they have evolved under different conditions and are not adapted to the local climate. In other cases they do extremely well and become invasive. When this happens, native species often have no adaptation to compete with the invasive. There is ample documentation of how agriculturists and entrepreneurial land managers have relocated plants and animals around the world only to lose control of them causing unwanted and unforeseen consequences. It is interesting to note the definition of "weed" is simply an unwanted or problematic species. Furthermore, many of today's "weeds" were intentionally introduced before we had a sufficient understanding of ecology. In some cases, species have been introduced in an attempt to correct earlier weed problems and then become weeds themselves.

The Oregon Department of Agriculture (ODA) identifies noxious weeds as plants having the potential to cause economic losses. It is very costly to eliminate weeds once they are established and commonly involves intensive herbicide application. Many people prefer mowing rather than spraying but even this strategy involves significant costs in time, money, and energy and creates air, water, and noise pollution. Bio-control methods are available for some weed species but these are just being developed and often require knowledge, attentive fine-tuning, and commitment that are challenging in our busy times.

The BLM identifies Scotch broom (*Cytisus scoparius*) and tansy ragwort (*Senecio jacobaea*) as two species of major concern in our area. Scotch broom is listed due to its ability to take over land quickly and tansy ragwort is listed due to its toxicity to cattle. Note that Reed canarygrass (introduced for livestock forage) covers over 322 acres of the Salt Creek watershed—usually in already degraded streams and increasingly rare wetlands but also in the numerous small draws and irrigation reservoirs.

Dayton area farmer Sam Sweeney has a design for how to increase beneficial shade on these reservoirs while at the same time suppressing Reed canarygrass. His idea is to deepen reservoirs in some areas while creating an island in the middle. On the island he suggests planting trees to shade the water. The deeper water resulting from excavation would prevent Reed canary from completely dominating the reservoir, as it thrives only in shallow water.

Table 8. Yamhill County Priority Noxious Weed List

Common Name	Scientific Name	ODA Class	List Date
High Priority For Control			
Italian Thistle	*Carduus pycnocephalus*	B	1-29-90
Meadow Knapweed	*Centaurea pratensis*	B	8-13-90
Purple Loosestrife	*Lythrum salicaria*	B	2-26-91
Gorse	*Ulex europaeus*	B, T	1-29-90
Spurge laurel	*Daphne laureola*	Not listed	May 2, 01
Important To Control *Agric.* - Denotes species that are primarily a problem in agricultural production.			
Milk Thistle – *Agric.*	*Silybum marianum*	B	11-13-89
Canada Thistle	*Cirsium arvense*	B	11-13-89
Tansy Ragwort	*Senecio jacobaea*	B, T	11-13-89
Scotch Broom	*Cytisus scoparius*	B	11-13-89
Field Bindweed - *Agric.*	*Convolvulus arvensis*	B	2-26-91
Large Crabgrass - *Agric.*	*Digitaria sanguinalis*	-	2-26-91
Blackgrass - *Agric.*	*Alopecurus myosuroides*	B	3-26-97
Velvetleaf - *Agric.*	*Abutilon theophrasti*	B	3-26-97
Field Dodder - *Agric.*	*Cuscuta pentagona*	B	3-26-97
Himalayan blackberry	*Rubus discolor*	B	5/23/00
Reed Canarygrass	*Phalaris arundinacea & aquatica*	Not on list	5/23/00
Puncturevine	*Tribulus terrestris*	A, B	3/03/93
English Ivy	*Hedera helix*	B	5 / 2 /01

(Yamhill County SWCD, Updated May, 2001)

ODA Classifications:
"A" Weeds - a weed of known economic importance which occurs in the state in small enough infestations to make eradication/ containment possible; or is not yet known to occur, but its presence in neighboring states makes future occurrence in Oregon seem imminent.

“B” Weeds - a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties and is important to control where found.
“T” Weeds - a priority noxious weed designated by the Oregon State Weed Board as a target weed species on which the Department will implement a statewide management plan.

The Native Plant Society of Oregon lists 37 noxious invasive species for the region. Gardeners sometimes cultivate weeds, unaware of their status as a problem invasive. Invasives are sometimes even sold by local nurseries. Most commonly exotics are introduced accidentally through other means such as on vehicles, clothing, or animals. The current list of noxious weeds compiled by the Yamhill Soil and Water Conservation District includes several new additions. Himalaya blackberry and Reed canarygrass typically invade disturbed areas and form monocultures making regeneration of native species very difficult.

English ivy is is a recent addition to the ODA and the Yamhill SWCD Noxious Weed lists. It is one of the few exotics that can become established and grow in deep shade. English ivy forms thick carpets on the forest floor and chokes out native vegetation, including tree seedlings. It creeps up trees into the canopy, flowers and forms berries. Birds eat the berries and disperse seeds to other locations. Seedlings emerge and start new infestations. The vines weigh down tree branches causing them to break. English ivy is a threat to the integrity of area forests. To suppress it you can cut vines from trees but that will only kill the vines growing on the tree. To eradicate it, stems and roots on the ground must be pulled and then monitored for re-sprouting.

Sensitive Species

The Federal or State government lists nine species native to the watershed as rare, threatened, or endangered. These species have been field-verified by the Oregon Natural Heritage Program (ORNHP, 1998). Additionally, the BLM lists 16 species as special status species and seven species as sensitive species that may be present in the watershed.

Historically, these species were much more widespread than they are today. The importance of preserving their habitat and working to ensure their future survival is important generally for preserving Oregon’s natural heritage. Preserving biodiversity is significant for more specific reasons, as well, but these often become apparent only after we’ve lost something. Aldo Leopold pointed out over fifty years ago that if we’re going to tinker with the system we should at least be careful to keep all the parts. He wrote “[w]hat of the vanishing species…[t]hey helped build the soil, in what unsuspected ways may they be essential to its maintenance…who knows for what purpose cranes and condors, otters and grizzlies may some day be used.” With the loss of any species—whether it is plant, bird, fish, mammal, amphibian, insect, or soil bacteria—a valuable piece of the ecosystem on which we depend is lost.

Often we hear about the loss of genetic diversity and think that it is inevitable, natural, or that we have no role in it. Strictly speaking, extinction is natural and inevitable over the course of millions of years. Humans currently have an inflated role in extinction due to our fossil-fuel-driven growth in population, technology, and consumption. We now threaten even our own extinction. It is simply enlightened self-interest to pay attention to the health of local species. They not only serve as “canaries in the coal mine” but increasingly we understand that nearly all species play a discernable role in the health of our surroundings.

A complete species list of all animals thought to occur on the western side of the Willamette basin at the time of Euro-American arrival has been compiled by Hulse et al. for the Muddy Creek sub-basin of the Marys River watershed. This list includes 234 amphibian, reptile, mammal, and bird species. Eight vertebrate species are listed as extirpated (extinct locally) from the sub-basin: grizzly bear, California condor, lynx, gray wolf, white-tailed deer, yellow-billed cuckoo, black-crowned night heron, and spotted frog.

The following lists indicate species that are in danger of disappearing from our watershed. To learn more, consult The Oregon Natural Heritage Program (821 SE 14th Avenue, Portland, OR 97124-2531, (503) 731-3070 ext. 335 or 338) or the U.S. Fish and Wildlife Service website.

Table 9. Endangered and Threatened Species of the Salt Creek Watershed.
Listing Status: E = Endangered, T=Threatened

Animals	
E Short-tailed albatross (*Phoebastria albatrus*)	T Salmon, chum (Columbia R.) (*Oncorhynchus keta*)
E Fender's blue butterfly (*Icaricia icarioides fenderi*)	T Salmon, coho (OR, CA pop.) (*Oncorhynchus kisutch*)
T Oregon silverspot butterfly (*Speyeria zerene hippolyta*)	E Salmon, sockeye (*Oncorhynchus nerka*)
E Chub, Borax Lake (*Gila boraxobius*)	T Sea turtle, green (locally endangered) (*Chelonia mydas*)
T Chub, Hutton tui (Hutton) (*Gila bicolor ssp.*)	E Sea turtle, leatherback (*Dermochelys coriacea*)
E Chub, Oregon (*Oregonichthys crameri*)	T Sea turtle, loggerhead (*Caretta caretta*)
T Foskett speckled dace (*Rhinichthys osculus ssp.*)	T Steller Sea-lion (eastern pop.) *Eumetopias jubatus*)
E Columbian white-tailed deer (*Odocoileus virginianus*)	T Steelhead (Snake R. Basin) (*Oncorhynchus mykiss*)
T Bald eagle (*Haliaeetus leucocephalus*)	T Steelhead (lower Columbia R.) (*Oncorhynchus mykiss*)
T Fairy shrimp, vernal pool (*Branchinecta lynchi*)	TSteelhead (middle Columbia R.) (*Oncorhynchus mykiss*)
T Aleutian Canada goose (*Branta canadensis leucopareia*)	T Steelhead (upper Willamette R.) (*Oncorhynchus mykiss*)
T Canada Lynx (lower 48 States) (*Lynx canadensis*)	E Sucker, Lost River (*Deltistes luxatus*)
T Marbled murrelet (*Brachyramphus marmoratus*)	E Sucker, shortnose (*Chasmistes brevirostris*)
T Northern spotted Owl (*Strix occidentalis caurina*)	T Sucker, Warner (*Catostomus warnerensis*)
E Brown pelican (*Pelecanus occidentalis*)	T Bull trout, (lower 48 states) (*Salvelinus confluentus*)
T Western snowy Plover (*Charadrius alexandrinus*)	T Lahontan cutthroat (*Oncorhynchus clarki henshawi*)
T Salmon, chinook (*Oncorhynchus tshawytscha*)	E humpback whale (*Megaptera novaeangliae*)
Plants	
E Marsh sandwort (*Arenaria paludicola*)	T Lupine, Kincaid's (*Lupinus sulphureus kincaidii*)
E Applegate's milk-vetch (*Astragalus applegatei*)	T Four-o'clock, MacFarlane's (*Mirabilis macfarlanei*)
T Golden paintbrush (*Castilleja levisecta*)	E Popcornflower, rough (*Plagiobothrys hirtus*)
E Willamette daisy (*Erigeron decumbens decumbens*)	T Nelson's checker-mallow (*Sidalcea nelsoniana*)
E Gentner's fritillary (*Fritillaria gentneri*)	E Malheur wire-lettuce (*Stephanomeria malheurensis*)
T Water howellia (*Howellia aquatilis*)	T Howell's spectacular thelypody (*Thelypodium howellii spectabilis*)
E Western lily (*Lilium occidentale*)	
E Bradshaw's lomatium (*Lomatium bradshawii*)	
Species of concern listed by ESA	
Tall bugbane (*Cimicifuga elata*)	Long-eared bat (*Myotis evotis*)
Oregon giant earthworm (*Megascolides macelfreshi*)	Southern seep salamander (*Rhyacotriton variegatus*)
State of Oregon candidate for listing as endangered or threatened	
Willamette Valley larkspur (*Delphinium oreganium*)	Meadow checker-mallow (*Sidalcea campestris*)

Table 10. Special Status Species Possibly Native to the Salt Creek Watershed.

Clouded salamander (*Aneides ferreus*)	Long-legged bat (*Myotis volans*)
Marbled murrelet (*Brachyramphus marmoratus*)	Silver-haired bat (*Lasionycteris noctivangans*)
Northern goshawk (*Accipiter gentilis*)	Columbia torrent (*Rhyacotriton kezeri*)
Pileated woodpecker (*Dryocopus pileatus*)	Southern torrent salamander (*Rhyacotriton variegatus*)
Red tree vole (*Arborimus longicaudus*)	Red-legged frog (*Rana Aurora*)
Long-eared bat (*Myotis evotis*)	Tailed frog (*Ascaphus truei*)
Fringed bat (*Myotis thysanodes*)	White-footed vole (*Phenacomys albipes*)

Table 11. Sensitive Species Possibly Native to the Salt Creek Watershed.
Howell's bentgrass (*Agrostis howellii*)
Golden paintbrush *Castilleja levisecta*)
Tall bugbane (*Cimcifug elata*)
White rock larkspur (*Delphinium leucophaeum*)
Peacock larkspur (*Delphinium pavenaceum*)
Queen-of-the-forest (*Filipendula occidentalis*)

The Oregon Natural Heritage Program (ONHP) lists approximately 90 sensitive species that have potential habitat in the Salt Creek watershed.

Many other species are thriving. Turkeys are now present in large numbers. Area farmer Eugene Villwock sees large groups of them around his farm in the Salt Creek area, he says, but they've only been in the area in the last three years. Coyotes arrived 40 to 50 years ago and are present throughout the watershed. Bob Scharf, who has also spent his life in the area farming, believes they are responsible for chasing off red foxes that used to be plentiful and helped to suppress the rodent population. Orchards used to be deer-free, unlike now. Eugene feels that in the past, more plentiful cougars kept the deer numbers down. Bob contends it is the re-growth of Coast Range forests that's responsible for more blacktail deer moving into the valley.

Conclusion

One-hundred and fifty years ago, there was less conifer forest in the Salt Creek watershed. Today, conifers are found in riparian areas and in hilly areas intermixed with deciduous trees and in small pure stands. Current conditions show farmed perennial grass is the dominant cover of the watershed. The third largest cover class is annual grass. Together, these two grass seed crops cover over half of the watershed.

Vegetation in the watershed varies from being forested in the hilly areas to a patchwork of residential development and agricultural crops in bottomland areas. Approximately three-fourths of the watershed is non-forested—lands under cultivation or development. On forested land, conifers make up three-fifths of the mixed forest while hardwoods comprise two-fifths of the area. There are four main types of native habitat in the watershed—riparian forest, prairie (wet and dry), woodlands, and oak savanna. These habitats evolved with natural and human-caused fire and likely are now reduced or they are evolving in response to fire suppression.

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CHAPTER 4

Riparian Areas and Wetlands

Introduction: Riparian Conditions

"Riparian" is from the Latin *ripa* meaning "stream bank." The riparian zone generally includes the stream or river and the land next to it. We can use more specific definitions and say the riparian area includes everything within a certain distance of the water; Oregon Forest Practices sets the official definition for riparian zones at 20 feet from the stream. We can also base our definition on ecological conditions that indicate the effected area. By this more ecological definition, not only the stream and riverbanks are included but also wetlands or any part of the landscape with enough moisture to support the unique combinations of plants and animals typically found in the riparian zone. Riparian areas generally have higher moisture levels than the adjacent land. The elevated moisture level supports a more diverse and productive ecosystem.

Land managers regard riparian areas as a buffer because the vegetation and soil functions as a filter for pollutants picked up as rainfall flows over our roads, lawns, and fields. The beneficial effects of riparian vegetation on aquatic life include cooling, balanced water chemistry, and nutrient assimilation from the surrounding soil.

Riparian vegetation influences fish habitat and water quality in a variety of ways including:

- Shade, which helps prevent extreme daily fluctuations in water temperature and provides fish cover from predation.
- Stabilizes stream banks, which decreases erosion and prevents downcutting of banks.
- Provides habitat for insects and macro-invertebrates, which are a food source for fish.
- Provides detritus or organic litter to the stream, which adds nutrients to the entire ecosystem.
- Riparian areas are also important sources of large wood. Large wood is vital for fish habitat because it provides cover for fish, diverts channels, and obstructs flows. These conditions in turn increase channel and habitat complexity.

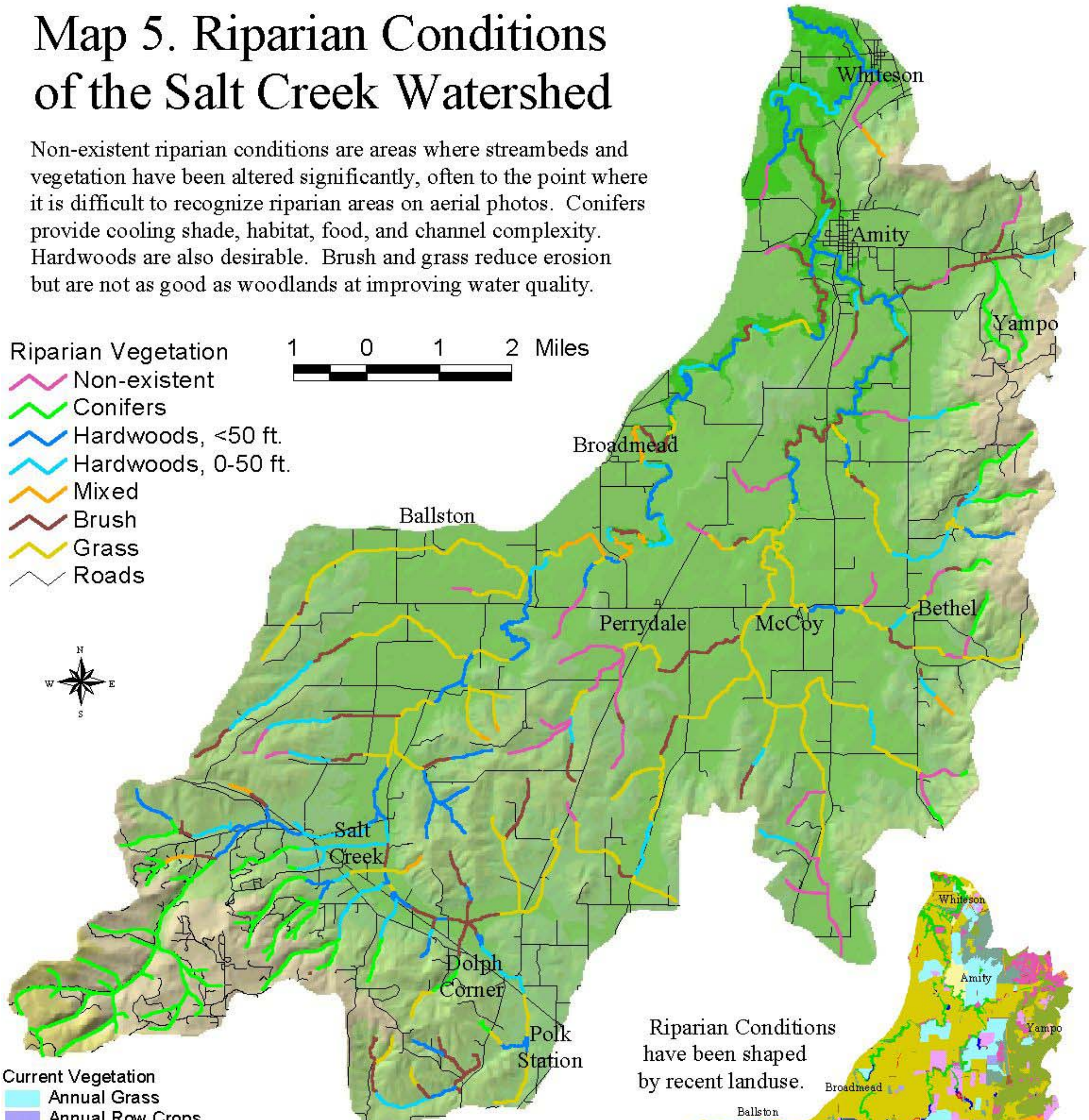
The Importance of Large Woody Debris

Logs in streams or "large woody debris" (LWD), which only a few decades ago we considered detrimental to stream health, are now recognized as essential for clean, cool water. Throughout the Willamette Valley, logjams are generally lacking from streams. Large trees that fall into streams are beneficial for a variety of reasons. They increase pool depth, reduce erosion, and are a source of in-channel habitat diversity. Some literature refers to trees falling into streams as "LWD recruitment." Trees need to be close enough to the stream to be "recruited" when they fall down. The size and diameter of the trees necessary to perform this function is directly related to the size of the stream. Streams with higher flows and wider streambeds need larger trees for the wood to remain in place during winter storms.

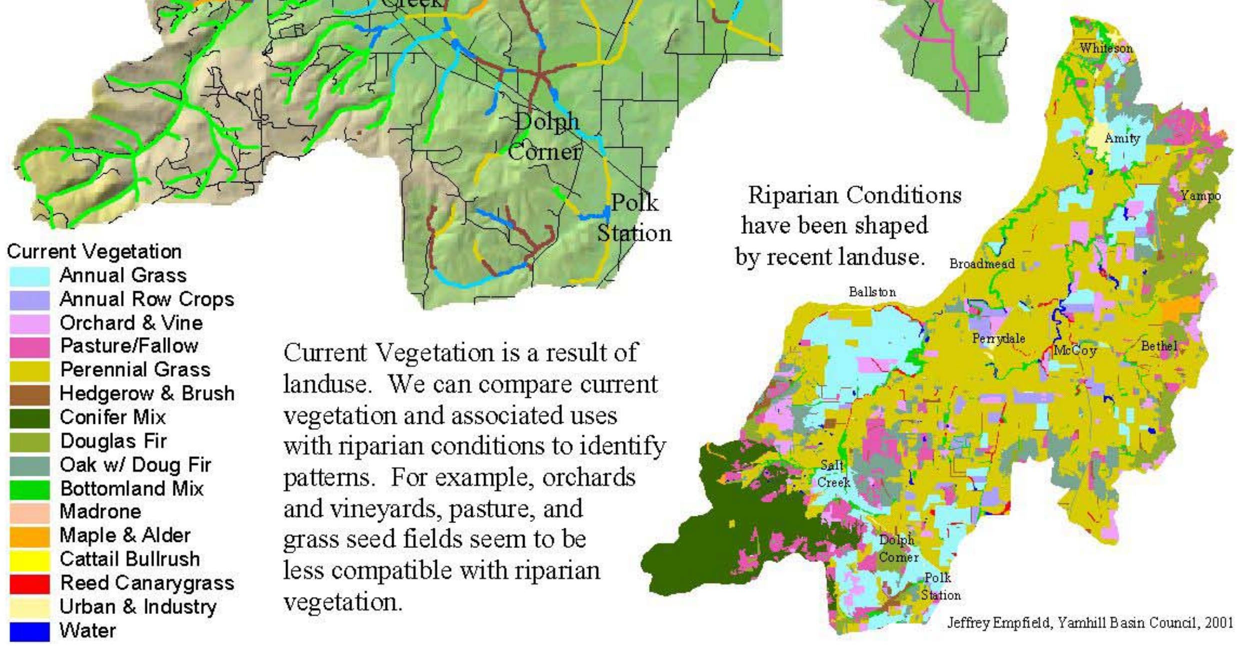
Logs in streams retain much of the gravel and finer sediments on their upstream side. This in turn creates terraces, meanders, larger riparian zones, a pool and waterfall pattern, and slower, less concentrated floods. The pools are formed on the downstream side of large logs; water accelerates to flow past the obstruction and scours the stream bed for a short distance. Pools

Map 5. Riparian Conditions of the Salt Creek Watershed

Non-existent riparian conditions are areas where streambeds and vegetation have been altered significantly, often to the point where it is difficult to recognize riparian areas on aerial photos. Conifers provide cooling shade, habitat, food, and channel complexity. Hardwoods are also desirable. Brush and grass reduce erosion but are not as good as woodlands at improving water quality.



Riparian Conditions have been shaped by recent landuse.



Current Vegetation is a result of landuse. We can compare current vegetation and associated uses with riparian conditions to identify patterns. For example, orchards and vineyards, pasture, and grass seed fields seem to be less compatible with riparian vegetation.

provide swimming space, water storage, and cool habitat. The relocated sediment creates beneficial water spaces and habitat in sand and gravel bars.

Farmers' Historical Use of Creeks

According to area farmer Sam Sweeney, landowners historically depended on creeks and riparian areas for several farm operations. Livestock grazing in the past was nearly always confined to the riparian areas, he explains. Farmers wanted to use the more level tillable acreage for grain and other cash crops. "Not wanting to waste tillable crop land," farmers "would fence and keep their livestock in the riparian areas close to the creeks." These areas not only provided pasture and shade, but also stock water.

Old property lines illustrate the widespread importance of access to bottomland areas for early farmers. Sam discovered this pattern when his family bought their farm on the east branch of Palmer Creek near Dayton. "I often wondered why the donation land claim was divided into different boundary configurations with each parcel having access to the creek," he says. The previous owner of the farm told him that the original landowner had given his daughters parcels of land and wanted them each to have access to the creek for their livestock

Sam estimates that approximately 60% to 70% of streams in the area were utilized this way. Why isn't this true today? The livestock industry has bypassed the small producer, Sam explains, and few mixed family farms remain. Livestock in Polk and Yamhill Counties is now kept primarily for recreation or in small holdings where agriculture is a secondary income. Many fields previously reserved for cropping are now used for pasture.

Landowners also used riparian areas as a source of forest products. Wood lots would often be close to the creek or within the riparian areas. These lots were considered a "nest egg" that landowners could use during hard times or to meet a particular need for lumber. This is still true today, he points out. A significant difference was that in the past, the forest would re-seed itself. "The area did not have the blackberries that would take over," Sam says, "and hold back the growth of the seedlings." People rarely took an active role in replanting trees until the 1940s when foresters introduced the idea.

Another common use of creeks in early times was for power and transportation for lumber or flour gristmills. People would be busy during the spring and summer months with planting and harvesting. But after winter rains began, they would have time to work in the mill and naturally there would be more flow in the creeks to drive numerous small mills. Area creeks were also used for transporting logs in the winter months during high water. To supply the mills with logs, trees would be felled, probably on the upper ground that would be later cleared for crops. The logs would be pulled down to creek bottoms with horses in the spring, summer, or fall. Then men would secure them with ropes, wait for high water, and float them downstream to the mills. Early settlers built saw mills as early as the 1840s and 1850s. Initially they used waterpower for sawing logs. Later, steam engines and internal combustion engines powered mills in the area.

Map and Photo Analysis

Map 5 indicates the dominant vegetation type for each section of stream in the Salt Creek watershed. The five dominant vegetation categories are brush, conifers, grass, hardwoods, and "mixed" which in our area is typically either brush or grass interspersed with broadleaf trees. The pink segments indicate areas where riparian benefits are effectively non-existent with little or no riparian vegetation. In many cases, the streambed itself has been altered beyond recognition. Although they are shown on topographical maps, they appear to no longer exist as natural waterways with associated vegetation.

Black and white aerial photographs on the scale of 1:660 (one inch equals 660 feet) from the Farm Service Agency offices in Dallas and McMinnville served as the primary source for evaluating riparian conditions. Periodically the Department of Agriculture makes a new series of aerial photos covering the countryside. The most recent series for our area dates from 1994 and shows summer conditions. Summer vegetation photographed in black and white from ten thousand feet is sometimes difficult to differentiate—between hardwoods and conifers, for example. Aerial photos taken in the winter show standing water (possible historic wetlands with hydric soils) and more clearly contrast evergreen and deciduous vegetation. U.S.G.S. topographical maps helped in locating landmarks and stream channels in the photos.

Current riparian conditions can be compared with what historically would have been found in the watershed. The scale of the historical vegetation map and the current vegetation map do not facilitate detailed comparisons for each waterway. Rather, general conclusions can be made about historic versus current conditions. Table 12 gives the miles of stream in each riparian class. The majority of streams surveyed are bordered by either a narrow or wide band of hardwoods. It is important to note that more than 10% of the riparian areas surveyed are now non-existent.

Table 12. Riparian Vegetation in the Salt Creek Watershed

Riparian description	Length (miles)*	Percent of total
Non-existent	17.82	10.2%
Brush	24.95	14.3%
Grass	42.97	24.6%
Conifers	32.33	18.5%
Hardwoods, >50 ft.	29.11	16.7%
Hardwoods, 0-50 ft.	22.24	12.8%
Mixed	4.95	2.9%
Total	174.37	100%

* Includes all streams and in-stream reservoirs. These numbers exclude off-stream ponds and reservoirs.

Ideally, riparian areas should include some mature conifers. Hardwoods decompose more easily in moist conditions and do not provide structure and complexity in the stream for as long as conifers. Based on air photo analysis and field verification, it appears that conifers are lacking from many riparian areas in the watershed.

Introduction: Wetlands

There are many different types of wetland, but they all share three characteristics: water, hydric soils, and wetland plants.

- *Water*—Usually in abundance from either high water table, rain water "perched" over impervious layers in the soil, frequent flooding, or a groundwater seep is necessary. It can also include areas with saturation in the top 12 inches of soil. One point of wetland determination that many find difficult to understand is that there does not need to be visible water year round. Water levels vary from year to year and season to season. Since many wetlands appear dry at times, standing water is only one of three components to be examined.
- *Hydric soils*—Developed under mostly saturated conditions. Soil scientists have established criteria for identifying soils that have historically been saturated for a period of time on an annual basis. These are closely associated with wetlands.
- *Wetland plant community*--Called *hydrophytes*, these plants have special adaptations for life in permanently or seasonally saturated soils.

The Oregon Division of State Lands defines wetlands for removal-fill permits as:

> …those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands can be dry during summer months and still be a wetland. Sometimes we refer to wetlands as swamps, marshes, or bogs. They can also be called wet meadows, swales, seasonal seeps, and sometimes even ditches if there is standing water part of the time and other conditions are right to support wetlands.

To be considered a wetland for legal purposes, land must meet the three criteria listed above unless it is farmed. Agricultural areas are assessed on the basis of hydrologic conditions and soils only since cultivation typically precludes wetland vegetation. A wetland does not have to be mapped by the state or otherwise designated to enjoy wetland protection under state and federal regulations.

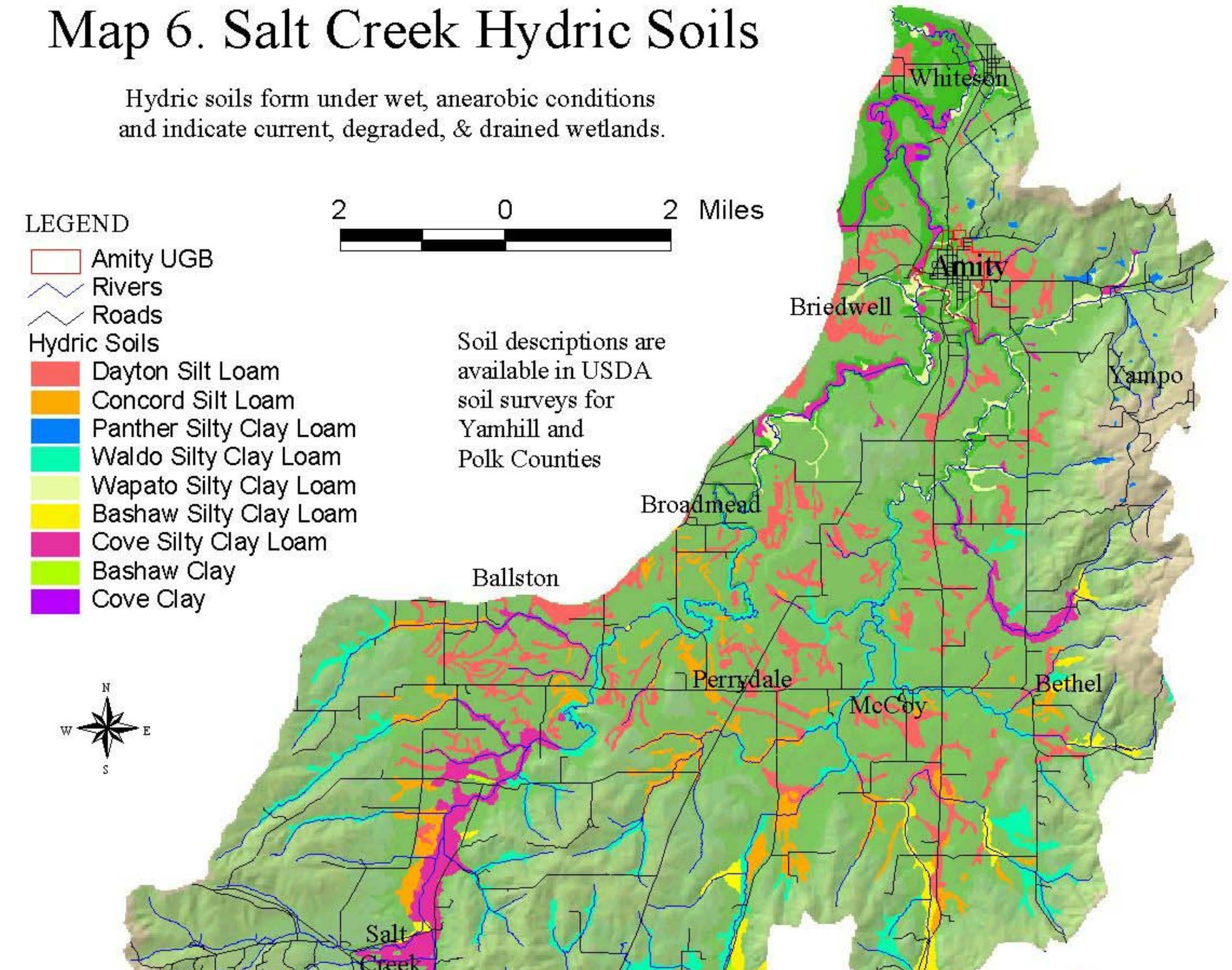
Wetlands play numerous roles in the health of the watershed. Their benefits include:
- Connecting upland and aquatic ecosystems, necessary for many species.
- Connecting lakes, streams, rivers, and riparian areas with one another.
- Capturing sediment from erosion runoff.
- Consumption of nitrogen from agricultural runoff.
- Recharging groundwater by retaining water that percolates into the ground.
- Maintaining more steady flows to streams by slowing peak flows.
- Flood mitigation for the same reason.
- Providing habitat for wildlife including rare and endangered species.
- Open space, outdoor recreation, education, and aesthetics.

Not all wetlands provide all these benefits to the same extent. Each has a unique setting and provides different functions as conditions vary.

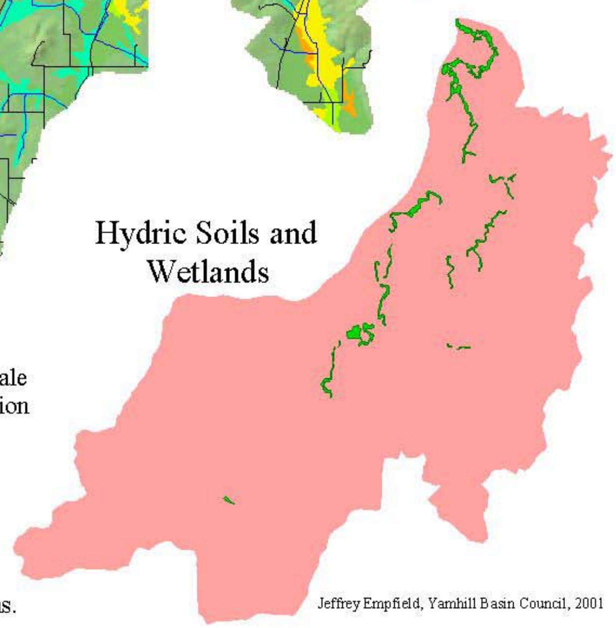
Several agencies are involved in the regulation and protection of wetlands including:
- Oregon Division of State Lands (DSL)
- State Department of Forestry under the Forest Practices Act
- U.S. Natural Resources Conservation Service (NRCS) under the Farm Bill
- U.S. Army Corps of Engineers under the federal Clean Water Act and the Harbors Act.

Map 6. Salt Creek Hydric Soils

Hydric soils form under wet, anearobic conditions
and indicate current, degraded, & drained wetlands.



The map at right approximates wetland areas from a large scale overview of the Willamette Valley. A more accurate indication of existing wetlands is found on National Wetland Inventory (NWI) maps. NWI maps cooresponding to USGS "quads" are available from the U.S. Fish and Wildlife Service. They can also be viewed at the local Soil and Water Conservation District office and at university libraries. Wetland labels indicate hydrology, soil, and vegetation which can be useful in land management decisions.



Jeffrey Empfield, Yamhill Basin Council, 2001

In seeking to understand wetland conditions in the Salt Creek watershed, we need information on both current and "prior converted" wetlands. Prior converted—labeled PC on many photos and maps—means simply that these wetlands were converted to non-wetland uses such as pasture or cultivation prior to our current understanding of the importance of wetlands. Until passage of the 1985 Farm Bill, the U.S. subsidized, encouraged, and facilitated draining of wetlands for cultivation. In 1985 there was a change in policy ending subsidies. We continue to lose wetlands through many ongoing development pressures.

The location of prior-converted wetlands are identified by several sources including:

- Soil Conservation Service soil surveys of Yamhill (1974) and Polk (1982) counties (scale 1:20,000) *Note: The Soil Conservation Service is now the Natural Resources Conservation Service.*
- Farm Service Bureau black and white aerial photos (1994 summer fly-over, scale 1:660).

Wetland Distribution and Trends

As part of a National Wetlands Inventory (NWI), the U.S. Fish and Wildlife Service (USFWS) mapped areas for remaining wetlands using color infrared aerial photographs at a scale of 1:58,000. Most wetlands on the map are not field-verified. The minimum acreage mapped is two acres so smaller wetlands do not appear, though many remain. Wetlands that are cultivated but not classified as prior converted are not included in NWI maps but may still be regulated. NWI maps are available in digital form through the USFWS or NWI websites. They can be viewed on paper at your local soil and water conservation district or at Oregon State University. Currently available digital quads appear on Map 7.

The majority of wetlands in our area are long and narrow—too narrow to be mapped at this scale. Linear-shaped wetlands are characteristic of the Willamette Valley where wetlands have typically formed in abandoned river and stream beds or in low-lying draws between hills rather than in the classic manner of glaciated kettles or potholes.

Hydric soils—outlined on soil maps and elsewhere—are another indicator of current and historic wetlands. Hydric soils have formed under predominantly wet conditions. The locations of hydric soils in the Salt Creek watershed are shown in Map 6. For more information regarding the location or significance of these soils, contact the Polk Soil and Water Conservation District at (503) 623-5534 or the Yamhill Soil and Water Conservation District at (503) 472-6403.

Table 13 shows the wetland classifications that apply to Salt Creek watershed. The chart starts with general categories and continues to more specific descriptions. Each wetland marked on a NWI map has a code indicating whether it is *palustrine* (nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens), *riverine* (associated with flowing water) or *lacustrine* (lakes). Wetlands are described further by subsystem codes that describe their hydrology. The final level is the class level, which describes the vegetation or substrate. The classification system also includes "special modifiers" that can be used to describe human alterations to the wetland.

Table 13. Wetlands Descriptions

Ecological System

The First Character in the Wetland Label (i.e. **P**UBHx**)**

Palustrine (P) These are the freshwater wetlands commonly referred to as marshes, bogs, and swamps. Included are wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and some non-vegetated wetlands that do not meet the criteria for Lacustrine wetlands.

Riverine (R) River, creek and stream habitats contained within a channel, where water is usually, but not always flowing. Riverine systems are usually unvegetated but may include nonpersistent emergent vegetation; Palustrine (persistent vegetation) wetlands are often adjacent to Riverine system or contained within them as islands.

Lacustrine (L) Lakes, Reservoirs, and deep ponds. Typically there is an extensive area of deep, open water and wave action.

Classes

The Middle Characters in the Wetland Label (i.e. P**UB**Hx)

Aquatic Bed (AB)
Wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season during an average year.

Unconsolidated Bottom (UB)
Includes all wetlands and deepwater habitats with at least 25% cover of particles smaller than stones (less than 6-7cm) and a vegetative cover less than 30%.

Emergent Wetland (EM)
These wetlands have rooted herbaceous vegetation standing above the water or ground surface.

Open Water (OW)
Areas of open water or water with unknown bottom.

Scrub-shrub Wetland(SS)
Wetlands dominated by shrubs and tree saplings that are less than 20 feet high.

Forested Wetland (FO)
Wetlands dominated by trees that are greater than 20 feet high.

Unconsolidated Shore (US)
Unconsolidated substrates with less than 75% area cover of stones, boulders, bedrock; less than 30% area cover of vegetation other than pioneering plants; and any of the following: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, seasonal-tidal, temporary-tidal, or artificially flooded.

Modifiers

The Last Characters in the Wetland Label (i.e. PUB**Hx**)

Temporarily Flooded (A)
Saturated (B)
Seasonally Flooded/Well Drained (C)
Semipermanently Flooded (F)
Permanently Flooded (H)
Artificially Flooded (K)
Intermittently Flooded/Temporary (W)
Saturated/Seasonal (Y)
Intermittently Exposed/Permanent (Z)

Special Modifiers	
b Beaver	**h Diked/Impounded**
dd Partially Drained	**r Artificial Substrate**
f Farmed	**x Excavated**

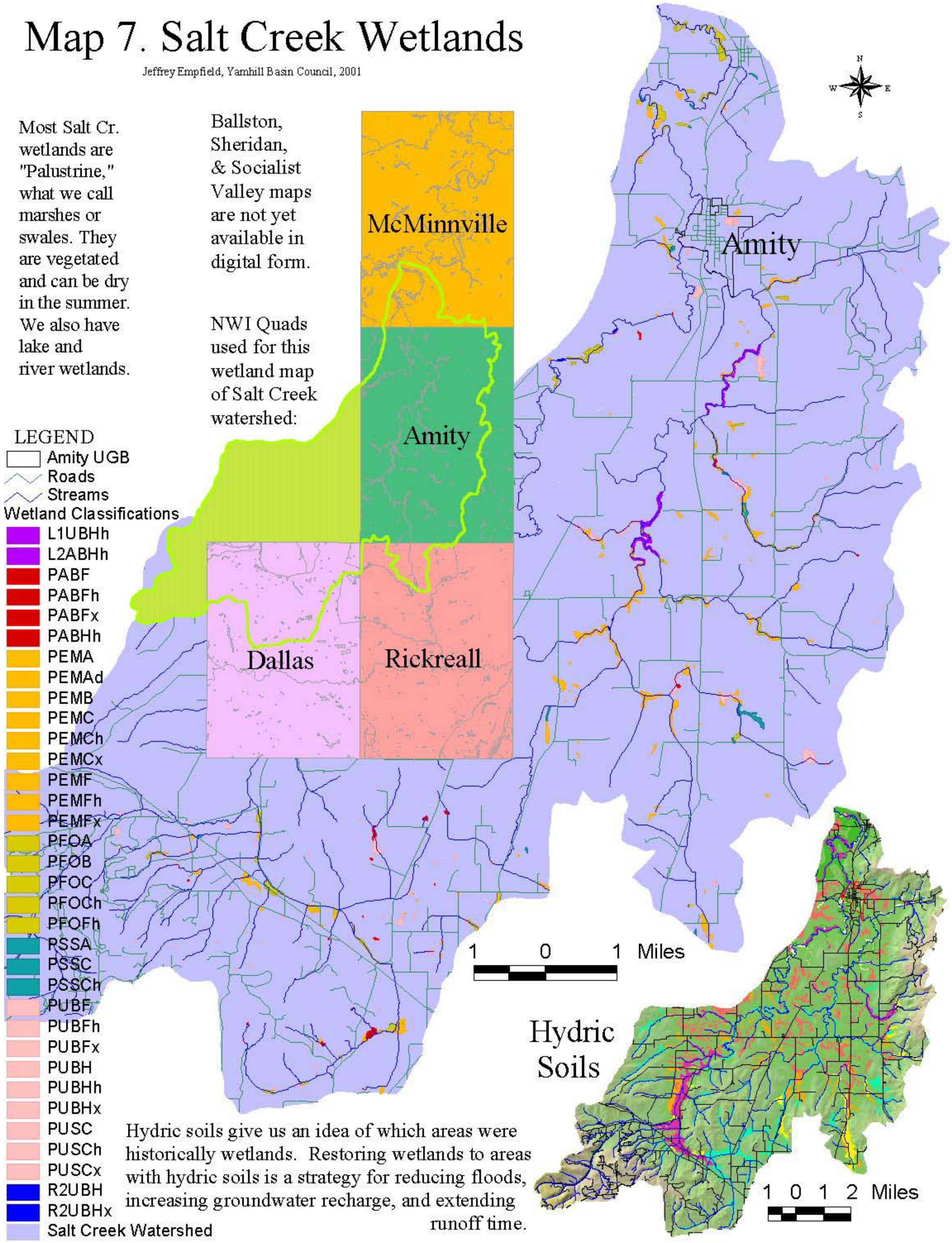
Map 7. Salt Creek Wetlands

Jeffrey Empfield, Yamhill Basin Council, 2001

Most Salt Cr. wetlands are "Palustrine," what we call marshes or swales. They are vegetated and can be dry in the summer. We also have lake and river wetlands.

Ballston, Sheridan, & Socialist Valley maps are not yet available in digital form.

NWI Quads used for this wetland map of Salt Creek watershed:



Hydric soils give us an idea of which areas were historically wetlands. Restoring wetlands to areas with hydric soils is a strategy for reducing floods, increasing groundwater recharge, and extending runoff time.

The distribution and acreage of wetlands shown on the map only approximates actual wetlands. Again, it is important to remember that NWI maps are not very useful on a small scale for identifying local wetlands. Unfortunately there is no definitive source of information about all the area's wetlands or about specific parcels of land. Local wetland inventories are needed.

The area of hydric soils in the Salt Creek watershed is larger than the area currently designated as wetlands. We have an inherent conflict because most wetlands occur in the lower, more flat parts of the landscape that are also desirable for farmland. The vast majority of land under cultivation in the watershed, (greater than 50% and maybe up to 80%) is tiled to drain water from fields in order to improve access for large machinery earlier in the growing season. There has not been any monitoring to document this and records of tiling are not open to the public. Drainage tiles carry water away that previously would have remained in the ground and gradually percolated into aquifers supplying springs and streams with year-round flow.

The Oregon Division of State Lands uses the Cowardin system of wetland classification as do the NWI Maps. This makes it easy to compare conditions across the state. More specific descriptions are used when developing Local Wetlands Inventories (LWI) which are usually completed as a partnership between the Oregon Division of State Lands and a local community.

Further information is available from a series of DSL flyers called *Just the Facts....* that include guidance for how to identify, assess, and inventory wetlands. Contact DSL at 775 Summer St. NE, Suite 100, Salem, OR 97301-1279, (503) 378-3805 or click on wetlands at their website.

Conclusion

Historically, riparian areas and wetlands were much more extensive in the valley than they are today. Over the past century and a half, riparian forest and wetland acreage has been significantly reduced through ditching, draining, and tiling in order to make cultivation possible earlier in the growing season. Wet prairie is now almost non-existent in the watershed. It once played a significant role for providing habitat for aquatic wildlife, provided off-channel storage of floodwaters, and groundwater recharge to the system during low-flow summer months.

Restoration and enhancement projects may help restore some of these functions to the watershed. Although converted wetlands in developed areas will likely not be reclaimed in the foreseeable future, it is important to determine where the best opportunities exist to enhance, restore, and even create wetlands. This may help mitigate or compensate for the net loss in wetland function in the area. State and federal assistance may be available for landowners that want to enhance, restore, or create wetlands on their land.

For more information contact the Oregon Freshwater Assessment Methodology (OFWAM), Wetlands Program, Oregon Division of State Lands, 775 Summer Street NE, Salem, OR 97310 or call the Yamhill Basin Council at (503) 472-6403.

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CHAPTER 5

Channel Habitat Types

Introduction

Channel Habitat Type (CHT) is a classification system designed to describe the physical characteristics of our streams. The Oregon Watershed Assessment Manual (OWAM), drawing on several stream classification systems already in use, describes 15 types of channel habitat.[1] As he Yamhill basin doesn't have coastal estuaries, high mountains, or desert environments, not all the OWAM designations apply.

CHT classifications appear on Map 8 and are based on conditions as recorded in aerial photos and USGS 1:24,000 topographical quadrant maps. The maps were particularly important for estimating gradient, confinement, and size of floodplains. Each stream is divided into segments according to their pattern of steepness, confinement, and size.

Stream channels in our area do not always fit clearly into one CHT category. This is due in part to the imperfect nature of all classification systems—they try to simplify things that are infinitely complex. It is also due in part to the altered physical condition of the area's streambeds. Channel Habitat Types describe natural stream patterns.

Incision or Downcutting

Many streams in the Salt Creek watershed are deeply incised or downcut meaning they have steep banks which greatly impact the stream's natural meandering and seasonal flooding. A natural bottomland stream floods regularly creating new channels and depositing sediments. In their natural state, these are *Flood Plains* (FP1, 2, or 3).

Many of the bottomland areas in our watershed, however, more closely fit the description of a *Low gradient, Moderately confined* stream. These channels do not meet the OWAM manual description of "variable confinement by low terraces or hill slopes." Instead, their confinement is due to downcutting of the stream banks. For this assessment they are labeled LC for *Low gradient, confined* streams. See Table 14 for descriptions. The important thing is to find some general indication of conditions on the ground and use that to guide land use strategies.

Table 14. Channel Habitat Type Descriptions

Channel Habitat Type	**Description**	**Fish Utilization**
Low Gradient Large Floodplain Channel **(FP1)**	Lowland and valley bottom channels of large watersheds. These have extensive valley floodplains and river terraces. Sloughs, oxbows, wetlands and abandoned channels are common. Numerous overflow side-	Anadromous: Potential steelhead rearing. Resident: Potential overwintering.

[1] OWAM's CHT system synthesizes six other systems that focus variously on mountain and forest streams, Washington and Alaska streams, stream habitat, map-based surveying, physical geology, and geomorphology.

	channels, extensive gravel bars, avulsions, and logjams in forested basins are characteristic.	
Low Gradient Small Floodplain Channel (**FP3**)	Located in valley bottoms and flat lowlands. Usually adjacent to toe of foot slopes or hill slopes within the valley bottom. May contain wetlands. Beavers can dramatically alter channel characteristics. Sediment from upstream temporarily stored in these channels and on the adjacent floodplain.	Anadromous: Potential steelhead rearing. Resident: Potential overwintering.
Low Gradient Confined Channel (**LC**)	Incised channels. Lateral migration is controlled by frequent bedrock outcrops, high terraces, or hill slopes along stream banks. Channels are often stable. High flows are often contained by the upper banks and move all but the most stable log jams downstream. Stream banks are susceptible to landslides in areas where steep slopes abut the channel.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering
Moderate Gradient Confined Channel (**MC**)	Flow through narrow valleys or are incised into valley floors. Hill slopes may lie directly adjacent to the channel. Bedrock steps, short falls, cascades, and boulder runs may be present. Moderate gradients, well-contained flows, and large-particle substrate indicate high stream energy. Landslides along channel side slopes may be a major sediment contributor.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Moderate Gradient Headwater Channel (**MH**)	Common in plateaus in Columbia River basalts, young volcanic surfaces, or broad drainage divides. May be sites of headwater beaver ponds. Similar to LC channels, but exclusive to headwaters. Potentially above the anadromous fish zone.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Moderately Steep, Narrow Valley Channel (**MV**)	Moderately steep gradient, confined by adjacent moderate to steep hill slopes. High flows are generally contained within the channel banks. A narrow floodplain, one channel width or narrower.	Anadromous: Potential steelhead spawning and rearing. Resident: Potential spawning, rearing, and overwintering.
Steep Narrow Valley Channel (**SV**)	Constricted valley bottom bounded by steep mountain or hill slopes. Vertical steps or boulders and wood with scour pools, cascades and falls are common. Channels are found in the headwaters of most drainages or side slopes to larger streams. May be shallowly or deeply incised into the hill slope. Channel gradient may be variable due to falls and cascades.	Anadromous: Lower gradient segments may provide rearing. Resident: Limited spawning and rearing.

(From the Oregon Watershed Assessment Manual, 1999)

Table 15 provides descriptions of the gradient, channel confinement, stream size, and sensitivity to restoration. Stream gradient is the steepness of the channel. The gradient is generally highest in the headwaters and lowest in the valley. There are exceptions to this rule. Sometimes headwater valleys are gently sloping and areas downstream have steep gradients for a while.

“Confinement” describes the narrowness of the stream banks; it determines whether the stream is able to flow onto its floodplain. Unconfined streams meander freely, flood during high flows, and occasionally create new channels. Confined streams become entrenched within steep walls that prevent lateral movement. A moderately confined stream has conditions between these two parameters. Table 16 provides descriptions of the restoration potential associated with CHTs.

Table 15. Channel Habitat Type Parameters

Channel Habitat Type	Gradient	Channel Confinement	Stream Size	Responsiveness to Change
Low gradient large floodplain **(FP 1)**	<1%	Unconfined	Large	High
Low gradient small floodplain **(FP3)**	<1%	Unconfined	Small to medium	High
Low gradient confined **(LC)**	<2%	Confined	Variable	Low to Moderate
Moderate gradient confined **(MC)**	2-4%	Confined	Variable	Medium
Moderate gradient headwaters **(MH)**	1-6%	Confined	Small	Medium
Moderately steep narrow valley **(MV)**	3-10%	Confined	Small to medium	Medium
Steep narrow valley **(SV)**	8-16%	Confined	Small	Low

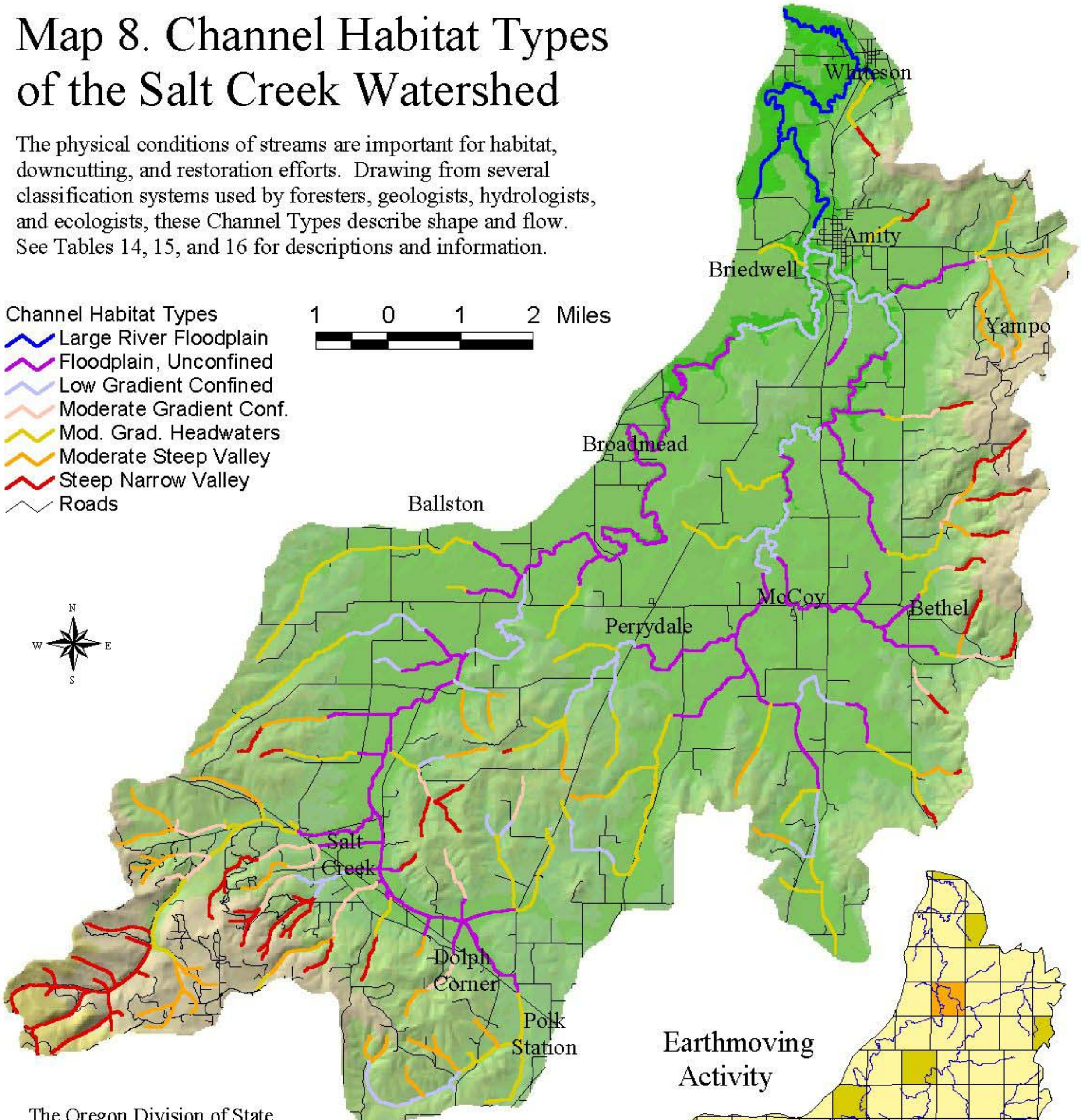
(From Oregon Watershed Assessment Manual, 1999)

Possible reasons for stream incision:

- A large proportion of the area's flood plains no longer function naturally by flooding during heavy precipitation and gradually draining over a period of hours or days. This is due to decades of dredging, dike building, straightening, damming, and wetland drainage projects aimed at making flood plains accessible year-round for agriculture and building sites. A consequence is that a larger volume of water is concentrated in the stream during shorter periods of time causing higher velocities. These higher velocities carry more energy and they tend to erode banks and scour the channel.
- Settlers began removing large woody debris from the area's rivers in the 19th century and we continue to remove many large trees from the system. As late as the 1960s Oregonians cleared wood from streams because it was mistakenly thought this would increase the quality of fish habitat. We now know that log jams decrease velocity, increase storage capacity, and create habitat.
- Stream bank modifications such as hardening of the bank with rip-rap (rocks that hold the soil in place) or concrete prevent the stream from gradually changing its course through meandering. Meander patterns find the stream's natural curvature to best dissipate energy and decrease erosion.

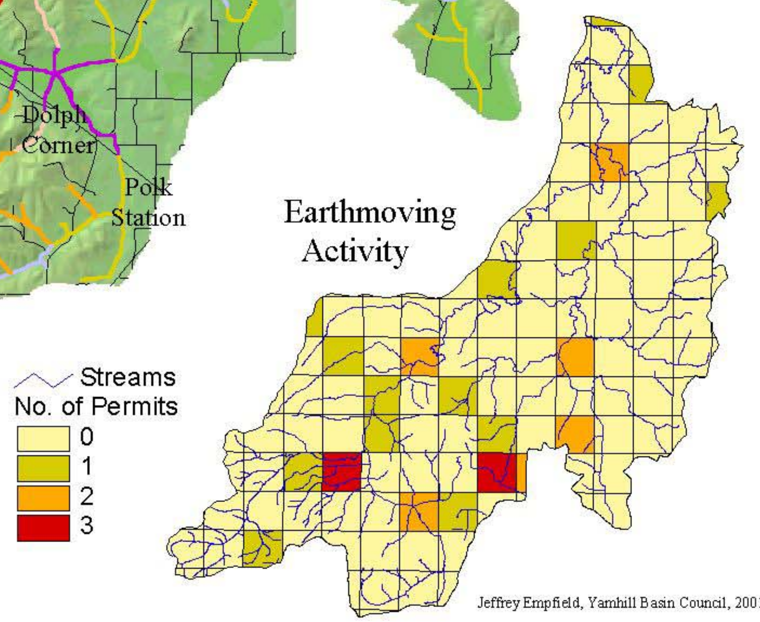
Map 8. Channel Habitat Types of the Salt Creek Watershed

The physical conditions of streams are important for habitat, downcutting, and restoration efforts. Drawing from several classification systems used by foresters, geologists, hydrologists, and ecologists, these Channel Types describe shape and flow. See Tables 14, 15, and 16 for descriptions and information.



The Oregon Division of State Lands issues Fill and Removal Permits for earthmoving. The permits issued in various areas of the watershed provide some indication of the amount of stream channel modification. Much more activity actually takes place than is recorded in the files. Problems like erosion and wetland degradation are related to channel modification.

Earthmoving Activity



Jeffrey Empfield, Yamhill Basin Council, 2001

Table 16. Channel Habitat Type Restoration Potential

CHT	Riparian Enhancement Opportunities
Low gradient large floodplain **(FP1)**	Due to the unstable nature of these channels, the success of many enhancement efforts is questionable. Opportunities for enhancement occur where lateral movement is slow. Lateral channel migration is common and efforts to restrict this natural pattern will often result in undesirable alteration of channel conditions downstream. Side-channels may be candidates for efforts that improve shade and bank stability.
Low gradient small floodplain **(FP3)**	The limited power of these streams [i.e. low stream flows] offers a better chance for success of channel enhancement activities than the larger floodplain channels. While the lateral movement [i.e. meandering] of the channel will limit the success of many efforts, localized activities to provide bank stability or habitat development can be successful.
Low gradient confined **(LC)**	These channels are not highly responsive and in-channel enhancements may not yield intended results. In basins where water-temperature problems exist, the confined nature of these channels lends itself to establishment of riparian vegetation. In non-forested land these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.
Low gradient moderately confined **(LM)** *Note: although no sections have this designation in the Salt Creek Valley watershed, this restoration characterization may apply to sections designated LC.*	Like floodplain channels, these channels can be among the most responsive of channel types. Unlike floodplain channels, however, the presence of confining landform features often improves the accuracy of predicting response and helps limit the destruction of enhancement efforts common to floodplain channels. Because of this, LM channels are often good candidates for enhancement efforts. In forested basins, habitat diversity can often be enhanced by the addition of wood or boulders. Pool frequency and depth may increase, and side-channel development may result from these efforts. Channels of this type in nonforested basins are often responsive to bank stabilization efforts such as riparian planting and fencing. Beavers are often present in the smaller streams of this channel type.
Moderate gradient confined **(MC)**	Same as LC and MV.
Moderate gradient headwaters **(MH)**	These channels are moderately responsive. In basins where water temperature problems exist, the stable banks generally found in these channels lend themselves to the establishment of riparian vegetation. In non-forested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access and control measures.
Moderately steep narrow valley **(MV)**	Same as LC and MC.
Steep narrow valley **(SV)**	These channels are not highly responsive and in-channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. Where stable banks exist, opportunity for riparian enhancement. This may serve as a recruitment effort for large woody debris in the basin.

(Oregon Watershed Assessment Manual, 1999)

Channels respond to change differently based on their position in the watershed. The headwaters of Salt Creek and Ash Swale, for example, are steep with low responsiveness to changes in channel pattern, location, width, depth, sediment storage, and bed roughness. The segments labeled moderate gradient confined (MC), moderate gradient headwaters (MH), and moderate steep narrow valley (MV) throughout the watershed are more likely candidates for enhancement.

Low gradient streams that are most responsive to change are generally located in the most developed parts of the watershed where land is under cultivation. Refer to Map 4 for current vegetation patterns in the watershed. Each low gradient stream has significant lengths that could be enhanced. Depending on land use, these areas may benefit from projects that encourage meandering or moderate flooding. At the very least, these areas would be improved by increasing stream bank vegetation.

Conclusion

Channel Habitat Types help us understand the streams in our landscape by labeling them according to varying gradient, channel confinement, size, and substrate. This classification should be useful in combination with other characterizations in the assessment to estimate a given stream's sensitivity to restoration efforts.

Channels respond to change differently based on their conditions and position in the watershed. The headwaters of streams like Ash Swale are steep, with low responsiveness to changes in channel pattern, location, width, depth, sediment storage, and bed roughness. The segments labeled moderate gradient confined (MC), moderate gradient headwaters (MH), and moderate steep narrow valley (MV) throughout the watershed are more likely candidates for enhancement projects.

The majority of channels in the lowland areas of the watershed were once floodplain type channels and are now deeply incised channels that meet the criteria for low gradient, confined channels. These channels pose the greatest challenge to restoration efforts but also provide the greatest value for improving habitat.

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CHAPTER 6

Channel Modifications

Introduction

This chapter illustrates some of the known modifications to our streams. The Oregon Watershed Assessment Manual (OWAM) describes channel modifications as any of the following: impounding, dredging or filling water bodies and wetlands, splash damming, hydraulic mining, stream cleaning, and rip-rapping or hardening of the streambanks. Other modifications include road crossings (bridges and culverts) and streams with "permanent discontinuity" due to the artificial effects of a roadbed being constructed next to a stream.

Stream channels are normally dynamic systems that respond to physical conditions including climate. Human manipulation at times magnifies or eliminates the evolutionary changes that streams naturally undergo. This section examines how humans have impacted stream channel structure and consequently the aquatic habitats of Salt Creek watershed. This chapter includes information from residents, fill and removal permits, dam records from the Oregon Water Resources Department (OWRD), aerial photos, and Federal Emergency Management Agency (FEMA) floodplain data.

Historic Channel Modifications

Throughout history humans have modified streams both intentionally for irrigation, transportation, and drinking water and accidentally through a variety of uses and landscape modifications. In the Yamhill basin, for instance, residents dug a new channel for Mill Creek in 1900 using muscle and animal power. Over the past century the growth in our earth-moving technology has resulted in a much larger scale of modification.

In terms of area affected, agriculture has had the greatest impact on stream modification in the Salt Creek watershed. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating streams and wetlands. This, along with the installation of drainage tiles means standing water drains and soil dries faster allowing farmers to access their fields earlier in the season. Historical aerial photographs reveal different conditions near streams in the past. Photos from the mid-20th century show streams in roughly the same location as they are now. The interesting difference is that the land adjacent to streams contained wet oxbows, what we know today to be valuable wetlands. Many of these large wetland areas no longer exist. On aerial photos taken in 1994 some ghostly contours of the historic oxbows are still visible, although most are now drained and cultivated.

The powerful technology associated with road building is another major cause of channel modification. In hilly areas, road construction follows the path of least resistance, inevitably the course of the stream. To protect our investment in road infrastructure we have learned to use channel hardening or bank stabilization (rip-rap) to keep streams from undercutting our roads. Unfortunately this has harmful effects on the health of our streams by preventing natural channel movement. By restraining the flow to one channel we have taken away the stream's ability to meander. This prevents streams from evolving in ways that dissipate energy, sustain habitat, and recharge wetlands. When constrained, the stream cannot dissipate energy; during heavy flows it maintains a high velocity, erodes its channel, picks up sediment, and becomes incised.

Road crossings have similar effects. Because of the proximity of many roads to streams and our desire for relatively straight roadways, we design our roads to cross streams repeatedly. Bridges and culverts at stream crossings are often in the floodplain or the streambed and require permanent footings and backfill. Private residences and side roads require additional bridges or culverts to provide access. This further limits the movement of the stream. Roads placed next to streams also prevent the formation of side channels while they reduce or eliminate many needed functions associated with riparian areas. These include shade, a source of large woody debris, area for flooding, and habitat complexity.

Other human interventions such as dam building, dredging and straightening of streams, and removing wood from streambeds have also contributed to the high level of modification in our streams. Even our straight property lines have an impact by orienting land use and development to imaginary boundaries rather than natural ones such as streams and ridgelines. Section line boundaries, for example, cross streams rather than following them as natural boundaries.

DSL Fill and Removal Permits

It is difficult to thoroughly assess the extent and location of historic channel modifications in the watershed. Fill and removal permits (on file at the Division of State Lands) give some sense of the physical modifications in the area. Permits were not required until the late 1970s, so little is recorded prior to then. While many fill and removal permits apply to off-stream projects such as road work or reservoir construction, others focus on in-stream channel modification. Much off-stream work has direct or indirect effects on streams—by eliminating wetlands, for instance.

There is a great deal of activity surrounding bridge replacement, bridge removal, road crossings with culverts and earth fill, upgrading culverts, replacing culverts, extending culverts, highway widening, and filling in wetlands for "ingress and egress" from residences. In 1983, for example, a 75-yard section of Salt Creek was rip-rapped for bank stabilization to stop severe erosion that was undermining the Brown Road bridge. There are also many small dams for agriculture such as a 1990 installation of a concrete "flashboard"-type dam on Ash Swale to store water for irrigation. Other modifications are for things like installing pipelines, electrical lines, or sewer lines.

There is an encouraging trend toward increased ecological awareness indicated by permits. As early as the 1970s, many permits alluded to erosion control and reseeding. Through the 1980s, ecological efforts expanded and by the 1990s they play a major role in most designs for modification work. In 1991, for example, bridge replacement plans kept vehicles out of the stream bed and the site was chosen to minimize impact on stream and wetlands. Another 1991 bridge replacement started with locating hydric soils and

limited the work area to the existing road. In 1996, a bridge replacement design aimed to keep all debris from entering the waterway.
The project included silt fences to prevent soil erosion, placed "waste material" above the top of the bank, and maintained the existing grade and elevation of the streambed. Elsewhere, road work included efforts to minimize impacts to wetlands by mapping the local hydric soils. Another 1996 bridge replacement included a culvert designed with fish passage in mind and included efforts to prevent siltation, erosion, and minimal removal of vegetation. Also in 1998, the Amity School District worked with the Yamhill SWCD to install a footbridge to access wetlands on the south side of Ash Swale as part of an ongoing Environmental Science Project.

Agriculture and private land management is becoming more sensitive to natural resources. Earthen dams for livestock watering are now designed to have a limited footprint—the area of disturbance—by excavating from within the planned reservoir. Water is also now piped to stock troughs outside fenced reservoirs or wetlands. Area residents are also excavating and building low dikes to restore wetlands on prior converted farmland for wildlife purposes. Some property owners manage their land primarily for wildlife purposes and plant diverse riparian forests and native prairie species such as tufted hairgrass. Another local practice is to build a shallow impoundment below a spring to create a small pond and wetland to provide year-round habitat for wildlife. In 2000, a cooperative effort of the US Department of Fish and Wildlife (USDFW) and Salt Creek landowners aimed to "impound water and create a seasonal wetland which will benefit local migratory bird, reptiles, and amphibians."

Many restoration projects on Salt Creek from the past decade illustrate how fill and removal activity increasingly includes habitat considerations:

- The creation of three acres of wetland, wildlife pond, and shelterbelt connected to existing four-acre wetland.
- A landowner and USDFW restoring 11.1 acres of drained farmland to seasonal, shallow water wetland. This was to benefit among other species the following rare, threatened, or endangered species: Bald Eagle (*Heliaeetus leucocephalus*), Peregrine falcon (*Falco peregrinus*), Aleutian Canada goose (*Branta canadensis leucopareia*), and Western pond turtle (*Clemmys marmorata marmorata*).
- A project to enhance existing wetland by constructing a low (4 ft) dike increasing the surface area by approximately .3 acres and including plantings of native grasses, trees, and shrub species.
- Restoring 45 acres of wetlands and 26 acres of non-wetland wildlife habitat using a small dam and water control structure. The average dike height was 2.5 ft created by scalping and surface shaping.
- Creating a wildlife pond near Ash Swale (but not in the floodplain) with a 10 ft. earthen dam fed primarily by drainage tiles.
- A large project to provide two acres of shallow water for habitat. The surrounding 12 acres were converted from agriculture to a natural wet meadow and woods. Five or six excavated ponds with natural curving outline.
- Creation of a shallow water area for wildlife about an acre or less in size.
- Restoring a wetland area by excavation of a historic stream meander on Salt Creek. This USDFW site was to provide year-round habitat. "The site is, predominantly, an undisturbed oak/ash woodland. The easement boundary blocks in the historic meanders of Salt Creek. The creek was channelized in the late 1950s and the central area of the site has been cleared of trees in an attempt to farm the ground. It is this cleared area with its readily visible meandering channel that is the proposed habitat restoration area. [The] water level will be manageable to allow for modification of the Reed's canary grass...this species is intolerant of water depths beyond 18 inches...pond and channel contours are designed to facilitate both waterfowl and farm equipment. The Canadian thistle must be sprayed as biological

control agents are less than feasible at this time. The adjacent woods, wetlands and meadows will provide a seed stock for native and or desired plant species as the project area recovers from the restoration activity."

- Three low-berm dikes constructed for wetland restoration on upper Ash Swale. "WRP Wetland Plan focussed on restoration of Ash Swale floodplain to create wetland and wet prairie habitat. There is an extremely low probability of a take of winter steelhead given that this reach is 10 miles from the confluence with Salt Creek, which has a number of water diversion structures that do not allow upstream and/or downstream fish passage at any range of flow levels. The stream does provide habitat for a variety of warm water fish. Passage concerns occur directly upstream from this project as this reach of Ash Swale is just north of the divide with Basket Slough/Rickreall Creek."
- A project restoring 66 acres of wetland and wet prairie grasslands, redistributing 11,800 cubic yards of earth, restoring natural spillways, installing log structures in three locations in Ash Swale, and planting six acres mixed deciduous riparian forest. This included Oregon ash, big-leaf maple, cottonwood, and Oregon white oak, woods rose, snowberry, Douglas hawthorn, and Douglas spiraea creating a buffer at least 50 ft wide along the banks. The plan explained that Ash Swale had been extensively channelized with hydric soils drained and graded for grass seed agriculture. "Sediment discard is relatively high during the winter," the applicant explained, since wetlands and riparian vegetation had been largely eliminated, "reduced to a ribbon-like strip bordering the stream channel."

Growing awareness of natural resources is reflected in public works policy as well. Road and bridge work now typically includes a Wetlands Mitigation Monitoring Program. These address things like creating gradual stream banks to avoid scour, increasing runoff storage capacity in wetlands, improving wildlife habitat, and restoring detour areas to preexisting wetland conditions. Bridge replacements also include efforts to avoid impacting wetlands as well as mitigation for any wetland areas that are unavoidably lost.

"Mitigation" means to mollify, to make less severe, or to temper one's impact. In Oregon if you damage or destroy wetlands you may be able to mitigate that by creating new wetlands or by enhancing other degraded wetlands in the area. Mitigation involves re-grading and planting native wetland species in the impact zone as well as building new wetlands at the standard ratio of 1.5:1 wetland acres lost. Replacing 50% more wetland area than you destroy recognizes that artificial wetlands do not replicate the functions of natural wetlands.

Monitoring for success requires 80% survival of new plants after three years. The overall design may also include constructed wetlands intended to improve water quality of runoff from roads and parking lots. Pavement runoff contains sediment and pollutants such as steering fluid, antifreeze, oil, gasoline, tire rubber, and heavy metals from brake pads.

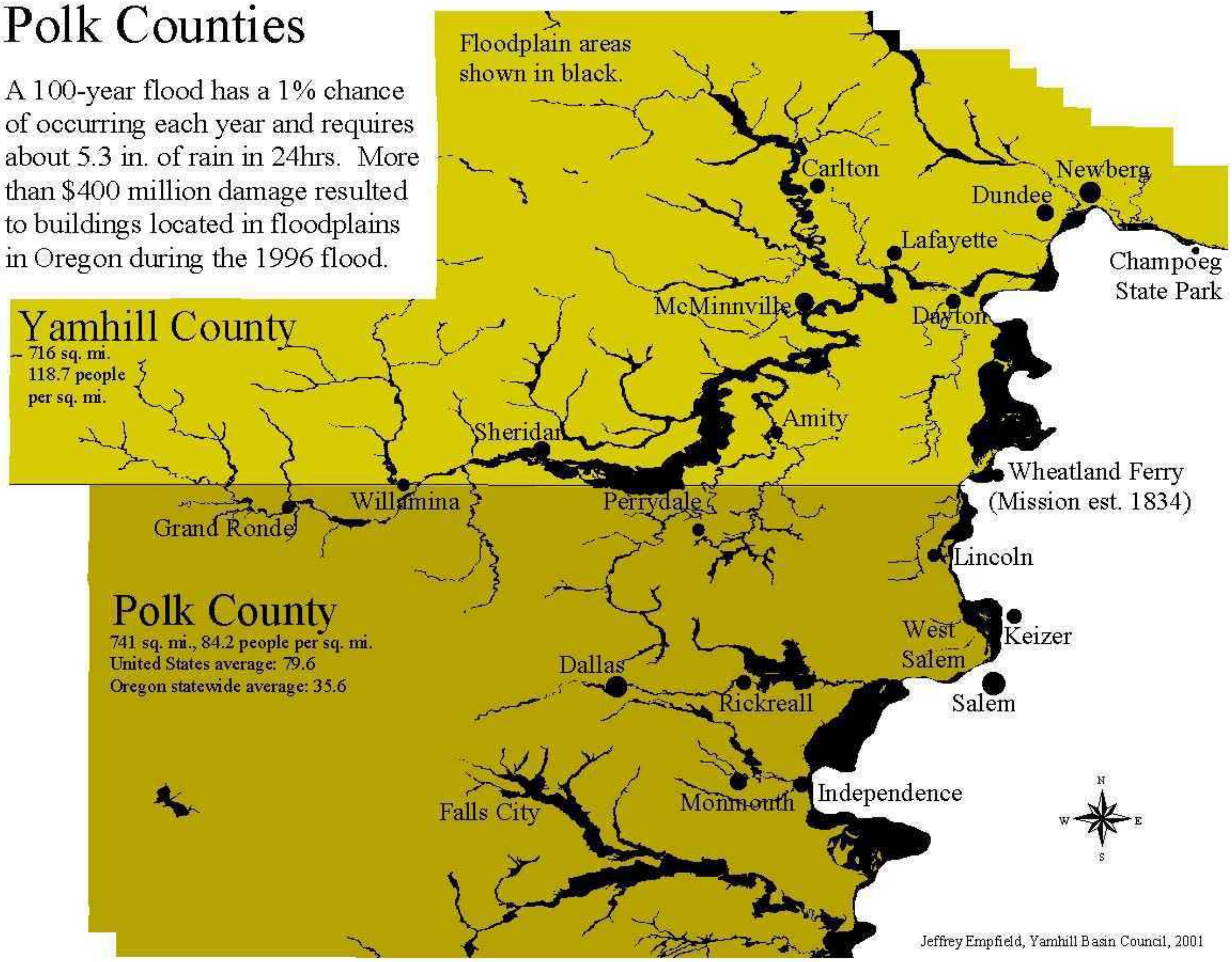
Mitigation is still needed even for Prior Converted farmland when a wetland designation exists. A wetland delineation determines the extent and location of the wetlands and includes an analysis of soils, vegetation, and hydrology.

Dams

Salt Creek watershed reservoirs of various type, purpose, and size are noted in Table 17. Dam locations and dimensions are only given for those dams that meet the state criteria to be monitored. There are many more unregistered dams. According to Jon Falk of the Water Resources Department (WRD), only those dams that are 10 feet or greater in

Map 9. One Hundred-Year Floodplain of Yamhill and Polk Counties

A 100-year flood has a 1% chance of occurring each year and requires about 5.3 in. of rain in 24hrs. More than $400 million damage resulted to buildings located in floodplains in Oregon during the 1996 flood.



Below, Salt Creek flood waters approach a house and barn near Perrydale, December 2001.

height and that store more than 9.2 acre feet are required to be engineered and recorded in a dam safety database. Smaller structures are not recorded although all storage projects require a reservoir permit. Falk notes that a structure less than 10 feet high could have a storage pond of 9.2 acre feet or approximately 3 million gallons of water.

The structures with a zero in the Drainage Area column are off-channel storage reservoirs. Dams with a number in the Drainage Area column, representing the square miles being drained, are in-channel storage structures. In-channel storage is important to note because of its possible effects on streams such as introduction of non-native fish, loss of spawning and rearing habitat, possible migration barrier, and water quality impacts. These dams need further investigation to determine if temperature or fish passage are issues that need to be addressed for any of them.

Flood Plains

The Federal Emergency Management Agency (FEMA) 100-year-floodplain is shown on Map 9. The map identifies which areas of the region are prone to flooding. The larger rivers and streams in our area historically meandered and routinely flooded their banks, changed directions, and carved side channels. There is physical evidence of this natural process in ghost channels, oxbow lakes, and wetlands.

Table 17. Dam Locations and Descriptions for the Salt Creek Watershed

Dam I.D. Number	Name (Owner)	Year Completed	Type	Purpose	Dam Lgth (ft)	Dam Ht (ft)	Storage (acre/ft)	Surface Area (acres)	Drainage Area (sq. i.)	Hazard
OR-00831	R. L. Walker Dam	NA	Private	NA	NA	16	10	NA	NA	Low
OR-01016	Aebi Reservoir	NA	Private	NA	NA	15	12	NA	NA	Low
OR-01291	Gordon Buhler Reservoir	NA	Private	NA	NA	17	14	NA	NA	Low
OR-01307, 01308	Burr Reservoir	NA	Private	NA	NA	22	22	NA	NA	Low
OR-00734	Marvin DeRaeve Reservoir	1978	Private Earthen	Irrigation	300	18	346	42	0	Significant
OR-00659	DeRaeve Reservoir (Philip R. Olson)	1975	Private	Irrigation	180	14	93	13	36	Significant
OR-01503	Marvin DeRaeves Reservoir	1987	Private Earthen	Irrigation	250	20	103	13	0	Low
OR-01683	Marvin Fast Reservoir	NA	Private	NA	NA	22	NA	35	NA	Low
OR-00673	Roy Freeman Reservoir	1979	Private Earthen	Irrigation	930	18	74	8	0	Significant
OR-01767	Freeman Reservoir 1	NA	NA	NA	NA	11	NA	45	NA	Low
OR-00663	Ingebrand Reservoir (Ken Eichler)	1979	Private Earthen	Irrigation	325	11	76	15	39	Significant
OR-00678	Stewart M. Lancefield Reservoir	1967	Private Concrete	Irrigation	40	10	72	14	22	Significant
OR-00486	Richard Martin Bros. Flashboard Dam	1973	Private	Irrigation	305	10	71	7	3	Low

OR-02513	Neighbors Reservoir (Robert Muller)	NA	Private	NA	NA	10	NA	19	NA	Low
OR-00724	Mark Olson Reservoir	1988	Private Earthen	Irrigation	360	25	45	4	0	Sig-nificant
OR-02589	Philip Olson Reservoir, 2-B	1977	Private Earthen	Irrigation	500	18	50	8	0	Low
OR-00329	William Reimer Reservoir (Eugene Reimer)	1958	Private Earthen	Irrigation	570	22	125	15	1	Low
OR-00444	Eugene Rohde Reservoir	1967	Private Earthen	Irrigation	1620	17	74	21	2	Low
OR-02973	Bob Sharf Reservoir	NA	Private	NA	NA	10	NA	41	NA	Low
OR-02977	Sharf Reservoir 2	1980	Private Earthen	Irrigation	655	15	36	NA	0	Low
OR-03064	Ross Simpson Reservoir	NA	Private	NA	NA	22	NA	42	NA	Low
OR-03175	Hal Stapleton Reservoir	NA	Private	NA	NA	10	NA	9	NA	Low
OR-00206	Don Walker Reservoir	1952	Private Earthen	Irrigation	700	22	52	16	1	Low
OR-01389	Clarence Buhler Dam	NA	Private	NA	NA	19	11	NA	NA	Low
OR-01435	James Copp Reservoir	NA	Private	NA	NA	12	16	NA	NA	Low
OR-00366	Jack and James DeJong Reservoir	1961	Private Earth	Irrigation	500	35	72	4	0	Low

(Oregon Water Resources Department website)

Conclusion

In terms of area affected, agriculture has had the greatest impact on stream modification in the watershed. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating stream qualities. Many streams are restricted within steep banks, have lost many of their side channels, and no longer routinely flood. Instead, surface flows are altered, resulting in less frequent but more concentrated floods. The larger creeks of the Salt Creek watershed flow through developed land or are being farmed on their floodplain; increasingly, area streams receive additional infrastructure incompatible with seasonal flooding.

There are immediate opportunities for enhancing vegetation to provide more diversity. Where possible, owners with land that floods could leave that land undeveloped and use it in flood-compatible ways. Such an approach will reduce flood damage and increase wetland area for wildlife and open space as well as for groundwater infiltration. Streams can provide additional off-channel water storage during high flows.

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CHAPTER 7

Sediments

Introduction

Sediments are a concern in the watershed due to their effects on water quality and aquatic resources. Major sources of sediment include cultivated fields, construction sites, landslides, roads, pavement, and insufficiently vegetated stream banks. Bank erosion potential is greatest in the lower elevation main channels where soils contain mostly fine materials that erode easily. This is also where stream entrenchment encourages lateral scour of stream banks.

Water draining from roads can move considerable amounts of sediment from drainage ditches and road surfaces. Road ditches sometimes fill in with sediment from *ravel*, sliding and erosion of the road cut slope. Ditches are designed to move water away from the roads; when the ditch has no vegetation, flowing water picks up sediment and carries it into streams. It is important to remember ditches are essentially an extension of streams because they drain directly to them.

The amount of sediment potentially contained in runoff from any road is difficult to estimate because of variable conditions. A road surfaced with high-quality rock can be quickly reduced to a quagmire if water pools during wet weather or if there is heavy traffic. Conversely, a road with poor-quality surface may not degrade much at all if it is used mainly during dry weather. Paved roads prevent road surface erosion but create other problems including petroleum-based pollution and impervious surfaces that prevent surface water from soaking in to the ground.

Hilly areas classified as having a potential for debris flows or high risk of erosion are a major concern. Debris flows are initiated by landslides on steep slopes that quickly transform into semi-fluid masses of soil, rock, and other debris. Typically they scour materials for a portion of their path and move rapidly down steep slopes and confined channels. Landslides can become large debris flows; the debris flow inset on Map 10 does not indicate maximum potential size.

In forested uplands, logging is challenging due to steep slopes. Soils are also shallow and loose in these areas. Constructing roads into the forest requires many stream crossings and heavy rains produce surface and subsurface flows that often result in erosion or even road fill failures.

Decades of Erosion

Over thirty years ago county officials identified stream bank erosion as the largest single soil erosion problem in Yamhill County according to the 1979 *Natural Resource Conservation Plan* of the Yamhill County Soil and Water Conservation District. The major causes of erosion were agricultural cultivation, increased runoff due to agricultural drainage ditching and tiling, timber harvesting and urban development within riparian areas, the removal of riparian vegetation, and straightening of streambeds.

Roadside erosion was also identified as one of the worst contributors of sediment to streams in 1979. At that time the Yamhill County Road Department identified 35 miles of “severe roadside erosion” in the county. Several factors contributed to the problem including narrow right-of-ways requiring steep road cuts, inadequate drainage ditches and culverts, siting roads in areas with highly slumping soils, and lack of soil-stabilization seeding and maintenance.

Soil erodibility (also called K factor) is a measure of the susceptibility of soil particles to detachment and movement by rainfall and runoff. Soil properties affecting soil erodibility include soil texture, percent of sand present greater than 0.1mm, organic matter content, soil structure, soil permeability, clay mineralogy, and the presence of rock fragments. Soil erodibility and steepness can be correlated for relative risk for sedimentation. Map 10 illustrates the erosion potential of areas in the watershed.

Recognizing that rural roads contribute significant amounts of sediment to waterways, the Yamhill Basin Council helped form a Roadside Water Quality Committee that meets quarterly to collaborate on issues related to county roads. Currently, the members include representatives from the Yamhill Basin Council, Polk and Yamhill County Public Works Departments, Yamhill Soil and Water Conservation District, Oregon State University Extension, Oregon Department of Transportation, and local landowners and residents. They are working to improve the conditions of ditches through a seeding project that began in 1997. The goal is to improve the ability of ditches to transport water while leaving the soil in place. This is accomplished through reshaping the ditch, preparing a good seed bed by eliminating weeds, and seeding a low growing grass such as creeping red fescue or the bluegrass “fowel” in the ditch.

Yamhill County maintains its ditches by mowing but it does not mow all the ditches in agricultural areas, only those where visibility is an issue. Polk County applies an herbicide to roadside vegetation. In terms of sedimentation, mowing is preferable to herbicides because vegetated ditches hold sediments instead of letting them pass on to streams. Equally important, chemicals sprayed in or near drainage ditches will likely end up in streams.

Ditches in Yamhill County are re-graded on a 10-year rotation. Budget constraints prevent a more ideal seven to eight year schedule. Some areas receive yearly maintenance while others are maintained every twenty years. Ideally, re-ditching would be restricted to the driest months of the year to prevent sediment from the exposed surface from entering waterways. However, due to the workload, road ditching is scheduled year round. Most road grading occurs during the winter months when the road substrate has enough moisture to be reshaped.

If you would like further information on roadside seeding or other road-related issues contact the Yamhill Soil and Water Conservation District, 2200 SW 2nd St., McMinnville, (503) 472-6403 and ask for the “Roadside Vegetation Management” brochure.

Urban and Industrial Runoff

Storm water runoff is drained both by pipe and natural open channels from urban and industrial areas. Some drainage systems are inadequate or improperly located. Frequent flooding and ponding is often due to under-capacity storm drains and debris-blocked ditches. Upgrading, rerouting, and detention are possible alternatives for these ongoing problems.

Upgrading usually involves installation of larger capacity pipes. Generally, engineers design public storm water drains for five or ten-year "frequency events." Rerouting means laying new lines to carry water to a different drainage. Another strategy is designing for stormwater detention. Runoff detention is a straightforward approach: simply delay runoff in upstream locations using something like a constructed wetland. By slowing runoff we can reduce flooding problems downstream. Water can be released slowly at a rate the system can handle. Detention can also occur in ponds, underground, or on rooftops.

In many parts of the Willamette Valley, especially in towns and cities, there are drainage management sub-basins ranging in size from 30 to 60 acres in areas of dense development and larger than 60 acres in less developed areas. These sub-basins are used for storm water planning and for flood modeling by the Corps of Engineers. To better understand this, consider that every square foot of land is part of a drainage basin. The smallest basins are ones that create puddles or rivulets. These combine to form headwaters that in turn combine to form streams, then bigger streams, and finally rivers. We find boundaries between basins where there is high ground. The boundaries are physically determined by the lay of the land. The scale, however, depends on whether we want to address large areas such as the entire Willamette Valley or something more local such as the drainage system of Amity, a stretch of road, or a private compound with residential and business activities that impact storm water.

Currently, there are no requirements by the U.S. Environmental Protection Agency (EPA) on storm water quality for towns the size of Amity and the smaller communities of the area. Such requirements will likely be imposed eventually. It would be prudent for communities to anticipate potential problems and to act accordingly. Low cost or no cost options for improved storm water quality should be implemented including:

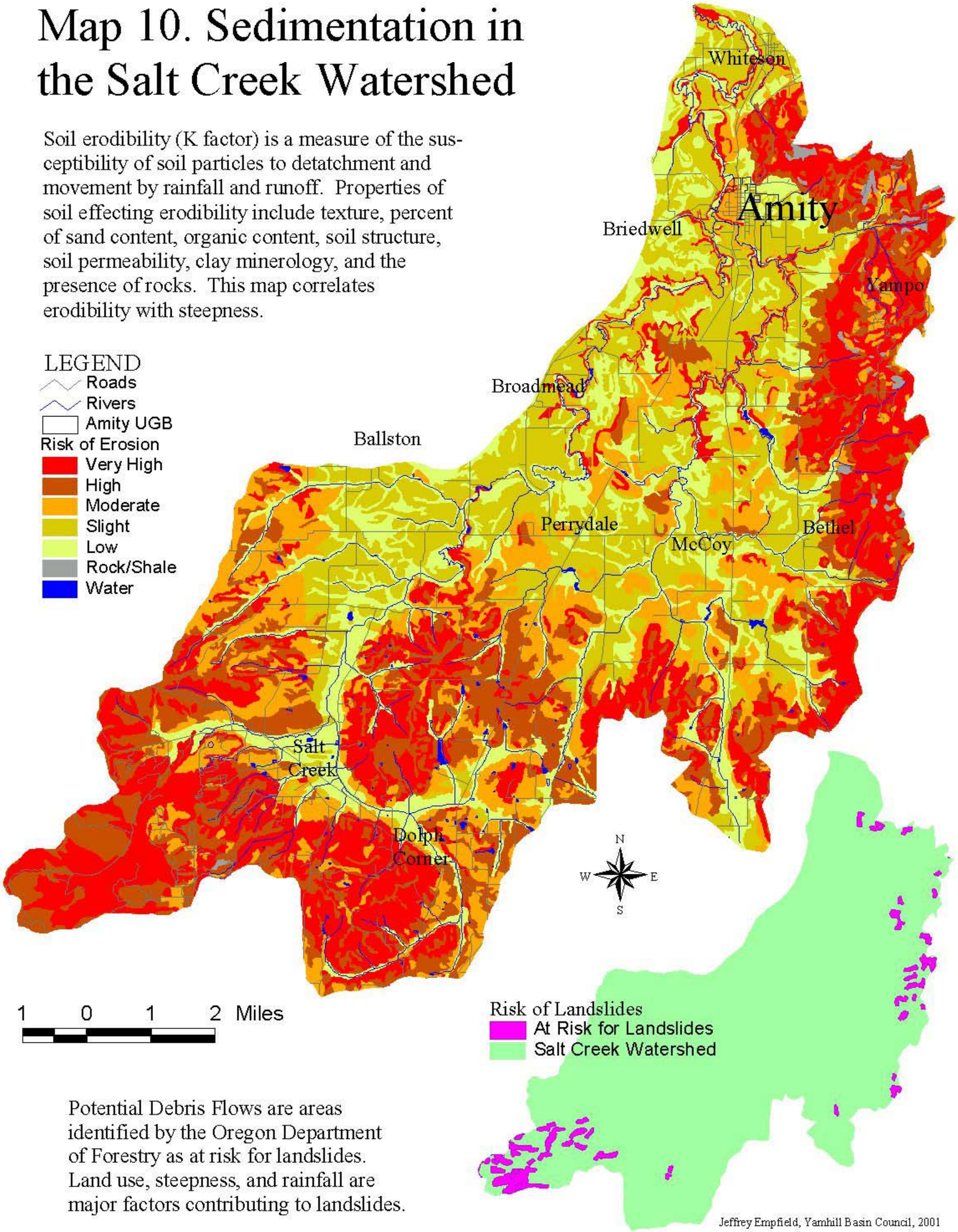
- Keeping natural channels open where possible in preference to installation of storm drains.
- Adopting appropriate erosion control measures for construction activities.
- Adopting standards for the construction of water quality and detention facilities for major new industrial and commercial projects.

Impervious Surfaces

Storm water runoff increases substantially where there is development and associated impervious surfaces including streets, parking lots, sidewalks, and loading areas, as well

Map 10. Sedimentation in the Salt Creek Watershed

Soil erodibility (K factor) is a measure of the susceptibility of soil particles to detatchment and movement by rainfall and runoff. Properties of soil effecting erodibility include texture, percent of sand content, organic content, soil structure, soil permeability, clay minerology, and the presence of rocks. This map correlates erodibility with steepness.



Potential Debris Flows are areas identified by the Oregon Department of Forestry as at risk for landslides. Land use, steepness, and rainfall are major factors contributing to landslides.

Jeffrey Empfield, Yamhill Basin Council, 2001

as rooftops. Together these surfaces increase the volume of runoff by preventing water from soaking in to the ground. Impervious surfaces also tend to concentrate runoff in streams more quickly. This in turn decreases the time of concentration for a given rainfall to enter the stream and generally increases peak rates of runoff downstream. Transforming agricultural lands to urban lands can increase the rates of storm runoff by a factor of two to four. Consequently, impervious area is very significant in the analysis of storm drainage systems.

Mapped Impervious Area (MIA) is a rating system for different degrees of impermeability. For in-town residential areas, the estimated MIA ranges from 40% to 65%, depending on housing density and residents' propensity for paving their lot. For commercial areas it is 90% and for industrial areas it is about 80% due to the lack of vegetation. Open areas or "green spaces" have an MIA of zero.

Impervious surfaces in the Salt Creek watershed are concentrated in the commercial area of Amity and on private agricultural and industrial compounds. Large buildings, parking lots, roads, and paved driveways contribute to the problem in many areas of the watershed.

Runoff Contaminants

Inevitably, impervious surfaces and rural road ditches collect a lot of the oil and gas, steering fluid, exhaust particulates, rubber from tires, and anti-freeze that all our cars leave behind. Nitrogen from our agricultural lands and the many pollutants originating with our industry and consumer household products also collect in surface runoff. What can be done to keep these toxic sediments out of the streams? It is easier to control contaminants at the source than to remove them downstream through some treatment process. Simply curtailing our purchases of chemicals (including petroleum products) is the first step. Strategies are also needed for buffering our fresh water. There are several forms of remediation for reducing the impact of contaminants that get into our water.

Contaminants are most effectively removed by passing runoff through an area where plant uptake of the nutrients is significant and where heavy metals and toxins can either settle out or be consumed in a safe way before entering the stream. There are a variety of techniques being developed called "bioremediation." These areas can be natural or man-made grassy swales, settling or detention ponds, or constructed wetlands. With each of these activities, the objective is to maximize the amount of surface contact and time of contact with the remediation plants. For phosphorous, this method is a type of "banking" because phosphorous does not really leave the system unless the plant that takes it up is removed, harvested, or eaten.

For reducing soil sediments, in all cases, it is more effective to substantially reduce erosion at the source. This is one of the biggest challenges for farmers. The costs of erosion go beyond the loss of fertility of the land. All reservoirs have a limited life span before sediments fill them.

In addition to cultivated fields, construction sites are sediment contributors because soil is generally left bare until the finishing touches are applied. Irrigation installers and landscapers are then hired to create lawns. A possible solution would be to plant a drought-tolerant landscape and save money on irrigation and lawn care. Either way, sediment catch techniques such as straw bales, silt fences, woven matting, detention ponds, and temporary swales can be used to filter runoff from building sites to the extent that most of the transported sediments will remain on the site. Another possibility is gravel exit routes to help remove mud from vehicle tires. This helps keep soil off the pavement and out of streams.

In general, natural draws and streams should be retained. A well-vegetated, slow-moving creek system can provide channel storage of runoff waters and can often assimilate contaminants prior to discharging water into the river. Wetlands are highly valuable in this respect.

Conclusion

Potential sources of sediment include dirt roads and ditches, impervious surfaces, slope failure, and erosion of disturbed soil. All ditches drain to a water body, usually a stream. Some area ditches are being managed to decrease their sediment contribution through roadside seeding. Please mow rather than spraying.

The volume of storm water runoff is increased substantially through development, especially by increasing impervious surfaces. Impervious areas include all pavement such as streets, parking lots, sidewalks, and loading areas, as well as rooftops. Runoff contaminants are most effectively removed by passing runoff water through a constructed wetland. There, plant uptake of nutrients may be significant. Heavy metals and toxins can either settle out or be consumed more safely before storm water reenters a stream.

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CHAPTER 8

Hydrology and Water Use

Introduction

This chapter covers the hydrology of the watershed in terms of hydrology, flood history, groundwater aquifers, and ways that human uses of land and water affect stream flows.

The hydrologic cycle is the circulation of water through plants and animals into the atmosphere, as precipitation, surface water (streams, lakes, and oceans), and finally as groundwater before again entering plants, animals, and the atmosphere. It has distinct stages including precipitation, surface run-off, percolation, ground water, transpiration/respiration (plants and animals expire water vapor), and evaporation. Human activities and technologies influence each stage.

"Peak Flow Events," a.k.a Floods

The earliest recorded floods in our region occurred in 1843, 1844, 1852, 1861, and 1890. The 1861 flood (likely a "100-year frequency event") is considered by some to be the largest known flood in our area. It is difficult to know because there were no measurements of volume being taken at that time. The largest floods in the past century occurred in December 1955, December 1964, January 1965, January 1972, November 1973, January 1974, and January 1996.

In the Salt Creek watershed, about every third year the bottomlands flood sufficiently to inundate low-lying secondary roads. Major roads have been sited or built up sufficiently so that they are seldom flooded. Only once in recent memory has water flooded Route 22 and then only briefly when a culvert became blocked.

The amount of precipitation is not the only factor influencing peak flows. Withdrawals for irrigation and drinking water, stream and wetland modifications, changes in land use and water-related technology, and the removal of vegetation are also important. These factors not only affect the amount of water present in streams but also the rate of release of water into streams during a storm. For example, if a braided stream (multiple intertwined channels) is modified or restricted to one channel, it will act more like a flume than a slow moving reservoir for storm water. The flow will respond more rapidly and will move rain water downstream leaving less water upstream to gradually soak in or drain over a longer period of time.

When left in their natural state, streams drain slowly and provide a variety of benefits:

- Greater sinuosity (meandering) resulting in more stream-riparian contact, larger riparian areas, and slower flow velocities.
- Raised channels that reach the flood plain exchange water with wetlands and help to transfer water to riparian areas more efficiently.
- Deeper flood plain soils for water storage and plant growth.

- Evolving channels that change in location and create backwaters and other aquatic habitat.
- More pools and deeper pools that fish, children, and the young-at-heart love.
- Natural disturbance of riparian areas that promote habitat complexity.
- Less fluctuation between low flows and peak flows resulting in less property damage.
- More frequent, minor, localized flooding and less frequent, major flooding downstream.

The opposite of peak flows are low flows. These are the lowest flow rates for a given stream over a given time period, usually recorded annually. Low flows contribute to increases in stream temperatures and decreased water quality conditions that adversely affect aquatic life. Low flows may also restrict water rights use, especially for junior users. Low flows are influenced by many of the same factors as high flows: precipitation, channel modification, wetland removal, ditching, and tiling. The two extremes of flow go together—if you have a stream that experiences extreme peaks, it will likely experience extreme dips at other times.

Predicting Flood Frequency and Risk

By looking at historic stream flow records we can estimate likely flood levels and frequency. This gives us the probability of a given flood level occurring in a given year. For example, a 100-year flood has a 1 in 100 chance of occurring in any given year. Map 9 shows the 100-year flood plain for Polk and Yamhill Counties as outlined by the Federal Emergency Management Agency (FEMA). The 1968 Flood Insurance Act subsidizes property owners' purchases of flood insurance. The FEMA map is a Flood Hazard Boundary Map; it indicates flood-prone areas. A structure's risk is based on the elevation of its lowest floor.

Flow records are essential for predicting future flood levels. Some flow records in Oregon date back about 100 years but most areas have been measured for a much shorter period. Models have been developed to examine the relationship between precipitation and various land uses to predict flood recurrence levels without actual flow data. Even in areas where flow records exist, predicting floods is difficult.

Table 18. Precipitation Rate and Annual Probability for Various Levels of Flooding

Flood Frequency	Rate of 24 hr. Precipitation	Annual Probability
2 year	2.4 in	.50 (50%)
5 year	3.1 in	.20 (20%)
10 year	3.6 in	.10 (10%)
25 year	4.2 in	.04 (4%)
50 year	4.7 in	.02 (2%)
100 year	5.3 in	.01 (1%)

The state climatologic service examines weather trends for Oregon. The state has a 20-year wet and 20-year dry cycle. The significance of this for flood information is that data collected from a stream for the past 30-year period may contain 20 years of relatively dry conditions so flood predictions will be different from data collected during a 20-year wet period.

Sources of Error in Determining Flood Levels:
1. The length of time records have been kept is significant because of long-term cycles and gradual natural fluctuations.
2. Conditions in the watershed may change. For example, increasing urbanization tends to increase impervious surfaces and the intensity of flooding for a given amount of rain.

Groundwater

The Yamhill basin is subject to the pressures of a rapidly growing Willamette Valley population. Salt Creek feels this pressure from Dallas, McMinnville, Salem, and even Portland. Because of the region's rapid growth, water needs continue to increase. In addition, much of the area is not served by central water and sewage systems, so many homes depend on individual wells and septic systems. To obtain ample water supplies, wells commonly must be drilled to depths of several hundred feet. Even at these depths some wells produce poor quality water.

The Salt Creek sub-basin consists of a series of uplands surrounded by low-lying plains; this has implications for groundwater. The water table is generally highest beneath upland areas and lowest beneath the valley floor. In other words, the water table elevation somewhat follows the land surface elevation. There are also many local variations in groundwater, some of which reflect seasonal changes.

Parts of Salt Creek watershed are classified as a "Ground Water Limited Area" (GLA). Called the Eola Hills GLA, it runs east from 99W to the Willamette River and from just north of Rickreall Creek to the north boundary of Township 6S, or about three quarters of a mile north of the Polk/Yamhill County line. Only certain uses are allowed in a GLA. The Eola Hills GLA allows exempt uses (listed in ORS 537.545), irrigation, and rural residential fire protection systems. Water Rights Permits are required for fire protection and irrigation—required to be drip irrigation or something equally efficient. Permits may be issued for a period not to exceed five years and may be renewed. GLAs are established by rule and the ones for the Willamette basin are covered in OAR 690-502. More information is available at the OWRD website.

Lowland Aquifers

Both sides of the watershed have foothills composed of marine rocks. Much of the valley has 10 to 25 feet of alluvial soils lying over marine sandstone, siltstone, and shale. Alluvial deposits can be water bearing where they are relatively thick, permeable, and in hydraulic contact with adjacent streams, although this is generally rare.

According to Marc Norton of ODWR, yields in marine sediments are generally adequate for single family domestic uses, especially if a large storage tank is used. Yields range from less than 1 gallon per minute to over 20 gallons per minute. Yields generally decrease over time and the well will need to be deepened or a new well drilled. Wells in marine sediments have a tendency to develop iron bacteria problems which can affect the quality and quantity of the water. These wells also sometimes yield brackish water, particularly with greater depth.

The low-lying areas of Salt Creek watershed are covered with Willamette Silt. It is composed of thinly bedded layers containing lenses of fine sand and clay. Locally it contains scattered pebbles of granite and quartzite. In general, it ranges in thickness from a few feet to 50ft. Due to low permeability of Willamette Silt, this formation yields water slowly. There are very few wells in the lowlands. Wells are more common and of better quality to the east and to the southwest in the foothills of the Coast Range.

Basalt Group Aquifer

The most important aquifer in the area is the Columbia River Basalt Group. Groundwater from this aquifer is chemically suitable for most uses including drinking. Some wells drilled into marine sedimentary rocks produce water that is too mineralized for general use without filtration.

Because many wells drilled in uplands penetrate isolated groundwater bodies perched high above the water table, they have a large range in depth, water level, and yield. Some wells have water levels of less than 50ft below land surface, while others nearby or at lower altitudes have much deeper levels. Where the basalt aquifer is heavily pumped, water levels have declined about 1 foot per year. This decline is not universal throughout the Columbia River Basalt Group.

The basalt consists of a series of individual lava flows that are mostly blocky, jointed lava—each with a unique system of joints. Between some flows are zones of ash, soil, breccia, cinders, or broken rock that are porous enough to permit the movement of water. These are called "interflow zones" and are the main aquifers (water-bearing and water-yielding zones) in the basalt. The basalt group ranges in thickness from only a few feet in some places to 1000ft; individual flows can be up to 100ft thick. Because of this, wells drilled in the Columbia River Basalt Group are highly variable. Yields of wells drilled into the basalt range from about 15 gal/min in the upland areas to as much as 1000gal/min in some lowland areas.

The Perrydale Domestic Water Association draws water from seven wells, six of which are drilled in basalt. Two are drilled in fractured basalt just west of the Willamette near Lincoln while the remaining four are located near Reimer Road in Columbia River Basalt. The remaining well, located in the Troutdale formation, requires some filtration (green sand) for iron and mangenese from marine deposits.

Groundwater Recharge

Area aquifers are recharged mostly during winter and spring through precipitation. Many lowland areas are of low permeability; consequently recharge to these units is small. Besides permeability, recharge depends on slope, vegetative cover, attitude of rocks, and precipitation.

Recharge in the area is mostly from direct infiltration of precipitation. Aquifers in the lowlands also may receive some recharge from streams during periods when ground-water levels are lower than adjacent stream levels. However, water levels indicate that adjacent to most streams the water table is actually higher than the stream. Consequently, most streams gain water from the aquifers through springs. In the low-lying residential areas of the valley, quick recharge from streams is unlikely because of the low permeability.

Groundwater levels of the Columbia River Basalt Group are subject to long-term water-level declines in some heavily pumped areas where use of groundwater is continually increasing. The recovery of water levels each winter to approximately the same level indicates that these aquifers are supported by recharge from the direct infiltration of precipitation and that, in general, recharge balances discharge.

Domestic and Municipal Needs

The population of Amity has increased over 25% in the past decade, which is substantial even for a fast-growing state like Oregon. This trend will continue for the foreseeable future raising concerns for the already-scarce supply of clean water. Water use data appears in Table 19.

Part of the solution will be conservation. Conservation means changing technology and habits to reduce per capita demand for water. For individual consumers, water conservation programs typically take three approaches: education, technical assistance, and regulations. The first two are relatively easy to implement but take longer to impact demand, while the regulatory approach is much more difficult to pass. Water rates can be used to reduce peak demand during the summer. Inverted block rates charge higher rates for large users. With growing population densities, landscape regulations that reduce water needs can be anticipated.

Amity's drinking water comes from the South Yamhill River and is treated with chlorine, aluminum sulfate, and soda ash to regulate the pH, which in this case is too acidic.

Table 19. Salt Creek Watershed Domestic Water Statistics

Amity Municipal Water Quality and Volume, 2001

Amity pumps drinking water from the South Yamhill River. The treated wastewater "outfall" is on Salt Creek

Service Customers and Water Volume

Month	Bills	Gallons Used	Month	Bills	Gallons Used
May 2001	602	47,337,806	Aug. 2001	580	5,135,620
June 2001	578	48,741,066	Sept. 2001	584	5,442,931
July 2001	575	4,316,523	Oct. 2001	584	4,128,169

Amity has one reservoir on the hill to the northwest of town. It holds 1,000,005 gollons.

Perrydale Domestic Water Association Quality and Volume, 2000—2001

The Association draws water from 7 wells: 2 are drilled in fractured basalt west of the Willamette, 1 is in the Troutdale formation with marine deposits, and 4 are located near Reimer Road in Columbia R. basalt.

2000 Water Quality Testing

	Fecal Colif-orm	E. Coli	Lead
Violation	Yes	No	No
Level Detected	NA	0	<0.002
Unit of Measure	ppm	ppm	Mg/l
MCL*			0.015
Most Likely Source	Line break/ natural in soil	Human animal fecal waste	Erosion of nat. depo-sits

*Maximum Contaminant Level

Average Monthly and Daily Water Volumes

	Total Gallons	Number of Households	Avg. Monthly Gal./House	Avg. Daily Gal/House
Sept. 2000	7,355,700	620	11,902	397
Oct. 2000	6,103,300	627	9,737	324
Nov. 2000	4,782,500	636	7,520	251
Dec. 2000	4,578,900	636	7,199	240
Jan. 2001	4,511,400	643	7,016	234
Feb. 2001	3,848,500	654	5,885	196
Mar. 2001	3,967,100	654	6,066	202
April 2001	4,687,700	660	7,089	236
May 2001	4,797,500	660	7,269	242
June 2001	6,213,800	660	9,415	314
July 2001	7,626,600	662	11,520	384
Aug. 2001	7,953,100	666	11,941	398
Totals	66,417,100		102,556	
Mo. Avg	5,534,758		8,546	285

The Association currently has 665 customers (homes, churches, schools, businesses) requiring 118 miles of pipeline and four storage tanks: three 50,000 gallon tanks and one 20,000 gallon tank.

Amity's wastewater treatment plant was originally constructed in 1973. It is currently being expanded from a one lagoon system to a two lagoon system. In the summer months, water from the lagoon is used to irrigate nearby fields. In the winter, lagoon water goes into Salt Creek after the flow increases sufficiently to dilute it. Am-Test of Tigard does the water sample testing for Amity. In the past four years, the monthly test has indicated an absence of fecal coliform.

Ray Hobson worked with other area farmers and homeowners to form the Perrydale Domestic Water Association in 1972. The Association started with about 300 customers and has grown steadily over the past three decades. Ray is proud of their service, the quality of the water, and the fact that they have the "lowest rates in the country" which he attributes to the fact that the Association has never needed to pay a manager's salary. They continue to expand service and have more water available from their existing wells and storage tanks.

The Association currently has 665 customers (homes, churches, businesses) requiring 118 miles of pipeline and four storage tanks: three 50,000 gallon tanks and one 20,000 gallon tank. Service is concentrated in Perrydale, Ballston, and increasingly in the Salt Creek area south of Rt. 22. Ray believes the Association may eventually sell water to the Buell/Red Prairie Water District to the west. Another possible customer would be the Rickreall Water Coop to the south. According to the Rickreall Watershed Assessment, flows fall to very low levels during the summer and are over-allocated for stream withdrawals. Projections for Dallas indicate that "a water shortage may be expected by 2010."

An earlier attempt at developing the area's water supply was the now defunct Red Prairie Irrigation District. It would have served the southern portion of Salt Creek watershed from 99w to the Coast Range and from the South Yamhill to just south of Rt. 22, roughly the area served today by the Perrydale Domestic Water Association. Red Prarie Irrigation District was formed in 1965 in response to a Bureau of Reclamation recommendation for construction of a sizable dam (53,000 ac. ft.) on Mill Creek, just to the west of Salt Creek watershed. That project was deemed economically unfeasable and was finally dropped in 1974. The irrigation district continued to develop plans for a variety of alternative sources including smaller reservoirs and pipelines from either the South Yamhill or the Willamette to supplement Salt Creek flows. These planning efforts went on for a number of years but never came to fruition. Citizens who invested in the Red Prairie Irrigation District eventually received refunds.

The residents of the town of Salt Creek (located near Rt. 22) installed a small spring-fed municipal water system in 1928. It originally served ten residences and still provides water for a number of homes in the area. Other, newer residences are served by the Perrydale Domestic Water Association which continues to expand its service range.

The Growth of Irrigation

Fifty years ago, upper Salt Creek was often diverted for large parts of the summer to flood irrigate pasture, according to farmer Eugene Villwock. At those times the creek became totally dry. With the introduction of ground water irrigation systems flood irrigation ceased and the upper Salt has not gone completely dry since.

As early as the 1960s supplies for irrigation water were becoming scarce. The Yamhill basin had an increasing demand for water and, according to community leaders, stream flow was "not going to be sufficient to provide water to everyone" who needed it. In 1964 it was reported that there had been a tremendous increase in the last two years in water users on the South Yamhill. The amount of irrigated land in the region was relatively small but it was increasing quickly. The amount in Yamhill County had increased from 12,475 acres in 1954 representing 15.9% of all farms and averaging 31.8 acres per irrigated farm to 19,218 acres in 1964 representing 18.8% of all farms and averaging 49.8 acres per irrigated farm.

Natural resource conservationists expected area land to yield 15 inches of runoff in an average year, meaning that each acre would produce 15 acre-inches or 1¼ acre-feet of runoff. "Without storage," they concluded, "this water is already passed onward toward the sea in great part when the irrigation season starts."

"The limitation on irrigation appears to be not so much a lack of usable land," wrote the Yamhill County Economic Development Committee in the 1960s, "but limited number of dams, insufficient water, and possibly, the types of farming operations which can make irrigation economically feasible." They knew that there was about 20,000 acres irrigated in 1962 and they felt that twice that amount would be needed by 1970. They also knew that in addition to developing reservoirs, we would need to adjust our needs. Current figures for irrigated acres in the county are not available. According to the OSU Yamhill County Extension Office, irrigated acreage is difficult to track because of the variability in use from year to year.

As early as the 1970s, *ecology* became a household word in America. Concern in the Yamhill basin had extended to groundwater as withdrawals for irrigation, domestic, and public supplies increased. Because withdrawals were expected to increase further, information was needed "to aid in the orderly and efficient development of the ground-water resources of the area."

Well Data

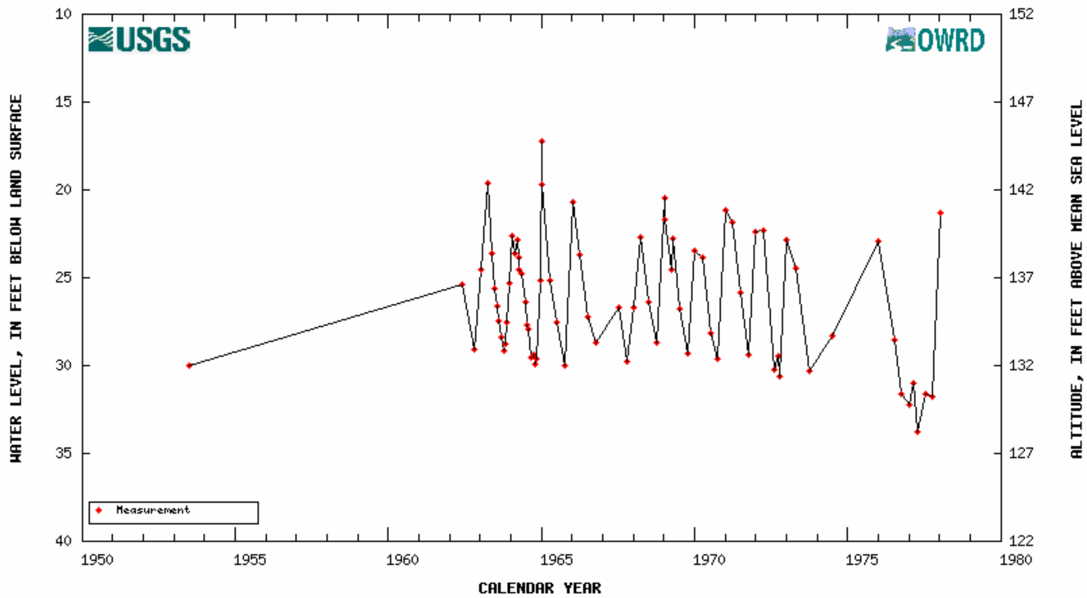
Well information is available from the well log database maintained by the Oregon Water Resources Department (OWRD) and is available on the OWRD website. The contractors who construct wells supply data to OWRD by submitting a well log. The well location on some well logs may only be to the closest 40-acre parcel. Water levels shown in Figure 3 indicate the approximate static water level below the surface for observation wells in the Salt Creek area.

The system used for locating wells is based on the rectangular section system. The position of a township is given by its north-south "Township" position relative to the baseline and its east-west "Range" position relative to the meridian. Each township is divided into 36 sections approximately 1-square-mile (640-acre) in area and numbered from 1 to 36. The letters following the section number correspond to the location within the section.

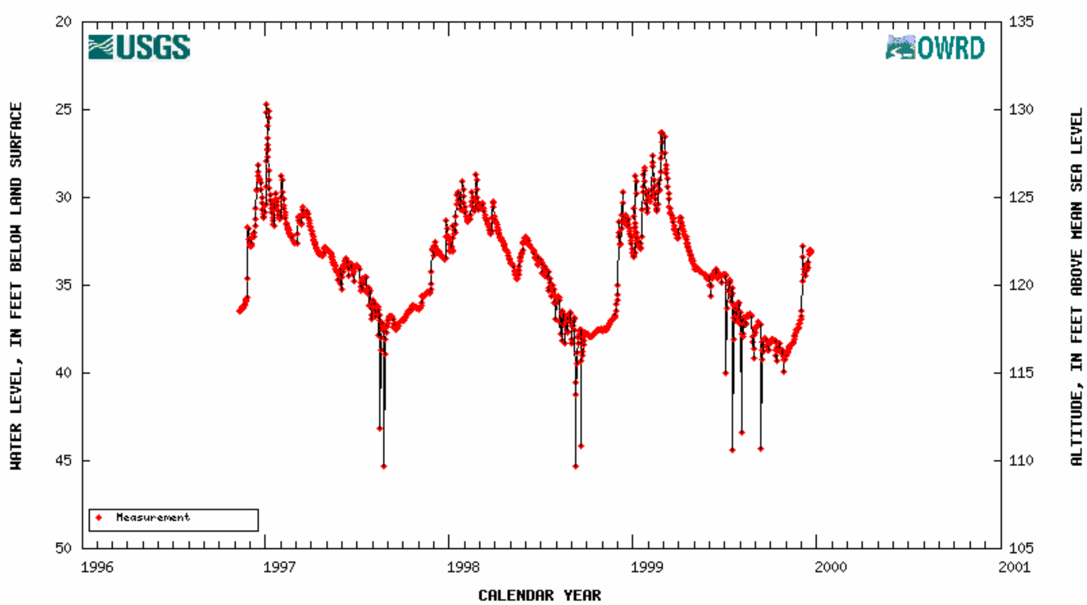
The Well Log IDs shown on Map 11 are unique for each well and can help you find current data on the groundwater of your area. The ID contains a four-letter county-code ("YAMH" or "POLK") and a well-log number. The information is recorded in the Ground Water Resource Information Distribution (GRID) and is easily accessible on the OWRD website. The USGS also maintains a national database of wells and their website may provide additional information.

Figure 3. Hydrographs for Five Wells in the Salt Creek Watershed

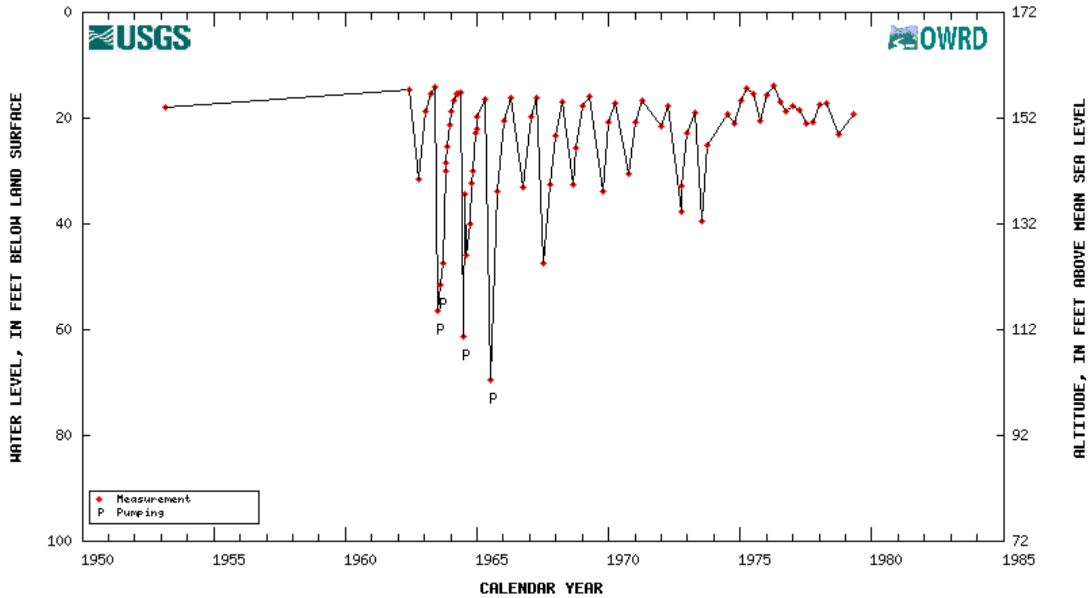
U.S. Geological Survey Site ID	450659123125101
Well Location	05S/04W-20CCC
Oregon Water Resources Department Well Log-ID	YAMH 7058
Well depth, in feet below land surface	126
Land surface altitude, in feet above mean sea level	162
Primary use of well	unused
Hydrogeologic unit(s) that the well is completed in:	Willamette Aquifer Unit



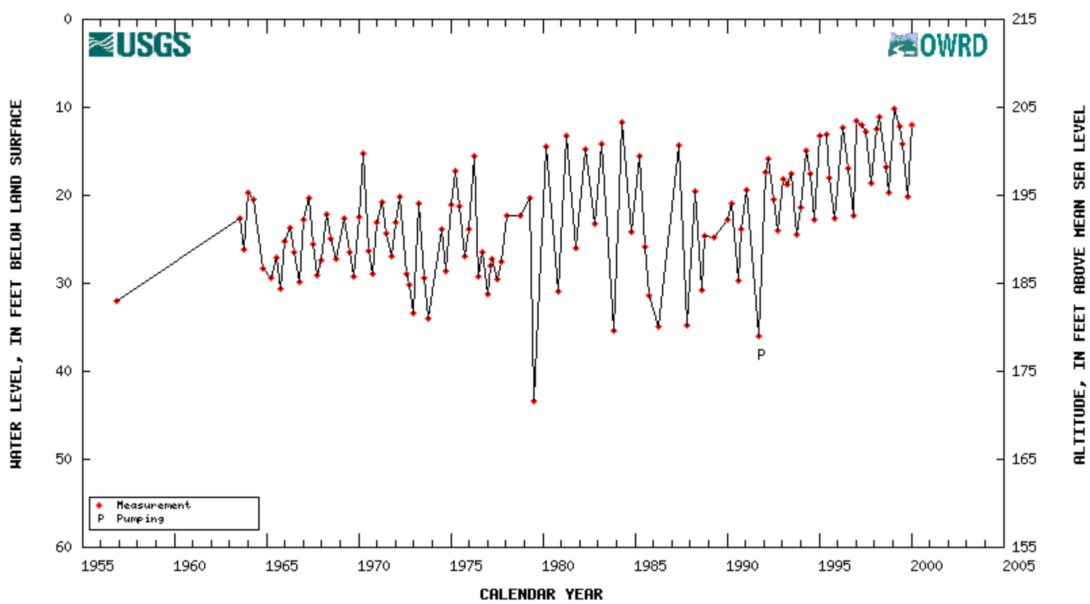
U.S. Geological Survey Site ID	450658123123701
Well Location	05S/04W-20CDC2
Oregon Water Resources Department Well Log-ID	YAMH 2787
Well depth, in feet below land surface	200
Land surface altitude, in feet above mean sea level	155
Primary use of well	unused
Hydrogeologic unit(s) that the well is completed in:	Willamette Aquifer Unit



U.S. Geological Survey Site ID	450632123102201
Well Location	05S/04W-27BCD
Oregon Water Resources Department Well Log-ID	YAMH 7141
Well depth, in feet below land surface	77
Land surface altitude, in feet above mean sea level	172
Primary use of well	irrigation
Hydrogeologic unit(s) that the well is completed in:	Basement Confining unit



U.S. Geological Survey Site ID	450300123121001
Well Location	06S/04W-17DDB
Oregon Water Resources Department Well Log-ID	POLK 1192
Well depth, in feet below land surface	270
Land surface altitude, in feet above mean sea level	215
Primary use of well	domestic
Hydrogeologic unit(s) that the well is completed in:	Basement Confining unit



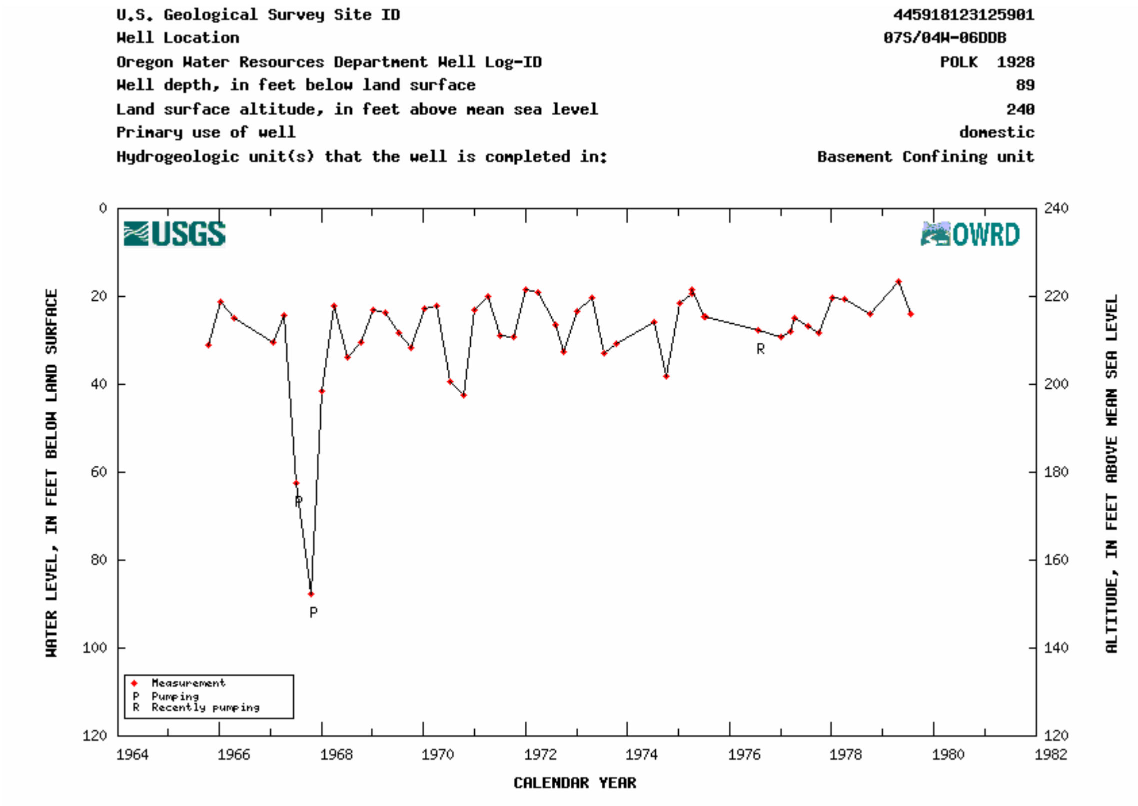


Table 20. Measuring Status Codes for Hydrographs in Figure 3

The status of the site at the time of measurement	Measuring method
D, the site was dry (no water level is recorded);	A, Airline measurement;
E, the site was flowing recently;	B, Analog, graphic, or digital recorder;
F, the site was flowing;	C, Calibrated airline measurement;
G, a nearby site was flowing;	E, estimated;
H, A site that taps the same aquifer had been flowing recently;	G, Pressure-gage measurement;
I, injector site (recharge water being injected into the aquifer);	H, Calibrated pressure-gage measurement;
P, the site was being pumped;	M, Manometer measurement;
R, the site was pumped recently;	R, Reported, method not known (generally by driller);
S, a nearby site was being pumped;	S, Steel-tape measurement;
T, a nearby site had been pumped recently;	T, Electic-tape measurement;
V, foreign substance was present on the surface of the water;	V, Calibrated electric-tape measurement;
W, the well was destroyed;	Z, Other.
Z, other conditions.	--, no data.

Water Rights and Stream Flow

Under Oregon law all water is publicly owned. Before water is used or consumed, a water right needs to be obtained. This applies to use of water from a creek, stream, or river even if the water is for domestic use. In some cases water rights are needed for ground water as well. Water rights are issued through an application process administered by the OWRD.

Water rights are becoming increasingly important as seasonal water demands are exceeding supplies with growing frequency. Competition between in-stream and out-of-stream uses is intensifying according to the 1992 Willamette Basin Report. At present, issuance of water rights is very limited in the Yamhill basin. Generally, if water is desired for the period May 1 through October 31, new non-storage water right applications are being processed only for domestic use, commercial use for customarily domestic purposes not exceeding 0.01cfs (4.48 gal/min), livestock use, and public in-stream uses. Some streams are limited year round to only domestic, commercial uses for customarily domestic purposes not exceeding 0.01cfs (4.48 gal/min), livestock, and public in-stream uses. Use may be limited further in the future due to water availability, fish, and water quality concerns.

During the low flow time of year, streams of the Salt Creek watershed are currently over appropriated. This means that the sum of water rights is greater than the estimated flow in the streams. If all the area's water rights were exercised simultaneously, the streams would be dry. This oversimplifies the hydrology of the watershed because it doesn't take into account that some portion of the water removed theoretically flows back into the system. Another factor is the time of day that the water is used—this is not taken into consideration when calculating sum flow and appropriation. Figure 4 illustrates the wide fluctuations in flow volumes of area streams and rivers. Figure 5 indicates the typical difference in flow volumes and water rights through the water year.

Oregon water law states that water rights not exercised for five consecutive years are forfeited. Currently there is no system in place to monitor all water withdrawn by users or stream flows. Therefore, it is difficult to determine the amount of water actually being used.

Map 11 shows the land area with irrigation rights, as well as the points of diversion (surface water) and points of appropriation (wells). Points of diversion, points of appropriation, and place of use (irrigated land area) are based on maps supplied by the water rights applicant or from a final proof survey or court decree. The irrigated acreage polygons represent the areas with rights to both surface and ground water for irrigating that acreage. It does not mean those rights are being exercised—the land may not actually be irrigated.

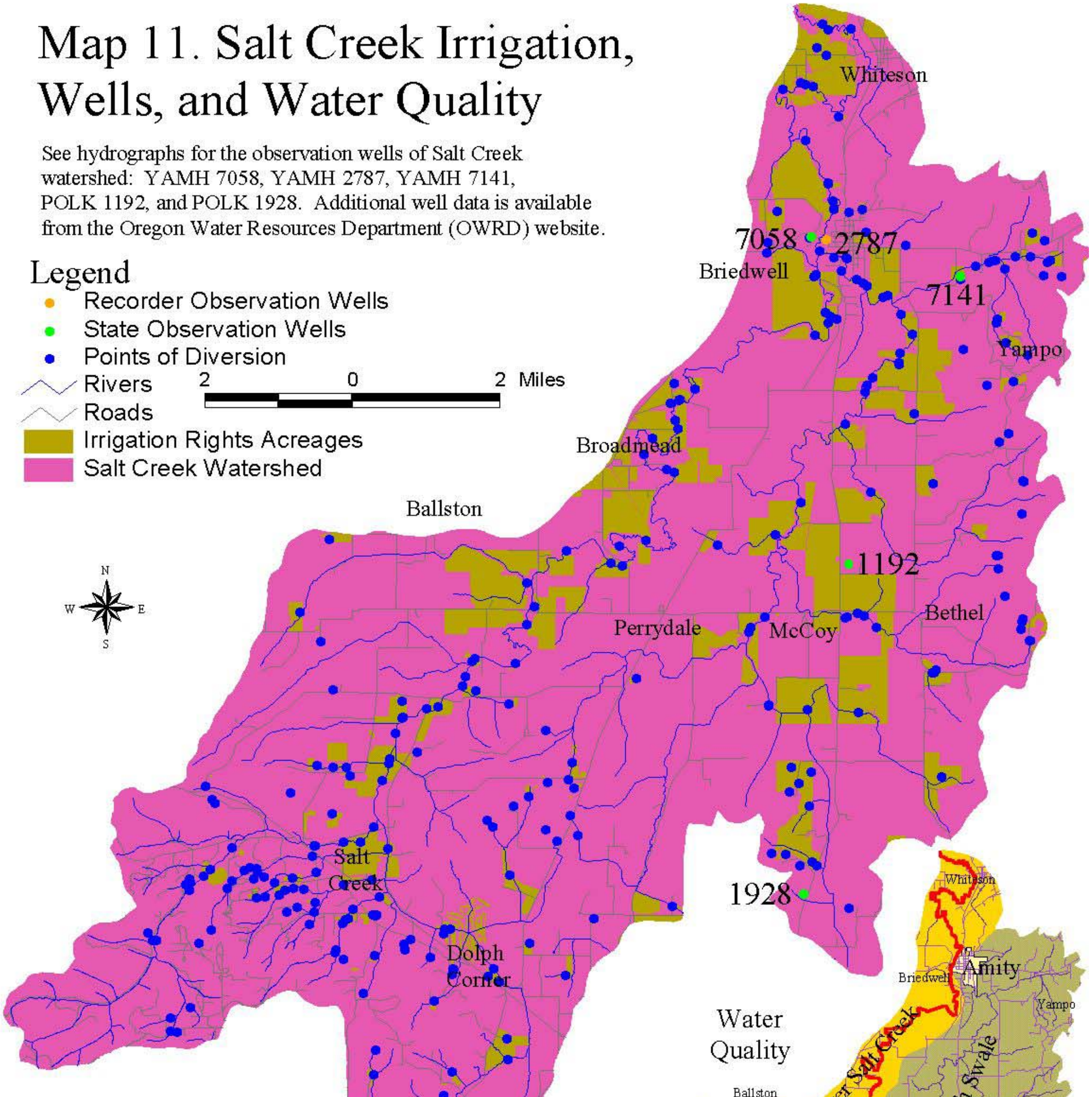
Oregon water law is based on the prior appropriation doctrine—first in time is the first in right. When exercised water rights exceed the available flow and water users are not able to get the amount of water they can use under their water right(s), water is distributed among users based upon the priority date of their water right. The priority date is set by court decree or by the date the application is accepted by OWRD. Junior users can be told to stop using water if a senior user is unable to exercise his/her full right.

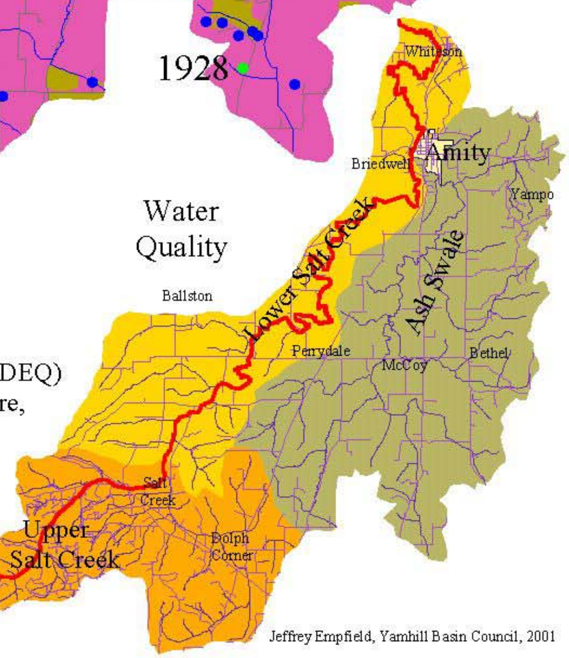
An online introduction to Oregon's water law and water rights on the OWRD website states,

> "Watermasters respond to complaints from water users and determine in a time of water shortage who has the right to use water. They may shut down junior users in periods of

Map 11. Salt Creek Irrigation, Wells, and Water Quality

See hydrographs for the observation wells of Salt Creek watershed: YAMH 7058, YAMH 2787, YAMH 7141, POLK 1192, and POLK 1928. Additional well data is available from the Oregon Water Resources Department (OWRD) website.





Section 303(d) of the Clean Water Act requires states (Oregon DEQ) to list rivers that do not meet minimum standards for temperature, pH, dissolved oxygen, toxins, flow, habitat, sedimentation, bacteria, nutrients, biological criteria, or aquatic weeds. Salt Creek is 303(d)-listed for chlorophyll a, dissolved oxygen, bacteria (fecal coliform during fall, winter, and spring), and high temperature. Salt Creek is also at risk for flow modification, toxic pesticides, sedimentation, bacteria (fecal coliform during summer), and phosphorous. Other streams are likely polluted, but have not been checked.

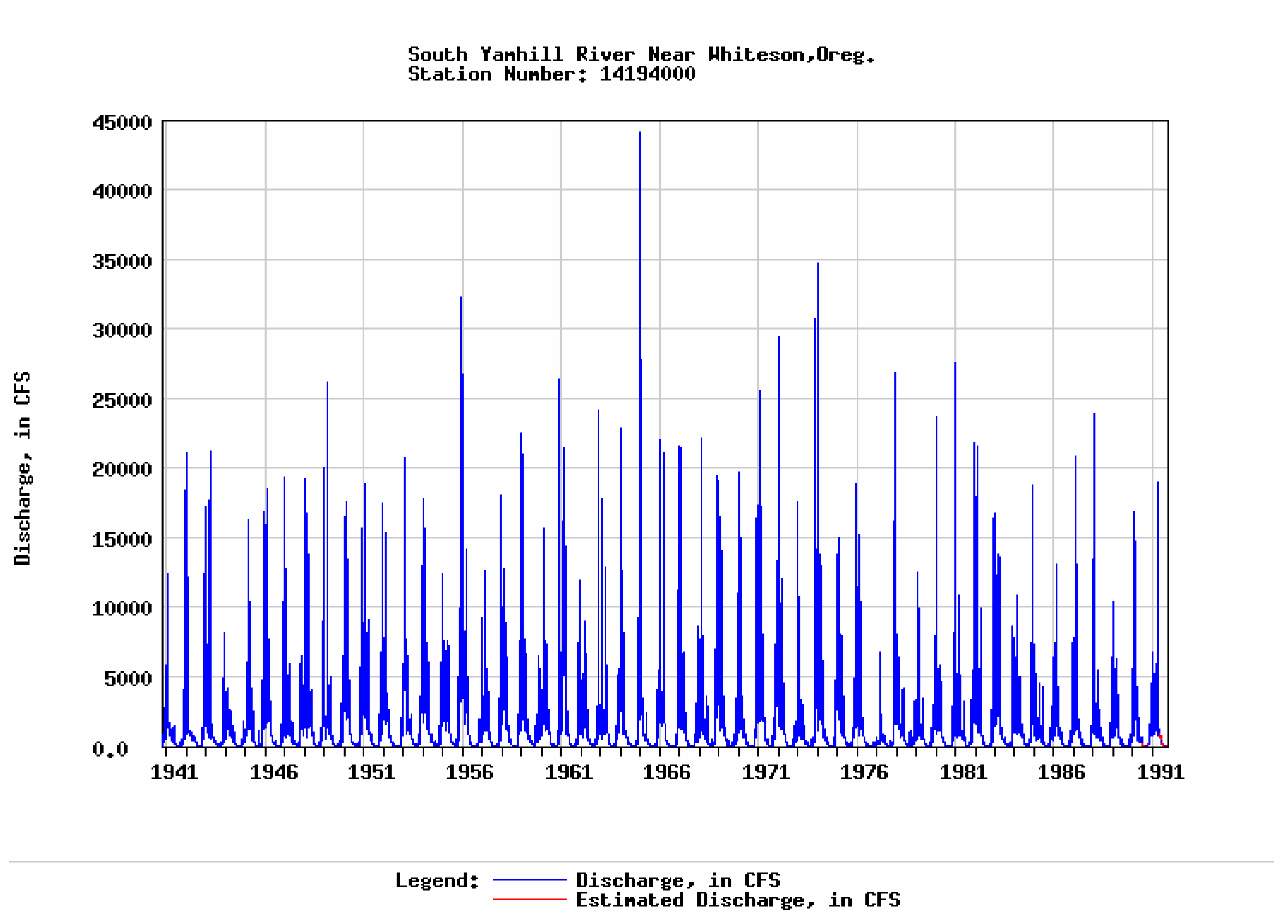
Jeffrey Empfield, Yamhill Basin Council, 2001

shortage.

"Watermasters work with all of the water users on a given water system to ensure that the users voluntarily comply with the needs of more senior users. Occasionally, watermasters take more formal actions to obtain the compliance of unlawful water users or those who are engaged in practices which "waste" water. The waste of water means the continued use of more water than is needed to satisfy the specific beneficial use for which the right was granted."

When the quantity of water in a stream is less than the instream water right, the Department will require junior water right holders to stop diverting water. However, under Oregon law, an instream water right cannot affect a use of water with a senior priority date (OWRD 1996).

Figure 4. Historical Streamflow Daily Values Graph for South Yamhill River Near Whiteson,OR (14194000)

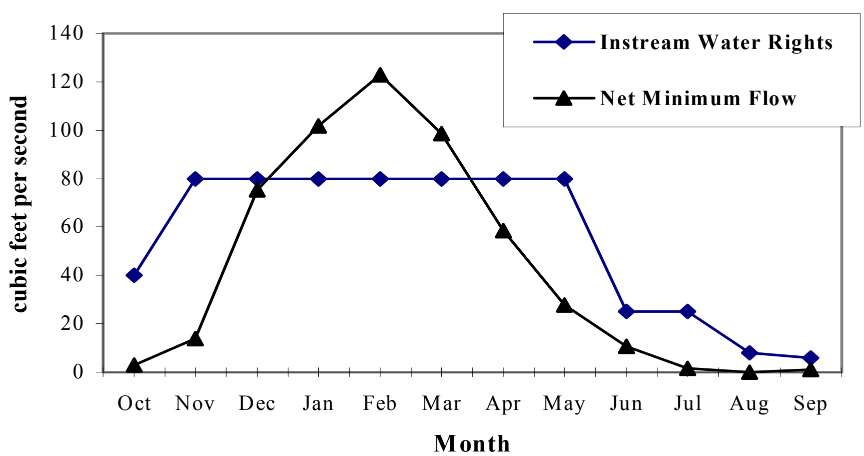


Flow data was collected on the south Yamhill River at Whiteson gaging station (gage # 1419400). It drains an area of 502 sq. miles, and is located 82.3 feet above sea level (Water Resources Department website). The USGS Oregon website provides current hydrographs for the South Yamhill River.

According to Bill Ferber, the OWRD watermaster for the area, conflict seldom happens. On paper streams appear over-allocated. In reality users have not yet been denied access to water in the area. How is this possible? Bill has three hypotheses: 1) users are not exercising their full right since we have had more evenly distributed rain in recent years or 2) much of the irrigation water eventually percolates through the water table and re-enters the stream or 3) users are not filing complaints. Another possibility is that users are not all taking the water from the stream at the same time of the day. Some may remove water at night or in the evening while others are use water during the day.

A lack of sufficient streamflow to dilute pollutants and support aquatic life is an issue throughout the Willamette basin. This is especially true during the summer when flows are naturally low due to the lack of precipitation. The absence of snow pack in the coast range also contributes to low flows. Consequently, the primary source of water during the summer is groundwater that enters the streams through seeps and springs. This condition is worsened by out-of-stream demands for irrigation. There is an Instream Water Right (ISWR) on Salt Creek to maintain a flow of 1.5 cfs ("cubic feet per second") throughout the year for pollution abatement. The certificate number is 72983 with a "quite junior" priority date of 8/5/1993. The ISWR is not monitored due to workload at OWRD and the fact that there are only two water rights junior to it, according to Bill Ferber. Since there is no monitoring there is no enforcement of the ISWR.

Figure 5. Typical Net Flow Versus In-stream Water Rights



At this time, there are no plans for the state to change the way water rights are allocated or to increase the enforcement of the "use it or lose it" policy. However, this discrepancy between available water and water rights has not been tested by a severe drought (necessitating that more users exercise their irrigation water rights) according to the area watermaster Bill Ferber.

Conclusion

Stream flows and ground water are influenced by precipitation, loss of wetlands, withdrawals for irrigation and municipal drinking water, stream channel modifications, changes in land use and water-related technology, and the removal of vegetation. Local flooding has changed due to clearing, straightening, hardening, and deepening of major stream channels. Extensive irrigation rights are held for land along Ash Swale and Salt Creek. Streams in the watershed are over-allocated for water rights. This means that at times seasonal demands exceed the water supply. Conflict has occurred, but presently most users are not exercising their full water rights. Much of these areas were historically wetlands but are now drained and tiled.

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CHAPTER 9

Water Quality

Introduction

This chapter provides an overview of water quality as it applies to the Salt Creek watershed. It addresses issues including temperature, dissolved oxygen, pH, nutrients, bacteria, and chemical contaminants. It also provides information on local domestic water providers and household sources of pollution.

In-stream water quality is desirable for a variety of “beneficial uses” as defined by Oregon water quality standards. Beneficial uses for watersheds in the Willamette Valley appear below.

Table 21. Beneficial Uses for Willamette River Tributaries

• Public Domestic Water Supply	• Resident Fish and Aquatic Life
• Private Domestic Water Supply	• Wildlife and Hunting
• Industrial Water Supply	• Fishing
• Irrigation	• Boating
• Livestock Watering	• Water Contact Recreation
• Anadromous Fish Passage	• Aesthetic Quality
• Salmonid Fish Rearing	• Hydro Power

In the Salt Creek watershed, cutthroat trout are one of the most important indicators of the overall health of streams. If they’re not present and healthy in areas where they were found historically, then the quality of that water is likely a problem. Salmonids need specific water conditions for spawning and rearing juvenile fish.

Oregon is required to set standards of water quality under section 303 of the Federal Clean Water Act. When the standards are not met, the stream becomes listed under section 303(d) rules. The stream section currently listed from the Salt Creek watershed are shown in Table 22 below. “Listing” means the water quality is not in compliance with the law and steps need to be taken to bring it into compliance. The Oregon Department of Environmental Quality (DEQ) administers the rules and manages the data that determines 303(d) listing.

The Perrydale Domestic Water Association tests for contaminants that may be in the source water such as microbial or inorganic contaminants, pesticides and herbicides, organic chemicals, and radioactivity. In 2000 there were no detectable levels exceeding the Maximum Contaminant Level Goal (MCLG) for any of these contaminants. MCLGs are determined by our medical knowledge of the level below which there is no known risk to health. They are stricter than the Maximum Contaminant Level (MCL) that serves as the actual standard. MCLs are the *highest* level of contamination allowed; they are set as close to the MCLGs as feasible using the best treatment technology but they still incur some risk. Fortunately, Perrydale water meets the more stringent MCLGs.

**Table 22. Water Quality Limited Streams—
303(d) List for the Salt Creek Watershed**

Stream Location	Parameter (polution type)	Criteria	Season of concern	Basis for Listing	Supporting Data
Salt Creek, mouth to headwaters	Chlorophyll a	NA	Summer	DEQ Data	DEQ Data (Site 404184; RM 1.8): 16% (4 of 25) Summer values exceeded chlorophyll a standard (15 ug/l) with a maximum value of 29 between 1986 - 1992.
Salt Creek, mouth to headwaters	Dissolved Oxygen (DO)	Cool-water aquatic resources: DO < 6.5 mg/l	May 1 through October 31	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 381: severe, observation (DEQ, 1988)	DEQ Data (Site 404184; RM 1.8): 95% (37 of 39) May through October values exceeded dissolved oxygen standard (6.5 mg/l) with a minimum of 0.1 mg/l between WY 1986 – 1995 (Cool water fishery, annual).
Salt Creek, mouth to headwaters	Bacteria	Water Contact Recreation (fecal coliform-96 Std)	Fall, Winter, Spring	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 381: moderate, observation (DEQ, 1988)	DEQ Data (Site 404184; RM 1.8): 33% (12 of 36) FWS values exceeded fecal coliform standard (400) with a maximum value of 1600 between 1986 - 1992.
Salt Creek, mouth to headwaters	Temperature	Rearing 64 F (17.8 C)	Summer	DEQ Data (Temperature Issue Paper, 1994); NPS Assessment - segment 381: severe, observation (DEQ, 1988)	DEQ Data (Site 404184; RM 1.8): 54% (14 of 26) Summer values exceeded temperature standard (64) with exceedences each year and a maximum of 72.3 in WY 1986 - 1992.

(Oregon Department of Environmental Quality website)

The Association also tests for fecal coliform and *Escherichia Coli* (*E.coli*) on a monthly basis. In 2000, they had two detections of coliform as a result of line repairs where water came in contact with soil. Fecal coliform occurs naturally in all soils so this was expected. The source water did not contain coliform and the lines were flushed thoroughly.

Sources of Pollution

National Pollutant Discharge Elimination System (NPDES) permits are required for point sources of pollution that are registered with the EPA. "Major" NPDES permits are for facilities that discharge more than one million gallons in any 24-hour period. There are no major permits in the Salt Creek watershed. Amity holds a minor permit. To put this in context, 33 major NPDES sites and 320 minor sites discharge effluent into the Willamette River or its tributaries. Relatively little is known about their nutrient content.

Stream flow influences the concentrations of both dissolved and suspended contaminants, but the relation between concentration and stream flow is not straightforward. For example, high flows can reduce concentrations by diluting point-source inputs, or, conversely, they can be associated with additional inputs such as non-point-source contaminants in surface runoff. Because flows vary among sites and at individual sites, their variability should be considered whenever concentrations are compared.

The period of greatest concern for pollution or "contaminant loading" of rivers in our area is during the summer months of July through September. This period is important because non-point source contaminants tend to accumulate between infrequent rainfall during the summer and are then washed into rivers with relatively low rates of flow. Our low summer flows limit the capacity of the river to dilute incoming contaminants.

Types of non-point source contaminants in storm water:

- Nutrients (such as phosphorous and nitrogen) act as fertilizer for aquatic plants like algae. They come from leaking septic tanks, domestic animal wastes, feedlots, fertilizer applied to lawns and cropland, detergents—especially those used outdoors (car washing) and rinsed into street drains, and from decaying plant debris.
- Sediment is considered to be a non-point source contaminant because it causes turbidity and may leave damaging deposits of silt on gravel spawning beds. It also reduces flood storage volumes by filling in streambeds and pools. Sediment is caused by erosion at construction sites, along poorly protected banks of fast moving streams or drainage ditches, from agriculture fields, and from recently or poorly landscaped areas.
- Bacteria such as *E. coli* come from human and animal waste and serve as an indicator that waste is present. It means other harmful bacteria or pathogens may also be present. *E. coli* and fecal coliform are common in the environment but are not always dangerous; when they are found in high concentrations there is likely a source of raw sewage that requires further investigation or treatment.
- Organic compounds and solvents such as benzene, oil, gasoline, and tri-chloro-ethane (TCE) can be soluble or insoluble. Light, floating solvents such as gasoline or oil will often be transported by surface "sheet" flow. Leaking underground fuel tanks can contribute to ground water contamination for years without detection. The plume will generally travel downward until it reaches the water table and then it will move laterally at the top of the water table. Heavier insolubles such as TCE will migrate downward through soil horizons rather than being transported by either surface or subsurface water flow. Soluble organics such as anti-freeze are difficult to remove from storm water and will be transported downstream. Concerns: changing oil, steam cleaning, degreasing, industrial activities, underground fuel tanks, pesticides, household cleaners, paint, etc.
- Metals, primarily lead, cadmium, copper, and zinc are a concern because of their possible toxic effect on aquatic, animal, and human life. Metals can reenter the food

chain through bottom feeding (benthic) species like clams. Significant sources of trace metals are industry, leaded gas, brake shoes, and tires.

Table 23 provides information from the DEQ database of reaches in the Salt Creek watershed that have been considered for listing but for one reason or another were not placed on the 303(d) list. According to Mark Charles of DEQ, the EPA is revising its requirements so the decision whether or not to list will be simplified. Mark points out that the stretches listed in Table 23 deserve more attention and will remain areas of concern for state agencies until shown otherwise.

Table 23. Salt Creek Areas of Concern for 303(d) Standards

Stream Section	Criteria	Cause for Concern (but *not* 303(d) listed).
Salt Creek, mouth to headwaters	Flow Modification	NPS Assessment - segment 381: severe, observation (DEQ, 1988) **Rationale for not Listing:** Need data
Salt Creek, mouth to headwaters	Sedimentation	NPS Assessment - segment 381: moderate, observation (DEQ, 1988) **Rationale for not Listing:** Need data
Salt Creek, mouth to headwaters	Bacteria, Water Contact Recreation (fecal coliform-96 Std)	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 381: moderate, observation (DEQ, 1988) **Supporting Data:** DEQ Data (Site 404184; RM 1.8): 5% (1 of 21) Summer values exceeded fecal coliform standard (400) with a maximum value of 1100 between 1986 - 1992. **Rationale for not Listing:** Did not meet listing criteria
Salt Creek, mouth to headwaters	Toxics, pesticides	NPS Assessment (DEQ, 1988) **Rationale for not Listing:** Need data
Salt Creek, mouth to headwaters	Nutrients, phosphorous	DEQ Data; d1 in 305(b) Report (DEQ, 1994); NPS Assessment - segment 381: severe, observation (DEQ, 1988) **Supporting Data:** DEQ Data (Site 404184, RM 1.8): 100% (35 of 35) May through October values exceeded TMDL phosphorus standard (70 ug/l) with a maximum of 330 ug/l between 1986 - 1992. **Rationale for not Listing:** TMDL established for phosphorus, approved (12/8/92) and being implemented

(Oregon Department of Environmental Quality website)

Nutrients

Total phosphorus is a measurement of the amount of phosphates in the water column and phosphorus in suspended organic material. Total nitrate is a measurement of the nitrogen present in water. Scientists identify the two as the major limits to plant growth. If there are excessive amounts of phosphorus and nitrates present, plant growth increases and can be a problem in slow-moving water. Algae and other plants remove dissolved oxygen from the water, can interfere with recreation, and with certain algae, produce chemicals that are toxic to animals.

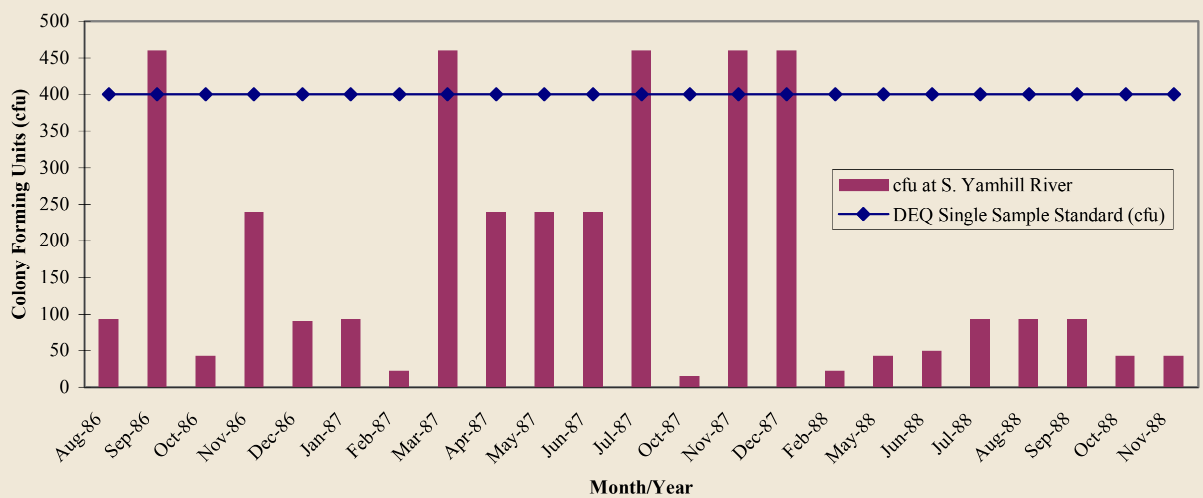
Fecal Coliform and *E. coli*

Fecal coliforms are a group of microorganisms that indicate when feces (animal or human) are present in water; they warn us of the associated pathogenic health hazards.

Their sources include faulty septic systems, runoff from feedlots or other high concentration of domestic animals, leaking sewer pipes, overflows from sewers or wastewater treatment facilities, and wildlife. Fecal coliform bacteria are to be expected in all surface streams. In-stream concentrations less than 100 colonies per 100ml are considered acceptable but concentrations above 200 suggest a source of raw sewage and are cause for concern. Water quality standards are changing to focus specifically on a subset of the fecal coliform group known as *Escherichia coli (E. coli.*)

According to the 1979 *Natural Resource Conservation Plan* of the Yamhill County Soil and Water Conservation District, failing septic systems are a source of pollution in the area. According to soil surveys, 93% of the soils in Yamhill County severely limit the functioning of septic systems. As long as we rely on conventional flush toilets and septic systems, soil acts as a limitation for residential development in our area. This is the case where there is too much clay for effluent to move through the soil at a sufficient rate, where winter standing water eliminates many potential septic sites, and in foothills that are too steep for installing drainage fields.

Figure 6. South Yamhil River Fecal Coliform Data from DEQ (1986-88)



Fecal counts as high as 10,000 have been recorded in the area after sewer system overflows, with levels greater than 1000 common. The duration depends on the magnitude of the spill and the stream flow at the time. Coliform levels can return to normal in as little as 24 hours for small spills at high flows. For larger spills at lower stream flows, it can take a week or longer for the counts to return to ambient or pre-spill levels.

DEQ has recently changed the fecal indicator from the bacterial group of fecal coliforms to *E. coli*. The new limit is a 30-day mean of 126 *E. coli* organisms per 100ml of sample water. This is also the discharge limit of many new National Pollutant Discharge Elimination System (NPDES) permits in the area. The *E. coli* limit replaces the previous limit of 200 fecal coliform per 100ml of sample water.

The change is intended to improve the accuracy of the standard. Other standards will be established for the Yamhill basin (including the Salt Creek watershed) during the total maximum daily load (TMDL) process scheduled for 2007. This process will assess the "natural" or background concentrations of fecal pollution, temperature, etc. and then establish a threshold by which the watershed will be monitored. The DEQ water quality program website has additional information on this process or you can reach the water quality program office at (503) 229-5279.

Sewage Treatment

All waste treatment or decomposition systems involve bacterial growth—this is a useful tool for consuming nutrients under controlled conditions. In the environment, bacteria are found naturally but certain bacteria can threaten the health of plants and animals, including humans. This is especially true of bacteria associated with human waste. These bacteria are constantly evolving and some that live in humans evolve to be pathogenic to humans. A related variable is the volume of water in area streams and rivers that fluctuates widely during the year from huge winter storms to very little volume during late summer.[1] High flows effectively dilute discharges; during low flows discharges to the river have more of an impact.

Few things make less sense than mixing our sewage with fresh water and then trying to separate the two. The less fresh water we pollute, the better. Amity has a lot of storm water entering their sewage through combined pipelines and leaking manhole covers according to Gary Bacon of the public works department. New storm drain pipes discharge directly to creeks. Another problem with old pipelines is that they leak and allow "I & I"—inflow and infiltration of groundwater during the winter when the water table rises. These same pipes allow some limited "exflow" of raw sewage when the water table drops during summer months.

An interesting innovation at Newberg's treatment plant removes solids (sludge), then thickens, dehydrates, and composts the remaining waste. This involves adding carbon in the form of sawdust to the "dewatered" sludge. The carbon balances the concentrated nitrogen and the two fuel a biological process that accelerates breakdown of the sludge. This quickly eliminates the polluting characteristics of waste and creates soil compost as a byproduct. The composting results in a stable, environmentally safe fertilizer available to the public. Called "Newgrow," it exceeds all EPA and DEQ standards and is free of pathogens, although it may have some low levels of heavy metals. According to the promotional literature, Newgrow provides a long-term slow release of nitrogen, phosphorous, and potassium and improves the quality of any soil. For more information call the City of Newberg Wastewater Treatment Plant at (503) 537-1254.

This same basic technique can be used by anybody on a small scale. In fact, it is the basis of many composting toilet systems. The essential thing is to add carbon (preferably sawdust), put a roof over it, and give it some time to decompose. All plant material is

[1] Levels in the Yamhill River illustrate the seasonal fluctuation. Flows peaked at over 47,000 cubic feet per second (cfs) during the 1996 flood. In contrast, September flows typically drop to only ~10cfs or less.

high in carbon content and the carbon balances the nitrogen in animal (human) waste to promote efficient decomposition. In a relatively short time the combined material becomes soil, suitable for planting.

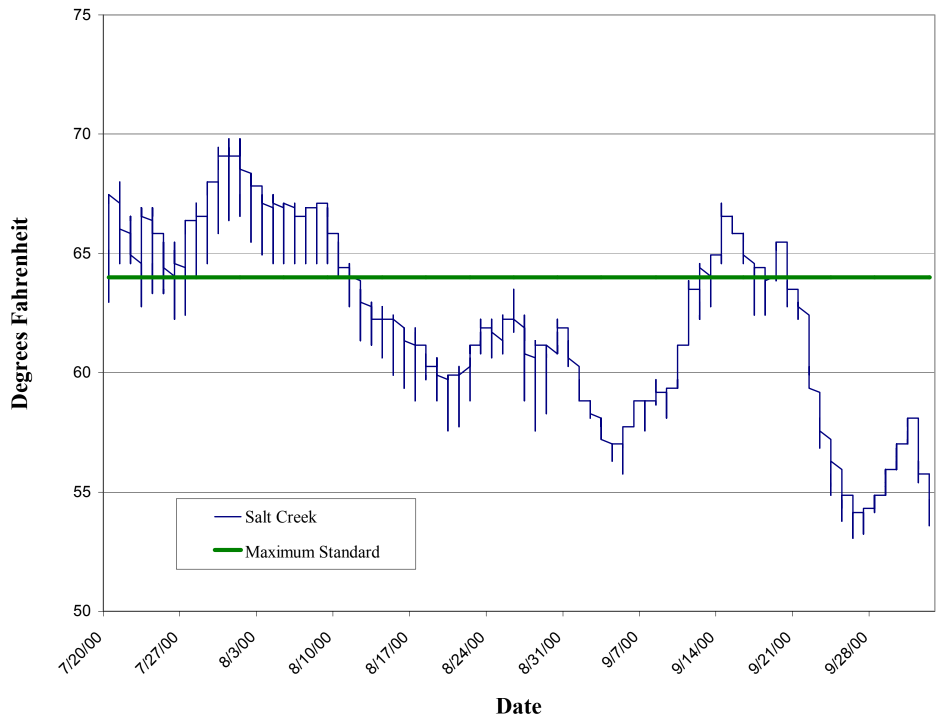
Temperature

High temperatures affect native fish by physically stressing them and even leading to death in many cases. Above their normal range of temperatures, salmon and trout experience increased metabolism that makes it difficult for them to eat enough to maintain their body weight. Further exacerbating this condition is that salmonids may lose their appetites and become less competitive in catching food at abnormally high temperatures.

Figure 7 shows Salt Creek temperature data for the year 2000. The YBC implemented a monitoring program in 1999 in association with DEQ. The technique is to place special thermometers in area streams that record temperatures every half hour and store the data on a computer chip for later analysis. A number of streams in the Yamhill basin experience their seasonal seven-day maximum around the beginning of August.
The maximum seven-day average temperature standard for the Yamhill basin is 64°F (17.8ºC). This means that over any seven-day period, the average maximum daily temperature ideally will not exceed 64°F. During spawning season for winter steelhead, the seven-day moving average temperature is not to exceed 55°F in order to support salmon spawning, egg incubation, and fry emergence from the egg. These standards are widely debated because temperature cycles vary daily and seasonally and different life stages and different species of fish exhibit different tolerances.

When DEQ begins working on the TMDLs ("Total Maximum Daily Loads") for the Yamhill basin they will examine temperature and determine if 64°F is an attainable maximum temperature for the region. Critics say that historically the area's waters exceeded 64°F under natural conditions. Unfortunately, there is no historical temperature data to confirm or refute this. There is no dispute that water temperature influences the aquatic ecosystem, including the composition of the biological community and the chemical behavior of the system. Most living organisms have adapted to and tolerate only limited temperature ranges. For example, water temperatures exceeding 68ºF (20ºC) are dangerous for salmonid species and temperatures exceeding 77ºF (25ºC) can be lethal.

Figure 7. Salt Creek Temperatures



Dissolved Oxygen

Temperature also influences the chemical behavior of many dissolved gases because they decrease in concentration with increasing temperatures. This effect is particularly important for dissolved oxygen (DO) and is one cause of the seasonal variation in the DO concentration.

Dissolved oxygen is important for supporting cold-water organisms such as salmon and trout. Throughout their lifecycle, these species have different dissolved oxygen demands. The Oregon Water Quality Standards specify the amount of dissolved oxygen to meet the needs of these species. The level of DO that is desired is 8mg/L or higher. In the Yamhill basin, samples range from 8.5mg/L to 13.5mg/L with the majority of the samples in the 9.0mg/L to 10.0mg/L range.

pH

pH is a measure of the hydrogen ion concentration in water and indicates the relative acidity or alkalinity. pH values greater than seven indicate alkaline conditions and those less than seven indicate acidic conditions. Water chemistry and water quality are profoundly affected by the relative acidity of the water as hydrogen ions participate in many equilibrium reactions in water. Consequently, the pH can be used to indicate which chemical reactions predominate and can be very important when considering the toxicity of a weak acid or base. In the case of ammonia, for example, the non-toxic, ionized form is dominant when the pH is low (<9.3); but when the pH is high (>9.3) the toxic, neutral form is dominant.

The Oregon Water Quality Standards specify an acceptable pH range of 6.5 to 8.5 for basins west of the Cascades. Water having a pH value outside of this range is toxic to freshwater organisms. Note that pH values vary during different times of the year based on natural conditions such as photosynthesis and respiration cycles of algae present in the water.

Turbidity and Suspended Solids

Turbidity is a measure of the refraction of light and is measured by recording the amount of light that passes through a water sample. It can be worsened by runoff of sediment or by suspended material such as algae. High values indicate high amounts of suspended sediments or particles in the system. Sediment affects salmonids by damaging their gills and reducing their ability to see their prey. Sediments also clog gravels salmonids use for spawning.

No turbidity data is available for the Salt Creek watershed. Data recorded by DEQ from 1986-88 showed turbidity levels in the South Yamhill River near the Whiteson gaging station between 1.0 and 34.0 Hach FTU. This is an area DEQ lists as needing more information.

Other Contaminants: Organic Compounds, Pesticides, and Metals

The literature concerning pesticides and other water quality contaminants is extensive. Many studies have been conducted in the Willamette basin. Most of the reports focus on the Willamette River with occasional references to the Yamhill. There is little specific information for the streams in the Salt Creek watershed. In general, there are several different pesticides likely to exist in the streams and rivers of the Yamhill basin. The most common are atrazine, desethylatrazine, simazine, metolachlor, and diuron.

Given the dominant upland vegetation and crops present, there are likely to be a number of agricultural contaminants in the water. According to Susan Aldrich Markham of the OSU Extension Service in McMinnville, diuron and metolachlor are used on grass seed fields in the basin. Atrazine and simazine are used on Christmas tree farms. Atrazine is no longer used on grass seed fields. Aldrich-Markham says that glyphosate (Roundup) does not travel through the soil to reach the water table and thus does not pose problems for the watershed. However, according to a report by Oregon Pesticide Education Network:

> "Roundup, or glyphosate, has been publicized as an environmentally friendly herbicide that breaks down shortly after application. However, experiments have shown that glyphosate may persist in the environment for as long as 3 years (Torstensson et al., 1989). Its metabolite, AMPA, may persist even longer (World Health Organization, 1994). Glyphosate is typical of many pesticides in that its breakdown is dependent upon the environmental conditions in which it is used

> and that the toxicity of its breakdown products is equal to or greater than the toxicity of glyphosate itself. Pesticides may remain in the environment much longer than expected or claimed, and the breakdown products may also be toxic to organisms (Oregon Pesticide Education Network, 1999)."

Roundup is often applied by hand using backpack sprayers in limited quantities, however. According to Dayton area farmer Sam Sweeney, it is a concern in the region because of the larger volumes used to "clean up" fields prior to establishing grass seed fields. Even at limited volumes, there are some concerns associated with its use.

Conclusion

Scattered stream surveys exist but there is no comprehensive source of local information. Salt Creek is 303(d) listed for bacteria (fecal coliform), chlorophyll a, dissolved oxygen (DO), and high temperature. It is also at risk for, nutrients (phosphorous), sedimentation, toxics (pesticides), bacteria (fecal coliform threatening water contact recreation), and flow modification. The period of greatest concern for pollution or "contaminant loading" of streams in our area is during the summer months from July through September. This period is important because non-point source contaminants tend to accumulate between infrequent rainfall and are then washed into rivers with relatively low rates of flow. The Yamhill Basin Council has a stream temperature monitoring program.

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CHAPTER 10

Fish Habitat and Barriers

Introduction

Even if you do not fish, this chapter is important for bringing watershed issues to a focal point. The history, geology, vegetation, soils, hydrology, and water quality all come together to influence the fish populations in the creeks around us. As the *Rickreall Watershed Assessment* states it: "This will clue one into subtle workings of the watershed" and help to identify areas that are critical to the "good things" and "important functions." Think of these functions as *services* provided by the water and the basins that collect it. Although saying "good things to protect and bad things to fix" sounds a little brash, the fact is Americans want clean water and they agree on many of the basic pre-requisites. What's needed for maintaining water quality is some way to know when there is a problem. Keeping an eye on the health of your local cutthroat trout, then, serves as a way to monitor your local water quality.

The objective of this chapter is to identify historic and current fish populations in the watershed and to evaluate current habitat conditions. The Yamhill basin and upper Willamette have several native anadromous species: winter steelhead, Pacific lampray, and spring chinook salmon. Upper Willamette winter steelhead and upper Willamette spring chinook salmon are listed as threatened species under the federal Endangered Species Act.

Cutthroat trout are the most plentiful and widespread native salmonid in the Yamhill basin. They play an important role in the aquatic ecosystem. Since they are more widely distributed in the streams of the Salt Creek watershed than any other salmonid, the effects of habitat restoration programs can be more readily discerned by looking at the effects on trout. This makes cutthroat the best indicator species for water quality in the Salt Creek watershed.

The list in Table 24 is a general fish list for the Yamhill basin. These are native species that are likely to be found in the streams of the watershed given the habitat, water quality, and what ODFW has found in other similarly sized streams. The list includes native species. Other, non-native fish are present throughout the watershed. For example, coho salmon, catfish, mosquitofish, large and smallmouth bass, and crappie are all common to the area but are non-native, introduced species.

Table 24. Native Aquatic Species in the Yamhill Basin

Common Names of Local Aquatic Species	
• cutthroat trout	• Pacific lamprey
• winter steelhead salmon	• brook lamprey
• sculpin	• northern pike minnow
• dace (speckled, longnose, etc.)	• sucker
• redside shiner	• spring chinook salmon
• three spine stickleback	• crayfish

Fish History

As early as 1962 the Yamhill County Economic Development Committee found that all fish populations were decreasing in the area except "silver" (coho) salmon. They knew establishing minimum flows would help fish populations. However they erroneously thought that raising the water temperature by constructing reservoirs would also be beneficial. They called for eliminating industrial pollution. "The establishment of minimum flows and elimination of pollution are the most important things needed to increase the fish population," they wrote. They stated that "treatment of the waters with Rotenone and Toxaphine is about the only successful way to eliminate trash fish" whose populations were increasing.

Currently, there is a great deal of historical fish population information for the region, although there is limited information available specifically for the Salt Creek watershed. Gary Galovich of ODFW explains that Salt Creek and Ash Swale have never been viewed as high priority streams in terms of salmonids, so there has been little sampling here. Anecdotal evidence suggests habitat and populations are decreasing in area streams but cutthroat remain in many stretches. According to Eugene Villwock and Greg Creal, who both own land in the upper reaches of Salt Creek, there are definitely cutthroat in the headwater streams. Eugene notes that there were more fish in area creeks in the past.

Based on similar streams in the region, it is safe to say that the only year-round salmonid presence is native cutthroat trout in the upper reaches of streams. Only in headwater streams can cutthroat find the diversity of habitat and water quality needed for all of their life stages. Salmonid activity in the lower reaches of the watershed is seasonal due to low water quality during the summer. Adult cutthroat trout use lower stretches as a migration corridor while juvenile cutthroat use them for rearing and refuge. Juvenile steelhead produced in other South Yamhill tributaries also use lower stretches for seasonal refuge and rearing before migrating downstream.

From mid January through mid May 1999, a small hoop trap was operated in Ash Swale near Amity. A hoop trap is not the most efficient method of trapping but is low-cost, safe to operate and can remain in the stream during high water. During much of this period, high flows and backwater influence prevented the trap from being regularly checked. The following is a list of fish species sampled and range of sizes in fork length (FL, mid-eye to where the tail forks):

Table 25. Fish Trapped by ODFW from Ash Swale, January to May, 1999 (ODFW)

Cutthroat trout	110 – 180 mm FL
Winter steelhead	140 – 170 mm FL (these are typical "smolt size" or fish that would be expected to outmigrate to the ocean that spring - it is unlikely that these fish were spawned in Ash Swale but rather migrated into the stream from the S Yamhill)
Largescale sucker	260-470 mm FL
Bullhead catfish	150 – 280 mm FL
Bluegill	50 – 160 mm FL
Largemouth bass	310 mm FL
Sculpin	a small fish, various sizes
Redside shiner	a small fish, various sizes

Pre-settlement in-stream habitat was different from present conditions. Log jams created diverse habitat, fish passage impediments such as culverts and dams were non-existent, mature timber provided shade resulting in cooler water temperatures and greater dissolved oxygen, and stream meanders provided complex habitat with pools and riffles. Many long-time Salt Creek residents recall when the stream would cease flowing in late summer. It did not run dry; instead it had numerous deep pools where fish, insects, and microorganisms remained.

Fish Hatcheries

The ODFW stocking program of the second half of the 20th century aimed to establish new coho runs in the upper Willamette Valley (including the Yamhill basin) and supplement the native coho population of coastal rivers. Coho salmon are not native above Willamette Falls, though, so these fish would not have been found in our area prior to stocking. Coho have historically been an important part of the Oregon economy and are also popular with ocean sport fishermen. It made sense to increase their range and numbers with stocking before adverse impacts to other species became apparent. Releases occurred on a variety of South Yamhill River tributaries from the 1950s to the 1980s, but not in the streams of the Salt Creek watershed. Stocking took place in headwater streams of the larger watersheds for reasons of water quality and habitat.

Some hatchery fish have found their way to the lower stretches of Salt Creek. All anadromous fish released in the upper Willamette basin have potentially entered the drainage; spawning likely takes place elsewhere in larger, cooler, cleaner stretches.

In the 1980s, concerns over the effect of coho on native cutthroat trout and winter steelhead led ODFW to reformulate their hatchery release plan for the region. Obviously, there are limits to how many fish an area can support. Short of exceeding the carrying capacity, there is the problem of non-native fish displacing native species. ODFW did not want to risk further decreasing populations of native fish by continuing to introduce non-native coho. According to Gary Galovich, ODFW has documented adult coho returning and juvenile coho present in the upper Willamette basin even after hatchery releases were discontinued. This means that introduced coho have been able to sustain themselves through natural reproduction and will possibly remain a factor in the Yamhill basin.

Table 26. Yamhill River Basin Stocking History

Species	Anadromous or Resident	Native	Stocking Notes
Winter Steelhead Trout (*Oncorhynchus mykiss*)	A-winter/ spring	Y	No hatcheries present in watershed. Not many fish present historically, hatchery releases into the S.Yamhill River 1964-82 from Big Creek stock. Area may not have any indigenous stock. STEP fry releases in recent years.
Coho Salmon (*Oncorhynchus kisutch)*	A- late fall/early winter	N	No hatcheries in basin. Stocking from Bonneville, Oxbow, Eagle Creek, Cascade, and Sandy and in 1983, from Cowlitz Hatchery in WA. In 1980s, number of streams stocked decreased to minimize effects on steelhead and cutthroat. Many releases in 60s and 70s to supplement Columbia River run.
Cutthroat trout (*Oncorhynchus clarki clarki)*	R	Y	Never stocked.
Rainbow trout (*Oncorhynchus mykiss)*	R	N	Hatchery rainbow trout released to create fishery. Early as 1920s, 30s. until 1980s. No evidence of natural reproduction.

Table 27. Summary of Fish Life History Patterns

Species	Spawning Pattern	Preferred Conditions
Winter Steelhead Trout (*Oncorhynchus mykiss*)	Late January – late April: Juveniles stay 1-2 yrs. Migrate to the ocean in spring where they stay 2-3 years. Return to spawn in winter. May spawn more than once in a season. Ocean distribution not well understood. It appears steelhead move further offshore than other salmonids (OSUES, 1998).	Prefer fast moving water, stream gradient >5%, cool waters, large woody debris important component for their habitat
Coho Salmon (*Oncorhynchus kisutch)*	Juveniles rear throughout watersheds, live in pools in summer. Juveniles migrate to ocean in Spring, rear just off OR coast. Adults return to rivers late fall/early winter. Spawn when 3 years old. Following spawning, they die.	Prefer gravel bars and upper watersheds.
Cutthroat trout (*Oncorhynchus clarki clarki)*	Variable spawning and migration. Potanadromous cutthroat migrate into headwater streams in fall/winter, spawn, return to larger streams. Some do not migrate. Some migrate to estuaries.	Only native trout in basin. Prefer slow moving water, overhanging vegetation.

Cutthroat trout are native in the Salt Creek watershed and have never been stocked here. Although cutthroat are not listed as an endangered or threatened under the Endangered Species Act (ESA), it has been a candidate for listing and is being managed accordingly by ODFW. In general, cutthroat in the Yamhill basin live their entire life in one watershed. Some cutthroat populations are "fluvial," meaning they migrate within their river system, while others like those in Salt Creek streams tend not to migrate.[1] Because of this, it is easier to determine if habitat restoration efforts are impacting the survival of native cutthroat. With anadromous fish such as winter steelhead, the journey from stream to ocean and back involves many unknown perils, making the effects of individual watershed restoration projects difficult to discern.

[1] "Anadromous" is used to describe species that live in the ocean and ascend rivers to spawn. "Fluvial" or "potamodrous" fish live in freshwater and migrate into small headwater streams to spawn. "Catadromous" species such as eels live in freshwater but migrate to the ocean to spawn.

Fish Habitat

According to the StreamNet website, the lower 7.5 miles of Salt Creek are currently used by spring chinook salmon and winter steelhead for rearing and migration. That's approximately 22% of the creek's 32.8 mile length. Gary Galovich of ODFW explains that this doesn't necessarily mean fish do not use other areas or would not use other areas if habitat were improved. ODFW has also recorded juvenile steelhead in the North Yamhill River and several of its tributaries. This suggests at least the possibility of transient winter steelhead in Salt Creek.

Other tributaries of the South Yamhill are documented as supporting migratory species including steelhead, coho, and pacific lamprey that move from the lower Columbia, up the Willamette and the Yamhill River systems. These species may also use the Salt Creek watershed. "All watersheds in the area contain coastal cutthroat trout (*Oncorhynchus clarki*) and Pacific lamprey (*Lampetra tridentata*)," writes Rod Thompson of the Confederated Tribes of Grand Ronde, adding that these are "important fishing and cultural resources for Tribal members."

Adult steelhead use the South Yamhill River for migration to spawning areas in upper reaches of the basin. Parr emerge from gravel beds in late spring. They typically remain in these upper reaches for one to two years before migrating downstream as smolt during spring run-off. Some adults may migrate back down to the Pacific after spawning but little is known about the timing or frequency of that. Steelhead require cold, clean streams. For the survival of their eggs and young alevin, dissolved oxygen levels need to be at or near saturation. Turbidity can harm eggs and interfere with emergence as well as effect the swimming ability of juveniles. For spawning, gravel must be clean and range from pea to grapefruit size.

There is no continuous fish-monitoring program on any stream in the Salt Creek watershed and surveys performed at one point in time do not take into account the dynamics of fish life cycles. If a species isn't found in a stream on a given day, that does not mean it never uses the stream during some part of its lifecycle. Juvenile rearing is a very critical stage in salmonid development, and many streams support salmonids only for rearing.

Regardless, it is important not to focus only on restoring habitat for salmon—especially in areas such as ours that are not known primarily for salmon populations. A more appropriate goal is to improve stream health for all aquatic and terrestrial life (including people).

Fish Barriers

Fish barriers are either natural or human-created obstacles that impede the passage of fish and other organisms. Barriers include culverts, dams, waterfalls, logjams, and beaver ponds. They block the movement of anadromous fish as well as fluvial populations such as cutthroat trout. Barriers can impact all aquatic species because changes in habitat, population, or water quality conditions create pressure for fish to relocate.

Culverts that act as fish barriers on state and county roads are reported in an ODFW database. The barriers reported for the Salt Creek watershed are described in Table 28 below. Numerous studies, including ones conducted in 1996 by the National Research Council, conclude that migration barriers have substantially impacted fish populations. The extent to which culverts impede or block fish migration appears to be substantial. During fish surveys conducted in coastal basins during 1995, nearly all of the barriers identified (96%) were culverts associated with road crossings.

Culverts reported in the database are found on fish-bearing streams and were evaluated against established passage criteria for juvenile and adult salmonids. Parameters measured or estimated and recorded include:

- Culvert diameter (inches) and length (feet);
- Culvert slope (percent); *Generally, non-embedded metal and concrete culverts are considered impassable if the slope exceeds 0.5 to 1.0 per cent. At slopes greater than this, water velocities within the culvert are likely to be excessive and hinder passage;*
- Presence or absence of a pool;
- Pool depth, if present, (in inches);
- Distance of drop (in inches) to the streambed or pool at outlet; *Conditions at the culvert outlet are evaluated for drop (distance from culvert invert to stream below) and the presence or absence of a jump pool. If a pool is present, its depth is recorded. The general criteria for pool depth is 1.5- to 2.0-times the height of the jump required to reach the culvert—the fish need a running jump, so to speak. Pools shallower than this depth are considered inadequate. If the height of the jump (pool surface to water level in the culvert) into a culvert exceeds 12 inches during the period of migration, the culvert is judged inadequate and included in the listing of culverts needing attention. If the jump is greater than 6 inches but less than 12, the culvert is judged to be a passage problem for juveniles only;*
- Whether the culvert is embedded in the streambed and contains substrate;
- Whether water runs beneath the culvert at the upstream end of the culvert; *this is a problem for downstream migration of juvenile fish in low water;*
- Fish size (juvenile, adult, or both) likely to be hindered.

Table 28. Fish Passage Barriers on Public Roads in the Salt Creek Watershed

Location: Waterbody, Road, Approximate Road Mile (RM)	Priority	Comments
Unnamed Tributary of Salt Creek, Road 6508, RM 1.34	NA	NA
Unnamed Tributary of Salt Creek, Hwy 22, RM 7.8	Low	Not on straight-line chart. Rusted out. No access to downstream end.
Salt Creek, Road 7509, RM 0.08	Medium	3 culverts. Inadequate pool, drop and velocity create juvenile barrier; adults inhibited.
Unnamed Tributary of Hoekstre Slough, Road M-16, RM 0.31	Low	High velocity outflow inhibits passage. No access to assess slope.

Unnamed Tributary of Hoekstre Slough, Hwy 22, RM 8.9	NA	Not on straight-line chart.
Unnamed Tributary of Hoekstre Slough, Hwy 22, RM 9.28	Medium	Water empties onto fill; no pool. High velocity outflow.
May Creek, tributary of Hoekstre Slough, Road M-16, RM 1.13	Medium	Pool is 7' downstream from outflow. Passage difficult or impossible at various flows due to velocity.
Unnamed Tributary of Salt Creek, Road M-3, RM 4.76	NA	NA
May Creek, tributary of Hoekstre Slough, Hwy 22, RM 9.68	Medium	No pool. Water falls to 8% slab. Barb wire fence further impedes fish.
Unnamed Tributary of Hoekstre Slough, Road M-16, RM 1.66	Low	No pool. Fill piled below. Impassable at most flows.
Unnamed Tributary of Hoekstre Slough, Hwy 22, RM 10	Low	Not on straight-line chart.
Unnamed Tributary of Salt Creek, Road M-3, RM 1.9	NA	NA
Unnamed Tributary of Salt Creek Road 6513, RM 0.99	NA	NA
Unnamed Tributary of Salt Creek, Road M-3, RM 3.04	NA	NA
Unnamed Tributary of Salt Creek Road 6517, RM 0.3	Low	Not in Co Rd log. Needs a pool.
Unnamed Tributary of Hoekstre Slough, Hwy 22, RM 11.05	Low	Culvert #1105. Drop prohibits juveniles, inhibits adults.
Unnamed Tributary of Hoekstre Slough, Road M-16, RM 0.07	Low	Velocity and inadequate pool inhibit fish.
Unnamed Tributary of Hoekstre Slough, Road 7510, RM 2.15	Low	Velocity inhibits fish.
Hoekstre Slough, Road M-4, RM 8.63	Low	Upper 1/2 of pipe @ 1 %, lower @ 2%; Rusted through. 1 mi S of int w/Hwy 22.
Hoekstre Slough, Hwy 22, RM 12.16	NA	NA
West Branch Ash Swale, Road M-4, RM 3.98	Low	Not in County Road log.
West Branch Ash Swale, Road M-4, RM 3.55	NA	NA
West Branch Ash Swale, Road 7503, RM 0.57	NA	NA
Ash Swale, Hwy 99, RM 52.81	NA	NA
Unnamed Tributary of Ash Swale, Road 7411, RM 0.7	NA	Not in Co Rd log.
Ash Swale, Road 445, RM 2.38	NA	NA
Unnamed Tributary of Ash Swale, Hwy 153, RM 8.4	Low	Not on straight-line chart. 2 culverts. No pool.

(Fish Passage Culvert Database from ODFW)

The impacts of barriers on migratory species are obvious. The major impacts on resident, non-migratory populations are less obvious but include:

- Juvenile and resident adult fish must be able to move upstream and downstream to adjust to changing habitat conditions (i.e., temperature fluctuations, high or low flows, competition for available food and cover);
- Resident fish need continuity of stream networks to prevent population fragmentation which decreases gene flow and genetic integrity;
- Catastrophic events can displace entire populations. Barriers can prevent the escape or re-colonization of these habitats

Tony Snyder of Polk County Public Works reports that since the 1996 floods, they have been working to regrade ditches to match the grade of culverts. They also regularly flush culverts to remove sediment. Yamhill County Public Works Bridge Supervisor Susan Mundy reports that they also regularly check and clear culverts. When they do so they also record information relating to fish passage to compile a local database on all county road culverts.

Conclusion

Based on first-hand accounts, aquatic populations were larger and more diverse in the past.
Historical in-stream habitat was very different than present conditions. Log jams created diverse habitat, fish passage impediments such as culverts and dams were absent, water quality was higher, mature timber provided stream shade resulting in cooler water temperatures and greater dissolved oxygen, and stream meanders provided complex habitat with pools and riffles.

Cutthroat trout were once more abundant in the watershed and their sizes and numbers have declined over the years according to residents and fishermen. Cutthroat trout have the potential for abundance and are resident fish—meaning they live in the watershed year-round. This makes cutthroat the best local indicator species for salmonids and fish species in general.

Coho salmon were stocked nearby throughout the 1970s and 80s; stocking was discontinued due to concerns about the interactions between hatchery fish and native fish. Introduced coho have sustained themselves through reproduction and remain a factor in the Yamhill basin.
Native winter steelhead are threatened but use the Willamette, the South Yamhill, and the lower Salt Creek for part of the year and have the potential for interactions in the watershed.

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CHAPTER 11

Restoration and Enhancement

Introduction

Restoration is an increasingly popular response to many of the issues raised in the previous chapters. Restoration draws on our knowledge of ecology to improve natural functioning of ecological services. Nearly all the ways we have considered water and water-related land use can be understood as functions. The power of science lies in its ability to reduce nature down to these functions to better understand them. Ecology is valuable for once again considering the whole system or at least many of its parts simultaneously in relation to one another. Together, this enables watershed residents to understand how their surroundings work and to restore functions that are absent or degraded. Under our system of private property and with our cultural and ecological mandate for local determination, restoration is taking place in many independent projects across the region.

It is valuable to evaluate local efforts already underway when considering possible approaches to designing a restoration project. Coordination, monitoring, and subsequent fine tuning will increase the likelihood of having a positive impact. This will also help generate new restoration designs and provide opportunities to increase awareness of the local issues.

One source of information concerning restoration efforts is first-hand accounts by landowners who report on a voluntary basis to the Oregon Plan Watershed Restoration Inventory (OPWRI). The Oregon Watershed Enhancement Board (OWEB) has been acquiring watershed restoration information since 1997 to track on-the-ground efforts to restore aquatic habitat and water quality conditions in Oregon. Each year, OWEB publishes a report summarizing projects. The specific objectives of the OPWRI are to:

- synthesize and evaluate the types of restoration activities implemented;
- document voluntary efforts in the public and private sectors to restore watershed conditions;
- provide information (in database and GIS formats) to watershed councils and other local groups to support watershed assessments and future restoration planning and prioritization;
- estimate the proportion of restoration activities meeting state habitat restoration guidelines;
- provide information to support monitoring of regional and statewide restoration activities.

Landowners can offer information to OWEB's Corvallis office upon completion of restoration projects. Data is submitted using a standardized reporting form and project location maps. Currently, the data predominantly represents restoration practices on non-federal lands in Western Oregon (i.e., west of the Cascade Range) implemented between 1995 and the present. If you would like to learn more about this voluntary database, contact Bobbi Riggers at (541) 757-4263 or by e-mail at: Bobbi.Riggers@orst.edu. A great deal of relevant information including recent annual reports is available at www.oregon-plan.org.

Another source of information for existing restoration projects is the StreamNet website. For the Salt Creek watershed, StreamNet lists two installations undertaken by Willamette Industries to improve roads, bridges, culverts, campgrounds, and attempts at erosion/sedimentation control.

Table 29. Salt Creek Projects Listed in the Oregon Plan Watershed Restoration Inventory

Affiliation	Name/Type	Cost	County	Year	Project Description
Willamette Industries	97-552-30382	$4,600	Polk	1997	Streambank stabilization; legacy road improvements, bank stabilization
Willamette Industries	Salt Cr Installation	$400	Polk	1997	Peak flow passage improvements
Yamhill SWCD	Riparian Habitat Restoration	$2,700	Yamhill	1998	Riparian tree planting
Willamette Industries	Logging	$8,500	Polk	1999	Voluntary Riparian Tree Retention
ODFW	Salmonid Habitat Restoration for Salt Creek	$11,326	Yamhill	2000	Instream large wood placement
Willamette Industries	Logging	$12,128	Polk	2000	Voluntary Riparian Tree Retention
Willamette Industries	Moore WVL R/W	$7,219	Polk	2000	Surface drainage improvements

The local USDA Service Center is an excellent starting point for local residents interested in restoration. The U.S. Department of Agriculture, the Natural Resource Conservation Service (formally the Soil Conservation Service), and the local Soil and Water Conservation District are housed in the Service Center. Advice, design consultation, plantings, and sometimes even partial funding is available. People from one or more of these agencies were involved in many of the projects reported in the database and described below.

For additional information on USDA program eligibility contact:

USDA Service Center
2200 SW 2nd Street
McMinnville, OR 97128
USDA: (503) 472-1474
Yamhill SWCD: (503) 472-6403

USDA Service Center
289 E. Ellendale Rd., Suite 504
Dallas, OR 97338
USDA: (503) 623-9680
Polk SWCD: (503) 623-5534

Passive and Active Restoration

Passive restoration is the easiest method for improving the watershed. It is as straightforward as letting nature alone to recover over time from disturbance through natural succession and evolution. Often our faith in human technology leads us down the path of more manipulation, often with further economic and ecological costs, even when the shortcomings of the very same technologies got us into trouble in the first place. In most cases we can save time, money, and ecological integrity simply by identifying a problem and curtailing its causes.

Passive restoration involves simply ending disturbance and letting land heal with time. For example, where domestic animals have access to streams we can install off-stream watering for livestock to keep them out of the muck and allow the stream to recover naturally. That's what area residents Jim and Linda May and their neighbors did. When they noticed a herd of cattle was in the creek just upstream of their four-acre pond, they contacted their neighbors to work out a solution. The owners agreed that it would be simple enough to water the cattle off stream and now they keep the cows fenced out of the riparian area.

In another area of the Yamhill basin, the Mays are pursuing active restoration by planting vegetation to stabilize their stream bank on Millican Creek. They were concerned about erosion taking place along the creek flowing through their property so they worked with Dean O'Reilly of the Yamhill Soil and Water Conservation District to plant appropriate riparian plants and stem the problem, so to speak. Native plants are better adapted to the climate and ecological conditions and consequently require less care to become established. Planting native vegetation is also important because it reduces the potential of introducing noxious weeds.

Active restoration (or enhancement) efforts try to speed up the ecological recovery of a disturbed area by rebuilding natural functions that appear to be missing. For example, in our contemporary landscape of towns, housing developments, shopping areas, and fields there are large stretches of streams that have very little or no large woody debris. What's more, without adequate mature trees nearby, these streams will not receive debris in the foreseeable future. Consequently it is increasingly common for landowners and land managers to add tree trunks and root wads to streams that are downcut, eroding their banks, or lack habitat complexity. This is clearly an active approach.

Active solutions are far trickier because of the complexity of our interactions with nature and the difficulty of identifying the causes instead of merely the symptoms. Done without adequate respect for nature's patterns, active restoration can do more harm than good. The potential for unanticipated negative results is directly related to the degree of manipulation. A low-tech activity is less likely to produce negative results than reshaping the streambed with a bulldozer. Bulldozers can be a great tool for certain jobs but greater care is needed when you harness that much power.

An example of the needed care comes from a fill and removal permit for the relocation of a Willamette & Pacific rail line. It reflects our society's growing awareness as we attempt to accommodate the complex interrelationships of water, land, flora, and fauna as we continue to build across the landscape. The following description of preexisting conditions was written by a biologist hired to help the company avoid a net loss of wetland functions:

> "An extensive emergent and shrub-scrub marsh lies on the south side of the railroad embankment. It occupies a broad swale about 25 acres in size which joins the South Yamhill River half a mile to the east. Hydrology is driven by groundwater discharge and runoff from adjacent industrial uses and irrigated fields. Soils are hydric and high in clay content with an organic surface layer. Vegetation consists mainly of typical emergent marsh species such as *Typha latifolia* (cattail), *Scirpus acutus* (hardstem bulrush), *Carex spp*. (sedges), *Juncus spp.* (rushes), and associated shrubs such as *Salix lasiandra* (Pacific red willow). There is some use by typical songbird species (warbler, red-winged blackbird), small mammals (raccoon), and deer. Sediment trapping is an important function of the wetland."

It is important to consider natural conditions (and their functions) in any restoration effort. This is particularly true with projects that changes land contours, hydrology, and vegetation cover.

Design

For most restoration projects, the costs of heavy machinery, labor, and materials will largely determine the limits of what happens. This can be an advantage when viewed from a long-term evolutionary perspective. Restoring ecosystems slowly, incrementally, with an eye to how the ecosystem responds is preferable to a quick, machinery-intensive makeover. Organic systems appear remarkably well designed but they reach that condition (and sustain it) through endless incremental changes and adaptations. When approaching a problem then, avoid the assumption that you will be able to solve it once and for all in one muscular effort. Only by fine tuning your use of the land and water repeatedly over a long period of time may you be able to imitate natural processes.

Many of our development strategies already reflect this. Lifelong resident Eugene Villwock tells a story of his archeological observances from a few years back when the road in front of his house was rebuilt to install a new culvert. As the heavy machinery removed the pavement and roadbed, he noted at least three distinct stages in the development of the road. He describes how the road initially followed the contour of the land as it dipped down to the seasonal stream. In the bottom was a small diameter clay tile placed under the initial road. The next two stages were progressively higher, serving to level the road as it crossed the dip with additional tiles to carry water under the road. Each new road surface was also wider, presumably to accommodate heavier, faster moving traffic.

Adaptive Management

A good model for managing restoration projects is one that takes advantage of our adaptive abilities and mimics natural processes such as local determination and gradualism. In recent years, a more holistic approach to land management has emerged in America. It reflects a growing consensus apparent in many professions and disciplines. From logging and farming to the high tech industry and large organizations, we increasingly see people using nature as a model. In the language of our governmental agencies, this nature-based model is called a*daptive management*. As explained in the BLM and Siuslaw National Forest's *Northern Coast Range Adaptive Management Area Guide*, "[a]daptation is the process of responding positively to change."

> "[T]he term adaptive management is used to describe an approach to managing complex systems that builds on common sense and learning from experience. Adaptive management…consists of three basic steps:
>
> - Conscious experimentation in the design of activities
> - Careful monitoring to see how things turn out
> - Regular adjustment of practices based on observation
>
> "Monitoring is perhaps the most critical step in the process: people and funds must be provided to monitor results, analyze what happened, and feed the results back into the design of new projects. Monitoring, based on a sound sampling design, provides regular feedback about how well things are working—or not working—so that practices can be frequently modified in response to new information and changing values."

The same nature-as-model philosophy applies to our towns, domestic life, and architecture. In his book on the evolution of buildings called *How Buildings Learn*, Steward Brand points out that the advantage of make-do solutions is that they require more modest investments of time, resources, and money and they make it easier to improve or dismantle shortcomings later. Although many of the challenges facing us have large-scale causes that require relatively large-scale solutions, much can be accomplished through small projects. The point is to set *improvement* as a goal during the design stage in hopes of avoiding problems through overkill.

A similar model for designing restoration projects is *A Pattern Language*. In it, Christopher Alexander describes his approach for achieving timeless architectural designs that mimic natural processes—precisely like evolution. Alexander's technique is to imitate designs that have created beautiful, functional, evolving human structures and towns throughout history. Traditional builders use a shared language of patterns that orient design to actual results rather than symbolic façades or the latest high-tech building products. In regulatory land management terminology, these patterns are called "best management practices."

Successful design is an organic process. "In nature you've got continuous very-small-feedback-loop adaptation going on," Alexander says, "which is why things get to be harmonious." He explains further:

> [L]arge-lump development is based on the idea of *replacement*. Piecemeal growth is based on the idea of *repair*. Since replacement means consumption of resources, while repair means conservation of resources, it is easy to see that piecemeal growth is the sounder of the two from an ecological point of view. But there are even more practical differences. Large-lump development is based on the fallacy that it is possible to build perfect buildings [or wetlands.]

> Piecemeal growth is based on the healthier and more realistic view that mistakes are inevitable.

The technique is remarkably straightforward: pay attention to what is beautiful and functional in our surroundings, try to understand why—ask what is the essential quality that makes it good—and then mimic that quality intentionally through design. We can use a similar approach for identifying any quality we want to promote in our surroundings.

This approach is highly successful at identifying universals—sources of the good life—that involve not only the built environment but also the way we organize ourselves socially. *Human nature* means our deepest natural tendencies, after all, and interconnection between generations as well as the connection between people and their natural surroundings is fundamental to life.

We can all identify desirable patterns. Watershed patterns that local residents have been pursuing for years include “RIPARIAN CONDITIONS,” “WETLAND RESTORATION,” and “WILDLIFE HABITAT.” Many other yet-to-be-named patterns are implicit in watershed qualities and problems. The idea of using desirable patterns to design your surroundings is a voluntary, constructive approach. The point is that we can recognize what is good about living where we do, we can agree on a great deal, and we can work both as individuals and with others to foster those things. It will require some planning and design. In many cases it will involve modifying things or building them differently the next time. Usually, all that is required is restraint based on our experience with past degradation.

Local Restoration Examples: On-going Design

A Chehalem Valley restoration project on the property of James Stonebridge and Kathleen Boeve serves to illustrate the evolving design process. It involves 15 acres of bottomland that is not suited for agricultural uses. The original idea developed through the landowners’ contact with Dean O’Reilly of the Yamhill SWCD while he was designing a drainage system for their vineyard. Following a soils investigation, it was clear that one 15-acre field was not suited to grapes or even filberts, reports NRCS Resource Conservationist Rob Tracey. The clay soils didn’t drain well enough to allow grape or nut production, he says. The site is also a low-lying frost pocket.

Later, the Stonebridges read about the federal wetland reserve program (WRP) and again contacted the SWCD office to inquire about participating. At that time WRP was not available in Oregon but Rob and Dean agreed to investigate other sources of financial assistance since the Stonebridges were interested in restoring a wetland. They were envisioning “water to attract water fowl,” according to James Stonebridge. The NRCS/SWCD office drew up a project plan before applying for Long Term Agreement (LTA) funds. In the fall of 1991, the Stonebridges received $13,000 in cost-share funding from the federal government.

In subsequent site investigations Dean discovered the original design would need to be modified in several ways due to conditions that were not immediately evident. One of the most dramatic changes was that a drainage ditch that was going to be inundated needed to remain open for a drainage system on the neighboring property. This meant that there would need to be two smaller ponds on either side of the ditch where initially Dean and the Stonebridges had envisioned one large pond. They also added two smaller seasonal ponds in areas where water was collecting at old drainage tile outlets. Throughout the process, Dean consulted with Steve Smith of the Oregon Department of Fish and Wildlife (ODFW) to maximize habitat values.

The final design involved six ponds, the larger four being hydrologically connected by a system of inlets and overflows that actually go underneath the road and drainage ditch. These changes illustrate that projects start out with an ideal, a pattern such as "water to attract water fowl," and evolve from there. Changes in design occur according to economics and materials, the skills and preferences of the people involved, and physical conditions such as the soil, hydrology, vegetation, and existing infrastructure.

The Stonebridge project is still being designed, over seven years after its initial completion. On one edge of the project they planted Douglas-fir and western red-cedar in hopes of establishing a conifer forest. About midway in this strip of conifers the young trees died and on either side of the dead zone the surviving trees are stunted. Clearly, the growing conditions here do not favor these two tree species. Dean theorizes that the soil is poor in that one area and that some Willamette Valley ponderosa pines would do better. Elsewhere, he would like to plant more native species that were not available commercially even a few years ago. The initial planting included tufted hairgrass, birdsfoot trefoil, and switchgrass for forage and nesting habitat.

Landowners can choose their level of participation in this ongoing design process. There is always more that could be done in restoration if you pay attention to what seems to be working and what doesn't. If you would rather not continue with active efforts indefinitely, then shift your focus to passive restoration (by preventing major disturbance) and let the local natural conditions effectively redesign the site through evolution.

Patterns used in Dean's conceptual plan and design include Conifer Forest, Deciduous Forest, Grass Meadow, Wildlife Food Plots, Shallow Water Pond, Water Diversions, Grassed Waterway, Low Dike, and Spoil Bank. Combining these allowed the Stonebridges to succeed with their goal of having "water attracting waterfowl."

Incremental Restoration

In 1999 Doug Rasmussen decided he wanted to do something with his farm near the South Yamhill River where he has lived all his life. He wanted to restore it for wildlife habitat and water quality protection. Doug contacted Rob Tracey of the NRCS for assistance. After visiting and discussing various alternatives for protecting the site, Doug decided to apply for planning and financial assistance under the Conservation Reserve Enhancement Program (CREP).

For eligible acres—generally riparian corridors and associated wetland—CREP provides an annual rental payment for land removed from agricultural production. Many farmers find these rental payments more profitable than cropping. CREP also provides financial assistance for establishment of *conservation practices*—suggested land use patterns available in print through the NRCS/SWCD. Some forms of financial assistance require implementation of at least a few conservation practices. Aside from this incentive, "conservation practices" are a useful guide for anyone looking to improve agricultural or rural acreage.

Working together, Doug and Rob designed a restoration plan that included native trees and shrubs along a stream, destruction of the existing drainage system, shallow excavations for restoring wetland functions, and establishment of a wet prairie plant community. The parcel will "no longer contribute to the degradation of water quality in the area," Rob feels. Instead it actually improves water quality while also providing valuable wildlife habitat.

Following completion of the CREP plan and after beginning the on-site restoration, Doug became so enthused by the process that he began making plans for other portions of his farm. He requested information on how to improve an additional 24 acres of upland that had been in continuous crop production for over 50 years. The fields were eroding and washing sediments into the river. Doug wanted to address the erosion by establishing permanent cover on the cropland, provide additional wildlife habitat, and begin to rebuild soil tilth. Following a planning process similar to that used on the wetland, Doug elected to apply for the Environmental Quality Incentive Program (EQIP) for technical and financial assistance. Doug was successful with his EQIP application and he and Rob subsequently designed a conservation program for the upland. Doug is now in the process of establishing shelterbelts around the crop fields and planting a mix of trees within the fields. These practices serve to increase infiltration of rainwater, provide wildlife habitat, reduce soil erosion, and provide high-value wood products.

Starting Small and Urban Options

County resident Ted Gahr is known for his expertise in creating wetlands. This is due to years of experimentation on his own property and through assisting with a number of neighbors' restoration projects. Ted learned how to run a bulldozer years ago when he was a rancher in California. Now he uses them to construct dikes for wetlands and ponds.

His experience in restoration work started years ago on his land in Muddy Valley almost by accident. He had placed some rocks in a stream on his land to make crossing the stream easier. He later noticed that during heavy rainfalls the stream overflowed its banks at that point and flooded part of his field. He liked the idea of having a little wetland there so he expanded the flooded area by digging a little diversion ditch to carry the floodwater further into the field. Ducks soon arrived. He continued to take small steps like that, based on experimentation and common sense, to gradually increase the functioning and size of his restored wetland. Eventually he removed the drainage tiles from the field and now has a 15-acre constructed wetland. In all, he has about 30 acres of restored wetland on his land.

Ted found he could still grow oats and barley in the recently inundated fields as long as he planted in the spring. Winter wheat wouldn't have worked. A beneficial side effect was that the winter flooding killed the agricultural weeds as well as left over seeds from the previous crops—historically the field had vetch and ryegrass. For several years the field was essentially weed-free without any spraying or cultivation. Subsequently, perennial wetland plants became established and now serve as "weeds" in terms of raising grains. This, along with the drop in crop prices, led Ted to discontinue cropping in his wetland.

He is now looking for wetland plants with wildlife or domestic feed value and high yields that could be used as wetland crops. One of his leading candidates is yellow vetchling from the pea family. It possibly could be used as chicken feed, he thinks, or as a legume in rotation with other wetland crops. Another possibility is leafy beggars tick (native) and tall beggars tick (non-native). Steve Smith of ODFW told Ted that beggars tick has a higher energy yield than the same acreage of corn. Elk and ducks both love it and seek it out around Ted's place.

Although not everyone will want to devote the time, acreage, and creative energy to restoration that Ted has, his initial, accidental flooding of Prior Converted wetland (drained for agriculture) serves as a model for small, low input restoration that almost anyone can follow. Check with the Water Resources Department and the Division of State Lands before getting started.

A similarly small-scaled example comes from McMinnville resident Kareen Sturgeon. Kareen is a professor of biology at Linfield College and has both a personal and a professional interest in wetlands. So when she heard of a program in Portland that paid homeowners to divert their gutter runoff away from storm drains, she was interested in learning more. This has a variety of benefits such as easing the load on drains and increasing percolation into groundwater aquifers.

Although the financial reimbursement is not available in McMinnville, Kareen still liked the idea. She consulted Dean O'Reilly of the SWCD and they came up with a plan. The design was to dig a trench about 20 feet long with a very gentle slope away from the house. Next, she installed a pipe connected to her downspouts and "daylighted" it in her backyard. Water now filters through her lower yard where she has planted a variety of water-loving natives. Now the water percolates slowly through the ground before reaching Cozine Creek.

One final example comes from homeowner Jacqueline Groth who has been gradually turning her small Dayton lot into an island of native vegetation over a number of years. Finding plants that both enhanced the landscape and were low maintenance were her initial objectives. Finding them proved to be a process of trial and error. She planted many things that were wrong for one reason or another. Then, Jacqueline explains:

> "I discovered the [Soil and Water Conservation District's Native Plant Sale] by accident, by following my nose to the least expensive way to acquire my favorite Oregon plant when I was growing up spending summers in the Oregon woods—the Pacific Dogwood. I planted it and it proceeded to die. This irked me, so I proceeded to study native plants, to find out what I was doing wrong. It seemed to me that native plants should just GROW wherever they were planted. What an eye-opening experience studying native plants proved to be. Now, after 15 years, I can say that the information about native plants has increased to the point where even I can find and use it! Information that was not available five years ago will enable me to grow more native plants. I have become an addict. Why? Native plants in the Willamette Valley are special. They define this area botanically as distinct from all others. They give a sense of place and integrity. This is where we live and what we are responsible to maintain."

Jacqueline considers each homeowner to be as important as any wildlife biologist or forester in helping to restore the natural systems of the Willamette Valley. She points out that this is really enlightened self-interest because extinctions will come back to haunt us. Jacqueline feels that by planting native plants in her urban setting she is helping to preserve native species, creating corridors for wildlife, enhancing seed banks, and reducing degradation in the region. She's not alone, either. Many area homeowners and even some new housing developments include native plants in their overall landscape design.

Jacqueline has several suggestions for getting started. The Native Plant Society of Oregon (NPSO) has a local chapter that is an excellent resource for homeowners because it involves networking with other people in the area who can share information. Jacqueline says the SWCD's sale is "far and away the best way to acquire native plants because they are so cheap that you can make mistakes (which you will do) and keep trying, experimenting, and not experience buyer's remorse!" Commercial nurseries are another resource. The Soil and Water Conservation District and Metro (Portland) have regular native landscape workshops for homeowners.

Economics of Restoration Projects

The cost for the Stonebridge project came to $23,000 but do not be discouraged by that cost, necessarily. This was a relatively large, active restoration involving labor and materials that are not always necessary. Many valuable projects can involve smaller acreages and less complicated infrastructure. Something as simple as spending several hours helping to pull shopping carts and old tires out of your local stream can have lasting benefits. That's what a group of Yamhill Basin Council volunteers did recently on Cozine Creek. This, along with many of the previous examples, show that watershed restoration can begin with little more than a good idea and a shovel. Water rights and a Division of State Lands fill and removal permit may also be required.

Another important factor is that federal and state agencies provide partial funding through a variety of programs. In the case of the Stonebridges, assistance from the USDA and ODFW brought the landowner costs down to approximately $5,800. In addition to the $13,000 USDA funds, the ODFW was able to provide $5,000 cost-share for earth moving, planting, and the costs of securing the required water rights.

Cost analysis for landowners should also account for the potential production lost by establishing habitat, keeping in mind that areas suited to restoration were often originally wetland, contain hydric soils, and are generally less well suited for agriculture. A related consideration is the added value of property that has ponds and swales with their associated plants and animals, open space, and clean water. Although these values are often difficult to quantify in monetary terms, they can have real economic benefits for agriculturists pursuing direct marketing, on-farm retail, or public relations efforts in a society that is becoming increasingly health-conscious.

We've mentioned a variety of funding programs throughout the assessment. Do not be deterred by not understanding them all. The folks at the USDA Service Center are there to advise you. Currently, many restoration and enhancement projects find support in the Environmental Quality Incentives Program (EQIP) established by the 1996 Farm Bill to provide a single, voluntary, conservation program for farmers and ranchers to address natural resource issues. There are other possibilities such as the Conservation Reserve Enhancement Program (CREP) as well as state Oregon Watershed Enhancement Board (OWEB) grants.

CREP is a USDA program that targets "significant environmental effects" related to agricultural land. It is a voluntary program that pays landowners for entering into Conservation Reserve Program (CRP) contracts of 10 to 15 years duration. OWEB grants are available to anyone addressing altered watershed functions, water quality, and fish. The funding priorities include removal and remediation of human-caused alterations, projects that change land management, projects that involve collaboration between stakeholders and agencies, projects located closer to headwaters (rather than downstream closer to the mouth of the river), and peer education where landowners share information regarding their watershed. Further information on EQIP, CREP, and OWEB funds are available by contacting the USDA Service Centers in Dallas (503) 623-5534 or McMinnville, (503) 472-1474. Ask for a copy of the "Guide for Using Willamette Valley Native Plants Along Your Stream."

Conclusion

Residents are doing a variety of things to improve water quality and habitat in local streams. They are getting involved with local groups or helping out in ways of their own design. Efforts include creating wetlands, planting native vegetation, and preventing erosion. Restoring ecosystems slowly, incrementally, and with an eye to how the ecosystem responds is preferable. Only by fine-tuning over a long period of time can we imitate evolution. Design is good when in addition to big elements being gradually added it also plans for a continuous series of adaptations—small, very small, and tiny ones in ever larger quantities—so that there will be many opportunities to reevaluate and fine-tune improvements.

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Watershed Conditions Summary

The Salt Creek watershed is very similar to other areas of the Willamette Valley that have been impacted by urban development and agriculture. Private ownership of nearly all the watershed leads to a wide variety of land-uses and restoration priorities. This document serves as a starting point for identifying ways to improve the water quality and habitat conditions in the watershed. Following is a summary of each chapter's major findings. Table 30 highlights sub-watershed conditions.

Chapter 1: Introduction and Watershed Characteristics

- The Salt Creek watershed has approximately 63,000 acres and three sub-watersheds: Ash Swale, Lower Salt Creek, and Upper Salt Creek.
- The majority of the watershed is privately owned. Historically, fire played a very important role in the maintenance of oak savanna and prairie ecosystems.
- Agriculture has been and continues to be an important part of the watershed's economy. Agriculture is the dominant land use and accounts for nearly 70% of the acreage. While the variety of crops grown has ranged from plums to hops to grass seed, the acreage under cultivation has remained fairly constant. Over 44% of the watershed is currently under cultivation for perennial grass seed making it the largest single land use. Another 13% of the land goes to annual grass—a total of 57% of the landscape devoted to grass seed.

Chapter 2: Historical Conditions

- Kalapuya Indians managed the watershed, in part, with summer burning. The majority of the Salt Creek watershed was savanna and prairie grassland in prehistoric times—over 75% combined.
- The Fuller and Fanning Mounds near the South Yamhill River are one of the richest archeological sites in the Willamette Valley. They indicate that the native Che-ahm-ill group of Kalapuyan people in this area were part of a distinct upper Willamette Valley culture that had close ties to the people along the Columbia and some contact with coastal and southern Oregon cultures. The local native Americans relied heavily on plant foods, secondarily on meat, and surprisingly little on salmon. They were muscular and remarkably healthy.
- European settlement brought an end to the intentional burns resulting in many areas becoming more heavily forested, mostly by Oregon white oak and Douglas-fir-dominated woodlands.
- Agriculture has been important to the area throughout history and produces an impressive array of food and other products. Over the past century, farms have decreased in numbers as larger operations grow ever larger and many small family farms go under. The larger farms are more specialized and less meat is raised in the area in general.

Chapter 3: Vegetation

- Vegetation in the watershed varies from being forested and increasingly planted in grapes in the hilly areas to a patchwork of residential development and agricultural crops in bottomland areas.
- Approximately 45,633 acres or 72.27% of the watershed is non-forested—lands under cultivation or development. Conifers make up 58% of mixed forest while hardwoods comprise 42%.
- There are four main types of native habitat in the watershed—riparian forest, prairie (wet and dry), woodlands, and oak savanna. These habitats evolved with natural and human-caused fire and likely are now reduced and evolving in response to fire suppression.
- The tall perennial grass species tufted hairgrass (*Deschampsia cespitosa)* serves as an example of a native prairie species that should be reestablished. It is well adapted to both periodic fires and hydric

soils—soils that were inundated for a significant part of the year. Today it remains only in isolated remnants and where it has been reintroduced in restoration projects.
- In prehistoric times, there was less conifer forest in the Salt Creek watershed. Today, conifers are found in riparian areas and in hilly areas intermixed with deciduous trees and in small pure stands. Nearly pure stands of Douglas-fir account for over 16% of the watershed.
- Current conditions show that farmed perennial grass dominates the watershed. The third largest cover class is annual grass. Together, these two grass seed crops cover over a half of the watershed.

Chapter 4: Riparian Areas and Wetlands

- Riparian areas have been intensively managed for agriculture for a long time. Due to the pressures of agriculture, forested buffers along stream banks are typically narrow.
- The majority of riparian areas have some vegetation, although it is often hardwoods or brush with low potential for adding large woody debris to streams. Many riparian zones have little vegetation to speak of (10.2% of the watershed). The benefits of riparian vegetation include cooling shade, balanced water chemistry, and nutrient assimilation from the surrounding soil.
- Non-native plants compete vigorously with native vegetation, especially in stressed or disturbed areas, and pose significant problems for landowners and managers.
- Hydric soils are those that have formed under wet conditions such as in a wetland. They characteristically have high water tables, are ponded or flooded frequently, or are saturated for extended periods during the growing season.
- The majority of wetlands in the watershed have been drained and tiled to make land available for agriculture, resulting in a loss of all but a tiny percentage of the native habitat.
- Wetlands play numerous roles in the health of the watershed. Their benefits include: connecting upland and aquatic ecosystems, lakes, streams, rivers, and riparian areas with one another, capturing sediment from erosion runoff, consumption of nitrogen from agricultural runoff, recharging groundwater by retaining water that then percolates instead of heading downstream, maintaining more steady flows to streams by slowing peak flows, and flood mitigation for the same reason, providing habitat for wildlife, open space, outdoor recreation, education, and aesthetics.

Chapter 5: Channel Habitat Types

- The majority of channels in lowland areas of the watershed were once floodplain-type streams and are now deeply incised channels that meet the criteria for low gradient, confined channels. These pose the greatest challenge to restoration efforts but also provide the greatest value for improving habitat.
- Channels respond to change differently based on their position in the watershed. The headwaters of streams like Ash Swale are steep, with low responsiveness to changes in channel pattern, location, width, depth, sediment storage, and bed roughness. Segments labeled moderate gradient confined (MC), moderate gradient headwaters (MH), and moderate steep narrow valley (MV) are more likely candidates for enhancement projects.

Chapter 6: Channel Modifications

- Channel modification has for years included the following: impounding, dredging or filling water bodies and wetlands, splash damming, stream cleaning, and rip-rapping or hardening of the streambanks. We can also include our ubiquitous road crossings (bridges and culverts) and streams with “permanent discontinuity” due to the artificial effects of a roadbed having been constructed within 200 feet the stream

- The small off-stream dams constructed in the watershed for flood control or fire protection are not barriers to fish passage. In-stream reservoirs, as are common on Salt Creek and Ash Swale, can be barriers to movement and habitat and exacerbate other problems such as high temperatures.
- In terms of area affected, agriculture has had the greatest effects on stream modification in the watershed. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating the stream and wetland qualities.
- Many fill and removal permits are related to roads. There is a lot of bridge replacement, bridge removal, straightening creeks, road crossings with culverts and earth fill, upgrading culverts, replacing culverts, extending culverts, highway widening, and filling in wetlands for "ingress and egress" from housing developments.
- There is an interesting trend toward more ecological awareness evident in permits. Many recent fill and removal permits reveal efforts specifically aimed at creating wildlife habitat or restoring wetlands

Chapter 7: Sediments

- Potential sources of sediment include dirt roads and ditches, impervious surfaces, slope failure on steep ground, and erosion of disturbed soil.
- All ditches drain to a water body, usually a stream. Some ditches are being managed to decrease their sediment contribution through roadside seeding. Please mow, do not spray.
- The amount of storm water runoff is increased substantially through development, especially by increasing impervious surfaces. Impervious areas include all pavement such as streets, parking lots, sidewalks, and loading areas, as well as rooftops.
- Runoff contaminants are most effectively removed by passing runoff water through a constructed wetland where plant uptake of the nutrients is significant and where heavy metals and toxins can either settle out or be consumed more safely before entering the stream.

Chapter 8: Hydrology and Water Use

- Stream flows and ground water are influenced by precipitation, loss of wetlands, withdrawals for irrigation and domestic water, stream channel modifications, changes in land use and water-related technology, and the removal of vegetation.
- Flooding has changed due to the clearing, straightening, hardening and deepening of the channels.
- On paper, streams and rivers in the watershed are over-allocated for water rights. This means that at times seasonal demands exceed the water supply. Conflict has occurred but presently most users are not exercising their full water rights. Extensive irrigation rights are held for land near Ash Swale and Salt Creek. Much of these areas were historically wetlands but are now drained and tiled.

Chapter 9: Water Quality

- Salt Creek is 303(d) listed for bacteria (fecal coliform), chlorophyll a, dissolved oxygen (DO), and high temperature. It is also at risk for, nutrients (phosphorous), sedimentation, toxics (pesticides), bacteria (fecal coliform threatening water contact recreation), and flow modification.
- The period of greatest concern for pollution or "contaminant loading" of rivers in our area is during the summer months of July through September. This period is important because non-point source contaminants tend to accumulate between infrequent rainfall and are then washed into rivers with relatively low rates of flow. The detritus from five weeks of heavy traffic on a large parking lot suddenly washed into the local trout stream brings new meaning to "summer freshet."
- The Yamhill Basin Council has a stream temperature monitoring program.

Chapter 10: Fish Habitat and Barriers

- Based on first-hand accounts, aquatic populations were larger and more diverse in the past. Historical in-stream habitat was very different than the present. Log jams created diverse habitat, fish passage impediments such as culverts and dams were non-existent, water quality was higher, mature timber provided stream shade resulting in cooler water temperatures and greater dissolved oxygen, and stream meanders provided complex habitat with pools and riffles.
- Coho salmon were stocked nearby throughout the 1970s and 80s; stocking was discontinued due to concerns about the interactions between hatchery fish and native fish. Introduced coho have been able to sustain themselves through natural reproduction and remain a factor in the Yamhill basin
- Cutthroat trout have declined over the years according to residents and fishermen. Cutthroat have the potential for abundance and are resident fish—meaning they live in the watershed year-round. Native winter steelhead are threatened but use the Willamette, the South Yamhill, and the lower Salt Creek for only part of the year and have the potential for many interactions away from the watershed. This makes cutthroat the best local indicator species for salmonids and fish species in general.
- Scattered stream surveys exist but there's no comprehensive source of local information.

Chapter 11: Restoration and Enhancement

- Everyone can identify desirable patterns. It is possible to design and build watershed functions.
- Restoring ecosystems slowly, incrementally, and with an eye to how the ecosystem responds is preferable. Design is good when in addition to big elements being gradually added it also plans for a continuous series of adaptations—small, very small, and tiny ones in ever larger quantities—so that there will be many opportunities to reevaluate and fine-tune things. Only by fine-tuning over a long period of time can we imitate evolution.
- Residents are doing a variety of things to improve water quality and habitat in local streams including creating wetlands, improving riparian conditions, and planting native vegetation. They're also getting involved with local groups or helping out in ways of their own design. There is a database available for landowners to be included in a statewide inventory of restoration and enhancement projects.

Table 30. Watershed Conditions Summary

Sub-Basin	Riparian Conditions	Wetland Conditions	Water Quality	Sediment Sources	Hydrology & Water Use
Ash Swale	Has the largest amount of degraded riparian areas. Problems in varied settings especially grass seed fields, pasture, orchards and vineyards. areas. Many areas with bare ground or short vegetation. Some areas with no vegetation or streambed remaining.	Many wetlands along bottomland reaches. Only NWI mapped information available. No Local Wetland Inventory data available. Large acreage of drained hydric soils. Many instream reservoirs.	No stretches listed or known to be at risk. Water quality very similar to lower Salt Creek. Need more data.	Highly erodible soils with construction sites, Some debris flow hazard potential. Areas of impervious surfaces, urban runoff non-point sources of pollution, annual grasses, row crops, clean cultivated orchards and forestry.	Considerable irrigation along middle and lower Ash Swale. Many domestic wells in Amity and Eola Hills, many in-stream reservoirs. some natural springs.
Lower Salt Creek	Many grass seed areas have no vegetation or streambed remaining. Other areas with narrow strip of trees or worse, only grass and brush in the riparian zone. Little shade.	Many wetlands along the lower reaches of creeks and Willamette. Only NWI mapped information available and not all in digital form. No Local Wetland Inventory data available.	Salt Creek is 303(d) listed for bacteria, chlorophyll a, dissolved oxygen (DO), and high temperature. It is also at risk for, nutrients, sedimentation, toxics, bacteria and flow modification.	Rural roads parallel to streams. Some impervious surfaces. Highly erodible soils with construction sites, annual grasses, row crops, clean cultivated orchards and some forestry.	Heavily irrigated along middle and lower Salt Creek, especially for annual and perennial grass. Many domestic wells and instream reservoirs. Water imported for domestic use.
Upper Salt Creek	Many areas with narrow strip of trees or worse, only grass and brush in the riparian zone. Insufficient shade and woody debris.	Many wetlands along Hoekstre Slough. Extensive areas of hydric soils drained—these provide a good opportunity for restoration.	See above.	A lot of debris flow hazard potential. Highly erodible soils with some field crops, pasture, grass seed and a lot of forestry.	Some irrigation along Salt Creek Creek and Hoekstre Slough. Some domestic wells and natural springs. Water imported for domestic use.