Lower Yamhill Watershed Assessment

The Yamhill Basin Council • (503) 472-6403
Yamhill and Polk Counties, Oregon
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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
DEQ	Department of Environmental Quality
DOGAMI	Dept. 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
LTA	Long Term Agreement
LWD	Large Woody Debris
LWI	Local Wetland Inventory
NWHI	Northwest Habitat Institute
NWI	National Wetland Inventory
NRCS	Natural Resource Conservation Service
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
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. Yamhill River Basin Fifth-field Watersheds

Who can swim in the summer, hunt crayfish, fish, row a boat, or even skate in winter on a polluted, smelly stream? Who in this generation knows what the Willamette ever looked like when it was a free running turbulent river, glistening in color, and abounding in game? This is now true also of the Yamhill River and its tributaries.

If the people in the county were aware of the expected increase in the population that has been published by the different surveys they could rearrange their thinking. This would give them some reason to see the need for a change. …If a service group backed this education idea, it would push it more than a state organization could. But authority is needed to be able to state some hard to accept facts.

—Yamhill County Economic Development Committee, 1963

CHAPTER ONE

Introduction and Watershed Overview

The Lower Yamhill River 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 how natural and human processes are influencing the watershed's ability to produce clean water and suitable habitat for aquatic life, both of which are quality of life issues for basin residents. It will serve as a baseline for developing and prioritizing restoration activities and will aid the Council and community members in developing monitoring plans for the Lower Yamhill watershed. This document is a snapshot, of sorts, but it's also tied to an ongoing process of community-based land use planning; the information contained will need to be updated as our needs and objectives evolve.

Methods

The guidance to develop and write this assessment came from a watershed assessment 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 section of the assessment. If you ever have the opportunity or inclination to assess your local surroundings using a manual like this, don't be put-off by the apparent immensity of the task. Understand that the authors were striving to give you as many tools as they could in terms of a broad working knowledge of water's role in our living environment. Accomplishing any portion of an assessment is valuable.

In our scientific age we rely heavily on data analysis. More specifically, we value approaches to measuring our surroundings in useful ways (data gathering) combined with analysis of trends and causality, or cause and effect. Why? Because we are looking for direction within a complex miasma of public policy, local politics, economic forces, diminishing resources, religious and cultural traditions, rapid changes in technology, and ultimately our natural surroundings—all of which we understand imperfectly.

Data used in the preparation of this document came from a wide variety of sources. The Bureau of Land Management's Geographic Information System (GIS) "base layers" were the basis of many of the maps on which this document is hinged. Interviews with local residents as well as natural resource managers from a wide variety of federal, state, and local agencies were valuable sources of information for helping to understand the information in this assessment.

In contrast to the personal knowledge many residents have of the area, relatively little is known about the local watershed in terms of scientific data. The Lower Yamhill watershed, like the entire 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 more recently ecological) management for our institutions and natural surroundings. This approach demands scientifically derived statistics to serve as a basis for our minimum standards for air and water pollution, habitat loss, and natural resource extraction. So it may surprise some readers to hear that there is little documentation on historic and current fish populations, for example, or even on species surveys in the area. Only scattered stream flow records, stream surveys, and water quality monitoring are available for the Basin.

Most of the information contained in the assessment comes from general databases for the Willamette Valley or for the state. Needless to say, there are opportunities for further investigation. Consequently, the Yamhill Basin Council under the leadership of Melissa Leoni began to collect stream temperature data in a number of locations in the watershed during the summer of 2000. Please contact the Council at (503) 472-6403 at the Yamhill County Soil and Water Conservation District if you are interested in doing monitoring or forming a community group to do so.

It is difficult to draw definitive conclusions on the condition of the watershed without information of this kind. We should not be discouraged, though. 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 brands 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 conditions. This versatility empowers us to answer many questions about our 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. A lot of data, including GIS, is available on the internet and most of the information contained within the assessment came to us that way. If you're interested in learning more about any of the topics in the assessment, a simple search on the internet (available free at the public library) will get you started.

Table 1. Examples of GIS Data Layers

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

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.

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 in ArcView. Unlike these larger formats, our watershed of approximately 60,000 acres is represented here on 8.5" x 11" pages. Consequently, even though we're looking at a relatively local area, a lot of detail is lost.

The significance for watershed 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 restoration. These maps should help in approximating locations and conditions before you set out.

Another possible tradeoff is that computer-generated maps don't necessarily compete on the human to human level of communication. Handmade maps of any kind (including quick sketches mapping out directions for someone) contain a human element that is sometimes lost in the process of making digitized, computerized maps. Handmade maps are like illustrations in guidebooks—they elucidate what's significant from a human point of view, seen through human eyes, and then processed by the big *Homo sapiens sapiens* brain. Images created with cameras or computers can sometimes be less helpful (or even reliable) than drawings. Although a surprising degree of the humanistic effect is likely retained by computer software that mimics pen and paper, we undoubtedly lose some of the human-to-human communication. We exchange this for the more standardized, quantified data available through GIS, as well as for the seductive presentation in bold colors.

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 Lower Yamhill Watershed?

The Lower Yamhill watershed is part of the Yamhill River Basin in the northwestern Willamette Valley. The 63,747-acre watershed is on the eastern side of the Coastal Mountain range. Nearly all of the watershed is within Yamhill County. Only the very southern tip of Palmer Creek's drainage reaches into Polk County.

The major streams of the watershed include Cozine Creek and the South Yamhill River in the west, Hawn Creek, Millican Creek, and Henry Creek in the north, and Palmer Creek in the south. There are many perennial or "blue line" streams contained in the watershed that do not have official names.[1] For the purpose of comparison, the watershed can be further divided into three sub-watersheds based on the guidelines set forth in the Oregon Watershed Assessment Manual (OWAM). These three sub-watersheds (6^{th} field watersheds) can be identified by their major streams as Cozine Creek/South Yamhill (in the west), Hawn Creek/Yamhill River (in the north), and Palmer Creek (in the south). Sub-watersheds of this size help citizens group themselves locally for addressing issues they have in common. See Map 2.

Elevations in the watershed range from about 60 feet above sea level to just over 1100 feet. The lowest point is at the Yamhill River confluence with the Willamette River on the east side of the watershed. The higher elevations are found in the hills to the south, north, and west. More specifically, the highest points of the watershed are 1160 feet in the Eola Hills to the south, 1067 feet in the Red Hills of Dundee, and 981 feet above sea level to the west of McMinnville in the foothills of the Coast Range.

Population

Yamhill County has a population of approximately 83,800. Although nearly all areas of the countryside are occupied, the population density of the watershed is concentrated mainly in the towns of McMinnville, Dayton, Lafayette, and Carlton.

Table 2. Population of Yamhill County

1900	13,400
1910	18,285
1920	20,529
1940	26,336
1950	33,484
1960	32,478
1990	65,551
2000	83,800

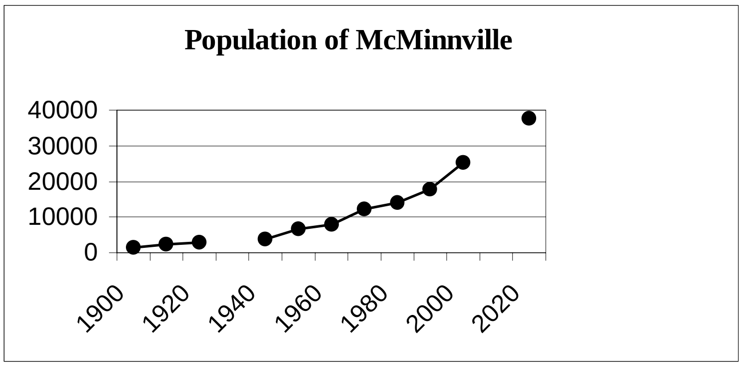
McMinnville is the economic and cultural heart of the county and is located near the confluence of the South and North Yamhill Rivers. Signs as you come into town give the population as 24,265 but according to Don Schut of the city planning department, the 1999 population of McMinnville was 24,420. The latest figure from the Portland State University Center for

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

Population Research and Census lists McMinnville's 2000 population at 25,250. Lafayette has 2,240 residents while Dayton has 1,930 and Carlton has 1,550 (about half of Carlton is in the Lower Yamhill watershed and half is in the North Yamhill watershed).

Current population figures are more revealing when viewed in terms of growth. For example, the following statistics for McMinnville over the past century indicate an accelerating rate of growth:[2]

Figure 1. Population Growth of McMinnville, 1900—2020



1900	1,420
1910	2,400
1920	2,917
1940	3,706
1950	6,635
1960	7,812
1970	12,125
1980	14,080
1990	17,841
2000	25,250
2020	38,720?

The city's official annual growth rate since 1900 has averaged just under three percent. The Oregon Department of Land Conservation and Development finds this to be "reasonable" but McMinnville's planning commission has recommended an average annual growth rate of 2.2 percent through the year 2020. Even if McMinnville could attain this slower rate, it would still yield a projected 2020 population of 38,720.

McMinnville's Urban Growth Boundary (UGB) was established in 1981 in response to the 1980 Oregon Statewide Planning Act. It's part of an effort to set goals and guidelines for urban growth to ensure adequate infrastructure. The current UGB—the hopeful limit of future urban growth—includes approximately 11 square miles or 7,190 acres (2,765 residential). Approximately ¾ of the UGB is within the existing city limits. The rest will likely be annexed by the year 2005. There are some 690 vacant residential acres (half of the 1,300 available a decade ago) remaining within the current UGB on which future residences may be built. This acreage must also include parks, schools, and churches. There are also about 200 partially vacant residential acres that already have residences on them but are large enough to accommodate additional development.

The city planners currently project that McMinnville will need approximately 3,000 additional dwelling units—houses and apartments—over the next 20 years. The question of how much land is needed to expand the UGB to meet this need (as well as for industrial and commercial development) has yet to be sufficiently answered. Creative solutions are needed. According to

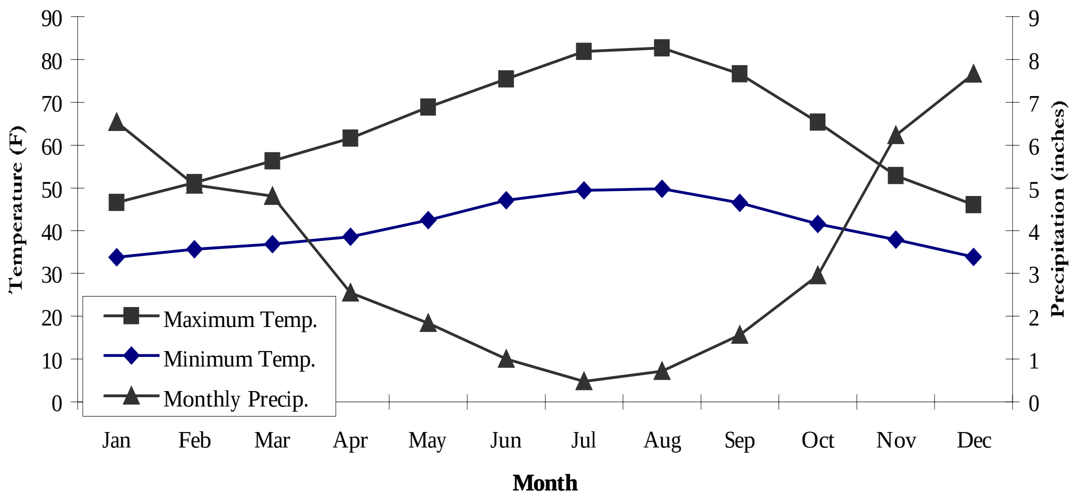
[2] For comparison, in the decades 1900-1940 Dayton had a population of 293, 453, 375, and 506. Note the decline from 1920 to 1930.

Senior Planner Ron Pomeroy, the city is in the process of establishing residential needs through data analysis, public planning workshops, and public hearings. The solution will likely include a combination of expanding the UGB and adopting appropriate growth management measures such as revising zoning to allow additional residential options.

Climate and Topography

The Yamhill Basin 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" [3] are rare. However, during the 1964 and 1996 winter storms enough snow did accumulate in the Coast Range to contribute to the record flooding that occurred in those years.

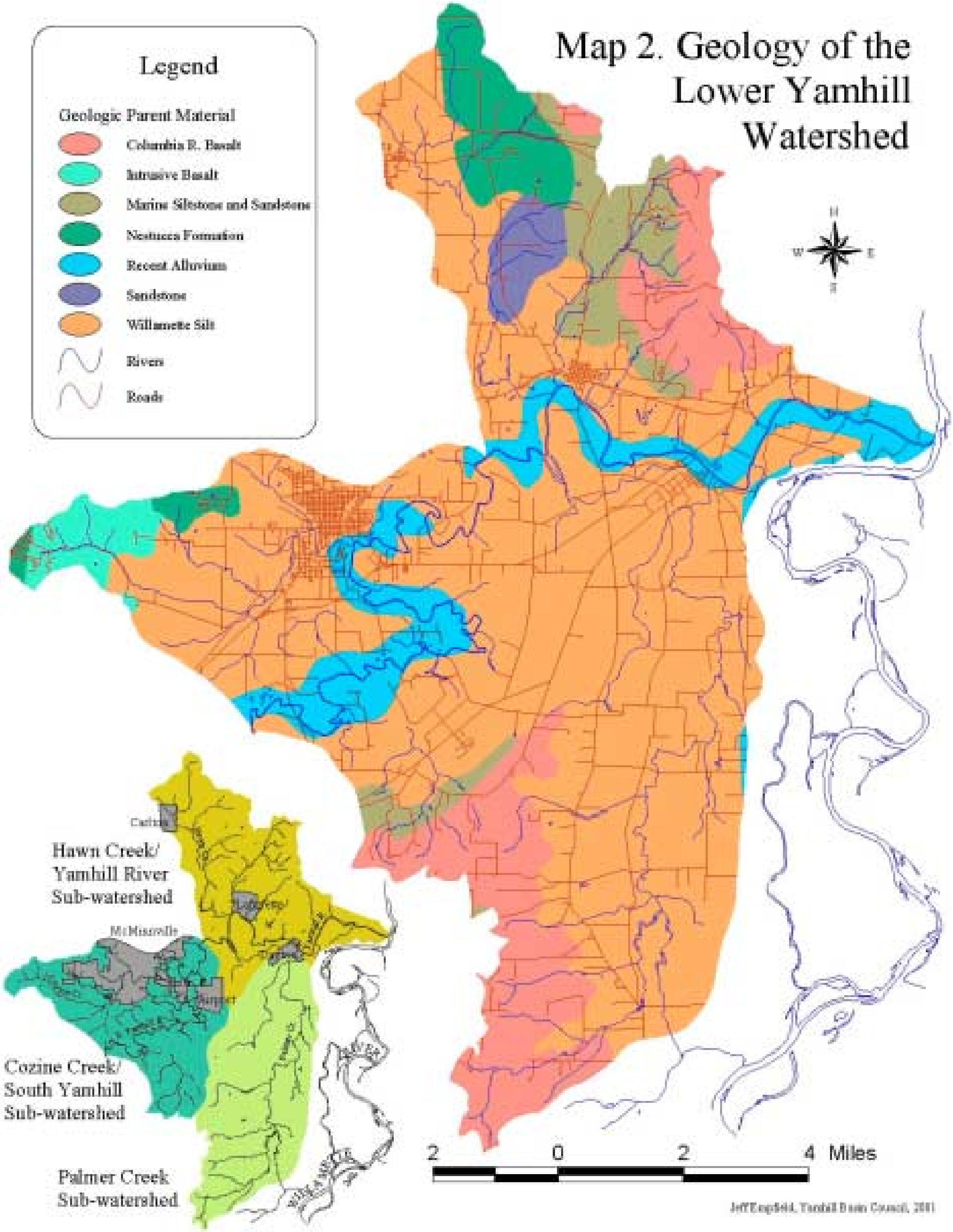
Figure 2. Average Monthly Temperatures and Precipitation McMinnville 1961-1990



Average annual precipitation estimates are available from the Oregon Climate Service. Rainfall amounts vary in the watershed; the higher elevations receive up to 60 inches of precipitation annually while the bottomlands receive about 40 inches annually.

As is typical for the west side of the Cascades, precipitation is not spread evenly over the calendar year but rather falls during the winter and spring months in a water year that runs from October to April. Figure 2 shows the average monthly temperatures and precipitation at McMinnville as recorded at the Oregon Climate Service at Oregon State University. Precipitation in McMinnville is typical of the Lower Yamhill watershed.

[3] "Rain on snow events" occur when heavy snow accumulation is followed by intensive rains. They can greatly increase the volume of runoff and may cause flooding.


Map 2. Geology of the Lower Yamhill Watershed
Legend
Geologic Parent Material
Columbia R. Basalt
Intrusive Basalt
Marine Siltstone and Sandstone
Nestucca Formation
Recent Alluvium
Sandstone
Willamette Silt
Rivers
Roads
Hawn Creek/ Yamhill River Sub-watershed
Cozine Creek/ South Yamhill Sub-watershed
Palmer Creek Sub-watershed
McMinnville
Carlton
2
0
2
4 Miles

Geology and Soils

The geology of the Lower Yamhill watershed is summarized in Table 3. This information helps us understand the shape and history of the landscape as well as the nature of the parent material that forms the soils. In turn it also helps us to understand how river channels have formed in our area and how changes in the landscape my lead to bank destabilization.

The Lower Yamhill watershed 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, Red Hills of Dundee, and the Amity and Eola Hills. The valley floor has sedimentary rock with deep alluvial deposits overlaying it. The geologic map of the watershed can be seen in Map 2.

The Soil Survey of Yamhill County and the Soil Survey of Polk County list five main soil associations for the Lower Yamhill watershed. In-depth information on the soils and their characteristics and locations can be found in those publications. The soils along the South Yamhill River and the Willamette River are of the Chehalis-Cloquato-Newberg association and are well-drained silty clay loams, silt loams, and fine sandy loams.

Table 3. Geology of the Lower Yamhill Watershed

Name	**Columbia River basalt**	**Willamette silt**	**Intrusive volcanic rock**	**Nestucca formation**	**Recent alluvium**	**Sandstone**	**Tuffaceous marine sedimentary rock**
Description	A succession of volcanic flows high in glass content	Unconsolidated light-brown silt up to 75 feet thick throughout the Willamette Valley	Basalt and gabbro sills and dikes intermixed with Nestucca formation	Very mixed: volcanic flows, tuffs, marine siltstone, and sandstone.	Unconsolidated silt, sand, and gravel.	Marine sandstone	Tuffaceous (fine volcanic) marine siltstone and sandstone
Location	The tops and eastern slopes of the Red Hills of Dundee, Amity & Eola HIlls	Most of the level urban, agricultural, and industrial land in the valley	Headwaters of Cozine Creek, elsewhere in Coast Range foothills	Coast Range foothills, northwestern slopes of the Red Hills of Dundee	Flood plain of South Yamhill and mainstem Yamhill Rivers	Southwestern slopes of the Red Hills of Dundee down to Hawn Creek	Central Red Hills of Dundee, western slopes of Amity & Eola Hills

The soils along the larger, bottomland creeks such as the mainstem Yamhill River (below the confluence of the North and South branches) as well as Hawn and Palmer Creeks have Woodburn-Willamette association soils. These are moderately well drained and nearly level silt loams and silty clay loams.

The tributaries of Palmer Creek running at the eastern base of the Eola Hills drain Amity-Dayton association soils. In general these are poorly drained, nearly level silt loams over silty clay loam and clay. The upper stretches of these creeks flow over the Jory-Yamhill-Nekia association soils of the eastern slopes of the Eola Hills. Jory-Yamhill-Nekia associated soils are also found in the eastern Red Hills of Dundee where several unnamed tributaries of the Lower Yamhill flow. Just north of Lafayette is Millican Creek which drains Willakenzie-Hazelair association soils of gently sloping to steep silty clay loams formed over clay and siltstone.

Vegetation

The vegetation in the Lower Yamhill watershed varies a great deal depending on the location. In general, the hilly areas in the north, south, and west are forested but in recent years have had increasing vineyard acreage. Meanwhile the more level valley bottoms are dominated by an impressive variety of agricultural crops ranging from annual and perennial grasses to row crops, berries, orchards, and vineyards. For a more detailed outline of the area's vegetation including current, and historic conditions, riparian conditions, species of special concern, wetlands, and noxious weeds see Chapter Three on vegetation.

Fire History

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

The Che-ahm-ill, the indigenous people of the "Yam Hills" area and a sub-group of the Kalapuyan culture, occupied the Yamhill River Basin at the time of Euro-American contact. The first white explorers to the valley in the 1820s reported large prairies and oak savannas and lots of smoke from widespread burning during the late summer. The new-comers reported that the natives intentionally torched large portions of the landscape annually to maintain prairies, oak savannas, and other plant communities useful for making their living. They had developed a system of land management to help maintain favorable conditions for meeting their food and other needs. We know now that many of these areas otherwise would have supported Douglas fir forests which have come to dominate more of the valley over the past century and a half.

Natural and human-caused wildfires continued to shape the landscape after Euro-Americans settled the area, but there were differences. In the 1850s the Coast Range forests burned more than they had in previous decades while valley prairies and savannas began to experience less fire and either were turned into field and pasture or began growing into forests. Euro-American settlers and their descendents have viewed fire control as necessary to protect timber and property in the region, an approach that continues to this day.

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. 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.

Present-day residential developments may face similar fires. 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 basin. Suppression of fire has contributed as much to the current vegetation pattern as historically intentional burning did. Of course there are differences between the two land use patterns. The most obvious difference is that the region has significantly more acres of Douglas fir and much less oak savanna and prairie since the end of intentional burning in the middle of the 19th century. See Maps 3 and 4 for maps of the historic and current vegetation.

Land Ownership and Land Use

The overwhelming majority of the watershed's 63,748 acres are privately owned. Land uses reflect this. There is a varied mosaic of agricultural, industrial, residential, and commercial uses throughout the watershed. Unlike much of the surrounding land where hills and forest predominate, here the land is a patchwork of independently and intensively managed relatively small parcels with a highly developed infrastructure.

Agriculture accounts for the lion's share of the acreage in the Lower Yamhill valley. Table 4 shows the acreage for various land use categories. The county uses many more zoning categories than what is shown here. Figures on more specific land uses (i.e. Ag-for, Mixed-EFU, etc) are available by contacting the Yamhill County Planning Department.

Table 4. Land Use of the Lower Yamhill Watershed

Land Use	Acres	Percentage
Agriculture	44,929	70.5%
Forested	14,208	22.3%
Urban	3,585	5.6%
Water	588	0.9%
Reed Canary Grass	257	0.4%
Parks/Cemetaries	93	0.14%
Quarries	66	0.1%
Hairgrass Prairie	22	>0.1%
Total	63,748	100%

Figures derived from ArcView analysis of Yamhill county data provided to the BLM in 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 (DOGAMI) 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. Small amounts of earth can be moved legally without permit unless one is near a wetland or body of water. In that case, the Department of State Lands would need to be contacted for a permit.

Permits are filed with the DOGMAI office in Albany, Oregon if more than 5,000 cubic yards is being disturbed. This permitting process became law in 1974, making records of mines and quarries before that date unknown or anecdotal. One rock pit and three quarries are shown on the USGS topographical maps of the watershed. For further information on these quarries, contact the USGS office in Portland.

Table 5. Quarry Permits in the Lower Yamhill Watershed

Number	Status	Name of Permit Holder	Type	Location
36-0005	Permitted	Timmons Quarry.	Basalt	3S 3W sec. 33
36-0011	New	Muhs Quarry	Basalt	4S 4W sec. 23,26
36-0025	Permitted	Crabtree Pit	Basalt	3S 3W sec. 28,33
36-0032	Permitted	Larry L. Turner	Basalt	4S 4W sec. 23,26
36-0041	New	Sohrweid Quarry	Rock	3S 3W sec. 31

From DOGAMI records office in Albany, Oregon.

Agriculture

Since Yamhill and Polk counties were organized in the 1840s, agriculture has been an important part of the culture and economy. In 1947 there were 276,000 farmer-owned acres in the county. By 1959 this had dropped to 229,137 acres—87.9% of the county. The dominant land use in the Lower Yamhill watershed to this day is agriculture. Any approach to addressing the area's landscape-related issues must address the importance of agriculture.

Of course agriculture has great significance for the area's streams and rivers. Most 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 that is too flat to provide adequate drainage. Outlets for drainage systems allow water to be channeled off the surface and into the stream network 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.

References

JoAnn Albertson, Lafayette City Hall, personal communication, November, 2000.

April Denman, Carlton City Hall, personal communication, December, 2000.

Dave Hanson, ed., Wamka: The Journal of the Che-ahm-ill Watershed Society, Sheridan, OR 2000.

Denise Hoffert-Hay, Lower South Yamhill-Deer Creek Watershed Assessment, Yamhill Basin Council, September, 2000.

Dawn Marshall, Oregon Dept. of Geology and Mineral Industries, personal communication, November, 2000.

Oregon Department of Fish and Wildlife. *Willamette Valley Land Use/Land Cover Map*. 1998.

Oregon Department of Forestry. *Land Ownership Map.* Forest Grove Unit. Northwest Oregon Protection District. 1998.

Oregon Natural Heritage Program. 1998.

Dolly Owens, Dayton City Hall, personal communication, December, 2000.

Portland State University Center for Population Research and Census website.

Martin Peterson, "The Swedes of Yamhill," *Oregon Historical Quarterly*. March, 1975.

Ron Pomeroy, McMinnville City Planning Department, personal communication, January, 2001.

Don Schut, McMinnville City Planning Department, personal communication, September, 2000.

U.S. Department of Agriculture, Soil Conservation Service. (SCS). 1982. *Soil Survey of Polk County, Oregon*. Yamhill County NRCS office, McMinnville, OR.

U.S. Department of Agriculture, Soil Conservation Service. (SCS). January, 1974. *Soil Survey of Yamhill County, Oregon*. Yamhill County NRCS office, McMinnville, OR.

CHAPTER TWO

Historical Conditions

Introduction

This chapter provides an overview of cultural and ecological factors that have helped shape the Yamhill Basin. By looking at the ecological history of the watershed—the natural and human influences on our surroundings—it becomes possible to identify how we got here and to incorporate this information in efforts of planning, restoration, and enhancement.

Timeline:

Pre-European Kalapuyan people numbering in the thousands occupy the Willamette Valley and use fire as a land-management tool; the Lower Yamhill watershed is predominantly grassland maintained through periodic burning.

1782 Willamette Valley natives exposed to smallpox and the population severely declines. Intentional burns subsequently decrease.

1812 Pacific Fir Company traders enter the Willamette Valley under the leadership of Donald McKenzie—this was the first documented contact between Kalapuyan and European people.

1831 Severe malaria outbreak in Indian populations of the valley.

1840+ Wetland areas tiled and drained to make land available for agriculture and residential development

1841 Kalapuya population estimated at 600 for the entire Willamette Valley. Malaria outbreaks continue. Open areas in the valley continue to grow up in forest.

1848 Nestucca fire burns area forested lands.

1849 Kalapuya population dropped to 60 individuals.

1844 McMinnville founded

1846 First circuit court in Oregon held at Lafayette

1847 Lafayette organized as a town

1848 Dayton and Yamhill organized as towns.

1855 Kalapuya, Umpqua, and Takelma peoples moved to the Grand Ronde Reservation. Congress ratifies treaty with Confederated bands of Grande Ronde.

1861 Large flood on the Yamhill River and its tributaries. Estimates of magnitude comparable to those of 1964 flood levels.

1870s Carlton grew up around a rail depot for area agriculture products being shipped to Portland.

1877 Area farmers organize a railroad called the Dayton and Sheridan Narrow Gauge Railroad Company to assist in hauling grain to the boats on the Yamhill River in Dayton. The line was completed in 1878.

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

1892 First "cleaning" of the Yamhill River. An estimated 1200 trees and snags cut and floated out of the lower 17 miles of river to allow greater river access for commercial traffic. Clearing the channel also made log drives easier. The impacts of channel clearing and log drives include: simplification and widening of the channel, loss of instream cover for fish, scouring of gravels needed for salmonids, and the loss of vegetation and soils from the channel sides.

1900+ The logging industry thrived until the forests became depleted in mid-century. Logging and wood related jobs now represent a smaller but more stable part of the local economy. The nearly complete initial clear-cutting and ongoing rotational logging results in a pattern of trees in area forests typically being young (0-39 years) or medium age and size (40-80 years).

1900s Row crops such as wheat and hay gave way to a valley-wide orchard boom in the early 1900s. Largely clean cultivated, orchards tended to suffer serious erosion. (Willamette Basin Task Force, 1969).

1902 Lock and dam built at Lafayette rapids on Yamhill River. Fish barrier for anadromous fish—a fish ladder was constructed on the dam but it reportedly was not very effective.

1911 First track-type tractor developed. Lumber companies replace animals with tractors for logging on gentle slopes.

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

1929 Southern Pacific discontinued passenger service through Yamhill County.

1930s The Depression greatly affected agriculture and ended the production of hops and prunes as major crops. Hops farmers lost the market due to prohibition. The next big change in land use came in the 1930s with the development of the seed industry. Production of hairy vetch seed largely replaced grain production in the valley, and eventually perennial grass seed came into production, which meant the ground was covered year round.

1945 McMinnville was the first small city in Oregon to create a city planning commission whose initial work was to increase the size of the city from 5 to 12 square miles, zone industrial areas, and plan an infrastructure for growth.

1948 Tansy ragwort, an invasive and aggressive plant introduced from Europe, had taken root in the area of the South Yamhill River. Tansy ragwort quickly colonizes areas of disturbance such as cut-over areas, roadside ditches, and overly grazed pastures.

1954 Officials released the first of many hatchery-raised coho salmon to the Basin. Release programs continued into the 1980s but with little or no success.

1964 December 22 and 23, tremendous floods damage homes and businesses in low-lying areas. Significant flooding of agricultural lands also takes place as rivers leave their banks and flow across the landscape.

The floods of 1964 did considerable damage to agricultural lands. An estimated 20 million tons of soil was washed into streams by this flood. Significant damage also occurred from the accumulation of logs and other logging debris on agricultural lands when the wood was washed into swollen streams and then deposited in fields as the water slowly subsided. Bridges were damaged or destroyed when log jams developed and brought the full force of the water against them. A total of 32,750 dollars was spent in 1965 to repair the flood damage, including the "restoration" of 26,000 feet of stream channels.

1980s Hatchery stocking of coho salmon and rainbow trout discontinued after biologists began to question detrimental interactions between wild and stocked species.

1996 Large-scale flooding throughout the Willamette Basin (probably a 100+ year flood). DEQ listed the South Yamhill River on 303(d) list of water quality limited streams.

1998 Winter steelhead in upper Willamette watershed (including the Yamhill River basin) were listed as threatened under the Federal Endangered Species Act.

2000 Yamhill Basin Council began stream temperature monitoring on a number of creeks throughout the basin.

Lands along the Yamhill and its tributaries have undergone tremendous change in the last 50 years. Natural vegetation was removed, land was converted to crop land through a system of drainage ditches and tiling. At least six tile factories have operated continuously in the Willamette Basin for more than 50 years" (Willamette Basin Task Force, 1969).

Prehistoric Yamhill

When Lewis and Clark passed through the Columbia Gorge in 1805 they encountered a settled landscape west of the Cascades full of varied and interconnected native cultures. They noted that there was a lively trade network across the whole region. This in spite of the fact that many natives had already died from one of the initial waves of European disease that swept through the dense population—before most victims had even seen a white person. We can imagine the well-established systems of trade, communication, and social organization that had evolved here over millennia. We can also imagine that native culture was experiencing the first stresses of decline.

Along the Columbia lived the head-flattening Chinookan tribes whose activity and iconography focussed on the river and the bounty of food available there. Just south of the Chinook villages were the Tualitin people—the northernmost of the Kalapuya tribes living north of the Yamhill Basin on the cultural fringe between the Willamette Valley and the Columbia River culture groups. As Kalapuyans, the Tualitins were one of several 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, possibly following watershed boundaries. Within their area the group had access to most of what they needed in plants, animals, and other resources. Archeologists theorize that within each sub-basin the tribe likely occupied several villages that shared access to resource and hunting areas. In addition to sharing resources it is also plausible that each village had its own plant harvest areas "which may have been further divided into individual gardens or plots," according to archeologist David Stepp.

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

We are fortunate to have a time capsule from that culture, or rather a series of time capsules, in the form of dozens of graves in two burial mounds located near the South Yamhill River not far from McMinnville. They contained the skeletal remains of at least 66 individuals along with a variety of items buried with them. Excavated in 1941 and 1942, these mounds provide a fascinating repository of artifacts from a people who were as different from us as we can likely imagine but who also faced many of the same challenges we do today. What little we can learn about their economy, technology, and land use from these graves is an excellent point of comparison for what it means to live in the Yamhill Basin today.

The Fuller and Fanning Mounds provide the most diverse inventories of artifacts from any known archeological site in the Willamette Valley. "Exotic" artifacts suggest contact with coastal, Columbia River gorge, and plateau cultures. Examples of imported goods include ceremonial obsidian blades similar to ones from Gold Hill in southwest Oregon, whalebone salmon clubs from the coast, and a wood carving of staring owl eyes similar to ones found along the Columbia River and on the interior plateau. Another indication of contact outside the Basin is that nine of the 66 individuals studied from the mounds had some intentional forehead flattening.

We can understand something about how the groups interacted in the region by tracing the cultural practice of head flattening. Gradually deforming the fronto-occipital part of the scull was common with the Chinookan cultures for whom this type of head flattening is named (i.e. the "Chinookan" type of flathead). The Tualatin Kalapuyans were influenced by the Chinookan cultures immediately to their north and consequently some Tualatin individuals also practiced head-flattening. Central valley Kalapuyan tribes practiced cranial deformation less often and southern Kalapuya show little Chinookan influence, in this respect. Remarkably, in spite of our current level of transportation, communication, and transience we can still identify patterns of culture and economy having similar geographical poles.

The burial items represent a surprising variety of both utilitarian and symbolic items. They include tools such as elk-horn wedges, projectile points and scrapers, broken and complete mortars, pestles, bone awls, stone bowls, stone mauls, stone drills, whalebone clubs, a bone poniard (dagger), a large obsidian blade, antler digging sticks, and antler digging stick handles. They include symbolic and ornamental items like an owl's head carved in bone, shell beads and pendants, bone beads and pendants, antler labrets (lip discs) or ear plugs, feathers, and trade items such as copper pendants, copper bangles (ornamental bracelet or anklet), copper buttons, and glass beads. They also include more cryptic artifacts such as animal remains (bear penis bone, bird bills, cat claws, and fish vertebrae), a sandstone disc, cedar bark, wood fragments, and some corroded iron fragments. Of course the full significance of artifacts remains mostly buried in the past. We can glean some meaning from them, though.

Interestingly, there are differences in the mixture of items buried with deformed and non-deformed individuals. Archeologist David Stepp suggests this indicates either 1. a later arrival of cranial deformation practices (and possibly another cultural group) to the area, 2. possibly more than one culture group using the Fuller and Fanning sites, or 3. an elite class separation defined in part by artificial deformation of crania. Our interpretations must rely mainly on informed speculation. Ultimately, we have to be satisfied with basic conclusions such as there was a deeply complex culture developed in this place over a time period lasting much longer than the current historic period. More significantly, the prehistoric system co-evolved with the local ecology, relied largely on local, renewable resources, supported a large, relatively healthy population, and was rich in leisure time, craft, and both utilitarian and non-utilitarian art.

We know that the Kalapuya inhabited permanent villages during the wet, cold season, but ranged through itinerant camps during the rest of the year from April or May to November. Their winter houses were semi-subterranean, rectangular structures made from a pole framework with bark or plank siding. Their villages also contained sweathouses for both men and women. Summer shelters used while moving through seasonal hunting and gathering sites, were often just a natural or hand-built windbreak of brush or trees.

Surprisingly, plant foods accounted for more of their nutritional intake than meat did. Camas was the most important of their staples; they roasted it in pit-type ovens. Other nutritionally important plants were wapato, tarweed seeds, hazelnuts, and various berry species. We know that they cultivated Tobacco (Nicotiana sp.) Although oaks were common in the valley, acorns don't seem to have been an important part of the Kalapuyan diet. Abundant wildlife was also utilized by the Kalapuya including deer, elk, small mammals, black bear, birds, fish, lamprey, and grasshoppers.

Finally, the Che-am-ill population of Kalapuya appears to have been in general good health. Very few pathologies can be detected in their skeletal remains. Most of the individuals, while being relatively short compared to modern populations, were "somewhat robust in musculature as evidenced by rugged areas of muscle attachment in the skeletal remains." These were people who were well-adapted to their surroundings who had developed a system of supporting themselves on local resources. And even after thousands of years of continual settlement, the land appeared pristine to European eyes and supported more biodiversity than we enjoy today.

When Commodore Charles Wilkes visited the Willamette Valley in 1841 he found a well-cared-for landscape, though the significance of that was likely lost on him. Europeans had trouble seeing past the cultural differences and like J.C. Cooper regarded the natives as "neither crafty nor cunning…a quiet, indolent people." Wilkes instead focussed 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.

"These hills are clothed to the very top with grass, and afford excellent pasturage for cattle," Wilkes concluded, and soon they would be fenced-over for that purpose. Already in 1841 on their "route through the Yam Hills," Wilkes reported, "we passed many settlers' establishments"

Early History: 19th Century Yamhill

The Yamhill Basin was home to some of Oregon's earliest white settlers who began arriving in significant numbers in the 1840s. A great many of them were from Virginia and Maryland originally and had first moved to Missouri, Tennessee, or Kentucky before embarking on the Oregon trail. A commonly held belief is that they "farmed out" one area and moved on. Undoubtedly many were enticed by lavish descriptions of the Willamette Valley and the Federal government's "Donation Land Claim" system that predated the Homestead Act. In the1840s it served as a means for Federal managers of the Oregon Territory to sell 160 acres or more to settlers at cheap rates. Settlers could get more than the standard 160 acres if they were married and more yet for having children.

Other ethnic groups rounded out the population in early decades of the modern era. In the 1860s and 1870s Chinese-American immigrants worked in the area cutting oak firewood for the Portland market. Swedes began to arrive in the 1860s and established farms. In addition there was a smattering of Germans settling the valley at this time. Finnish people immigrated to the area between 1900 and 1920.

In the early years following settlement, agriculture meant cattle grazing and subsistence farming. During the first two decades the valleys filled up rapidly while cattle herds pushed back into the hills. Farmers grew wheat on the level land and it became the dominant farm industry. The 1880 census reported that wheat, oats, and hay accounted for 99 percent of the agricultural production in the area.

During the 1880s, farmers were so successful in growing clover that it became the dominant cash crop. By 1900 clover occupied 1,216 acres, wild grasses 250 acres, tame grasses 8,007 acres, and grain (which farmers cut green for hay) 3,033 acres. With an increase in clover production the livestock industry flourished. Hops also became a significant part of the local agricultural economy with a 1900 census reporting 1,801 acres in production in Yamhill County alone.

Area resident Gordon Jernstedt grew up on a farm along Hawn Creek and provided the following circumstances of settlement from his family history. In 1882 Frank and Anna Jernstedt (his grandparents) moved from Colorado to hire on with area landowner John Wennerberg who employed young Swedish couples until they could purchase land in the area. Frank farmed while Anna served as housekeeper and hostess in Wennerberg's home for business and social entertainment. Wennerberg instructed Frank and Anna to save their salary for land and farm equipment. When they were ready they were to purchase their own land in the valley. Wennerberg employed a series of Swedish couples over a period of years for these purposes. Frank and Anna bought their first 100 acres in 1885 and were able to pay it off in less than four years. They raised hops as their first cash crop.

Apparently land in the valley changed hands regularly from settlement time on. Frank and Anna went on to purchase additional farms and at one point held over 600 acres. Area farms of the late-19th century were often over 200 or even 300 acres. This surprisingly large size was mostly dedicated to woodlots, however, with some field cropping and pasture for cattle, sheep, hogs, and horses. The historic prairie was well-suited to growing wheat and for pasture.

The Past Century

From 1900 to 1910, the dairy industry gradually expanded in the area. Yamhill and Polk County dairies used primarily Jersey & Guernsey cows because there were a couple of breeders in the area, according to Gordon Jernstedt. The Tillamook and Portland area dairies were primarily Holstein, by contrast. Every farm had at least a few cows. They could sell the milk to the local "creamery." There were milk trucks that had regular routes and would stop and pick up milk cans on a daily basis. If they did not produce milk for the creamery, they usually kept one cow for the families milk. Dairymen could make a modest living on only 20 or 30 cows. The increase in dairy cattle increased the production of clover, grasses, and hay. By 1909 clover production showed an increase of nearly 500% and acres of grain cut green for hay had increased by 600%. Fruit and nut production started around the turn of the century as well and contributed significantly to the agricultural economy by 1909. Production of hogs, sheep, goats, and poultry continued to make large contributions to the agricultural economy.

After 1919 wheat production decreased while dairy and prune production increased. By 1925 there were 2,864 farms in Yamhill County with an average size of 83.56 acres per farm. The twenty-five year period between 1925-1950 witnessed a drop in the fruit tree production of apples and pears while filbert production increased.

Commercial production of berries came into play following World War I. Loganberries, strawberries, raspberries, blackberries, and gooseberries comprised the initial mix with strawberries being dominant. "Franquette" walnuts also became an important part of the local farm economy.

During the 1930s the federal government encouraged the then innovative use of cover crops during the winter to help retain soil. Grass seed crops became important between 1935 and 1939 and the acreage for lawn grass seed continued to increase to its present-day levels.

Mr. Jernstedt recalls that forests in the valley in his lifetime have been relatively young stands that have been cleared periodically. He feels that trees in the valley generally aren't very old. This is consistent with what we know about prehistoric management that favored prairie and savanna. There have been mature forests in places, though, in Gordon's estimation. For instance there are now fields of barley and clover on his family's land that were covered with "old growth" firs 6-8' wide during his childhood. Gordon is quick to add that on another area of the farm he has recently had conifers and oaks planted on five acres.

Gordon has made a study of agriculture in the area throughout his life. He grew up farming and earned his M.S. in Agricultural Economics at OSU. When he was young the farmers in his area were primarily orchardists but they also raised a variety of animals and field crops. Their field crops were primarily wheat, Austrian winter field peas, and red clover—which went out in 1935 due to blind seed disease. To harvest the clover they used a wooden, pully driven, steam powered clover huller. During the 1930s legumes were taken over by Oklahoma and other southern states due to their compatibility with cotton as a green manure. Red clover came back as a profitable crop in the 1950s. At this time they also grew malting barley which paid a premium of $5 over the regular price, or $47/ton instead of $42. To get the premium, however, the farmers needed some rain in late June or early July and then no rain until threshing.

Gordon witnessed firsthand the boom and bust pattern that has plagued farmers throughout the country over the past century. For example, in the summer of 1929 prune prices spiked. His father sold in September for a large profit; he was then able to buy a 15' combine, a Caterpillar 22, and a John Deere Model D all from that one crop. In addition, he still had enough left over to pay his farm workers through the 1934 season—all on the 1929 prune income. Finances on the farm have probably not been that good since then. The 1930s brought falling prices, market collapse, and many foreclosures on area farms. World War II improved the farm economy somewhat. Yamhill County ranked first in Oregon in production of prunes and walnuts and was also strong in cherries, filberts, forage seeds, vegetables, flax, turkeys, and chickens.

Then in the 1950s agriculture prices took a nosedive in general. Farmers increasingly moved from mixed, small-scale operations to specializing in a few revolving cash crops. Hairy Vetch and field peas held on longer than alfalfa as a viable crop in our area. There's still some common vetch being grown in the valley. Farmers turned to wheat and grew all the government would allow—it was one of the few profitable choices. These were still relatively small, mixed farms, though, by the standards of today. The Jernstedt's "upper farm," for instance, was still a mixed orchard of apples, cherries, and prunes and most farms still had several types of animals that served a variety of purposes.

In the late 50s an agriculture depression set in due to production surpluses—in spite of large foreign-aid programs aimed at feeding the war-torn nations of the world. This was just one step in the increasing financial insecurity experienced by farmers nationwide and here in Yamhill County. At the time, common knowledge held that a farmer in 1900 needed only one good year in nine to remain solvent—they could then weather three bad and five or six so-so years on that one good year's income. By 1950, though, farmers needed one good year in three due to being more mechanized and carrying debt.

When asked what else has changed about making a living on farm income, Gordon says that now we have many more expenses for consumer goods and luxuries in addition to increasingly expensive farm equipment. He added that farming is less physically difficult but more difficult in terms of financial management. One oft-cited result is the loss of family farms to consolidated corporate operations. Between Gordon's childhood school bus stop ("over by those tall firs") and Carlton there were 10 farms. In the same area now there are only three. The whole farm structure has changed, he says. Those three farms are much larger and spread out on rented land. There's also a lot of residential, non-farm land use mixed in.

Gordon's sister Carolyn sees the main differences from when they grew up as there are no longer many sheep and goats being raised in the valley. She also reports that gardens are smaller and that there is little homegrown meat these days.

Palmer Creek area farmer Sam Sweeney agrees. Family farms in earlier times were much more diversified and self sufficient than they are today according to Sam. They had to be, he says, because a good farm economy was never guaranteed. "For family consumption," he says, "most farms kept chickens for the eggs and even hogs for bacon." Sam also confirms that livestock was a big part of the area's farm economy in the past. Sheep were valued for meat and wool and there were also horses for powering farm work. Sam's family kept a team of horses as late as the 1940s.

According to a 1947 Department of the Interior report the forests of Yamhill County 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 had classed 51 % of the county as forestland, 48% agricultural, and 1% as waste. Nearly half of the forestland contained immature conifers in '47 while only one-fifth represented saw-timber; the rest was cut over or deforested by fire. Saw timber volume totaled 1.4 billion board feet that year, nearly all in Douglas fir.

The area's larger rivers still provided transportation for something other than our wastewater. Logs were still commonly floated to mills on the Yamhill and Willamette Rivers. From McMinnville to the mouth of the Yamhill a minimum channel depth of 4 feet and width of 60 feet at low water were maintained by the government. On the Willamette the minimum channel depth was 3.5 feet. The Willamette River Project of the U.S. Army Engineers aimed for a channel width of 150 feet and a minimum depth of 6 feet from Salem to Portland.

McMinnville's municipal water system was already drawing its water from Haskins Creek. It owned the 4,000 acre watershed which, according to engineers' surveys, could supply a town of 15,000 to 18,000 people—about five or six times the population at that time but already about half of today's burden. Developed storage capacity was 120 million gallons. A 4 million-gallon waterline was built to the city reservoir in 1946 to meet growing demands.

McMinnville still dumped sewage into the Yamhill River until 1951 when it built its first wastewater treatment plant. By 1971 it needed to be expanded. The new Water Reclamation Facility replaced the outdated system in 1996. Lafayette began treating its sewage in 1964. Dayton built its first treatment system in 1965 and expanded it in 1980.

According to Palmer Creek area resident Sam Sweeney, Yamhill County garbage disposal methods of the past left a lot to be desired. Sam recalls that "city dumps" were often located on the banks of rivers and creeks. McMinnville had one off of Norton Lane on the banks of the Yamhill, (behind the current location of Tanger Outlet Center). The dump was there as long as Sam can remember:

> Later they closed it and moved it up on the west side of town on a hill off of Baker Creek road. This one had a continual fire in it that smoldered and gave off a horrible smelling smoke. At the bottom of the dump was a small stream that entered into Baker Creek. One can only speculate as to what this dump may be contributing to water quality in Baker Creek.
>
> Dayton also had one. This one too, was located on the banks of the Yamhill river just off of Wallace road on Neck Road. And, probably like all of them, had a large population of rats.

By 1962 Yamhill County's municipal water supply systems served 7,270 homes (23,371 people) with 1,226,000,000 gallons of water. Half of the consumption occurred during the three summer months and the water utilities were already reporting shortages

Irrigation was becoming more common. In the 1940s alone, irrigated acreage had doubled reaching over 6,000 acres countywide. The bulk of the irrigated land in 1946 was on Grand Island. At least 95% was irrigated by sprinkler systems. Estimates of land that could be brought under irrigation ran as high as 67,000 acres (National Resources Planning Board). These new acres would come mainly from areas south and east of the Yamhill River. Water for irrigation would be obtained by pumping from the Yamhill or Willamette Rivers and from creeks. Experience with sprinkler irrigation indicated that it was the method of choice for the topography, soil, and climate of this area. Portable systems made it possible to irrigate a particular crop without building a system to furnish water for an entire farm.

Another issue was farmland being flooded. The land could not be intensively cultivated, everyone agreed, until drained and protected from inundation. Government agents recommended drainage systems be installed on 28,000 acres or nearly half the total recommended for irrigation.

At the same time a "considerable proportion" of area farmland was suffering "seriously from erosion." Cultivation in orchards and on steep land more suitable for pasture was believed to be the main reason. Contour plowing, cover cropping, and switching from annual to perennial grasses and legumes were still new ideas being promoted by the Soil Conservation Service and county agents.

The 1947 report touts tourism as an important and growing part of the economy and quality of life for the region. In addition to providing services for travelers heading to the coast, Yamhill County itself held tourist attractions such as excellent mountain fishing streams and camp sites.

Modern Times

Fifteen years later, the lumber and wood products industries in the county had declined further, agriculture was still losing jobs, and Yamhill County had just come through one of its toughest decades in memory. In March, 1962, the County Court sat for the transaction of county business and set out to do something about it.

> "IT APPEARING TO THE COURT and the Court finding that the Area Redevelopment Act was signed into law by President Kennedy on May 1, 1961: that the said Act was for the purpose of giving aid to areas suffering substantial and persistent unemployment and underemployment; That a county group had

> made application for said aid and that the county Court, under this Act, are required to appoint a committee for the purpose of administration."

This committee was made up of one man from each town as well as three agriculture men and one representing labor. Together they identified the main factors contributing to economic decline in the county: "Several years ago employment in the logging and lumber industry declined quite markedly. Employment on the farms was gradually declining and several processing plants for poultry and other farm products left the area." They also agreed that as a subsidiary of the U.S. Area Redevelopment Administration, they were "to promote and develop industrial and economic interests for the county."

Throughout the rest of the year the committee developed an overall economic plan for the county. They found there did "not appear to be any catastrophic problems confronting the area. Housekeeping type of problems do exist. Better roads, improved transportation, sewer systems, pollution abatement and the elimination of flood damage and erosion along the streams."

In terms of tourism and recreational facilities, the committee wanted to see development of additional facilities at existing parks. They also wanted to acquire additional public land for access to streams, historical sites, an historical museum, convention facilities, and other possible development for water-related recreation.

For public health, education, and welfare, the committee called for a survey of the methods necessary to eliminate pollution from the county's rivers and streams. They wanted to study the feasibility of increasing the minimum flows in streams to abate pollution, enhance fish and wildlife, and create opportunities for recreation. Following the thinking of the time, they advised clearing streams of debris to improve stream channels—we've since rejected this line of thinking in favor of the exact opposite: putting woody debris into streams. Rip-rapping and revetment work was also needed along streams, they said, to protect against flooding and erosion—again, the best information we have today is that this should be avoided whenever possible. Finally, they called for planning for the highest use of the available water to meet "all local needs."

By the beginning of 1963, just before submitting their report, the committee agreed to place more stress and importance on water resource development. They wanted storage of water for irrigation and flood control. Of course they also felt drainage practices should be continued and encouraged, which they were. But their support for building reservoirs was emphatic:

> One thing the committee wishes, however, to emphasize and place in the very highest priority, is the conservation and development of the water resources of the area. Conservation in this instance being used and intended to mean wise use of these resources. Yamhill County has an abundance of water both in quantity and quality and it is adjudged adequate for all foreseeable needs of the area. The problem which confronts the area is not new. It is the old story of too much when it is not needed and not enough when needed. Storage is the answer and we have adequate storage sites. In the years ahead there will be great competition among users for the available sites and water. All of these users are important to the economic well being of the area. Municipal, industrial, agricultural and recreational needs must be met if the area is to develop a sound economy.
>
> Agriculture does have a large and important impact on the economy of the area and it will continue to be one of the dominant factors in any development of Yamhill County and it would appear that here lies the real opportunity for the creation of jobs…This change

> in our agricultural crops will afford the opportunity to attract freezing and processing plants to the area as well as new service organizations and suppliers…All of these activities make for more jobs both on farm and off farm. How many, depends on how fast and how extensive the development. The committee feels that it could not at this time make an estimate but it does feel that it would be very large and very substantial in it's impact on the area.

In 1964 McMinnville developed a Comprehensive Plan that addressed many familiar issues. The Plan reported that agricultural employment dropped from 26.5% of county workforce (3,180) to 16.5% (1,861) during the decade 1950 – 1960. Similarly, lumber and wood products manufacturing saw a decrease from 15.5% (1,861) to 10.3% (1,157) of county jobs through the fifties.[4] "The future in both these categories seems to indicate a continuation of these declines," the authors wrote. They projected that mechanization and technology would further reduce farm employment in coming years. Unlike their predecessors, though, they felt that increases in productive land through irrigation "may slow the trend, but the greatest impact of such projects would be felt in an increase in farm output and food processing activities rather than employment." History has confirmed this.

In the decade prior to 1964, the value of farm products increased despite a steady loss of farmland. As the number of farms decreased by 16.9% (417 farms) during that time the average size increased from 110.2 ac. to 124 ac., a 12.5% increase. "Commercial" farms averaged 213.7 acres while noncommercial ones averaged 30.9 acres during the same period.

The 1960s: Planning for the Future

Interest in improving the quality of life in Yamhill County mounted through the following years. In contrast to the problems of the past decades, things were looking up in 1964. The economy of the county seemed healthy finally and was growing after a lengthy period of recession. Likewise, after a population decline of 3% during the fifties, the county appeared to have more than recovered the losses over the past few years and was headed for further growth.

From 1954 to 1964 the value of vegetable sales increased by 108%. Field crops were still more important with 23.6% of total agricultural sales. During the same time "automobiles and better roads, which allow local citizens to shop in Portland and Salem" caused a decrease from 96.6% down to 91.1% of total personal income being spent locally.

Once the necessities of employment and food on the table were taken care of, the county could turn its attention to planning for higher quality of life. "[A] large park is suggested along the South Yamhill River northeast of Three-Mile Lane," planners wrote, "to take advantage of available river frontage and to provide a large permanent open space." The proposed park would be connected to City Park by a reservation along Cozine Creek. The network of public land would form a green space through the city. Like many public land holdings, this one would serve multiple purposes by avoiding development in a low-lying area that is subject to seasonal flooding. It was even feasible to develop a small lake in the area, planners suggested, to be used

[4] Put another way, in 1940, agriculture accounted for 33.8% of total county employment. In 1950, 42% of county employment was made up by agriculture, timber, and wood products. By 1960 these jobs had declined to 27% of the total and were declining further.

for fishing and possibly motorless boating. This proposal, or any additional parks for that matter, have yet to be realized.

"Several boat landings are in operation as at Dayton," officials wrote. Other recreational opportunities were rare, though. Several ponds were stocked with fish and public fishing was allowed. One fish hatchery had recently began operation. Several private holdings were leased for duck hunting. A few stretches of river were reserved for youth fishing. County leaders found optimism in the increasing numbers of small county rest areas and parks along roads adjacent to streams. Unfortunately, hiking and horse riding trails were "scarce and only locally known" and there were remarkably few swimming holes available due to pollution and withdrawals from the streams. Even today, these amenities elude the residents of Yamhill County.

Doubtless, officials had an eye to developing a tourist trade in the growing outdoor recreation industry that remains underdeveloped in Yamhill County. Historically the county has not emphasized establishing parkland. In 1966 we 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.

The county has not created any additional parks, though the existing park acreage has increased to over 81 acres. The budget has increased to an estimated $110,000 annually through a complicated arrangement where the parks department is tacked on to the county corrections department. Ron Huber wears several hats as a corrections officer and the county park supervisor. He explains that the park system is like an "orphan" and could not be sustained without the maintenance labor of inmates and the managerial efforts of corrections employees like himself. Huber reports that the parks receive $68,000 from the county general fund and additional funding comes from building permits (~$1k), the state Marine Board (~$7k), and most significantly from an Oregon State Parks fund (~$35-40k) on an annual basis. Yamhill County's share of this fund is based on the number of R.V.s registered in the county and the number of public campsites available in the county. Other counties in western Oregon benefit from having campsites so much so that several counties 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. By contrast, Yamhill County has zero camp sites.

References

Bruce Bilodeau, City of Dayton, personal communication, January, 2001.

Jacob Calvin Cooper, *Military History of Yamhill County*, McMinnville, Oregon, 1899.

Carol Colver, *The Economic Base for Power Markets in Yamhill County, Oregon*, US Dept. of the Interior, Bonneville Power Administration, May 1947.

City of McMinnville Water Reclamation Facility brochure.

Comprehensive Plan: McMinnville Urban Area, Yamhill County, Oregon, June 1964.

Jerome J. Dasso, *Economic and Population Analysis, Yamhill County, Oregon*, Bureau of Municipal Research and Service, University of Oregon, 1967.

Flood Hazard Analyses: Cozine Creek and Tributaries, City of McMinnville, Yamhill County, Oregon prepared by: Department of Agriculture, Soil Conservation Service, Portland, Oregon in cooperation with City of McMinnville, Yamhill Soil and Water Conservation District, Yamhill County, State Water Resources Department, May 1978.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Ron Huber, Yamhill County Parks Supervisor, personal communication, January, 2001.
Gordon Jernstedt, personal communication, October, 2000.
June Olson, Confederated Tribes of Grand Ronde, unpublished transcript “Cultural Resource Comments,” August 9, 1999.
Provisional Overall Economic Development Program for Yamhill County, Oregon, March 21, 1962
David Stepp, *Descriptive Analysis of Human Remains from the Fuller and Fanning Mounds, Yamhill River, Willamette Valley, Oregon*, M.A. Thesis in interdisciplinary studies.
Sam Sweeney, personal communication, January, 2001.
The Sun, February, 25, 1998.
“Yamhill River Flood Plain Information,” Yamhill Soil and Water Conservation District, January 1976.

CHAPTER THREE

Vegetation

This chapter gives an overview of current and historic vegetation patterns, including wetland and riparian vegetation conditions, sensitive and threatened species, and exotic plant species.

Map 4 shows the current vegetation of the watershed. The basis for this map is a 1998 study of the vegetation of the entire Willamette Valley conducted by the ODFW Ecological Analysis Center and the Northwest Region Habitat Program (NWHI). NWHI mapped 90% of the landscape through field surveys and the remaining ten percent using aerial photos. They estimate their accuracy for Yamhill county at 83% and for Polk County, 85%. Some uncertainty is due to the difficulty in differentiating between annual and perennial grasses—large fields of lawn regardless—but significant due to the loss of soil accompanying annual cultivation.

Like all maps, this one represents a moment in time and any changes in land use since the late 1990s is not reflected here. For our purposes there has been little change in the vegetation pattern in the watershed since the survey. Approximately 50,000 acres or 79% of the watershed is non-forested—lands under cultivation or development. On the forested land, conifers make up 30% of the mixed forest while hardwoods comprise 70%. Other analyses frame the Yamhill County proportion of hardwoods at about 20% of the total land coverage compared to the regional (northwest Oregon) average of only 7% hardwood coverage.

Basic Vegetation Patterns

There are four main types of habitat in the Willamette Valley[5]—riparian forest, prairie (wet and dry), woodlands, and oak savanna. These habitats evolved with natural and human-caused fire and likely are evolving in response to fire suppression over the last century.

Map 3 shows the approximate vegetation of the watershed prior to Euro-American settlement. The Nature Conservancy compiled the information for this map by researching the descriptions written by surveyors for the Government Land Office in the mid 1800s. At that time surveyors were establishing section lines and took notes on the landscape and vegetation they encountered as they crisscrossed the valley. Although their botanical knowledge was imperfect and their note taking was not standardized, their descriptions provide us with a good sense of the general historic patterns of vegetation in our area of interest. Table 6. provides a sense of the information available in the Nature Conservancy database of the surveyor's notes. Descriptions from the database that were similar or seemed to overlap were combined for the map. Map categories that do not appear in Table 6 (Upland Prairie, Xeric; Brush, and Water) come directly from the database.

[5] The Willamette Valley is a distinct "ecoregion" according to current thinking in the biological sciences. There are nine such regions in Oregon. They're 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 of the Lower Yamhill c. 1850

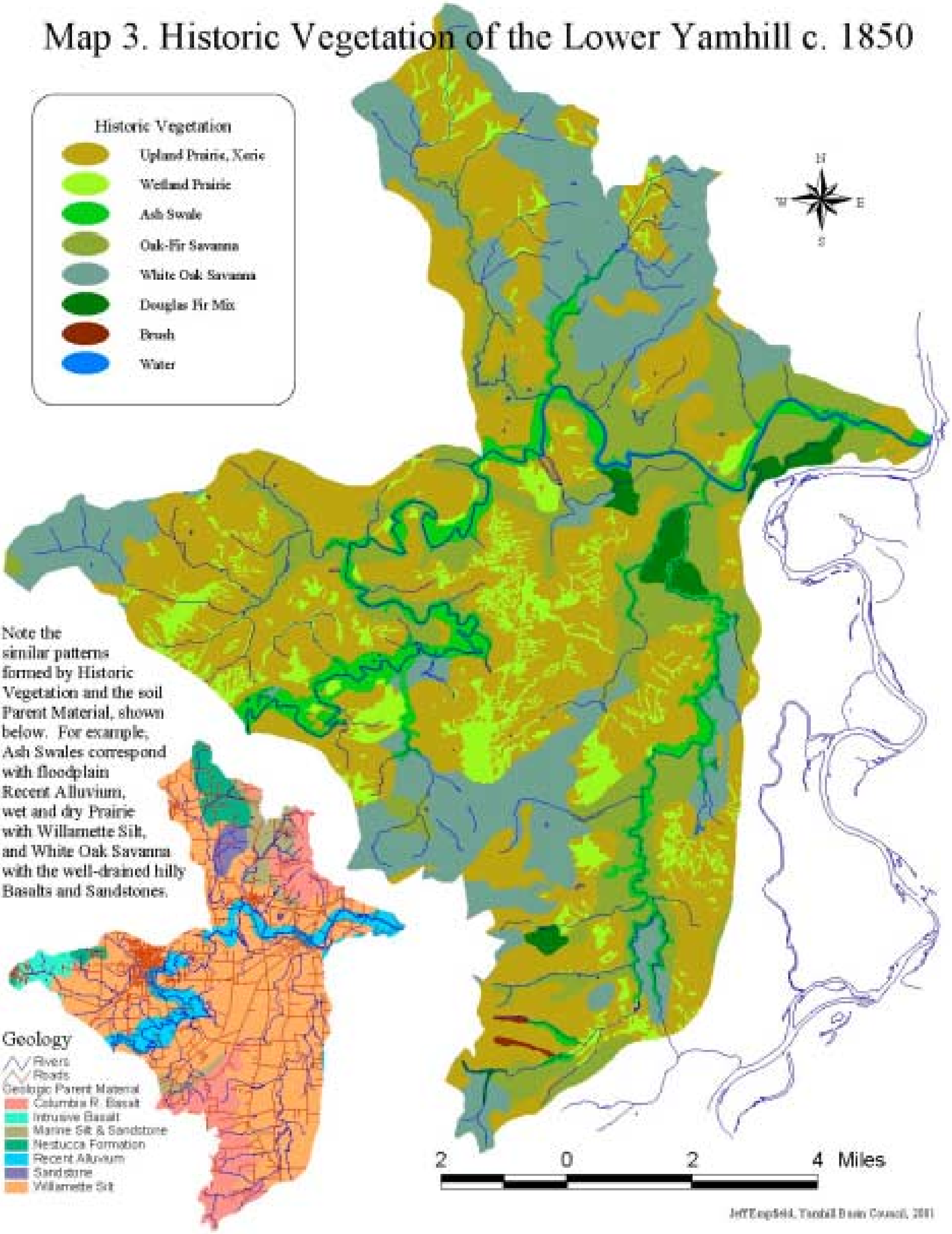


Table 6. Simplified Categories for Historic Vegetation Map of the Lower Yamhill c.1850

Mapped Category	Nature Conservancy Database Categories Combined in Mapped Category
Wetland Prairie	• Seasonally wet prairie. • Emergent wetland.
Ash Swale	• 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.
Oak-Fir Savanna	• Scattering or thinly timbered Douglas fir-white oak woodland. • White oak-Douglas fir savanna, mostly herbaceous undergrowth.
White Oak Savanna	• “Scattering” or “thinly timbered” white oak woodland, brushy. • White oak forest, oak brush, or oak and hazel brush. • White oak savanna.
Douglas Fir Mix	• Douglas fir forest, often with bigleaf maple, grand fir. • Douglas fir woodland or “timber” often with bigleaf maple, alder.

The current and historic vegetation maps are even more informative when compared with one another. It’s interesting to locate an area with which you’re familiar and then figure out if the current map is accurate and what vegetation was likely there a hundred and fifty years ago. The more inquisitive reader will 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 current vegetation map is more detailed because it’s based on a more recent and thorough study aimed specifically at identifying vegetation cover. Consequently it can be viewed as more accurate for indicating conditions on specific plots of land. The historic vegetation map serves as a valuable reconstruction of prehistoric conditions but is less reliable for specific locations. The greatest contribution of the interpretation of historic conditions is having a benchmark for the scale of change resulting from modern land management. “Wet prairie,” for example, is nearly non-existent in the watershed now. Much of the valley’s wetlands are now cultivated land and have been tiled, ditched, and drained over the past century. Conversely, the amount of forested land has increased. The lack of fire has allowed Douglas-fir, especially to expand its range. Compare these maps with Map 10 of the acreage under irrigation.

Riparian Forests

In the past, rivers and streams 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 very fire sensitive it would not have been common. Regular burning by natural and human-set fires would have effected 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 river’s floodplain and transitioned into wet prairies which were more open.

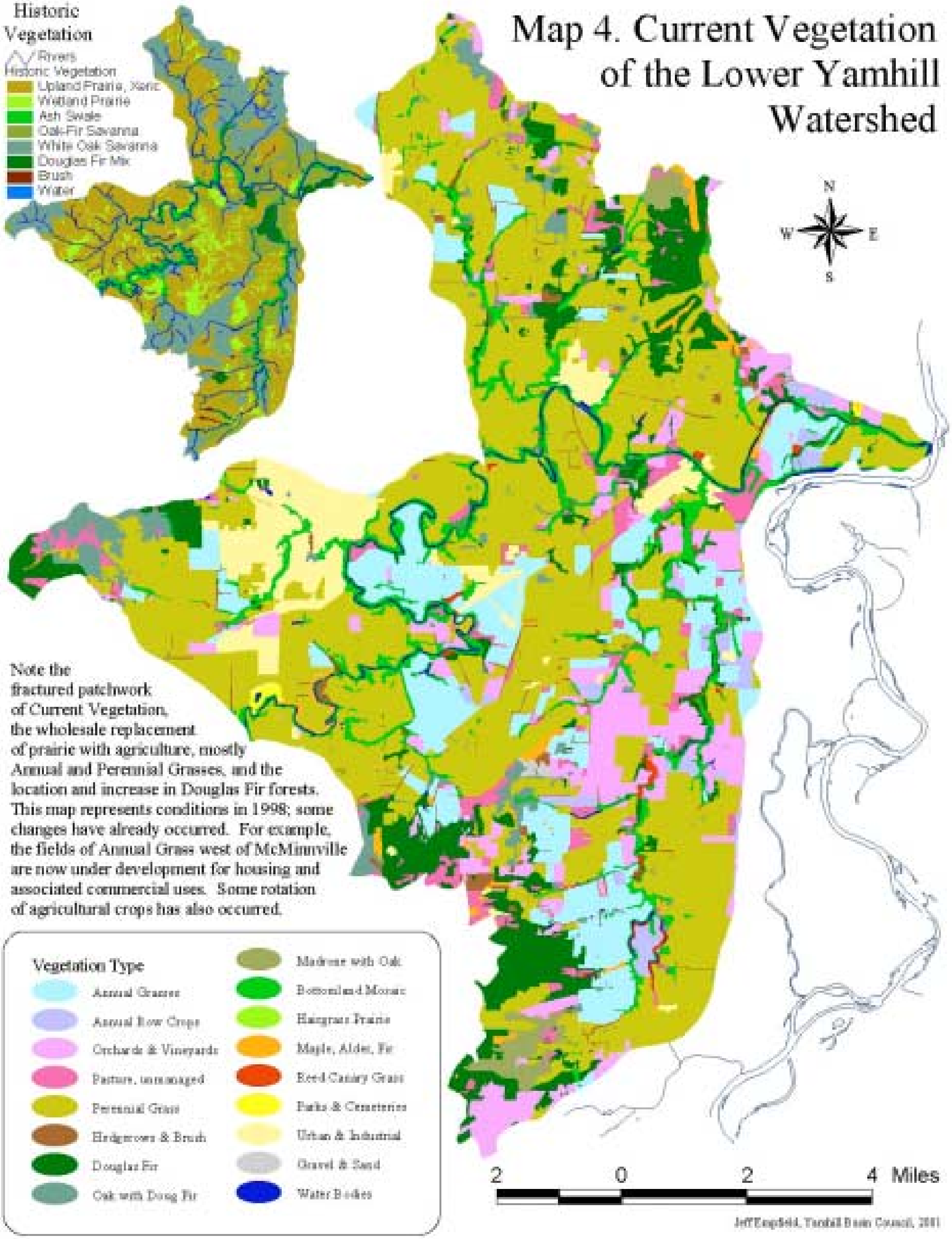

Map 4. Current Vegetation of the Lower Yamhill Watershed
Historic Vegetation
Rivers
Historic Vegetation
Upland Prairie, Xeric
Wetland Prairie
Ash Swale
Oak-Fir Savanna
White Oak Savanna
Douglas Fir Mix
Brush
Water
N
W
E
S
Note the fractured patchwork of Current Vegetation, the wholesale replacement of prairie with agriculture, mostly Annual and Perennial Grasses, and the location and increase in Douglas Fir forests. This map represents conditions in 1998; some changes have already occurred. For example, the fields of Annual Grass west of McMinnville are now under development for housing and associated commercial uses. Some rotation of agricultural crops has also occurred.
Vegetation Type
Annual Grasses
Annual Row Crops
Orchards & Vineyards
Pasture, unmanaged
Perennial Grass
Hedgerows & Brush
Douglas Fir
Oak with Doug Fir
Madrone with Oak
Bottomland Mosaic
Hairgrass Prairie
Maple, Alder, Fir
Reed Canary Grass
Parks & Cemeteries
Urban & Industrial
Gravel & Sand
Water Bodies
2
0
2
4 Miles
Jeff Empfield, Yamhill Basin Council, 2001

Table 7. Current Vegetation and Land Use in the Lower Yamhill Watershed

Vegetation/Land use	Acres	Percent of Watershed	Explanation of vegetation and land use classes
Row crops	1,016	1.6%	Farmland could be vegetables or herbs.
Annual grass	7,315	11.4%	Farmland for production of wheat, oats, barley, and rye. Generally, without irrigation.
Perennial grass	28,882	45.2%	Farmland for production of perennial grass especially grass seed and hay. Also without irrigation.
Orchards, berry farms, nurseries	5,386	8.3%	Farmland used for fruit trees, berries, Christmas trees, and nursery stock usually requiring a high volume of water for irrigation.
Unmanaged pasture	2,330	3.6%	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.
Parks, cemeteries	93	0.1%	Too small to be seen on this map.
Urban & industrial zones	3,582	5.5%	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	587	0.9%	Only areas of water that have enough surface area to be seen at this scale are shown on the map.
Black hawthorn, riparian, hedgerows	886	1.4%	Many of these areas are too small to be seen clearly on the map at this scale.
Cottonwood riparian	152	0.2%	Located along waterways. These areas are too thin to be seen on the map at this scale.
Willow riparian	26	0.04%	Expect willow along most waterways. These areas are too small to be seen on the map at this scale.
Reed canarygrass	257	0.4%	Promoted as a forage grass, it now overwhelms many wetlands and riparian areas as an unwanted invasive. Native but altered through breeding.
Hairgrass prairie	22	0.03%	This is remnant native prairie.
Ash, cottonwood, maple bottomland	3,906	6.0%	This habitat is usually a seasonal wetland, bordering streams.
Oak mostly w/ Douglas-fir	1,881	3.0%	Usually very diverse habitat with many species of forbs and grasses in the understory.
Douglas-fir mostly w/ oak	2,299	3.5%	Mixed forest with diverse habitat but with less understory foliage and diversity.
Oak, madrone	738	1.2%	Not possible to see this easily at this scale.
Maple, alder, fir Hardwoods dominant	656	1.03%	Along streams typically in response to logging or fire where conifers weren't actively planted.
Douglas-fir	3,663	5.6%	In many areas in planted pure stands. Unharvested Christmas tree plantings likely got this classification too.
Gravel bars or sand	65	0.1%	Shows areas where there is commercial gravel and sand operations.
Forest/urban interface	3	0.005%	Highly variable.
Total	63,748	100%	

Today, the bottomland areas of the watershed produce some large woody debris in areas that have sufficient riparian vegetation. These areas have been intensively managed for agriculture for a long time. Due to the economic pressures of agriculture, forested parts of the bottomland typically are narrow strips along stream banks and increasingly rare hedgerows. In many areas, non-native blackberry dominates streambanks and field/forest edge, exasperating 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 sometimes 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 in, new channels typically form carrying the current around the obstructing dam. This also leads to 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 dissipated floodwaters over the adjacent floodplain. Sediments then have time to settle out and accumulated on these floodplains. Their seasonal inundation also serves to recharge groundwater levels that are the main source for summer flows. These conditions are prevented in much of the watershed due to downcutting, straightening, and dyke building.

Historically in the hilly regions of the watershed, the riparian tree species were alder, maple, and Douglas-fir. This is contrasted with the bottomland riparian forests of Oregon ash, black cottonwood, Douglas fir, and bigleaf maple. Steeper stream gradient and less frequent fires characterized the hilly areas where mixed-forest riparian corridors have been logged or cleared for agriculture and 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 for much-needed cooling of the water in streams as well as large woody debris for slowing the flow and increasing complexity of the stream. Unfortunately, these forests are absent from large portions of the watershed and the trees that do line the riparian corridors are often too small for creating adequate complexity in the 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 valley floor in prehistoric times. Approximately one third of the prairie was described as “wet prairie” in surveyors’ notes. The tall perennial grass species tufted hairgrass (*Deschampsia cespitosa)* serves as an example of a native prairie species because it is well adapted to both periodic fires and hydric soils—soils that were inundated for a significant part of the year. It was an important source of forage for animals. Today it remains only in isolated remnants of prairie and where it has been reintroduced in restoration projects. There are only about 22 acres of tufted hairgrass in the Lower Yamhill watershed, less than a tenth of the area covered by invasive Reed canarygrass.

Numerous species in the lily family had co-evolved in the valley with the Native Americans who cultivated them in semi-wild settings for centuries. In addition to benefiting from periodic weeding and selection, they were 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 which many native cultures throughout the West dug and stored as a staple of their diet.

The dominant grass of the valley's native dry prairies is red fescue (*Festuca rubra rommerii*). In both the wet prairies and the dry prairies, shrubs and small trees such as hazel, serviceberry, and cascara were present. Again, they seem well-adapted to burning which consumes their woody, above-ground structure encouraging a burst of sprouts the following spring. This re-sprouting, we currently believe, was a major source of the native people's fiber material for making such things as clothing, shelter, and baskets.

The Kalapuya burned prairies throughout the valley and into the foothills of the Coast Range to elevations of 1000 feet. 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*.)

Conifer Forest

In prehistoric times, there was relatively little conifer forest in the Lower Yamhill watershed. Interestingly, the conifers that were here were in pure bottomland stands and intermixed with broadleaf trees along rivers and streams. Today, conifers are still found in riparian areas but they have also spread into some of the hilly areas of the watershed where they're found intermixed with deciduous trees and in small pure stands. Conifers, mostly Douglas fir, account for about 10 percent of the vegetation cover of the Lower Yamhill watershed.

Though logging is more important in other parts of the basin, tree harvests also occur in the Lower Yamhill. 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, though, because of the closed canopy of larger conifers and the high density of young trees established after cutting or disturbance.

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

Gaps in the canopy provide light and moisture for understory species such as shrubs, hardwoods, and herbaceous ground cover. Dead snags 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 many of the watershed's conifers are found.

Oak Forests and Oak Savanna

The Oregon white oak is found everywhere in the Willamette Valley (totaling about 1 million acres) and on drier soils throughout western Washington and Oregon in coastal mountains and halfway up the eastern slopes of the Cascade mountain range. It is slow-growing compared to other deciduous trees and thrives where conifers are limited by low soil moisture. Many forests of the Willamette Valley have both oak and Douglas fir-dominated forests forming a patchwork as well as intermixed in many areas. Pacific madrone, another dry-soil tree, often occurs in large stands within oak dominated forests. Western poison oak is also common in the understory. Yamhill County has a higher ratio of Oregon white oak than many surrounding areas. 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. 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 Oregon white oak as the dominant tree. Black cottonwood, red alder and Oregon ash are also sometimes present. Historically oak savanna was quite open with expanses of grass between trees. The canopy has closed in to create more of an oak woodland where management prevents fire from keeping young saplings in check.

Older, dead, or dying Oregon white oak trees provide more "cavity" habitat than any other type of vegetation in the area. Twenty-eight bird species including white-breasted nuthatch and black-capped chickadee seek out these cavities along with small mammals that don't seem as well adapted to Douglas-fir-dominated woods.

A newly discovered oak disease ("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 two-tailed fungus with an appetite for oak bark is probably to blame for the death of thousands of black and tanoak trees in coastal California.

Rizzo's investigation showed that the culprit is a novel fungus related to the organisms that caused the Irish potato famine of 1845-50 and the modern deaths of Port Orford cedar trees in Northern California and southern Oregon. Contrary to some Internet reports, the pathogen is not related to the oak wilt fungus (Ceratocystis fagacearum), an important 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.

If people aren't careful, he warns, the deadly microbe could spread to the nation's other oak forests. 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," he says. "In particular, firewood and soil should not be moved from [potentially infected] areas." Any wood already moved elsewhere should be burned.

Non-native Plants

Non-native species (also known as exotics) are species that have been introduced by humans from other regions or, in some cases, from the other side of the globe. Oftentimes exotics don't do well because they have evolved under different conditions and aren't adapted to the local climate. In other cases they do too well and become invasive—the native species did not evolve with the exotic and often have no adaptation to compete with them. There are now whole books documenting how agriculturists and land managers have relocated plants and animals around the world only to lose control of them causing unwanted and unforeseen consequences. It's interesting to note the basic definition of a weed is simply an unwanted or problematic species. Further, many of our weeds were intentionally cultivated and introduced before we had a very sophisticated understanding of the interconnected nature of nature. The tragic comedy of human folly is never better illustrated than by accounts of introductions gone awry only to be followed by additional introductions meant to correct the problem only to become problem "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 them once they are established, and usually requires intensive herbicide application to manage the population. Some species have bio-control methods available, but these are by far the minority. The BLM identifies Scotch broom (*Cytisus scoparius*) and tansy ragwort as two species of major concern. Scotch broom is listed due to its ability to over run land, and tansy ragwort is listed due to its toxicity to cattle.

Note that Reed canary grass (introduced for livestock forage) covers over 250 acres of the Lower Yamhill watershed—usually in already degraded and increasingly rare wetlands but also in the numerous small irrigation reservoirs. Local resident and farmer Sam Sweeney has an idea for how to increase beneficial shade on these reservoirs while at the same time suppressing Reed canary grass. His idea is to bring in an earth mover and deepen the reservoir in some areas while creating an island in the middle. On the island he would plant trees to shade the water while the deeper water would prevent Reed canary from completely dominating the reservoir, as it thrives in shallow standing water.

The Native Plant Society of Oregon listed 37 noxious invasive species in 1997. These species are either being cultivated by naïve gardeners, sold by local nurseries, or introduced through some other means. The Native Plant Society of Oregon can be contacted for further information on these species.

The current list of noxious weeds compiled by the Yamhill Soil and Water Conservation District includes two additions: Himalaya blackberry and Reed canarygrass. The complete 2000/2001 noxious weed list appears below. Noxious weeds typically invade disturbed areas and form monocultures making regeneration of native species nearly impossible without significant management efforts.

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.

Sensitive Species

The Federal or State government lists nine species native to our 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 for generations to come. Preserving biodiversity is significant for more specific reasons but these usually become apparent only after we understand what we've lost. With the loss of any species, whether it is plant, mammal, amphibian, or insect, a valuable piece of the ecosystem in which we live 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 at least for some species. Our role dominates the earth now, though, so it is simple enlightened self-interest to pay attention and to have meaningful discussions about the role we play in making sure Oregon's unique and diverse species survive.

The following lists give the names of the species that are in danger of disappearing from this watershed. Please consult one of the following organizations to learn more about any of these species listed here.

The Oregon Natural Heritage Program
821 SE 14th Avenue
Portland, OR 97124-2531
(503) 731-3070 ext. 335 or 338
http://ocelot.tnc.org/nhp/us/or/index.html#mission

Bureau of Land Management
Salem District Office
1717 Fabry Road S.E.
Salem, OR 97306

Table 9. Threatened, Endangered, or Sensitive Species of the Yamhill Basin.

Threatened species listed by ESA and state of Oregon	
Sidalcea nelsoniana	Nelson's sidalcea
Lupinus sulphureus ss Kincaidii	Kincaid's lupine
Candidate for protection under ESA	
Icaricia icarioides fenderi	Fender's blue butterfly
Species of concern listed by ESA	
Cimicifuga elata	Tall bugbane
Megascolides macelfreshi	Oregon giant earthworm
Myotis evotis	Long-eared bat
Rhyacotriton variegatus	Southern seep salamander
State of Oregon candidate for listing as endangered or threatened	
Delphinium oreganium	Willamette Valley larkspur
Sidalcea campestris	Meadow checker-mallow

Table 10. Special Status Species Possibly Native to the Yamhill Basin.

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

Table 11. Sensitive Species Possibly Native to the Yamhill Basin.

Agrostis howellii	Howell's Bentgrass
Castilleja levisecta	Golden paintbrush
Cimcifug elata	Tall bugbane
Delphinium leucophaeum	White rock larkspur
Delphinium pavenaceum	Peacock larkspur
Filipendula occidentalis	Queen-of-the-forest

References

Atlas of Oregon, University of Oregon Books, Eugene, 1976.

Peter Alden and Dennis Paulson, *National Audubon Society Field Guide to the Pacific Northwest,* Alfred A. Knopt, New York, 1998.

E. William Anderson, et. al., *The Ecological Provinces of Oregon: A Treatise on the Basic Ecological Geography of the State,* Oregon Agricultural Experiment Station, May 1998.

Robert Boyd, "Strategies of Indian Burning in the Willamette Valley," Canadian Journal of Anthropology, 1985.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment,* Yamhill Basin Council, September, 2000.

Northwest Habitat Institute website.

UC Davis Expert Identifies Oak-Tree Killer and Warns Public to Use Caution, UC Davis website.

Dan Upton, Willamette Industries, personal communication, January, 2001.

CHAPTER FOUR

Riparian Areas and Wetlands

Riparian Conditions

"Riparian" is from the Latin *ripa* meaning "stream bank." Riparian areas generally include the stream or river and the land next to it. For certain purposes we sometimes get more specific with our definition and say the riparian area includes everything within a certain distance of the water. This is somewhat arbitrary but serves some purposes. We can also base our definition on ecological conditions that indicate the effected area. By this more ecological definition, not only the stream and river banks 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 in the soil than the adjacent land. The elevated moisture level supports a more diverse and productive ecosystem.

Land managers often regard riparian areas as a buffer zone because the vegetation and soil functions as a filter and "buffers" the stream, hopefully, from pollutants picked up as rainfall flows over our roads, lawns, and fields.

The beneficial effects of riparian vegetation on aquatic life include cooling shade, balanced water chemistry, and nutrient assimilation and transformation from the surrounding soil. The absence of adequate vegetation results eventually in the depletion of aquatic nutrients. Large woody debris (LWD), which only a few decades ago we considered detrimental to stream health, is now recognized as integral to many functions essential to clean, cool water. For example, logs in the water will retain about half of the gravel and sediment present. This in turn helps to create flood terraces, meanders, larger riparian zones, a pool and waterfall pattern, and less powerful floods.

The Importance of Large Woody Debris

Throughout the Willamette Valley there is a general lack of log jams or "large woody debris" (LWD) in streams and rivers. Large trees that fall into streams are beneficial for a variety of reasons, not least of which because they're a natural source of in-channel habitat diversity. Land managers with a propensity for jargon refer to trees falling into streams as "LWD recruitment." Of course, trees need to be close enough to the stream so that when they die and fall down, they sometimes will land in the channel.

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 recruitment in order for the wood to remain in place during winter storms.

LWD across a stream or lodged in the stream bed slows down the water upstream of it and causes the sediment to settle, thus creating gravel beds, sand bars, and silt terraces. The downstream side will often develop a scour pool due to the temporarily higher velocity of the water moving over or under the LWD.

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

- Provides shade which aids the decrease of daily fluctuations in water temperature and provides fish cover from predation.

- Stabilizes the 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 recruitment to the stream system. Large wood is vital for fish habitat because it provides cover for fish, diverts channels and obstructs flows, which in turn increases channel and habitat complexity.

The map of the historical vegetation provides background on what the vegetation looked like prior to extensive European settlement. See Map 3. It shows that the pre-settlement vegetation bordering the waterways was very different from what exists today. This map is not a snapshot of the vegetation at that time, but rather an approximation of what the vegetation was like at the time of pioneer settlement.

Farmers' Historical Use of Creeks

According to area farmer Sam Sweeney, landowners historically depended on the creeks and riparian areas within the basin for several uses. Livestock grazing in the past was nearly always confined to the riparian areas, he explains. This was because farmers wanted to use the more level tillable acreage for grain and other cash crops. "Not wanting to waste tillable crop land," he says, farmers "would fence and keep their livestock in the riparian areas close to the creeks." Sam recalls this was a common practice throughout the basin in his youth. This made good sense, from the small, mixed-farm perspective. These areas not only provided pasture and shade, but also drinking 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. "I often wondered why the donation land claim was divided into different boundary configurations with each parcel having access to the creek," he says. When asked, the previous owner of the farm replied that the original donation land claim holder had given his daughters parcels of land and wanted them each to have access to the creek for their livestock.

This undoubtedly had an effect on the riparian vegetation. Sam provided the following account:

> From what I remember, the creek areas were free of underbrush in earlier years. Clayton Richards, an old timer who passed away about ten years ago, told me that when he was a teenager and going to Dayton High School he ran a trap line along the West fork of Palmer Creek. This would have been in the late teens or early twenties. He mentioned that the creek bottoms were so clear and brush-free that he could check his trap line on the way to school and never have a branch touch his face. This was a distance of several miles. This would largely be due to the livestock that kept the riparian areas grazed and free of brush.

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 Yamhill County is now kept primarily for recreation or for home use and fields previously reserved for cropping can now be used for pasture, he feels.

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. They were considered a “nest egg,” according to Sam, that landowners could use during hard times or to meet a particular need for lumber. This is still true today, he points out. Sam’s family logged a riparian woodlot recently and knows of six other landowners along Palmer Creek who have done likewise in recent years. It was also common after logging to clear any of this land that was level enough for tilling. A significant difference was that in the past, the forest would reseed itself. “The area did not have the blackberries,” Sam says, “that would take over and hold back the growth of the seedlings.” People rarely took an active role in replanting trees, he recalls, until the 1940s when foresters introduced the idea. Now most landowners want to replant, Sam feels, and are required to do so by the forest practices act.

Another common use of creeks in early times was for power and transportation. For example there was a flour grist mill on the East fork of Palmer Creek below the Palmer Creek bridge. 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 a small mill. Area resident Bob Dorsey faintly remembers the mill on Palmer Creek. It was dismantled in the 1930s and the mill owner’s descendants removed the stones using them for lawn decorations.

The East fork of Palmer Creek was also used for transporting logs in the winter months during high water. “There was an old sawmill on the East fork of Palmer Creek,” Sam recalls, “off of Stringtown road on a small farm that I lived on in my very early years.” By the time Sam lived there in the late 1930s, the only thing left was the millpond. 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 drug down to the creek bottoms with horses in the spring, summer, or fall. Then they would “raft them up,” wait for high water, and float them downstream to the mills.

Early settler and co-founder of Dayton Joel Palmer, built a big saw mill near the mouth of Palmer Creek sometime in the 1840s or 1850s. Initially they used water power for sawing logs. Later steam engines powered mills in the area before internal combustion engines became available. “From what I understand there were other small mills upstream,” Sam says, “they remained in operation until sometime in the early fifties.”

Methodology

The OWAM protocol for determining riparian conditions in our watershed includes estimating riparian zone width, vegetation types, and vegetation density, stream shading, and the continuity or interruption of the riparian zone from road crossings, streamside roads, and other land uses.

Black and white aerial photographs on the scale of 1:660 (one inch equals 660 feet) from the Farm Service Agency in McMinnville served as the primary source for making these estimates. Periodically the agency makes a new series of aerial photos covering the countryside. The most recent series for Yamhill County dates from 1994 and shows summer conditions. With summer vegetation seen in black and white from ten thousand feet it is sometimes difficult to differentiate vegetation types—between hardwoods and conifers, for example. Aerial photos taken in the winter, done most recently in 1980, show standing water (possible historic wetlands with hydric soils) and more clearly contrast evergreen and deciduous vegetation. Yamhill and Polk county soil surveys and U.S.G.S. topographical maps helped in locating landmarks and stream channels in the photos.

It was not possible to differentiate between the left and right banks for any stream other than the Yamhill River. Small streams are difficult to see on air photos—they are often dry, or nearly so during the summer, and at other times they're obscured by vegetation. Where the actual channel was not visible but apparent because of the narrow band of vegetation (its riparian zone), it was sufficient to make estimates using the middle of the band of vegetation. These figures can be seen in the Riparian Condition Units appendix. For wide stretches of the Yamhill River you'll find specific information for both the left and right bank. For all the rest you'll find one figure for each stretch of stream with a consistent pattern of vegetation.

The map indicates the length, width, and dominant vegetation type of various sections of streams in the watershed. The length of each of these sections can be estimated using a map wheel. We further measured and estimated the width of the riparian zone as either non-existent, 0-50 feet, or over 50 feet. The five dominant vegetation categories are brush, conifers, grass, hardwoods, and "mixed" which in our area is typically a hardwood savanna with either brush or grass interspersed with broadleaf trees. The "non-existent" category indicates stretches of waterway where not only is there no riparian vegetation to speak of, but in many cases the stream bed itself has been altered beyond recognition.

The 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 allow detailed ecological comparisons for each waterway. Rather, general conclusions about the historic conditions versus current conditions can be made.

The reaches represented on the map included here are approximations only and are not meant for use in determining precise locations for restoration or enhancement projects. More in-depth analysis of a specific area is recommended before proceeding with such projects. This map and information is meant to provide starting points or for identifying areas of concern, not to pinpoint specific locations. The mylar overlay kept by the Yamhill Basin Council has more accurate measurements. Please consult the YBC if you have specific questions. To contact the Council, call (503)472-6403.

Map Analysis

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 8% of the riparian areas surveyed are now non-existent due to industrial or agricultural development. By non-existent we mean they are shown on topographical maps but appear to no longer exist (at least under dry summer conditions) according to the photos.

Table 12. Riparian Condition Units for the Lower Yamhill Watershed

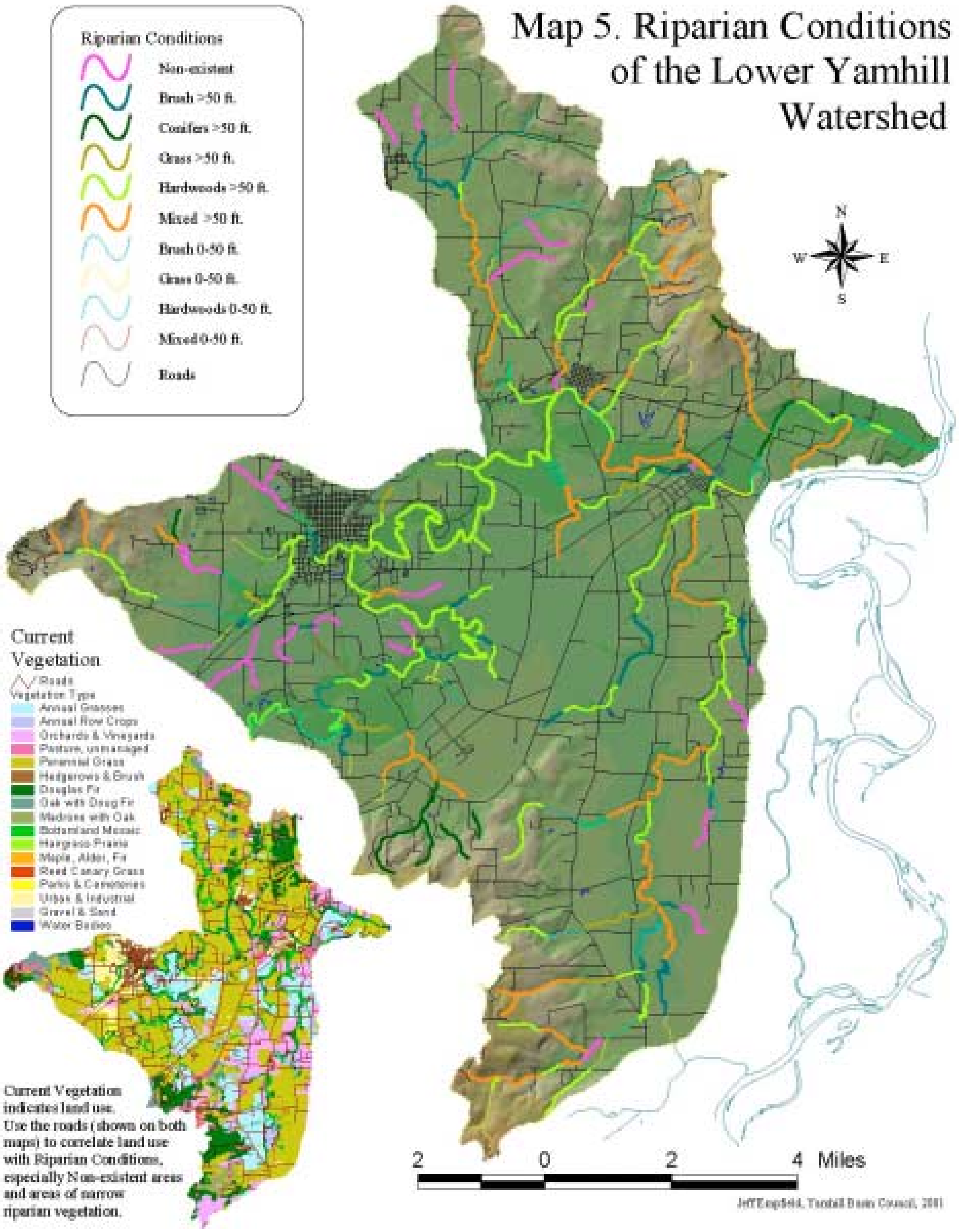
Riparian description	Length (miles)	Percent of total water edge miles*	Percent of in-stream total**
Non-existent	16.66	6.9%	8.46%
Brush, >50 ft.	13.11	5.43%	6.65%

Conifers, >50 ft.	6.53	2.7%	3.31%
Grass, >50 ft.	4.98	2.06%	2.53%
Hardwoods, >50 ft.	67.53	27.96%	34.28%
Mixed, >50 ft.	35.01	14.5%	17.77%
Brush, 0-50 ft.	11.64	4.82%	5.91%
Grass, 0-50 ft.	9.12	3.78%	4.63%
Hardwoods, 0-50 ft.	24.40	10.1%	12.38%
Mixed, 0-50 ft.	8.03	3.32%	4.08%
Off-stream ponds/reservoirs	44.51	18.43%	
Total	241.52	100%	100%

* Includes all streams, in-stream reservoirs, and off-stream reservoirs (not assessed) totaling 241.52 miles.
** Includes all streams and in-stream reservoirs totaling 197.01 miles. These numbers are more meaningful for assessing the riparian conditions of the watershed.

Ideally, the riparian area that contributes LWD should include some 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. The air photos also indicate that most streams receive some shade that helps to reduce water temperatures.

Map 5 shows the streams with different colors and line widths representing different riparian conditions. The hot pink segments indicate streams with little or no vegetation and altered stream characteristics. These are areas of concern. The map only provides approximate locations.


Map 5. Riparian Conditions of the Lower Yamhill Watershed
Riparian Conditions
Non-existent
Brush >50 ft.
Conifers >50 ft.
Grass >50 ft.
Hardwoods >50 ft.
Mixed >50 ft.
Brush 0-50 ft.
Grass 0-50 ft.
Hardwoods 0-50 ft.
Mixed 0-50 ft.
Roads
N
W
E
S
Current Vegetation
Roads
Vegetation Type
Annual Grasses
Annual Row Crops
Orchards & Vineyards
Pasture, unmanaged
Perennial Grass
Hedgerows & Brush
Douglas Fir
Oak with Doug Fir
Madrone with Oak
Bottomland Mosaic
Hairgrass Prairie
Maple, Alder, Fir
Reed Canary Grass
Parks & Cemeteries
Urban & Industrial
Gravel & Sand
Water Bodies
Current Vegetation indicates land use. Use the roads (shown on both maps) to correlate land use with Riparian Conditions, especially Non-existent areas and areas of narrow riparian vegetation.
2 0 2 4 Miles

Wetlands

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.

There are many different types of wetland, but they share three characteristics: water, saturated soil, and wetland plants.

1. An abundance of water from either high water table, rain water "perched" over impervious layers in the soil, frequent flooding, or groundwater seeps is necessary. However, there does not need to be visible water year round. This is the area of wetland determination that people find most difficult to understand. Water levels vary from year to year and season to season within a given year. That is why standing water is only one of three components that need to be examined.
2. Hydric soils that 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 associated with wetlands.
3. A plant community called hydrophytes, plants with special adaptations for life in permanently or seasonally saturated soils.

The most important thing to remember is that wetlands can be dry during the summer months and still be a wetland, though we may call it something else. 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 and other conditions are right to create wetlands.

To be considered a wetland for legal purposes, a piece of land must meet two of the three criteria. Agricultural areas are assessed on the basis of hydrologic conditions and soils since cultivation typically precludes wetland vegetation. The absence of wetland vegetation does make delineation more challenging, but if a piece of land meets the other two criteria, it can be reliably considered a wetland. 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 then percolates instead of heading downstream.
- Maintain more steady flows to streams by slowing peak flows.
- Flood mitigation for the same reason.
- Habitat for wildlife including rare and endangered species.

- Open space, outdoor recreation, education, and aesthetics.

Of course not all wetlands provide all these benefits or provide them to the same extent. Each one has a unique setting and provides different functions as conditions fluctuate. It is safe to say that there is an immense variety in the functions and condition of the wetlands in the watershed. This assessment provides an overview as a starting point for further investigation.

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.

Permits for work taking place in wetlands or for their creation and enhancement are issued through DSL.

In seeking to understanding wetland conditions in the Lower Yamhill 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 we subsidized, encouraged, and facilitated the draining of wetlands for cultivation. In '85 there was a change in policy concerning wetlands ending these subsidies. Of course we continue to lose wetlands through a myriad of development pressures.

The location of prior-converted wetlands are identified by a variety of sources including:
- Soil Conservation Service soil surveys of Yamhill and Polk counties (1974, scale 1:20,000)
- National Wetlands Inventory (NWI) maps (1976, 1982, scale 1:24,000 and 1:62,500)
- USGS topographical maps (scale 1:24,000)
- Farm Service Bureau black and white aerial photos (1994 summer fly-over, scale 1:660).

As part of a National Wetlands Inventory, the U.S. Fish and Wildlife Service mapped our 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 2 acres so smaller wetlands do not appear, though many remain. Wetlands that are cultivated but not classified as prior converted for one reason or another are not included in NWI maps but may still be regulated. Further information on NWI maps is available from the DSL publication: *Just the Facts #1*.

Methodology

Again, we used a mylar base map to locate wetlands in relation to streams and roads in the watershed. We did so by tracing NWI maps. Fortunately, they have the same scale as USGS quadrangles so they are compatible with the other base map components such as riparian conditions and Channel Habitat Type designations.

Hydric soils—outlined on soil maps and elsewhere—are another indicator of current and historic wetlands. Hydric soils are those that have formed under predominantly wet conditions as in a wetland. The locations of hydric soils in Yamhill County are available in digital format (meaning we have them in a GIS layer) from the BLM and are shown in Map 6. For more information regarding the location or significance of these soils, contact the Yamhill Basin Council or the Yamhill Soil and Water Conservation District at (503) 472-6403.

The actual size and shape of the wetlands, as well as more exact location, can be viewed on the base map (contact the Yamhill Basin Council). Even better, read how to identify wetlands and see if you can find a wetland in your area that may need your protection.

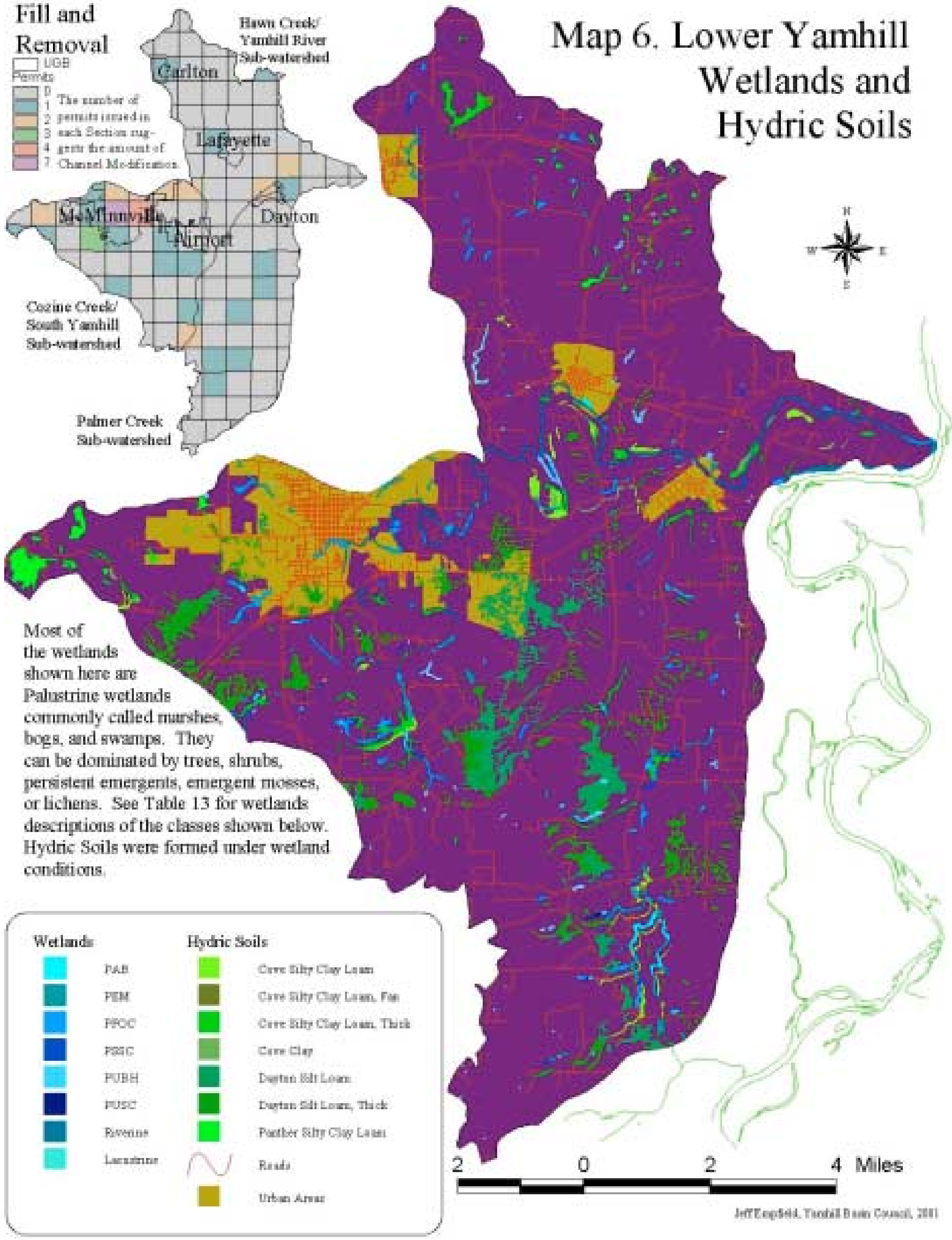
Wetland Distribution and Trends

The distribution and acreage of wetlands shown on the map is only an approximation of the wetlands actually in the watershed. Again, it's 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. 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.

Map 6 illustrates that the sum area of wetland hydric soils 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 and these areas are also desirable for farmland. The vast majority of land under cultivation in the watershed, (greater than 50 percent and maybe up to 80 percent) 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 the records of tiles and drainage are not open to the public. This is an estimate by Natural Resource Conservation Service (NRCS) staff familiar with the area. Drainage tiles carry water away where before it remained in the ground and gradually percolated into aquifers or supplied springs and streams with year-round flows.

The Oregon Department of State Lands uses the Cowardin system of wetland classification as do the National Wetlands Inventory 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.

Table 13 shows the wetland classifications that apply to the Lower Yamhill watershed. The chart moves from the general description down to more specific descriptions. Each wetland marked on a NWI map has a code indicating whether it is palustrine (associated with standing shallow water), riverine (associated with flowing water) or lacustrine (lakes). The palustrine wetlands are described further by subsystem codes that describe the 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.



Map 6. Lower Yamhill Wetlands and Hydric Soils
Fill and Removal
UGB
Permits
0
1
2
3
4
7
The number of permits issued in each Section suggests the amount of Channel Modification.
Hawn Creek/ Yamhill River Sub-watershed
Carlton
Lafayette
McMinnville
Airport
Dayton
Cozine Creek/ South Yamhill Sub-watershed
Palmer Creek Sub-watershed
Most of the wetlands shown here are Palustrine wetlands commonly called marshes, bogs, and swamps. They can be dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. See Table 13 for wetlands descriptions of the classes shown below. Hydric Soils were formed under wetland conditions.
Wetlands
PAB
PEM
PFOC
PSSC
PUBH
PUSC
Riverine
Lacustrine
Hydric Soils
Cove Silty Clay Loam
Cove Silty Clay Loam, Fan
Cove Silty Clay Loam, Thick
Cove Clay
Dayton Silt Loam
Dayton Silt Loam, Thick
Panther Silty Clay Loam
Roads
Urban Areas
2
0
2
4 Miles
N
W
E
S
Jeff Empfield, Yamhill Basin Council, 2001

Table 13. Wetlands Descriptions

Ecological System

The First Letter in the Wetland Label (i.e. **P**UBH**)**

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.

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

Classes

The Second and Third Letters in the Wetland Label (i.e. P**UB**H)

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.

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 Fourth Letter in the Wetland Label (i.e. PUB**H**)

Seasonally Flooded/Well Drained (C)
Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to9 the surface to a water table well below the ground surface.

Permanently Flooded (H)
Water covers the land surface throughout the year in all years.

Conclusions

Historically wetlands were much more extensive in the valley than they are today. With European-American settlement, Kalapuya burning ended allowing woody vegetation to move in.

Over the past century and a half wetland acreage has been significantly reduced through draining and tiling in order to make agricultural land available. Wet prairie is now almost non-existent in the watershed. It once played a significant role for providing habitat for fish and other wildlife, provided off-channel storage of floodwaters, and groundwater recharge to the system during low-flow summer months.

Wetland restoration and enhancement projects help restore some of these functions to the watershed. Converted wetlands in developed areas will likely not be reclaimed in the foreseeable future, though. So it's important to determine where the best opportunities exist to enhance, restore, and even create wetlands to compensate for the net loss in wetland function in the area. A good place to start may be to complete local wetland inventories or to raise awareness of the problem simply by talking with your neighbors. Also, state and federal assistance may be available for landowners that want to enhance, restore, or create wetland functions on their land that floods seasonally.

Resources for Further Information on Wetlands:

Oregon Freshwater Assessment Methodology (OFWAM)
Wetlands Program
Oregon Division of State Lands
775 Summer Street NE
Salem, OR 97310

Wetland Bioassessment Fact Sheets
U.S. Environmental Protection Agency
Office of Wetlands, Oceans, and Watersheds Division
Washington, DC
EPA843-F-98-001

References

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Janet C. Morlan, "Wetlands Inventory User's Guide. National Wetlands Inventory and Local Wetlands Inventory," Oregon Division of State Lands, Wetlands Program, May, 2000.

National Wetlands Inventory. Department of the Interior. Fish and Wildlife Service. Quads: Dundee, Dayton, Carlton, Amity, St. Paul, Muddy Valley, McMinnville, and Mission Bottom.

Oregon Division of State Lands, Wetlands Program, "Just the Facts #1," June, 1991.

Oregon Watershed Enhancement Board, *Oregon Watershed Assessment Manual*, July, 1999.

Sam Sweeney, "Farmer's Historical, or Early Use of the Creeks and Riparian Areas," unpublished transcript, January, 9, 2001

U.S. Department of Agriculture, Soil Conservation Service. (SCS). 1982. *Soil Survey of Polk County, Oregon*. Yamhill County NRCS office, McMinnville, OR.

U.S. Department of Agriculture, Soil Conservation Service. (SCS). January, 1974. *Soil Survey of Yamhill County, Oregon*. Yamhill County NRCS office, McMinnville, OR.

CHAPTER FIVE

Channel Habitat Types

Introduction

Like all systems of organization (e.g., language, history, science), "Channel habitat type" (CHT) is a construct of factors we wish to emphasize. In this case we're looking at the physical characteristics of our streams. The OWAM draws on several stream classification systems already in use to create a system for classifying Oregon streams into one of 15 types of channel habitat.[6] The Yamhill Basin doesn't have coastal estuaries, high mountain, or desert environments so not all of these designations apply. For the current watershed assessment, we only needed to use seven.

CHT classifications help us to understand the streams in our landscape by labeling them according to varying gradient, channel confinement, size, and likely substrate. These segment classifications should be useful in combination with other characterizations in the assessment to estimate a given stream's sensitivity to restoration efforts. More specifically, CHT classifications will help identify those stream reaches with the greatest potential for positive response to restoration efforts.

Methodology

CHT assignments are based on apparent conditions recorded in aerial photos and USGS 1:24,000 topographical quadrant maps. For this assessment, the maps were particularly important for estimating gradient, confinement, and size of streambeds. Only perennial streams (those with year-round flow) are included. Each stream is divided into segments depending on their pattern of steepness, confinement, and size. Segments of at least 1,000 feet appear on Map 7 in the color corresponding to the likely CHT conditions present.

The map in this document is an approximation of the CHT locations. For more exact locations consult the Yamhill Basin Council who retains the topo maps and mylar overlay used to determine our CHTs. The next step involves going into the field to fine-tune the general information included in these designations.

Channel Habitat Types

Stream channels in our area do not always clearly fit into one of the CHT categories provided by the manual. This is due in part to the imperfect nature of all classification systems. It's also partly due to the altered physical condition of the area's stream beds—they don't always follow natural patterns.

Many of the stream beds in the Lower Yamhill watershed are deeply incised or downcut meaning they have steep banks which greatly impact the stream's natural meandering and seasonal flooding. A natural low gradient stream typically floods regularly and is constantly

[6] OWAM's CHT system synthesizes six systems developed for focussing variously on mountain and forest streams, Washington and Alaska streams, stream habitat, map-based surveying, physical geology, and geomorphology.

creating new meandering channels and depositing sediments. Unmodified bottomland areas continue this pattern and deserve a CHT label of *Flood Plain* (FP1, 2, or 3). Many of the botttomland areas in our watershed more closely fit the description of a *Low gradient, Moderately confined* stream. The channels do not meet the OWAM manual description of "variable confinement by low terraces or hill slopes" though. Instead, their confinement is due to downcutting of the stream banks so for this assessment they are labeled LC for *Low gradient, confined* streams. See Table 14 for descriptions of the categories used in the assessment. Needless to say, the conditions on the ground and in the streams are infinitely complex and do not always fit easily into a classification system such as ours. The important thing is to find some indication of conditions from the CHT designation and identify problems such as downcutting.

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 system during shorter periods of time causing higher velocities. These higher velocities carry more energy and so they tend to erode banks and scour the channel.

- Removal of large wood debris from the stream network. Settlers began removing woody debris from the area's rivers in the 19th century; we continue to remove most large trees from the system before they even enter the streams. As late as the 1960s we cleared wood from streams because we mistakenly thought we were increasing the quality of fish habitat. We now understand that log jams decrease the velocity, increase the storage capacity, and generally create beneficial habitat pools of water in our streams.

- Stream bank modifications such as hardening of the bank with rip-rap (rocks that hold the soil in place) or concrete. These prevent the stream from gradually changing its course through meander patterns that find the stream's natural curvature to best dissipate energy.

The channel habitat type descriptions offered in the OWAM manual are reprinted in Table 14. Map 7 shows the locations of streams and their *approximate* channel habitat type.

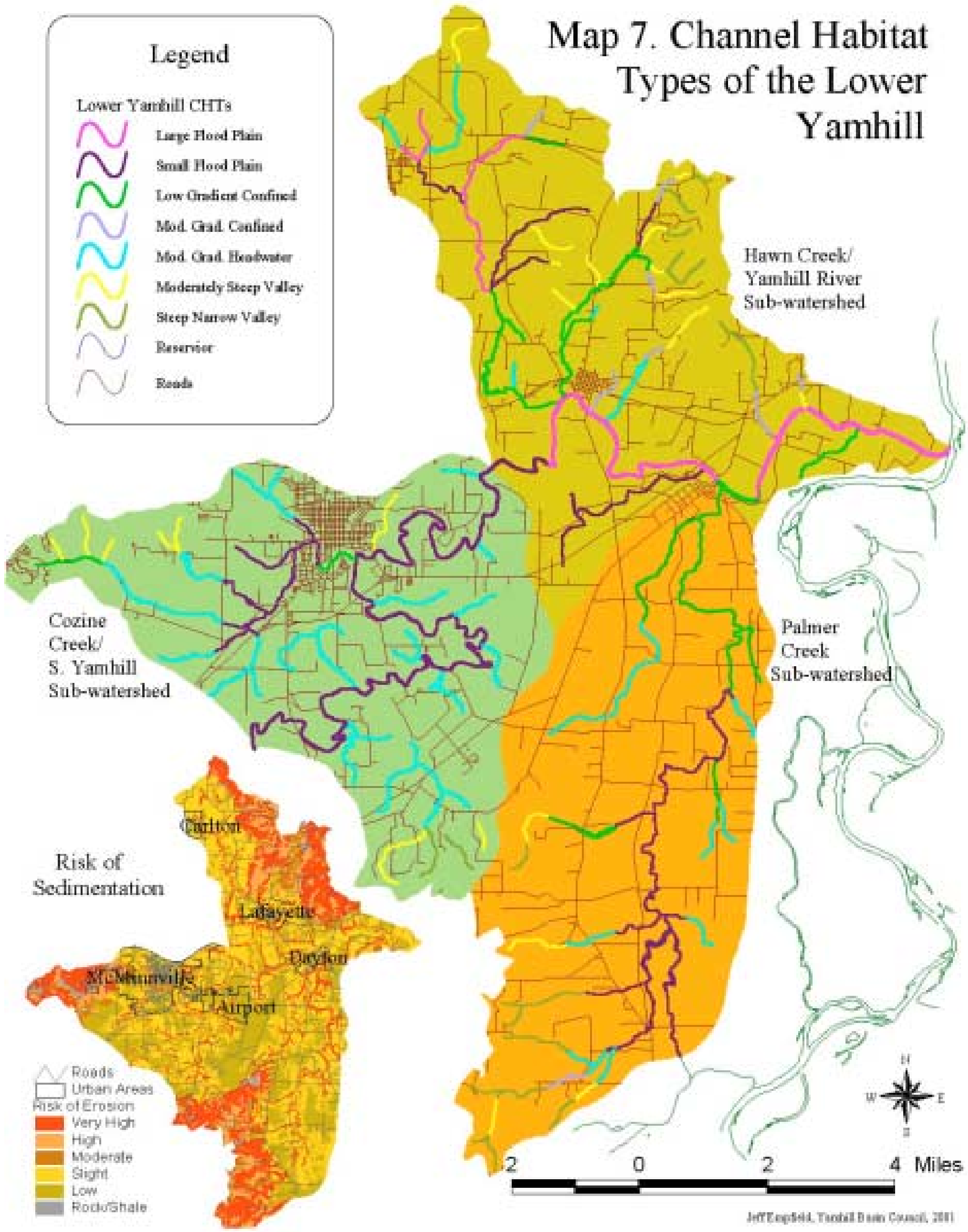
Table 15 provides descriptions of the gradient, channel confinement, stream size, and the sensitivity of that channel to restoration as provided by the OWAM. Stream gradient is the steepness of the channel. The gradient is generally highest near the headwaters and lowest in the valley where the land is flat. Of course, there are exceptions. Sometimes headwater valleys can be gently sloping and areas downstream can have steep gradients for a while.

Confinement describes the steepness and narrowness of the stream banks; it determines whether the stream is able to overflow 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 somewhere between these two descriptions. Channel sensitivity describes how receptive streams are to enhancement and restoration work. Table 16 provides descriptions of the restoration potential associated with the each channel habitat type.

Table 14. Channel Habitat Type Descriptions

Channel Habitat Type	Description	Fish Utilization
Low Gradient Medium Floodplain Channel **(FP2)**	Main-stem streams in broad valley bottoms with well-established floodplains. Channels are often sinuous, with extensive gravel bars, multiple channels, and terraces. These channels are generally associated with extensive and complex riparian areas that may include sloughs, side-channels, wetlands, beaver ponds, and groundwater-fed tributary channels.	Anadromous: Potential steelhead rearing. Resident: Potential overwintering.
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 Enhancement Board Manual, 1999)



Map 7. Channel Habitat Types of the Lower Yamhill
Legend
Lower Yamhill CHTs
Large Flood Plain
Small Flood Plain
Low Gradient Confined
Mod. Grad. Confined
Mod. Grad. Headwater
Moderately Steep Valley
Steep Narrow Valley
Reservior
Roads
Hawn Creek/ Yamhill River Sub-watershed
Cozine Creek/ S. Yamhill Sub-watershed
Palmer Creek Sub-watershed
Risk of Sedimentation
Carlton
Lafayette
Dayton
McMinnville
Airport
Roads
Urban Areas
Risk of Erosion
Very High
High
Moderate
Slight
Low
Rock/Shale
2 0 2 4 Miles
Jeff Empfield, Yamhill Basin Council, 2001

Table 15. Channel Habitat Type Parameters

Channel Habitat Type	Gradient	Channel Confinement	Stream Size	Responsiveness to Change
Low gradient medium floodplain **(FP 2)**	<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 Enhancement Board Manual, 1999)

Channels respond to change differently based on their position in the watershed. The headwaters of Palmer Creek and Millican Creek 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 low gradient streams that are most responsive to change are also the ones in the most developed parts of the watershed where land is under cultivation. Refer to Map 4 for current vegetation. Each have significant amounts of stream length that could be enhanced. With current land use these areas would benefit most from riparian enhancement projects that may or may not encourage meandering or flooding but would at least improve the quality of the vegetation along the channels.

Table 16. Channel Habitat Type Restoration Potential

CHT	Riparian Enhancement Opportunities
Low gradient medium floodplain **(FP2)**	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 nonforested 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 Lower Yamhill 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 nonforested 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.

(From Oregon Watershed Enhancement Board Manual, 1999)

References:

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Oregon Watershed Enhancement Board, *Oregon Watershed Assessment Manual*, July, 1999.

CHAPTER SIX

Channel Modifications

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. We can also include road crossings (bridges and culverts) and streams with “permanent discontinuity” due to the artificial effects of a roadbed having been constructed near the stream.

Stream channels are normally dynamic systems that respond to physical and weather conditions. 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 habitat in the Lower Yamhill watershed.

Methodology

The channel modification section includes information from residents, fill and removal permits including streambank hardening projects such as rip-rapping), dam records from the Water Resources Department (WRD), aerial photos, and FEMA floodplain maps.

Historic Channel Modifications

Throughout history humans have modified the streams where they live both intentionally for irrigation, transportation, and drinking water and accidentally through a variety of 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 fueled by fossil fuels has resulted in a larger scale of channel modifications in our streams and rivers.

In terms of area affected, agriculture has had the greatest effects on stream modification in the Lower Yamhill watershed. It is now common for small drainages to be disked and plowed in cultivated fields, effectively eliminating the stream and wetland qualities. 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. For example, photos from the mid-20th century not surprisingly show that rivers and streams were in roughly the same location as they are now. The interesting thing is that the land adjacent to streams historically contained wet oxbows and standing water, what we know today to be valuable wetlands. Many of these large wetland areas no longer exist along the South Yamhill and Yamhill Rivers as well as along Cozine, Hawn, and Palmer Creeks. On aerial photos taken in 1994 some ghostly contours of the historic oxbows are still visible, though they are now drained and cultivated.

Our powerful technology associated with road building is another major cause of channel modification. In hilly areas road construction follows the path of least resistance which inevitably is right next to streams. 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. It creates problems primarily in two ways: first, by restraining the flow to one channel we've taken away the stream's ability to meander, to evolve in ways that sustain habitat and clean water. Second, because it's constrained, the stream cannot dissipate it's energy; 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 typically encroach into stream beds and usually involve very permanent footings and backfill. Private residences and side roads require additional bridges or culverts to provide access further limiting the acceptable movement of stream beds. 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, flood mitigation, 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 cross streams rather than respecting them.

It is difficult to thoroughly assess the extent and location of historic channel modifications. Fill and removal permits on file at the Division of State Lands give some sense of the physical modifications that have taken place in the area over the past several decades. Permits were not required until the late 1970s, though, so little is known prior to that. A lot of the fill and removal permits apply to off-stream projects such as road building or reservoir construction. A lot of in-stream channel modification appear as well, though, and most of the off-stream work has direct or indirect effects on streams anyhow—by eliminating wetlands, for instance. The whole watershed is interconnected, after all.

DSL Fill and Removal Permits

Most fill and removal activity is either road-related or for reservoir construction. There is a lot of activity surrounding 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 are also a lot of small earthen dams for watering stock and for irrigating vinyards, for example. The rest are for things like installing pipelines, electrical lines, or sewer lines, constructing "outfall" for water treatment plants, and the rare construction of a boat launch.

There is an interesting trend toward more ecological awareness in the permits. In 1978 we read that new and disturbed dirt slopes were to be seeded and mulched at a bridge and culvert replacement. The work also included reshaping of slopes for stabilization and erosion control. By the 1990s we see evidence of more far-reaching ecological concern. Earthen dams for livestock watering and wildlife were now to have a limited footprint—the area of disturbance—

by requiring excavation to be taken from within the planned reservoir. Additionally, water would now be piped to a stock trough outside the "fenced reservoir and wetland."

Some fill and removal permits reveal efforts specifically aimed at creating wildlife habitat or at restoring wetlands. In 1995 we had excavation and dike-building to restore a wetland on prior converted pasture for wildlife purposes. The property owners were managing for wildlife purposes and had previously planted a diverse forest, native tufted hairgrass, and other native plants. And in 1996 an impoundment of an unnamed spring near Cozine Creek was to create a small pond (about .2 acres) and a small wetland to provide year-round habitat for wildlife.

In one case a landowner worked with the Corps of Engineers to remove silt from a low-lying area, hence providing open water and various wetland functions. The Corps has authority to do such work according to nationwide permit rules governing "restoration of altered and degraded non-tidal wetlands" and the creation of wetlands on private lands. It needs to be done in accordance with the terms and conditions of a binding wetland restoration or creation agreement between the landowner and the U.S. Fish and Wildlife Service or the Natural Resource Conservation Service. "Such activities include, but are not limited to: installation and maintenance of small water control structures, dikes, and berms; backfilling of existing drainage ditches; removal of existing drainage structures; construction of small nesting islands; and other related activities." The nationwide permit applies to restoration projects that serve the purpose of restoring "natural" wetland hydrology, vegetation, and function to altered and degraded non-tidal wetlands and "natural" functions of riparian areas.

Dams

Lower Yamhill 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 criteria to be monitored as such. According to Jon Falk of the Water Resources Department (WRD), only those dams that are 10 feet or greater in height and that store more than 9.2 acre feet are required to be engineered and are part of a dam safety database. Smaller structures are not recorded in the database although all storage projects require a reservoir permit. Falk also notes that a structure less than 10 feet high could have a storage pond of 9.2 acre feet which is approximately 3 million gallons of water stored.

Table 17. Dam Locations and Descriptions for the Lower Yamhill Watershed

Dam I.D. Number	Name	Year Comp-leted	Owner Type	Purpose	Dam Length (ft)	Dam Height (ft)	Storage (acre/ft)	Surface Area (acres)	Drainage Area (sq. mi.)
OR-00229	Cole and Forrester	1951	Private Earth	Irrigation	325	35	122	10	1
OR-00367	Hawn Creek Reservoir	1961	Municipal Earth	Irrigation	268	23	153	26	11
OR-00433	Kauer Reservoir	1968	Private Earth	Irrigation	350	35	116	12	NA
OR-01502	Dayton Facility Waste Reservoir	NA	Municipal	Waste Water	NA	11	31	NA	NA
OR-00305	Keene Reservoir	1957	Private Earth	Irrigation	520	20	125	21	6
OR-02123	Kunz Dam	NA	Private	Irrigation	NA	20	45	NA	NA
OR-02241	Log Storage Reservoir	NA	Private	NA	NA	16	22	NA	NA
OR-02556	North Reservoir	NA	Private	NA	NA	12	29	NA	NA
OR-02980	Schindler's Reservoir	1966	Private Earth	Rec/Fish/ Wildlife	442	29	15	3	NA
OR-00477	Stringer Reservoir	1969	Private Earth	Irrigation	300	26	78	12	1

(From the Oregon Water Resources Department web page)

The structures with a zero in the Drainage Area column are off-channel storage reserviors. Those 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 non-native fish introduction, 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 Flood

The Federal Emergency Management Agency 100-year-floodplain map is included in Map 9. Note that it is not the same scale as the other maps and shows all of Yamhill County, though the shape of the county is somewhat distorted. The Yamhill River historically was a meandering river that routinely flooded its banks, changed directions, and carved side channels. The landscape clearly shows evidence of this in ghost channels and oxbow lakes and wetlands near the river.

Currently the river is restricted within steep banks, has lost many of the side channels, and no longer routinely floods. It is unlikely that we'll see the historic conditions return as long as we continue to build in the flood plain, make intense efforts to restrain floods, and rely on federal assistance when our efforts fail. The river flows through several communities on its way to the Willamette and the land being farmed on the floodplain increasingly receives a built infrastructure incompatible with seasonal flooding. What can be done to accommodate the natural tendencies of the river? There are opportunities for enhancing the vegetation to provide more diversity. Where possible, owners with land that floods year after year could be encouraged or provided with incentives to leave that land undeveloped. This would reduce flood damage and increase wetland area for wildlife and ground water infiltration when streams provide off-channel water storage during high flows.

References:

Federal Emergency Management Administration (FEMA) 100-year floodplain data.
Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.
Oregon Watershed Enhancement Board, *Oregon Watershed Assessment Manual*, July, 1999.
Water Resources Department web page.

CHAPTER SEVEN

Sediments

Introduction

Sediments are of great concern in the watershed due to their effects on water quality and aquatic resources. Erosional features actively contributing sediment to streams are fields, construction sites, landslides, roads, and streambanks. Bank erosion potential is greatest in the lower elevation main channels where soils and banks contain mostly fine materials that erode easily. This is also where stream entrenchment encourages lateral scour of the streambanks.

The water draining from roads can move considerable amounts of sediment from adjacent lands via drainage ditches and unpaved road surfaces. The road ditch is filled 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 the variability of conditions teamed with the fact that conditions can change so rapidly. A road surfaced with high-quality rock can be quickly reduced to a quagmire if water is allowed to pool during wet weather and there is heavy traffic. Conversely, a road with a poor-quality surface may not degrade much at all if it is used mainly during dry weather. Paved roads prevent road surface erosion but exacerbate another set of problems related to chemical and petroleum-based contaminants and impervious surfaces that prevent surface water from soaking in to the ground.

A major concern are the hilly areas classified as having a moderate or high potential for debris flows. 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 travel distance and move rapidly down steep hillslopes and confined channels. Very small landslides can become large debris flows so the debris flow inset on Map 8 does not indicate minimum size.

Decades of Erosion

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

Roadside erosion has also been one of the worst contributors of sediment to streams. Also in 1979, The Yamhill County Road Department identified approximately 35 miles of "severe roadside erosion." 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 (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 0.10mm, organic matter content, soil structure, soil permeability, clay mineralogy, and the presence of rock fragments. Soil erodibility and steepness can be correlated to indicate relative risk for sedimentation in various areas. These are shown on Map 8.

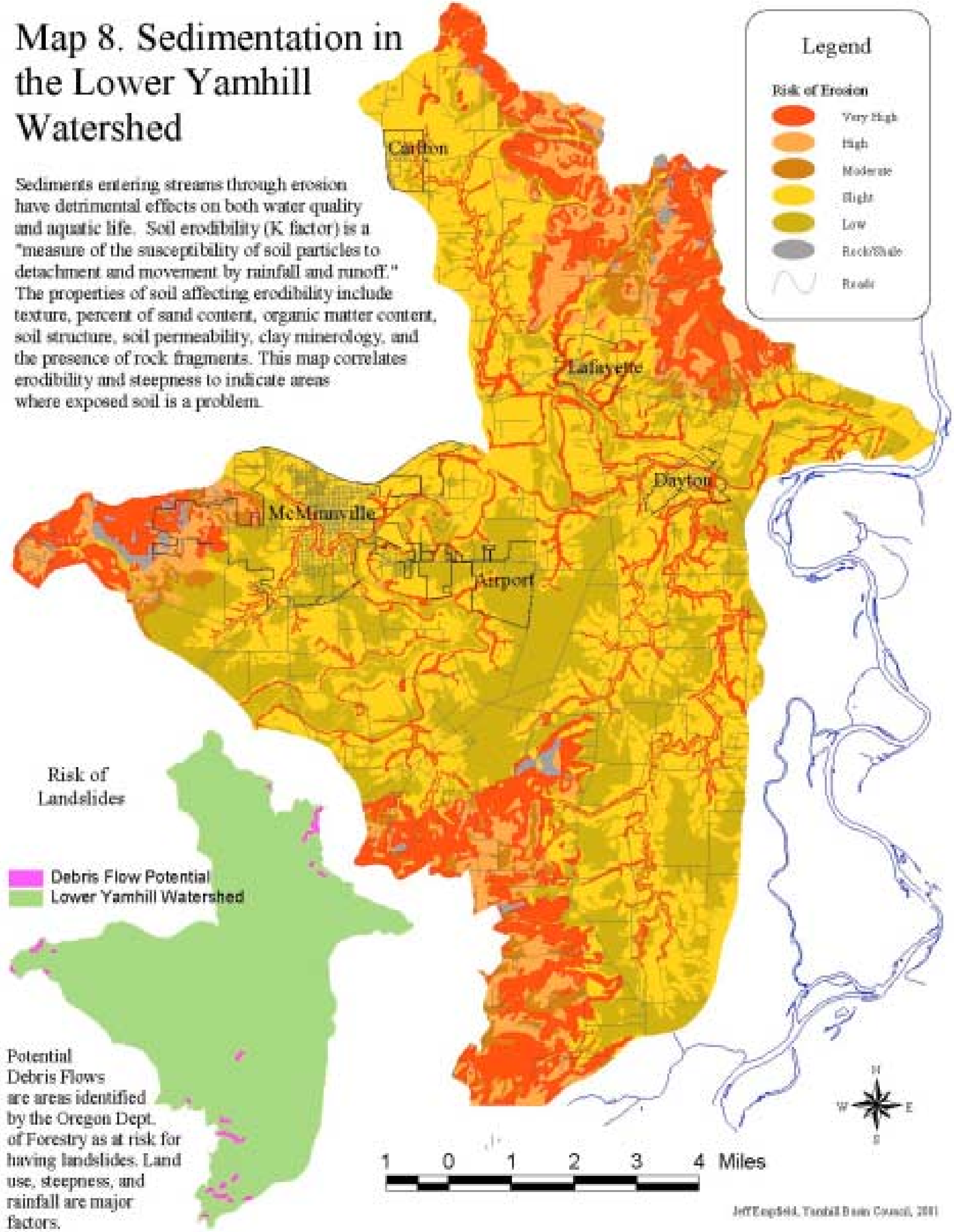
Recognizing that rural roads contribute significant amounts of sediment to waterways, the Yamhill Basin Council started a Roadside Water Quality Committee that meets quarterly to collaborate on issues related to county roads. Currently, the members include representatives from the Yamhill Basin Council, Yamhill and Polk Counties Public Works Department, 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 the ditches through a seeding project that began in the summer of 2000. The goal is to improve the ability of the 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.

Currently Yamhill County maintains the vegetation in its ditches by mowing. However, Yamhill county does not mow all the ditches in the agricultural areas, only those where visibility is an issue. Regardless, mowing is preferable to removing vegetation because vegetated ditches hold sediments instead of sending them into the streams. In Polk County crews apply herbicides to sections of ditches to suppress vegetation for improved visibility. Polk county also has a better arrangement for landowner maintenance of ditches.

Ditches in Yamhill County are re-graded on a 10-year rotation. Seven to eight years would be ideal but budget constraints prevent that schedule. Some areas have yearly maintenance and others only every twenty or so years. Ideally, re-ditching would be restricted to the driest months of the year to prevent sediment from the exposed surface from entering the waterways. However, due to the amount of work that needs to be done, road ditching is scheduled year round. Most road grading occurs during the winter months when the road substrate has enough moisture to be reshaped.

Map 8. Sedimentation in the Lower Yamhill Watershed

Sediments entering streams through erosion have detrimental effects on both water quality and aquatic life. Soil erodibility (K factor) is a "measure of the susceptibility of soil particles to detachment and movement by rainfall and runoff." The properties of soil affecting erodibility include texture, percent of sand content, organic matter content, soil structure, soil permeability, clay minerology, and the presence of rock fragments. This map correlates erodibility and steepness to indicate areas where exposed soil is a problem.



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

Jeff Empfield, Yamhill Basin Council, 2001

If you would like further information on roadside seeding or other road-related issues contact the following and ask for the "Roadside Vegetation Management" brochure:

Yamhill Soil and Water Conservation District
(503) 472-6403
2200 SW 2nd Street
McMinnville, OR 97128

Polk Soil and Water Conservation District
(503) 623-9680
580 Main Street, Suite
Dallas, OR 97338

Urban Runoff

McMinnville is bounded by the North and South Yamhill Rivers and by Baker and Cozine Creeks. According to its Storm Water Master Plan, the city relies on these waterways as a perimeter endpoint of storm water drainage. Storm water runoff is drained both by pipe and natural open channels. It is piped primarily from the central business district. The developed areas of town lie on land that is sufficiently higher than the surrounding waterways and is generally unaffected by floods, except that floodwater from the South Yamhill River backs up in Cozine Creek upstream as far as Fellows Street.

McMinnville's current Urban Growth Boundary (UGB) is approximately 11,505 acres, 2/3 of which is drained by Cozine Creek. This means that most storm drains in McMinnville eventually discharge into Cozine Creek and the remaining smaller areas drain directly into the other perimeter rivers. This results in almost 75% of McMinnville's total storm water being drained by the South Yamhill River.

Within the UGB there are 144 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 the fact that every square foot of land is part of a drainage basin. The smallest basins are ones that create puddles or rivulets. Dozens of these combine to form headwaters which in turn combine to form streams, then bigger streams, and finally rivers. We can recognize boundaries between basins by observing where there is high ground between drainages. The boundaries are physically determined by the lay of the land. The scale, however, is arbitrarily established depending on whether we want to address big problems common to the entire Willamette Valley or whether we're talking about the drainage system of downtown McMinnville.

Planners deem McMinnville's drainage system adequate except for a number of drains that were designed in the past with a capacity for only a 2-year "event" or less and a few other areas of concern. Generally, engineers now design public storm water drains for five or 10-year "frequency events."

Points of major concern, circa 1991:

- West Cozine Creek area is developing rapidly with residential subdivisions. Additional greenway flood detention is recommended to prevent further impact on downstream properties.

- Ditch flowing into West Cozine Creek upsteam of Russ Lane is difficult to maintain and overloads creek. If should be piped to confluence with Cozine creek.
- Storm drain in Michelbrook Lane is undersized. A bypass drain should carry excess flow to Elm Street.
- Overloaded East 12th Street drain can be improved by routing the flow generated in the Adams Street drain into another basin.
- The remaining combined sewers in the City should be replaced with separated storm and sanitary systems.

Currently, there are no requirements by the U.S. Environmental Protection Agency (EPA) on storm water quality for cities the size of Dayton, Lafayette, Carlton, and McMinnville. Such requirements will eventually be imposed, though. It is would be prudent, therefore, to consider the probable direction of those requirements and to act accordingly.

Low cost or no cost options for improved storm water quality should be implemented including:
- Keeping natural open channels where possible in preference to installing 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.
- Continuing McMinnville's storm water quality sampling program that was begun in the late 1980s during the storm water planning process.

McMinnville has a $2.00 per month User Fee on each utility account. This charge is important since it helps offset the costs of storm water capital improvement and upkeep costs. However, it will not fully meet the need for drainage capital improvements identified above. City planners expected in 1991 that total public drainage project costs over 15 years to be approximately $3.6 million.

Impervious Surfaces

The amount of storm water runoff is increased substantially through development by increasing impervious areas within the watershed. Impervious areas include all pavement such as streets, parking lots, sidewalks, and loading areas, as well as rooftops. Together they increase the volume of runoff by preventing water from soaking in to the earth. Further, these impervious surfaces tend to concentrate the runoff into storm drains or ditches which more rapidly carry the runoff to the receiving stream. This in turn decreases the time of concentration for a given rainfall to enter the stream and generally increases peak rates of runoff downstream. Transformation of agricultural lands to highly urbanized lands can increase the rates and volumes of storm runoff by a factor of two to four (2x-4x), according to the Storm Water Drainage Plan. Consequently, impervious area is a very significant factor in the analysis of storm drainage systems.

Mapped Impervious Area (MIA) is a rating system for different degrees of impermeability. For residential areas the estimated MIA ranges from 40% to 65%, depending on housing density and the residents' propensity to build-on or pave their yard. For commercial areas it's 90% and for

Industrial areas it's about 80% due to the lack of vegetation and open ground in these areas. Of course open areas or green spaces have an MIA of zero.

Impervious surfaces in McMinnville are concentrated in the downtown area and northeast of there. The shopping centers, highway retail establishments, car dealerships, and warehouse sales operations are generally located north of the city center along highway 99. These areas are characterized for drainage purposes by large expanses of parking areas. The downtown area generally has small shops, office space, and institutional centers with smaller parking areas and a higher density of structures.

Runoff Contaminants

Inevitably, impervious surfaces and rural road ditches collect a lot of the oil and gas, exhaust particulates, rubber from tires, and anti-freeze that all our cars leave behind, as well as excess nitrogen running off our agricultural lands, and myriad pollutants originating with our industry. What can be done to keep these sediments out of the streams? Of course it is easier to control contaminants at their source than to remove them downstream through some treatment process. Fortunately, there are several forms of remediation for reducing the impact of contaminants that get into our water.

Runoff contaminants are most effectively removed by passing runoff water 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 towards this end under the rubric of "bioremediation." These areas can be natural or man-made grassy swales, settling or detention ponds, or constructed wetlands. In each, the objective is to maximize the amount of surface contact and contact time with the remediation plants. For phosphorous this is a type of banking because phosphorous doesn't really leave the system unless the plant that takes it up is removed, harvested, eaten, etc.

For removing 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 go beyond fertility of the land, though. All reservoirs have a limited life span determined by the amount of time it will take for sediment to fill them. In addition to cultivated fields, construction sites are often heavy sediment contributors because work site soil is generally left unprotected. Sediment catch techniques such as straw bales, silt fences, woven matting, detention ponds, and temporary swales can be used to clean storm water runoff to the extent that most of the transported sediments will be deposited and will remain on the site. Another technique is to require gravel on exit routes from work sites to remove most of the mud from vehicle tires prior to the vehicle leaving the site. This helps keep soil off the pavement and out of drains.

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 widely recognized for their value in this respect.

References

CH2M Hill, David J. Newton Associates, Inc., *City of McMinnville Storm Drainage Master Plan*, March 1991.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Oregon Department of Forestry website.

Yamhill Soil and Water Conservation District, *Natural Resource Conservation Plan*, Yamhill County, Oregon, 1979.

CHAPTER EIGHT

Hydrology and Water Use

Introduction

The circulation of water through the atmosphere, ground water, and surface water is called the hydrologic cycle. It has a variety of stages including precipitation, surface run-off, ground water, transpiration (plants expire water vapor), and evaporation. Human activities and technology influence all of these to some degree, some more than others.

This section covers the hydrology of the watershed as it relates to flood history, land use, and the extent that different water uses and water rights affect flows.

"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 flood in recorded history. It's 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. The December 1964 flood peaked at 47,200 cfs (cubic feet per second) at Whiteson—25% more than the previous highest recorded flood of January, 1972. The 1996 flood was similar and peaked at about 47,000 cfs.

The USGS gaging station near Whiteson has documented flows on the South Yamhill from 1941 to 1991. See Figure 3. In 1991 the USGS moved their gage to McMinnville at the Three Mile Lane bridge.

The amount of precipitation is not the only factor that influences peak flows. Stream flows are also influenced by withdrawals for irrigation and municipal drinking water, stream channel modifications, changes in land use and water-related technology, and the removal of vegetation. 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, that stream will act more like a flume than a slow moving reservoir for storm water concentrated from across the landscape. The flow will respond more rapidly and 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, flooded streams draining slowly provide a variety of benefits:

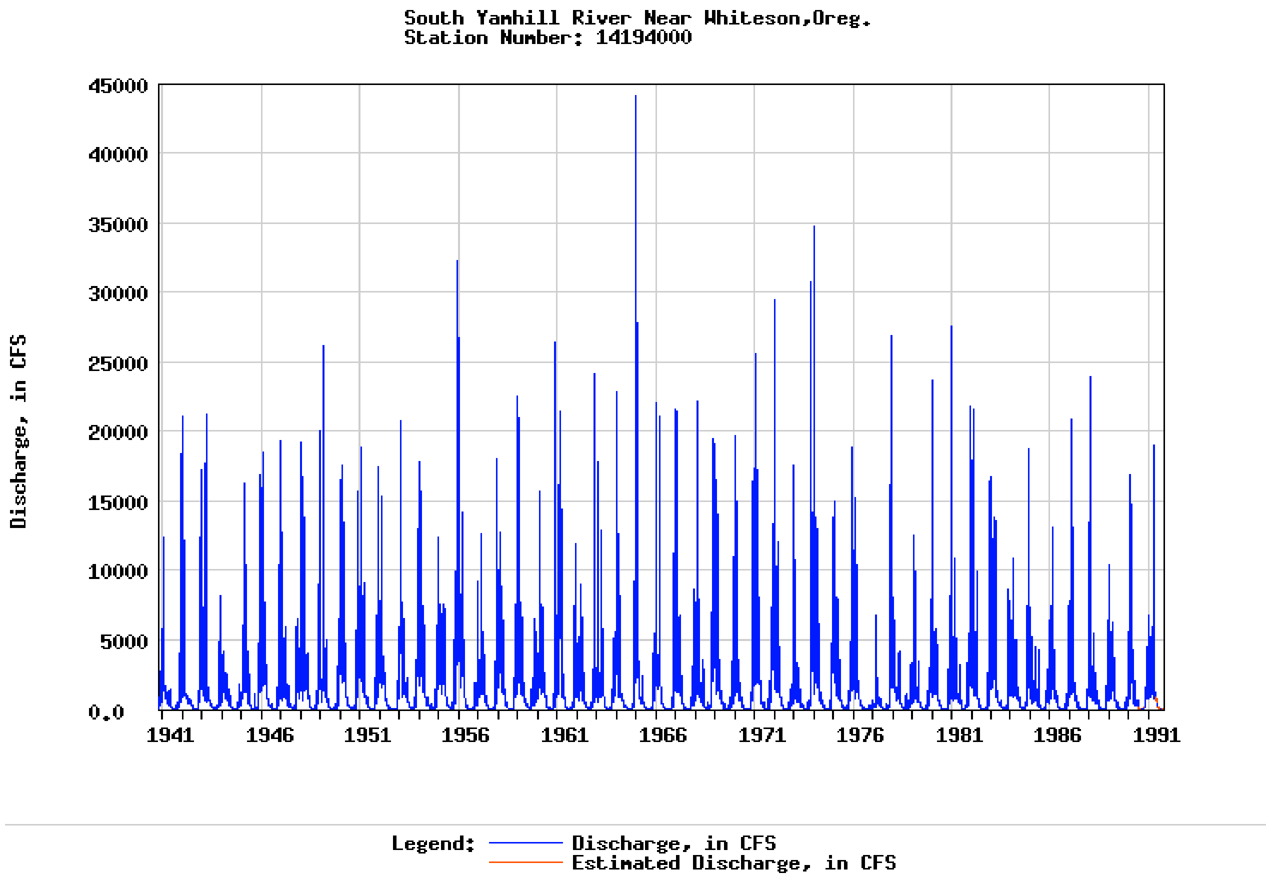
- Deeper flood plain soils for water storage and plant growth.
- Raised channels that reach the flood plain more often exchange water with wetlands, and transfer water to riparian areas more efficiently.
- Greater sinuosity (meandering) resulting in more stream-riparian contact, larger riparian areas, and slower flow velocities.
- 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 the riparian area that promotes habitat complexity.
- Less fluctuation between low flows and peak flows resulting in less property and ecological damage.
- More frequent, minor, localized flooding and less frequent, major flooding downstream.

Low Flows

Low flows 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 habitat. 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.

Figure 3. Historical Streamflow Daily Values Graph for South Yamhill River Near Whiteson,OR (14194000) Peak and Low Events most Clearly Seen Values

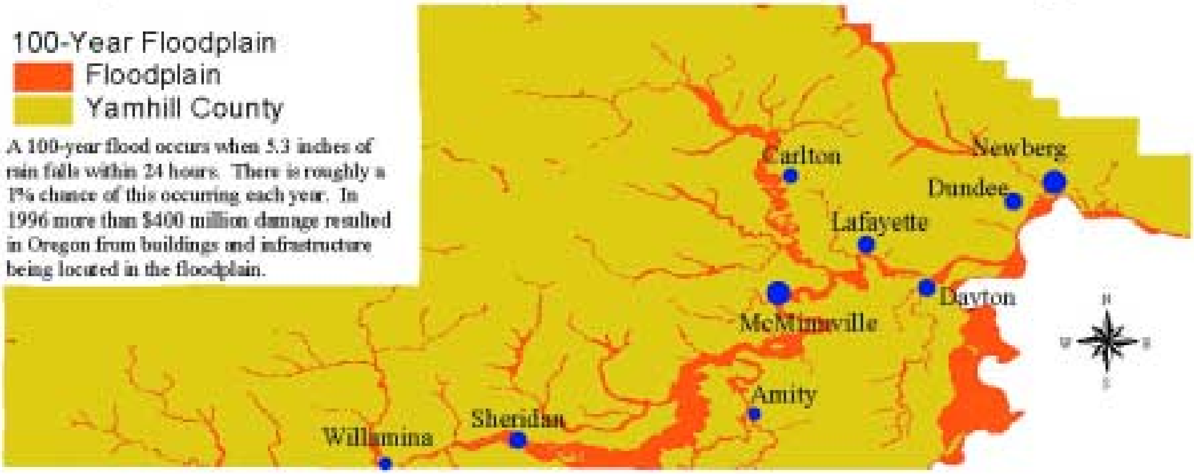


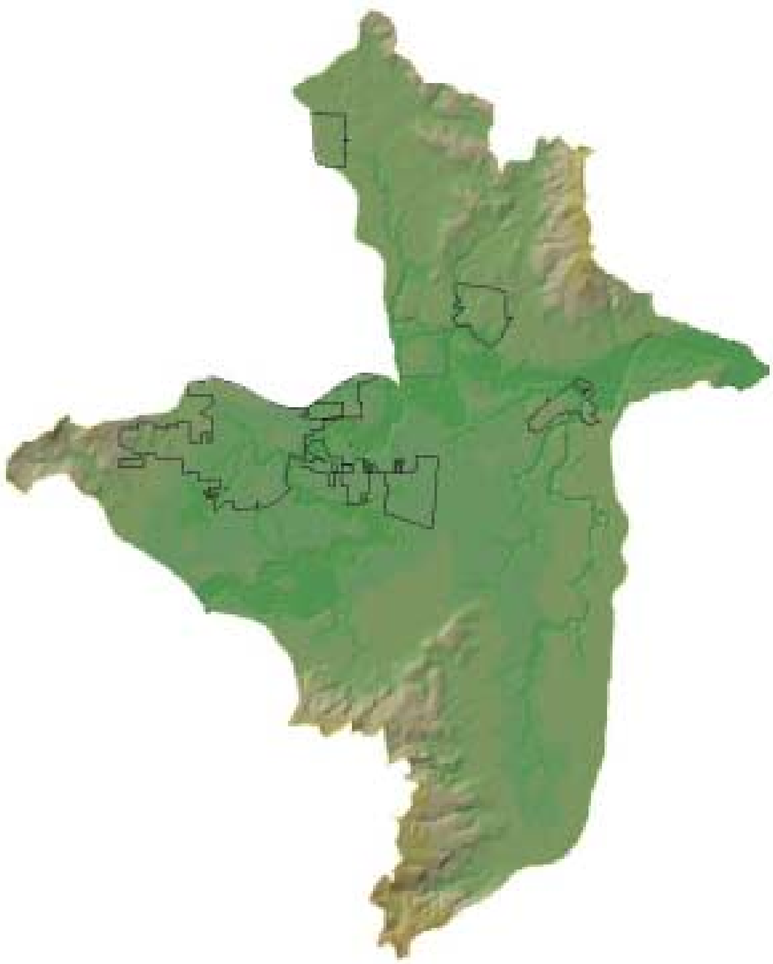
Flow data was collected on the south Yamhill River at Whiteson gaging station (gage # 1419400). It drains an area of 502 sq. miles, and is located 82.3 feet above sea level (Water Resources Department website).

Predicting Flood Frequency

By looking at the historic stream flow records it is possible to estimate the probability of flood recurrence frequency. We're talking about the likelihood of a given flood level occurring in a given year. It's a measure of probability, rather than a forecast. For example, a 100-year flood has a 1 in 100 chance of occurring in any given year. Over the course of 30 years, there is a 26% chance that there will be a 100-year flood. Map 9 shows the 100-year flood plain for Yamhill County as outlined by the Federal Emergency Management Agency (FEMA).

Map 9. Yamhill County One Hundered-Year Floodplain





Flow records are essential for establishing accurate local probabilities. Some flow records in Oregon date back about 100 years. Most areas have a much shorter record to examine, though. Models have been developed to examine the relationship between precipitation and various land uses to predict flood recurrence levels without actual flow data. They are not commonly used at this point, though. Even in areas where flow records exist, predicting floods is an inexact science.

The state climatologic service examines weather trends for Oregon and believes 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 likely contains 20 years of relatively dry conditions and the flood predictions will be different than if the data were collected during a 20-year wet cycle.

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%)

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 changes over time. For a record-keeping period 25 years long, there is an 85% confidence level that the statistics will accurately represent expected flood levels.
2. Conditions in the watershed may change over time. For example, increasing urbanization tends to increase impervious surfaces and the intensity of flooding for the same amount of rain. This means the mapped 100-year flood plain may be out of date.

The Growth of Irrigation

As early as the 1960s supplies for irrigation water were becoming scarce. Yamhill County 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 just 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 the 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.[7]

Natural resource conservationists expected Yamhill land to yield 15" of runoff in an average year meaning that each acre would produce 15 acre-inches or 1¼ acre-feet of runoff. "Without

[7] Figures from another report show similar growth, though the totals vary. According to them, in 1959 irrigated acres in Yamhill County represented 9.2% of all county cropland but by 1964 it had increased to 13.7%.

storage," they concluded, "this water is already passed onward toward the sea in great part when the irrigation season starts." Note that many of the dams listed in Table 17 were built soon after this.

It's interesting to note the juxtaposition of our needs and limits regarding natural resources. "The limitation on irrigation appears to be not so much a lack of usable land," community leaders wrote in the 60s, "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 in1963 and they felt that twice that amount would be needed by 1970. 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 there is a lot of variability from year to year.

Community leaders displayed a mixed understanding of their natural surroundings 40 years ago. For example, one report from the 1960s states that "it is probable that brush along the streams uses some water and allows the soil to absorb extra water by slowing down the streams and thus reduces the amount of water available for irrigation." At the same time, residents displayed an understanding of the complexity of their natural surroundings. They reported that the "yield of water from each watershed varies from year to year depending on changes in land use, vegetative cover, rainfall intensity, etc. Also one watershed varies from another according to topography, dominant slopes, general shape of watershed, and other features." Future watershed residents will likely be struck by a similar mixture of shortsightedness and sophistication evident in what we're doing today.

As early as the 1970s *ecology* had become a household word and ecological limits were becoming apparent. Concern in Yamhill County had extended to ground water as withdrawals for irrigation, domestic, and public supplies had increased steadily in recent years. Because withdrawals were expected to continue in the future, information was needed "to aid in the orderly and efficient development of the ground-water resources of the area."

Palmer Creek Irrigation District

The Palmer Creek Irrigation District takes water out of the Willamette River and uses the Creek to distribute it to irrigation users. According to district member Sam Sweeney, this takes place at a pumping station on Wallace Road. The district uses a 300hp pump capable of raising 12,000 to 14,000 gallons per minute and two smaller ones capable of 5,000 gallons per minute each (total capacity: 22-24k gal/min). The water is then channeled to the main branch of Palmer Creek through an old drainage canal that has been reversed in slope to carry water away from, rather than towards, the Willamette. The canal crosses drainage ditches north of Hopewell and enters Palmer Creek near the county line. There are about 40 additional pumps along the system (including canals and Palmer Creek) where the water is removed for irrigation purposes.

About 2300 to 3500 acre feet are metered to irrigation district members at a rate of efficiency of 30-60%. Therefore, the total flow input to the Lower Yamhill watershed of the irrigation district averages an estimated 5111 to 7777.78 acre feet per year.

Sam Sweeney reports there are a few problems, not least of which is that sometimes Palmer Creek is sucked completely dry. Another is the occasional bloom of duck weed and other algae caused by high temperatures. Sam feels shade trees would help in this respect.

Water Rights and Stream Flow

Under Oregon law all water is publicly owned. Before water is 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 Oregon's Water Resources Department (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, commercial use for customarily domestic purposes not exceeding 0.01 cfs (4.48 gallons per minute), livestock, and public in-stream uses. Some stream basins are limited year round to only domestic, commercial uses for customarily domestic purposes not exceeding 0.01 cfs (4.48 gallons per minute), 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 the rivers and streams of the Lower Yamhill watershed are currently over appropriated. This means that the sum of water rights is greater than the estimated flow in the river. If all the area's water rights were exercised simultaneously, the river would be dry. This oversimplifies the hydrology of the watershed, though, because it does not take into account that some portion of the water removed for uses such as irrigation or domestic use 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.

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, though. Therefore, it is difficult to determine the amount of water actually being used.

Map 10 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 shown based upon maps supplied by the 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 and the land may not actually be irrigated.

Well information is available from the well log database maintained by the Oregon Water Resources Department. The contractors who construct the wells supply the data to OWRD by submitting a well log. The well location on some well logs may only be to the closest 40-acre parcel.

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 (usually during the summer months) and water users are not able to get the amount of water they can beneficially use under the 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 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.

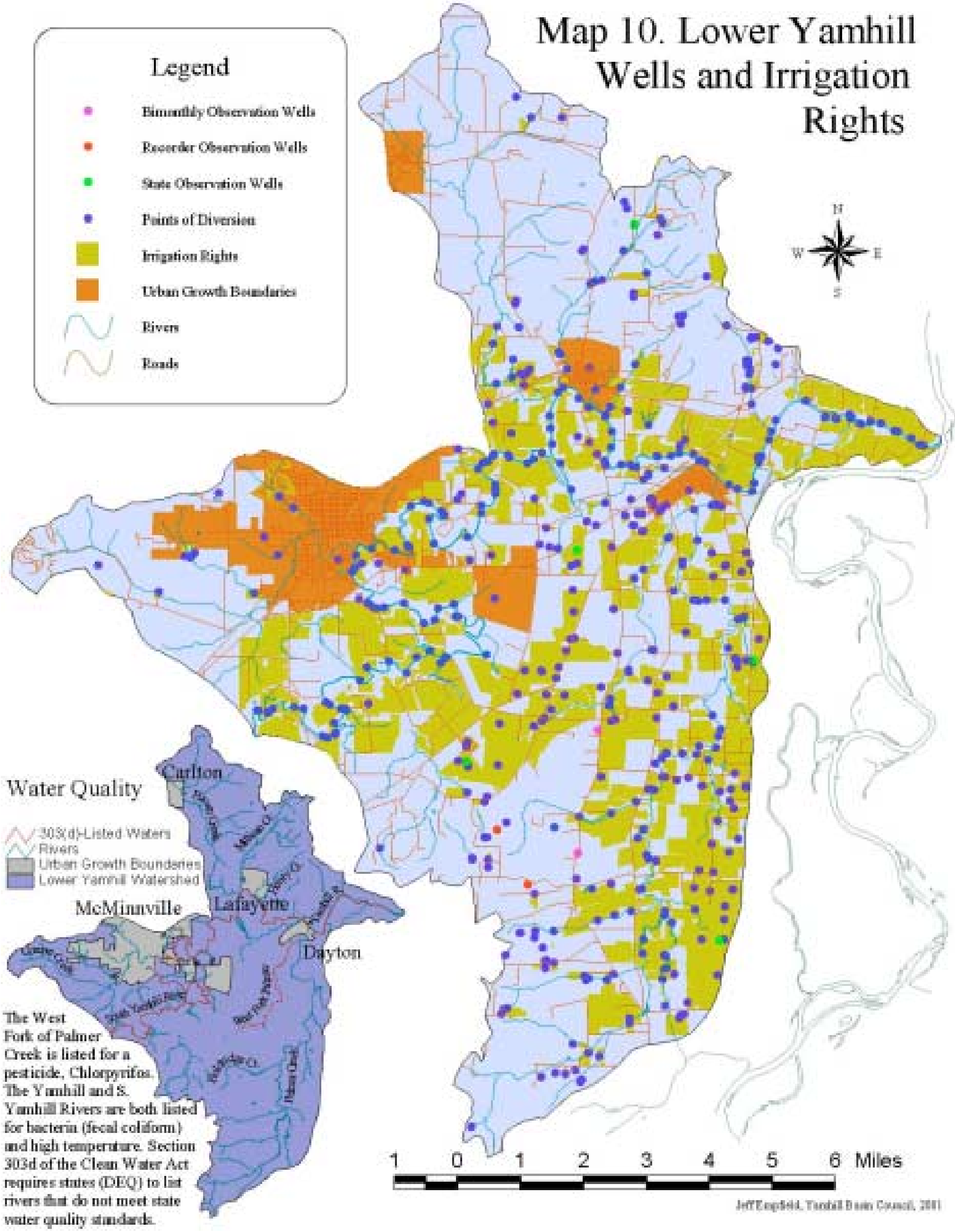
An online introduction to Oregon's Water Law and Water Rights System on the website for OWRD states,

> "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 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.
>
> Instream water rights are not guarantees that a certain quantity of water will be present in the stream. 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)."

According to Bill Ferber, the OWRD watermaster for the area, conflict seldom happens. On paper streams appear over-allocated. In reality users have not been denied access to water. How is this possible? Ferber has three hypotheses: 1) users are not exercising their full right since we have had more evenly distributed rain in recent years or 2) he suspects that 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 removing water during the day.

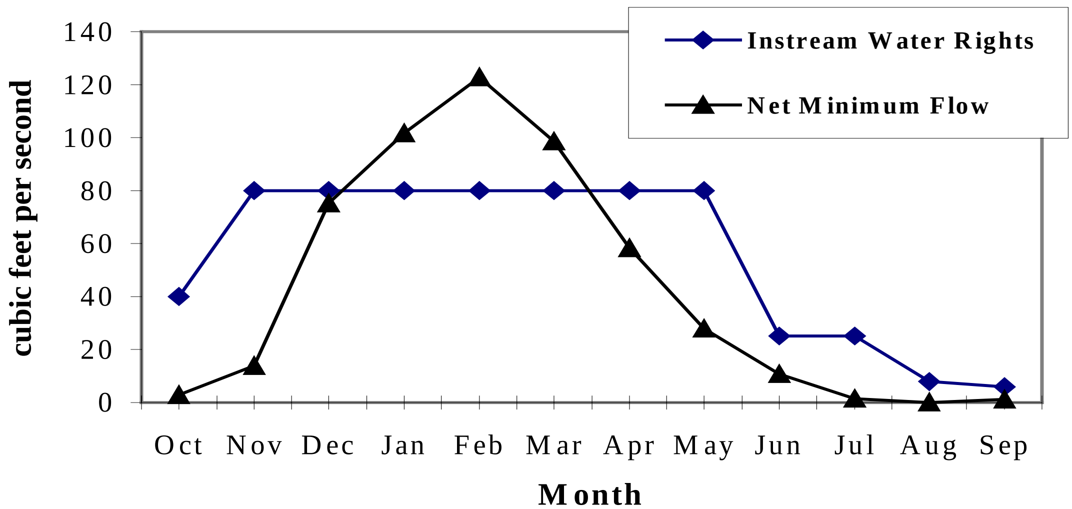
The lack of sufficient streamflow to dilute pollutants and support aquatic life (including salmonids) is an issue throughout the Willamette Basin. This is especially true during the summer when flows are naturally low due to the lack of precipitation in the valley during summer months and the absence of snow melt in the coast range. Consequently, the primary source of water during the summer is groundwater that enters the steams through seeps and springs. This condition is worsened by out-of-stream demands especially for irrigation.

At this time, there are no plans for the basin or 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.



Map 10. Lower Yamhill Wells and Irrigation Rights
Legend
Bimonthly Observation Wells
Recorder Observation Wells
State Observation Wells
Points of Diversion
Irrigation Rights
Urban Growth Boundaries
Rivers
Roads
N
W
E
S
Water Quality
303(d)-Listed Waters
Rivers
Urban Growth Boundaries
Lower Yamhill Watershed
Carlton
McMinnville
Lafayette
Dayton
The West Fork of Palmer Creek is listed for a pesticide, Chlorpyrifos. The Yamhill and S. Yamhill Rivers are both listed for bacteria (fecal coliform) and high temperature. Section 303d of the Clean Water Act requires states (DEQ) to list rivers that do not meet state water quality standards.
1 0 1 2 3 4 5 6 Miles
Jeff Empfield, Yamhill Basin Council, 2001

Figure 4. Typical Net Flow Versus In-stream Water Rights



References

Luella Ackerson, OSU Yamhill County Extension Office, personal communication, January, 2001.

Comprehensive Plan: McMinnville Urban Area, Yamhill County, Oregon, June 1964.

Jerome J. Dasso, *Economic and Population Analysis*, *Yamhill County, Oregon*, Bureau of Municipal Research and Service, University of Oregon, 1967.

Bill Ferber, OWRD, personal communications, December, 2000, January, 2001.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Melissa Leoni, Yamhill Basin Council, unpublished temperature monitoring data, December, 2000.

Don Price and Nyra A. Johnson, Oregon State Engineers prepared in cooperation with The U.S.G.S., Northern Willamette Valley, Oregon, *Selected Ground Water Data in the Eola-Amity Hills Area*, November, 1965.

Sam Sweeney, interview and tour, September, 2000.

CHAPTER NINE

Water Quality

Introduction

This section provides a screening level assessment of the water quality in the Lower Yamhill watershed. This is a broad overview and addresses water issues not examined in the other sections including: temperature, dissolved oxygen, pH, nutrients, bacteria, chemical contaminants, and turbidity. This section provides a starting point to analyze the water quality of the watershed.

The method of analysis for this section involved (1) identifying the beneficial uses for the watershed (2) selecting the appropriate water quality criteria to apply, and (3) assembling existing water quality data for the watershed.

Beneficial Uses

In-stream water quality is maintained to protect "beneficial uses." These are legally defined in the Oregon Water Quality standards to include: domestic water supply, fishing, aesthetic quality, resident fish and aquatic life, salmonid fish rearing, salmonid fish spawning, and water contact recreation. The beneficial uses for watersheds within the Willamette Valley can be seen in Table19.

Table 19. Beneficial Uses for Willamette River Tributaries

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

In most cases, the most sensitive of these uses is maintaining water for the rearing and spawning of salmonids—including cutthroat trout. In the Yamhill Basin cutthroat trout are one of the most important indicators of the overall health of the stream. If they are 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 fry and juvenile fish. They are very sensitive to changes in water quality at these early stages in development.

Oregon set standards to measure water quality under section 303 of the Clean Water Act. When the standards are violated, the stream becomes listed under the 303(d) rules of the Federal Clean Water Act. Listing means the water body is not in compliance with the law, and steps need to be taken to bring it into compliance. The Oregon Department of Water Quality (DEQ) administers the rules and manages the data that caused the stream listing.

Table 20. Water Quality Limited Streams—303(d) List for the Lower Yamhill Watershed

Stream Location	Parameter examined	Criteria	Season of concern	Basis for Listing	Supporting Data
Palmer Creek, West Fork, mouth to headwaters	Toxics	Pesticides (water) Chlorpyrifos,	Year Around	USGS data. Added to list in 1998.	USGS site at Webfoot Road. Chlorpyrifos was found in three out of five samples above water quality standards for chlorpyrifos.
Yamhill River, mouth to confluence of North and South Yamhill Rivers	Bacteria	Water contact, recreation (fecal coliform)	Fall Winter Spring	DEQ data, d1 in 305(b) report (DEQ, 1994); NPS assessment moderate, observation (DEQ, 1988)	DEQ data 46% (33 of 71) FWS values exceeded fecal coliform standard (400) with a maximum value of 2400 between WY 1986-1995.
Yamhill River, mouth to confluence of North and South Yamhill Rivers	Temperature	Rearing of salmonids 64º F (17.8º C)	Summer	DEQ data (Temperature Issue Paper, 1994); NPS assessment moderate, observation (DEQ, 1988)	DEQ data (2 sites: RM 5, 8) 88% (64 of 73) and 83% (15 of 18) samples exceeded temperature standard in WY 1986-1995.
South Yamhill River, mouth to Salt Creek	Bacteria	Water contact, recreation (fecal coliform)	Fall Winter Spring	DEQ data; d1 in 305(b) report (DEQ, 1994); NPS assessment moderate, observation (DEQ, 1988)	DEQ data 27% (19 of 70) FWS values exceeded fecal coliform standard (400) with a maximum value of 2400 between WY 1986-1995.
South Yamhill River, mouth to Salt Creek	Temperature	Rearing of salmonids 64º F (17.8º C)	Summer	DEQ data (Temperature Issue Paper, 1994); NPS assessment moderate, observation (DEQ, 1988)	DEQ data (RM 16.5) 88% (46 of 52) summer values exceeded temperature standard (64ºF) with exceedences each year and a maximum of 81.5ºF in WY 1986-1995.

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 1 million gallons in any 24 hour period. The McMinnville Water Reclamation Facility holds the only major NPDES permit in the Yamhill Basin. There are also a number of minor NPDES permits in the Basin including four for the smaller municipalities (including domestic and industrial wastes), four for forest products industries, and one for a steel rolling mill.

To put this in context, 33 major NPDES sites and 320 minor ones discharge effluent into the Willamette River or its tributaries. Relatively little information is available about the nutrient inputs in these discharges.

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 and are then washed into rivers with relatively low rates of flow. The low summer flow in the river limits 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 such as algea. 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 damaging deposits of silt on gravel spawning beds. It also reduces flood storage volumes by filling in stream beds 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 landscaped areas.
- Bacteria such as E. coli come from human and animal waste and serve as an indicator that waste is present and 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, though, 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 not and either heavier than water or not. 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. It will

generally travel downward until it reaches the water table and then it will move laterally with 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. Concern: changing oil, steam cleaning, degreasing, industrial activities, underground fuel tanks, use of pesticides, use and disposal of 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 species and benthic organisms (like clams). Significant sources of trace metals are industry, leaded gas, and the wearing of brake shoes and tires.

Table 21 provides information from the DEQ database of reaches 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 Environmental Protection Agency is revising its requirements so that the decision whether or not to list will be simplified. Mark adds, though, that the stretches listed in Table 21 deserve more attention and will remain areas of concern for state agencies until shown otherwise.

Table 21. Lower Yamhill Areas of Concern for 303(d) Standards

Stream Section	Criteria	Cause for Concern but not Listed
Cozine Creek, mouth to headwaters	Bacteria	Anecdotal reports of sewers overflowing. More data needed.
Hawn Creek, mouth to headwaters	Sedimentation	Moderate level of concern. More data needed.
	Flow modification	Moderate level of concern. More data needed.
	Bacteria	Moderate level of concern. More data needed.
	Toxics, pesticides	Moderate level of concern. More data needed.
	Dissolved oxygen	Moderate level of concern. More data needed.
	Temperature	Moderate level of concern. More data needed.
	Nutrients	Moderate level of concern. More data needed.
Palmer Creek, mouth to headwaters	Toxics, trace metals	Arsenic, Iron, and Manganese were found above the water quality standards, Table 20 value, once. Minimum Data Requirements were not met (Minimum of two exceedences of a standard and 10% of time are needed). More data needed.
	Toxics, trace metals	Lead and Zinc were found in water, but levels were below the water quality standards. No other trace metals were found. More data needed.
	Toxics, pesticides (water)	Diethylphthalate was found in elevated levels, however, below the water quality standards Table 20 values. Di-n-butylphthalate was found, however, there are no well-established guidelines available for evaluating risks, nor have there been any beneficial use impairment evaluations. No other PAHs, Semi or Volatile Organics were detected. More data needed.
	Toxics, pesticides (water)	Atrazine was found but below water quality standard Table 20 value. No other Pesticides detected. More data needed.
	Sedimentation	Moderate level of concern. More data needed.

	Nutrients Aquatic weeds, algae Dissolved Oxygen Bacteria Temperature	Moderate level of concern. More data needed. Severe level of concern. More data needed. Moderate level of concern. More data needed. Severe level of concern. More data needed. Moderate level of concern. More data needed.
South Yamhill River, Salt Creek to mouth	Sedimentation	Moderate level of concern. More data needed.
	Toxics, trace metals	Copper and Nickel were found in water, but levels were below the water quality standards Table 20 values. No other trace metals were detected. Rationale for not Listing: Did not meet listing criteria. More data needed.
	Toxics, pesticides (water)	Atrazine, Cycloate, Desethylatrazine, Desisoproylatrazine, Diuron, Ethoprop, Hexazinone, Metolachlor, Metribuzin, Napropamide and Simazine were found but either do not have or were below any water quality standard, guidance level or criteria. No other pesticides detected. Rationale for not Listing: Did not meet listing criteria. More data needed.
	pH	DEQ Data (3 Sites: 402623, 402624, 402625; RM 1.0 - 16.5): 0% (0 of 7, 18, 52) Summer values respectively exceeded pH standard (6.5 - 8.5) between WY 1986 -1995. DEQ Data (Site 402625; RM 16.5): 0% (0 of 73) FWS values exceeded pH standard (6.5 - 8.5) between WY 1986 - 1995. Rationale for not Listing: Did not meet listing criteria. More data needed.
	Toxics, water—trace metals (Mercury)	USGS Data (Site at Hwy 99 Bridge): 1 value detected above standard, a minimum of two exceedences needed to be listed - did not meet listing criteria. More data needed.
	Nutrients	DEQ Data (Site 402625; RM 16.5): 0% (0 of 10) May through October values exceeded phosphorus TMDL standard (70 ug/l) with a maximum value of 60 ug/l between 6/94 - 10/95. Rationale for not Listing: TMDL established for phosphorus, approved (12/8/92) and being implemented.
	Chlorophyll a	DEQ Data (3 Sites: 402623, 402624, 402625; RM 1.0 - 16.5): 29% (2 od 7), 0% (0 of 19, 50) Summer values respectively exceeded chlorophyll a standard (15 ug/l) with a maximum value of 20 between WY 1986 - 1995. Did not meet "Minimum Data Requirements," data did not exceed the 3-month average criteria. More data needed.
	Dissolved Oxygen (DO)	DEQ Data (Site 402625; RM 16.5): 0% (0 of 123) Annual values exceeded dissolved oxygen standard (6.5 mg/l) between WY 1986 - 1995 (Cool water fishery, annual). Rationale for not Listing: Did not meet listing criteria. More data needed.
	Bacteria	DEQ Data (Site 402625; RM 16.5): 4% (2 of 46) Summer values exceeded fecal coliform standard (400) with a maximum value of 1100 between WY 1986 - 1995. Rationale for not Listing: Did not meet listing criteria. More data needed.
Yamhill River, mouth to confluence of North and	Flow Modification	Severe level of concern. More data needed.
	Toxics, pesticides (water)	Diethylphthalate was found in elevated levels, however, below the water quality standards Table 20 values. Di-n-butylphthalate was

South Yamhill Rivers		found, however, there are no well-established guidelines available for evaluating risks, nor have there been any beneficial use impairment evaluations. No other PAHs, Semi or Volatile Organics were detected.
	Toxics, pesticides (sediment)	Total Dioxin and Furans were found in sediments, but below various guidelines or guidance values. No beneficial use impairment evaluations are available that show a toxicity problem. Further studies would be needed to determine if there was any toxicity.
	Toxics, pesticides (sediment)	Antimony, Arsenic, Chromium, Copper, Manganese, Nickel and Zinc were found in elevated levels in sediments when compared to various guidelines or guidance values, however, sediment toxicity does not correlate well with sediment contaminant concentrations and is dependent on local conditions. To determine toxicity a demonstration of a beneficial use impairment is needed. No data on beneficial use impairment (e.g. bioassays) is available. For constituents in sediment there is no singletype of sediment-quality guideline generally accepted in the scientific literature. More data needed.
	PH	DEQ Data (Site 402031; RM 5.0): 0% (0 of 12) May through October values exceeded pH maximum standard (6.5 - 8.5) between WY 1994 - 1995. Rationale for not Listing TMDL has been established for phosphorus, approved (12/8/92) and is being implemented.
	Nutrients	DEQ Data (Site 402031; RM 5.0): 80% (8 of 10) May through October values exceeded phosphorus TMDL standard (70 ug/l) with a maximum value of 2.7 ug/l between 6/94 - 10/95. Rationale for not Listing TMDL established for phosphorus, approved (12/8/92) and being implemented.
	Chlorophyll a	DEQ Data (2 Sites: 402031, 402601; RM 5.0, 8.0): 31% (22 of 72), 25% (4 of 16). Summer values respectively exceeded chlorophyll a standard (15 ug/l) with maximum values of 61, 47 between WY 1986 - 1995. Rationale for NOT Listing: TMDL has been established for phosphorus, approved (12/8/92) and is being implemented.
	Dissolved Oxygen(DO)	DEQ Data (Site 402478; RM 5.0): 4% (6 of 145) Annual values exceeded dissolved oxygen standard (6.5 mg/l) with a minimum of 5.4 mg/l between WY 1986 - 1995 (Cool water fishery, annual). Rationale for NOT Listing: Did not meet listing criteria, Water Quality Based Permit. More data needed.
	Bacteria	DEQ Data (Site 402031; RM 5.0): 5% (3 of 59) Summer values exceeded fecal coliform standard (400) with a maximum value of 1100 between WY 1986 - 1995. Rationale for NOT Listing: Did not meet listing criteria. More data needed.
	Sedimentation	Moderate level of concern. More data needed.

(Oregon Department of Environmental Quality website)

Nutrients

Total phosphorus is a way to measure the amount of phosphates in the water column and phosphorus in suspended organic material. Total nitrate is a way to measure the majority of nitrogen present in the water. Scientists identify the two as the major limits to plant growth. If there are excessive amounts of phosphorus and nitrates, 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 livestock and wildlife.

A Total Maximum Daily Load (TMDL) for phosphorus has been established for both the South Yamhill River and the entire Yamhill Basin by DEQ and was approved in December of 1992. This TMDL is in the process of being implemented to control phosphorous at point sources through, for example, improved municipal water treatment.

Fecal Coliforms

Fecal coliforms are microorganisms that indicate when feces (animal or human) is present in the water and warn us of the associated pathogenic health hazards. Sources of fecal coliforms include faulty septic systems, runoff from animal husbandry, wastewater treatment facilities, and wild animals.

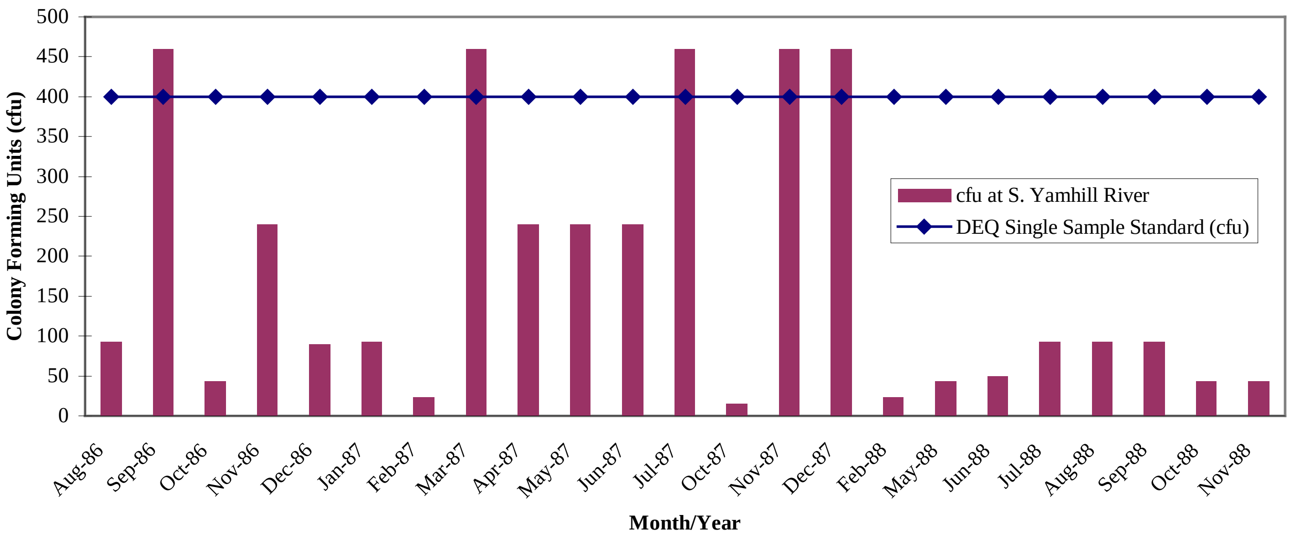
In April, 1989 the city of McMinnville sampled water quality in preparation for it's storm water master plan and found that there was abnormally high levels of fecal coliform in the North Tributary of Cozine Creek and a high level of nitrogen in the main branch of Cozine. Interestingly, the nitrogen was highest where Cozine enters the city from agriculture lands and decreased as it passed downstream from that point.

Fecal Coliform bacteria are to be expected in all surface streams. In-stream concentrations less than 100 colonies per 100 ml are considered to be low and concentrations over 1,000 are considered to be high. The concern when levels are high is that it is that other more dangerous pathogens may be present. High concentrations are not generally caused by normal surface activity in the watershed but rather by such specific contributors as failed septic systems, leaking sewer pipes, combined sewer overflows, feedlots, or by a dead animal in the stream.

According to the 1979 *Natural Resource Conservation Plan* of the Yamhill County Soil and Water Conservation District, failing septic systems are a significant source of pollution in the county. According to soil surveys, 93% of the soils in Yamhill County severely limit the functioning of septic systems. Consequently, this acts as a limitation for residential development. 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 conversely in foothills areas that are too steep for installing drainage fields.

Since the time of this listing, DEQ has changed the fecal indicator from the bacterial group of fecal coliforms to a subset of that group known as *Escherichia coli* (E.coli). The change is intended to improve the accuracy of the standard. Fecal coliform standards will be established for the Yamhill Basin using this new technique during the total maximum daily load (TMDL) process scheduled for 2007. This process will assess the 'natural' or background concentrations of fecal pollution and then establish a threshold by which the watershed will be monitored. Fecal coliforms and E. coli are common in the environment and by themselves are not necessarily dangerous to human health. Rather, they serve as indicators for the presence of raw sewage when found in high concentrations. They indicate that other dangerous pathogens and bacteria may be present.

Figure 5. South Yamhil River Fecal Coliform Data from DEQ (1986-88)



Sewage Treatment

In 1996 the City of McMinnville completed its new $28,000,000 Water Reclamation Facility (WRF). The new plant not only removes bacteria, which most municipal treatment facilities address, but it also goes one step further by dealing with nutrients which were reaching unacceptably high levels during low flow summer months. According to Environmental Services Supervisor Don Young, the new facility in McMinnville was designed and built with ammonia and phosphorous in mind. Dallas, Newport, and Silverton have emulated McMinnville's design in their new treatment plants.

Lafayette is also planning a new biological nutrient removal facility similar in design to McMinnville. It is scheduled to be completed in 2003. Currently Lafayette uses an activated sludge, extended aeration system that has been in operation since 1975. Beginning in1964 they treated their wastewater with a multiple cell lagoon system, not unlike what is used for dairies, feed lots, and other high concentrations of livestock.

In 1965 Dayton began wastewater treatment with a two-cell lagoon system and increased the treatment to a five-cell system in 1980. The system works well for Dayton and can service a population of up to 3000 persons. The current population is about 2000.

All treatment systems involve bacterial growth—this is a useful tool for consuming nutrients under the controlled conditions of a treatment facility. In the environment, bacteria are everywhere and that is natural and good but certain bacteria can threaten the health of plants and animals, including humans. This is especially true of bacteria associated with human waste because as living organisms, these bacteria are constantly evolving and some of the ones that live inside humans evolve to be pathogenic to humans. A related variable is the volume of water in Yamhill River which fluctuates widely from over 40,000 cubic feet per second (cfs) during winter storms to virtually nothing in late summer.[8] High flows effectively dilute discharges to the river while during low flows discharges to the river have more of a potential impact. Consequently, the managers of the McMinnville Water Reclamation Facility monitor nutrients and bacteria during the summer near the USGS gaging station at Three-mile Lane bridge over the South Yamhill and at the confluence of the Yamhill and the Willamette.

Among the innovations in wastewater treatment incorporated in McMinnville's WRF is an additional clarifying tank and several creative approaches to absorbing odors. The design of the plant includes using fruit tree wood chips to create a "biofilter" to absorb odors coming off a liquid compost that consumes nutrients essentially by growing bacteria. This bacteria is then harvested and given away to hay farmers for fertilizer. There are also about 1500 poplar trees that now grow around three sides of the property—their leaves absorb odors and they receive treated irrigation water in the summer. Unfortunately it would take about 1000 acres of poplars to absorb all of the summer discharge of treated water. Consequently, most of the treated water still goes to the South Yamhill River.

Most treatment plants only deal with toxicity, solids, and bacteria. McMinnville needed to reduce the summer outflow of nutrients, though, especially phosphorous because it is a limiting factor for algal growth. Algal blooms can take over a body of water to the detriment of other living organisms. In the past they have been a problem on the Yamhill and South Yamhill River where McMinnville's treated water goes. Surprisingly, phosphorous is not an identified issue downstream on the Willamette River.

Ammonia is removed biologically at the WRF; basically bacteria in the treatment system metabolizes it. Instead of metabolizing phosphorous, bacteria incorporate it into their bodies, not unlike the carbon sequestration in trees currently being promoted as a treatment for greenhouse gases. The phosphorous can then be removed by taking out a portion of the bacteria to be used as fertilizer. In McMinnville this exported fertilizer amounts to about 5000lbs/day. The facility also exports bio-solids—don't call it "sludge." Bio-solids have a reduced volatility compared to sludge and are usable as a non-food crop fertilizer.

The tertiary clarifier is the pride of the facility. Most municipal treatment only has two levels. This one goes one step further by circulating wastewater through a settling tank during summer months to take out additional phosphorous and heavy metals. According to Don Young it makes the treated water as clean or cleaner than any other treated water in the country. Even so, the water is still slightly below drinking standards because it still has some pathogens in it. The tertiary clarifier is only used in the summer when the plant can't discharge secondary treated water into the South Yamhill River. In the winter time, treated water goes into the river after the secondary treatment because river volumes are higher and phosphorous is less of a concern.

Not only is the volume of the river higher in the winter, but so is the amount of wastewater coming into the plant. The reason is that some storm water still enters the system. The plant can

[8] The Yamhill River peaked at over 47,000 cfs during the 1996 flood. In contrast, September flows typically drop to only ~10cfs or less.

handle up to 32 million gallons per day but sometimes levels exceed that during winter storms. To stay below this maximum capacity it is imperative that McMinnville phase out combined storm/wastewater drainage and manhole covers with holes in them that drain storm runoff when streets become inundated. In part of McMinnville's downtown area stormwater is still combined with sewage pipes in one network and is conveyed to the sewage treatment plant via lift station pumps. During heavy rainfall, the capacity of these lift stations is sometimes exceeded and the excess overflows directly to the South Yamhill River. Under normal flow conditions both stormwater and sanitary flows entering combined sewers can be treated at the reclamation facility. Nonetheless, 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. Towards this end, newly installed drain pipes discharge directly to creeks. Eventually all the combined pipes will be replaced and only the sewage lines will flow to the plant. McMinnville replaces these combined sewers as funds become available and only a relatively small area of combined pipes remain.

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. This is also a concern in Dayton where the treatment facility works well and has an adequate capacity for the size of the community but receives volumes above capacity during heavy rain.

Temperature

High temperatures affect native fish by stressing them in a variety of ways and even leading to death in many cases. Above their normal range of temperatures salmon and trout experience an increased metabolism so that they cannot eat enough to maintain their body weight. Further exacerbating this for salmonids is the fact that they lose their appetites and become less competitive in catching food at abnormally high temperatures.

Table 22 shows Yamhill Basin Council and McMinnville WRF temperature monitoring data for the year 2000. Watershed Coordinator Melissa Leoni implemented a temperature monitoring program in association with the Oregon Department of Environmental Quality (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. In order to verify the accuracy of the thermometers, Melissa visited the sites periodically throughout the season to audit temperatures using another thermometer and to make sure the thermometers were still in the water. Despite these efforts, several stream water levels fluctuated causing the thermometers to record air temperatures. On August 13, for instance, the data for Hawn Creek showed high and low spikes, suggesting that it was exposed to air temperatures instead of remaining submerged below water. Although this invalidates the data in a regulatory sense, it is still useful for informing us what temperature conditions are in the Lower Yamhill watershed. One redeeming correlation is that other streams in the Yamhill Basin had their seasonal seven-day maximum around the same day (August 1).

The West Fork of Palmer Creek had similar problems. Melissa did an audit on August 16 and the thermometer was in place. Then on August 17, the recorded temperatures were suspiciously extreme indicating that fluctuating water levels exposed the thermometer to air temperatures. When this happens, DEQ recommends splitting the data into two sets for analysis by a computer program. The first set of data contains the necessary two endpoints (installation and audit) so the first set (7/22 to 8/16) is valid and can be used by DEQ—it also contains the seasonal seven-day maximum which is significant for determining Total Maximum Daily Load (TMDL) for temperature. The second set, like the data for Hawn Creek, is not acceptable for regulatory purposes but still contains valuable information such as the seasonal minimum temperature.

Table 22. Stream Temperatures in the Lower Yamhill Watershed

Temperatures are in degrees Fahrenheit		West Fork Palmer Creek 7/22/00-8/16/00	West Fork Palmer Creek 8/18/00-10/4/00	Hawn Creek 7/22/00-10/4/00	South Yamhill River #6750 06/24/00-10/15/00	South Yamhill River #6751 06/24/00-10/15/00
One-day Extremes	Maximum	70.5º (7/31/00)	65.8º (9/19/00)	84.0º (7/30/00)	78.6º (8/05/00)	78.1º (7/31/00)
	Minimum	58.1º (8/16/00)	52.0º (9/28/00)	52.7º (8/11/00)	56.3º (10/15/00	55.9º (10/15/00)
	Maximum Change in Temp.	7.7º (7/30/00)	6.7º (8/20/00)	22.9º (8/11/00)	4.5º (7/16/00)	4.3º (7/16/00)
7-Day Average Extremes	Maximum	68.7º (7/29/00)	64.2º (9/17/00)	80.7º (8/01/00)	78.2º (8/06/00)	77.6º (8/03/00)
	Minimum	63º	61º	65.1º	75.2º	75.6º
	Change in Temp.	5.6º	3.2º	15.6º	3º	2º
Number of Days	>55º	26 days	45 days	24 days		
	>64º	23 days	3 days	24 days		
	>70º	2 days	0	23 days		

(Yamhill Basin Council, 2000, McMinnville Water Reclamation Facility, 2000)

The maximum seven-day average temperature standard for the Yamhill Basin is 64°F. This means that over any seven-day period, the average daily stream temperature ideally will not exceed 64°F. The South Yamhill River, the West Fork of Palmer Creek, and Hawn Creek exceeded this standard in the summer of 2000. 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 species of fish exhibit different tolerances according to OWEB.

When DEQ begins working on the TMDLs for the Yamhill Basin they will examine temperature and determine if 64°is an attainable temperature for the watershed. Critics say that historically the Yamhill River and it's tributaries exceeded 64°under natural conditions. Unfortunately, there is no historic temperature data to confirm or refute this.

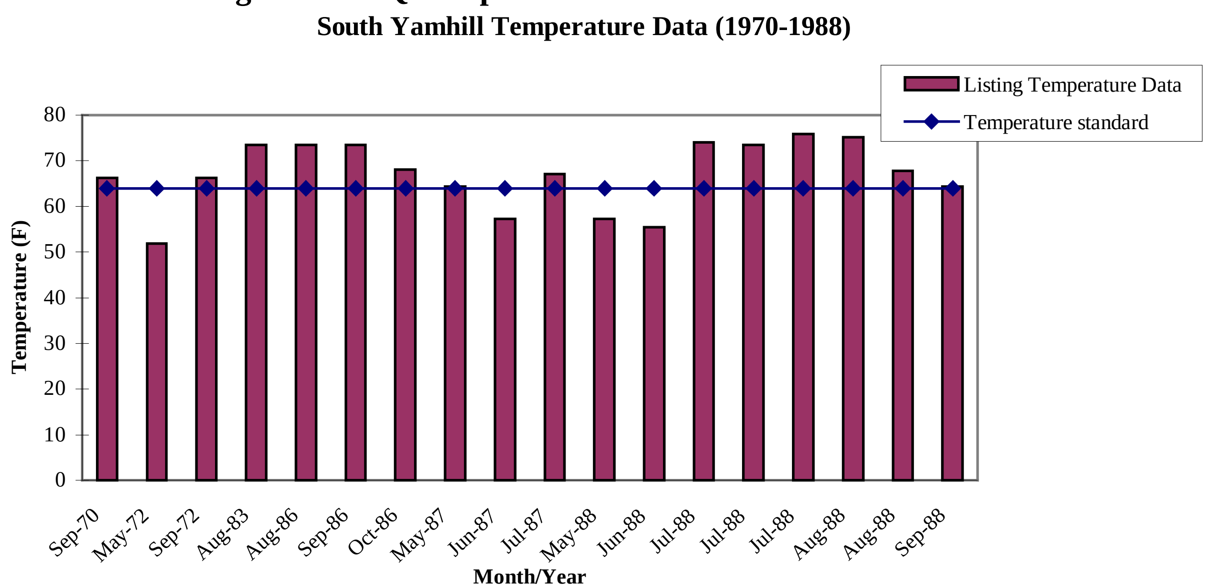
There is no dispute that water temperature influences the aquatic ecosystem, including the composition of the biological community and the chemical behavior of the system. Most living organisms have adapted to and tolerate only limited temperature ranges. For example, water temperatures exceeding 20ºC are dangerous for salmonid species and temperatures exceeding 25ºC can be lethal.

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. For the screening level of this assessment, the level of DO that is desired is 8mg/L or above. On the South Yamhill river, samples range from 8.5 mg/L to 13.5 mg/L with the majority of the samples in the 9.0 mg/L to 10.0 mg/L range, which is also meets the standard.

Figure 6. DEQ Temperature Data for S. Yamhill River



pH

pH measures the hydrogen ion concentration in water which means it indicates the relative acidity or alkalinity. pH values greater than seven (>7) indicate alkaline conditions and those less than seven (<7) indicate acidic conditions. Knowing the pH of water tells us how available nutrients are and how toxic chemicals may be. 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 because water having a pH value outside of this range is toxic to freshwater organisms. The South Yamhill River pH ranged from 6.9 to 7.9 in ODEQ data from 1970 to 1988 taken from the Whiteson location at the same time as the temperature and DO readings. 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 water clarity. It can be caused by runoff of sediment or by suspended material such as algae. Turbidity is measured by recording the amount of light that passes through a water sample. High values (>50 Hach FTU) indicate high amounts of suspended sediments or particles in the system. Sediment affects salmonids by damaging their gills and reducing their ability to sight their prey. Sediments also clog the gravels salmonids use for spawning.

Data recorded by DEQ from 1986-88 showed turbidity levels in the South Yamhill River near the Whiteson gaging station between 1.0 to 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 rest of the streams in the watershed. The one exception is the West Fork of Palmer Creek which became 303(d) listed in 1998 for having toxic chemicals in the water. Researchers found a high concentration of a pesticide called chlorpyrifos at the USGS site at Webfoot Road. Chlorpyrifos was found in three out of five samples in concentrations above the minimum water quality standards.

In general, there are several different pesticides likely to exist in the streams and rivers of the Yamhill Basin. The most commonly found pesticides in the Willamette basin are atrazine, desethylatrazine, simazine, metolachlor, and diuron. Urban areas contributed significantly to the chemicals present in the watershed areas studied.

Given the dominant upland vegetation and crops present, there are likely to be a number of agricultural contaminants in the water. According to Susanne Aldrich Markham of the OSU Extension Service out of 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 doesn’t 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 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.

The data available on pesticides is beyond the scope of this document and could not be easily summarized. Further information on effects of pesticides on aquatic life can be found by downloading the report found at: http://www.pond.net/~fish1ifr/salpest.htm

References

Bruce Bilodeau, City of Dayton, personal communication, January, 2001.

Bernadine A. Bonn, Stephen R. Hinkle, Dennis A Wentz, and Mark A. Uhrich, *Analysis of Nutrient and Ancillary Water-Quality Data for Surface and Ground Water of the Willamette Basin, Oregon, 1980-90*; U.S.G.S. Water Resources Investigations Report 95-4036; Portland, 1995

Mark Charles, DEQ, personal communication, February, 2001.

CH2M Hill, David J. Newton Associates, Inc., *City of McMinnville Storm Drainage Master Plan,* March 1991.

Richard D. Ewing, *Diminishing Returns: Salmon Decline and Pesticides.* Oregon Pesticide Education Network. February 1999.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

Sue Hollis, City of Dayton, personal communication, January, 2001.

Sam Sweeney, personal communication, January, 2001.

Leoni, Melissa Yamhill Basin Council, personal communication, January, 2001.

Natural Resource Conservation Plan, Yamhill Soil and Water Conservation District, Yamhill County, Oregon, 1979.

Boots Ward, City of Lafayette Sewer Plant, personal communication, January, 2001.

Don Young, Environmental Services Supervisor, interview and tour of the McMinnville Water Reclamation Facility, September, 2000, personal communication, January, 2001.

CHAPTER TEN

Fish Habitat and Barriers

Introduction and Methodology

The objectives of this section are to identify historical and current fish populations in the watershed, current locations of these species, and to evaluate the current fish habitat conditions. The Yamhill Basin has 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. These and other native species would benefit from restoration of water quality and habitat in the watershed.

Cutthroat trout are the most plentiful and widespread native salmonid in the Yamhill Basin, though. Needless to say, they play an important role in the aquatic ecosystem. Since they're more widely distributed 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 salmonids and fish species in general in the Lower Yamhill watershed.

Fish History

There is a great deal of historical fish population information for the region, though there is little available specifically for the Yamhill Basin. What we do have, though, is a lot of local knowledge regarding fish and anecdotal evidence suggests habitat and populations are decreasing in some areas of the Lower Yamhill watershed. For example, according to lifelong resident Sam Sweeney, both the East and West Forks of Palmer Creek had trout populations in the early 1900s. "It was recognized that the best time to fish the forks was early in the spring," he says, "usually before the official season opened." As a teenager Sam caught trout as late as May. Oden Morgareidge recalled his father saying that if you wanted to catch enough trout for supper, you'd go down to the West Fork of Palmer. But if you wanted more, you went to the East Fork. The description makes sense to Sam because the East Fork is larger. It is reasonable to surmise, based on first-hand accounts, that prior to European American settlement fish populations were higher and possibly more diverse in the watershed.

Historically, in-stream habitat was different from present conditions. 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.

The Yamhill Basin has supported large numbers of salmonids, though the variety of species has been influenced by Willamette Falls (at Oregon City) which limited certain anadromous fish species to the Lower Willamette and Columbia Rivers since time immemorial. In spite of this obstruction, many tributaries of the upper Willamette have a variety of salmonids, even some anadromous species such as steelhead and chinook. Significantly, we know that these populations are currently in decline indicating degraded water quality or habitat or both.

Salmon, trout, and other native populations were likely affected by the lock and dam built on the Yamhill River by the U.S.Army Corps of Engineers in 1902. It is located one mile upstream from Lafayette. Fish biologists hypothesize that this dam decreased the anadromous fish population in the basin because the dam was not sufficiently passable for fish. Although a fish ladder of sorts was constructed, it was not kept in good repair. The dam remained in use until the 1960s when it was decommissioned. With a sophisticated highway system in place, it was no longer needed to impound water for barge transportation. Ruins of the dam and lock remain at the site.

The list in Table 23 is a general fish list for the Yamhill Basin. These are native species that are found or are likely to be found in the rivers and streams of the watershed given the habitat, water quality, and what ODFW has found in other similarly sized streams. It is important to note that some of these species may only be present seasonally. The list is general and uses the most common names. Also, it doesn't include all commonly found species, only the native ones. For example, coho salmon, catfish, mosquitofish, large and smallmouth bass, and crappie are all common to the Yamhill Basin but they are non-native, introduced species. There may be other introduced species, as well.

Table 23. Native Aquatic Species Likely to be Found in the Yamhill Basin

Aquatic species (common name)
Winter steelhead salmon
Cutthroat trout
Sculpin
Dace (speckled, longnose, etc.)
Redside shiner
Threespine stickleback
Pacific lamprey
Brook lamprey
Northern pike minnow
Sucker
Spring chinook salmon
Crayfish

It's interesting to note that as early as 1962 the Yamhill County Economic Development Committee found that all fish populations were decreasing in the Basin 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 and other types of pollution. "The establishment of minimum flows and elimination of pollution are the most important things needed to increase the fish population," they wrote. They finally noted that "treatment of the waters with Rotenone and Toxaphine is about the only successful way to eliminate trash fish" whose populations were increasing.

Fish Hatcheries

The ODFW stocking program of the latter half of the 20^{th} 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, therefore these fish would not have been found in the Yamhill Basin without 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 before adverse impacts to other species became apparent. Releases occurred from the 1950s to the 1980s, though there were none in the South Yamhill after 1974. Generally releases occurred in headwater streams (as opposed to the Lower Yamhill) for reasons of water quality and habitat. Watershed-specific data for these releases appear in the other 5^{th} field assessments for the Yamhill Basin.

Certainly many hatchery fish found there way to the Lower Yamhill, if for no other reason than to pass through on their way to the ocean. It is likely that some of these fish found their way back to the Yamhill Basin to spawn in subsequent years. All anadromous fish releases in the Basin have potentially had some relation to the Lower Yamhill watershed, though spawning and other resident activity likely takes place upstream in cooler, cleaner waters.

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

Cutthroat Trout

Cutthroat trout are native in the Yamhill Basin 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 the Yamhill Basin tend not to migrate.[9] 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 a little more difficult to discern. Of course, juvenile populations and habitat surveys can still get at the question in the case of anadromous species.

[9] “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.

Table 24. Yamhill River Basin Stocking History Summary Table

Fish Species	A=Anadromous R=Resident	Native	Non-native	Stocking Notes
Winter Steelhead Trout (*Oncorhynchus mykiss*)	A-Winter/Spring spawn	X		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		X	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	X		Neither currently nor historically stocked.
Rainbow trout (*Oncorhynchus mykiss)*	R		X	Hatchery rainbow trout released to create fishery. Early as 1920s, 30s. until 1980s. No evidence of natural reproduction.

Table 25. Summary of Fish Life History Patterns

Fish Species	Location	Spawning	Interesting Notes
Winter Steelhead (*Oncorhynchus mykiss*)	Present in the S. Yamhill, the N. Yamhill (and its tributaries), and the Yamhill River.	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)*	Spawning surveys from 60s and 70s, suspecting spawning area: S. Yamhill River miles 7.0-15.5	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)*	Occur in most perennial streams, in some intermittent streams. Prefer smallest, highest tributaries in a basin.	Variable spawning and migration. Potanadromous cutthroat migrate into small headwater streams in fall/winter, spawn, return to larger streams. Some do not migrate at all. Some migrate to estuaries.	Only native trout in basin. Prefer slow moving water, overhanging vegetation.

Fish Habitat

According to the StreamNet website, the South Yamhill and Yamhill Rivers are winter steelhead habitat. According to Gary Galovich of ODFW, this does not necessarily mean the 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 and several of its tributaries. This all suggests at least transient presence of winter steelhead in the Lower Yamhill watershed.

Stream surveys done by ODFW in the 1980s did not find salmonids on streams in the Yamhill Basin.[10] Again, Galovich cautions surveys performed at one point in time do not take into account the dynamics of fish life cycles. There is no continuous fish monitoring program on any stream in the Yamhill Basin. If a species isn't found in a stream on a given day, that doesn't necessarily 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's 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 ourselves) with a view to the whole ecosystem.

Fish Barriers

Fish barriers are either natural or human-created obstacles that impede the passage of fish. Barriers include culverts, dams, waterfalls, logjams, and beaver ponds. This has obvious repercussions for anadromous fish. Unobstructed, anadromous fish could move through the Yamhill Basin from headwater streams to its mouth on the Willamette River and beyond. Barriers can impact all aquatic species, though. Changes in habitat, population, or water quality conditions create pressures to relocate for more favorable conditions. Therefore, barriers are significant for all aquatic organisms including both anadromous and resident fish species.

Major impacts of fish barriers on resident, non-migratory populations 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 resident fish populations. Barriers can prevent the recolonization of these habitats.

Culverts that act as fish barriers on state and county roads and their locations are reported on an ODFW database. The ones reported for the Lower Yamhill watershed are all classified as low or medium priority. They are described in Table 26 below. Numerous studies, including ones

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[10] To survey a stream for spawning salmon, ODFW personnel walk the streams looking for evidence of fish presence and make notes on the condition of the habitat. They count live fish, spawned-out fish (mortalities), and "redds," or the gravel mounds created by fish at spawining sites.

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, 96% of the barriers identified were culverts associated with road crossings.

Fish Passage Criteria

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/absence of a pool;
- Pool depth, if present, (in inches);
- Distance (inches) of drop, if any, 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 (drop) into the culvert; 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 contained substrate;
- Whether water runs beneath the culvert at the upstream end of the culvert (a problem for downstream migration of juvenile fish in low water);
- Fish size (juvenile, adult or both) likely to be hindered;

Table 26. Fish Passage Barriers on Public Roads in the Lower Yamhill Watershed

Stream Name/Number	Priority	Comment
Ford St. crossing of Cozine Cr. McMinnville owned 0.3 miles from college	Medium	Lower end is submerged, high velocity entering upper end. May need larger culvert.
Cozine Creek Elmwood St. crossing	Medium	Owned by City of McMinnville
Palmer Cr. 459 crossing	Low	Possible velocity barrier.
Millican Cr. 208 crossing 0.1 mi. from Abbey Rd.	Medium	Below culvert is 10' concrete slide w/ slope of 3%. Lower end of slide has the 30" step. Beaver pond above.
Henry Cr. 99W crossing	Low	Culvert slope estimated due to curve in culvert. Velocity at upper end appears prohibitive. Culvert 0.5 mi. below reservoir.
Unnamed trib of Palmer	Low	Crossing 0.2 miles south of Kirkwood Rd. Lower end corroded with holes. Possible step barrier.

Yamhill County Public Works Bridge Supervisor Susan Mundy reports that the county regularly checks and clears culverts. When they do so they also record information relating to fish passage in an effort to compile a local database on all county road culverts.

References

Coast Range Sub-watershed-Fish Management Plan, Oregon Department of Fish and Wildlife, Portland, OR, 1992.

Gary Galovich, ODFW, personal communication, December, 2000.

Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.

A. Mirati, *Fish Passage Culvert Database from ODOT and County Roads,* Oregon Department of Fish and Wildlife, Portland, OR, 1999.

Susan Mundy, Yamhill County Public Works, personal communication, November, 2000.

Janet Shearer, ODFW, personal communication, October, 2000.

A Snapshot of Salmon in Oregon, Oregon State University Extension Service (OSUES) Publications, OSU, Corvallis, OR, 1998.

CHAPTER ELEVEN

Restoration and Enhancement

Introduction

Before beginning a restoration or enhancement project, it is valuable to evaluate approaches to design and some of the local efforts already underway. Coordination, monitoring, and subsequent fine tuning will increase the likelihood of having a positive impact. These efforts will also help generate new restoration designs and provide opportunities to increase awareness of the issues.

One source of information concerning restoration efforts comes from first-hand accounts of restoration practitioners—landowners and land management professionals—who report on a voluntary basis to the Oregon Plan Watershed Restoration Inventory. Unfortunately, few Oregonians are even aware of the existence of this database. Each year the folks at the Oregon Watershed Enhancement Board (OWEB) publish an annual report summarizing restoration efforts statewide including the Yamhill Basin. It is a valuable tool for anyone who wants to either encourage restoration by offering their project as a model or for those who are interested in examples before designing a project for the land they manage. If you are a landowner or land manager who would like to learn more about this voluntary data base, 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.

The USDA Service Center in McMinnville is another excellent starting point for citizens. There you can tap into the resources and expertise of the U.S.Department of Agriculture, the Natural Resource Conservation Service (formally the Soil Conservation Service), and the local Soil and Water Conservation District. Advice, design consultation, plantings, and sometimes even partial funding can be garnered there. People from one or more of these agencies were involved in most of the projects reported in the database. It's up to the individual landowners whether or not to contact the database, though, as government employees do not provide information on individual projects without the landowner's authorization.

For additional information on USDA program eligibility contact:

USDA Service Center
2200 SW 2nd Street
McMinnville, OR 97128
By phone: (503) 472-1474

Yamhill Soil and Water Conservation
2200 SW 2nd Street
McMinnville, OR 97128
By phone: (503) 472-6403

Passive and Active Restoration

Passive restoration can be the easiest thing in the world. It's as straightforward as letting nature alone to recover over time from disturbance through natural succession and evolution. Its remarkable how 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. The risk in such an approach is that we often misidentify the cause of the problem and instead only treat the symptoms. This almost never works. In most cases we can save time, money, and ecological integrity simply by identifying the problem and curtailing its causes. Passive restoration involves simply ending the ongoing source of disturbance.

For example, where domestic animals have access to streams we can install off-stream watering for livestock and allow the stream to recover naturally. That's what Jim and Linda May and their neighbors did on their land along Millican Creek. They operate their 22 acres as a retreat center and have been managing it for ecological and aesthetic values. When they noticed that a herd of cattle was hanging out in the creek just upstream of their four acre pond, they contacted their neighbors to work out a solution. The folks at The Trappist Abbey of Our Lady of Guadalupe agreed that it would be simple enough to water the cattle off stream and now keep the cows fenced out of the riparian area.

In another area the Mays are pursuing active restoration by planting vegetation to stabilize the stream bank. They were concerned about erosion taking place along the stretch of Millican 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 community and consequently require less care to become established. Of course, 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 watershed 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 (LWD). What's more, without adequate mature trees in the riparian zone, these streams will not receive LWD 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 than passive ones 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. An active restoration project as simple as planting riparian vegetation is less likely to produce negative results than, say, reshaping the streambed with a bulldozer.

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. The following description of preexisting conditions was written by a biological consultant hired to help the company meet Department of State Lands requirements:

> "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."

Hydric soils are those that have formed under wet conditions. They characteristically have high water tables, are ponded or flooded frequently, or are saturated for extended periods during the growing season. It is important to consider as much as possible of what we can discern about natural conditions (or their functions) in any restoration effort, especially active restoration that changes land contours, hydrology, and vegetation cover.

Design

For most active restoration projects, the costs of heavy machinery, labor, and infrastructure 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, and with an eye to how the ecosystem responds is preferable.

In 1956 the distinguished systems theorist Herbert Simon coined the word "satisficing" to describe solutions that both satisfy and suffice. He observed that in nature "organisms adapt well enough to 'satisfice'; they do not, in general, 'optimize.'" Not all at once, at least. To optimize a solution in one fell swoop requires understanding and analysis "several orders of magnitude more complex" than that required for satisficing. Organic systems are, in fact, remarkably optimized but they reach that condition (and sustain it) through a multitude of 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. Instead, understand that only by fine tuning your use of the land and water repeatedly over a long period of time can you imitate evolution.

Allan Savory, a leading proponent of rotational grazing, has gained international recognition for identifying problems with conventional land use and for advocating an alternative he calls "holistic management." He says that in current Western problem solving, such as that involved in natural resource management, we typically design a system and then put all our effort into defending and maintaining it. He insightfully points out that there are always problems, however, and suggests that a wise alternative would be to immediately look for the weaknesses in our newly developed systems and work to redesign them from the beginning, on an ongoing basis.

In his book on the evolution of buildings called *How Buildings Learn*, Steward Brand says 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. Another advantage is that satisficing is usually done by the occupants of a place which brings an efficient directness and a higher degree of responsibility-taking for the results, he says. Of course some of the watershed problems we have identified have large-scale causes and may still require relatively large-scale solutions. The point is to set "improvement" as a goal during the design stage in hopes of avoiding additional problems through overkill.

A Pattern Language

A superb model for how to design restoration projects is a technique that mimics natural processes such as local determination and gradualism. The approach of the influential architectural theorist Christopher Alexander is to follow processes that have created beautiful, functional, evolving structures and towns throughout history. He anchors his philosophy on the idea that traditional builders rely on a shared language of patterns that orient design to actual results rather than symbolic facades and building products.[11] Alexander understands successful design is an organic process:

> In nature you've got continuous very-small-feedback-loop adaptation going on, which is why things get to be harmonious. That's why they have the qualities that we value. If it wasn't for the time dimension, it wouldn't happen. Yet here we are playing the major role in creating the world, and we haven't figured this out. That is a very serious matter.

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. At the scale of the individual residence this might mean a fence here, an undrained wet spot there, a tree, a couple of standing snags that provide habitat.

In his design for the campus of the University of Oregon described in *The Oregon Experiment* Alexander explains that:

> [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 watershed restoration projects.] Piecemeal growth is based on the healthier and more realistic view that mistakes are inevitable. …Piecemeal growth is based on the assumption that adaptation between buildings [or landscapes] and their users is necessarily a slow and continuous business which cannot, under any circumstances, be achieved in a single leap.

Designers can't visualize exactly how a restoration project will work, nor can anyone else—no matter how well thought out or computer-enhanced the design—and so construction benefits from a process of trial and error. You will constantly learn more about the project's situation while constructing it and what you will find out is inherently and necessarily unpredictable.

[11] Stewart Brand says Alexander's *A Pattern Language* is the "one book that everyone dealing with buildings (or towns) should have." He says *The Timeless Way of Building* is a philosophy of design and buildings of great depth, savvy, and subtlety. In a sense, it is a treatise on evolutionary design. In another sense it is about the ethics of design. He lauds *The Oregon Experiment* for its principles of community planning, especially the idea of "piecemeal growth."

"You are watching a developing wholeness," Alexander says. Whether applied to buildings or restoration work, this approach is remarkable for mimicking nature by using nature's method—ruthless evolutionary selection.

In *A Pattern Language* Alexander and his colleagues provide specific patterns for use within this approach to design. Their technique is remarkably straightforward: pay attention to what is beautiful and functional in our surroundings, describe why—what is the essential quality that makes it good—and then mimic those qualities through design. We can use a similar approach for identifying watershed values we want to promote in our surroundings.

A Pattern Language is a highly successful attempt to identify universals—sources of the good life—that involve not only the built environment, but also the way we organize ourselves socially. The authors address the effects of design on human relationships in patterns such as "LIFE CYCLE," "CONNECTED PLAY," and significantly "THE FAMILY" and "OLD PEOPLE EVERYWHERE." *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. In regards to this, and of particular interest for watershed issues, are patterns such as "STILL WATER," "POOLS AND STREAMS," "ACCESS TO WATER," and "SITE REPAIR."

The list in the book is not the final word on patterns, though. On the contrary it is only the beginning—just as this assessment is only a tentative step in the process of identifying watershed patterns for the Yamhill Basin. Everyone can identify desirable patterns. The assessment provides suggestions for these qualities; they're seen in the chapter titles and section headings as well as in tables and text. For example, "RIPARIAN CONDITIONS," "WETLAND RESTORATION," and "WILDLIFE HABITAT" are watershed patterns that Yamhill County residents have already been pursuing. Many other yet-to-be-named patterns are implicit in the qualities and problems identified in the previous chapters. For instance, channel modification in most cases has the potential for creating problems. This reality can be restated as a positive, desirable goal as "RIVER CHANNELS UNMODIFIED" or "RIVERS FREE OF RIP-RAP" perhaps. 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 in a watershed, we can agree on a great deal regarding this, and we can work both as a community and as individual landowners and residents 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, though, all that is required is restraint based on our experience with past degradation.

Local Restoration Examples: On-going Design

A 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 well-suited for agricultural uses. The original idea developed through the landowners' contact with Dean O'Reilly of the Yamhill SWCD while he was designing an extensive drainage system for their new vineyard.

The Stonebridges had contacted the NRCS/SWCD office in the summer of 1988 to request assistance with developing a conservation plan for their recently acquired property. Dean inventoried the site and advised the Stonebridges on which of their fields were suited to grape production. The hillside fields had seeps that would require drainage before planting the vines.

Following the 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 present did not drain well enough to allow grape or nut production, he says. The site is also a low-lying frost pocket. At this time Dean asked the Stonebridges if they would be interested in establishing a wildlife habitat or wetland restoration in the field—additions he felt would be appropriate in their situation. They were not interested at that time, but they included the suggestion in their conservation plan as a future possibility.

In the summer of 1991 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 Ageement (LTA) funds. In the fall of 1991 the Stonebridges received $13,000 in cost share funding from the federal government for the wetland project.

In subsequent site investigations Dean discovered that the original design would need to be modified in several ways due to local conditions that were not immediately evident. One of the most dramatic changes was that a drainage ditch that was to be inundated needed to remain open for a drainage system on the neighboring property. This meant that there would 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 Oregon Department of Fish and Wildlife (ODFW) to maximize habitat values according to the best information available.

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 access 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 available materials, the skills and preferences of the people involved, and physical conditions such as the soil, hydrology, vegetation, and prior infrastructure. This evolution over time is essential to getting a good result. Local conditions will ultimately determine the ecological response to projects anyway, so flexibility in design—including ongoing redesign—facilitates working within local parameters rather than ignoring them.

Construction took place between the fall of 1992 and the summer of 1993. Steve Smith of ODFW provided evaluation of the design and made recommendations for plantings that would benefit wildlife. He offered valuable suggestions for where to place habitat islands in the ponds and the “spoils” removed to create the ponds. He was also instrumental in assisting Dean with a planting plan for the upland portion of the area. Local nurseries donated approximately 1000 trees and shrubs from their surplus stock. The team of natural resource professionals planted tufted hairgrass provided by ODFW on the dikes. Birdsfoot Trefoil and Switchgrass were also broadcast throughout the site for forage and nesting habitat.

The Stonebridge project is still being designed, in a sense, 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 interplant more native species that were not available commercially even a few years ago. Of course, 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 conditions effectively redesign the site through evolution.

Patterns used in Dean's conceptual plan and final 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 adjacent to the 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 numerous visits and development of 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.* These are another group of land use patterns available in print through the NRCS/SWCD. Some forms of financial assistance require implementation of at least a few conservation practices. They are a useful guide, though, for anyone looking for better management practices on agricultural and rural agreage.

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 throughout the area. "Installation of this restoration package insures this 46-acre parcel," according to Rob, "will no longer contribute to the degradation of water quality in the area." Instead it now serves to actually improve the quality of water cycling through the property, it provides valuable wildlife habitat, and provides an opportunity for the reintroduction of rare and endangered plant species.

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 similiar 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 ultimately provide high-value wood products.

The combination of these incremental restoration efforts along with associated conservation practices will serve to dramatically improve the ecological functions of this farm. This is an excellent example of the benefits that can be realized by landowners taking the initiative to improve the resources on their land and subsequently the natural resources of the watershed.

Every Little Bit Helps: Starting Small and Urban Options

County Resident Ted Gahr is known for his expertise in creating wetlands after years of experimentation on his own property and through assisting with many restoration projects in the area. 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 flood water further into the field. Ducks soon arrived. He continued to take small progressive steps like that, based on experimentation and common sense, to gradually increase the function and size of his restored wetland. Eventually he removed the drainage tiles and now has a 15-acre constructed wetland on this field. 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 them in the spring. Winter wheat wouldn't have worked. He found that the winter flooding killed all 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 established themselves and would now serve as weeds for any grains. This along with the drop in crop prices led Ted to discontinue cropping in that field.

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 a small, low input restoration that almost anyone can follow. Check with the Water Resources Department and the Department of State Lands before getting started.

A similarly small-scaled, yet important example comes from McMinnville resident Kareen Sturgeon. Kareen is a professor of biology at Linfield College and has a deep interest in wetlands. She heard of a program in Portland that paid homeowners to divert their gutter runoff away from storm drains. This has a variety of benefits such as easing the load on stormwater drains and increasing percolation into groundwater aquifers.

Although the 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" and percolates slowly through the ground before reaching Cozine Creek. Her proximity to the creek made this alternative feasible. Check with your local planning department before making any similar changes.

One final example comes from Dayton homeowner Jacqueline Groth who has been gradually turning her small urban lot into an island of native vegetation over a number of years. As a new homeowner Jacqueline says she was "graced with the nightmares of cheap plants" put in places they didn't belong. She was driven to remove what was ugly and dying in her yard and find replacements. "Over the years, every original thing has been dug up and burned," she says. 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. *Landscaping for Wildlife in the Pacific Northwest* by Russell Link (U. of Washington Press, 2000) is "state of the art" and *The Wild Lawn Handbook, Alternatives to the Traditional Front Lawn* by Steve Daniels (MacMillan, 1995) is another good source of ideas. Jacqueline says the NPSO'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. Wally Hansen in Salem is expensive but he has everything. The Portland Nursery and Metro (Portland) have native landscape workshops for homeowners. Another option is to contact Jacqueline with your questions.

Economics of Restoration Projects

The cost for the Stonebridge project came to $23,000. Don't be discouraged by that, though. There are several things to keep in mind regarding this price. First of all 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 for hydrology. These last examples show that watershed restoration can take place with little more than a good idea and a shovel. Remember that water rights and a Department 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 federal Wetland Reserve Program dollars, 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 less well suited for agriculture anyway. A related consideration is the added value of property that has ponds and swales with their associated plants and animals, open space, clean water, et cetera. 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 world that is becoming increasingly conscious of environmental health.

The Stonebridges' project is a prime example of something that likely would not have happened without cooperation between landowners and several government agencies. The landowner was unable to expend all these funds and neither of the two agencies were able to fund the difference. By working together and each party providing a portion of the funding, they were able to create an enduring wetland habitat

The NRCS provides money each year in federal matching funds for conservation projects on farms and other privately owned land. Most projects require a 50% match by landowners, though this rarely means a dollar for dollar match. Instead, landowners can provide labor, materials, or equipment totaling the value of federal funding. For smaller projects technical advice rather than funding will be the main service available through the SWCD.

We've mentioned a variety of funding programs throughout the assessment. Don't 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. Funding in Yamhill County through EQIP has been relatively high in recent years and is dropping. 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 EQUIP, CREP, and OWEB funds are available by contacting the USDA Service Center, 2200 SW 2nd Street, McMinnville, OR 97128. Phone: (503) 472-1474. Ask for a copy of the "Guide for Using Willamette Valley Native Plants Along Your Stream."

References

Christopher Alexander, *A Pattern Language: Towns, Buildings, Construction*, Oxford University Press, New York, 1977.
Stewart Brand, *How Buildings Learn: What Happens After They're Built*, Viking Press, New York, 1994.
Ted Gahr, personal communication, January, 2001.
Jacqueline Groth, personal communication, January, 2001, unpublished transcript "Making a Silk Purse Out of a Sow's Ear and Other Trials of a Homeowner in the City Limits."
Denise Hoffert-Hay, *Lower South Yamhill-Deer Creek Watershed Assessment*, Yamhill Basin Council, September, 2000.
Linda May, personal communication, October, 2001.
Dean O'Reilly, SWCD interview and tour, January, 2001, plan view "James Stonebridge Upland and Wetland Wildlife Habitat—W1 & W2," September, 28, 1992.
Oregon Watershed Enhancement Board website.
Doug Rasmussen, personal communication, January, 2001.

Bobbi Riggers, Oregon Plan Watershed Restoration Inventory Data Specialist. Personal communication. November, 2000.

Allan Savory, Center for Holistic Management, "Holistic Resource Management: An Alternative View," presentation at the joint conference of OWEB and the Oregon Association of Conservation Districts, November, 2000.

Kareen Sturgeon, personal communication, January, 2001.

James Stonebridge, personal communication. January, 2001.

Rob Tracey, NRCS, personal communication, January, 2001, unpublished transcript "Jim Stonebridge Wildlife Habitat."

Watershed Conditions Summary

The Lower Yamhill 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 land in the watershed leads to a wide variety of 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 and a Table 27 highlighting sub-watershed conditions.

Chapter One: Introduction and Watershed Characteristics

- The Lower Yamhill watershed has approximately 63,000 acres and three sub-watersheds: Hawn Creek/Yamhill River, Cozine Creek/South Yamhill River, and Palmer 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 in the watershed.
- Agriculture has been and continues to be an important part of the watershed's economy. Agriculture is the dominant land use and accounts for over 70% of the acreage. While the variety of the crops grown has ranged from plums to hops to grass seed, the acreage under cultivation has remained fairly constant. Over 45% of the watershed is currently under cultivation for perennial grass seed making it the largest single land use. The next largest land use acreage is annual grass at nearly 11.5% of the watershed.

Chapter Two: Historical Conditions

- Kalapuya Indians managed the watershed, in part, with summer burning. The majority of the Lower Yamhill watershed was grassland in prehistoric times.
- 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-am-ill group of Kalapuyan people in this area were part of a distinct upper Willamette valley culture that had close ties to the Columbia and some contact with coastal and southeastern Oregon cultures. The local native Americans relied heavily on plant foods and secondarily on meat and were muscular and remarkably healthy.
- European settlement brought an end to the intentional burns resulting in some 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 Three: Vegetation

- Vegetation in the watershed varies from being forested in the hilly areas to the north, south, and west to the bottomland agricultural areas.

- Approximately 50,000 acres or 79% of the watershed is non-forested—lands under cultivation or development. On the forested land, conifers make up 30% of the mixed forest while hardwoods comprise 70%.
- 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 evolving in response to fire suppression over the last century.
- The tall perennial grass species tufted hairgrass (*Deschampsia cespitosa)* serves as an example of a native prairie species that should be accommodated. 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 of prairie and where it has been reintroduced in restoration projects. There are only about 22 acres of tufted hairgrass in the Lower Yamhill watershed, less than a tenth of the area covered by invasive Reed canarygrass.
- In prehistoric times, there was relatively little conifer forest in the Lower Yamhill watershed. Today, conifers are found in riparian areas and in hilly areas intermixed with deciduous trees and in small pure stands. Conifers, mostly Douglas fir, account for about 10% of the vegetation cover of the watershed.
- Current conditions show that farmed perennial grass is the dominant cover of the watershed. The next largest cover class is annual grass. Together, these two grass seed crops cover over half of the watershed.

Chapter Four: Riparian Areas and Wetlands

- Riparian areas have been intensively managed for agriculture for a long time. Due to the economic pressures of agriculture, forested parts of the bottomland typically are narrow strips along stream banks.
- The majority of riparian areas have some vegetation, although it is often hardwoods or brush with low potential for large woody debris. Many riparian zones have no vegetation at all (8% of the watershed). The beneficial effects of riparian vegetation on aquatic life include cooling shade, balanced water chemistry, and nutrient assimilation from the surrounding soil.
- Non-native plants compete vigorously with native vegetation in wetlands and in disturbed areas and pose significant problems to some types of restoration and enhancement projects.
- Hydric soils are those that have formed under wet conditions such as 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 the 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 wet prairie in the watershed.
- 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 Five: Channel Habitat Types

- 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 the greatest value for improving habitat.
- Channels respond to change differently based on their position in the watershed. The headwaters of Palmer Creek and Millican Creek 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.

Chapter Six: Channel Modifications

- Channel modification are 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. We can also include 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 dams constructed in the watershed for flood control or fire protection are likely not significant barriers to fish passage. In-stream reservoirs, as are common on Palmer Creek, can be barriers and create other problems such as raising 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.
- Most fill and removal activity is either road-related or for reservoir construction. There is also 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. Some recent fill and removal permits reveal efforts specifically aimed at creating wildlife habitat or restoring wetlands

Chapter Seven: Sediments

- Potential sources of sediment include surfaces and ditches of rural roads, urban runoff from impervious surfaces, slope failure on steep ground, and surface erosion from agricultural lands.
- The ditches of the watershed are being managed to decrease their sediment contribution through roadside seeding and reshaping in cooperation with landowners. It is important to remember that all ditches drain to a water body, usually a stream..

- The amount of storm water runoff is increased substantially through development by increasing impervious areas within the watershed. 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 in a safe way before entering the stream.

Chapter Eight: Hydrology and Water Use

- Stream flows are influenced by precipitation, withdrawals for irrigation and municipal drinking water, stream channel modifications, changes in land use and water-related technology, and the removal of vegetation.
- Flooding has changed due to the hardening and deepening of the major stream channels.
- Streams and rivers in the watershed are over-allocated for water rights. This means that seasonal demands exceed the water supply. There has not been any conflict over this because most users are not exercising their full water rights.
- Extensive irrigation rights are held for land near the South Yamhill and Yamhill Rivers as well as Palmer Creek. These areas historically were wetland and are now drained and tiled.

Chapter Nine: Water Quality

- The South Yamhill River is 303(d) listed for bacteria (fecal coliform) and temperature. It is also at risk for pH, nutrients, sediment, toxics, dissolved oxygen (DO), and chlorophyll.
- The Yamhill River is 303(d) listed for bacteria and temperature and is also at risk for flow, toxics, pH, nutrients, chlorophyll, DO, and sediment.
- The West Fork of Palmer Creek is 303(d) listed for toxics (Chlorpyrifos) and is also at risk for other toxics, bacteria, nutrients, DO, sediment, algae, and temperature.
- Hawn Creek is at risk for temperature, sediment, flow, bacteria, toxics, DO, and nutrients.
- Cozine Creek at risk for bacteria.
- 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 Yamhill Basin Council started a stream temperature monitoring program throughout the basin in 2000.

Chapter Ten: Fish Habitat and Barriers

- Based on first-hand accounts, fish populations were higher and possibly more diverse in the watershed in the past.
- Historical in-stream habitat was different from present conditions. 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 throughout the 1970s and 80s but this practice was discontinued due to concerns about the interactions between hatchery-stocked fish and native fish. Introduced coho have been able to sustain themselves through natural reproduction and will possibly remain a factor in the Yamhill Basin
- Cutthroat trout were once abundant in the watershed and their sizes and numbers have steeply declined over the years according to anecdotal information.
- Cutthroat trout 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 watershed for only part of the year and have the potential for many interactions away from the watershed. This makes cutthroat the best indicator species for salmonids and fish species in general in the Lower Yamhill watershed
- Scattered stream surveys have been completed but no comprehensive stream information exists.

Chapter Eleven: Restoration and Enhancement

- There is a database available for landowners to be included in a statewide inventory of restoration and enhancement projects.
- Restoring ecosystems slowly, incrementally, and with an eye to how the ecosystem responds is preferable. Only by fine-tuning our use of the land and water repeatedly over a long period of time can we imitate evolution. We will learn more about a restoration project's situation while constructing it and what we find out is unpredictable.
- 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.
- Everyone can identify desirable patterns. The assessment provides suggestions for patterns of desirable watershed qualities; they're seen in the chapter titles and section headings as well as in tables and text. It is possible to design and build for watershed qualities.
- Watershed residents have completed a variety of projects to improve the habitat conditions in the watershed including projects to create wetlands, improve riparian conditions, improve upland conditions, and plant native vegetation.

Table 27. Watershed Conditions Summary

Sub-Basin	Riparian Conditions	Wetland Conditions	Water Quality	Sediment Sources	Hydrology and Water Use
Cozine/ South Yamhill	Most degraded riparian areas in the watershed. Very narrow bands of vegetation with agricultural uses bordering closely. Many areas with bare ground or short vegetation. Some areas with no vegetation or streambed remaining.	Many wetlands along the South Yamhill and its tributaries. Only NWI mapped information available. No Local Wetland Inventory data available. Large acreage of drained hydric soils.	South Yamhill 303(d) listed for bacteria and temperature. Also at risk for pH, nutrients, sediment, toxics, dissolved oxygen (DO), and chlorophyll. Cozine Creek at risk for bacteria.	Some debris flow hazard potential. Large areas of impervious surfaces, urban runoff non-point sources of pollution, construction sites, annual grasses, row crops, clean cultivated orchards.	Heavily irrigated along South Yamhill River, many domestic wells, some in-stream reservoirs.
Hawn Creek/ Millican Creek/ Yamhill River	Some areas with no vegetation or streambed remaining. Other areas with narrow strip of hardwoods in the riparian zone, agriculture or pasture on the uplands. More forested with hardwoods and conifers in the Red Hills of Dundee.	Only NWI mapped information available. No Local Wetland Inventory data available. Drained hydric soil areas in foothills provide good opportunity for wetland restoration.	Yamhill River 303(d) listed for bacteria and temp. Also at risk for flow, toxics, pH, nutrients, chlorophyll, DO, and sediment. Hawn Cr. at risk for temp, sediment, flow, bacteria, toxics, DO, and nutrients.	Some debris flow hazard. Rural roads parallel to streams. Some areas of impervious surfaces, urban runoff non-point sources of pollution, construction sites, annual grasses, row crops, clean cultivated orchards.	Heavily irrigated from Yamhill River. Some domestic wells.
Palmer Creek	Mostly hardwoods in the riparian zone, agriculture or pasture on the uplands. More forested with hardwoods and conifers in the Eola and Amity Hills.	Only NWI mapped information available. No Local Wetland Inventory data available. Large acreage of drained wetlands	West Fork Palmer 303(d) listed for toxics (Chlorpyrifos). Palmer Cr. also at risk for toxics, bacteria, nutrients, DO, sediment, algae, and temperature.	Some debris flow hazard. Rural roads parallel streams. areas of impervious surfaces, annual grasses, row crops, clean cultivated orchards.	Largest acreage of irrigation in the watershed. Palmer Cr. Irrigation District, many in-stream reservoirs, points of diversion. Some domestic wells.