Luckiamute / Ash Creek / American Bottom Watershed Assessment

June 2004

Submitted to
Luckiamute Watershed Council

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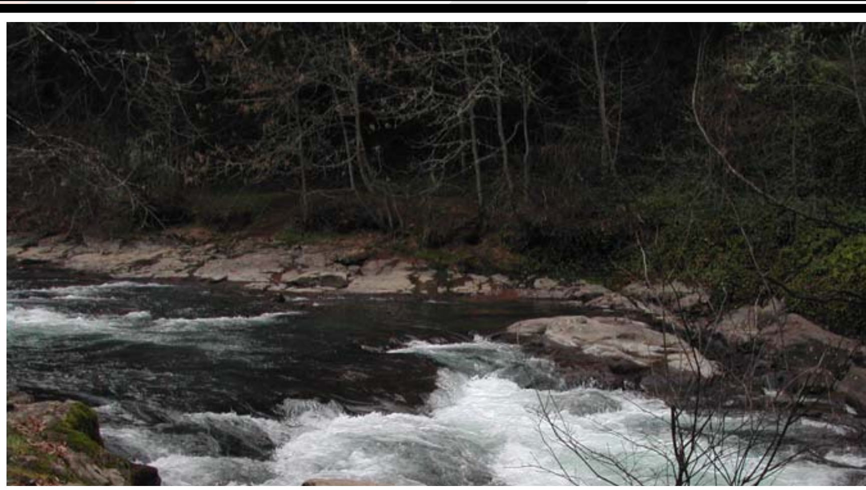

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1 INTRODUCTION

1.1 List of Acronyms and Abbreviations

AFS	American Fisheries Society
AHI	Aquatic Habitat Inventory
BLM	Bureau of Land Management
CD-ROM	Compact Disc, Read Only Memory
CLAMS	Coastal Landscape Analysis and Modeling Study
CFS	Cubic feet per second
DEM	Digital elevation model (GIS representation of topography)
DLCD	Department of Land Conservation and Development
DLG	Digital Line Graph
DEQ	Department of Environmental Quality
DOGAMI	Oregon Department of Geology and Mineral Industries
DOQ	Digital Ortho Quad
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information Systems
GPM	Gallons per minute
HUC	Hydrologic Unit Code
K	1,000 (used in scale descriptions, *e.g.* 1:100K = 1:100,000 scale)
LASAR	Laboratory Analytical Storage and Retrieval Database
LDC	Legacy Data Center
LWC	Luckiamute Watershed Council
LULC	Land Use/ Land Cover
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service (formerly SCS)
NMFS	National Marine Fisheries Service
OCSRI	Oregon's Coastal Salmon Restoration Initiative
OGDC	Oregon Geospatial Data Clearinghouse
ODFW	Oregon Department of Fish and Wildlife
ODF	Oregon Department of Forestry
ODOT	Oregon Department of Transportation
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
POD	Point of Diversion
PNERC	Pacific Northwest Ecosystem Research Consortium
PNW	Pacific Northwest
PRISM	Parameter-Elevation Regressions on Independent Slopes Model
REO	Regional Ecosystems Office
RM	River Mile
RMA	Riparian Management Area

STEP	Salmon and Trout Enhancement Program
STORET	EPA's STOrage and RETrieval database
SSURGO	Soil Survey Geographic Database
TMDL	Total Maximum Daily Load
USFS	U.S. Forest Service
USGS	U.S. Geologic Survey

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1.3 Executive Summary

The Luckiamute/ Ash Creek watersheds, located near the intersection of five ecoregions, support a rich flora and fauna. Ample resources together with the relatively mild climate and juxtaposition to a major water thoroughfare have made the Luckiamute/ Ash Creek watersheds an important area for human settlement. With their arrival in the Luckiamute/ Ash Creek watersheds thousands of years ago, humans have intentionally and accidentally manipulated and altered many watershed features. Many of the ecological processes that structure and maintain natural resources in the region have also been affected. Today, we see the consequences of these alterations: as the structure and function of the watershed changed, plants and animals had to adapt to the new conditions.

Some species could not adapt and are no longer found in the study area. Populations of other species are currently depressed. For example, valued natural resources in the Luckiamute / Ash Creek watersheds include spring chinook salmon and winter steelhead trout (listed as Threatened (Licata et al., 1998; McElhany et al., 2003) and the Oregon chub is listed as Endangered (Wevers et al., 1992). Many other threatened and endangered plant and animal species are described and listed in Chapter 7 of this report. Wetland and oak savanna communities were also identified as being of concern by the Luckiamute Watershed Council. The persistence of threatened and endangered species depends on proper management of the features in the Luckiamute/ Ash Creek watersheds and an understanding of the ecological processes on which these species depend.

This watershed assessment follows the guidance of the Oregon Watershed Enhancement Board (OWEB); however, there are two important distinctions: (1) the Luckiamute Watershed Council requested that the assessment team include information on terrestrial communities and associated wildlife populations and (2) spatial data were collected, compiled and summarized whenever possible. The goal of this project was to compile existing information to support future action planning and to educate council members. As such, the assessment was meant to summarize current conditions in the watershed using both descriptive and quantitative information and to identify data gaps. Although several example analyses and spatial summaries were performed, this assessment was not intended to identify specific places in the watershed for specific management actions.

In addition to characterizing the status of important natural resources within the study area, the assessment team was charged to provide an ecological context so that members of the Luckiamute Watershed Council could understand the important connections between watershed components, and between watershed components and ecosystem processes. Understanding the relationship between the valued resources and the natural processes that maintain those resources is critical to the development of a successful watershed management plan.

Photo 1: Luckiamute River

1.4 Study Area

We completed the assessment of the Luckiamute (201,738 acre) and Ash Creek (33,887 acre) watersheds in May of 2004. The study area is located in the Willamette Valley, approximately 62mi south of Portland, Oregon and is located in Benton and Polk Counties. The study area falls within two major (5th field) watersheds. It is bounded on the west by the ridge tops of the Coast Range Mountains and on the east by the Willamette River. Both physical and biological factors affect the quantity and quality of natural resources in the Luckiamute/ Ash Creek study area. Interestingly, humans have influenced both at regional and global scales.

Physically, the interplay between the climate and the geomorphology created and maintain the structure of the Luckiamute/ Ash Creek stream network and the plant communities. The relatively mild climate of the Luckiamute/ Ash Creek study area is characterized by cool wet winters and warm dry summers. The annual mean temperature in the watershed is 51.9˚F. Mean summer temperatures range from about 55˚F in May to 66˚F in July and August. Mean winter temperatures range from about 39˚F in December to 42˚F in February. Most precipitation falls as rain so that streams and rivers are fed by rainfall rather than snowmelt (Clark, 1999). Seventy-five percent of the annual rainfall occurs between October and March. Elevation profoundly affects precipitation patterns. In the lowlands the mean annual rainfall is approximately 53.0 inches (Oregon Climate Service, 2003). The highest amount of rainfall occurs along the northwestern boundary of the watershed in the Coast Range Mountains where the annual precipitation is greater than 150 inches (Daly et al., 2003; Taylor et al., 2003).

Most of the Luckiamute / Ash Creek study area ranges between 105 to 1,000 feet in elevation. A small proportion of the watershed reaches elevations of 2,000 to 3,650 feet. Rain-on-snow events, important events that structure stream networks and deliver sediments and debris to streams, are relatively rare at the low elevations and in the mild climate of the study area. Instead, steep slopes and the underlying, slide-prone Tyee Formation, common to the western portion of the study area, lead to the hillslope processes that deliver sediments and debris to the stream network. Also important to salmon are the volcanic rocks that support the ridge tops in the Coast Range Mountains. Spawning gravel beds are made up of erosion resistant igneous rocks.

1.5 Human Impact

At the local scale, human actions probably do not have much of an effect on climate in the study area; however, many of our actions have changed the quality, quantity and timing of sediment and organic debris delivery to the stream network. Intentional fires were set in the lowlands by Native Americans to clear underbrush and promote game production. Fires probably burned through wet shrubby areas and removed stream side vegetation, and added ash to streams and rivers. It is difficult to say what the impact of these fires would have been on fish and wildlife populations at the time. However, major, persistent alterations to streambeds and riparian areas occurred as the area was settled by European settlers. Settlers cleared the lowlands for agricultural (and livestock) uses. Streams and rivers were cleared of debris jams for navigation. Splash dams were built to transport lumber from the upper watershed to the river transportation corridors. Historic records indicate that there were from 80-100 splash dams on the Luckiamute River (Licata et al., 1998) with some major ones documented on Pedee Creek and Ritner Creek (Theurer, 2003).

Stream Channels

The condition of the stream channels is not well known in the Luckiamute/ Ash Creek study area. A recent report describes nearly all stream channels in the study area as being incised and disconnected from their floodplain. The impact on in-stream biota is one where water velocities are typically much greater, over larger areas than they were historically. Stream network simplification has perpetuated the cycle of increased downcutting and increased stream bank erosion. Consequently, floodplain water storage has been reduced leading to a reduction in summer baseflows and a degradation of water quality. We found that only 12% (of the 1:100K stream length) of the streams in the study area have been surveyed by Aquatic Habitat Inventory (AHI) crews and some of the surveys are more than nine years out of date. We used ODFW benchmarks to evaluate stream segments for each of the 7th field subbasins surveyed by AHI crews. Of all the 12 7th field watersheds, only Lower Pedee Ck (#17090003060401) ranks high in terms of desirable pool characteristics although, like the other basins, none of its stream reaches meet ODFW benchmark criteria for distance between pools.

We also evaluated AHI data for each of the 7th field watersheds using the ODFW habitat benchmarks for key pieces of large wood, number of large wood pieces and large wood volume. Numerous debris jams have been observed by residents of the Luckiamute/ Ash Creek watershed yet AHI surveys show that overall, large wood is scarce in the stream reaches surveyed. Only two of the 7th field watersheds have any stream

reaches that meet the desired criteria for key pieces of large wood. Several of the watersheds have stream reaches that meet desirable benchmarks for the number of pieces and large wood volume, but over all the majority of habitat surveyed falls into the undesirable category. Upper Pedee Ck (7090003060402) stands out as having the highest proportion of stream reaches meeting the desirable criteria for large wood. These results suggest that an important component of 'salmon habitat' is missing or severely compromised over much of the study area. Action planning should focus on improving in-stream habitat quality by reconnecting floodplains and adding structural complexity to the streams.

Ecosystems are dynamic. In developing a restoration and management strategy, it is important to consider the current status of the resource and the natural range in variability of that resource. In the case of large wood in streams, the Watershed Council must reconcile what they 'know' to be true for the amount of large wood in streams with what the natural range in the amount of wood should be (ODFW benchmarks can be used). This will undoubtedly be accomplished through a standardized survey, *i.e.*, AHI surveys or aerial photography. Part of the management strategy for maintaining in-stream complexity (large wood) should include natural wood recruitment. Wood enters stream networks from the upper watershed ('hollows' or 'zero-order' streams) and from the riparian area. As part of this assessment, we used aerial photographs to characterize riparian areas throughout the Luckiamute/ Ash Creek watersheds

Riparian areas (defined as 100ft on either side of the stream) in the Luckiamute watershed are dominated by dense conifer forests (43.5% of the riparian zone) and dense deciduous forests (19.4% of the riparian zone). About 18.4% of the riparian zone is herbaceous land cover indicating that there may be ample opportunity for stream side planting wherever appropriate. In contrast, the Ash Creek watershed is dominated by herbaceous cover (45.3% of the riparian zone) and only 13.5% and 12.9% of the riparian zone is covered with dense coniferous and deciduous forests, respectively. For the areas that were surveyed by AHI crews, we found that none of surveyed stream reaches met the ODFW-benchmarks for riparian conifers and that most of the streams were unshaded by trees within 12m of the stream edge. Short-term management planning may involve placing wood in streams to increase in-stream complexity that has been removed or degraded while not adding to the major debris jams that are known from some areas. However, stream complexity is the result of interactions between water and the landscape. Long-term management strategies should include management for peak hydrologic flows (i.e., increasing watershed water storage and desynchronizing peak flows) and managing vegetation in 'zero-order' streams and along riparian areas to promote natural recruitment of large wood to streams.

Photo 2: Helmick Park

Land Cover

Land cover and vegetation also affects the way in which a watershed functions. For example, large conifers in the fog zone can cause atmospheric moisture to condense, flow down the branches and tree trunk and eventually into streams. And, living and dead vegetation acts as a giant sponge, holding water thereby increasing watershed water storage. There have been dramatic changes in the quality and distribution of plant communities in the study area primarily due to human alterations.

Analysis of the Pacific Northwest Ecosystem Research Consortium (PNERC) pre-settlement vegetation layer indicated that the coniferous forests dominated the western, higher elevations of the watershed and a large area along the south central boundary of the Luckiamute/ Ash Creek study area. Coniferous forests covered approximately 31.9% (76,000 acres) of the study area. Interestingly, prior to European settlement, shrubby areas were just as common as coniferous forests. Upland and wetland shrubby areas covered much of the eastern, low areas in both the Luckiamute and Ash Creek watersheds covering about 76,114 acres (32.0% of the study area). Much (53,674 acres or ~22.5% of the study area) of the remaining area was dominated by herbaceous plant communities, wet prairies and natural grasslands. Mixed and deciduous forests (which included Oak Savanna) covered 7.3% and 5.8% of the study area, respectively.

To compare past with present land cover, we summarized the PNERC LULC_90 (LULC is Land Use Land Cover) data set. We combined 60 original cover classes into nine major cover classes (and a background class). Surprisingly, we found that coniferous forests also dominate the current Luckiamute and Ash Creek watersheds, covering 32% (~76,153 acres) of the study area. Current coniferous forests cover approximately the same extent as pre-settlement coniferous forests. The largest change in land cover has been in the shrub cover classes, which have decreased by approximately 24% since the time of European settlement. Shrubby communities include shrubby wetlands and riparian areas, as well as field-forest transitional communities. Herbaceous land cover classes are currently a dominant feature, the second largest cover class, in the Luckiamute / Ash Creek watersheds covering about 30%

(70,623 acres). Originally, native grasslands only accounted for approximately 5% of the watershed area prior to European settlement. Native grasslands have been replaced by cropped fields and pastures. Although it is tempting to suggest that the coniferous forests have remained pretty much the same and that shrub communities have been replaced by herbaceous communities, the distribution and composition of forests, shrub and herbaceous communities have changed across the Luckiamute/ Ash Creek study area.

The quality of land cover and plant communities has changed as well as the quantity. Although it is not possible to say for certain, the distribution of the major vegetation cover classes has apparently changed in the Luckiamute/ Ash Creek watersheds. We do know that the landscape has become more fragmented by roads and development than it was prior to European settlement. These changes have undoubtedly had an effect on the delivery of water, sediments, and debris to the stream network and on the way in which fish and wildlife use and move through the study area watersheds. The composition of the plant communities has changed also as non-native and pest plant species have become established in the study area. Lists of non-native and invasive plant species are currently being complied by at least two separate groups for the study area; however, the affect of these non-native species on the structure and function of the watershed are not known.

Wetlands perform numerous ecological roles including water storage, improving water quality, providing food and shelter for many types of fish and wildlife species. Wetland maps were not available for the entire study area; however, we estimated the change in wetland area for each 7th field watershed from pre-settlement to modern times. In the Luckiamute watershed, we found that generally 0-32% of the original wetland acreage remains, while in the Ash Creek watershed 2-63% of the wetlands remain (except for the American Bottom 7th field watershed, which has 95% of its original wetlands remaining). Future action planning and management should include the restoration of wetlands because increasing the amount of wetlands will likely increase watershed water storage, improve water quality, and may provide important fish and wildlife habitat.

Water Quality & Quantity

In addition to changing the composition and the distribution of plant communities in the Luckiamute/ Ash Creek watersheds, the increasing human population has dramatically affected the quality and quantity of water available in streams for use by fish and wildlife. In 2002, approximately 32 miles of the Luckiamute River appear on the 303(d) list. The Luckiamute River was listed in 1998 for fecal coliform bacteria concentrations that exceeded the water quality standards for water contact recreation. Approximately 17 miles of Soap Creek are listed for not meeting the dissolved oxygen concentration water quality standard from October through May. Soap Creek was listed in 2002 and salmonid spawning was the beneficial use that was impaired. Finally, approximately two miles of the South Fork of Berry Creek were listed for temperature in 2002. Stream water temperature exceeded the state water quality standards ($17.8^{o}C$) for salmon fish rearing. Both salmonid fish rearing and anadromous fish passage are the beneficial uses that were affected.

We also reviewed water quality data collected by various agencies and stored in the ODEQ LASAR and US EPA STORET databases. We found it difficult to draw conclusions from these data because measurements tended to be made at irregular intervals and at widely separated monitoring stations. Results of several intensive studies were also available. Unfortunately, these studies occurred under drought conditions and were thought not to be representative of conditions in the watershed.

Western Oregon is known for its abundant precipitation. However, both surface and ground water supplies are heavily used in the Willamette Valley and there frequently is not enough water to meet water demands. There are almost 1,000 unique surface water withdrawal permits in the study area. Approximately 59% of the surface water used in the study area is for irrigation and an additional 17% to water livestock. About 16% of the current surface water use is for domestic, municipal and water storage use. Most of the streams in the watershed are fully appropriated for summer and early fall use; that is, the streams will not support additional water withdrawal for use at these times.

Summary

Most (85-90%) of the land in the study area is privately owned. Therefore, action planning will rely heavily upon the cooperation and participation of willing landowners. The statuses (e.g., population size) of many of the valued resources are not well known; however, many factors that affect these valued natural resources have been identified. Many of these factors, *e.g.*, climate, land cover/ land use, habitat fragmentation, water quality, hydrologic patterns, erosion, urbanization, and stream channel modification have been summarized in this report. We have identified many data gaps. Action planning should focus on management actions that (1) quantify valued resources and (2) restore important ecological processes to their natural range variability and break trends in cycles of resource degradation. Above all else, management and restoration plans must balance the needs of the more than 150,000 people living in Polk and Benton Counties with the needs of the plants and animals of the Luckiamute / Ash Creek watersheds.

1.6 Purpose and Goals

Purpose

The purpose of this watershed assessment is to characterize the current conditions in the Luckiamute/ Ash Creek watersheds and to rank stream reaches and 7th field sub-basins so that actions can be planned "for protecting and improving fish habitat and water quality" (Watershed Professionals Network, 1999).

Project Goals

According to the Oregon Watershed Enhancement Board (OWEB), Oregon Watershed Assessment Manual, a Watershed Assessment is a process for evaluating how well a watershed is working (Watershed Professionals Network, 1999). "An assessment can't give us site-specific prescriptions for fixing problems, but it can, and should, tell us what we need to know to develop action plans and monitoring strategies for protecting and improving fish habitat and water quality" (Watershed Professionals Network, 1999). Therefore, a goal of this project is to produce a document that will support future action planning. This document includes a summary of conditions in the Luckiamute (201,737.94 acre) and Ash Creek (33,887.36 acre) watersheds (Map 1). This assessment is not intended to identify specific places in the watershed for specific actions, rather it is intended to:

(1) summarize the current conditions of the watershed, both descriptively and quantitatively;
(2) identify important data gaps; and
(3) suggest ways in which the watershed council can proceed in its action planning.

Wherever possible, we have maintained links to the underlying data so that site specific action planning can be accomplished in the future.

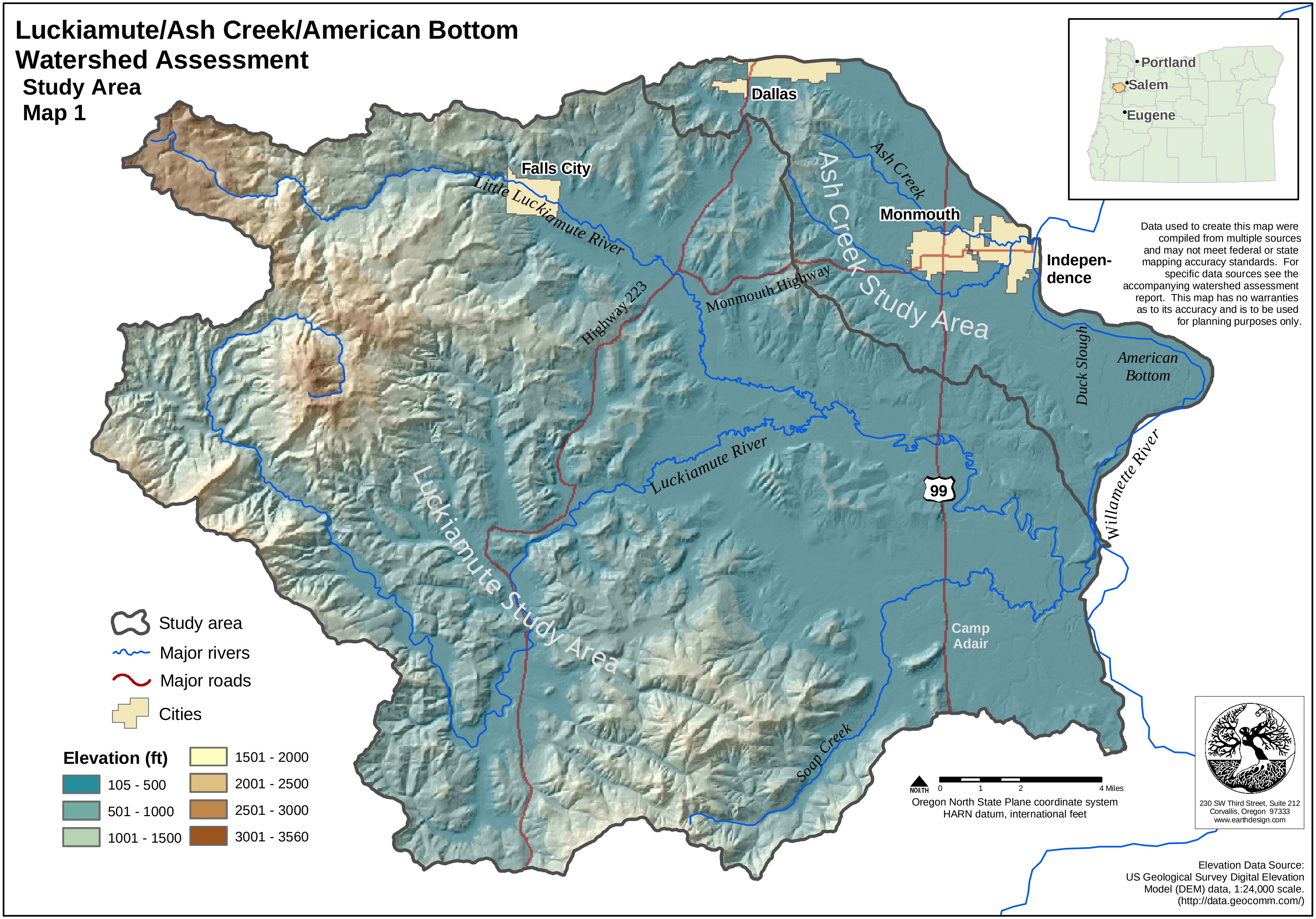
The Luckiamute Watershed Council (LWC) established the following goals and guidelines for this Watershed Assessment.

This assessment will address all major topics outlined in Sections I-X of the OWEB Manual for the Luckiamute and Ash Creek watersheds. In addition, the assessment will address major ecosystem elements and ecological processes in the watershed uplands and a set of key questions developed by the watershed council members. The LWC identified the following goals for this assessment to (1) produce a source of educational information about watershed resources, environmental and biological processes, and human land uses that affect watershed resources and processes; (2) produce results that will provide restoration recommendations and support development of an action plan that will prioritize future outreach, restoration and monitoring; and (3) identify significant gaps in the understanding of watershed conditions in order to guide future information gathering efforts.

Map 1. The Luckiamute/ Ash Creek study area. Shown are the two major watersheds, major roads, major rivers, cities and elevation.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Study Area
Map 1



1.7 Definitions & Strategy

Stream networks, together with the landscape they drain, are called watersheds. Watersheds, sometimes called basins or sub-basins, come in all shapes and sizes. Regardless of size, all watersheds are defined by topographic drainages. That is, precipitation falling anywhere within a watershed must eventually flow into a stream, river, lake, or aquifer. Water that has become part of a stream or river leaves the watershed at a specific point. Watersheds of different sizes are nested within one another. For example, large watersheds, such as the one that drains to the Columbia River, are made up of smaller watersheds, such as the Willamette River Basin. Ridge tops delineate watersheds.

In order to facilitate communication among interested groups, larger watersheds have been identified and delineated by governmental agencies such as the U.S. Geologic Survey. These watersheds are designated by unique identifier numbers called Hydrologic Unit Codes (HUC). Frequently watersheds are referred to as 5^{th}, 6^{th} or 7^{th} field watersheds. The terms "fifth", "sixth" and "seventh" field refer to the size of watersheds, with fifth field being the largest of the three. Fifth field watersheds, the size of watershed for which the OWEB manual was developed (Watershed Professionals Network, 1999), range in size from 40,000 to120,000 acres and average about 60,000 acres. The Luckiamute and Rickreall watersheds are examples of 5^{th} field watersheds and each contain many nested 6^{th} and 7^{th} field watersheds (Map 2). Watersheds are convenient ecological units because they represent bounded areas that often share similar properties like flora and fauna, climatic patterns, and disturbance regimes.

For the purposes of this report the study area is defined by the Luckiamute Watershed Council as the Luckiamute River Basin and Ash Creek, which is part of the Rickreall Basin. We acknowledge that the Ash Creek (Rickreall Basin) is not a complete 5^{th} field watershed (Map 2).

Photo 3: View of a farm in study area

This assessment uses both descriptive and quantitative data. Wherever possible we used quantitative data. Quantitative data are frequently provided in geographic information system (GIS) format. Many agencies now only supply their data sets as GIS files. Loosely defined, GIS is an interactive mapping system composed of computer hardware and software, spatial data, and trained users. Spatial data can be representations of just about anything, including but not

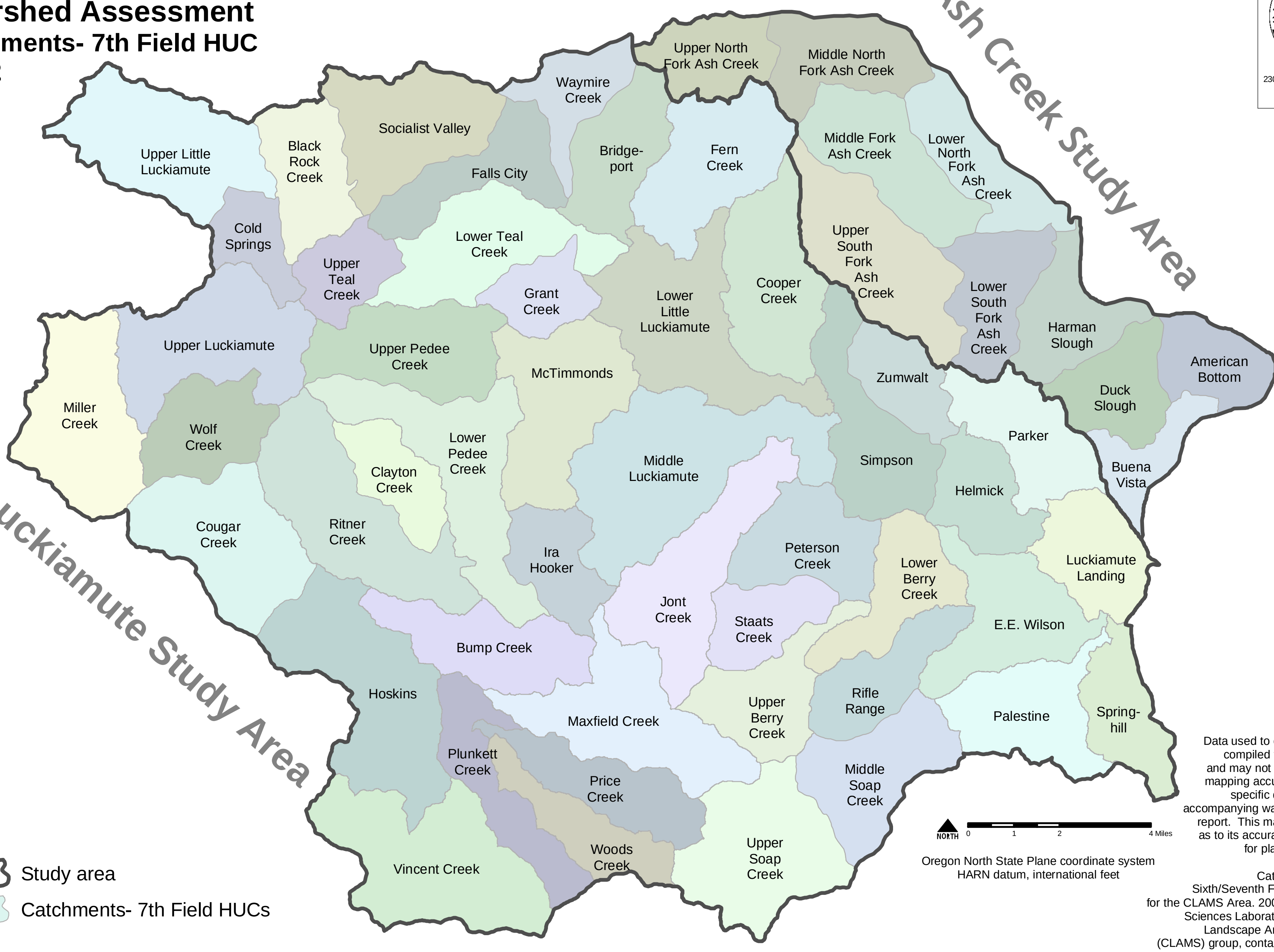
Map 2. Seventh Field HUC Watersheds in the Luckiamute / Ash Creek Study area. Shown are the 7^{th} field HUC names assigned to each watershed by the Luckiamute Watershed Council.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Catchments- 7th Field HUC

Map 2

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Study area

Catchments- 7th Field HUCs

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Catchment Data Source:
Sixth/Seventh Field Hydrologic Units for the CLAMS Area. 2000. Corvallis Forestry Sciences Laboratory (USDA)- Coastal Landscape Analysis and Modeling (CLAMS) group, contact: Z. Rickenbach, S. Clarke, et al.
(http://www.fsl.orst.edu/clams/data_index.html)

limited to biological populations, roads, plants, streams, buildings, and terrain that are referenced by their geographic (map) coordinates.

GIS is a tool that is used to create, store, display, and analyze data and relationships between data. The primary advantage to the LWC in using GIS is that most new data will be distributed by agencies as GIS files. Therefore, the GIS can be used to store data. GIS can also be used to quickly produce maps of key data sets. Therefore, GIS can be used to effectively communicate to watershed council members, local stakeholders or to agencies when the council is requesting funds to implement its action planning activities. Finally, when used properly, GIS is a powerful analytical tool that will allow the LWC to identify areas using multiple selection criteria. For more information see Garono and Brophy (1999) for a discussion on the use of GIS in an Oregon coastal watershed.

Strategy

This assessment is organized around the procedures outlined in the OWEB watershed assessment manual and around a set of key questions developed by the LWC. The assessment team reviewed and acquired available data necessary to follow the OWEB protocols and to address the watershed council's key questions. The assessment team did not acquire data if it was not germane to questions asked by the Council or the OWEB manual. When data gaps were encountered, we made suggestions for filling those gaps.

Not all data are good data for answering all questions. Wherever possible, we presented the strengths and weaknesses of each data set as the data related to the questions being asked.

This report includes methodological steps that were used to summarize existing conditions in the watershed. This will assist the Watershed Council in repeating these analyses should better data sets become available in the future. **We recommend that all summaries and results be critically reviewed before being used in action planning.** Our presentation of data limitations and methods should make the report summaries as 'transparent' as possible so that watershed council members can use this watershed assessment wisely.

We urge the Council members to keep in mind that the results of this assessment are based on observations and measurements made by many people using many methods at many different times. In most cases, it is very difficult to know how representative the observations and data are of actual watershed conditions. In addition, it is important to remember that data sets and GIS maps are only representations of actual watershed conditions. By definition, GIS

maps are much simpler than the phenomena that they represent – they are imperfect. Be a critical data user.

Wherever possible, we have used quantitative data that were collected using known protocols. For the GIS-based analyses (spatial summaries), we used 1:24,000 uniform scale data that covered the entire study area whenever possible. In addition to summaries produced using GIS, we also used descriptive information to characterize the Luckiamute and Ash Creek watersheds.

Our strategy entailed working closely with members of the LWC by meeting 1-2 times each month; and frequent communication with our LWC liaison. Wherever possible, we involved LWC council members in the synthesis of watershed data.

2 HOW TO USE THIS REPORT

This report is organized into ten major sections and several appendices. Each major section is divided into multiple related sub-sections. Sections 1-3 provide introductory information. Sections 4 and 5 present descriptions of important watershed characteristics. Sections 6-9 present summaries or analyses of watershed resources and summarize watershed processes. Section 10 summarizes our recommendations. The LWC requested that wherever possible, results be summarized for the Luckiamute and Ash Creek watersheds separately. To minimize redundancy we have referenced material from related sections to each other throughout the report. The LWC, however, requested that recommendations be repeated both after each main section and again at the end of the report.

Wherever possible, each section contains a description of the resources, the ecological importance of those resources, a description of the data and methods used in the assessment, the general results, and, where appropriate, our team's recommendations. Since material on any given subject may appear in several places throughout the text, **we recommend that the entire document be read.**

We have supplied LWC with identical versions of this report, both "hard" (printed) and electronic copies. The electronic copy consists of Adobe's Portable Document Files (PDF). PDF can be easily viewed and printed from any computer using the Adobe Acrobat Reader, available free on the World Wide Web at *http://www.adobe .com /products/ acrobat/readstep.html*.

Spatial data files were supplied to the watershed council in a common GIS projection. These data are available from the watershed council.

The LWC requested that English units be used instead of metric units.

Photo 4: Soap Creek Ranch entrance

3 DATA

3.1 Use Restrictions

Some of the data used in this report were given to us with the condition that they would not be distributed. Specifically, we agreed not to distribute data concerning rare, threatened and endangered species that we acquired from the Natural Heritage. The Natural Heritage Program data will be kept in the LWC office. In addition, we obtained the Coastal Landscape Modeling and Analysis Study (CLAMS) land cover data from researchers at Oregon State University Program and the Weighted Species Richness (WSR) data grids from Patti Haggerty. These data cannot be distributed by LWC. Persons wishing to use the CLAMS data should contact the CLAMS directly. CLAMS researchers are in no way responsible for our use of or conclusions drawn from our use of their data. Those wishing to use the WSR data grids should contact Patti Haggerty. **We recommend that the LWC coordinator be contacted before any of the data are distributed from this assessment.**

3.2 Use of Existing Data

This assessment was conducted with existing data. No new data were collected for this report. Both descriptive and quantitative data were used in this assessment. Some data were supplied in geographic information format (GIS). For GIS data, we used uniform scale data that covered the entire study area whenever possible. Quantitative data were used to rank 7th field watersheds or stream reaches. In some instances, data were only available for portions of the study area or stream network. In these cases, we used our judgment to determine if enough data were available to summarize the condition of a 7th field watershed or stream reach and to rank it. In cases where there were not enough data to rank a watershed, we left the 7th field watershed or steam reach unranked. In other cases where there was only partial coverage, we indicated such on the map and in the report.

3.3 Scale of Data and Units of Comparison

This watershed assessment was performed using existing1:24,000 data sets, unless otherwise noted. This is the scale of a 7.5' USGS topographical map. In this assessment we provide descriptive information on species distributions, and general watershed characteristics and processes. With an eye toward action planning, we have used GIS to highlight areas for consideration by future monitoring and restoration planning. Since we relied almost exclusively on existing data, some of our prioritizations were constrained by those data sets. In particular, LWC requested that we prioritize stream reaches using the aquatic habitat inventory (AHI) data. Since the existing AHI data set did not cover the entire study area, we prioritized individual stream reaches, as defined by the data collection agency, in this assessment. Therefore, the

units of comparison for the AHI summaries are individual stream reaches. In other summaries, the 7th field watersheds are the units of comparison.

3.4 Accuracy & Uncertainty

Both **accuracy** and **precision** are important considerations in making any measurement; generally, as accuracy and precision go up, so do the costs. Accuracy tells us how well our measurements reflect the condition of a variable (*e.g.*, how many salmon there actually are in the watershed in which we are interested). Precision tells us how repeatable our measurement is time after time. You can have measurements that are precise and not accurate, ones that are accurate and not precise, and ones that are neither accurate nor precise. Statistics are used to assess accuracy and precision. Of course, the accuracy and precision of anecdotal observations cannot be known (in a statistical sense).

The relationships between the various salmonid species and the watersheds they inhabit are extremely complex. Often, we assume that "given enough research and the right models, or other analytical approaches, exact numbers [of salmon] can be determined for population size, components of population dynamics, and the responses of populations to given harvest levels... this assumption is nearly always erroneous" (Botkin *et al.*, 1993). Botkin *et al*. (1993) have identified three sources of environmental uncertainty: (1) incomplete information regarding the current state of a resource; (2) incomplete information on details of cause and effect relationships; and, (3) intrinsic unpredictability in nature. Since most population estimates are based on a relatively small proportion (*i.e.*, a sample) of the actual population, appropriate sampling methods and interpretation of results are necessary to allow one to estimate the amount of uncertainty associated with each sample and to develop an understanding of causal relationships.

Making management decisions based on observations or measurements that do not accurately describe watershed conditions may produce unexpected results.

4 WATERSHED CHARACTERISTICS

4.1 Location

The study area is located in the Willamette Valley approximately 62 mi south of Portland, Oregon and is composed of the Luckiamute and Ash Creek watersheds (Map 1). The study area stretches across Polk and Benton Counties, bounded to the west by the ridge tops of the Coast Range Mountains and to the east by the Willamette River. The 235,500 acre (95,300 hectare) study area falls within two major watersheds, the Luckiamute and Rickreall 5^{th} field HUCs. Fifty-seven 7^{th} Field HUCs are contained within the study area (Map 2). The Luckiamute watershed consists of the Luckiamute River, Little Luckiamute River, Soap Creek, and their tributaries. At the southern end of the study area, Soap Creek flows into the Luckiamute River about 3mi upstream of the Luckiamute's confluence with the Willamette River near the Benton-Polk County line (Map 1). Duck Slough and American Bottom, also in the Luckiamute watershed, are adjacent to the Willamette River just south of the town of Independence. Ash Creek, technically a part of the Rickreall watershed but added to the study area for this assessment, joins the Willamette River at the town of Independence (Map 1). Ash Creek itself was reportedly created by ditching and may not represent a natural drainage (M. Cairns, personal communication). Elevations in the watershed range from 105 feet above sea level at the Willamette River to 3,333 feet at Fanno Peak in the Coast Range (Taylor *et al.*, 2003).

4.2 Climate

Climate is one of the factors that determine how watersheds look and behave. For example, climate ultimately determines the type of vegetation (or potential vegetation) that is found in a region. Climate also determines how watersheds function, *e.g.*, the interplay of geology, soils, vegetation, and patterns in rainfall influence sediment and material transport in streams.

The Luckiamute watershed and environs has a climate influenced by the Pacific Ocean and surrounding topography (Map 1). The area is characterized by cool, wet winters and warm, dry summers (Licata *et al.*, 1998).

Temperature

Monthly average, and mean high and low temperatures for each month were obtained from observations measured in Dallas, Oregon, from 1971 to 2000 (Oregon Climate Service, 2003). The annual mean temperature of the area is 51.9˚F. Mean summer temperatures range from about 55˚F in May to 66˚F in July and August and mean winter temperatures range from about 39˚F in December to 42˚F in February (Table 1). The lowest mean monthly temperature, 33.1˚F, was in January, and the highest mean monthly temperature, 81.5˚F, was in August.

Precipitation

Precipitation patterns vary from year to year, from season to season and by elevation across the study area. During the period of record (Dallas, OR) from 1935 to 2002 the annual precipitation ranged from 23.0 inches in 2000 to 69.6 inches in 1937 (Oregon Climate Service, 2003). Rainfall in the area is highly seasonal, with 75% of the annual rainfall occurring between October and March (Table 2). Most precipitation is delivered in the form of rainfall, such that the rivers are fed primarily by rainfall rather than snowmelt (Clark, 1999). Streamflows are therefore typically highest during the winter months.

Precipitation is also dramatically affected by elevation. Along the northwestern boundary of the watershed in the Coast Range Mountains the annual precipitation is greater than 150 inches (Map 2). In contrast, in the lowlands of the Willamette Value the annual precipitation is about 45 inches (Daly *et al.*, 2003; Taylor *et al.*, 2003).

Table 1. Mean temperature (˚F) from the years 1971 to 2000 in Dallas, OR. (Oregon Climate Service, 2003).

Month	Mean Maximum	Mean Minimum	Mean
January	45.3	33.1	39.2
February	49.7	34.8	42.3
March	55.2	36.9	46.1
April	60.4	39.4	49.9
May	66.9	43.7	55.3
June	73.0	47.8	60.4
July	80.9	50.4	65.7
August	81.5	49.8	65.7
September	76.7	47.0	61.9
October	64.7	41.2	53.0
November	50.7	37.2	44.0
December	44.2	33.2	38.7
Annual	62.4	41.2	51.9

Table 2. Average precipitation (in.) from the years 1971 to 2000 in Dallas, Oregon. Data from Oregon Climatic Service (Oregon Climate Service, 2003).

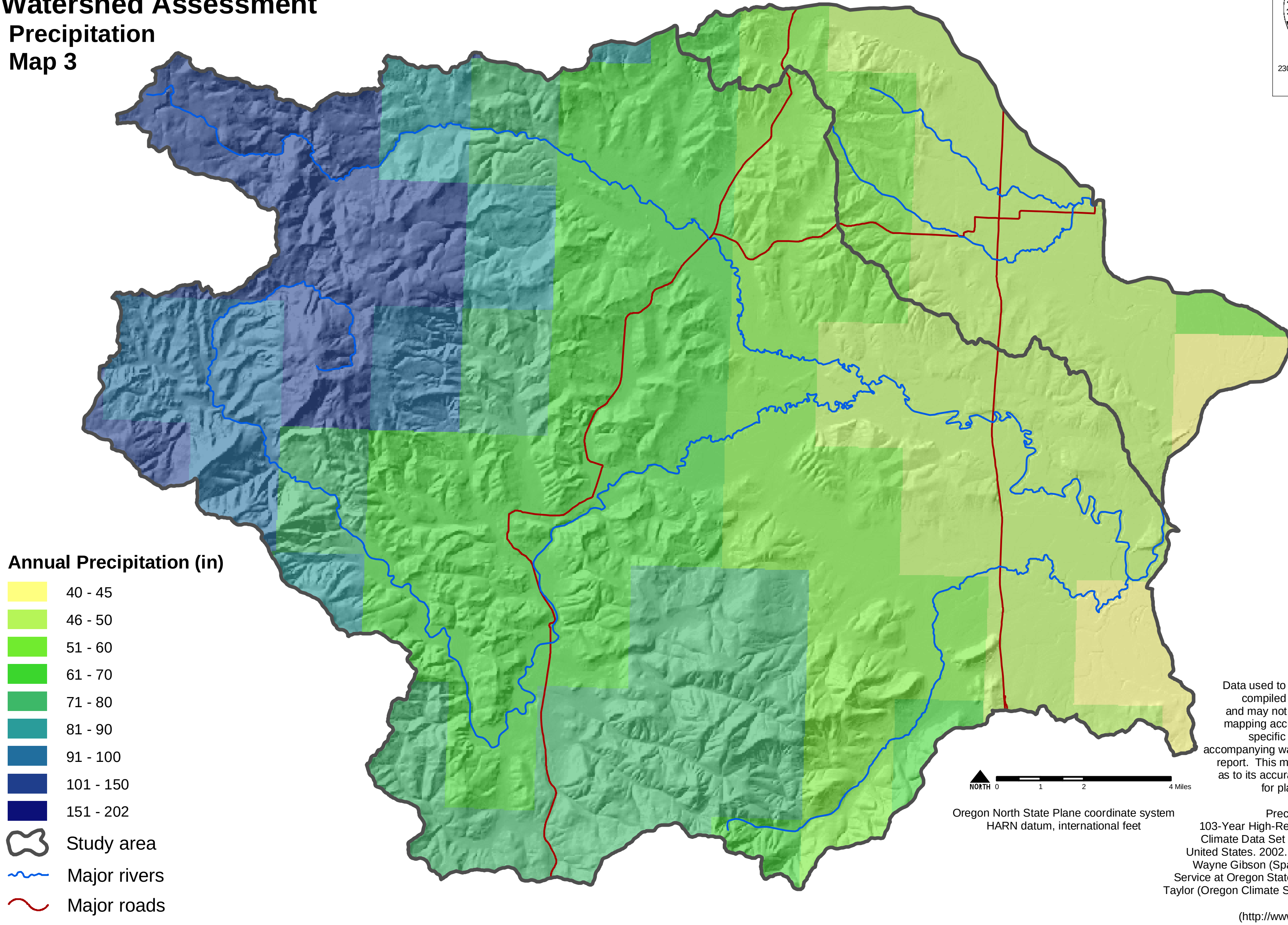
Month	Mean
January	7.8
February	6.7
March	5.3
April	3.2
May	2.2
June	1.4
July	0.5
August	0.7
September	1.4
October	3.3
November	7.8
December	8.8
Annual	49.1

Map 3. Mean Annual Precipitation in the Luckiamute/ Ash Creek Study area. Shown is the mean annual precipitation in inches for the period of 1971-2000.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Precipitation
Map 3

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Precipitation Data Source:
103-Year High-Resolution Precipitation Climate Data Set for the Conterminous United States. 2002. contacts: Chris Daly, Wayne Gibson (Spatial Climate Analysis Service at Oregon State University), George Taylor (Oregon Climate Service, Oregon State University).
(http://www.ocs.orst.edu/prism/)

4.3 Elevation

Elevation is an important property of a watershed. Plant communities are influenced by elevation, as are temperature, precipitation and rain-on-snow patterns. Precipitation and rain-on-snow events, in turn, control hydrological patterns in the stream network which influence erosion and sediment transport.

The majority of the Luckiamute / Ash Creek study area lies in lower elevations from 105 to 1,000 feet (72.6%), with a smaller area in mid elevations from 1,000 to 2,000 feet (21.7%), and the remainder in the highest elevations of the watershed from 2,000 to 3,650 feet (5.8%). The Ash Creek study area lies within lower elevations from 105 to 1,000 feet, with the majority of the area (91.1%) occurring from 105 to 500 feet (Map1, Tables 3 and 4).

Tables 5 and 6 show the topographic characteristics for each of the 7th Field HUC subbasins.

Table 3. Elevation within the Luckiamute Watershed study area.

Elevation (ft)	Area (acres)	% Total
105 - 500	87,784.0	43.5%
>500 - 1000	58,611.7	29.1%
>1000 - 1500	29,902.3	14.8%
>1500 - 2000	13,938.6	6.9%
>2000 - 2500	7,580.2	3.8%
>2500 - 3000	36,18.5	1.8%
>3000 - 3560	302.7	0.2%
Total	201,737.9	100.0%

Table 4. Elevation within the Ash Creek study area.

Elevation (ft)	Area (acres)	% Total
105 - 500	30,859.3	91.1%
>500 - 1000	3028.1	8.9%
Total	33,887.4	100.0%

Table 5. Topographic characteristics of subunits of the Luckiamute watershed.

Watershed name	7th Field HUC	Area (acres)	Elevation (ft) median	Elevation (ft) minimum	Elevation (ft) maximum	Slope median	Slope maximum
Black Rock Creek	17090003060603	3381.37	401	227	711	6	42
Bridgeport	17090003060704	3548.01	133	76	269	2	48
Bump Creek	17090003060305	4206.43	168	80	309	5	34
Clayton Creek	17090003060403	2443.17	192	92	563	6	31
Cold Springs	17090003060602	1880.39	627	295	834	12	36
Cooper Creek	17090003060903	4905.97	115	60	245	3	29
Cougar Creek	17090003060202	5622.91	327	118	818	11	54
E.E. Wilson	17090003061301	4545.68	63	48	224	0	20
Falls City	17090003060702	3320.33	227	89	613	3	34
Fern Creek	17090003060901	5014.4	118	71	233	3	19
Grant Creek	17090003060803	2038.5	213	86	466	5	36
Helmick	17090003061003	2847.88	62	49	144	0	30
Hoskins	17090003060203	7207.68	196	97	551	6	45
Ira Hooker	17090003060501	2646.55	145	72	298	5	38
Jont Creek	17090003060504	5543.55	147	59	531	4	22
Lower Berry Creek	17090003061204	3323.89	70	57	225	1	26
Lower Little Luckiamute	17090003060902	6474.7	80	59	268	1	19
Lower Pedee Creek	17090003060401	6044.2	181	79	763	5	49
Lower Teal Creek	17090003060802	4930.24	244	76	669	5	40
Luckiamute Landing	17090003061005	3308.22	61	48	133	0	36
Maxfield Creek	17090003060304	5849.73	287	89	638	7	33
McTimmonds	17090003060502	5449.35	160	72	431	5	32

Table 5. Topographic characteristics of subunits of the Luckiamute watershed.

Watershed name	7th Field HUC	Area (acres)	Elevation (ft) median	Elevation (ft) minimum	Elevation (ft) maximum	Slope median	Slope maximum
Middle Luckiamute	17090003060503	8336.57	82	59	261	1	28
Middle Soap Creek	17090003061102	4353.44	135	73	479	4	29
Miller Creek	17090003060102	5668.6	363	230	861	8	46
Palestine	17090003061302	4148.89	68	48	225	0	39
Parker	17090003061004	3795.77	83	49	147	1	23
Peterson Creek	17090003061203	3704.75	86	61	200	1	18
Plunkett Creek	17090003060301	3393.33	181	89	635	4	45
Price Creek	17090003060303	3358.29	307	92	637	8	39
Rifle Range	17090003061103	3074.23	76	57	481	1	30
Ritner Creek	17090003060404	6371.19	211	80	860	7	36
Simpson	17090003061001	4419.95	83	54	197	1	23
Socialist Valley	17090003060701	4969.67	332	127	612	6	40
Springhill	17090003061303	2884.11	57	47	158	0	14
Staats Creek	17090003061202	2482.92	102	64	392	2	17
Upper Berry Creek	17090003061201	3482.58	258	61	578	5	33
Upper Little Luckiamute	17090003060601	6044.48	738	294	1010	7	44
Upper Luckiamute	17090003060101	5922.72	487	230	981	9	34
Upper Pedee Creek	17090003060402	4630.46	370	129	809	8	41
Upper Soap Creek	17090003061101	5918.17	267	109	615	8	39
Upper Teal Creek	17090003060801	2206.75	585	349	809	6	43
Vincent Creek	17090003060204	7211.93	217	97	597	5	38
Waymire Creek	17090003060703	2447.36	225	89	422	4	33
Wolf Creek	17090003060201	3230.87	418	177	981	10	41
Woods Creek	1709000306030	2748.3	357	108	625	8	33

Table 5. Topographic characteristics of subunits of the Luckiamute watershed.							
Watershed name	7th Field HUC	Area (acres)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Slope	Slope
			median	minimum	maximum	median	maximum
	2						
Zumwalt	17090003061002	2395.89	85	54	185	1	13

Table 6. Topographic characteristics of subunits of the Rickreall watershed.

Watershed name	7th Field HUC	Area (acres)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Slope	Slope
			median	minimum	maximum	median	maximum
American Bottom	17090007020501	2541.48	49	44	53	0	8
Buena Vista	17090007020404	1978.06	64	44	137	1	46
Duck Slough	17090007020502	2952.72	53	45	144	0	16
Harman Slough	17090007020503	3160.93	54	41	117	0	11
Lower North Fork Ash Creek	17090007020603	3450.47	58	41	129	0	10
Lower South Fork Ash Creek	17090007020606	3299.6	60	45	114	0	9
Middle Fork Ash Creek	17090007020604	4411.2	81	50	252	1	22
Middle North Fork Ash Creek	17090007020602	3623.2	98	65	253	1	24
Upper North Fork Ash Creek	17090007020601	2755.96	149	97	277	3	21
Upper South Fork Ash Creek	17090007020605	5713.14	92	58	245	2	28
	Total	235621.13					
	Mean	4133.7	195.6	94	445.9	3.8	31

4.4 Lithology

Many watershed processes are influenced by bedrock lithology. The geologic formations that underlie each watershed determine how groundwater moves (therefore, stream temperature); how stream channels form; how soils form, weather, and erode; and many other watershed characteristics that directly and indirectly influence salmonid habitat.

Taylor *et al*. (2003) report that the lower Luckiamute watershed is characterized by a mixture of alluvial layers and the upper regions of watershed are supported by small-scale intrusions and volcanic rocks. Hillslope processes, *e.g.*, debris flow, creep, sliding, dominate the upper Luckiamute watershed. Therefore, the surficial geology profoundly influences the structure of the stream networks as well as the delivery of sediments and organic debris.

There are several types of geologic strata in the study area (Map 4, Table 7). The Tyee Formation dominates the southwestern half of the study area. Five pockets of landslide and debris flow deposits are scattered in the western, higher elevation area of the study area (see Section 6.2). The southern portion of the study area is dominated by Siletz River Volcanics and related rocks. The northwestern portion of the study area is classified primarily as Yamhill Formation and related rock and Mafic Intrusions. The eastern portion of the study area is primarily Lacustrine and Fluvial Sedimentary rock, Tuffaceous Siltstone and Sandstone, and Alluvial Deposits.

The Tyee and Lacustrine and Fluvial Sedimentary Formations underlie most of the Luckiamute River watershed (Map 4, Table 8). Steep areas that occur on Tyee (and similar) geologic formations are prone to slide. Interestingly, the Tyee Formation, such an important formation in the Coast Range, does not extend to the Ash Creek watershed. The Ash Creek watershed is dominated by Lacustrine and Fluvial Sedimentary and Tuffaceous Siltstone and Sandstone (Table 9).

Understanding patterns in underlying lithology helps with the interpretation of other analyses in this watershed assessment. For example, when analyzing the length of streams with gravel substrate in a watershed, it might be useful to consider the total area of igneous *versus* sedimentary formations within that watershed. Gravels, cobbles and boulders formed from igneous rock tend to be quite durable, compared to those formed from sedimentary formations, which may break down within periods of tens to hundreds of years (Siuslaw National Forest 1997). The general lithology map can help predict and interpret stream channel morphology data and predict where dramatic changes in stream morphology may occur. For example, for some areas in the Coast Range, igneous intrusions such as dikes and sills can create natural barriers to anadromous migration as headward erosion of streams is impeded (Boateng

& Associates Inc. 1999). Finally, groundwater flow in some areas may not follow surface features (Siuslaw National Forest 1997), which may help interpret stream water temperature measurements.

The data set used for this summary is the 1:500,000 scale data set from the Oregon Geospatial Data Center, taken from the Walker and MacLeod 1991, "Geologic map of Oregon" produced by the USGS. A 1:100,000 scale map of the entire state is being created by the Oregon Department of Geology and Mineral Industries (known as DOGAMI), but this endeavor is still in the process of being completed (*http://pubs. usgs.gov/of/of97-269/staub.html*). For more information on the Geology of the Luckiamute/ Ash Creek study area, see Appendix A.

Table 7. Description of the lithology of the study area (OGDC). Shown are type, lithology and description.

TYPE	LITHOLOGY	DESCRIPTION
Qal	Alluvial deposits	Sand, gravel, and silt forming floodplains and filling channels of present streams; in places includes talus and slope wash; locally includes soils containing abundant organic material and thin peat beds
Qls	Landslide and debrisflow deposits	Unstratified mixtures of fragments of adjacent bedrock; locally includes slope wash and colluvium
Qs	Lacustrine and fluvial sedimentary rocks	Unconsolidated to semiconsolidated lacustrine clay, silt, sand, and gravel; in places includes mudflow and fluvial deposits and discontinuous layers of peat
Qt	Terrace, pediment, and lag gravels	Unconsolidated deposits of gravel, cobbles, and boulders intermixed and locally interlayered with clay, silt, and sand
Ti	Mafic intrusions	Sheets, sills, and dikes of massive granophyric ferrogabbro; some bodies strongly differentiated and include pegmatitic gabbro, ferrogranophyre, and granophyre
Tsr	Siletz River Volcanics and related rocks	Aphanitic to porphyritic, vesicular pillow flows, tuffbreccias, massive lava flows and sills of tholeiitic and alkalic basalt; upper part of sequence contains numerous interbeds of basaltic siltstone and sandstone, basaltic tuff, and locally derived b
Tss	Tuffaceous siltstone and sandstone	Thick to thin bedded marine tuffaceous mudstone, siltstone, and sandstone; fine to coarse grained; contains calcareous concretions and, in places, is carbonaceous and micaceous
Tt	Tyee Formation	Very thick sequence of rhythmically bedded, medium to finegrained micaceous, feldspathic, lithic, or arkosic marine sandstone and micaceous carbonaceous siltstone; contains minor interbeds of dacite tuff in upper part
Ty	Yamhill Formation and related rock	Massive to thin bedded concretionary marine siltstone and thin interbeds of arkosic, glauconitic, and basaltic sandstone; locally contains interlayered basalt lava flows and lapilli tuff

Table 8. Lithology of the Luckiamute Watershed study area (Oregon Geospatial Data Center, taken from the Walker and MacLeod 1991).

Symbol	Lithology	Area (acres)
Qal	Alluvial Deposits	7,992.4
Qs	Lacustrine and Fluvial Sedimentary	35,543.4
Qls	Landslide and Debris Flow Deposits	2,845.8
Ti	Mafic Intrusions	16,912.4
Tsr	Siletz River Volcanics and Related Rocks	36,939.6
Qt	Terrace, Pediment, and Lag Gravels	1,355.3
Tss	Tuffaceous Siltstone and Sandstone	15,574.7
Tt	Tyee Formation	55,622.2
OW	Water Body	33.3
Ty	Yamhill Formation and Related Rock	28,918.9

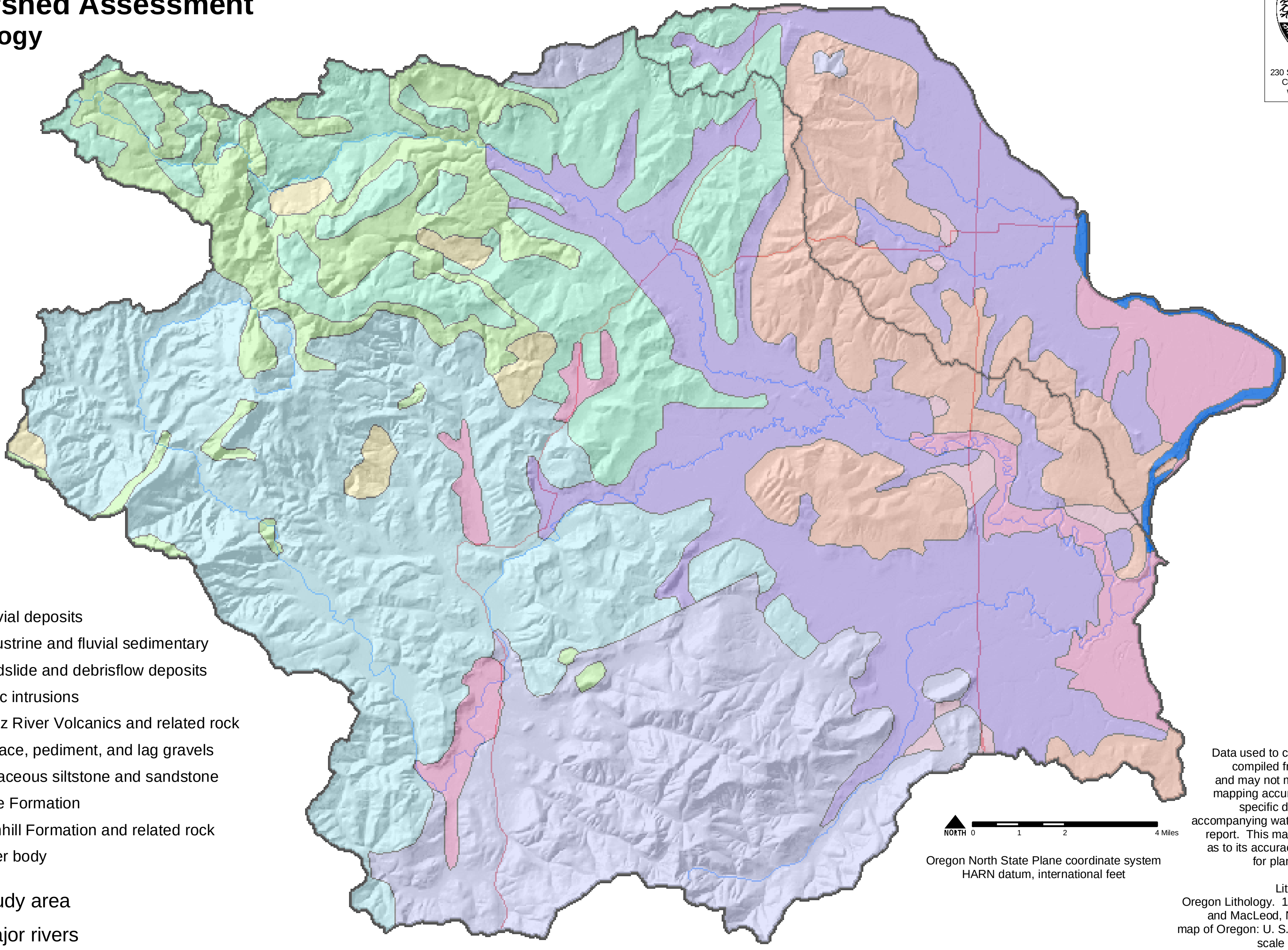
Table 9. Lithology of the Rickreall Watershed study area (Oregon Geospatial Data Center, taken from the Walker and MacLeod 1991).

Symbol	Lithology	Area (acres)
Qal	Alluvial Deposits	4,451.6
Qs	Lacustrine and Fluvial Sedimentary	14,329.5
Tsr	Siletz River Volcanics and Related Rocks	207.1
Qt	Terrace, Pediment, and Lag Gravels	333.1
Tss	Tuffaceous Siltstone and Sandstone	11,266.3
OW	Water Body	1,119.4
Ty	Yamhill Formation and Related Rock	2,180.3

Map 4. Lithology of the Luckiamute/ Ash Creek Study Area.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Lithology
Map 4



230 SW Third Street, Suite 212
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www.earthdesign.com

Lithology

- Alluvial deposits
- Lacustrine and fluvial sedimentary
- Landslide and debrisflow deposits
- Mafic intrusions
- Siletz River Volcanics and related rock
- Terrace, pediment, and lag gravels
- Tuffaceous siltstone and sandstone
- Tyee Formation
- Yamhill Formation and related rock
- water body

- Study area
- Major rivers
- Major roads

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Lithology Data Source:
Oregon Lithology. 1991. Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U. S. Geological Survey, scale 1:500,000, 2 sheets.
contact: Oregon Geospatial Data Clearinghouse. (http://www.gis.state.or.us/)

4.5 Soils

The distribution of different soil types can affect land cover/ land use, and hydrology. Hydric soils are formed around lakes and ponds, wetlands, and streams. Erodible soils are a component of the ecological processes that deliver woody debris to the streams that create salmonid habitat. Ultimately, soils affect where people choose to live, as well, as the variety and condition of wildlife within the watershed.

For this assessment, we obtained soils information from the Soil Survey Geographic (SSURGO) database. The SSURGO database contains soil mapping information compiled by the Natural Resources Conservation Service (NRCS). Map scales generally range from 1:12,000 to 1:63,360 and are suitable for use by landowners, townships, and county natural resource planning and management (*http://www.ncgc.nrcs.usda.gov/branch/ssb/ products/ ssurgo/fact-sheet.html*).

Hydric Soils

Hydric soils, by definition, are soils that formed under conditions of saturation, flooding, or ponding for long enough during the growing season to develop anaerobic conditions. We created a hydric soils layer by merging the SSURGO soils data set with a table of hydric soils (compiled by P. Adamus) listing hydric soils in the Willamette Valley (Table 10).

Unaltered hydric soils generally support the growth of hydrophytic (wetland) vegetation, and presence of hydric soils is used to assist identification of wetland areas. By acreage, 77% of the watershed's wetlands occur on soils that usually are hydric, and another 18% occur on soils that sometimes are hydric (*i.e.*, only a portion of the mapped units are hydric). Wetlands that persist on soils mapped as non-hydric (5% of the wetland area) often do so because of artificial impoundments. Conversely, the presence of hydric soils alone does not necessarily indicate the presence of a 'jurisdictional' wetland. For example, for the portion of the watershed having both wetland and soils maps available, 24% of the area that is mapped as hydric soil does not currently contain wetlands, probably because of the drainage that has occurred, or because some soils designated as hydric "may have phases that are not hydric depending on water table, flooding, and ponding characteristics" (USDA Natural Resources Conservation Service, 2000).

Many hydric soil areas that currently lack wetlands are prime areas for restoration (Table 11). Restoration projects located on Holocene (<10,000 BP) alluvial deposits are perhaps the most likely to succeed (D'Amore *et al.*, 2000). Most hydric soils in the Willamette Valley were formed in the Late Pleistocene when glacial floods deposited sediments on older geomorphic soils, resulting in vertically and horizontally abrupt textural differences. Moreover, deposition of lake sediments during the Late Pleistocene (when much of the Willamette Valley was a lake) disrupted gradients along streams well into the Holocene, as they entered from adjoining foothills, thus causing further deposition of fine alluvial sediments in fans along the valley margin (Balster and Parsons, 1969; Reckendorf, 1993). The rather impermeable clay layer that was deposited commonly holds rainwater in a "perched" position near the ground surface, giving rise to the chemically-reducing conditions that characterize hydric soils. During dry periods, deeper soils slowly and independently discharge groundwater upward, keeping wet the hydric soils that are closer to the surface (D'Amore *et al.*, 2000).

As one would expect, most of the hydric soils and soils with hydric inclusions are located in the eastern portion of the study area in the lowlands associated with the major rivers (Map 5).

Table 10. Soils types most commonly associated with wetlands in the Luckiamute-Rickreall watershed, based on overlay of NWI map of mid-1980's wetlands with county soil maps.

Soil map unit name	Hydric?	Acres in Wetlands
Waldo silty clay loam	Yes	1012.37
Water	Yes	650.15
Wapato silty clay loam	Yes	319.94
Dayton silt loam	Yes	208.46
Cove silty clay loam	Yes	198.93
Chehalis silty clay loam, occasionally flooded	Some	124.86
Riverwash	Yes	77.54
Xerofluvents, loamy	Some	71.99
Amity silt loam	Yes	68.74
Bashaw silty clay loam	Yes	66.92
Malabon silty clay loam, occasionally flooded	Some	65.95
Cove silty clay loam, thick surface	Yes	62.73
Concord silt loam	Yes	61.52
Mcbee silty clay loam	Some	61.49
Coburg silty clay loam, occasionally flooded	Some	60.00
Woodburn silt loam, 0 to 3 percent slopes	Some	50.99
Cloquato silt loam	Some	49.57
Coburg silty clay loam	Some	23.87
Bashaw clay, 0 to 3 percent slopes	Yes	21.67

Table 10. Soils types most commonly associated with wetlands in the Luckiamute-Rickreall watershed, based on overlay of NWI map of mid-1980's wetlands with county soil maps.

Soil map unit name	Hydric?	Acres in Wetlands
Dupee silt loam, 3 to 12 percent slopes	No	21.51
Newberg fine sandy loam	Some	21.11
Xerochrepts and haploxerolls, steep	No	13.66
Witham silty clay loam, 2 to 7 percent slopes	No	13.22
Newberg loam	Some	11.30
Pits, quarries	No	10.38
Willamette silt loam, 0 to 3 percent slopes	Some	9.67
Woodburn silt loam, 3 to 12 percent slopes	Some	9.48
Pits	No	8.88
Malabon silty clay loam	Some	8.63
Helvetia silt loam, 0 to 12 percent slopes	No	8.62
Steiwer silt loam, 3 to 12 percent slopes	Some	8.32
Helmick silt loam, 3 to 12 percent slopes	Some	8.06
Hazelair silt loam, 3 to 12 percent slopes	Some	7.78
Mcalpin silty clay loam	No	7.43
Conser silty clay loam	Yes	7.07
Willamette silt loam, 3 to 12 percent slopes	No	7.06
Mcalpin silty clay loam, 0 to 3 percent slopes	No	6.12
Chehalis silty clay loam	Some	5.41
Camas gravelly sandy loam	No	4.67
Mcalpin silty clay loam, 3 to 6 percent slopes	No	4.55
Santiam silt loam, 6 to 15 percent slopes	No	4.08
Salem gravelly loam	No	3.43
Suver silty clay loam, 3 to 12 percent slopes	No	3.20
Pilchuck fine sandy loam	No	3.11
Jory silty clay loam, 12 to 20 percent slopes	No	2.98
Santiam silt loam, 3 to 6 percent slopes	Some	2.95
Holcomb silt loam	Some	2.94
Bellpine silty clay loam, 3 to 12 percent slopes	Some	2.81
Jory silty clay loam, 2 to 12 percent slopes	No	2.74
Chehulpum-steiwer complex, 12 to 40 percent slopes	No	2.70
Willakenzie silty clay loam, 2 to 12 percent slopes	No	2.37
Price-ritner complex, 30 to 60 percent slopes	No	2.33
Dupee silt loam, 12 to 20 percent slopes	No	1.76
Suver silty clay loam, 12 to 20 percent slopes	No	1.70

Table 10. Soils types most commonly associated with wetlands in the Luckiamute-Rickreall watershed, based on overlay of NWI map of mid-1980's wetlands with county soil maps.		
Soil map unit name	Hydric?	Acres in Wetlands
Bellpine silty clay loam, 12 to 20 percent slopes	No	1.44
Steiwer silt loam, 12 to 20 percent slopes	No	1.35
Jory silty clay loam, 20 to 30 percent slopes	No	1.19
Hazelair silt loam, 12 to 20 percent slopes	No	1.11
Jory silty clay loam, 2 to 30 percent slopes	No	0.98
Dixonville silty clay loam, 12 to 20 percent slopes	No	0.93
Helmick silt loam, 12 to 20 percent slopes	No	0.89
Chehulpum silt loam, 3 to 12 percent slopes	No	0.83
Willakenzie silty clay loam, 12 to 20 percent slopes	No	0.80
Dixonville silty clay loam, 3 to 12 percent slopes	No	0.63
Rickreall silty clay loam, 3 to 12 percent slopes	No	0.37
Chehulpum silt loam, 12 to 40 percent slopes	No	0.36
Santiam silt loam, 15 to 20 percent slopes	No	0.34
Nekia silty clay loam, 2 to 12 percent slopes	No	0.33
Bellpine silty clay loam, 30 to 50 percent slopes	No	0.33
Ritner-price complex, 12 to 30 percent slopes	No	0.31
Abiqua silty clay loam, 3 to 5 percent slopes	Some	0.27
Price-ritner complex, 20 to 30 percent slopes	No	0.26
Suver silty clay loam, 20 to 30 percent slopes	No	0.17
Bashaw silty clay loam, 0 to 3 percent slopes	Yes	0.17
Woodburn silt loam, 12 to 20 percent slopes	No	0.14
Willamette silt loam, 12 to 20 percent slopes	No	0.04
Willakenzie silty clay loam, 20 to 30 percent slopes	No	0.04

Table 11. Area of hydric soils, by subunit, that have or do not have wetlands at the present time. Watersheds for which wetland maps were not available are not listed.				
Watershed Name	Hydric and have wetlands (acres)	Hydric but lack wetlands (acres)	Total Hydric Area	% of hydrics lacking wetlands
Woods Creek	1.0	72.0	73.0	98.7
Price Creek	0.00	11.08	11.08	100.0
Maxfield Creek	66.29	53.06	119.35	44.5
Bump Creek	25.79	55.67	81.47	68.3
Ira Hooker	20.91	60.65	81.56	74.4

Table 11. Area of hydric soils, by subunit, that have or do not have wetlands at the present time. Watersheds for which wetland maps were not available are not listed.

Watershed Name	Hydric and have wetlands (acres)	Hydric but lack wetlands (acres)	Total Hydric Area	% of hydrics lacking wetlands
McTimmonds	0.04	603.06	603.09	100.0
Middle Luckiamute	687.48	756.24	1443.72	52.4
Jont Creek	599.94	47.85	647.79	7.4
Socialist Valley	0.00	2.85	2.85	100.0
Falls City	0.00	41.74	41.74	100.0
Waymire Creek	0.00	25.56	25.56	100.0
Bridgeport	252.78	88.49	341.27	25.9
Lower Teal Creek	14.51	87.39	101.90	85.8
Grant Creek	0.00	45.27	45.27	100.0
Fern Creek	797.40	22.90	820.30	2.8
Lower Little Luckiamute	509.69	71.75	581.44	12.3
Cooper Creek	471.78	18.86	490.64	3.9
Simpson	542.23	256.29	798.52	32.1
Zumwalt	437.33	53.76	491.09	11.0
Helmick	911.54	55.48	967.02	5.7
Parker	578.90	45.96	624.86	7.4
Luckiamute Landing	721.82	143.10	864.92	16.5
Upper Soap Creek	98.08	0.41	98.49	0.4
Middle Soap Creek	623.28	16.36	639.63	2.6
Rifle Range	789.60	62.37	851.98	7.3
Upper Berry Creek	130.15	23.98	154.12	15.6
Staats Creek	438.79	6.47	445.26	1.5
Peterson Creek	500.81	285.01	785.82	36.3

Table 11. Area of hydric soils, by subunit, that have or do not have wetlands at the present time. Watersheds for which wetland maps were not available are not listed.

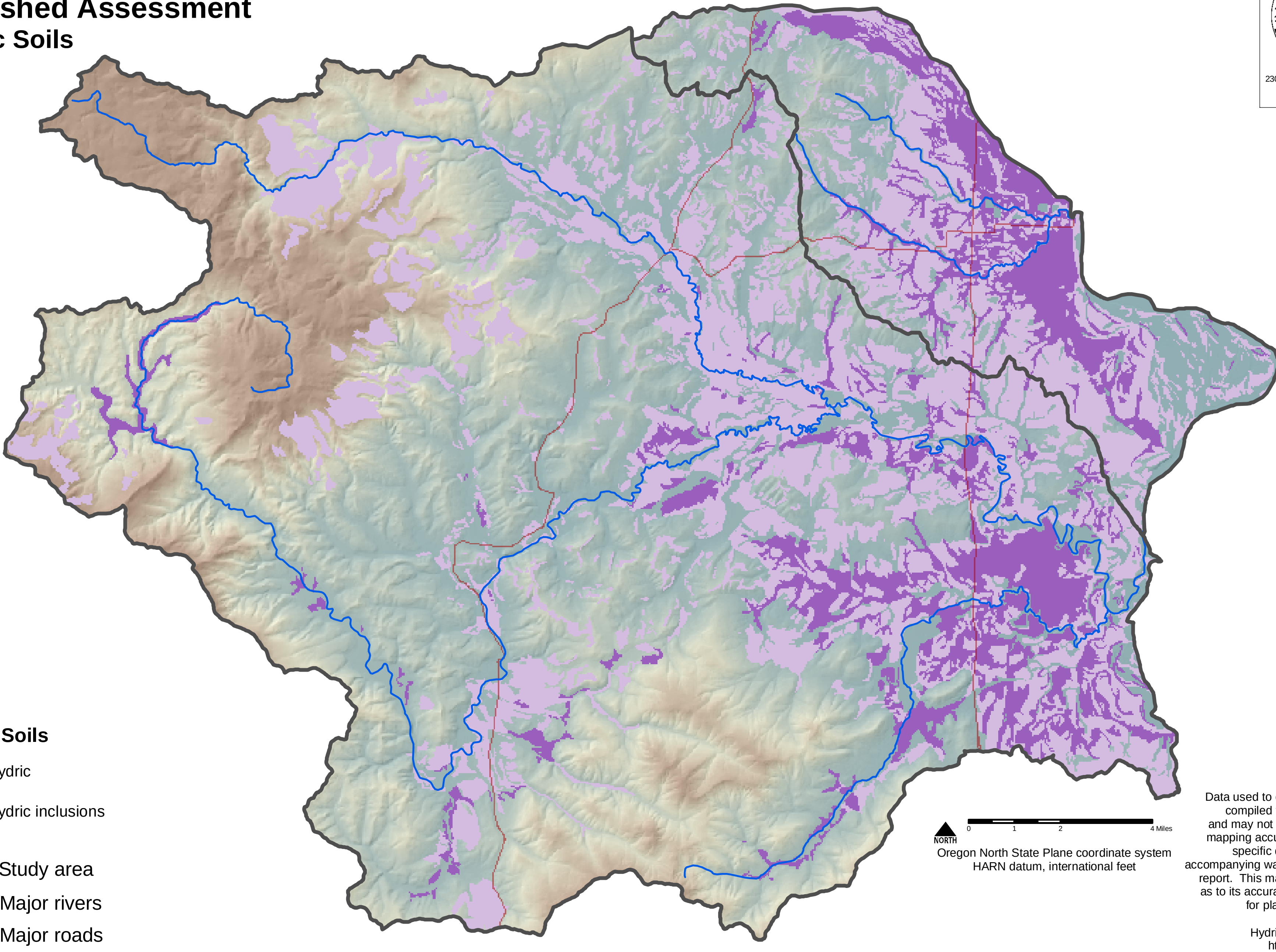
Watershed Name	Hydric and have wetlands (acres)	Hydric but lack wetlands (acres)	Total Hydric Area	% of hydrics lacking wetlands
Lower Berry Creek	405.77	457.65	863.42	53.0
E.E. Wilson	1706.57	240.68	1947.25	12.4
Palestine	923.77	222.27	1146.03	19.4
Springhill	544.11	80.80	624.91	12.9

Map 5. Hydric soils and soils with hydric inclusions in the Luckiamute / Ash Creek study area. Also shown are the major rivers and major roads.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Hydric Soils
Map 5

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Hydric Soils

- Hydric
- Hydric inclusions
- Study area
- Major rivers
- Major roads

NORTH
0 1 2 4 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Hydric Soils Data Source:.
http://groups.msn.com/OregonSocietyofSoilScientists/oregonhydricsoillist.msn

Erodible Soils

Under some circumstances, sediments and soils can move across the landscape and into the stream network where they can dramatically affect the quality of aquatic habitat. Circumstances that foster soil erosion include any actions that remove vegetation (which acts to stabilize soils), or any actions that lead to an increased frequency of mass wasting events. Detailed information on soils can be used to plan actions to minimize the impact on soils prone to erosion. For more information on erosion and landslides in the study area, see Section 6.2.

Ecoregions and Physiographic Provinces

There are many ways to group areas into regions. Ecoregions and physiographic provinces are two such methods. Ecoregions are areas that share similar soils, vegetation, and climatic characteristics. The concept of the ecoregion was introduced in 1987 as a water quality management tool that grouped areas based on perceived patterns in climate, soils, potential vegetation, land form and land use (Omernik, 1987). Since the concept was introduced, there have been many different ecoregion classifications schemes produced at many different scales, so it is necessary to know what ecoregion definition is being used to properly understand the designations. The study area is at the confluence of five ecoregions as defined by the Level IV EPA Ecoregion dataset available from the EPA (Map 6): Volcanics, Mid-Coast Sedimentary, Valley Foothills, Willamette River Tributaries Gallery Forest, and Prairie Terraces. Descriptions of each of the ecoregions in the study area are shown in Table 12.

In addition to ecoregions, physiographic provinces have been used to develop regional descriptions. For example, in their description of the natural vegetation of Oregon and Washington, Franklin and Dyrness (1988) divide the two-state area into 15 physiographic provinces. Physiographic provinces are defined natural features of the earth including land formation, climate, and distribution of flora and fauna. The Luckiamute and Ash Creek watersheds fall into the 'Coast Ranges' and 'Willamette Valley' physiographic provinces [see Chapter II in (Franklin and Dyrness, 1988) for complete descriptions of the characteristics of each of these physiographic regions]. Two major vegetation zones cover the study area, the *Tsuga heterophylla* (Western Hemlock) and Willamette Valley zones (see Section 7).

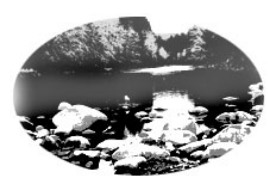


Table 12. Descriptions of the Level IV EPA Ecoregions within the study area (Woods *et al.*, 2000). Also see Map 6.

Level IV EPA Ecoregion	Description
Volcanics	The Volcanics ecoregion varies in elevation from 1,000 to 4,000 feet and is disjunct. Columnar and pillow basalt outcrops occur. Its mountains may have been offshore seamounts engulfed by continental sediments about 200 million years ago. The basaltic substrate preserves relatively stable summer stream flows that still support spring chinook salmon and summer steelhead. Its forests are intensively managed.
Mid-Coast Sedimentary	The Mid-Coastal Sedimentary ecoregion is commonly underlain by massive beds of siltstone and sandstone. Its dissected, forested mountains are rugged and are prone to mass movement when the vegetation cover is removed. Stream gradients and fluvial erosion rates can be high.
Valley Foothills	The Valley Foothills ecoregion is a transitional zone between the Willamette Valley, the Cascade Range, and the Coast Range. It has less rainfall than adjacent, more mountainous ecoregions and, consequently, its potential natural vegetation is distinct. Oregon white oak and Douglas-fir were originally dominant but, today, rural residential development, woodland, pastureland, vineyards, tree farms, and orchards are common.
Willamette Valley Tributaries Gallery Forest	In the Willamette River and Tributaries Gallery Forest ecoregion, meandering, low-gradient channels and oxbow lakes are incised into broad floodplains. Deciduous riparian forests that once grew on its fertile, alluvial soils have been largely replaced by agriculture and rural residential, suburban, and urban development.
Prairie Terraces	The undulating Prairie Terraces ecoregion is dissected by low-gradient, meandering streams and rivers. Its fluvial terraces once supported prairie and oak woodlands which were maintained by burning; Oregon ash and fir occurred in wetter areas. Today, grass seed and grain crops are commonly grown.

Map 6. Ecoregions in the Luckiamute/ Ash Creek Study area. Source (Omernik, 1987)

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Ecoregions
Map 6

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Corvallis, Oregon 97333
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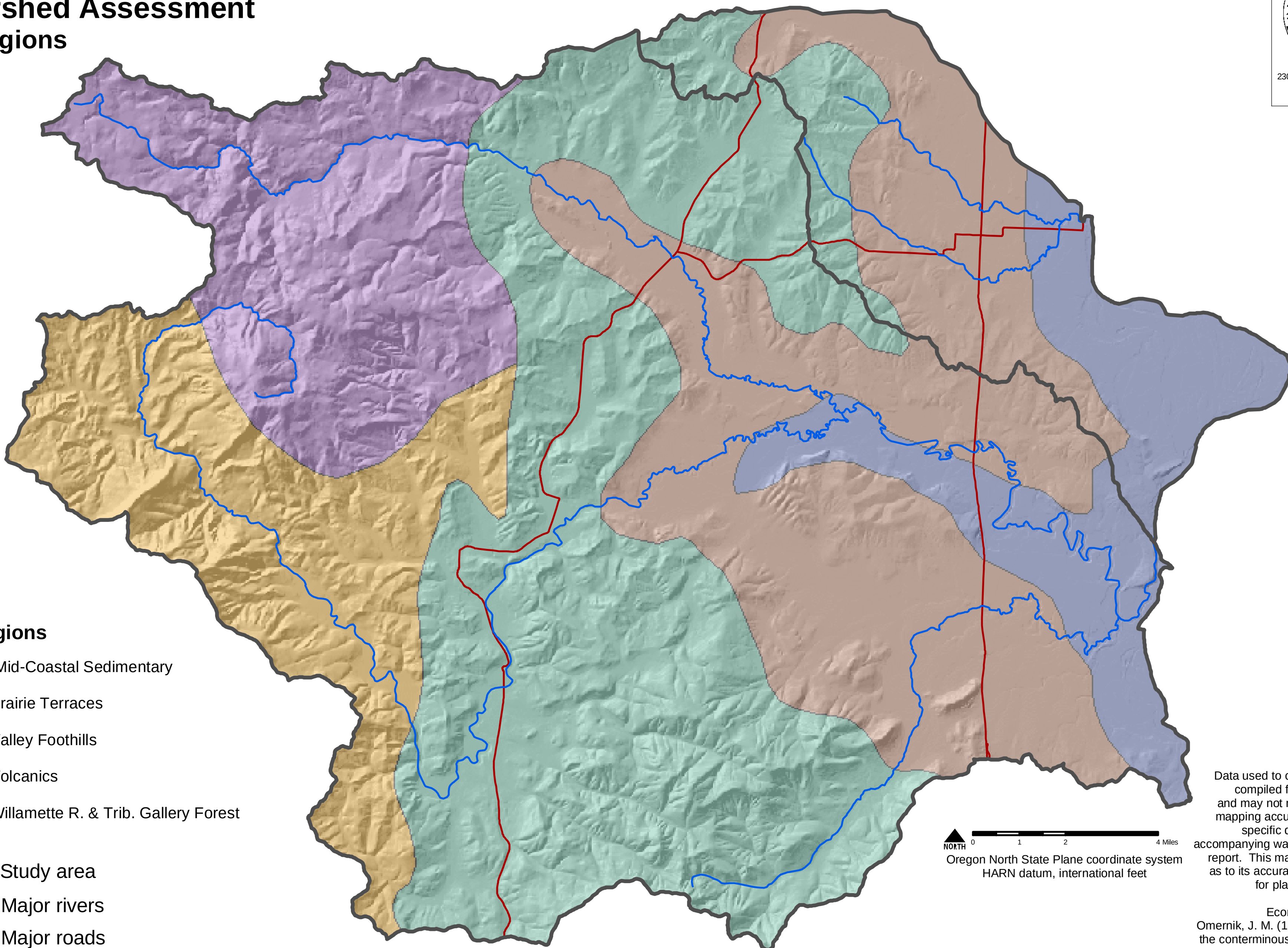

Ecoregions

- Mid-Coastal Sedimentary
- Prairie Terraces
- Valley Foothills
- Volcanics
- Willamette R. & Trib. Gallery Forest

- Study area
- Major rivers
- Major roads

NORTH 0 1 2 4 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Ecoregions Data Source:
Omernik, J. M. (1987). "Ecoregions of the conterminous United States. Map (scale 1:7,500,000)." Annals of the Association of American Geographers 77(1): 118-125.

5 HUMAN HABITATION

5.1 Settlement

Historic Settlement

Archaeological information provides insight into where Native Americans settled in the Willamette Valley. Artifacts and burial sites throughout the Willamette Valley reveal tools, food remains, and other indications of native culture and lifestyle. Hager's grove, near Salem has artifacts associated with charcoal-filled fire hearths and earth ovens. Other artifacts include narrow-pointed arrowheads from around 2,500 BP, apparently used for arrows, and charred camas bulbs, hazelnuts and acorns (Aikens, 1992). Archeologists conclude that this site was used as a seasonal hunting site, probably used during midsummer or fall, where game was hunted and plants were collected (Aikens, 1992). With information from many sites like this, archeologists have reached some major conclusions about indigenous peoples in this area. Indigenous peoples of the Luckiamute Valley lived in small, independent groups, but belonged to the larger Kalapuyan family of peoples who occupied the Willamette Valley. In the Luckiamute Valley, there were probably six different bands (Ruby and Brown, 1992) who were speakers of Central Kalapuyan, one of the three Kalapuyan languages (Aikens, 1992). These people made seasonal camps within their individual ranges, so that groups could harvest various resources as they ripened or were most readily obtained (Aikens, 1992). Camas root was harvested throughout the summer, and fishing occurred mainly in spring, fall, and winter.

As in other places in the United States, many Native Americans were killed by diseases introduced by European-American settlers. Even before 1812, when contact with fur-traders and explorers began, native populations were being decimated by European-American diseases such as smallpox and malaria (Whitlock and Knox., 2002). Arrival of European-American settlers and the policies of the federal government further displaced Native Americans from their homelands. The residents of the Luckiamute Valley were "relocated" twice and, in 1855, moved to a reservation designated by the U.S. government in Grand Ronde, just north of the Luckiamute homelands. The Native Americans of the Luckiamute Valley lived on this reservation along with people from other tribes until the reservation was dissolved in 1957 (Ruby and Brown, 1992). The Donation Land Act of September 29, 1850 gave incentive for Americans to move to the West. Settlers were given land, provided that they live on and cultivate them. A man was offered 640 acres if married and 320 acres if single.

For more information on the history of the Luckiamute / Ash Creek watersheds, see Appendix B.

Historic Sites

The following list of historic sites was supplied by the LWC.

Fort Hoskins- this pre-settlement site is located in Kings Valley.
Old California Trail- this major wagon trail was used during settlement of the watershed.

Sulphur Springs- the site of mineral springs and a historic spa in the Soap Creek valley. The site is now administered by OSU Research Forests.

Soap Creek Historic School House – it is a National Historic Site.

Parker School House

Pioneer Cemeteries – including the Pedee Cemetery; a list is available from the Polk Co. Historical Museum.

Cities

The Luckiamute/ Ash Creek study area includes the cities of Monmouth, Independence, Dallas, and Falls City, as well as the communities of Adair Village, Airlie, Buena Vista, Hoskins, Kings Valley, Pedee, and Suver (Map 1). Major cities in the region, but outside of the study area, are Corvallis and Albany to the south and Salem to the northeast.

McArthur (1992) provides information on the naming of cities within the study area (see also Section 5.4).

Adair Village- Adair Village is located just south of the Luckiamute Watershed on state highway 99W. Adair Village was named for Camp Adair (see Section 5.4 for more information on Camp Adair).

Airlie- This town was established at the terminus of a narrow gauge line of the Oregon Railroad Company. The railroad track was removed in 1929, but the community of Airlie remained.

Buena Vista- The land for this community was donated from the land claim of Reason B. Hall. Buena Vista received its name in 1850, and was named thus because one of Hall's relatives fought in the battle of Buena Vista in Mexico.

Dallas- The town of Dallas was initially called 'Cynthia Ann'; it was settled in the 1840s but moved more than a mile south in 1856 due to an insufficient water supply. The town was later named for George Mifflin Dallas, a vice-president of the United States under Polk. Dallas was chosen over Independence as the county seat of Polk County after securing a narrow gauge railroad into the town at the cost of $17,000 in 1878-1880.

Falls City- Falls City was named for the falls in the Little Luckiamute River, on the western edge of this community. Falls City started as the town of Syracuse. The place originally served as a post office named Syracuse, which was established in February 1885. In 1889 Frank Hubbard decided to move Syracuse two miles to the site of present day Falls City (Arlie Holt, personal communication). The name of the post office was changed to Falls City in October 1889.

Photo 5

Hoskins- The community of Hoskins is close to the site of Fort Hoskins. The Fort was established on July 26, 1856 by the federal government to oversee the "resettlement" of western Oregon native peoples to the newly established Coastal Indian (Siletz) Reservation. The location of the fort was on the Luckiamute River near the mouth of what is now Bonner Creek. The land was probably owned by Rowland Chambers.

Independence- This city was founded by Elvin A. Thorp, from Missouri, who named it for Independence, Missouri. Thorp acquired the land for the community from a donation land claim.

Kings Valley- This community was named for the pioneer Nahum King who arrived in Oregon in 1845. A flourmill was built at this site by Rowland Chambers in 1853. Kings Valley post office was established on April 13, 1855.

Lewisville- Lewisville was established on the donation land claim of and named for David R. Lewis, a pioneer living around 1845. Lewisville is located about 0.7mi North of Maple Grove.

Monmouth- This city was settled by a group of pioneers from Monmouth, Illinois who arrived in 1852. The same party gave 640 acres of land on which to establish a town and college. This college, originally known as Monmouth University, later became Christian College. In 1883, the Oregon Legislature passed a bill creating the Oregon State Normal School, which was later renamed the Oregon College of Education, then Western Oregon State College, and today is known as Western Oregon University.

Pedee- the Pedee community is near the mouth of Pedee Creek, a tributary to the Luckiamute River. Pedee creek was named by Colonel Cornelius Gilliam who came to Oregon in 1848 from North Carolina, home of its own famous Peedee River.

Suver- This community is named for the pioneer Joseph W. Suver who was born in Virginia in 1819 and settled on a donation land claim in the area in 1845.

5.2 Human Population

The human population within the study area has increased dramatically. Using data from the U.S. Census Bureau, we looked at changes in the populations of cities within and near the study area, and in Benton and Polk Counties.

From 1990 to 2000, most of the cities in or near the study area saw an increase in population, with the exception of Adair Village. Table 13 shows the population change for several of these cities (U.S. Census Bureau, 2002). Within the study area, the population of Independence increased by approximately 27%, Monmouth by almost 19% and Falls City's population by about 17%.

Table 13. Population change for cities in or near the study area (U.S. Census Bureau, 2002).			
City	**1990 Population**	**2000 Population**	**% Change**
Adair Village[3]	548	536	-2.2%
Albany[3]	29,463	40,852	27.9%
Corvallis[3]	44,757	49,322	9.3%
Dallas[2]	9,422	12,459	24.4%
Falls City[1]	800	966	17.2%
Independence[1]	4,425	6,035	26.7%
Keizer[3]	21,884	32,203	32.0%
Monmouth[1]	6,288	7,741	18.8%
Salem[3]	107,786	136,924	21.3%

[1] City is within the study area, [2]City is partially within the study area, [3]City is near the study area and information is provided for comparison.

During the same 10-year period, Polk County's population grew by about 22% and Benton County's population by about 9% (U.S. Census Bureau, 2003). For comparison, the state of Oregon grew by 18% during this same period (U.S. Census Bureau, 2003).

From 1860 to about 1945 there was a gradual rate of increase in the populations of Benton and Polk Counties. From 1945 to 2000, the rate of population increase became exponential. At the time of the last census, the population of Benton County was 77,926 and Polk County was 63,679 (U.S. Census Bureau Population Division, 1995; University of Virginia Geospatial and Statistical Data Center, 1998; U.S. Census Bureau, 2003).

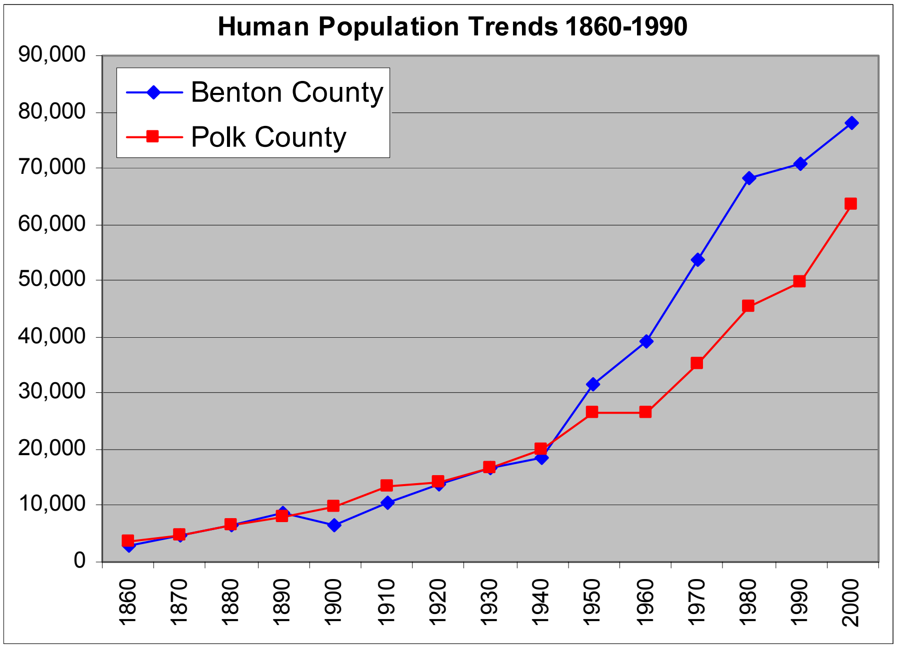

Figure 1. Human population trends in Benton and Polk Counties from 1860-1990 (U.S. Census Bureau Population Division, 1995; University of Virginia Geospatial and Statistical Data Center, 1998; U.S. Census Bureau, 2003).

5.3 Transportation

Roads

Two state and one regional highways pass through the study area (Map 1). Oregon State Highway 99W runs along the eastern perimeter of the study area. Oregon State Hwy 223, also known as Kings Valley Highway, crosses through the western portion of the study area. Both 99W and Hwy 223 are oriented north to south. The Monmouth Highway runs from Monmouth in an east-west direction between the two other highways (Map 1).

Knowledge of the type and location of roads is important for a watershed assessment (see Section 6). For example, roads located in floodplains and roads that cross streams can directly affect hydrologic patterns by constraining stream channels. Indirectly, road building replaces permeable soils with impervious surface so that instead of slowly infiltrating soils, water runs along road surfaces and enters the stream network over a short period of time. In extreme cases, roads have actually functioned as extensions of the stream network during storm events (Wemple, 1994). Since roads also act as barriers for many types of wildlife and transportation corridors for invasive species, roads can have a dramatic impact on watershed wildlife habitat.

The Watershed Assessment Manual (Watershed Professionals Network, 1999) suggests that when impervious surfaces of roads cover 4% to 8% of a watershed's area, there is a moderate to high risk of alteration to hydrologic peak flows. As water moves over a road surface it can transport pollutants and sediments to the stream network. A study by an independent group of scientists reported that roads could be a chronic source of sediments to streams (Independent Multidisciplinary Science Team, 1999).

In order to determine the risk of sediment (and pollutant) delivery and stream channel constraint that roads pose to each watershed, it is necessary to map and categorize roads throughout the basin. This would include classification of roads into paved and unpaved categories, and determination of road width. If road densities were to be calculated, a uniform-scale map of roads is necessary. The best available roads information is provided on paper USGS topographic maps at a scale of 1:24,000. Although it is possible, it is very time consuming to make many of the measurements called for in the OWEB watershed assessment using the paper maps. In addition, without the proper equipment rounding errors usually make measurements made from paper maps less accurate than those made using a computerized system. Fortunately, there is a GIS layer depicting roads in the study area available from the BLM. While there are known quality issues with this layer (especially in the description of the road surfaces on each road segment), this layer represented the best data available at the time this assessment was conducted. Therefore, the BLM roads layer is used throughout the assessment. **We recommend that the LWC develop a more accurate roads layer from USGS topographic maps and other sources, if more accurate road information is needed for action planning.**

Using the BLM roads layer, we found that there is a total of 1,432.2 miles of roads in the study area, with the majority of the roads with a known road surface having an aggregate surface (16.5%) (Table 14).

Table 14. Road length by surface type (Bureau of Land Management, 2003).

Road Surface	Length (mi)	% Total Length
Aggregate Base ASC - Aggregate Surface	236.5	16.5%
Bituminous	41.0	2.9%
Hard Surface	36.1	2.5%
Natural Unimproved	8.8	0.6%
Not Designated	3.4	0.2%
Not Known	1,061.9	74.1%
Pit Run	44.5	3.1%
Total	1,432.2	100.0%

Railroads

Railroads have been important in the area since the early 1900s. The Valley & Siletz Railroad, which was incorporated in 1912 by the Cobbs & Mitchell Lumber Company, passed through the watershed along the Luckiamute River linking Kings Valley and Pedee with Independence. It connected to the Southern Pacific Railroad at Independence. The primary goal of its construction was to move timber, but it was also used to move agricultural products. The line was purchased in late 1984/early 1985 by the Willamette Valley Railroad Company. The Willamette Valley Railroad Company continued to operate carrying cargo for the Mountain Fir Lumber Company until the lumber facility closed in May of 1992. This railroad is no longer in use *(http:// www .pnwc-nrhs. org/rr-history/rr-history-VS.html*).

Airports

There are several airports in the study area. The Independence State Airport is located north of the City of Independence. McNary Field in Salem is the closest regional airport, and the closest international airport is located in Portland.

Ports

The Buena Vista Ferry, not really a port but rather a transportation corridor, runs across the Willamette River from Independence/Buena Vista (*http://publicworks.co. marion.or.us/ operations/ ferries/bvinfo.asp*).

5.4 Land Use

Land use is discussed in more detail in Section 7.

Mills

The LWC asked the team to identify mills associated with some of the early Land Claims. Table 15 lists Donation Land Claims for the Luckiamute/Ash Creek study area.

Table 15, Donation Land Claim settlers and mill sites in the Luckiamute Valley. Listed are the owner, year of claim, township and range, quarter section and notes. Sources of information are listed below.

Owner	Year	Township	Range	Section	Quarter/ Other
Sawmills Identified within the OSU Research Forest (Wisner, 1992)					
Coote/Cornutt	1935-1937	T10S	R5W	9	north half, middle
Coote/Cornutt	1929-1935	T10S	R5W	16	north half, middle
Coote/Weinert	1936-1939	T10S	R5W	15	SE 1/4
Cooper's Mill	1930s	T10S	R5W	8	SW 1/4
Bennett Brothers	1930s	T10S	R5W	16	SW 1/4
Oak Creek Mill	1910-1920	T11S	R5W	7/18	
Oak Creek Mill	1910-1937	T11S	R5W	18	SW 1/4
Oak Creek Mill	1910-1937	T11S	R5W	17	NW 1/4
OSU Mill	1947-1955	T11S	R5W	20	NW 1/4
Govier Mill	1931-1939	T10S	R5W	10	SE 1/4
Soap Creek Mill	1890	T10S	R5W	35	SW 1/4
Valley Mill	1935-1955	T11S	R5W	3	NE 1/4
Calloway Creek Mill	1911-1916	T10S	R5W	36	E middle
Mt. View Mill	1934-1937	T11S	R5W	2	NE 1/4
Zager Mill	1937	T11S	R6W	24	E middle
Zeller Mill	1937	T11S	R6W	12	E middle
Unnamed	1937	T11S	R5W	10	W middle
Sulphur Springs Mill	1890	T11S	R5W	5	NW 1/4
Sharp's Mills		T8W	R4W	20	
Scott's Mill		T8W	R4W	28	
Sawmills identified near Falls City (fall city draft document received from C. Vandenberg)					

John Thorp	1853	T9W	R4W	11	
Shrader-Mowery			on teal creek, near the Falls City water reservoir		
Rowell			9 miles west of Dallas		
Palmehn			above Falls City, above Dutch Creek		
Sawmills near Kings Valley (Theurer, 2003)					
Barnhart-Kochis			upper end of the Luckiamute		
Henry Baumann	1920s		up Luckiamute canyon		
Earl Godsey	early 1930s		Luckiamute river, in the "flat field along the river". Powered by steam tractor and did not have a mill pond		
Alvin Jones	1916		"in this area"		
Moody brothers	1930s		Benton County, below Barnhart's mill, no burner or pond		
Frantz family - Big mill at Hoskins	before 1910		on the old Fort Hoskins site. Mill put on Luckiamute and run with water power.		
Bayless Moser and Bill Coote	early 1920s		Between Hoskins and Kings Valley, beside railroad		
Archie and Dorval Bevens	1923		on the Walter Cosgrove farm, west of Kings Valley		
Charles Moser	1931		above Hoskins, on Burgett Creek		
Simpsons	Unknown		Maxfield Creek Road		
Christenson	1906		up the "canyon"		

Mining

Locations of mines, gravel pits and quarries are important watershed features because they can affect water quality and wildlife. We examined available USGS topographical maps for quarries and mines. We found fifty-five quarries or gravel pits located in the study area (Table 16), these are used primarily for road aggregate (S. Taylor, personal communication). In addition to the USGS topographical maps, we found the S2F quarry, located on Coffin Butte that is used as a source for rock to cover the landfill (*mindat.org*). Admittedly, only a small amount of the quarry's total production goes to the landfill. We also searched the Oregon Department of Geology and Mining Industries (*www. oregongeology. com*) web page for information on mines in the study area. Unfortunately, we did not find anything for the Luckiamute/ Ash Creek study area.

Table 16. List of Gravel Pits and Quarries by 7th field watershed. Source was 7.5' USGS topographical map

Sub-Basin Name	HUC	Feature	Number
Upper Luckiamute	17090003060101	Pit	3
Miller Creek	17090003060102	Pit	1
Wolf Creek	17090003060201	Pit	1
		Quarry	2
Hoskins	17090003060203	Quarry	1
Woods Creek	17090003060302	Quarry	1
Price Creek	17090003060303	Quarry	1
Maxfield Creek	17090003060304	Pit	1
		Quarry	1
Bump Creek	17090003060305	Quarry	1
	17090003060401	Quarry	2
Upper Pedee Creek	17090003060402	Pit	2
		Quarry	2
McTimmonds	17090003060502	Quarry	1
Jont Creek	17090003060504	Quarry	1
Upper Little Luckiamute	17090003060601	Pit	4
Cold Springs	17090003060602	Pit	5
Black Rock Creek	17090003060603	Pit	2
		Quarry	1
Waymire Creek	17090003060703	Quarry	1
Bridgeport	17090003060704	Quarry	4
Upper Teal Creek	17090003060801	Pit	2
Lower Teal Creek	17090003060802	Pit	1
S2F (Coffin Butte: Not shown on topo map)	17090003061003	Quarry	1

Table 16. List of Gravel Pits and Quarries by 7th field watershed. Source was 7.5' USGS topographical map			
Sub-Basin Name	**HUC**	**Feature**	**Number**
Upper Soap Creek	17090003061101	Quarry	7
Upper Berry Creek	17090003061201	Quarry	2
Harman Slough	17090007020503	Pit	3
Upper North Fork Ash Creek	17090007020601	Quarry	1
		Total	55

Landfills

The Coffin Butte Landfill is located near Adair Village just west of Oregon State Highway 99. It is situated at the head of an unnamed tributary to the Luckiamute River, between Poison Oak Hill and Coffin Butte. Valley Landfills, Inc., of Corvallis, operates the landfill, and the land now occupied by the landfill was previously used as part of the Camp Adair Army Training Facility (Taylor *et al.*, 2003). The Coffin Butte Landfill is the second largest landfill in Oregon and is classified by the EPA as a multi-layered composite lined subtitle "D" facility operating under Oregon DEQ permit #306. The Valley Landfills, Inc. property covers 700 acres, about 116 acres of which are being used as a landfill at this time. The site has nine cells which will eventually be filled. Cell 1 has been completely filled landfill receives approximately 1,800 to 2,000 tons of municipal solid waste a day during the spring, and as much as 2,500 to 3,000 tons a day in the summer. Valley Landfills, Inc. plans on increasing tonnage received every year, as demand dictates. The site is equipped with a leachate treatment system, and a methane-base electrical generator (Benson, 2003). There are water quality monitoring wells located around the facility (see Section 6).

Our assessment team was asked by LWC to follow up on reports of a historic landfill located on the military camp. We examined historic aerial photos and military camp building layout blueprints, and did not find evidence of an onsite landfill. The manager and workers at the E.E. Wilson Wildlife Refuge were also unaware of a historic landfill. We did find evidence of a sewage yard located along the east side of the compound and a drainage ditch running through the center of the camp. All maps and blue prints were viewed at the E.E. Wilson Wildlife Refuge.

Photo 6:Coffin Butte Landfill

Military Facilities

Camp Adair, named in honor of Henry Rodney Adair (a West Point graduate and descendant of Oregon pioneers who was killed in 1916) is located 10 miles north of Corvallis. Camp Adair was a military training facility that operated in the southern portion of the Luckiamute watershed between 1941 and 1946. Camp Adair, a WWII army cantonment, occupies 50,000 acres in Benton and Polk Counties. The camp itself occupied only a small portion of that land and covered an area 2 miles wide and 6 miles long, along Oregon state highway 99W near the Benton County line. It was once used as a training site for army infantry, artillery and engineering units and associated support personnel. The camp had over 1,800 buildings, consisting of barracks, mess halls, offices, churches, five movie theaters, stores, a post office, a bank, and a hospital. Although Camp Adair never reached its full complement of men and women, it quickly became the second largest city in Oregon. Interestingly, full-scale models of European towns were constructed in this area for training troops. During WWII casualties from the Pacific Theater were brought to Camp Adair for treatment and recuperation; the hospital facility could care for 3,600 individuals. Once the troops left Camp Adair, it served as a prisoner-of-war (POW) camp for Italians, then Germans from 1944 through 1946.

Photo 7: Camp Adair

Today, the site is owned by state and local governments and a few individuals; only a few buildings and foundations remain of the WWII camp. The former army camp now hosts the E. E. Wilson Wildlife Area and is home to upland game birds, waterfowl, bald eagles, deer and other species. There are trails, stocked ponds and hunting (during fall and winter) for visitors. Bullets are still being found in trees in the area that is now the McDonald forest (Rogers, 2003). The portion of Camp Adair that is now E. E. Wilson no longer has shooting ranges. However, a shooting range, located on Rifle Road, is still used by the National Guard (personal communication, C. Smitker). There were reports that area police departments also used this shooting range but we were unable to determine if the area was used by

Oregon State Patrol or the Corvallis Police Department. The Benton Co. Sheriff Department no longer uses this area.

Today, the area that was Camp Adair has many land uses, including Coffin Butte Landfill (see previous section), the McDonald State Forest, and E.E. Wilson Wildlife area (see next section). For more information visit *http:// home .teleport.com/ ~eewilson/ campadair.html or http://www.ohwy.com/ or/e/eewilswa.htm*

Wildlife Preserves

The E.E. Wilson Wildlife Area (formerly Camp Adair) is managed by Oregon Fish and Wildlife. The area supports a diversity of habitats for a variety of sensitive species such as the sharp-tailed snakes, red-legged frogs, and the western pond turtles. Trails are well established at E.E. Wilson. See Section 7 for information on ORNHP ecological cells.

Photo 8: E.E. Wilson Wildlife Area

5.5 Land Ownership

Land ownership affects the condition of the landscape indirectly because of the various uses for which different owners have used the land. Past land uses have set the stage for the current condition of the natural resources of the Luckiamute/ Ash Creek study area (see Section 7). Land ownership also directly affects the current management practices and restoration potential for individual land parcels. Consequently, patterns in land ownership become very important when developing watershed management and restoration plans.

Tables 17 and 18 show the current ownership patterns for the study area. In the Luckiamute/ Ash Creek study area, most ownership is private; therefore, most monitoring and restoration is likely to occur on private lands. The ownership data set is a combination of the Polk and Benton County tax lot GIS data. After the two data sets were merged in a GIS, the ownership information from the tax lot data was reclassified into public or private ownership. **We recommend that a more detailed ownership assessment be performed (*i.e.*, identify public and willing private land owners) to develop a monitoring and restoration plan.**

Table 17. Land ownership in the Luckiamute Watershed study area.		
Ownership	**Area (acres)**	**% Total**
Private	170,305.6	84.7%
Public, County	1,141.0	0.6%
Public, Federal	8,339.8	4.1%
Public, Municipal	51.8	0.0%
Public, State	7,314.1	3.6%
Unknown	13,958.9	6.9%
Total	201,111.2	100.0%

Table 18. Land ownership in the Ash Creek Watershed study area.		
Ownership	**Area (acres)**	**% Total**
Private	31,510.6	93.1%
Public, County	23.5	0.1%
Public, Federal	59.7	0.2%
Public, Municipal	276.3	0.8%
Public, State	255.4	0.8%
Unknown	1714.4	5.1%
Total	33,839.9	100.0%

5.6 Zoning and Regulations

By 1975, the State of Oregon had adopted 19 statewide land use planning goals covering topics from housing to natural resource use, which are achieved through local comprehensive plans. State law requires each city and county to adopt a comprehensive plan that meets the 19 goals, and develop the zoning and land-division ordinances needed to put that plan into effect. These goals are intended to promote consistency in statewide land use and coordination between various local governments. Goal 5, which was amended in 1996, governs natural resources, scenic and historic areas, and open spaces.

Goal 5: Natural Resources, Scenic and Historic Areas, and Open Spaces (Oregon Department of Land Conservation and Development, 2003)

- Plan development to conserve open spaces
- Plan to conserve natural resources: renewable and non-renewable
- Consider efficient consumption of energy when using natural resources
- Protect fish and wildlife areas, in accordance with Oregon Wildlife Commission's fish and wildlife management plans
- Protect stream flow and water levels at an adequate level for fish
- Inventory historically and ecologically significant natural areas
- Investigate building in cluster

developments

- State and federal agencies should develop plans for natural resources, historic areas, and open spaces that coordinate with local and regional plans

Goal 5 requires state and local governments coordinate plans for rivers, trails and natural resources, such as wetlands, riparian corridors, wildlife habitat, federal wild and scenic areas. For more information see *http://www. lcd.state.or. us/ goalpdfs /goal05.pdf.* The Oregon Legislature passed Senate Bill 1010 to improve agricultural practices near streams. Senate Bill 1010, or the Agricultural Water Quality Management Act was passed in 1993 at the request of many agricultural interests so that Oregon agriculture could regulate itself as much as possible. Senate Bill 1010 directs the Oregon Department of Agriculture (ODA) to develop an Agricultural Water Quality Management Plan and Rules for watershed in Oregon where there are water quality problems. The ODA along with other agencies identifies priority watersheds for development of Agricultural Water Quality Management Plans. The Luckiamute / Ash Creek study area falls within the Middle Willamette Agricultural Water Quality Management Area. Under this plan local operators will be asked to deal with identified problems such as soil erosion, crop nutrient loss from fields, or degraded streamside areas. Farmers are allowed to choose their own ways of meeting established water quality goals; however, if problems are identified, those who are asked to deal with a problem but continually refuse to do so could be assessed a civil penalty. For more information see *http://www.peak.org/~bentoncd/SB1010.html.*

5.7 Recommendations

We recommend that the LWC develop a more accurate roads layer from USGS topographic maps and other sources. More accurate road information will be needed for action planning. Information on location and type are particularly important. A roads layer can be obtained from private industry or by digitizing digital orthoquad photographs.

We recommend that a more detailed ownership assessment be performed (*i.e.*, identify public and willing private land owners) to develop a monitoring and restoration plan.

6 PHYSICAL PROCESSES

6.1 Hydrology, Water Use and Water Quality

Hydrology

Streams

Streams can be categorized by their order. In one categorization scheme, headwater streams are known as first order streams. Where two first order streams join, they form a second order stream, and so on. In general, higher order streams are large and lower order streams are small. [Please note that there are other stream categorization schemes where the larger streams have lower numbers, so make sure you understand what scheme is being used when discuss stream order.]

Streams form a network; therefore, factors that influence the headwaters of a stream also affect higher order streams. Thus, higher order streams are said to "express" the cumulative effects of the entire watershed. Multiple spatial data sets (layers) depicting streams were available for the study area. We acquired 1:24,000 streams layer from the Oregon State University CLAMS project. This layer was developed using digital elevation models and ancillary data sources (maps or topographic maps). This is a standardized stream layer that was created from the DEMS and carefully reviewed. This layer is used by groups throughout the CLAMS study area. Unfortunately, the CLAMS streams layer did not cover the entire Luckiamute study area, especially in the lower reaches of the watershed. Therefore, we added streams to the CLAMS streams layer that we generated from DEMs (using 10m DEMs and ArcHydro extension with ArcGIS 8.3) to form a complete coverage of the study area. We added stream order by hand to compliment the information that was in the existing CLAMS layer. We summarized the total length of streams in the study area based on stream order.

Most streams in the Luckiamute/ Ash Creek study area are first order streams (Tables 19 and 20). These smaller streams are important sources of sediments and organic debris. Surrounding land use can influence water quality. For example, woody debris, gravel, and sediments can enter the stream network from first order streams, travel throughout the stream network to eventually be transported out of the watershed. Sometimes it can take years or decades for debris to work its way down the stream network and out of the watershed. Water temperature of the first order streams can also influence the temperatures of stream into which they flow. Therefore, shade along lower order streams will help to keep water temperatures cool throughout the stream network. Although salmon do not ordinarily have access to first order streams, these streams are an important, and frequently overlooked, component of salmonid habitat. **We recommend that first order streams be evaluated for shade and for the potential to deliver large wood to the stream networks.**

Gage Data

Stream flow is an important component of salmonid habitat. Salmon may not be able to move into, spawn or forage in some stream reaches during low flows. Low flows are also related to warm stream temperature because smaller water volumes heat up more quickly than deeper water. Finally, low flows can further isolate the stream from its floodplain. Humans compete with fish and wildlife for use of the water (see Section 6). Patterns in steam flows are measured by stream gages.

Stream flow data are recorded at stream gages. The US Geological Survey and the State Water Resource Department operate gages throughout the state. This information can be used to evaluate long-term pattern in stream flow and water availability. Stream gage data are used to develop water appropriate models (described below).

We searched USGS and the Oregon Water Resource Department web sites (*http://nwis. waterdata. usgs.gov/ or/nwis/ discharge*/and *http://www.wrd.state. or.us/ surface_ water/index.shtml*, respectively) for information on stream gages. We found records from ten stream gages located in the Luckiamute / Ash Creek study area (Table 21). The dates between USGS and WRD data sets closely correspond but vary in some of the stream gage stations.

Photo 9: USGS stream Gauge on the Luckiamute River

USGS operates a streamflow gage on the mainstem of the Luckiamute River near Suver at an elevation 171.9 ft. This station, number 14190500, has been in operation since 1874 (however, not continuously) and measures the discharge for an area of 240 mi^2. USGS has recorded “acceptable” data only from the period 1940 to 1988. Data on daily flow, monthly means and yearly means are available.

We gathered data from the Suver (located in Helmick State Park) gage because it was the gage with the longest period of record (although not operated continuously). Figure 2 shows variability in the annual mean flow during the past 99 years. Multi-year drought patterns are visible especially in the early 1990s.

Table 19.Stream length by order for the Luckiamute Watershed study area (Miller *et al.*, 2001).

Increasing stream size

Stream Order	Length (ft)	Length (mi)	% Total
1	2,565,780.0	485.9	49.5%
2	1,175,520.6	222.6	22.7%
3	620,055.0	117.4	12.0%
4	311,985.3	59.1	6.0%
5	297,699.3	56.4	5.7%
6	197,966.1	37.5	3.8%
7	13,260.4	2.5	0.3%
Total	5,182,266.7	981.5	100.0%

Table 20. Stream length by order for the Ash Creek Watershed study area (Miller *et al.*, 2001).

Increasing stream size ↓

Stream Order	Length (ft)	Length (mi)	% Total
1	244,007.0	46.2	45.7%
2	125,478.6	23.8	23.5%
3	73,818.6	14.0	13.8%
4	75,862.4	14.4	14.2%
5	15,094.0	2.9	2.8%
Total	534,260.6	101.2	100.0%

Table 21. Names and periods of record for stream gages located in the Luckiamute/ Ash Creek study area. We included dates from both USGS and OWRD where there were discrepancies in dates. Sources were USGS and OWRD webpages.

Stream Gage Name	Start Date	End Date	Source
Hoskins	1/5/1934	9/30/1978	USGS
	5/1934	10/1978	WRD
Little Luckiamute	1/8/1965	9/30/1971	USGS
	8/1965	9/2000	WRD
Pedee	1/10/1940	9/30/1970	USGS
	10/1940	9/1971	WRD
Rickreall Creek-Dallas	6/1926	11/1978	WRD
Rickreall Creek-Dallas Dam	10/1970	9/1979	WRD
Rickreall Creek-Mercer Dam	4/1979	9/1979	WRD
Rickreall Creek-Rickreall	4/1964	9/1985	WRD
Rickreall Creek-Salem	4/1964	9/1965	WRD

Table 21. Names and periods of record for stream gages located in the Luckiamute/ Ash Creek study area. We included dates from both USGS and OWRD where there were discrepancies in dates. Sources were USGS and OWRD webpages.

Stream Gage Name	Start Date	End Date	Source
Suver (actually constructed in late 1800's but not continuously operated)	1/8/1905	9/30/2002	USGS
	8/1905	9/1901	WRD
Teal Creek	6/1968	9/1973	WRD

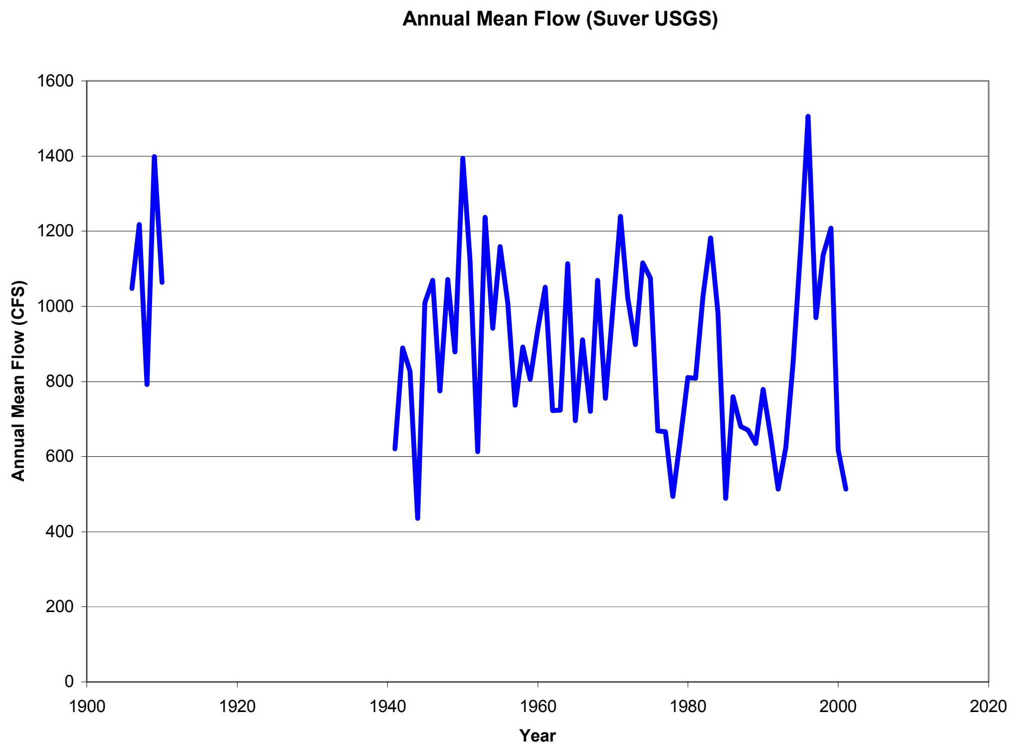

Figure 2. Annual mean flow from the Suver gage. Note that the period of record extends back to the late 1800's but those records were not available. Also, the gage has been operated continuously since the 1940's (see text for details).

Channel Modifications

Channel modifications are features that alter the structure of the stream channel. For example, channel modifications can be areas where the natural stream channels have been channelized, dredged or culverts installed. Stream banks can also be modified with rip-rap, reinforcing walls, or bridge structures.

Channel modifications have the potential to affect in-stream salmonid habitat by altering water velocities and currents. Channel modifications can also have an impact on stream dynamics which, in turn, can alter the location and rates of erosion. One good source of existing information for channel modifications come from the AHI data. **<u>We recommend that LWC inventory streams to map areas where channels have been modified.</u>**

Stream Dynamics

The morphology or physical form of a stream channel at any point is a dynamic expression of the climate (as it affects stream flows) and the geology (as it affects sedimentation). Other variables, such as resistance to flow (friction) and bed particle size, also influence important channel variables, such as width, depth, velocity, slope, and pattern. Both human and natural disturbances to a fluvial system can result in site-specific channel changes (*e.g.*, changes in cross-sectional geometry at the point of disturbance) and/or channel morphology adjustments longitudinally over an area of stream downstream or upstream from the point of disturbance.

Human modifications of channels can cause an array of effects depending on the inherent characteristics of a system. In larger river systems these modifications rarely occur in isolation, but interact with other upstream and downstream to channel segments.

Channel erosion is the detachment and transport of material from a gully or stream channel. The material may be derived from the channel itself or material that has been deposited within the channel by surface or mass erosion. The size, complexity (sinuosity) and transport capability of channels is determined by the energy of the water, which flows through the channel. High gradients, low friction, and unimpeded water flow characterize high-energy channel systems.

Channels are unique; therefore their responses to natural factors and human-induced modifications are also unique. Changes in channel form and process occur longitudinally along a stream. In the downstream direction, the gradient decreases, sinuosity ("curviness") increases, the ratio of bedload to total sediment load decreases, the grain size of material which can be transported decreases, and the total discharge or streamflow increases. Large-scale determinants of channel morphology include the following factors: climate, geology/ topography, vegetation and soils, land use practices, and in-channel modifications.

Fluvial processes are structured by hydrology, sediment load and movement, and the resistance of the channel to flow and sediment movement. Components of hydrology include the type of flow (baseflow, bankfull flow, and highflow), stream power, and the hydrological disturbance regime. Sediments can differ in their source, type (suspended load, bedload, turbidity), and size. Changes in sediment load that occur through land use practices can result in sediment accumulation (aggradation) or loss (degradation) in portions of the stream. Channel resistance is determined by the bank and bed material, vegetation (large wood, riparian vegetation, and roots), and physical form of the channel. Adjustments of channels include a number of factors. Log jams or large wood intentionally added to streams to restore or enhance salmonid habitat acts to increase channel resistance. Increased resistance slows water velocities thereby decreasing the water's capacity to transport sediments and bedload, and erode stream banks. Large log jams can have the unexpected consequence of actually increasing bank erosion as flowing water is diverted around the obstacle.

Photo 10: Log jam on the Little Luckiamute River downstream of Elkins Road Bridge

Channels have four degrees of freedom or ways in which the form can change: 1) the longitudinal profile, 2) channel sinuosity, 3) roughness of bed or bank, and 4) the hydraulic radius.

The LWC instructed the assessment team to search for information on factors that affected stream dynamics particularly log jams. We found several potential sources of this information (series of aerial photographs) but it was beyond the scope of this project to prepare and analyze these data sets. Other sources include comment fields in the AHI databases. **We recommend that the digital orthoquads be reviewed and that log jams be located and mapped. In addition, land owners can be contacted and stream walked to record log jams and other stream channel elements (*i.e.*, riprap, boat launches, bridge supports, *etc.*). Finally, comment fields from Aquatic Habitat Inventory data can be queried for observations of field crews.**

Lakes and Reservoirs

Lakes and reservoirs store water for consumptive use or for release into the stream networks during low flow periods. Lakes and reservoirs can harbor fish and wildlife populations. They can also dramatically impact water quality by trapping sediments or by releasing cold, oxygen-free water into streams.

We examined the USGS topographic maps for locations of larger reservoirs. We found a few major reservoirs in the Luckiamute/ Ash Creek study area. These include Buchanan Reservoir and Hamilton Reservoir northeast of Airlie, McCrae Reservoir and Bauman Reservoir west of Monmouth, Fall City Reservoir south of Falls City, Lake of the Winds behind the dam on Burgett Creek, and Emry Pond/Moore behind the dam on the tributary of Maxfield Creek.

We also queried recreational online databases for reservoirs. We were able to retrieve all the reservoirs in Benton and Polk Counties (Table 22). Many, but not all, of these reservoirs are located in the study area. Locations of reservoirs were not identified as a high priority for this assessment. **Should action planning involve reservoirs, we recommend that these reservoirs be inventoried for size, potential water quality problems, and the type and location of dams.**

Table 22. Reservoirs from Benton and Polk Counties. Source: recreational online database, *www.wayhoo.com*.

Reservoir name	Latitude	Longitude
		Benton County
Bonner Lake	44.67845	-123.48983
Calloway Reservoir	44.66373	-123.23871
Clemens Log Pond	44.54651	-123.34454
Corvallis Reservoir	44.56123	-123.33232
Emery Moore Reservoir	44.68984	-123.41788
G P Reservoir	44.70956	-123.19704
Glenbrook Log Pond	44.31123	-123.40454
Gygi and Engle Reservoir	44.33234	-123.59289
Hobin Log Pond	44.53484	-123.36121
Hull-Oakes Log Pond	44.36012	-123.41371
Knight Reservoir	44.55262	-123.40815
Lake of the Winds	44.63595	-123.46233
Larson Log Pond	44.56373	-123.31232
Mitchell Reservoir	44.69428	-123.46927
North Fork Reservoir	44.52623	-123.49428
Nusbaum Farms Reservoir	44.36984	-123.36454
P M Delaubenfelds Reservoir	44.43984	-123.35788
Peak Log Pond	44.59845	-123.32065

Table 22. Reservoirs from Benton and Polk Counties. Source: recreational online database, *www.wayhoo.com*.

Reservoir name	Latitude	Longitude
Price Creek Reservoir	44.67123	-123.39343
Rambo Reservoir	44.32623	-123.41232
Thompson Lake	44.55984	-123.58150
Watkins Pond	44.51790	-123.45538
Whispering Winds Reservoir	44.63484	-123.45955
		Polk County
Aaron Mercer Reservoir	44.90373	-123.47011
Aebi Reservoir	44.99151	-123.35261
Alsip Reservoir	44.86651	-123.29982
Bailey Reservoir	45.03040	-123.52205
Bass Reservoir	44.85262	-123.35871
Bauman Reservoir	44.85678	-123.30093
Beyers Pond	44.92623	-123.17621
Blanchard Reservoir	44.95401	-123.33594
Boeder Pond	44.98456	-123.24843
Bowen Reservoir	44.85540	-123.32621
Bowles Reservoir	45.02345	-123.13593
Boyle Lakes	44.93984	-123.26010
Branson Reservoir	44.94012	-123.36928
Brier Pond	44.93012	-123.26621
Bruinsma Reservoir	45.05178	-123.26789
Brush Lake	45.03595	-123.62261
Brydon Reservoir	45.01345	-123.13315
Buchanan Reservoir	44.76206	-123.32121
Buhler Reservoir	45.01095	-123.34289
Burns Reservoir	45.07206	-123.52066
Campbell Reservoir	45.05401	-123.28454
Case Reservoirs	45.06428	-123.09232
Christianson Reservoir	44.79484	-123.14732
Classen Reservoir	44.98873	-123.35539
Copp Reservoir	44.97178	-123.28288
Cottonwood Pond	44.96095	-123.27093
Couter Reservoir	44.97484	-123.32066
Croft Reservoir	44.96317	-123.11454
De Jong Reservoir	45.05817	-123.34844
Dejong Reservoir	45.05651	-123.34789
Domaschofsky Reservoir	44.97484	-123.33871
Drazdoff Reservoir	44.76512	-123.15038

Table 22. Reservoirs from Benton and Polk Counties. Source: recreational online database, *www.wayhoo.com*.

Reservoir name	Latitude	Longitude
Dyer Reservoir	44.89428	-123.33454
Eagle Crest Reservoir	44.97762	-123.13454
Earl Kennel Reservoir	44.75151	-123.24621
Ediger Reservoir	44.94262	-123.27982
Eliander Reservoir	44.88595	-123.36232
Emerson Reservoir	45.04290	-123.37483
Falls City Reservoir	44.83678	-123.44789
Fast Reservoir	45.02206	-123.32816
Feldman Reservoir	45.05262	-123.16371
Fisher Reservoir	44.86373	-123.33038
Four H Reservoir	45.00178	-123.14482
Friesen Reservoir	44.93928	-123.29899
Frink Reservoir	44.86651	-123.39983
Garber Reservoir	44.87067	-123.32621
Garrison Reservoir	44.80262	-123.21371
Gibson Reservoir	44.96373	-123.11927
Goffrier Pond	45.07484	-123.09427
Green Acres Reservoir	45.04428	-123.29149
Haines Reservoir	44.97484	-123.11371
Halstead Reservoir	44.89290	-123.32760
Hamilton Reservoir	44.75456	-123.30871
Hart Reservoir	45.05678	-123.42205
Harvstack Reservoir	44.88456	-123.40816
Hibenthal Reservoir	44.99845	-123.28593
Hidden Lake Reservoir	45.00956	-123.29288
Hidout Reservoir	45.03039	-123.64150
Hoekstre Reservoir	44.99623	-123.34094
Ingebrand Reservoir	45.05484	-123.28288
Interstate Log Pond	44.86373	-123.18871
Jahn Reservoir	44.81095	-123.43733
Joe Crow Reservoir	45.05817	-123.39455
Johnson Reservoir	44.73317	-123.35399
Kenney Reservoir	44.74290	-123.35065
Kester Pond	44.73040	-123.27065
Kinsey Reservoir	44.37067	-123.33038
Kinsey Reservoir	44.89428	-123.32899
Kreder Reservoir	44.77623	-123.18871
Larson Reservoir	45.00956	-123.28177
Lenhard Reservoir	44.84706	-123.30260

Table 22. Reservoirs from Benton and Polk Counties. Source: recreational online database, *www.wayhoo.com*.

Reservoir name	Latitude	Longitude
Letteken Ponds	44.95623	-123.25315
Lewis Reservoirs	44.88178	-123.34843
Libolt Reservoir	44.88567	-123.31760
Lundeen Reservoir	44.79845	-123.20677
Maddux Reservoir	44.77317	-123.41732
Maple Mound Reservoir	45.01234	-123.14982
Markee Reservoir	45.02345	-123.22482
Martin Brothers Flashboard Reservoir	45.02317	-123.20121
Martin Reservoir	45.02484	-123.21510
Marvin Fast Reservoir	45.05484	-123.22288
Marx Reservoir	44.99317	-123.18621
McBee Reservoir	44.89151	-123.32760
McCrae Reservoir	44.86317	-123.28038
McGuire Reservoir	44.79901	-123.34621
Monmouth Reservoir	44.84567	-123.24843
Morgan Lake	44.98123	-123.26177
Morgan Reservoir	44.79151	-123.43454
Mountain Springs Ranch Reservoir	45.00095	-123.51289
Muller Ponds	44.99234	-123.37150
Muller Reservoir	45.02484	-123.32900
Murray Reservoir	44.88317	-123.38594
Myers Reservoir	44.92901	-123.15538
Neighbors Reservoir	45.02901	-123.31122
Neuschwanger Reservoir	45.04845	-123.37344
Nisly Reservoir	44.75790	-123.17565
Oak Crest Farm Reservoir	44.99484	-123.07121
Oakshire Reservoir	44.74928	-123.26815
Oberg Reservoir	44.86290	-123.35538
Olge Reservoir	44.77623	-123.19343
Parks Lake Reservoir	44.95540	-123.19704
Phoenix Reservoir	45.02956	-123.29927
Pond A	44.85178	-123.37204
Ratzlaff Reservoir	44.79345	-123.34204
Reimer Reservoir	44.99123	-123.29871
Riverbed Pond	44.98595	-123.04704
Rohde Reservoir	45.02317	-123.19954
Ross Reservoir	44.92623	-123.24760

Table 22. Reservoirs from Benton and Polk Counties. Source: recreational online database, *www.wayhoo.com*.

Reservoir name	Latitude	Longitude
Scharf Reservoir	45.05123	-123.29010
Schierling Reservoir	44.97484	-123.33594
Sexton Reservoir	44.94428	-123.10538
South Slough Pond	44.95428	-123.25649
Staats Reservoir	44.96373	-123.11093
Stamy Reservoir	44.94567	-123.34843
Stapleton Reservoir	45.02901	-123.26371
Steen Reservoir	44.87345	-123.42205
Stevens Reservoir	44.98456	-123.16093
Stewart Reservoir	45.06651	-123.19843
Stiles Reservoir	44.89706	-123.34427
Suttner Reservoir	45.04290	-123.54428
Swearingen Reservoir	45.02484	-123.29843
Sweet Reservoir	44.95678	-123.33594
Tellin Reservoir	45.00817	-123.28038
Trom Reservoir	44.90262	-123.33871
Valsetz Lake (historical)	44.85040	-123.66705
Villwock Reservoir	44.98345	-123.33539
Walker Reservoir Number Two	45.07484	-123.28122
Wall Reservoir	44.97706	-123.29204
Wendell Kreder Reservoir	44.77651	-123.18621
Willamette Log Pond	44.91373	-123.31510
Wilson Reservoir	45.05540	-123.23593
Wilson Reservoir	44.95817	-123.38039
Winegar Reservoir	44.79428	-123.25538

Springs

Springs provide cold water to streams and can lower stream temperatures. Springs themselves can provide thermal refugia for salmon in warm water streams.

We examined USGS 7.5' topographical maps and found twenty-six springs identified for the study area (Table 23).

Only a few of the springs were named including: Cauthorn, Cold, Crystal, Fort Hoskins, Maple, Nelson, Rattling, Sulfur, Thistledew, and Vitae Springs. Spring water can be used, in some cases, without obtaining a water use permit (see Section 6.1). **We recommend that these sites be verified and that the condition of the springs be recorded, if possible.**

Table 23. List of springs showing 7th field watershed and sub-basin name. Source was USGS 7.5' topographical maps.

Sub-Basin Name	HUC	Number
Hoskins	17090003060203	2
Vincent Creek	17090003060204	1
Plunkett Creek	17090003060301	2
Unnamed	17090003060401	2
Ritner Creek	17090003060404	2
McTimmonds	17090003060502	3
Middle Luckiamute	17090003060503	1
Cold Springs	17090003060602	3
Falls City	17090003060702	1
Lower Teal Creek	17090003060802	1
Grant Creek	17090003060803	2
Fern Creek	17090003060901	1
Lower Little Luckiamute	17090003060902	3
Upper Soap Creek	17090003061101	1
Rifle Range	17090003061103	1
	Total	26

Water Use

In the State of Oregon all water is publicly owned. This includes the surface water and groundwater that flows past or beneath privately owned property. A property owner does not automatically have a right to the water that flows on or near their property and, with a few exceptions, must obtain appropriate permits (water rights) to use water whether it is underground or on the surface (streams and lakes). The Oregon Water Resources Department (OWRD) issues water use permits.

Oregon's water laws, like many western US states, are based on the principle of prior appropriation. In Oregon, water appropriation doctrine has been law since February 24, 1909. Prior appropriation means that the first person to acquire a water right on a stream is the last person to be prevented from withdrawing water during low flow conditions. For this reason, water rights are ordered by date (generally date of application) and the oldest water right can demand use of the water resource to the exclusion of junior water right holders. Thus, water demand is filled by sequentially meeting demands from each diversion point from oldest to youngest.

Water use permits are acquired for particular uses. These uses include irrigation, municipal, industrial, commercial, domestic, agricultural, and other. Some uses, however, do not require permits. These water uses are called "exempt uses." Exempt uses of surface water include:

1. Natural springs: if a spring does not form a natural channel or flow off of the property at any time of the year;

2. Stock watering: if livestock drink directly from surface water and there is no diversion or other modification to the water source; this includes watering livestock from a permitted reservoir or water piped (under certain conditions) to a watering tank or trough;

3. Salmon: egg incubation projects under the Salmon and Trout Enhancement Program (STEP), and as water used for fish screens, fishways and bypass structures;

4. Fire control: water withdrawn for use in emergency fire fighting;

5. Forest management: water withdrawn (under some circumstances) for certain activities such as slash burning and mixing pesticides. [Jerry Peiring, ODF forester from the Dallas unit (503) 623-8146 reported that these water uses do need a permit].

6. Land management practices: water withdrawn for certain land management practices where water use is not the primary intended activity;

7. Rainwater: collection and use of rainwater does not require a permit if it is collected from an impervious surface.

Like surface water, there are some uses of ground water that do not require a permit. Generally, ground water use is allowed for a beneficial purpose without waste. These uses include:

1. Stock watering;

2. Lawn or non-commercial garden watering: of not more than one-half acre in area;

3. Single or group domestic purposes: for no more than 15,000 gallons per day;

4. Single industrial or commercial purposes: not exceeding 5,000 gallons per day;

5. Down-hole heat exchange uses;

6. Watering: the grounds, ten acres or less, of schools located within a critical ground water area.

In all cases of ground water use, Oregon's minimum well construction standards must be followed for the construction, maintenance, and abandonment of exempt wells. **For any water use, please check with the regional water master**.

If there is a conflict over use of water, the date of permit application (date of priority) determines who has first right to the water without regard to the water's use. If the dates of priority are the same in the conflict, then the law indicates that domestic use and livestock watering have preference over all other uses. However, under drought conditions, preference can be given to stock watering and domestic/ household use. Finally, ground water rights for geothermal uses are always junior in priority to other uses of water unless the water is also used for another purpose, such as irrigation, or injected back into the ground water reservoir.

There are groups in the state that acquire water rights for fish & wildlife use. Once such group is the Oregon Water Trust. The Oregon Water Trust is currently working in the Rogue, Umpqua, Deschutes, John Day and Umatila River basins. The Oregon Water Trust acquires water rights in these priority basins to benefit fish and water quality. **Should the LWC action planning involve the long-term protection of water rights, we recommend that they contact the Oregon Water Trust (*www. owt.org*) for more information on their programs.**

Surface Water Use

Water availability is determined for basins in the state through the use of water availability models. Briefly, water availability models are computer programs that are designed to predict the naturalized stream flow based on a previous period of record. For Oregon, the water availability model uses the period of record from 1958 to 1987. Once naturalized stream flows are modeled, consumptive and in-stream uses are subtracted according to the use permit. A detailed document describing how water allocations are made in Oregon is available online at *http://www. wrd.state. or.us/ programs/sw_studies /OpenFileSW02-002.pdf.*

Water availability models are generally run to show water availability at the 50% and 80% exceedance levels. Fifty percent exceedance flow is the modeled stream flow that occurs, on average, one of every two years, or 50% of the time. This modeled water availability is used to determine if water can be captured for water storage. The 80% exceedance level, the amount of streamflow that occurs on average four out of five years, is used to determine if water is available for issuing a new surface water permit. Modeled streamflows are generally calculated for every month at particular positions along the stream network.

Generally, before issuing a new water right, available water is compared against permitted withdrawals. If a stream is fully appropriated (all the water is permitted) no new withdrawals can be permitted.

Points of Diversion & Types of Water Use

In order to determine the status of the water resources in the Luckiamute basin, we first queried the online Oregon Water Resources GIS database containing the point of diversion and places of use. This GIS layer was built in March of 2001. Permitted and certificated water rights were digitized (excluding municipal rights) and have a planned update cycle of 6 weeks. In this GIS theme, each point represents a location where water is diverted for use according to the terms in the water right. We found that there was a total of 933 unique permit numbers for the study area, 711 in the Luckiamute watershed and 222 in the Rickreall watershed. Each permit may have multiple uses designated. We found a total of 1,458 designated water uses in 26 use categories listed on these permits (Table 24). Irrigation was the most commonly designated water use accounting for 53.6% of the designated water uses. Other common water uses included: livestock (16.8%), storage (7.3%), domestic (5.6%), supplemental irrigation (4.5%), and municipal (2.6%).

Keep in mind that not all water rights are in use at any one time. During times of water shortages, junior permit holders may be denied use. Finally, we found at least one permit that was incorrectly entered into the WARS database; Permit S 41181 was identified as being on the Mary's River although according to the GIS data set it was located in the Luckiamute watershed. Although we carefully examined the data in Table 24, there may be other errors. **We recommend that the Watermaster be contacted before POD data are used for detailed planning purposes.**

Water Availability

We queried the Water Availability Report System (WARS) for the Luckiamute watershed (*wars.wrd. state.or.us*) to determine the status of the water resources. Table 25 shows water availability, at the 50% and 80% exceedance levels, for five water availability basins. We found that, in general, the watersheds won't support any additional summer and early fall water withdrawals.

Information on individual water rights can be found at *http://stamp.wrd.state.or.us/ apps/wr/wrinfo/wrinfo.php?search_type=FindStream and http://www.wrd.state.or.us/*

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Table 24. Summary of the water withdrawal permits in the study area by watershed (Luckiamute and Rickreall). Shown are the source streams and permitted usage for all types of permits. AG= agriculture, CM=commercial, DI= domestic including lawn and garden, DN=domestic expanded including non-commercial garden , DO=domestic , DS=domestic & livestock , FI=fish culture, FP=fire protection , FW=fish & wildlife , GD=group domestic , I*=irrigation, livestock & domestic, ID=irrigation and domestic , IL=irrigation & livestock , IM=manufacturing , IR=irrigation, IS=supplemental irrigation, LV=livestock, MM=unspecified, MU=municipal, PW=power development, QM=quasi-municipal, RC=recreation, ST=storage , TC=temperature control, WI=wildlife, and BL=unspecified. For details on permitted uses see *www.wrd.state.or.us*.

Watershed	STREAM NAME	AG	CM	DI	DN	DO	DS	FI	FP	FW	GD	I*	ID	IL	IM	IR	IS	LV	MM	MU	PW	QM	RC	ST	TC	WI	BL	Total
Luckiamute	AIRLIE CR															1								1				2
	BEAVER CR							1							1													2
	BERRY CR					2										3		4						2				11
	BONNER CR					1																						1
	BOUGHEY CR			1																								1
	BUMP CR			1		1												4										6
	COOPER CR															1		6						4				11
	CRABTREE CR							1									1											2
	DUTCH CR			1														4										5
	EVERZ CR					2												1						1				4
	FARLEY CR																	3										3
	FERN CR					1		1							1			1						3		1		8
	FULLER CR																						1					1
	GLAZE CR																			1								1
	GRANT CR															1		1						2				4
	JONT CR															5								1				6
	KINSEY CR					1																						1
	LITTLE LUCKIAMUTE R			1		13										64	3	33		3	1		1	14		2		135

Table 24. Summary of the water withdrawal permits in the study area by watershed (Luckiamute and Rickreall). Shown are the source streams and permitted usage for all types of permits. AG= agriculture, CM=commercial, DI= domestic including lawn and garden, DN=domestic expanded including non-commercial garden , DO=domestic , DS=domestic & livestock , FI=fish culture, FP=fire protection , FW=fish & wildlife , GD=group domestic , I*=irrigation, livestock & domestic, ID=irrigation and domestic , IL=irrigation & livestock , IM=manufacturing , IR=irrigation, IS=supplemental irrigation, LV=livestock, MM=unspecified, MU=municipal, PW=power development, QM=quasi-municipal, RC=recreation, ST=storage , TC=temperature control, WI=wildlife, and BL=unspecified. For details on permitted uses see *www.wrd.state.or.us*.

Watershed	STREAM NAME	AG	CM	DI	DN	DO	DS	FI	FP	FW	GD	I*	ID	IL	IM	IR	IS	LV	MM	MU	PW	QM	RC	ST	TC	WI	BL	Total
	LUCKIAMUTE R	3		2	1	16	4	3	3	1			3	2	4	223	15	52			1			29		1	2	365
	MAXFIELD CR			1												3	4							1		2		11
	MCTIMMONDS CR					1		2								2		1						2				8
	N FK PEDEE CR					2										1		2						1				6
	N SANTIAM R																	4										4
	PEDEE CR				1											1		1										3
	PEEDEE CR					1										1		3										5
	PETERSON CR															5		3										8
	PLUNKETT CR		2									4		2														8
	PRICE CR								1							2								2				5
	RITNER CR			6		3										4		35										48
	ROCK CR															1												1
	S FK ASH CR															1		2										3
	SANTIAM R					1																						1
	SOAP CR			1		2	1	4	1			1			1	13	2						1	6		2		35
	TEAL CR			1		9		1	2							8	2	1	1	16			7	4				52
	UNN STR			2	1	11										14	4	16						3				51
	VINCENT CR			1			1								1	4		1					1	3				12
	WALKER CR															1												1
	WAYMIRE CR					2		2								3	1	3						2				13
	WILLAMETTE R			1	2	2	1	3					2		1	224	22	10						1		1		270

Table 24. Summary of the water withdrawal permits in the study area by watershed (Luckiamute and Rickreall). Shown are the source streams and permitted usage for all types of permits. AG= agriculture, CM=commercial, DI= domestic including lawn and garden, DN=domestic expanded including non-commercial garden , DO=domestic , DS=domestic & livestock , FI=fish culture, FP=fire protection , FW=fish & wildlife , GD=group domestic , I*=irrigation, livestock & domestic, ID=irrigation and domestic , IL=irrigation & livestock , IM=manufacturing , IR=irrigation, IS=supplemental irrigation, LV=livestock, MM=unspecified, MU=municipal, PW=power development, QM=quasi-municipal, RC=recreation, ST=storage , TC=temperature control, WI=wildlife, and BL=unspecified. For details on permitted uses see *www.wrd.state.or.us*.

Watershed	STREAM NAME	AG	CM	DI	DN	DO	DS	FI	FP	FW	GD	I*	ID	IL	IM	IR	IS	LV	MM	MU	PW	QM	RC	ST	TC	WI	BL	Total
	(blank)							3								20	1	8		6				1		2	5	46
	ASH CR							1							1	22		26					1	3		1		55
	DUCK SL															19												19
	FERN CR															1								1				2
	HARTMAN SLOUGH															3												3
	LITTLE LUCKIAMUTE CR															1												1
	LUCKIAMUTE R															2												2
	M FK ASH CR					2										1		4						3	1			11
	N FK ASH CR							2								5		1						5				13
	RICKREALL CR					1																						1
	S FK ASH CR															5		8		3				7				23
	UNN STR			1		4		1								5	1	6										18
	WILLAMETTE R	1						2			1				2	74	4	1		9				3				97
Rickreall	(blank)					3										6	2					2		1				14
Total		**5**	**2**	**20**	**5**	**82**	**7**	**27**	**7**	**1**	**1**	**5**	**5**	**4**	**12**	**782**	**66**	**245**	**1**	**38**	**2**	**2**	**12**	**107**	**1**	**12**	**7**	**1458**

Table 25. Water availability for the Luckiamute watershed at 50% and 80% exceedance modeled streamflow by month. Permits for water storage (*e.g.*, reservoirs) are based on the 50% exceedance values and permits for other uses are based on 80% exceedance values (see text) Data as of November 2003.

Name/ Watershed ID		50% Exceedance		80 % Exceedance	
	Month	Total CFS Used	Available	Total CFS Used	Available
Luckiamute River > Willamette River (Mouth) 117	J	1750.0	YES	840.0	YES
	F	1720.0	YES	938.0	YES
	M	1250.0	YES	751.0	YES
	A	745.0	YES	481.0	YES
	M	366.0	YES	235.0	YES
	J	142.0	YES	81.6	YES
	J	25.9	YES	-1.9	NO
	A	-1.2	NO	-12.9	NO
	S	11.8	YES	-1.5	NO
	O	49.0	YES	19.9	YES
	N	524.0	YES	149.0	YES
	D	1670.0	YES	727.0	YES
Luckiamute River > at Soap Creek Willamette River 118	J	1450.0	YES	691.0	YES
	F	1420.0	YES	733.0	YES
	M	1040.0	YES	622.0	YES
	A	616.0	YES	402.0	YES
	M	309.0	YES	196.0	YES
	J	120.0	YES	70.9	YES
	J	25.0	YES	--	NO
	A	-1.5	NO	--	NO
	S	8.6	YES	-4.4	NO
	O	40.9	YES	12.2	YES
	N	480.0	YES	136.0	YES
	D	1390.0	YES	621.0	YES
Luckiamute River > Willamette River at McTimmonds Creek 119	J	717.0	YES	348.0	YES
	F	690.0	YES	377.0	YES
	M	522.0	YES	303.0	YES
	A	295.0	YES	192.0	YES
	M	157.0	YES	97.9	YES
	J	62.7	YES	36.7	YES
	J	13.7	YES	--	NO
	A	-2.7	NO	--	NO
	S	-0.3	NO	-8.1	NO
	O	16.4	YES	0.6	YES
	N	247.0	YES	69.6	YES
	D	708.0	YES	312.0	YES
Luckiamute River > Willamette	J	316.0	YES	151.0	YES
	F	306.0	YES	166.0	YES
	M	246.0	YES	142.0	YES

Table 25. Water availability for the Luckiamute watershed at 50% and 80% exceedance modeled streamflow by month. Permits for water storage (*e.g.*, reservoirs) are based on the 50% exceedance values and permits for other uses are based on 80% exceedance values (see text) Data as of November 2003.

Name/ Watershed ID		50% Exceedance		80 % Exceedance	
	Month	Total CFS Used	Available	Total CFS Used	Available
River at Kopplein Creek	A	149.0	YES	93.2	YES
	M	73.7	YES	46.0	YES
	J	30.9	YES	20.0	YES
120	J	11.8	YES	--	NO
	A	--	NO	--	NO
	S	--	NO	--	NO
	O	14.0	YES	--	NO
	N	164.0	YES	52.9	YES
	D	321.0	YES	158.0	YES
Pedee Creek > Luckiamute River (Mouth)	J	97.0	YES	32.4	YES
	F	94.0	YES	38.6	YES
	M	67.4	YES	27.9	YES
	A	26.9	YES	7.5	YES
	M	-1.1	NO	-9.5	NO
	J	1.3	YES	-4.5	NO
148	J	0.1	YES	-2.9	NO
	A	----	NO	-12.9	NO
	S	-2.2	NO	-8.1	NO
	O	-4.4	NO	-7.0	NO
	N	22.4	YES	-9.7	NO
	D	95.0	YES	28.5	YES

Ground Water

In 1992 the Oregon Water Resources Department (OWRD) identified four major ground water issues in the Willamette Valley: (1) a sound, quantitative understanding of the ground-water hydrology was necessary to better manage ground- and surface-water; (2) long-term ground-water declines needed to be controlled; (3) low-yield aquifers needed to be better developed and managed; and (4) areas prone to natural ground-water quality problems needed to be identified. These issues were addressed in a two phase study initiated by the USGS and OWRD. The study examined the water resources in the Willamette Valley and focused on ground water (Oregon Water Resources Department and Oregon Department of Land Conservation and Development, 2002).

The goals of the USGS/ OWRD study were to: (1) provide a quantitative understanding of the regional ground-water flow system of the Willamette Valley sufficient to effectively evaluate the hydrologic effects of land- and water-use policies and climate changes; (2) develop the understanding and tools necessary to quantitatively evaluate the timing, location and magnitude of streamflow depletion caused by ground-water pumping; (3) characterize the unique hydrology of basalt aquifers within the Willamette Valley, particularly as related to water availability and management of multiple water-bearing zones; (4) develop a better understanding of the relations between well-yield and factors such as geology, well construction, and siting in areas underlain by low-yield aquifers; and (5) develop a better understanding of the origins and distribution of selected types of naturally occurring poor-quality ground water. The first phase of the study examined regional patterns in water-budgets, ground-water flow directions, and relations between the streams and aquifers in the basin. The second phase of the study focused data collection at specific sites within the basin. A two-phased approach was necessary because the size of the Willamette River Basin study area did not permit detailed study of every area. Studies carried out during the second phase were used to develop an understanding of specific hydrologic and geologic settings.

Western Oregon is known for its abundant precipitation; however, most precipitation falls from October through May and summer precipitation may not be sufficient to meet water demands. Therefore, many streams in the Willamette River Basin are closed to additional out-of-stream appropriations in the summer and ground water is used to satisfy the growing water demand (Lee and Risley, 2002).

The OWRD has identified Critical Ground Water Areas (CGWA) where ground water resources are of special concern. In these areas, OWRD can address interference between wells, excessive water level declines, and water quality degradation. In CGWA, the OWRD can create preferences of use without regard to water right seniority, or deference to the order in which water rights were granted; however, because CGWA can require use reductions, they may be difficult to establish. There are no CGWA in the Luckiamute/Ash Creek study area (Oregon Water Resources Department and Oregon Department of Land Conservation and Development, 2002). A word of caution: where OWRD has not restricted development of the ground water resources, one cannot assume that the resource is capable of sustaining additional water use. Land use decisions and water use decisions may exacerbate water supply problems. **We recommend that local planning groups work together with OWRD to prevent rural water supply problems.**

The LWC requested that this assessment summarize existing ground water withdrawals. We obtained municipal well water use data from the OWRD online Water Use Reporting System (Tables 26, 27, and 28). Well information includes point of diversion (POD) ID number, permit number, certification number, priority, township and range, section number, use, rate, stream name and source. We found records for 14 permitted wells in Monmouth, nine in Independence and

six in Falls City. Not all wells, however, had reported withdrawals (some had 0 withdrawals listed). In addition, for those records that did have reported use, the units varied from year to year. Therefore, we converted all units to cubic feet per second (CFS) for the following comparisons. In reviewing the data, we found that following our conversions, the patterns seemed to indicate that the units were incorrectly entered into the permitting system. We followed up with the Watermaster, Bill Ferber (Dec 2003), to make sure that we interpreted the unit codes correctly. Unfortunately, there is still reason to believe that some of the data were entered incorrectly. **Before the well withdrawal data are used for planning purposes, we strongly recommend that the Watermaster be consulted and that the data be carefully reviewed.**

Peak well water usage in Monmouth was during the period of 1993-1997 (Table 27). According to information obtained from Water Availability Reports System (WARS), the well water usage is decreasing at each of Monmouth's three points of diversion (POD). The City of Independence shows similar trends at one POD (Table 28); however, the usage data were only available from 1997 to 2000. The remaining Independence PODs show an increase in water usage. Finally, PODs from Falls City recorded usage in 1989, 1999, and 2000. Recorded usages from two PODs decreased from 1989 to 2000 while the remaining two PODs each had only one record.

More information on the Willamette Basin Ground-Water Study is online at *http://oregon .usgs.gov/ projs_dir/willgw/ index.html* and from *http://www. wrd .state.or.us.gov*.

Water District

One source of groundwater in Polk County is the Luckiamute Water District. It is a locally organized co-op that was formed at the request of the community. It is governed by a board of directors and provides water for domestic use to approximately 960 households in the rural Polk county area. The water is from wells and tested as required by law. For more information contact The Luckiamute Water District Office at #503-838-2075.

Table 26. Total reported groundwater withdrawal from four Falls City wells. Units are cubit feet per second (CFS). Data were originally reported in CFS, gallons per minute (GPM), and Million Gallons per Day according to watermaster Bill Ferber. Data were converted from GPM to CFS by multiplying GPM by 0.0022280 and from MGD to GPM by multiplying by 694.44. Data are from OWRD online Water Use Reporting database.

Year	POD 11474	POD 11475	POD 11479	POD 11480
1989	126,261	NA	138,264	138,153
1999	NA	45	65	NA
2000	42	NA	117,217	NA

Table 27. Total reported groundwater withdrawal from three Monmouth wells. Units are cubit feet per second (CFS). Data were originally reported in both CFS and gallons per minute (GPM) according to watermaster Bill Ferber. Data were converted from GPM to CFS by multiplying GPM by 0.0022280. Data are from OWRD online Water Use Reporting database.			
Water Year	POD 11794	POD 11795	POD 30217
1989	405,000	0	NA
1990	NA	NA	NA
1991	0	0	NA
1992	0	0	NA
1993	2,404,000	2,149,100	NA
1994	3,123,500	3,877,778	34,909,100
1995	827,200	1,851,097	35,834,692
1996	667,781	358,703	43,142,327
1997	1,651,470	692,740	43,355,549
1998	8,827	4,690	790,571
1999	NA	NA	48,860,696
2000	49,515	67,091	640,593
2001	13,208	86,296	639,299

Table 28. Total water reported water withdrawal from three Independence wells. Units are cubit feet per second (CFS). Data were originally reported in both CFS and gallons per minute (GPM) according to watermaster Bill Ferber. Data were converted from GPM to CFS by multiplying GPM by 0.0022280. Data are from OWRD online Water Use Reporting database.							
Year	POD 19923	POD 24740	POD 26997	POD 30064	POD 33137	POD 33138	POD 33139
1997	NA	NA	NA	NA	118,358	NA	NA
1998	93,342	82,299	12	109,092	65,183	74,906	NA
1999	96,843	79,110	0	119,962	102,683	70,667	67,309
2000	NA	NA	45	121,739	181,783	71,200	73,939

Water Quality

Water quality is a term that is often used to describe many properties of bodies of water including, but not limited to, temperature, nutrient concentration (most commonly nitrogen and phosphorus), pH, conductivity, alkalinity, dissolved oxygen concentration, contaminant (pollutant) concentration, and concentration of indicator bacteria. All of these factors vary in time and space within streams, rivers, lakes, and estuaries, which make them very difficult to study. Yet, water quality often limits (in biological terms) the types and abundance of organisms that live in these aquatic environments.

For this assessment, we focused on existing data sources. We used the Oregon DEQ 303(d) list, and data contained in ODEQ LASAR and EPA STORET databases. Both LASAR and STORET are used by DEQ to determine which stream segments are of poor water quality and will not support the designated use.

Factors Affecting Water Quality

A number of factors can affect water quality including land use, land cover, terrain, presence of point and non-point pollution sources. Because water quality is affected by so many factors, it is often thought of as an integrator of watershed condition. Larger stream reaches and receiving bodies of water (*i.e*., estuaries and lakes) are often assessed for 'cumulative effects.' That is, the influence of 'stressors' or factors that adversely affect water quality throughout the entire watershed.

Point Source Pollution

The 1972 Federal Water Pollution Control Act defined two sources of pollution: point and nonpoint. Point sources of pollution can be clearly identified; examples include discharges from industry and sewage treatment plants. Such discharges often enter the receiving waters *via* discharge pipes. All point sources discharging into navigable waters are regulated by the National Pollutant Discharge Elimination System (NPDES). In Oregon, the Department of Environmental Quality is responsible for implementing components of the NPDES program, such as storm water discharge permits.

The purpose of the NPDES Program is to protect human health and the environment. By point sources, EPA means discrete conveyances such as pipes or man made ditches. All facilities (excluding individual households) must obtain permits if their discharges go directly to surface waters. Examples of pollutants that may threaten public health and the nation's waters are human wastes, ground-up food from sink disposals, laundry and bath waters, toxic chemicals, oil and grease, metals, and pesticides (EPA, *http://www.epa.gov/owm/npdes.htm*).

Point sources of pollution include wastewater treatment plants and other effluent discharges. The Clean Water Act requires that all point sources discharging pollutants into waters of the United States must obtain an NPDES permit. This includes storm water discharges associated with "industrial activity," according to a fact sheet put out by ODEQ. Industrial activity is defined as having the industry listed by EPA or having storm or snow melt leaving the site through a point source (pipe, culvert, ditch, basin, channel, *etc.*) and reaching surface waters directly or through storm drainage. Some construction activities are also included.

We found six active NPDES permit holders in the study area (Table 29). Records for each facility were examined online. Most of the records showed that permits had expired. We contacted DEQ and learned that the information on the web site was the most recent (M. Hamlin, personal communication); however, we also learned that at least one permit was renewed on 9/17/02 and set to expire on 6/30/07 (Eric Tuppan, personal communication). All facilities were found to be operating within the conditions of their permits. No prior violations were recorded. We did not pursue updated records for this assessment because no recent problems were uncovered. **We recommend that the EPA web site be checked again in the future and discharge permits be carefully monitored.**

Table 29. Active NPDES permits found within the study area. Shown are the NPDES ID, facility name, county, permit issue and expiration dates, and facility description. Source was EPA web site.					
NPDES ID	Facility Name	County	Permit Issue Date	Permit Expire Date	Description
OR0043630	VALLEY LANDFILLS INC	BENTON	FEB-13-1998	DEC-31-2002	REFUSE SYSTEMS
ORG253505	FRANKLIN SWEED INCORPORATED	POLK	NOV-05-1996	JUL-31-2001	GRAY AND DUCTILE IRON FOUNDRIES
OR0020613	CITY OF MONMOUTH WASTE WATER TREATMENT FACILITY	POLK	AUG-10-1994	MAY-31-1999	SEWERAGE SYSTEMS
OR0032701	FALLS CITY, CITY OF	POLK	MAR-08-1991	FEB-28-1996	SEWERAGE SYSTEMS
OR0020443	INDEPENDENCE, CITY OF	POLK	AUG-10-1994	MAY-31-1999	SEWERAGE SYSTEMS
ORG703500	BOISE CASCADE CORPORATION	POLK	APR-14-1997	JUL-31-2001	SOFTWOOD VENEER AND PLYWOOD

Non-Point Source Pollution

Nonpoint sources of pollution may have no readily identifiable source, or may originate from broad areas rather than discrete points. Examples of non-point source pollution include: run-off from urban, construction, and agricultural activities and pesticides entering streams from aerial spraying. Of particular interest are the sediments or nutrients entering waterways from pastures (animal wastes), forestry, and septic tank seepage. Nonpoint source pollution can enter the receiving waters *via* overland or underground flow. It is much more difficult to identify and manage non-point sources of pollution than point sources.

No data were available on non-point pollution sources, and therefore we were not able to prioritize 7th field watersheds on this basis. However, both the Luckiamute River and Soap Creek appear on the state 303(d) list for low dissolved oxygen and bacterial concentrations; since many stream miles are listed both of these water quality impairments may be indicative of non-point source pollution. Part of good watershed management includes awareness of these pollution sources and the use of conservation tillage and manure management techniques where appropriate. **We recommend that local watershed groups work towards increasing awareness of nonpoint pollution sources, and take action to reduce these pollution sources.** Examples of actions that can reduce pollutants entering streams from surface water runoff include riparian fencing, riparian plantings, grazing management and pasture rotation, and education for responsible pesticide use.

Water Temperature

Stream temperature is a concern within the study area. A number of water temperature monitoring measurements have been conducted or are ongoing within the study area. The South Fork Berry Creek is on the 303(d) due to stream temperatures that exceed water quality standards.

Stream temperature is important for several reasons. First, temperature directly affects the amount of dissolved oxygen that water contains and, therefore, the productivity of the stream. Second, aquatic organisms have varying tolerances to temperature: salmon, in particular, are sensitive to warm temperatures. According to a fact sheet published by DEQ *(http:// www. deq.state. or .us/pubs/ water/ Stream Temperature .pdf)* Oregon salmonids require water temperatures to be 10^{o} C for spawning and 17.8^{o} C for all other life stages. Oregon DEQ temperature standards are based on a 7-day moving average of the high temperatures in a stream. There are also many indirect effects of stream temperature on the nature of streams. For example, temperature affects the viscosity of water; therefore cold water travels a little slower and transports more suspended particulates than warm water (*e.g.*, silt sinks twice as fast at 23^{o} C than at 0^{o} C: (Hynes, 1970).

Temperature fluctuates on daily and seasonal time scales. In aquatic ecosystems, this variability makes it difficult to interpret instantaneous measurements (discrete in time and space), which are often recorded by water quality monitoring teams. Because of this variability temperature data loggers are often used to make measurements at frequent, repeated intervals in streams. Models are often used to integrate these measurements over space.

ODEQ conducted a stream temperature study at 25 locations throughout the watershed in 2001. Unfortunately, this study also coincided with the low flows associated with a drought. Due to the relatively few sampling stations and the drought conditions, the LWC decided not to summarize these data.

To determine the current trends in water quality we queried the LASAR water quality database for stations where water temperature had been measured. We found that only six stations had measurements made with the past three years. Figure 3 shows the temperatures recorded from three stations. Notice that there are large gaps in the record. In addition, notice the variability in any one year's data. Unfortunately, existing temperature data were not useful in prioritizing 7th field watersheds in this assessment.

One way to use these data would be in the development of a temperature model. A model would use field measurements for calibration and would be useful in interpolating between each discrete observation. Many watershed groups are developing temperature models in Oregon from field data. ODEQ has information about temperature modeling on their webpages.

We recommend that LWC use the available water temperature data at the stream reach and basin planning scale to prioritize project sites. Data gathered during this assessment can be combined with water temperature data to provide powerful tools for action planning. For example, where a monitoring program shows a consistently high water temperature, AHI data, DOQs or local knowledge should be investigated to determine where in the watershed stream bank shading may be poor and riparian vegetation may be lacking. Riparian plantings and riparian fencing can then be planned for appropriate sites. **We also recommend that stream temperature models be considered. Models can be developed that integrate temperature over space and time, based on a relatively few number of measurements or based on emerging technology, such as, FLIR imagery.**

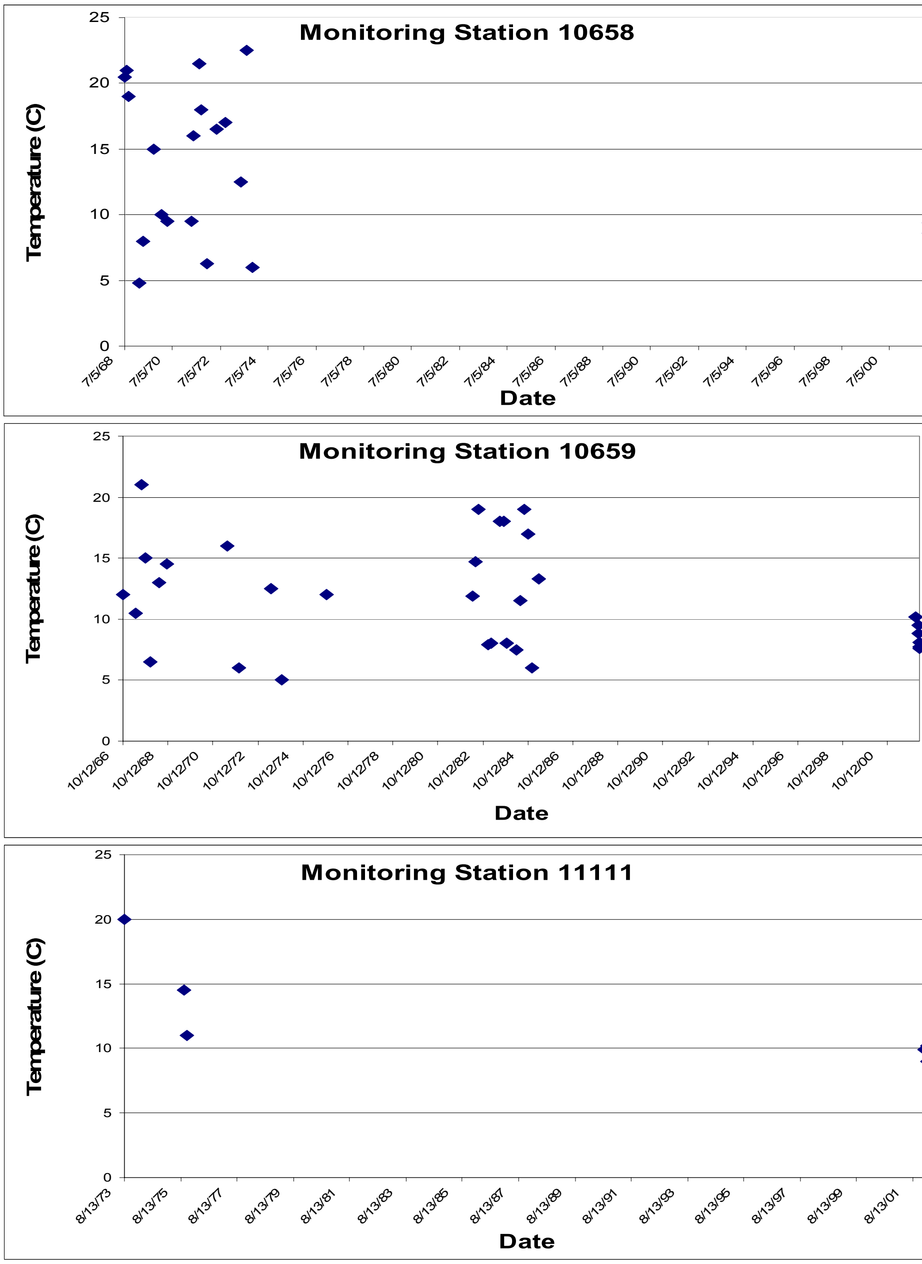


Figure 3. Stream temperatures at three water quality monitoring stations. Notice the gaps in the record. Source: ODEQ LASAR water quality database.

Water Quality Evaluation

303(d) Listed Streams

The 1972 Federal Water Pollution Control Act (amended as The Clean Water Act in 1977) established broad water quality goals for the nation's fishable and swimmable waters. The Oregon Department of Environmental Quality (ODEQ) is one of the agencies that monitor water quality in the State of Oregon. ODEQ is required by the federal Clean Water Act to maintain a list of steam segments that do not meet water quality standards, the so-called 303(d) list. Water bodies that do not meet water quality standards are said to be water quality limited or impaired. The term, “water quality limited”, refers to a limitation in a beneficial use of that water body. Beneficial uses of state waters, as defined by the Oregon Legislature (ORS 468.710) include: domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife and fish uses, and pollution abatement. Water quality standards, levels or concentrations of water quality variables, such as fecal coliform bacteria, temperature, or dissolved oxygen concentration, have been established to classify state waters as "supporting", "partially-supporting", or "not-supporting" certain beneficial uses.

The 303(d) list is used as a first step in locating water quality-impaired reaches, as described in the OWEB Watershed Assessment Manual. The 303(d) list does not include all streams that are impaired by high temperatures, sedimentation, fecal coliform, or other factors; however, all streams appearing on the 303(d) list have been assessed. This may reflect the methods used to designate 303(d) streams (*i.e.*, larger rivers may receive more scrutiny during the designation process) as well as actual differences in water quality. Streams suspected to be water quality impaired for which data have not been collected appear on ODEQ’s “Water Bodies of Concern” list.

We obtained database files and GIS coverages of Oregon's 2002 List of Water Quality Limited Water bodies (the "303[d] list") from the ODEQ website (Map 7). In 2002, there were 13,300 miles of Oregon streams listed on the 303(d) list including three streams in the study area (Table 30, Map 7).

Almost 32 miles of the Luckiamute River appear on the 303(d) list (Map 7). The Luckiamute River was listed in 1998 for fecal coliform bacteria concentrations that exceeded the water quality standards for water contact recreation (the beneficial use). The river is listed for winter, spring and fall. Fecal coliform bacteria are themselves an indicator of the potential human health risk due to waterborne pathogens.

Almost 17 miles of Soap Creek are listed for not meeting the dissolved oxygen concentration water quality standard from October through May. Soap Creek was listed in 2002 and salmonid spawning was the beneficial use that was impaired (Map 7).

Finally, about two miles of the South Fork of Berry Creek were listed for temperature in 2002. Stream water temperature exceeded the state water quality standards (17.8^{o}C) for salmon fish rearing. Salmonid fish rearing and anadromous fish passage are the beneficial uses that were affected.

Compare Map 7 with Maps 18-20. These are areas where water quality is likely to have a large impact on salmonid populations. Water quality can also restrict the movement of salmon and act as a barrier (see next sections). **We recommend that water quality monitoring stations be established on these reaches.**

In a relatively new approach to managing water quality, Total Maximum

Daily Loads (TMDL) are being developed. USEPA requires the state to develop TMDL that take in to account pollution from all sources that a water body can receive including discharges from industry, sewage treatment facilities, and runoff from agricultural, forests, and urban areas. Although EPA has not approved TMDLS in the Luckiamute basin, the Upper Willamette had TMDL (for temperature, bacteria and mercury) developed in 2003. They are now being reviewed. According to ODEQ, TMDL for the Willamette Basin are expected to be released in summer 2004. Contact Jared Rubin (541) 686-7838 for timeline updates or review requests. **We recommend that LWC keep abreast of and participate in the TMDL process.**

Table 30. Water quality limited stream in the study area. These streams appear on ODEQ's 303(d) list.

Record ID	Water body Name	River Mile	Parameter	Season	List Date
6054	Luckiamute River	0 to 31.7	Fecal Coliform	Winter/Spring/Fall	1998
8523	Soap Creek	0 to 16.8	Dissolved Oxygen	October 1 - May 31	2002
8791	South Fork Berry Creek	0 to 2.1	Temperature	Summer	2002

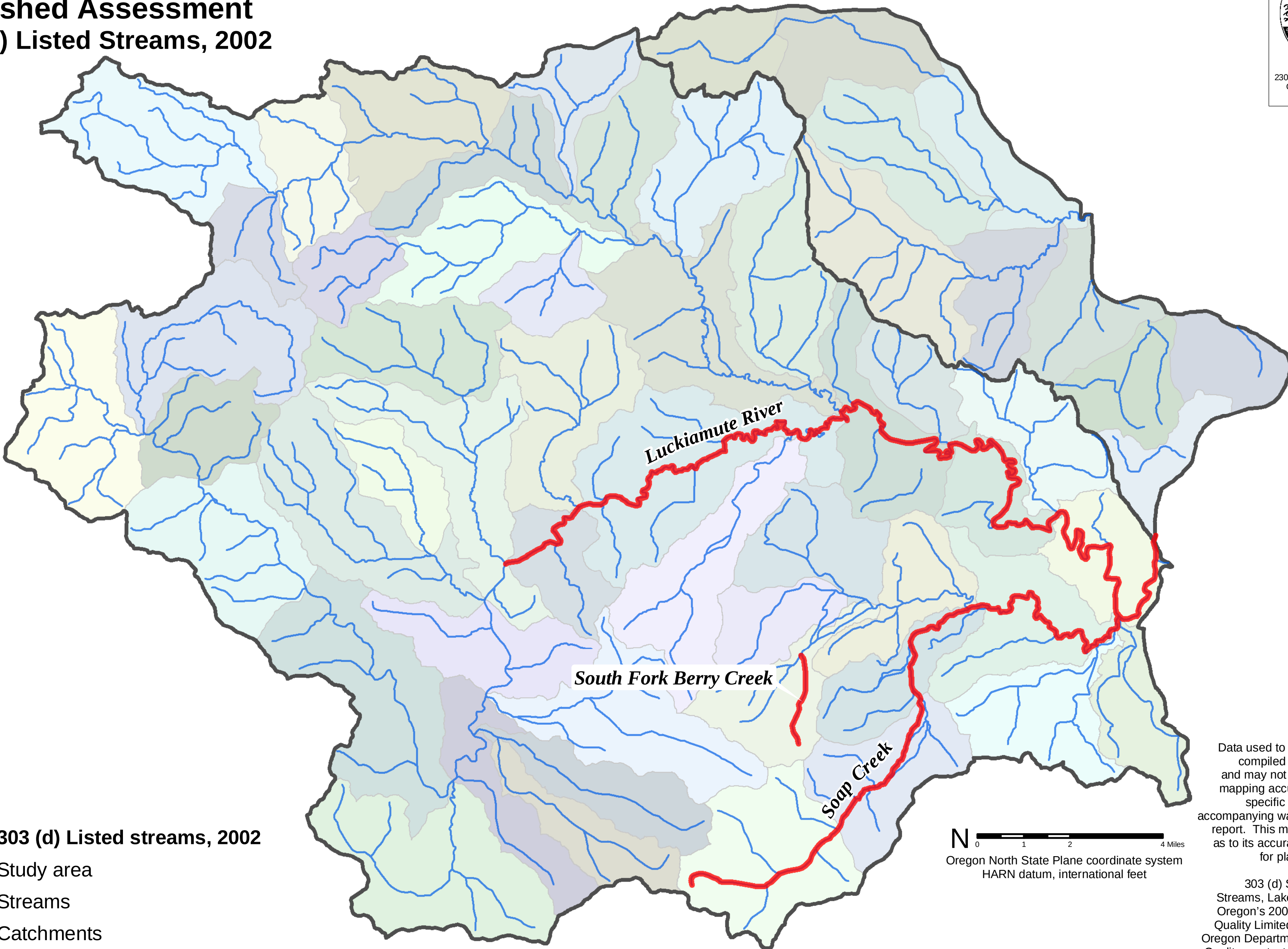
Map 7. Water Quality Limited Streams in the Luckiamute / Ash Creek Study Area. Source: ODEQ 303(d) List.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

303 (d) Listed Streams, 2002

Map 7

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



- **303 (d) Listed streams, 2002**
- Study area
- Streams
- Catchments

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

303 (d) Streams Data Source: Streams, Lakes and Reservoirs on Oregon's 2002 303(d) list of Water Quality Limited Water bodies. 2003. Oregon Department of Environmental Quality, contact: Malavika M. Bishop. (http://www.deq.state.or.us/wq/303dlist/303dpage.htm)

High Quality Waters

The LWC requested information on areas of high water quality in the Luckiamute/ Ash Creek study area. We checked Oregon's Waterwatch (*www.waterwatch.org*), America's Scenic Byways (*www.byways.org*), and Oregon Wild and Scenic Rivers Program (*www.oregonwaters.org*) for information on high quality waterways. We did not find any information on high quality waterways in the study area.

Water Quality Monitoring Data

EPA's STORET and ODEQ's LASAR

Water quality data, measured by federal, state and private groups, is available *via* two online databases, STORET and LASAR. The STORET (short for STOrage and RETrieval) database is a repository for water quality, biological, and physical data. STORET contains raw biological, chemical, and physical data on surface and ground water collected by federal, state and local agencies, Indian Tribes, volunteer groups, academics, and others. Data collected from all 50 States, territories, and jurisdictions of the U.S., along with portions of Canada and Mexico, are stored in the system. If water quality was measured, it generally ends up in the STORET database.

Currently, STORET data are available as two separate databases, divided according to when data were originally supplied to EPA. The older of the two databases is called the STORET Legacy Data Center (LDC), and the more current is called Modernized STORET. Water quality observations made prior to 1999 are stored in the LDC database. Both data sets are available on the Internet (*http://www.epa.gov/storet/*).

LASAR (Laboratory Analytical Storage and Retrieval Database) was developed and maintained by the Oregon Department of Environmental Quality (ODEQ). Generally, collected water quality data appears in both STORET and LASAR. The following is a brief description of how the data are organized in STORET and LASAR. Individual water quality measurements, called parameters, are given unique parameter codes. Within the STORET database parameters are grouped into 18 major categories (group codes) which include administrative, bacteriological, biological, dissolved oxygen concentration, flow, general inorganic, general organic, metal, nitrogen, oxygen demand, pesticide, phosphorus, physical, radiological, solid, temperature, miscellaneous, and other. Measurements are made at STORET stations, each identified by a unique number. Data can be retrieved online by 4th field HUC, by station, or by parameter number or group codes.

We queried both STORET (December 2003) and LASAR (July 2003) for water quality information collected within the study area. Table 31 summarizes water quality stations for which data were collected.

Table 31. Range of dates for which water quality measurements were made. Shown are station ID numbers. Data were obtained from LASAR in July 2003. A separate database showing locations and measured parameters for all WQ monitoring stations was provided to the Luckiamute Watershed Council as part of this assessment.

1970-1980	1981-1990	1991-2000		2001-present
10347	10348	11895	12456	10658
10844	14425	12433	12457	10659
11292	14426	12434	12458	11111
11293	14427	12435	14429	11113
11294	14428	12436	14435	11114
11295	14430	12437	14436	11118
11296	14431	12438	14438	
11297	14432	12439	14442	
11298	14433	12440	14444	
11299	14434	12441	14445	
11300	14437	12442	14446	
11301	14439	12443	14449	
11302	14440	12444	14450	
11109	14441	12445	14451	
11110	14443	12446	14452	
11112	14447	12447	14453	
11115	14448	12448	14454	
11117		12449	14455	
11319		12450	14457	
14424		12451	14458	
		12452	14459	
		12453	14460	
		12454	14461	
		12455	23866	

The following water quality monitoring stations were examined but contained no data records: 11894, 11896,12402, 12459, 16479, 16480, 1116, 14067, 14608, 14609, 14456, 16479, and 16480.

In general, we found that water quality was measured infrequently and not in enough locations to be of use in prioritizing 7th field watersheds. Only six water quality monitoring stations had measurements taken within the last three years. These stations were: Luckiamute River at Lower Bridge (ID 10658), Luckiamute River at Helmick St Park (ID 10659), Luckiamute River at Hoskins (ID 11111), Soap Creek at Corvallis Rd (Suver: ID 11113), Little Luckiamute River at Elkins Road (ID 11114), and Teal Creek at Gardner Rd (Falls City: ID 11118). Fecal coliform bacteria were measured at most of these stations; unfortunately, the measurements were made infrequently and at irregular intervals. For example, three of the sites had only 5-10 measurements made from the mid 1970's to 2002. The remaining two sites had between 16 and 20 measurements made between 1968 and the mid 1980's.

As mentioned previously, fecal coliform bacteria and E. coli are frequently measured as indicators of human health risk. Bacteria concentrations are highly variable and can be influenced by land use/ land cover, presence of animals, stream flows, and precipitation. It is very difficult to interpret field measurements. ODEQ and Pedee Creek residents undertook a bacterial study in portions of the Luckiamute watershed. Multiple E. coli samples were taken from 27 sites during the period from Mar 2001 to April- May 2002. Data were collected bi-weekly and during storm events (S. Mrazik, ODEQ, personal communication). Data showed elevated concentrations of E. coli in most samples. These data are being used for TMDL development and a report is available from ODEQ.

Most of the data we found in the STORET database are not suitable for looking at trends within the study area. This is due to the timing and number of observations. We provided spreadsheet and GIS copies of these data to assist the Luckiamute Watershed Council in their Action Planning.

Stream Flow and Flooding

Peak Flows

Impact of Land Use

Land use changes have undoubtedly had an impact on hydrologic patterns. Any action that results in less watershed water storage or quickly routes water into the stream network will increase peak flows. These land use changes and management practices include, but are not limited to, soil compaction, increases in impervious cover, tiling of agricultural fields, installation of culverts in forest road systems, draining of wetlands, channelization of steam beds, and loss of flood plain connectivity.

If hydrologic changes due to land use alterations are of major concern to the LWC, **we recommend the development of a GIS-based hydrologic model.** Developing a hydrologic model was beyond the scope of this assessment; however, a useful model was constructed for the Tillamook Bay watershed (Melancon,

1999) and was used to evaluate hydrologic patterns (and bacterial and sediment transport patterns) as they are affected by land use changes. The advantage of creating a calibrated computer model is that multiple scenarios can be evaluated using the computer before committing to the expense of making actual changes on the ground. In this way, the cost to benefit of management actions can be evaluated.

Impact of Roads

The Watershed Assessment Manual details two methods for evaluating the impact of roads on peak flows:

(1) Urban road density (expressed as miles of road per mi^2 of watershed) as a surrogate for Total Impervious Area and (2) Rural road density expressed as the percentage of total watershed area occupied by road surfaces.

We calculated road density (mi road/ mi^2) for each 7th field watershed. We found that a few of the 7^{th} field watersheds (Table 32) had road densities in the high risk category (>5.5 mi roads/mi^2) using the urban road density method (Watershed Professionals Network, 1999). As the name implies, this screening tool is most appropriate for urban watersheds; therefore, non-urban watersheds that appear to be at risk using this approach should also be evaluated using the rural road density method (below).

We also calculated the percent of watershed area in roads using the rural road density method (Watershed Professionals Network, 1999). We assumed that the average width of a road is 35 ft (Watershed Professionals Network, 1999). This resulted in the area of road (mi^2) per mi^2 of watershed area. The number of square miles of impervious surface per mi^2 of watershed ranged from 0.01 mi^2 roads/mi^2 to 0.05 mi^2roads/ mi^2. As with the previous analysis, we found that several 7^{th} field watersheds that were at risk for peak flow increases using the rural road density method (Table 33).

We recommend that watersheds identified in Tables 32 and 33 be evaluated for mechanisms to keep water from entering the stream networks from roads. Road densities are just a screening tool to alert the watershed council to potential problems. If problems are found to exist, then various management tools/ approaches that would increase watershed water storage could be evaluated including detention ponds, ditches, or vegetated buffer strips.

Table 32. Seventh field watershed that are in the moderate (4.2-5.5) and high (>5.5) risk category for the potential impact of roads on peak flows. Shown are watershed HUC and name, length of roads in watershed (mi), area of watershed (mi^2) and road density (mi road/ mi^2 of watershed).				
Name	HUC	Length (mi)	Area of HUC (mi^2)	Road Density (mi road/ mi^2 watershed)
Upper Luckiamute	3060101	52.0	9.3	5.6
Miller Creek	3060102	49.5	8.9	5.6
Wolf Creek	3060201	28.9	5.0	5.7
Ritner Creek	3060404	50.3	10.0	5
Cold Springs	3060602	23.0	2.9	7.8
Black Rock Creek	3060603	33.9	5.3	6.4
Socialist Valley	3060701	46.7	7.8	6
Falls City	3060702	36.9	5.2	7.1
Upper Teal Creek	3060801	18.5	3.4	5.4
Lower Teal Creek	3060802	40.9	7.7	5.3
Grant Creek	3060803	17.0	3.2	5.3
Upper Soap Creek	3061101	55.2	9.2	6
Palestine	3061302	38.0	6.5	5.9
Upper North Fork Ash Creek	7020601	25.0	4.3	5.8
Upper Pedee Creek	3060402	33.9	7.2	4.7
Lower South Fork Ash Creek	7020606	24.1	5.2	4.7
Lower North Fork Ash Creek	7020603	24.9	5.4	4.6
Upper Little Luckiamute	3060601	42.4	9.4	4.5
Price Creek	3060303	23.4	5.2	4.5
Middle Soap Creek	3061102	30.0	6.8	4.4
Maxfield	3060304	40.3	9.1	4.4

Table 32. Seventh field watershed that are in the moderate (4.2-5.5) and high (>5.5) risk category for the potential impact of roads on peak flows. Shown are watershed HUC and name, length of roads in watershed (mi), area of watershed (mi^2) and road density (mi road/ mi^2 of watershed).

Name	HUC	Length (mi)	Area of HUC (mi^2)	Road Density (mi road/ mi^2 watershed)
Creek				
Lower Pedee Creek	3060401	40.7	9.4	4.3
Bump Creek	3060305	28.1	6.6	4.3
Ira Hooker	3060501	17.5	4.1	4.2

Table 33. Seventh field watershed that are in the moderate (4.0-8.0) risk category for the potential impact of roads on peak flows. Shown are watershed HUC and name, length of roads in watershed (mi), area of watershed (mi^2) and road density (mi road/ mi^2 of watershed).

Name	HUC	Length (mi)	Watershed area (mi^2)	Area of roads (mi^2)	Percent of total watershed area that are roads
Cold Springs	3060602	23.0	2.9	0.2	5.2%
Falls City	3060702	36.9	5.2	0.2	4.7%
Black Rock Creek	3060603	33.9	5.3	0.2	4.2%
Socialist Valley	3060701	46.7	7.8	0.3	4.0%

Rain-on-Snow

When rain falls on snow, water does not infiltrate the soil, as it normally does. Instead, water runs over the surface of the ground into the receiving stream network. This can result in high water levels in streams (high peaks on the hydrograph). Therefore, rain on snow (ROS) events can dramatically impact the pattern of water delivery to streams. As more water enters the stream network, water velocities increase, so does the capacity of the water to erode banks and down cut streambeds.

The OWEB watershed assessment manual (Watershed Professionals Network, 1999) describes watersheds as having potential impact from ROS events if two conditions are met in 20% or more of the watershed area: (1) less than 30% crown closure and (2) elevations suitable for ROS events (not defined in OWEB manual). However, the manual does not have specific guidelines for mapping these areas in the Coast Range.

We used GIS to locate areas of **potential** ROS impact, that is, areas where conditions exist that could *potentially* lead to ROS events. This is not to say that ROS events always occur in these zones. ROS events have a greater probability of occurring under certain conditions. In the Oregon Coast Range, ROS events can have return intervals of several years to tens of years.

We used land cover and elevation in our analysis to locate higher elevations areas that were non-forested. Non-forested areas have the potential to form a layer of snow from which rain could run off quickly into streams. The Luckiamute/ Ash Creek study area is a relatively low elevation study area compared to other areas in the Coast Range. We used GIS to locate all non-forested areas from the current land use/ land cover vegetation data layer above 2,500 ft. We found one 7th field watershed, the Upper Little Luckiamute (17090003060601), in the study area which had 0.22 acres above 2,500ft. We conclude that ROS events probably occur infrequently in the Luckiamute / Ash Creek watersheds.

Flooding

Historically, there have been several large floods in or near the Luckiamute / Ash Creek study area (see Appendix B). Important flood events include the floods of 1861, 1864, 1898, 1948, and 1996. Changes in the watershed have probably reduced the frequency of flooding along the streams in the study area. According to a BLM report (Licata *et al.*, 1998),

"*Nearly all of the observed response channels in the analysis area are incised and moderately to highly unstable. Channels are "disconnected" from their floodplains (over-bank flooding occurs only during extreme storm events, if at all) which now primarily function as terraces. Water storage in floodplains has been reduced, contributing to the reduction in summer baseflows, and water quality has been degraded.*"

While the down cutting of streams and lack of a connection between streams and their floodplains may have reduced the frequency of flooding, it has not improved habitat for in-stream organisms. Licata (1998) reports that stream down cutting has "lead to an overall reduction in the quantity and quality of aquatic life relative to reference conditions throughout the analysis area." A certain amount of over bank flooding is necessary and floodplain connection is the natural (desirable) condition for stream ecosystems.

We acquired the FEMA floodplain maps for the study area. As expected, floodplains are most common in the eastern portion of the study area along the Willamette and Luckiamute Rivers (Map 8). Notice the strong relationship between floodplain areas and areas with hydric soils (Map 5). **We recommend that floodplain areas be evaluated for wetland restoration and riparian planting areas. In addition, areas could be evaluated for hydrologic between floodplains and rivers.**

Map 8: FEMA floodplains in the Luckiamute / Ash Creek study area. Also shown are major roads and major streams

Luckiamute/Ash Creek/American Bottom Watershed Assessment

FEMA Flood Plain

Map 8

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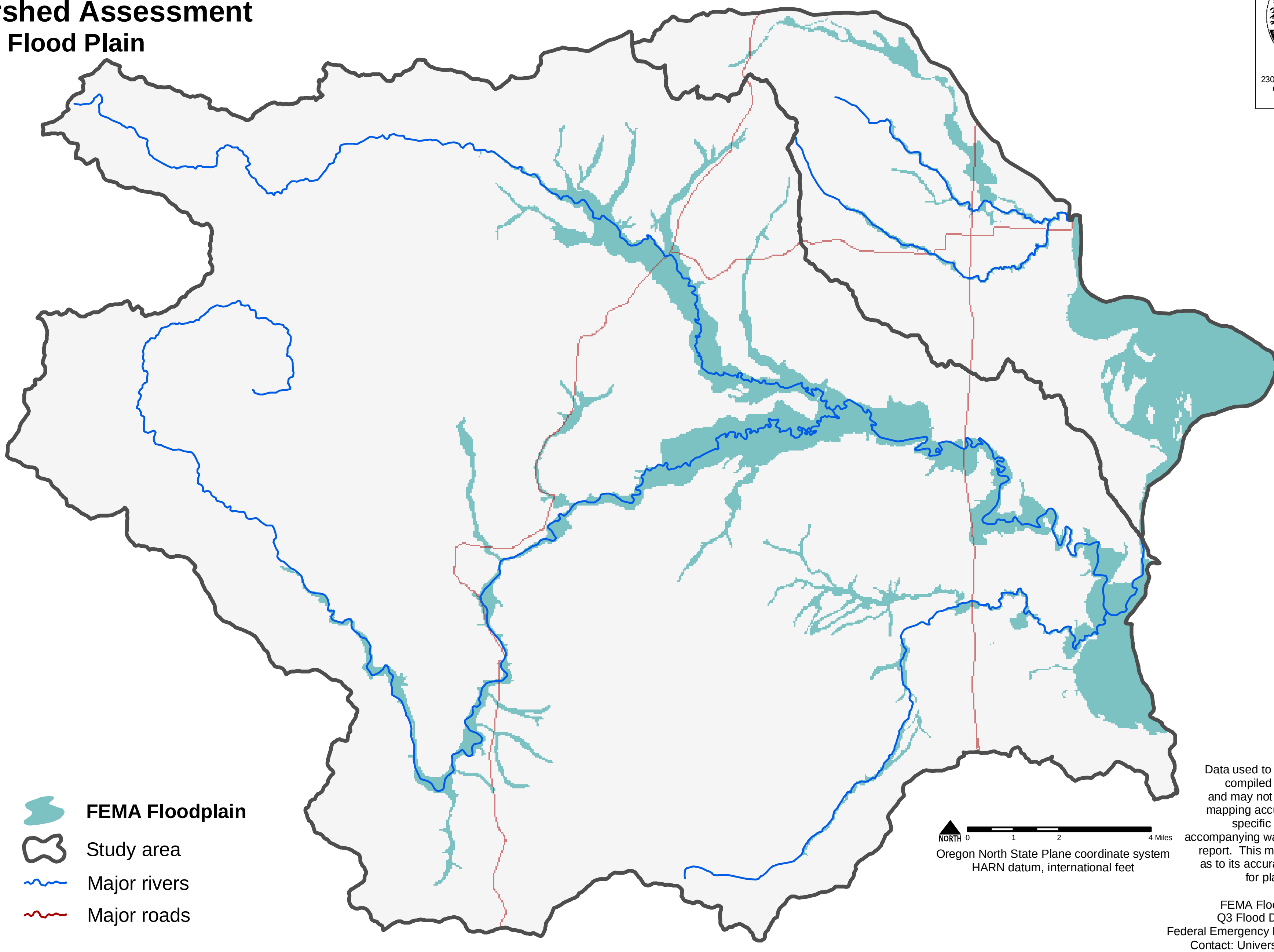
Corvallis, Oregon 97333
www.earthdesign.com



Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

FEMA Flood Plain Data Source:
Q3 Flood Data Coverage. 1996.
Federal Emergency Management Agency.
Contact: University of Oregon Library.
(http://libweb.uoregon.edu/map/map_section/fema_data/map_fema_index.html)

6.2 Erosional Processes

Surface erosion

Soils

Under some circumstances, soils and sediments can move across the landscape and into the stream network where suspended sediments can dramatically affect the quality of salmonid habitat. Circumstances that foster soil erosion include any actions that remove vegetation (which acts to stabilize soils), or any actions that lead to an increased frequency of mass wasting events. As previously mentioned, high stream water velocities can also erode steam banks thereby increasing sediment loads (see Section 6.1). Detailed information on soils provided here can be used to plan actions to minimize the effect on soils prone to erosion.

Roads

Roads can contribute sediments to streams, especially improperly constructed or abandoned roads. The LWC was interested in learning the status of abandoned roads in the watershed. We did acquire and use a roads layer from the BLM; however, BLM personnel recommended that the road attribute data not be used because of its low accuracy (Michelle Davis, personal communication, 7/23/2003). We also checked with the timber companies but were unable to obtain copies of their road data. The county data sets do have improved and unimproved roads data in them, but the counties have their data at different levels of detail (Polk is more detailed), so the data sets were not combined for this analysis. Therefore, we were not able to look at the impact of abandoned and unimproved roads on sediment loading. These data, however, may be useful in future LWC action planning.

In addition to unimproved or abandoned roads, roads passing over areas of steep slopes can fail, or act as chronic sources of sediments to streams. We ranked 7th field watersheds by the length of roads passing near streams.

We used the DEM and roads layers to rank 7th field watersheds by the length of roads that each had passing within 200 ft of a stream (Table 34). Roads passing over or near streams can contribute sediments directly to streams during rain events.

We recommend that actions to prevent sediment delivery to streams be prioritized by 7th field watersheds in Table 34. If sediment delivery to streams is found to be a problem, remediation action can be taken.

Table 34 List of 7th field watersheds ranked by the length of road passing within 200 ft of a stream.

Name	HUC	Total Length of Road (ft) within 200ft of a stream
Black Rock Creek	3060603	55,388.9
Bridgeport	3060704	28,164.1
Buena Vista	7020404	3,170.6
Bump Creek	3060305	62,936.9
Clayton Creek	3060403	26,025.3

Table 34 List of 7th field watersheds ranked by the length of road passing within 200 ft of a stream.

Name	HUC	Total Length of Road (ft) within 200ft of a stream
Cold Springs	3060602	18,160.9
Cooper Creek	3060903	28,928.1
Cougar Creek	3060202	36,376.8
Duck Slough	7020502	6,500.3
E.E. Wilson	3061301	6,215.5
Falls City	3060702	38,907.4
Fern Creek	3060901	41,660.3
Grant Creek	3060803	21,139.0
Harman Slough	7020503	6,728.7
Helmick	3061003	8,958.6
Hoskins	3060203	84,936.0
Ira Hooker	3060501	21,961.6
Jont Creek	3060504	43,647.2
Lower Berry Creek	3061204	3,547.6
Lower Little Luckiamute	3060902	19,218.6
Lower North Fork Ash Creek	7020603	8,918.4
Lower Pedee Creek	3060401	69,855.1
Lower South Fork Ash Creek	7020606	7,249.8
Lower Teal Creek	3060802	65,183.6
Luckiamute Landing	3061005	9,292.9
Maxfield Creek	3060304	106,170.8
McTimmonds	3060502	55,255.7
Middle Fork Ash Creek	7020604	23,610.2
Middle Luckiamute	3060503	35,265.7
Middle North Fork Ash Creek	7020602	37,835.7
Middle Soap Creek	3061102	30,121.2
Miller Creek	3060102	65,614.4
Palestine	3061302	19,862.1
Parker	3061004	9,678.7
Peterson Creek	3061203	27,155.2
Plunkett Creek	3060301	38,142.0
Price Creek	3060303	58,915.8
Rifle Range	3061103	10,773.3
Ritner Creek	3060404	62,158.1
Simpson	3061001	5,929.0
Socialist Valley	3060701	68,001.0
Springhill	3061303	14,073.6
Staats Creek	3061202	14,243.8
Upper Berry Creek	3061201	33,252.8
Upper Little Luckiamute	3060601	29,057.7

Table 34 List of 7th field watersheds ranked by the length of road passing within 200 ft of a stream.

Name	HUC	Total Length of Road (ft) within 200ft of a stream
Upper Luckiamute	3060101	57,582.7
Upper North Fork Ash Creek	7020601	29,327.7
Upper Pedee Creek	3060402	52,405.8
Upper Soap Creek	3061101	113,978.2
Upper South Fork Ash Creek	7020605	32,907.8
Upper Teal Creek	3060801	20,012.4
Vincent Creek	3060204	72,199.9
Waymire Creek	3060703	25,868.7
Wolf Creek	3060201	47,125.0
Woods Creek	3060302	35,914.8
Zumwalt	3061002	3,384.3

Streambank Erosion

Stream bank erosion can be a significant source of sediments entering streams. Bank erosion can cause sediment loading, which can cover gravel beds and make them unsuitable for salmonid spawning. Excessive fine sediments may also reduce the quality of in-stream habitat for other species such as lamprey, freshwater mussels and macroinvertebrates. The sediment input from streambank erosion can also provide gravel, which is needed for salmon spawning beds.

Observations made by Aquatic Habitat Inventory crews concerning actively eroding stream banks are recorded. We queried the AHI database and retrieved the records of actively eroding stream banks in Table 35. Keep in mind that the AHI data were limited in spatial extent and were somewhat out of date. These data should not be considered representative of the study area. **We recommend that the LWC map areas where stream banks are eroding as part of its future monitoring program.**

Landslides

Areas of the Luckiamute / Ash Creek study area are very dynamic, especially in the Coast Range. Steep slopes and high amounts of precipitation are generally responsible for mass wasting (*e.g.*, landslides and debris torrents) events throughout the region. Steep slopes are common in the west and southwest sides of the study area (Map 9). Even the earliest accounts of the region's explorers describe large areas of landslides and debris torrents. Thus, Oregon's Coast Range has been susceptible to mass wasting prior to the time of European settlement. Mass wasting is a natural process; it is the frequency and magnitude of events that are of concern. Many factors can contribute to an increased frequency of mass wasting events including, land use practices, road building, and development.

Mass wasting adds sediments (both fine and coarse) and organic material to the stream network. These natural stream components are neither good nor bad in themselves; it is the frequency, magnitude and duration of mass wasting events that may have undesired consequences on in-stream conditions, especially on salmonid habitat. Organisms like Pacific Northwest salmonids have evolved in these rapidly changing landscapes and they are adapted to the 'natural' (background) patterns of mass wasting.

ODF Debris Flow Hazard Maps

According to information available on the ODF web site, Western Oregon Debris Hazard Maps were prepared to depict areas that are subject to naturally occurring debris flows (Map 10). They include initiation sites and paths of potential debris flows. These are coarse scale risk assessment maps and should not be used without on-the-ground verification. These maps were developed from the 30m DEM and lithology data layers. Streams were represented by USGS digital raster graphic data. These maps were also developed using available historic information on debris flow from a variety of sources (*e.g.*, ODF, USFS, DOGAMI, BLM and ODOT). These maps did not account for patterns in rainfall.

Briefly, the ODF debris hazard maps assign a risk category to 2-4 acres parcels based on steepness and lithology. Steep areas that occur on Tyee (and similar) geologic formations are rated higher (*i.e.*, having a higher chance of sliding). Past landslide occurrence in an area resulted in a higher risk category being assigned to that area. ODF plans to develop additional guidance based on this work.

We summarized the areas of landslide risk from the ODF debris flow hazard maps for our study area (Table 36).

We recommend that 7th Field HUC be evaluated for debris flow hazard risk when planning for large wood source areas and in-stream restoration projects. Landcover can also be evaluated on those areas prone to flow to evaluate potential for large wood recruitment to the stream network.

We also contacted the State Department of Geology. We learned that debris hazard modeling has been done for the 19 county area west of the Cascades peaks. This mapping was done in response to Senate Bill 12 and HB 3075. Two data sets are currently available: web map-based relative hazard and a GIS layer debris hazard screening tool. Output from existing debris hazard models (*e.g.*, SHALSTAB) were used along rules developed by the authors to predict the relative risks associated with debris flows. The GIS layers can be used as a coarse screening tool. More detailed information can be viewed on the Coastal Atlas web pages (*www.coastalatlas.net*). These data were not used in this assessment because they were not available at the time of data acquisition.

Table 35. Stream reaches with actively eroding banks as identified by AHI crews.				
Stream ID	Stream	Reach Number	Percent Bank Erosion	Length (ft)
123148044755901	LUCKIAMUTE RIVER	1	5.3	2236.2
123148044755902	LUCKIAMUTE RIVER	2	0.0	1796.7
123148044755903	LUCKIAMUTE RIVER	3	4.2	11653.1
123148044755904	LUCKIAMUTE RIVER	4	0.8	7027.4
123148044755905	LUCKIAMUTE RIVER	5	14.1	8795.9
123148044755906	LUCKIAMUTE RIVER	6	19.7	15918.3
123148044755907	LUCKIAMUTE RIVER	7	8.9	12878.6
123163044730501	SOAP CREEK	1	67.3	33934.2
123163044730502	SOAP CREEK	2	27.8	5221.1
123287844891401	LITTLE LUCKIAMUTE RIVER	1	8.2	9153.1
123287844891402	LITTLE LUCKIAMUTE RIVER	2	18.5	5147.2
123287844891403	LITTLE LUCKIAMUTE RIVER	3	10.0	15257.9
123287844891404	LITTLE LUCKIAMUTE RIVER	4	4.3	22705.5
123287844891405	LITTLE LUCKIAMUTE RIVER	5	34.4	2969.3
123287844891406	LITTLE LUCKIAMUTE RIVER	6	10.2	1289.5
123287844891407	LITTLE LUCKIAMUTE RIVER	7	18.4	1380.2
123287844891408	LITTLE LUCKIAMUTE RIVER	8	71.2	1956.5
123287844891409	LITTLE LUCKIAMUTE RIVER	9	22.5	1577.3
123432744740001	PEDEE CREEK	1	25.0	2665.5
123432744740002	PEDEE CREEK	2	28.0	5655.0
123432744740003	PEDEE CREEK	3	26.0	6952.3
123447844771101	SOUTH FORK PEDEE CREEK	1	14.0	5758.9
123447844771102	SOUTH FORK PEDEE CREEK	2	13.0	4269.3
123447844771103	SOUTH FORK PEDEE CREEK	3	4.0	4102.8
123447844771201	NORTH FORK PEDEE CREEK	1	25.0	5473.7
123447844771202	NORTH FORK PEDEE CREEK	2	8.0	3783.8

Table 35. Stream reaches with actively eroding banks as identified by AHI crews.				
Stream ID	**Stream**	**Reach Number**	**Percent Bank Erosion**	**Length (ft)**
123447844771203	NORTH FORK PEDEE CREEK	3	26.0	7409.8
123447844771204	NORTH FORK PEDEE CREEK	4	20.0	2508.
123449244794201	PEDEE CREEK TRIBUTARY	1	5.0	1768.1
123449244794202	PEDEE CREEK TRIBUTARY	2	22.0	3264.7
123449244794203	PEDEE CREEK TRIBUTARY	3	12.0	2767.6
123449244794204	PEDEE CREEK TRIBUTARY	4	12.0	2389.1
123556944867701	CAMP CREEK	1	1.6	2152.6
123556944867702	CAMP CREEK	2	5.0	4125.9
123556944867703	CAMP CREEK	3	0.0	1336.1
123556944867704	CAMP CREEK	4	0.0	5408.0
123556944867705	CAMP CREEK	5	0.3	1935.4
123564544867001	LOST CREEK	1	34.6	8495.7
123565844758201	COUGAR CREEK	1	27.7	2769.8
123565844758202	COUGAR CREEK	2	16.9	2078.7
123565844758203	COUGAR CREEK	3	16.0	5109.8
123568644762701	SLICK CREEK	1	1.2	2313.6
123568644762702	SLICK CREEK	2	5.0	3254.2
123568644762703	SLICK CREEK	3	7.2	3729.8
123568644762704	SLICK CREEK	4	1.4	2111.1
123585844772501	ROCK PIT CREEK	1	11.8	9351.8
123589544776901	WOLF CREEK	1	71.5	3985.0
123589544776902	WOLF CREEK	2	47.8	4895.2
123593144793601	BOULDER CREEK	1	31.7	2379.6
123593144793602	BOULDER CREEK	2	2.5	7550.6
123593544776601	LUCKIAMUTE RIVER TRIBUTARY 1	1	20.7	11724.2
123593544776602	LUCKIAMUTE RIVER TRIBUTARY 1	2	0.9	7526.7
123596744788901	BEAVER CREEK	1	7.2	5398.6
123596744788902	BEAVER CREEK	2	0.8	2180.8
123600444776901	MILLER CREEK	1	15.6	2859.3
123600444776902	MILLER CREEK	2	2.2	7338.7
123608244774201	MILLER CREEK TRIBUTARY 1	1	18.0	2440.3
123608244774202	MILLER CREEK TRIBUTARY 1	2	9.8	824.1
123610444765001	MILLER CREEK TRIBUTARY 2	1	16.3	1643.4

Table 35. Stream reaches with actively eroding banks as identified by AHI crews.

Stream ID	Stream	Reach Number	Percent Bank Erosion	Length (ft)
123624444790701	LUCKIAMUTE RIVER TRIBUTARY 2	1	6.7	520.9
123624444790702	LUCKIAMUTE RIVER TRIBUTARY 2	2	37.3	3494.1

Map 9. Digital elevation model (DEM) derived slopes for the Luckiamute/ Ash Creek study area. Shown are slopes (%) for 0-5%, 6-10%, 11-15%, 16-20% and 21-63% slope classes. Also shown are major roads and major streams. Source 10m DEM.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Slope (percent)

Map 9

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Corvallis, Oregon 97333
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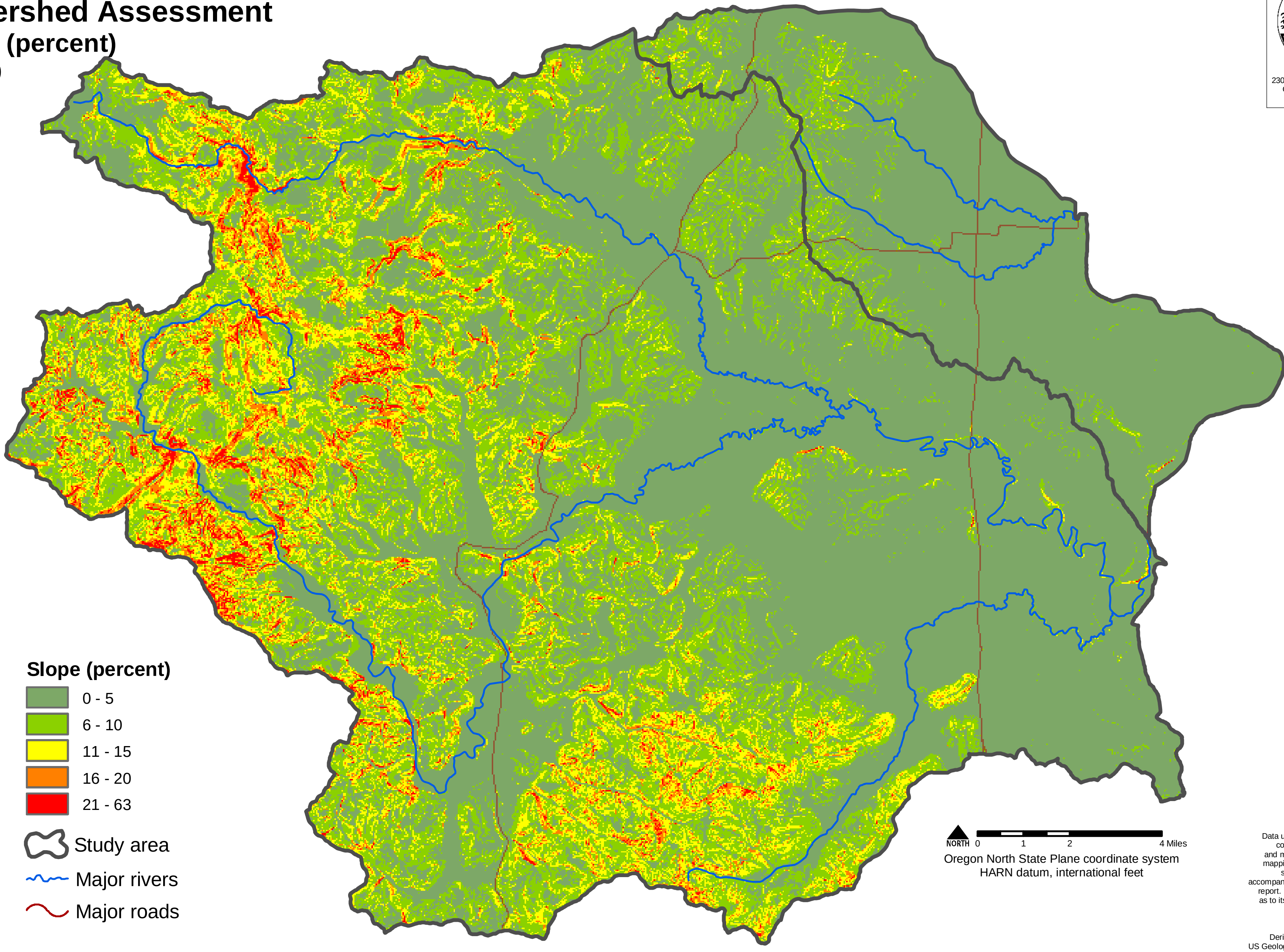

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Slope Data Source:
Derived in ESRI ArcGIS 8.3 from US Geological Survey Digital Elevation Model (DEM) data, 1:24,000 scale.
(http://data.geocomm.com/)

Map 10. ODF Debris Flow Hazard Risk. Shown are areas of High and Moderate risk. Also shown are major roads and major streams. Source: ODF, 1999.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Debris Flow Hazard

Map 10

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Corvallis, Oregon 97333
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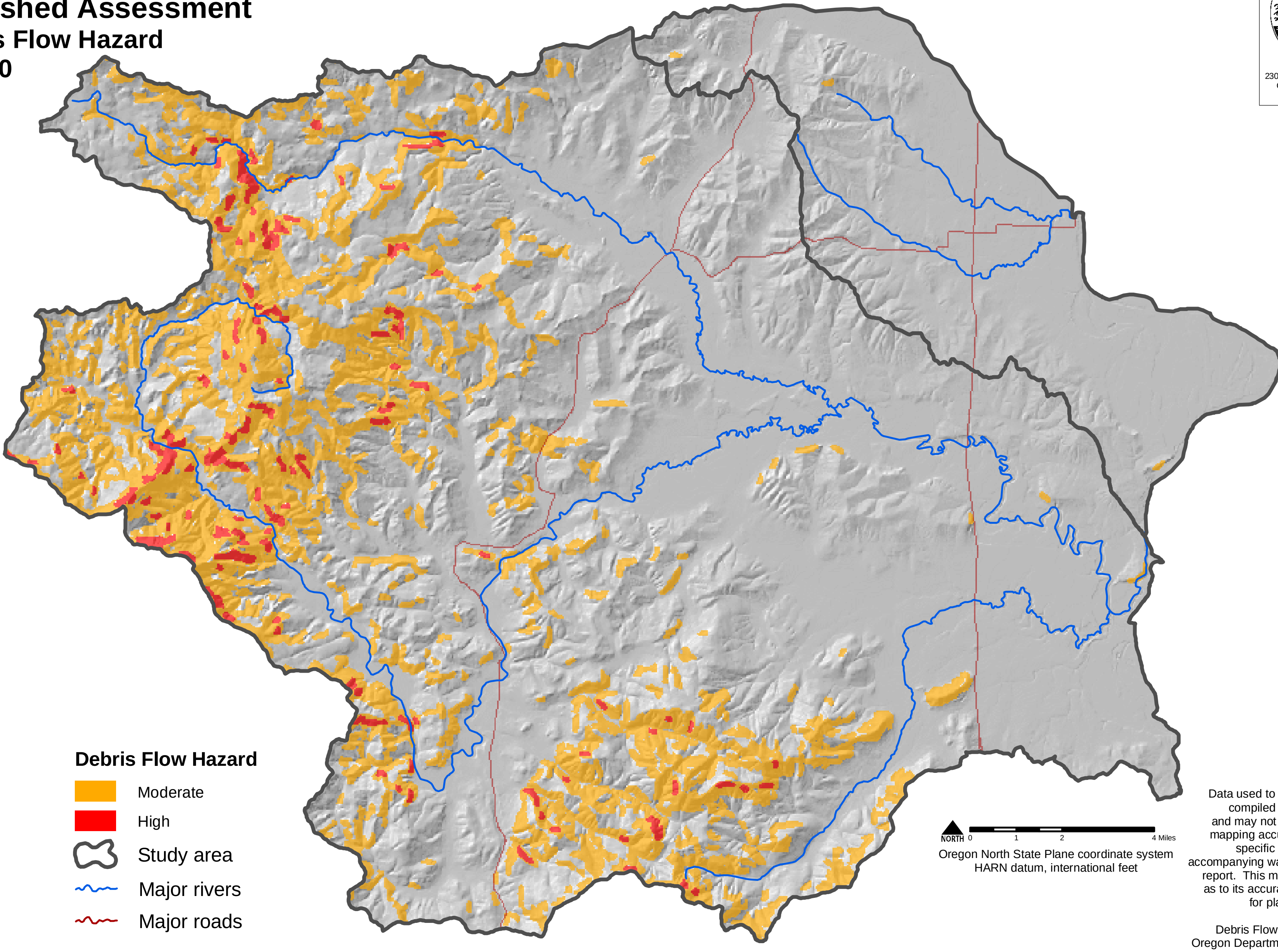


Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Debris Flow Hazard Data Source:
Oregon Department of Forestry. 1999.
contact: R. Smith.
(http://www.odf.state.or.us/gis/debris.html)

Table 36. List of ranked 7th field watersheds according to debris flow hazard. Shown are the watershed ID, name, the number of acres in the high and moderate risk categories (defined by ODF) and the total acres.				
Name	**HUC**	**High**	**Moderate**	**Grand Total**
Cougar Creek	3060202	719.3	3,368.6	4,087.9
Upper Luckiamute	3060101	244.7	3,258.6	3,503.3
Miller Creek	3060102	156.0	3,056.8	3,212.8
Upper Little Luckiamute	3060601	228.2	2,444.7	2,672.8
Maxfield Creek	3060304	81.9	2,435.8	2,517.7
Hoskins	3060203	268.0	2,231.0	2,499.0
Upper Soap Creek	3061101	115.2	2,321.2	2,436.3
Ritner Creek	3060404	109.2	2,325.3	2,434.5
Upper Pedee Creek	3060402	169.2	2,165.4	2,334.6
Wolf Creek	3060201	513.7	1,763.0	2,276.7
Price Creek	3060303	110.8	1,532.1	1,642.9
Socialist Valley	3060701	106.9	1,494.0	1,601.0
Cold Springs	3060602	287.9	1,268.8	1,556.7
Woods Creek	3060302	108.9	1,381.1	1,490.0
Lower Pedee Creek	3060401	52.5	1,293.4	1,345.8
Black Rock Creek	3060603	96.9	994.2	1,091.1
Vincent Creek	3060204	2.4	1,052.3	1,054.7
Lower Teal Creek	3060802	53.0	959.4	1,012.3
Middle Soap Creek	3061102		882.0	882.0
Upper Teal Creek	3060801	39.8	834.5	874.3
Plunkett Creek	3060301	39.5	805.8	845.3
McTimmonds	3060502		711.3	711.3
Clayton Creek	3060403	37.9	547.8	585.7
Falls City	3060702	0.2	564.5	564.7
Upper Berry Creek	3061201		553.6	553.6
Ira Hooker	3060501		454.8	454.8
Rifle Range	3061103		324.9	324.9
Bump Creek	3060305		322.4	322.4
Jont Creek	3060504		318.9	318.9
Middle Luckiamute	3060503		288.1	288.1
Grant Creek	3060803		262.8	262.8
Waymire Creek	3060703	0.4	165.0	165.4
E.E. Wilson	3061301		129.5	129.5
Palestine	3061302		90.2	90.2
Luckiamute Landing	3061005		50.0	50.0

Table 36. List of ranked 7th field watersheds according to debris flow hazard. Shown are the watershed ID, name, the number of acres in the high and moderate risk categories (defined by ODF) and the total acres.

Name	HUC	High	Moderate	Grand Total
Bridgeport	3060704		28.7	28.7
Simpson	3061001		24.5	24.5
Upper North Fork Ash Creek	7020601		21.4	21.4
Middle Fork Ash Creek	7020604		21.2	21.2
Buena Vista	7020404		20.7	20.7
Parker	3061004		20.6	20.6
Helmick	3061003		17.1	17.1
Lower Berry Creek	3061204		15.9	15.9
Middle North Fork Ash Creek	7020602		0.4	0.4
Fern Creek	3060901		0.2	0.2

6.3 Wildfire

Historic Wildfire Conditions

Wildfires are part of the natural disturbance regime of the region (see Appendix B). When considering the impact of fire on an ecosystem, it is important to consider the extent, frequency, timing, and intensity of the burn in relation to the natural range of variability. Fires create gaps important to wildlife and ecosystem processes in the forest canopy. Fires also impact watershed hydrology by altering watershed water storage capacity, erosion rates, nutrient and carbon mobilization, and soil permeability. Fire can also have an indirect impact on watersheds. For example, salvage operations that occurred in the Tillamook basin following the Tillamook Burn had a huge impact on stream network channel morphology because fallen trees were dragged out of the watershed using the streambeds [Note: current forest practices prohibit this activity]. Much of what we know about wildfires comes from soil profiles (pollen & charcoal) and from the accounts of witnesses.

Climate, vegetation, and fire regimes were closely interlinked in prehistoric times, as they are today. Changes in climate affected which types of vegetation dominated the landscape, and how frequently fires burned through the area. When the climate was historically warmer and drier, fires appear to have been more frequent and drought and disturbance-adapted species more widespread (Whitlock and Knox., 2002).

Historically, fires in upland forests were likely governed solely by weather patterns and natural ignition. High intensity, stand-replacement fires occurred in the Coast Range at irregular intervals of 150-400 years. This is based on an analysis of vegetation in the area which showed that late-seral and old growth forests historically occupied 60 to 80% of the Coast Range landscape (Licata *et al.*, 1998). Very little is known about the frequency and extent of lower intensity fires (referred to as "under- burns") in the northern Coast Range [(Walstad, 1990b)cited in (Licata *et al.*, 1998)]. There are few detailed historic accounts of low-intensity fires and generally there is little physical evidence that can be used to determine the frequency and intensity that persists more than a few years following an under-burn. Licata *et al*. (1998) write,

"*The influence of on-shore flow of marine air masses creates a predominantly cool and moist climate in the Coast Range, making the incidence of lightning strikes in this region one of the lowest in North America. This prevailing climatic condition is the primary reason for the infrequent nature of both major fires and underburns. It is hypothesized that human-caused ignitions played a more significant role in fire occurrence in the Coast Range compared with other areas of the state* (Teensma *et al.*, 1991)."

Humans have been part of the Pacific Northwest landscape for at least 8,000 years and probably closer to 11,000 years (Aikens, 1993; Licata *et al.*, 1998; Whitlock and Knox., in press). Historical accounts and archeological records indicate that the Kalpuyan peoples periodically burned the meadows of the valley floor to facilitate hunting large game, clearing meadows for the harvest of camas, a major staple to their diet, and promoting growth of seed-producing grasses (Aikens, 1993; Williams, 2002). These burnings may have occurred as frequently as several times a year or in intervals of every 5-years (Licata *et al.*, 1998; Williams, 2002).

In the spring there probably was no burning when Native Americans were concentrated on flood plain sites in the Willamette Valley wet prairies. During mid-summer (July and August), encampments probably shifted to drier prairie sites. Burning was sporadically initiated during July and August following the harvest of grass seeds, sunflower seeds, hazelnuts and blackberries (used as food) in limited areas. These burns would promote the re-growth of vegetation. Fire was used differently during the late summer. Burning facilitated the collection of tarweed and insects on the high prairies. In the fall, oak openings were burned following the harvest of acorns. The Kalapuya initiated large-scale communal drives for deer, which provided a winter's supply of venison by burning areas along the valley edge. If late summer and fall fires were ignited prior to the onset of strong east winds, it seems likely that fires would have burned up into the higher elevations of the Coast Range (Teensma *et al.*, 1991). Pushed by a strong east wind following a very dry summer, it is not difficult to envision a late summer fire, started at a valley margin site, burning well into the interior of the Coast Range before weather conditions changed and halted its advance.

Historic Fire Patterns

Historic fire patterns, and their effects on the landscape pattern of the Coast Range, have become an item of considerable interest to many authors (Walstad, 1990a; Teensma *et al.*, 1991; Agee, 1993). However, there is still debate over how wide-spread these controlled fires were and how much of an impact they actually had on vegetation composition in the valley (Aikens, 1993; Williams, 2002; Whitlock and Knox., in press).

Logging practices during the past 150 years have shifted the vegetation towards younger seral stages (< 80 years-old). Direct changes to the vegetation through logging may have altered fire regimes. Early European-American settlers' activities may have also altered fire regimes through direct ignition. The settlers introduced new fire-ignition sources to the landscape including logging, mining, and road-building activities, as well as burning on a large scale to remove trees and to prepare agricultural lands (Licata *et al.*, 1998; Whitlock and Knox., 2002). Licata *et al.* (1998) reported that, "Rapid response to extinguish all fires and discontinuous arrangement of fuels, due to clear cutting, slash burning and road construction, has kept most fires small."

A very large wildfire, or series of fires, burned approximately 480,000 acres of the Central Coast range in the period between 1853 to 1868 (Licata *et al.*, 1998). According to a BLM spatial data set describing the fire history of the northwestern Oregon forests at 30-40 year intervals from 1850 to 1940 (U.S. Bureau of Land Management, 1996), an area 20,200 acres in size in the Luckiamute watershed study area had been burned prior to 1850 and had not been reforested as of 1850. Between 1850 and 1890, three areas sized 290, 600, and 1,120 acres in the Luckiamute watershed study area were burned and had not been reforested as of 1890. Between 1890 and 1920 there were two areas that had not recovered from a fire. Because these two areas are the 290 and 1,120 acre areas that were burned prior to 1890, it is possible that either they were the same areas burned prior to 1890 and had not yet been reforested, or they were both burned twice. The last data set describing fire history in 1940 showed no burned areas. These data sets did not extend into the Ash Creek study area.

Current Wildfire Conditions

Today, the effects of logging on fuel structure and fire ignition continue to impact fire regimes in upland coniferous forests. Another factor influencing both fuels and ignition, both of which influence wildfire behavior, is fire suppression. Fires in the coastal forests of Oregon are rare today because the months of dry fuels and ignition are not coincident (Long and Whitlock, 2002).

According to a BLM dataset marking the initiation points of fires from 1980 to 1989, there have been 65 fires in the Luckiamute watershed and six fires in the Ash Creek watershed (Bureau of Land Management, 1991). During this time, the number of fires has varied from 3 to 14 per year (Fig. 4). In 1987, the Luckiamute watershed had the greatest number of fires and at the same time 5,000 acres burned in the Rockhouse Creek fire, located in the adjacent Rickreall watershed (Mattson and Gallagher, 2001). The next year, 318 acres were burned in wildfires, a number far exceeding the total number of acres burned for the other years in this timeframe (Table 37).

From 1980 to 1989, the majority of the fires reported were assumed to have been caused by lightning (41 fires); with the next most likely cause being fire control activities, *i.e.*, backfires (9); other causes included incendiary (4), campfire (2), smoking (2), railroads (1), and miscellaneous (6). The ODF Dallas Forester, Jerry Piering (ODF, personal communication), believed that the total of 41 fires reportedly caused by lightening was too high of an estimate. He examined the ODF Dallas Unit fire reports for all lands under their protection from 1982 through 1988. The Dallas office only had 2 lightning fires reported: one in 1984 and one in 1985. Jerry Piering (personal communication) reported that the majority of the Dallas Unit fires were caused by "ruralists/ homeowners" and most were related to debris burning. He also questioned the 9 fires attributed to backfires. One possible explanation for these different observations are the different areas (BLM *vs*. ODF) that were evaluated and the different time periods (1980-89 *vs.* 1982-1988).

Approximately the same number of fires had a flame length of 0-2 feet with a burning index of 1-20 (32 fires) and a flame length of 2-4 feet with a burning index of 21-40. Only three fires had a flame length from 4-6 feet and a burning index of 41-60. A burning index refers to the burning conditions (*e.g.*, fuel, moisture, weather) and is a number that represents the amount of effort necessary to contain a fire. It is an index value calculated using terms for flame length, amount of spread, energy release content and other factors. Generally, low index scores are calculated for fires that are easily controlled. For example, prescribed burns have burning index values between 0-30 and fires with poor prospects for control have burning index values between 60-80 and higher. For more information see *http://www.seawfo.noaa.gov/fire /olm/nfdr_ind.htm.*

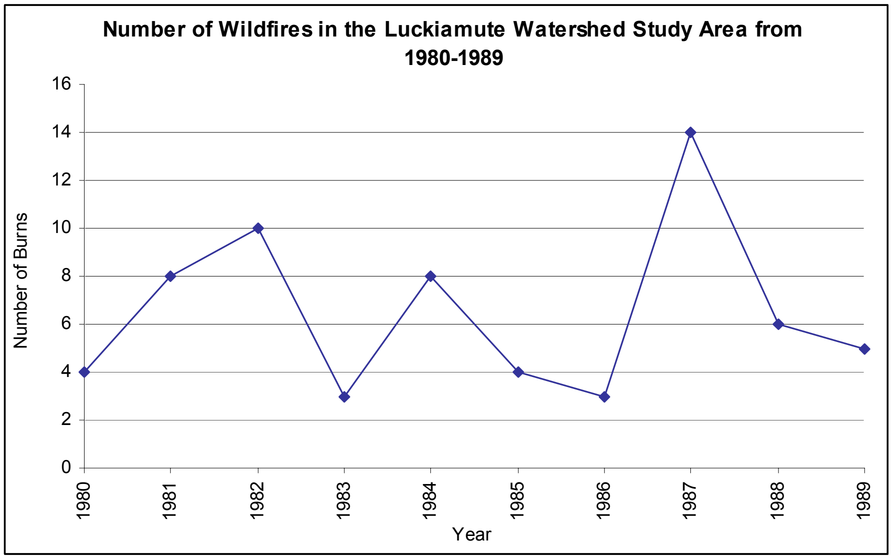


Figure 4. Number of wildfires in the Luckiamute watershed study area from 1980-1991 (U.S. Bureau of Land Management, 1991a)

Table 37. Number of acres burned from 1980 to 1989 in the Luckiamute watershed (U.S. Bureau of Land Management, 1991b).

Year	Area Burned (acres)
1980	2
1981	1
1982	1
1983	<1
1984	12
1985	4
1986	<1
1987	2
1988	318
1989	1

In the Ash Creek watershed, there was one fire reported in 1986, two in 1987, and three in 1989. The largest fire, burning 13 acres, was reported in 1987. For both 1986 and 1989 the total area burned was less than one acre. All of the fires reported during this time period were assumed to have been caused by lightning. One of the fires had a flame length of 0-2 feet with a burning index of

1-20 (32 fires), with the remainder of the fires having a flame length of 2-4 feet with a burning index of 21-40 (Bureau of Land Management, 1991).

6.4 Recommendations

Water Quality/ Use

<u>We recommend the following actions:</u>

- Educate yourself and new residents.
- Become familiar with water used planning in your community.
- Know where your water comes from.
- Protect sensitive aquifers and recharge areas.
- Establish stream gauging stations, weather stations and rainfall gages to improve knowledge of water availability.
- Verify mapped points of water diversion.
- Map (or verify) spring and well locations.
- Document areas of ground water shortages and water quality problems from well logs.
- Begin to gather information on the location of the water table. Subsurface water flow entering streams may help to maintain cool water temperatures necessary for good salmonid habitat.
- Conserve water.
- Indoors, use low-flow showers and toilets.
- Outdoors, limit the size of irrigated landscaping; require timed sprinklers.
- Consider rainwater collection and storage systems.
- Map roads that may confine streams.
- Fence areas where livestock can enter streams.

We recommend that first order streams be evaluated for shade and for the potential to deliver large wood to the stream networks. Areas that may be important to stream recruitment of wood should be identified.

We recommend that LWC inventory streams to map areas where channels have been modified. Modified stream channels can be photographed and the location measured on a USGS topographic map or using a GPS.

We recommend that the digital orthoquads be reviewed and that log jams be located and mapped. In addition, land owners can be contacted and stream walked to record log jams and other stream channel elements (*i.e.*, riprap, boat launches, bridge supports, *etc.*). Finally, comment fields from Aquatic Habitat Inventory data can be queried for observations of field crews.

We recommend that reservoirs be inventoried for size, potential water quality problems, and the type and location of dams. May larger reservoirs can be sources of water of poor quality (*i.e.*, low oxygen concentration, nutrient enriched, and sites of harmful algae).

We recommend that spring sites be verified and that the condition of the springs be recorded, if possible. Ownership of springs should also be recorded.

Should the LWC action planning involve the long-term protection of water rights, we recommend that they contact the Oregon Water Trust (*www. owt.org*) for more information on their programs.

We recommend that the Watermaster be contacted before POD data are used for detailed planning purposes. The Watermaster should also be contacted before the well withdrawal data are used for planning purposes: the data need to be carefully reviewed.

We recommend that the EPA web site be checked again in the future and discharge permits be carefully monitored. In addition, the location of discharge pipes into receiving waterways should be verified and photographed. Consider situation water quality monitoring stations upstream and downstream of selected discharge points.

We recommend that local watershed groups work towards increasing awareness of nonpoint pollution sources, and take action to reduce these pollution sources. Examples of actions that can reduce pollutants entering streams from surface water runoff include riparian fencing, riparian plantings, grazing management and pasture rotation, and education for responsible pesticide use.

We recommend that LWC use the available water temperature data at the stream reach and basin planning scale to prioritize project sites. Consider developing a water temperature model.

We recommend that water quality locations be established on 303(d) stream reaches. Set up water quality monitoring stations to answer specific questions. For example, pair monitoring locations can be established upstream and downstream of suspected problem areas (*e.g.*, land use, discharge pipes).

We recommend that LWC keep abreast of and participate in the TMDL process. Information collected in the Luckiamute watershed is already being used in TMDL development.

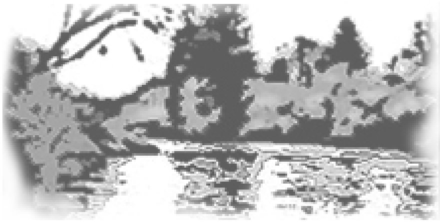
We recommend the development of a GIS-based hydrologic model. A tool can be developed, which builds on information already collected, that will link land use and water quality.

Erosion

- Acquire or develop a complete roads layer at a consistent spatial scale of 1:24,000 or better. Differentiate between paved and non-paved roads.
- Recommend using the Riparian layer to locate specific places (buildings) and bare areas where erosion may be a problem.
- Evaluate roads located in high sediment risk watersheds for sediment control, if necessary.
- Map road failures and the condition of roads that pass through riparian areas.
- Map culvert locations and collect information on culvert features, including degree of blockage and if culverts are fish barriers. Use a standardized data sheet to collect this information, similar to the one prepared by ODFW.
- During or after heavy rainfall events, record locations where surface flow runs directly along roadways and into streams. These roads can be major sediment sources of streams.

We recommend that watersheds identified in Tables 32 and 32 be evaluated for mechanisms to keep water from entering the stream networks from roads.

We recommend that floodplain areas be evaluated for wetland restoration and riparian planting areas. In addition, areas could be evaluated for hydrologic between floodplains and rivers.



We recommend evaluating sediment delivery to streams in 7th field watersheds shown in Table 34. If sediment delivery to streams is found to be a problem, remediation action can be taken.

We recommend that the LWC map areas where stream banks are eroding as part of its future monitoring program. Photographs should be taken and locations recorded using a USGS topographic map or a GPS.

We recommend that 7th Field HUC be evaluated for debris flow hazard risk when planning for large wood source areas and in-stream restoration projects. Land cover can also be evaluated on those areas prone to flow to evaluate potential for large wood recruitment to the stream network.

7 PLANT COMMUNITIES AND WILDLIFE

7.1 Land Cover, Vegetation and Land Use

Land cover, vegetation, and land use are related to and affect the placement and condition of one another (Fig 5). Land cover is the type of vegetation, plant communities, and land features present on the landscape. Vegetation communities are the groupings of specific plants, which commonly occur together, into functional units, such as wetlands and riparian areas.

Land Use

Land use, or the way the landscape is used by humans, affects land cover because, through specific uses of the land, the vegetation and plant communities are changed, as well as the land features present on the landscape. Land use can be affected by land cover if the land features are too extreme to be manipulated. For example, one would most likely leave exposed bedrock in place rather than attempt to move it to farm in that area.

An understanding of land use is vital to understanding the function and character of a watershed because land use is linked to many of the enhancements and degradations of a watershed. One land use type, for example agriculture, can produce both watershed enhancement -- by supporting the economy of the area, producing food, and creating jobs; and produce degradation --through means such as non-point source pollution from fertilizer and pesticides. Although no single land use produces only enhancements or only degradations, it is necessary to thoroughly investigate the land uses within the study area to document what the enhancements and degradations are. Land ownership is also important as it determines some of the land uses in the watershed and influences where monitoring and restoration can take place.

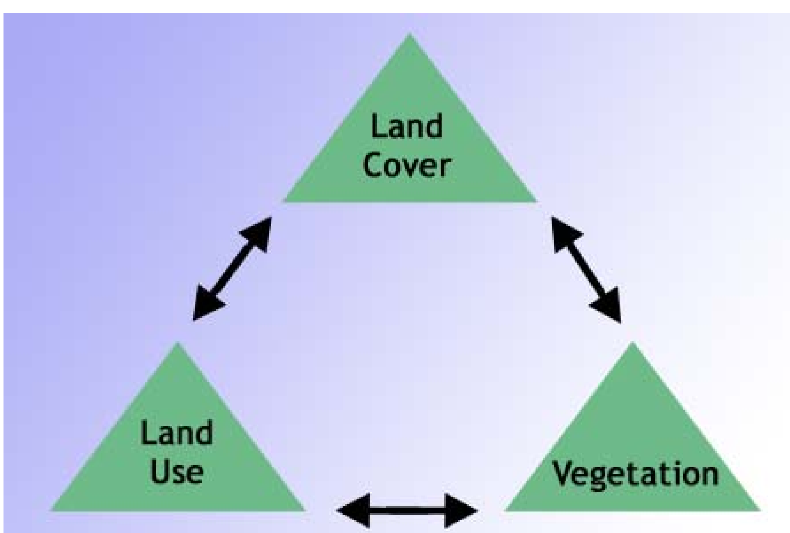


Figure 5 Diagram showing relationship between Land Cover, Land Use and Vegetation.

Historical Land Use

The earliest land uses in this region were the construction of homesteads and the clearing of lands for agricultural and pasture for grazing. The earliest European-American settlers to the valley cleared much of the land for planting and grazing. Pete Frantz, a Luckiamute Valley resident whose grandparents arrived in the Luckiamute Valley in 1866 gives the following account:

"At that time people thought that there would always be timber so they just ignored it or tried to get rid of it. In fact, on our land there were two places where the folks just burnt down the second growth timber…they had to have room to grow grain to feed their stock. There wasn't a demand for second growth timber anyway (Frantz and Brandon, 1976). "

In the early 1900s, timber became a profitable commodity, and logging began to increase in importance in the Luckiamute Valley. Logging was accomplished with horses and steam-powered donkey engines. Small mills were constructed throughout the valley, but most of the logs were sent to Salem for milling. Grains were also historically a major agricultural commodity, and Italian prunes and hops were introduced in 1890. These specialty crops became so valuable that at one point, there were over 4,600 acres of hops planted near Independence (Newton, 1971), however crops of both Italian prunes and hops declined by World War II (Mattson and Gallagher, 2001). More information on land use is detailed in Section 5.

Current Land Use

Today, agricultural use within the study area includes production of grass seed, wheat, hay and oats; orchards and vineyards; forest products; and the raising of both cattle and sheep, with the major commodities being grass seed, wheat, hay, and oats and minor commodities including clover, sweet corn, mint, alfalfa, and filberts (Taylor *et al.*, 2003). Other commodities grown in the area include nursery products and Christmas trees (Mattson and Gallagher, 2001). Many orchards exist in the northeastern portion of the watershed just west and north of the city of Monmouth, in the hills above Falls City, and north of the confluence of the Luckiamute and Little Luckiamute Rivers along Elkins Road. There are several vineyards in and around the study area including: Airlie Winery, Chateau Bianca, Eola Hills Wine Cellars, Flynn Vineyards, Schwarzenberg Vineyards, Oak Grove Orchards Winery, Serendipity Cellars, and Van Duzer Vineyards.

Photo 11: Christmas tree farm

Private timber companies own a substantial amount of land in the watershed (about 26%). The major timber companies include Boise and Weyerhaueser. Other timber companies include Starker Forests, Inc., Stimson Lumber Co. and B & D Timber Inc.

Cattle have always been an important part of valley life. Early settlers cleared land so that their livestock could graze. Today, cattle and sheep graze many areas in the Luckiamute Watershed. There are approximately 16,000 head of cattle in Polk Co. and 8,000 in Benton Co. Most of the cattle raised in Polk Co. are milk cows while most are beef cattle in Benton Co. In the study area, the Soap Creek and Berry Creek Ranches are primary cattle producers.

Land Cover

Land cover is also an important ecological characteristic to consider in a watershed assessment because land cover affects watershed characteristics such as potential for large wood delivery to a stream network, erosion or landslide potential, wildlife habitat potential, susceptibility to rain-on-snow events, riparian shade, amount of urbanization within the study area, and the location and amount of water present. Vegetation and vegetation communities are a component of land cover, and are also affected by it. For example, a type of land cover could be an exposed rock outcrop that vegetation could not grow on. Aquatic, riparian, wetland, and upland land cover classes are four major groupings that have a strong affect on the ecological processes and quality of the watershed.

For this watershed analysis, we relied on two existing data sets which describe past and present land cover/ land use for the Luckiamute and Ash Creek study area. The sections below detail land cover, vegetation and vegetation communities, and land use in the study area.

Native Vegetation and Invasive Plant Species

Plant Communities

Plant communities are defined as a group of interacting plant species that commonly occur together within a bounded area. Plant communities are often closely associated with environmental gradients such as elevation or moisture. It is the ecological requirements of each species within the community that are responsible for this change. For example, in the Pacific Northwest plant communities are often arranged along elevational gradients. Community composition differs from one elevation to the next as some plant species become more common, due to favorable conditions, while others become less common. This change continues until one community eventually replaces another. Plant communities replace one another along elevation gradients as each species responds to changing conditions, *e.g.*, temperature, precipitation, light, and soils.

Community ecology is the scientific discipline responsible for classifying communities and finding the ecological factors that structure communities. There are entire textbooks written on the statistical techniques and models used to describe communities and underlying environmental patterns. There are many ways to identify and organize plant communities.

A community approach is useful because many animals, which depend on particular plants for food and shelter, are often associated with specific plant communities. At the request of the LWC, we have listed some of the sensitive animal species for some of the community types described below. Often, conservation and management strategies are geared at maintaining a particular community with the assumption that if the plant community is intact, the associated animals will be conserved, as well. In some cases, a community approach is not useful. For example, many species use more than a single type of community or the edge areas between adjacent communities. The scientific discipline of Landscape Ecology is used to describe and understand how multiple communities interact upon the landscape.

Historically, plant communities in the study area mirrored those in the Willamette Valley. Four major vegetation types have been described: prairie, riparian forest, upland forest, and open woodland (Ferguson and Miller, 2002). Franklin and Dyrness (1988) describe five community types common to the Willamette Valley. These communities are conifer forests, *Quercus* woodlands, grasslands, sclerophyllous shrub communities, and riparian communities. Sclerophyllous shrubs are those with hardened or thickened leaves.

Depending on site conditions and disturbance patterns one community may replace another over time. This is known as the process of succession. For example, some conifer seedlings may become established under older oaks in relatively open settings. If nothing is done to control the growing seedlings, a conifer forest will replace the oak forest. Figure 6 shows the successional patterns of the major plant communities in the Willamette Valley. Many things can affect successional pathways and Figure 6 should be viewed as a general scheme.

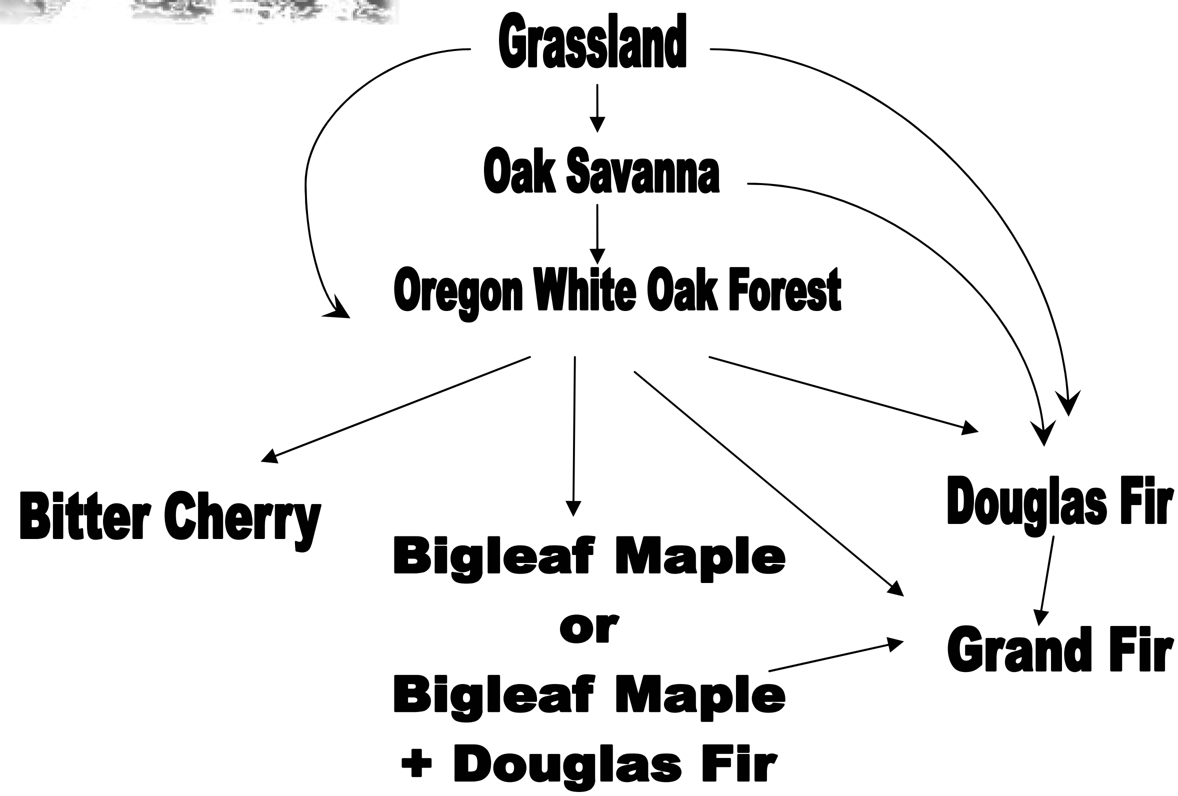


Figure 6. Conceptual model of successional patterns for forests in the Willamette Valley [from (Franklin and Dyrness, 1988)].

Photo 12:Clear cut

Coniferous Forests

In Oregon, the forests that dominate the landscape are, with rare exception, conifer forests (Franklin and Dyrness, 1988). "The forests of western Washington and northwestern Oregon are the archetype of mesic temperate coniferous forests in the world" (Franklin and Dyrness, 1988). Douglas-fir, western hemlock, and western red cedar are endemic to this area (Franklin and Dyrness, 1988). In the study area, forests at higher elevations in the more mountainous areas were "extensive, dense and contained large trees. Forests nearer to the valley were more open and diverse, influenced by frequent fire" (Ferguson and Miller, 2002). Transition forests (often called "open woodland") of white oak or Douglas-fir with either a grass or shrub understory were recorded by early land surveyors in areas between prairies and upland forests (Ferguson and Miller, 2002).

In the Willamette Valley two types of coniferous forest communities are described in Franklin and Dyrness (1988). Each community can be subdivided into tree, shrub and herb layers. The first community is called the "*Corylus cornuta californica/ Bromus vulgaris*" community and the second is called the "*Acer circinatum/ Gaultheria shallon (Corylus cornuta californica-Holodiscus* subtype) community. The first community is named after the dominant plants western hazel and Columbia brome and the second community after vine maple and salal. The tree layers of both community types are dominated by Douglas-fir (*Psuedotsuga menziesii*). The two communities differ in the abundance of grand fir (*Abies grandis*), bigleaf maple (*Acer macrophyllum*), Oregon white oak (*Quercus garryana*), and Pacific dogwood (*Cornus nuttallii*) in the tree layer. The species composition of the shrub and herbaceous layers of these communities are quite distinct. The *Corylus cornuta californica/ Bromus vulgaris* community has a shrub layer composed of *Corylus cornuta* var. *californica*, Creambush Oceanspray (*Holodiscus discolor*), balhip rose (*Rosa gymnocarpa)*, common snowberry (*Symphoricarpos albus)*, and Pacific poison oak (*Rhus diversiloba*) while the shrub layer of the *Acer circinatum/ Gaultheria shallon (Corylus cornuta californica-Holodiscus* subtype) community contains *Acer circinatum* in addition to the shrub species listed above and does not contain *Rhus diversiloba* and *Symphoricarpos albus*. The herb layers of both communities have only one species in common, Oregongrape (*Berberis nervosa*). The *Corylus cornuta californica/ Bromus vulgaris* community contains *Bromus vulgaris*, rough-leaf aster (*Aster radulinus)*, western wood strawberry (*Fragaria vesca* var. *bracteata*), yerba buena (*Satureja douglasii*), American vetch (*Vicia americana* var.*truncata*), snowqueen (*Synthyris reniformis*), woodland tarweed (*Madia madioides*), and mountain sweetroot (*Osmorhiza chilensis*). The *Acer circinatum/ Gaultheria shallon (Corylus cornuta californica-Holodiscus* subtype) community contains *Gaultheria shallon*, trail plant (*Adenocaulon bicolor*), swordfern (*Polystichum munitum*), threeleaf anemone (*Anemone deltoidea*), sweetscented bedstraw (*Galium triflorum*), and western fescue (*Festuca occidentalis*).

The composition of the forests varies. Orientation and position of the plant community on the hill slope may account for many of the compositional differences. Disturbance regimes also account for many differences in forest plant community composition. Today's forests exist as a patchwork on the landscape. Different types of land uses have altered the processes that create and maintain mature forest ecosystems. However, even before this area was settled, forests did not exist in even-aged stands of mature trees. Natural wildfires were the predominate disturbance in Pacific Northwest forests; however, other disturbances such as wind, disease and mass wasting events were also important to a lesser extent (Wimberly *et al.*, 2000). Thus, the forested ecosystems in the Luckiamute Watershed today are shaped by both natural and anthropogenic forces.

Sensitive Animal Species

The following species are associated with old-growth Conifer Forests.

Spotted Owl (*Strix occidentalis caurina)*. This legendary raptor occurs rarely within the watershed. Data on population size and productivity are unavailable. The species typically nests in old growth forests with a multi-layered canopy dominated by huge conifers.

Marbled Murrelet (*Brachyramphus marmoratus)*. During the nesting season, this robin-sized seabird travels many miles inland to nest in old-growth conifer forest. Its occurrence in the Luckiamute watershed apparently has been documented from only one location.

Purple Martin (*Progne subis).* This insectivorous, cavity-nesting bird historically nested in colonies situated in large snags created by fire or along the edge of open areas. Elsewhere in Oregon it currently nests mainly in artificial structures near water. Populations apparently have declined drastically over the past century with loss of suitable habitat. Its current breeding in the watershed is uncertain. It winters in the Neotropics.

Olive-sided Flycatcher *(Contopus cooperi)*. Among the Willamette Valley's songbirds, this species has suffered some of the severest recent declines. It nests along edges of stands containing tall coniferous trees, especially where snags are abundant. It winters in the Neotropics.

Oak-Dominated Deciduous Forests

Historically, oak-dominated forests were situated in the transition zones between the higher elevation coniferous forests and the floodplain and wetland communities (Ferguson and Miller, 2002). Oregon white oak (*Quercus garryana*) and California black oak (*Q. kelloggii*) are the two dominant oak species. *Q. garryana* is more common in the Willamette Valley and Q. kelloggii is more common from the southern Willamette Valley to the southern part of the state (Franklin and Dyrness, 1988). Most of the oak forests are privately owned. Gumtow-Farrior and Gumtow-Farrior (1993) report, "Farmers and other private entities own nearly 90% of the Willamette Valley's Oregon white oak and private forest industry holds title to approximately 8%."

Four oak community types are discussed in Franklin and Dyrness (1988). Like the case with the coniferous forest communities, each of the oak communities differs in the species that appear in each of the three layers (*i.e.*, tree, shrub and herbaceous). Of the four communities, the *Q. garryana*/ *Rhus diversiloba* community is the most common and occurs on heavily grazed sites (Franklin and Dyrness, 1988).

Of the oak communities, two forms are frequently discussed, oak forests (sometimes called woodlands) and oak savannas. The two forms of oak communities grade into one another and are related by a successional progression (Fig. 6). In general, oak forests have well developed understories and may have oak seedlings or saplings, or even conifers in the shrub layer. Oak savannas are dominated by large, often open-grown, oaks that have open understories. Oak savannas are thought to be maintained by fire (Franklin and Dyrness, 1988; Gumtow-Farrior and Gumtow-Farrior, 1993). When fires are prevented, oak savanna may transition into conifer or oak forests (Fig. 6). This suggests that removal of understories either mechanically or with controlled burns may be an effective tool for restoring oak savannas.

Sensitive Animal Species

The following species are associated with oak woodland forests.

Sharptail Snake *(Contia tenuis).* Although not restricted to oak woodland, this snake seems to be found most often in such habitats, especially where oak woodlands are intermixed with grassy ungrazed slopes with boulders, rock outcrops, and abundant logs. It is relatively secretive and resembles a very large earthworm. In the Luckiamute watershed it has been reported from near Amity, Dallas, Kings Valley, Coffin Butte, and McDonald Forest (St. John, 1987).

Acorn Woodpecker (*Melanerpes formicivorus).* This species occurs mostly in open-canopied stands of oak, sometimes intermixed with other deciduous trees. Although not included on the state or federal list of threatened or endangered species, this species is strongly associated with oaks and thus is potentially vulnerable. Application of a species-habitat relationship model to satellite imagery suggests that approximately 15% of the watershed might be at least marginally suitable for this species and less than 1% is of relatively high suitability.

Western Gray Squirrel (*Sciurus griseus*). This is the squirrel encountered most commonly in deciduous and mixed forests of the watershed. Population densities seem strongly linked to local density of oak (*Quercus* spp.), although not necessarily in pure stands. Despite its relative abundance, this species is listed by ODFW as potentially a sensitive species, but with status uncertain. No trends data are available. Its listing is perhaps based partly on an assumption of population vulnerability from decline of oak habitat in the Willamette Valley. Population densities may show considerable annual variation (Verts and Carraway, 1998). The species is legally hunted. Collisions with vehicles are an obvious and frequent cause of death. Application of a species-habitat relationship model to satellite imagery suggests that approximately 75% of the watershed might be at least marginally suitable for this species and possibly 30% is of relatively high suitability.

The following species are associated with oak savanna and upland dry prairies.

Kincaid's lupine (*Lupinus sulphureus* ssp *kincaidii)*. This species occurs in only a few remaining fragments of native upland prairie or meadow, such as occur in limited parts of the McDonald-Dunn State Forest. Scattered oaks and generally heavy soils are often present where it occurs. For more information see: *http://www.epa.gov/ fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm* .

Fender's blue butterfly (*Icaricia icarioides fenderi)*. Worldwide, this butterfly occurs only in the Willamette Valley and is strongly dependent upon Kincaid's lupine (see above). Consequently it shares the same habitat and has suffered the same declines.

Common Nighthawk (*Chordeiles minor)*. An aerial-feeding species, the common nighthawk historically has nested on mostly bare surfaces such as gravel bars, rock ledges, burned fields, sparsely-vegetated savanna, and even rooftops. In the Willamette Valley it currently nests predominantly in clearcuts with unvegetated surfaces, and feeds along nearby riparian areas and meadows. Application of a species-habitat relationship model to satellite imagery suggests that approximately 12% of the watershed might be at least marginally suitable for this species as feeding or nesting habitat, and less than 1% may be of relatively high potential suitability.

Horned Lark (*Eremophila alpestris strigata)*. The "streaked" race of this species is currently a candidate for federal listing, and field studies to determine its true status are underway. It nests mostly in very large fallow or sparsely-vegetated fields. Application of a species-habitat relationship model to satellite imagery suggests that as much as 83% of the watershed might be at least marginally suitable for this species as either feeding or nesting habitat, but less than 1% may be of relatively high potential suitability.

Western Bluebird (*Sialia mexicana)*. This cavity-nesting species was historically one of the most abundant

birds in the region, but its numbers have declined precipitously due largely to habitat loss and competition with European starling (*Sternus vulgaris*). Bluebirds nest in snags mostly along edges of grassy fields, upland prairies, and montane meadows, but also use clearcuts when suitable snags are available. Bluebirds feed mainly on insects during summer and on berries of madrone, mistletoe, and other shrubs during fall and winter. Application of a species-habitat relationship model to satellite imagery suggests that as much as 40% of the watershed might be at least marginally suitable for this species, either as feeding or nesting habitat, but less than 1% may be of relatively high suitability.

Western Meadowlark (*Sturnella neglecta*). Although still abundant in eastern Oregon, numbers of this species have declined sharply in the Willamette Valley with the loss of prairie. It occurs in both wet and dry prairie situations, and occasionally along edges of conifer plantations and in hayfields. It prefers denser grass cover than Horned Lark, especially when scattered shrubs are intermixed with grasses of varied heights, in fields generally larger than about 100 acres (Altman, 2000). Application of a species-habitat relationship model to satellite imagery suggests that as much as 38% of the watershed might be at least marginally suitable for this species, either as feeding or nesting habitat, but less than 1% may be of relatively high suitability.

Yellow-breasted Chat (*Icteria virens).* The Luckiamute watershed provides some of the best habitat in the Willamette Valley for this species, which has generally declined due to habitat loss associated with land development. Densities appear to be particularly high at E.E. Wilson Wildlife Area (B. Altman, personal communication). Chats nest mostly in large, tall, dense patches of thorny shrubs such as Himalayan blackberry, with little or no adjoining tree canopy. Application of a species-habitat relationship model to satellite imagery suggests that as much as 42% of the watershed might be at least marginally suitable for this species, either as feeding or nesting habitat, and about 6% may be of relatively high suitability.

Vesper Sparrow (*Pooecetes gramineus affinis).* Although apparently never abundant in the Willamette Valley, the Oregon race of this species has disappeared from many areas where it formerly nested. It historically bred in upland prairies. It currently nests in foothill areas along edges of conifer plantations, in clearcuts, and in lightly-grazed pastures with scattered shrubs. Application of a species-habitat relationship model to satellite imagery suggests that possibly 21% of the watershed might provide at least marginally suitable habitat for this species, either as feeding or nesting habitat, and less than 1% may be of relatively high suitability.

Photo 13. Agricultural Field.

Grasslands

Native prairies once covered extensive areas in the Willamette Valley prior to settlement. However, more than 99% of the native prairies in the Willamette Valley have been lost since the time of European settlement (City of Eugene, 2002). Franklin and Dyrness (1988) report on previous studies describing several different types of Willamette Valley prairie communities which are separated along a moisture gradient. For example, sweetbriar rose (*Rosa eglanteria)*- dominated prairies occupy higher-drier sites, Kentucky bluegrass – Bentgrass *(Poa pratensis*- *Agrostis* spp.) occurs at intermediate sites, and tufted hairgrass (*Deschampsia caespitosa*) at the low, flat, wet sites. Many other plant species are found in prairie communities in the Willamette Valley including at least 13 rare species (Wilson, 1998; Wilson, 2003).

Wet prairies are characterized by poorly drained soils that are seasonally flooded. During the summer, the soils dry out, and become hard and cracked, but between November and April groundwater levels rise to the soil surface (Finley, 1995.). The result is a unique microtopography of raised "pedestals" above a lower level of soil.

The vegetation of the wet prairie was historically maintained by periodic burnings by the Native Americans to remove woody vegetation and preserve the low stature of the ecosystem (Johanessen *et al.*, 1971; Franklin and Dyrness, 1988; Ferguson and Miller, 2002). The burnings promoted the development of grasses and a variety of native forbs (Wilson, 1998). This practice ended in the 1850's under the influence of European settlers, who converted the prairies to agricultural areas. Consequently, prairies are invaded by trees and shrubs, which crowd out the native plants (Johanessen *et al.*, 1971; Ferguson and Miller, 2002).
Loss of prairies to agriculture continues today. A recent study on wetland change in the Willamette Valley found that the greatest loss of wetlands between 1981 and 1994 was through the conversion to agricultural (Bernert *et al.*, 1999). Loss to agriculture, urbanization, succession and invasive plants has made the Willamette Valley wet prairies one of the most endangered types of ecosystems in the nation (Peters and Noss, 1995).

Prairie ecosystems are poorly understood, and studies of species biology, community composition, and ecosystem dynamics are greatly needed (Wilson, 1998). The West Eugene

Wetland Restoration, a joint project by the City of Eugene, BLM, and The Nature Conservancy, offers an opportunity to learn about native prairie restoration techniques.

Shrub Communities

Shrub communities were very common in the Luckiamute study area prior to settlement (see below). Not much is known about the ecology of shrub communities in the upper Willamette Valley. In the southern part of the state, a shrub chaparral community is the climax community type (Franklin and Dyrness, 1988). Although forested and grassland communities have a shrub component, shrub communities seem to be transitional communities (Fig. 6) in the upper Willamette Valley. The extent of shrub-dominated communities currently covers about 6% of the area. It is clear that this community type has declined.

Riparian Communities

The riparian communities of the Willamette Valley represent another community type of which little is known. These communities are characterized by frequent flooding and may be physically disturbed by high flow events. Species common in riparian communities include: black cottonwood (*Populus trichocarpa*), red alder (*Alnus rubra*), rigid willow (*Salix rigida)*, red willow (*S. lasiandra*), river willow (*S. fluviatilis*), soft-leaved willow (*S. sessilifolia*), and Scouler's willow (*S. scouleriana*), and *Fraxinus latifolia*. *Acer macrophyllum* can be common in some areas (Franklin and Dyrness, 1988).

Riparian zones link terrestrial and aquatic ecosystems. Riparian areas act as sediment filters and areas where organic material and nutrients are transformed before entering the stream; they also provide shade and detritus (dead organic material) directly to the stream ecosystem. Some unconstrained (or floodplain) riparian areas provide important backwater forage areas and refugia from high water flows for juvenile salmonids. Although riparian areas are frequently disturbed naturally, historic and current land use decisions have dramatically altered the magnitude and frequency of this disturbance.

The historic disturbance regime of the Luckiamute/ Ash Creek watersheds has influenced the current condition of riparian areas. On the valley floor stream channel paths constantly changed, side channels were added to and cut off from the river system, mainly in response to high flow events. In the forested upper reaches of the watershed, riparian vegetation composition was most likely influenced by other disturbances in addition to high water flow, *i.e.*, debris flows, wind throws, fire, *etc.*

Information on the presettlement vegetation is limited. Again, disturbance probably played an important role in structuring the composition of the plant communities. Plant communities would have changed in response the type and frequencies of these disturbances. No studies have quantified the relative proportion of hardwoods to conifers along Coast Range streams prior to European settlement. One study of vegetation composition around upland streams concluded that riparian trees

were mostly hardwoods, while another study concluded that there were many patches of old growth conifers around streams (Licata *et al.*, 1998).

Most likely, both types of vegetation, conifers and broad-leaved trees, were present along streams in the study area. An interesting consequence of the shift from conifers to alders comes from a recent study. As previously mentioned, the composition of stream side vegetation is known to affect water quality by filtering sediments and coarse organic material from runoff, and by slowing water infiltration so that important chemical transformations can occur (*e.g.*, denitrification and conversion of phosphorus containing compounds; both nitrogen and phosphorus are important nutrients for aquatic life). A recent study in the Salmon River (OR) watershed has linked land cover, in this case alder forest cover, with in-stream nitrate and dissolved organic N concentrations. The implications of this work indicate that human watershed modifications which increase the proportion of alder in the watershed can directly affect the availability of nitrogen and phosphorus in coastal stream networks (Compton *et al.*, In Press).

In addition to the composition of the riparian plant community, disturbance would most certainly have affected the size of the riparian vegetation. Undoubtedly, riparian areas within the Luckiamute/ Ash Creek study area were a shifting mosaic of different species, ages and sizes of trees. Licata (1998) concluded that there were probably more old trees along the streams historically than there are today, providing more large woody debris to the streams.

Sensitive Animal Species

The following species are associated with riparian native shrub and gallery forests.

Bald Eagle (*Haliaeetus leucocephalus*). Eagles are sighted frequently in the watershed but there has been no confirmation of current nesting. Many eagles visit from other regions, particularly during winter. Preferred habitat is large open-canopy trees along large rivers. This species is currently being considered for delisting as a federally-recognized threatened species.

Peregrine Falcon (*Falco peregrinus anatum*). This raptor often feeds within the watershed but does not nest in the watershed due to lack of suitable habitat, which typically is comprised of large cliffs near water.

Willow Flycatcher (*Empidonax traillii brewsteri).* Once an abundant bird in shrubs along the Willamette and Luckiamute, numbers of this species have declined considerably. A portion of the population uses clearcuts with extensive deciduous shrubs. Application of a species-habitat relationship model to satellite imagery suggests that possibly 16% of the watershed might provide at least marginally suitable habitat for this species, either as feeding or nesting habitat, but less than 1% may be of relatively high suitability.

Tailed frog (*Ascaphus truei).* This amphibian inhabits swiftly-flowing, heavily-shaded streams with abundant logs. Its occurrence in the watershed has been documented at just a single location.

Wetland Communities

Wetlands are not treated as separate communities in Franklin and Dyrness (1988). In this assessment, wet prairie and riparian communities have been described in other sections. There are many ways to describe wetland communities. One of the most commonly used is that developed by Cowardin *et al.* (1979). Cowardin's system describes wetlands on the basis of their water flow, substrate types; vegetation, dominant species, flooding regimes and salinity levels. The Cowardin system is used on the National Wetland Inventory maps.

Wetland types are often referred to as marshes, swamps, swales, sloughs, and wet prairies. No matter what you call them, wetlands are an important feature of the Luckiamute watershed. Potentially, wetlands are both a concern and a public asset. They are potentially a concern for two reasons. First, landowners proposing some types of activities in wetlands must first receive permits from federal and state agencies, and this can cause project delays unless planned for in advance. Wetland "removal' and 'fill' permits are nearly always granted, but landowners routinely are required to "mitigate" the alteration of wetlands by constructing, or preferably restoring, wetlands elsewhere, sometimes at substantial cost. Second, wetlands are a concern because as a resource, the current area of wetlands in the Willamette Valley is but a tiny fraction of what once existed (Table 38 and 39).

Table 38. Estimates of recent and historical wetland area (in acres) by subunit for Luckiamute watershed.

Subbasin Name	7th Field HUC	HUC Area	% of HUC mapped by NWI	Probable wetland area (NWI, early 1980s)	Possible wetland + water area (FSL, early 1990s)	Possible original wetland area (NRCS estimate #1)	Possible original wetland area (NRCS estimate #2)	% of original wetland area remaining
Upper Luckiamute	17090003060101	5922.7	0.0		0.0	408.1	408.1	
Miller Creek	17090003060102	5668.6	0.0		0.0	212.6	864.2	
Wolf Creek	17090003060201	3230.9	0.0		0.0	59.1	91.2	
Cougar Creek	17090003060202	5622.9	0.0		0.7	43.1	43.1	
Hoskins	17090003060203	7207.7	72.4		9.5	524.1	721.3	
Vincent Creek	17090003060204	7211.9	95.4		7.0	95.7	172.3	
Plunkett Creek	17090003060301	3393.3	100.0	0.0	7.4	159.7	731.7	0.0
Woods Creek	17090003060302	2748.3	100.0	3.1	1.3	94.9	343.4	3.0
Price Creek	17090003060303	3358.3	100.0	1.2	1.3	40.9	188.6	3.0
Maxfield Creek	17090003060304	5849.7	100.0	0.6	17.1	266.8	567.2	0.0
Bump Creek	17090003060305	4206.4	100.0	0.0	10.1	85.5	564.1	0.0
Lower Pedee Creek	17090003060401	6044.2	92.8		12.1	288.8	1169.6	
Upper Pedee Creek	17090003060402	4630.5	83.6		0.0	13.0	907.6	
Clayton Creek	17090003060403	2443.2	96.1		0.9	0.7	6.2	
Ritner Creek	17090003060404	6371.2	46.7		3.2	114.0	614.8	
Ira Hooker	17090003060501	2646.6	100.0	0.0	5.4	85.1	487.4	0.0
McTimmonds	17090003060502	5449.4	100.0	0.0	8.2	621.2	1042.1	0.0
Middle Luckiamute	17090003060503	8336.6	100.0	82.2	45.2	1543.6	4829.5	5.0
Jont Creek	17090003060504	5543.6	100.0	77.8	16.5	715.6	1661.5	11.0
Upper Little Luckiamute	17090003060601	6044.5	0.0		0.0	7.0	12.6	
Cold Springs	17090003060602	1880.4	0.0		0.0	0.0	43.4	

Table 38. Estimates of recent and historical wetland area (in acres) by subunit for Luckiamute watershed.

Subbasin Name	7th Field HUC	HUC Area	% of HUC mapped by NWI	Probable wetland area (NWI, early 1980s)	Possible wetland + water area (FSL, early 1990s)	Possible original wetland area (NRCS estimate #1)	Possible original wetland area (NRCS estimate #2)	% of original wetland area remaining
Black Rock Creek	17090003060603	3381.4	0.3		0.0	0.0	1444.8	
Socialist Valley	17090003060701	4969.7	82.7	0.0	0.0	44.7	816.0	
Falls City	17090003060702	3320.3	100.0	0.0	4.7	41.8	1088.1	0.0
Waymire Creek	17090003060703	2447.4	100.0	0.0	3.4	25.6	241.8	0.0
Bridgeport	17090003060704	3548.0	100.0	9.8	19.2	358.5	1432.7	3.0
Upper Teal Creek	17090003060801	2206.8	36.7		0.0	0.0	218.1	
Lower Teal Creek	17090003060802	4930.2	100.0	0.0	10.8	101.9	1403.6	0.0
Grant Creek	17090003060803	2038.5	100.0	0.0	1.1	45.3	248.2	0.0
Fern Creek	17090003060901	5014.4	100.0	51.6	22.1	820.3	1703.6	6.0
Lower Little Luckiamute	17090003060902	6474.7	100.0	134.8	53.1	637.8	3732.2	21.0
Cooper Creek	17090003060903	4906.0	100.0	79.2	32.6	499.5	1754.9	16.0
Simpson	17090003061001	4420.0	100.0	79.1	99.1	875.9	2747.5	9.0
Zumwalt	17090003061002	2395.9	100.0	29.5	6.3	602.5	1643.5	5.0
Helmick	17090003061003	2847.9	100.0	170.2	141.1	1079.3	2381.9	16.0
Parker	17090003061004	3795.8	100.0	148.5	44.3	698.8	2898.1	21.0
Luckiamute Landing	17090003061005	3308.2	100.0	230.1	170.1	1042.7	2758.3	22.0
Upper Soap Creek	17090003061101	5918.2	100.0	24.1	2.5	98.5	98.5	24.0
Middle Soap Creek	17090003061102	4353.4	100.0	163.6	17.1	648.0	954.0	25.0
Rifle Range	17090003061103	3074.2	100.0	365.0	16.0	1138.8	1578.7	32.0
Upper Berry Creek	17090003061201	3482.6	100.0	42.1	6.1	154.1	538.1	27.0
Staats Creek	17090003061202	2482.9	100.0	82.0	6.3	495.1	858.6	17.0

Table 38. Estimates of recent and historical wetland area (in acres) by subunit for Luckiamute watershed.								
Subbasin Name	7th Field HUC	HUC Area	% of HUC mapped by NWI	Probable wetland area (NWI, early 1980s)	Possible wetland + water area (FSL, early 1990s)	Possible original wetland area (NRCS estimate #1)	Possible original wetland area (NRCS estimate #2)	% of original wetland area remaining
Peterson Creek	17090003061203	3704.8	100.0	54.8	5.0	920.4	2216.0	6.0
Lower Berry Creek	17090003061204	3323.9	100.0	67.5	20.7	995.6	2142.3	7.0
E.E. Wilson	17090003061301	4545.7	100.0	143.8	17.1	2962.1	4012.4	5.0
Palestine	17090003061302	4148.9	100.0	161.0	42.1	1708.6	3254.2	9.0
Springhill	17090003061303	2884.1	100.0	228.0	64.1	772.6	2318.3	30.0
	Total	201734.4		2254.6	777.5	16297.7	39242.8	14.0

NWI = National Wetland Inventory
FSL = Forest Sciences Laboratory (ERC project) at Oregon State University
NRCS = hydric soil acreage from Natural Resources Conservation Service; estimate #1 is based only on soils that are listed as being hydric, estimate #2 also includes soils that only sometimes have hydric inclusions

Table 39. Estimates of recent and historical wetland area (in acres) by subunit for Rickreall watershed.								
Subbasin Name	7th Field HUC	Area	% of HUC mapped by NWI	Probable wetland area (NWI, early 1980s)	Possible wetland + water area (OSU, early 1990s)	Possible original wetland area (NRCS estimate #1)	Possible original wetland area (NRCS estimate #2)	% of original wetland area remaining
Buena Vista	17090007020404	1978.1	100.0	183.4	212.0	291.1	1362.3	63.0
American Bottom	17090007020501	2541.5	100.0	253.1	214.4	265.2	2336.1	95.0
Duck Slough	17090007020502	2952.7	100.0	72.8	36.7	778.1	2630.9	9.0

Table 39. Estimates of recent and historical wetland area (in acres) by subunit for Rickreall watershed.

Harman Slough	17090007020503	3160.9	100.0	261.4	248.2	1726.9	2982.4	15.0
Upper North Fork Ash Creek	17090007020601	2756.0	100.0	16.0	9.7	256.2	547.4	6.0
Middle North Fork Ash Creek	17090007020602	3623.2	100.0	43.2	8.3	1061.9	1801.0	4.0
Lower North Fork Ash Creek	17090007020603	3450.5	100.0	125.7	92.5	2129.6	3402.6	6.0
Middle Fork Ash Creek	17090007020604	4411.2	100.0	93.3	23.6	720.7	2523.9	13.0
Upper South Fork Ash Creek	17090007020605	5713.1	100.0	28.2	15.8	757.3	2273.9	4.0
Lower South Fork Ash Creek	17090007020606	3299.6	100.0	30.0	7.9	1378.0	2960.3	2.0
		33886.8		1107.2	869.1	9364.8	22820.8	12.0

NWI = National Wetland Inventory

FSL = Forest Sciences Laboratory (ERC project) at Oregon State University

NRCS = hydric soil acreage from Natural Resources Conservation Service; estimate #1 is based only on soils that are listed as being hydric, estimate #2 also includes soils that only sometimes have hydric inclusions

The loss of so much wetland area is a concern because wetlands in their natural condition typically provide a large number of services and thus are a vital public asset. For example, many wetlands can filter and cleanse surface runoff, help reduce flood peaks in rivers, and provide habitat for species found nowhere else. Infrastructure built in wetlands is susceptible both to frequent flooding and to unstable soils, making wetlands a poor, expensive choice for buildings and roads. Crops planted in many former wetlands are subject to frequent or late damage from frost, floods, and wildlife.

While the destruction of a small portion of a single wetland may seem too trivial to worry about, the repeating of such actions among many wetlands over time eventually adds up and imposes significant costs on taxpayers, *e.g.*, for repair of roads, flood damage payments.

Nonetheless, the conversion of many wetlands to agricultural uses, which mostly occurred in the early 1900's, has helped support the economy of the Luckiamute watershed. Recognizing this, state and federal agencies allow farming to continue in former wetlands where farming has long existed. Grazing also is permitted, and in some instances might benefit wetlands by minimizing incursion of Himalayan blackberry. Existing laws allow small fills in wetlands and other waters (less than 50 cubic yards, or less than 1 cubic yard in waters designated by the state as Essential Indigenous Anadromous Salmonid Habitat). For more information on wetland regulations, functions, and values, see: *http://www.epa.gov/owow/wetlands/* or *http://statelands.dsl.state.or.us/*.

Seasonally dry wetlands sometimes confuse landowners because such areas aren't obviously distinguishable from non-regulated uplands. To confirm or deny wetland status, an agency wetland specialist (or a consultant trained in use of the standardized federal delineation manual) must visit the site at an appropriate time of year and identify all dominant plant species, carefully examine the soil, and look for indicators of flooding or saturation. To many citizens, it may seem illogical to call areas that appear dry 95% of the year a "wetland." However, often it is the driest wetlands that provide the greatest benefits to society. Like a dry sponge, they are the most effective wetlands for soaking up excess runoff and the pollutants that it bears. When many wetlands in a watershed behave in this manner, downstream flood peaks are lower. Seasonally dry wetlands also host many plants seldom found in uplands or in wetlands that remain inundated year-round (Table 40).

While it is true that not all wetlands are equally effective in supporting functions valued by society, it also is not possible to identify the least effective ("marginal") wetlands by merely applying a one-factor criterion, such as "wetness" or "isolation." Seasonally dry wetlands that appear to be unconnected to other surface waters are very important for some functions, but this can be determined only by considering their watershed, soil type, slope, vegetation structure, and many other interacting factors. Procedures are available that account for such multiple factors in assigning ratings to wetlands and their functions, *e.g*., (Gersib, 1997), (Adamus and Field, 2001). For information on these, see: *http://www.oregonstatelands.us/hgm_guidebook.htm* and *http:// www.ecy.wa.gov/programs /sea/pubs/97-99/97-99.html*

Wetland maps produced by the National Wetland Inventory may be viewed online at: *http://www.nwi.fws.gov/mapper_tool.htm* . However, many wetlands that are regulated are not shown, and some of the wetlands that are shown are not legally regulated. As a precaution, landowners planning to fill low spots or excavate in areas mapped as floodplain or having any of the soils listed in Table 10, should minimize their legal liabilities by first asking wetland specialists to make and document a "wetland determination" at the project site.

Local Wetland Characteristics

Elevation, slope, soil type, land cover, and other characteristics of local wetlands are summarized geographically in Tables 40 and 41.

Conservation and Restoration Potential

Several government programs are available to provide technical support and funds to qualifying landowners who wish to restore wetlands to their property. For example, see: *http://www.sherm.com/wild/index.html*, *http://www.nrcs.usda.gov/programs/, http://www.epa.gov/owow/ wetlands/ facts/funding.pdf, http://publicworks.co.marion.or.us/parks/nhp/partnerships.asp,* or *http://www.oregon-plan.org/ archives/ steelhead_dec1997/st-12.html*

For general information about wetland restoration, consult this report that is downloadable from the internet: *http://www.nmfs.noaa.gov/habitat/habitatprotection/pdf/Wet%20Res%20Guidance_FINAL.pdf*

The extent of potential opportunities for wetland restoration, based only on soil conditions, is compiled geographically in Table 36.

Restoration opportunities must also take into account the ownership of potential wetland sites. We have summarized wetland sites by ownership for each of the 7th field subbasins in Tables 43, 44, and 45). About 48% of the probably wetlands occur on private lands in the Luckiamute / Ash Creek watersheds (Table 44). Additional information on the natural and developed land cover for probable wetlands are given in Appendices C,D,E,F,G, and H.

Table 40 Characteristics of wetlands of the Luckiamute watershed
Data are in acres unless noted otherwise.

Legend
Driest, Intermediate, Wettest: Most "driest" and many "intermediate" wetlands do not look like wetlands to some people because they are dry most of the year ("DriestW") or a minority of the year ("IntermediateW"). Based on hydroperiod codes on NWI maps.
StreamThru: Acres of NWI wetlands bisected by or along a channel according to the 1:24000 stream layer (not comprehensive)
InFloodplain: Acres of NWI wetlands located in floodplain according to FEMA
Emergent, Water, Shrub, Forested: Acres of wetland in each vegetation category according to NWI
DepresWetland, RIwetland, FlatsWetland, SlopeWetland: Acres of wetlands in Depressional, Riverine Impounding (RI), Flats, and Slope hydrogeomorphic classes (Adamus and Field, 2001). Based on inference from soil type, slope, NWI hydroperiod, and association with stream and/or floodplain. Needs field ve
Unmodified, Modified: A minimal estimate of acres of wetland modified by artificial impoundment, drainage, excavation. From NWI map codes.
ElevationAv: Mean elevation of wetland polygons.
SlopeAv: Mean slope of wetland polygons.

HUC7	DriestW	IntermedW	WettestW	StreamThru	InFloodplain	Emergent	Water	Shrub	Forested	DepresWetlands	RIwetlands	FlatsWetlands	SlopeWetlands	Unmodified	Modified	ElevationAv (ft)	SlopeAv
17090003060302	1.95	1.17	0	1167.10	0	1.17	1.95	0	0	0	3.11	0	0	1.17	1.95	340.11	6.69
17090003060303	0	1.16	0	168.28	0	0	1.16	0	0	0	1.16	0	0	1.16	0	267.81	3.59
17090003060304	0	0	0.56	307.60	0	0	0	0.56	0	0	0.56	0	0	0.56	0	196.35	0.93
17090003060503	2.79	2.15	87.27	11198.92	77.24	15.54	4.41	3.16	69.09	2.95	75.07	13.63	0.56	77.27	14.94	71.51	1.04
17090003060504	7.73	1.64	68.37	9094.79	63.66	23.35	9.37	5.69	39.33	5.47	71.03	0.61	0.63	62.07	15.67	98.57	1.31
17090003060704	0.79	0	9.04	2113.49	0	1.34	0.79	0	7.71	0	9.84	0	0	7.71	2.13	151.85	3.41
17090003060901	7.41	7.92	37.62	6749.01	27.86	11.05	15.11	4.76	22.03	5.82	42.61	1.09	3.43	36.12	16.83	104.58	1.68
17090003060902	7.23	6.05	126.05	15384.22	119.67	22.17	10	1.30	105.86	1.14	122.84	14.69	0.67	116.23	23.10	71.53	1.00
17090003060903	1.74	2.30	75.52	12586.96	62.31	16.84	3.85	3.30	55.57	0.68	73.60	4.94	0.34	69.76	9.79	95.53	1.92
17090003061001	1.63	2.49	89.88	13374.56	69.69	16.61	4.13	0.52	72.75	0.34	87.28	4.78	1.61	87.73	6.28	72.83	1.71
17090003061002	1.51	2.07	28.62	4767.51	11.54	0.15	3.58	1.44	27.03	1.64	27.17	0.15	3.24	27.37	4.83	77.14	1.39
17090003061003	5.95	6.49	157.74	10445.61	157.43	53.16	10.89	9.36	96.77	4.86	151.87	13.17	0.28	151.42	18.75	59.55	1.17
17090003061004	28.30	3.71	116.41	18366.33	5.85	62.90	29.37	7.85	48.29	6.69	132.74	2.24	6.75	114.58	33.83	78.83	1.49
17090003061005	7.77	494.39	146.65	40291.49	594.29	547.69	8.49	20.56	72.07	4.27	637.09	6.72	0.73	624.52	24.29	56.38	1.21

Table 40 Characteristics of wetlands of the Luckiamute watershed
Data are in acres unless noted otherwise.

Legend
Driest, Intermediate, Wettest: Most "driest" and many "intermediate" wetlands do not look like wetlands to some people because they are dry most of the year ("DriestW") or a minority of the year ("IntermediateW"). Based on hydroperiod codes on NWI maps.
StreamThru: Acres of NWI wetlands bisected by or along a channel according to the 1:24000 stream layer (not comprehensive)
InFloodplain: Acres of NWI wetlands located in floodplain according to FEMA
Emergent, Water, Shrub, Forested: Acres of wetland in each vegetation category according to NWI
DepresWetland, RIwetland, FlatsWetland, SlopeWetland: Acres of wetlands in Depressional, Riverine Impounding (RI), Flats, and Slope hydrogeomorphic classes (Adamus and Field, 2001). Based on inference from soil type, slope, NWI hydroperiod, and association with stream and/or floodplain. Needs field ve
Unmodified, Modified: A minimal estimate of acres of wetland modified by artificial impoundment, drainage, excavation. From NWI map codes.
ElevationAv: Mean elevation of wetland polygons.
SlopeAv: Mean slope of wetland polygons.

HUC7	DriestW	IntermedW	WettestW	StreamThru	InFloodplain	Emergent	Water	Shrub	Forested	DepresWetlands	RIwetlands	FlatsWetlands	SlopeWetlands	Unmodified	Modified	ElevationAv (ft)	SlopeAv
17090003061101	0.95	0.50	37.60	6255.32	14.80	2.24	1.45	0	35.36	0.95	35.86	0	2.24	37.86	1.19	143.34	3.40
17090003061102	5.47	1.47	336.45	26579.11	153.29	2.38	6.94	3.37	330.70	6.83	335.16	0.66	0.74	336.45	6.94	94.90	1.19
17090003061103	2.58	3.16	374.40	23709.86	112.88	52.17	2.58	18.64	306.75	2.58	340.85	36.72	0	372.10	8.05	66.71	0.36
17090003061201	6.22	0.35	46.09	2768.23	41.63	13.44	6.56	0	32.65	6.22	36.94	9.49	0	46.43	6.22	77.69	0.98
17090003061202	0.82	0	88.97	6135.41	50.09	5.04	0.82	5.44	78.49	0	83.75	6.04	0	88.37	1.42	72.17	0.68
17090003061203	2.52	1.53	55.61	8261.03	43.32	15.73	4.06	0	39.89	2.23	56.49	0.57	0.38	55.04	4.63	75.37	0.69
17090003061204	14.04	0.05	85.47	10157.99	63.64	21.71	14.10	14.57	49.20	2.44	87.17	9.91	0.05	74.72	24.85	63.13	0.61
17090003061301	7.03	483.05	152.17	43277.24	537.96	514.41	8.02	1.63	118.19	8.02	603.01	31.22	0	615.36	26.90	60.42	1.12
17090003061302	10.44	5.47	144.99	11686.76	47.67	70.37	15.23	10.98	64.34	8.34	88.83	61.01	2.72	143.85	17.05	66.65	0.96
17090003061303	8.53	483.73	217.59	45411.07	663.32	583.04	8.71	18.06	100.04	1.05	692.35	1.90	14.55	699.96	9.89	56.35	0.85
Luckiamute Sum (* = mean)	133.39	1510.85	2483.07	330257.89	2918.13	2052.45	171.57	131.20	1772.08	72.51	3796.35	219.53	38.91	3847.80	279.50	104.97*	1.64*

Table 41. Characteristics of wetlands of the Rickreall watershed
Data are in acres unless noted otherwise.

Legend
Driest, Intermediate, Wettest: Most "driest" and many "intermediate" wetlands do not look like wetlands to some people because they are dry most of the year ("DriestW") or a minority of the year ("IntermediateW"). Based on hydroperiod codes on NWI maps.
StreamThru: Acres of NWI wetlands bisected by or along a channel according to the 1:24000 stream layer (not comprehensive)
InFloodplain: Acres of NWI wetlands located in floodplain according to FEMA
Emergent, Water, Shrub, Forested: Acres of wetland in each vegetation category according to NWI
DepresWetland, RIwetland, FlatsWetland, SlopeWetland: Acres of wetlands in Depressional, Riverine Impounding (RI), Flats, and Slope hydrogeomorphic classes (Adamus and Field, 2001). Based on inference from soil type, slope, NWI hydroperiod, and association with stream and/or floodplain. Needs field verification.
Unmodified, Modified: A minimal estimate of acres of wetland modified by artificial impoundment, drainage, excavation. From NWI map codes.
ElevationAv: Mean elevation of wetland polygons.
SlopeAv: Mean slope of wetland polygons.

HUC7	DriestW	IntermedW	WettestW	StreamThru	InFloodplain	Emergent	Water	Shrub	Forested	DepresWetlands	RIwetlands	FlatsWetlands	SlopeWetlands	Unmodified	Modified	ElevationAv (ft)	SlopeAv
17090007020404	1.09	489.42	37.15	29499.67	499.72	497.00	2.61	9.31	18.73	0.53	523.71	3.09	0.32	518.69	8.96	56.30	1.19
17090007020501	18.88	488.09	94.06	31056.68	577.54	510.62	19.37	22.31	48.74	1.40	577.78	21.86	0	555.31	45.73	47.60	0.60
17090007020502	0.39	487.65	69.05	33532.49	528.67	528.17	2.00	1.65	25.27	1.22	531.78	22.29	1.80	522.47	34.63	56.40	0.70
17090007020503	6.25	524.97	84.01	33946.00	576.75	553.34	11.36	23.90	26.64	7.37	601.70	3.01	3.17	583.65	31.59	53.38	0.78
17090007020601	1.07	6.24	8.65	2582.83	4.91	2.90	6.24	4.61	2.21	1.67	10.07	1.12	3.11	5.11	10.86	124.70	2.60
17090007020602	0.63	1.89	40.68	1327.02	16.27	23.38	2.52	1.04	16.26	1.01	27.12	14.60	0.47	22.90	20.30	90.39	1.24
17090007020603	78.34	483.62	57.76	32673.79	494.12	510.26	79.90	1.67	27.89	2.84	605.33	11.16	0.39	525.82	93.90	55.64	0.45
17090007020604	15.92	3.13	79.51	13494.13	40.80	30.61	19.05	0	48.90	17.09	78.49	1.28	1.70	78.47	20.09	78.29	1.84
17090007020605	4.64	9.10	14.61	4267.44	2.59	6.74	12.75	2.14	6.72	5.09	18.03	3.38	1.86	13.53	14.82	89.78	1.85
17090007020606	6.93	3.87	19.40	4590.75	5.75	5.90	10.80	2.49	11.02	3.89	20.84	1.86	3.62	16.23	13.97	61.79	0.74
Rickreall Sum (* = mean)	134.15	2497.99	504.89	186970.79	2747.12	2668.93	166.61	69.13	232.37	42.09	2994.84	83.64	16.46	2842.19	294.84	71.43*	1.20*

Table 42. Native plant species that often characterize seasonal wetlands in the Willamette Valley.

Note: Wetland restoration projects (except those in floodplains) strive to favor these species through seeding, burning, and/or manipulation of flooding depth, duration, frequency, and seasonality. List provided by Kathy Pendergrass, US Fish & Wildlife Service. Luckiamute records are from ORNHIC (OH), OSU Herbarium (U), Beazell County Park (B), and may include a few records from outside the watershed in Polk/Benton County

Scientific Name	Common Name	Type	Luckiamute
Agrostis exarata	spike bentgrass	Perennial	U
Allium amplectens	slimleaf onion	Perennial	U
Aristida oligantha	prairie threeawn	Annual	
Aster curtus	Curtus' aster	Perennial	
Aster hallii ssp. chilensis	Hall's aster/ Pacific aster	Perennial	U, B
Barbarea orthoceras	wintercress	Bi/Peren	U
Beckmannia syzigachne	American sloughgrass	Annual	U
Boisduvalia densiflora	dense spike-primrose	Annual	
Brodiaea (Triteleia) hyacinthina	hyacinth brodiaea	Perennial	
Brodiaea coronaria	harvest brodiaea	Perennial	
Calandrinia ciliata	red maids	Annual	
Callitriche heterophylla	water starwort	Annual	U
Camassia leichtlinii	tall camas	Perennial	U
Camassia quamash	common camas	Perennial	U
Cardamine penduliflora	Willamette Valley bittercress	Perennial	U
Carex aurea	golden sedge	Perennial	
Carex densa	dense sedge	Perennial	U
Carex echinata	muricate sedge	Perennial	
Carex feta	green-sheath sedge	Perennial	
Carex pachystachya	thick-headed sedge	Perennial	U
Carex unilateralis	one-sided sedge	Perennial	U

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Scientific Name	Common Name	Type	Luckiamute
Centaurium muhlenbergii	monterey centaury	Annual	
Centunculus minimus	chaffweed	Annual	U
Danthonia californica	California oatgrass	Perennial	B
Deschampsia cespitosa	tufted hairgrass	Perennial	U
Deschampsia danthonioides	Annual hairgrass	Annual	
Deschampsia elongata	slender hairgrass	Perennial	U
Dodocatheon hendersonii	broadleaf shooting star	Perennial	U
Downingia elegans	showy downingia	Annual	U
Downingia yina	Willamette downingia	Annual	
Eleocharis acicularis	needle spike-rush	Annual	
Eleocharis ovata	common spike-rush	Annual	
Epilobium ciliatum var. watsonii	hairy willow-herb	Perennial	
Epilobium paniculatum	autumn willow-herb	Annual	
Erigeron decumbens var. decumbens	Willamette Daisy	Perennial	U
Eriophyllum lanatum	wooly sunflower	Perennial	U, B
Eryngium petiolatum	coyote thistle	Perennial	
Gnaphalium palustre	lowland cudweed	Annual	U
Gnaphalium purpureum	purple cudweed	Ann/bi	
Gratiola ebracteata	bractless hedge-hyssop	Annual	
Grindelia intergrifolia	Willamette Valley gumweed	Perennial	U
Haplopappus racemosus	racemed goldenweed	Perennial	

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Scientific Name	Common Name	Type	Luckiamute
Hordeum brachyantherum	meadow barley	Perennial	
Horkelia congesta	shaggy horkelia	Perennial	
Isoetes nutalli	Nuttall's quillwort	Perennial	
Juncus bolanderi	Bolander's rush	Perennial	
Juncus bufonius	toad rush	Annual	U
Juncus nevadensis	Nevada rush	Perennial	
Juncus tenuis	slender rush	Perennial	U
Lasthenia glaberrima	smooth lasthenia	Annual	
Lindernia anagallidea	false-pimpernel	Annual	
Lomatium nudicaule	barestem desert-parsley	Perennial	
Lotus formosissimus	seaside lotus	Perennial	
Lotus pinnatus	meadow deervetch	Perennial	U
Lotus purshianus	Spanish-clover	Annual	
Lupinus polyphyllus	bigleaf lupine	Perennial	
Luzula campestris	field woodrush	Perennial	
Madia glomerata	cluster tarweed	Annual	U
Microseris laciniata	cut-leaved microseris	Perennial	
Microsteris gracilis	pink microsteris	Annual	
Mimulus guttatus	common monkey-flower	Ann/per.	
Montia fontana	water chickweed	Annual	U
Montia linearis	narrow-leaved montia	Annual	U

Table 42. Native plant species that often characterize seasonal wetlands in the Willamette Valley.

Note: Wetland restoration projects (except those in floodplains) strive to favor these species through seeding, burning, and/or manipulation of flooding depth, duration, frequency, and seasonality. List provided by Kathy Pendergrass, US Fish & Wildlife Service. Luckiamute records are from ORNHIC (OH), OSU Herbarium (U), Beazell County Park (B), and may include a few records from outside the watershed in Polk/Benton County

Scientific Name	Common Name	Type	Luckiamute
Myosurus minimus	least mouse-tail	Annual	
Navarretia intertexta	needle-leaved navarrertia	Annual	U
Navarretia squarrosa	skunkweed	Annual	U
Orthocarpus bracteosus	rosy owl-clover	Annual	U
Orthocarpus hispidus	hairy owl-clover	Annual	
Panicum capillare	common witchgrass	Annual	U
Panicum occidentale	western witchgrass	Perennial	
Perederidia oregana	Oregon yampah	Perennial	
Perideridia gairdneri	yampah or false-carraway	Perennial	
Plagiobothrys figuratus	fragrant popcorn-flower	Annual	U
Plagiobothrys scouleri	Scouler's popcorn-flower	Annual	U
Poa scabrella	pine bluegrass	Perennial	
Polygonum douglasii	douglas knotweed	Annual	
Potentilla gracilis	slender cinquefoil	Perennial	U
Prunella vulgaris var. lanceolata	self-heal	Perennial	U, B
Psilocarphus elatior	tall wooly-heads	Annual	U
Ranunculus flammula	creeping buttercup	Perennial	
Ranunculus occidentalis	western buttercup	Perennial	
Ranunculus orthorhynchus	straight beaked buttercup	Perennial	U
Rorippa curvisiliqua	western yellowcress	Ann./bi.	U
Rosa nutkana	Nootka rose	Perennial	

Table 42. Native plant species that often characterize seasonal wetlands in the Willamette Valley.

Note: Wetland restoration projects (except those in floodplains) strive to favor these species through seeding, burning, and/or manipulation of flooding depth, duration, frequency, and seasonality. List provided by Kathy Pendergrass, US Fish & Wildlife Service. Luckiamute records are from ORNHIC (OH), OSU Herbarium (U), Beazell County Park (B), and may include a few records from outside the watershed in Polk/Benton County

Scientific Name	Common Name	Type	Luckiamute
Sanquisorba occidentalis	Annual burnet	Ann./bi	
Saxifraga oregana	bog saxifrage	Perennial	B
Sidalcea cusickii	Cusick's checker-mallow	Perennial	
Sisyrinchium idahoense (angustifolium)	blue-eyed grass	Perennial	B
Sisyrinchium hitchcockii	Hitchcock's blue-eyed grass	Perennial	
Spiranthes romanzoffiana	ladies-tresses	Perennial	
Trichestema lanceolatum	vinegar weed	Annual	
Veronica peregrina	purslane speedwell	Annual	
Viola adunca	early blue violet	Perennial	
Wyethia angustifolia	narrow-leaf mule's ears	Perennial	U
Zigadenus venenosus	death camas	Perennial	B

Table 43. Ownership category of probable wetlands, by subunit within the Luckiamute watershed. Data are in acres unless noted otherwise.

HUC7	Federal	State	County	Municipal	Private: Landfill	Private: Weyco	Private: Boise	Private: Other Timber	Private Other	Owner Undetermined
17090003060302	0	0	0	0	0	0	0	1.95	1.17	0
17090003060303	0	0	0	0	0	0	0	1.16	0	0
17090003060304	0	0	0	0	0	0	0	0	0.56	0
17090003060503	0	0	0	0	0	0	0	0	92.02	0.18
17090003060504	0	0	0	0	0	0	0	0.22	77.06	0.45
17090003060704	0	0	0	0	0	0	0	0	9.83	0
17090003060901	0	0	0	0	0	0	0	0	52.69	0.26
17090003060902	0	0	0.01	0	0	0	0	0	139.04	0.28
17090003060903	0	0	9.81	0	0	0	0	0	69.62	0.13
17090003061001	16.62	0	0.36	0	0	0	0	0.20	76.78	0.05
17090003061002	0	0	0	0	0	0	0	0	32.20	0
17090003061003	0	0.23	0	0	0	0	0	0	168.31	1.64
17090003061004	0	0	0	0	0	0	0	0	145.89	2.52
17090003061005	9.42	63.47	0	0	0	0	0	0	198.82	341.81
17090003061101	0	0	0	0	0	0	0	0	33.79	5.06
17090003061102	22.84	0	0	0	45.89	0	0	0	184.39	87.70
17090003061103	23.57	0	25.17	0	0	0	0	0	321.78	6.11
17090003061201	0	0	0	0	0	0	0	0	52.02	0.47
17090003061202	0	12.23	0	0	0	0	0	0	76.85	0.54
17090003061203	0	0	0	0	0	0	0	0	59.50	0.17
17090003061204	0	0	0	0	0	0	0	0	99.13	0.44
17090003061301	9.42	22.75	0	0	0	0	0	0	233.59	341.12
17090003061302	0	58.10	0	0	17.38	0	0	0	66.19	18.25
17090003061303	9.42	30.96	0	0	0	0	0	0	243.75	390.27
Luckiamute subtotal (acres)	91.29	187.74	35.34	0	63.27	0	0	3.53	2434.98	1197.45

Table 44. Ownership category of probable wetlands, by subunit within the Rickreall watershed.
Data are in acres unless noted otherwise.

HUC7	Federal	State	County	Municipal	Private: Landfill	Private: Weyco	Private: Boise	Private: Other Timber	Private: Other	Owner Undetermined
17090007020404	11.04	21.28	0	0	0	0	0	0	100.18	359.67
17090007020501	9.42	21.28	0	0	0	0	0	0	159.08	369.85
17090007020502	9.42	21.28	0	0.01	0	0	0	0	152.94	338.15
17090007020503	9.42	33.48	0	0	0	0	0	0	158.09	378.96
17090007020601	0	0	0	0	0	0	0	0	15.93	0.04
17090007020602	0	1.44	0	0	0	0.86	0	0	40.48	0.43
17090007020603	9.42	21.28	7.40	60.82	0	0	2.09	0	143.68	339.75
17090007020604	0	0.11	0	1.35	0	0	0	0	96.75	0.35
17090007020605	0	0	0	0.14	0	0	0	0	28.15	0.07
17090007020606	0	0	0.20	2.39	0	0	0	0	27.20	0.42
Rickreall subtotal (acres)	37.68	98.88	7.59	64.70	0	0.86	2.09	0	822.31	1428.00
Total acres, both watersheds	140.01	307.90	42.93	64.70	63.27	0.86	2.09	3.53	3357.47	2985.13
% of TOTAL	2.01	4.42	0.62	0.93	0.91	0.01	0.03	0.05	48.18	42.84

Table 45. Area (acres) of wetland in various zoning categories.		
Zoning Category	Luckiamute	Rickreall
Exclusive Farm Use	2049.77	739.80
Farm/Forest	48.35	24.98
Farm/Forest Overlay	53.38	3.97
Forest Conservation	123.59	1.45
Industrial	7.99	13.17
Mineral Extraction	0.04	0
Open Space	83.39	0
Public Park	0	11.04
Rural Residential	48.06	1.03
Suburban Residential	1.08	62.13
Urban	0	186.75

Sensitive Plant Species

Wet prairies once existed over large portions of the Valley floor where agricultural fields now predominate. They were dominated by tufted hairgrass, camas, and various sedges. Little or no wet prairie remains in the Luckiamute watershed. Most such areas that were not converted to agriculture have become wooded wetlands as a result of fire suppression, or have become dominated by reed canarygrass or other herbaceous species.

The following species are associated with wet prairies and seasonally-inundated marshes.

Bradshaw's Lomatium (*Lomatium bradshawii*). Worldwide, this plant occurs only in the Willamette Valley. It has declined due partly to loss of native wet prairie as a result of agricultural drainage. Only 16 known populations remain in the Willamette Valley (Pendergrass *et al*. 1999).

Nelson's Checker-mallow (*Sidalcea nelsoniana).* This showy plant is also endemic to the Willamette Valley. Like the other wet prairie species discussed here, it has declined due partly to loss of native wet prairie as a result of agricultural drainage. It appears to tolerate a wider range of habitat condtions than other rare plants listed here.

Willamette daisy (*Erigeron decumbens* var. *decumbens*). This variety of a colorful wildflower is endemic to the Willamette Valley and was once thought to be extinct. Like the other wet prairie species discussed here, it has declined due partly to loss of native wet prairie as a result of agricultural drainage. For additional information see *http://www.epa.gov/fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm* and *http://www.appliedeco.org/reports.html*

The following species are associated with perennial ponds and sloughs.

Western Pond Turtle (*Emmys marmorata marmorata).* Single ponds once contained hundreds of these turtles, but numbers have been drastically decimated due to many factors (Adamus, 2003). It prefers ponds or wetlands near permanent water, but also inhabits larger rivers provided deep pools or sloughs are accessible. This turtle nests up to 200 m from ponds and thrives best where surrounding land contains relatively open natural cover. Its current presence has been documented at about 12 locations in the watershed, extending from the Willamette River westward to near Dallas (Adamus *et al.*, 2003).

Red-legged Frog (*Rana aurora).* Populations of this frog appear to have been heavily impacted both from habitat loss and as a result of predation from introduced bullfrogs and bass. It inhabits both seasonal and permanent ponds, often somewhat shaded, and has been documented from several locations in the watershed.

Native *vs.* Invasive Plant Species

"Native plant diversity" is the variety of plants that occur naturally within an area. "Weeds" may be defined as non-native (mostly) plant species that flourish and invade desirable crops or native plant communities, especially when soil, land cover, and natural runoff patterns are disturbed by humans or natural events. Noxious weeds (a legal term, ORS 570.505) applies to a specific list of weeds that are considered injurious to public health, agriculture, recreation, wildlife, or any public or private property. Native plant communities – as well as croplands, roadsides, and residential areas -- are under constant siege by weeds.

Exotic, non-indigenous, weed, and invasive plants are terms that are used to describe plants that are normally not part of the native flora or that are native and occupy an abnormally large proportion of the plant community. Each of these terms can have slightly different meanings depending on the audience. Invasive plants can dramatically impact native plant and animal communities. For example, invasive plants may quickly become established and occupy large areas thereby crowding out native plants.

In studies conducted by our group, we have found that plant communities containing large proportions of invasive plants have invertebrate communities that are quite distinct from those found in native plant communities. We have also found that the physical structure of wetland communities is altered by invading plants as are leaf litter decomposition rates (Garono, unpublished data). Although the adverse effects of invasive plants are the subject of numerous studies, some of these plants do have positive attributes. For example, many of the species that we tend to think of as pest species were originally introduced to stabilize soil, provide forage for birds and wildlife, or for aesthetic reasons.

Invasive plants are typically generalists and can thrive over a wide range of environmental conditions. Invasive plants are frequently exotic plants: they occur well beyond the extent of their native range, often free from the herbivores and predators that keep their populations in check. There are many ways to manage invasive plants including mechanical removal, mowing, burning, chemical control, and biocontrol. See information available from the Oregon Weed Control Program (*http://www. oda. state.or.us/* Plant/

weed_control/) for control measures.

The proportion of local plant diversity that consists of weed species has not been tallied, but some of the more troublesome species are listed in Table 45 **We recommend that the Polk Co. plant species check list be compared to noxious weed lists and a master list of weeds present in Polk Co. be generated. Once identified, information on the location of weedy species observations can then be tracked using the LWC GIS and a suitable management plan be developed.**

A long-term project is currently underway at Western Oregon University to inventory and monitor the flora of Polk Co. The Polk Co. Flora Project focuses on native and invasive plant species in the County. The project is led by Western Oregon University biology professor Bryan Dutton who is working to train students to collect and preserve plants with the goal to create an Online Interactive Flora of Polk County that will be available to the research community through the World Wide Web. The flora project provides a collaborative framework for faculty, students, and the local K-12 education community to conduct botanical surveys using GIS, global positioning systems (GPS), and internet technologies. A check list of plant species and associated information is available online at *http://www. wou.edu/ ~duttonb/PCFP/*and it is estimated that Polk County will have a minimum of 1,500 plant species. A similar atlas project but covering the entire state can be accessed at *http://www.oregonflora.org/OFP/atlas.htm*

The Oregon State University Herbarium has also compiled a list of vascular plants that can be queried online by county (*http://oregonstate.edu/ dept/botany/ herbarium/db/ vasc_plant. html*). In addition, the University of Montana has complied a list of noxious weeds that can be queried by county (*http://invader.dbs. umt.edu/*), known as the Invaders Database System. Plant lists are available for the McDonald-Dunn Forest -- woody species only from the OSU College of Forestry, and Beazell County Park. Lists may be available for a few additional areas where jurisdictional wetland determinations have been made, for the Delbert Hunter Arboretum in Dallas, and/or for other areas visited by local botanists. Non-systematic records of rare plants are maintained and updated by the Oregon Natural Heritage Information Center (ORNHIC).

Species Status and Geographic Patterns

Probably well over 1,000 kinds of native plants occur in the Luckiamute Watershed, but the status and distribution of most of these within the watershed is unknown. In the Beazell Memorial

Forest alone, 246 plant species (185 of them native) were found during spring of 2001 (Kaye, 2001). As of 1990, 151 woody plant species had been reported from the McDonald-Dunn Forest (Oregon State University College of Forestry, 1990) and the OSU Herbarium contains specimens of about 650 species from Polk and Benton Counties.

Of particular concern are plants that are rare or believed to have declined severely or disappeared entirely from the region in recent years. The ORNHIC database includes 11 such species, subspecies (ssp.), or varieties (var.) that have been reported specifically from the Luckiamute Watershed (Table 37). It is virtually certain that other rare or declining species are present in the watershed but are not included in this table because of the lack of a survey covering all watershed lands.

In the Willamette Valley, many of the rarest native plants grow only in natural wetlands, riparian areas, oak woodlands, or prairie (Titus *et al.*, 1996). For additional information on composition of threatened native plant and animal communities of the Willamette Valley (especially prairies), see (Wilson, 1998a; Wilson, 1998b) and (Campbell, 2004).

Table 46. Notable plant species from the Luckiamute Watershed reported in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat
Anemone oregana var. *felix*	Bog anemone	G4T2 S1; 2	moist woods, montane meadows
Cimicifuga elata	Tall bugbane	G3 S3; 1; ODA=C	See: http://www.appliedeco.org/reports.html
Delphinium pavonaceum	Peacock larkspur	G1 S1; 1 Fed=SOC; ODA=LE	unmowed prairies, fencerows
Erigeron decumbens var. decumbens	Willamette daisy	G4T1 S1; 1 Fed=LE; ODA=LE	See: http://www.epa.gov/fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm and http://www.appliedeco.org/reports.html
Erythronium elegans	Coast range fawn-lily	G1 S1; 1 Fed=SOC; ODA=LT	upland prairie
Horkelia congesta ssp. *congesta*	Shaggy horkelia	G4 T2 S2; 1 Fed=SOC; ODA=C	See: http://www.appliedeco.org/reports.html
Lathyrus holochlorus	Thin-leaved peavine	G2 S2; 1 Fed=SOC	upland prairie

Table 46. Notable plant species from the Luckiamute Watershed reported in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat
Lupinus sulphureus ssp *kincaidii*	Kincaid's lupine	G5T2 S2; 1 Fed=LT; ODA=LT	See: http://www.epa.gov/fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm
Sidalcea nelsoniana	Nelson's checker mallow	G3G4 S1; 2	upland prairie
Wolffia borealis	Dotted water-meal	G5 S1; 2	sloughs
Lobaria linita	(type of lichen)	G4 S1; 2	mature Douglas-fir forest with old-growth structural components

* LE= legally listed as Endangered; LT= legally listed as Threatened; SOC= Species of Concern (ODA= Oregon Dept. of Agriculture). These species are protected only on state and federal lands.
G= global status (ONHP), S= state status (ONHP). 1= critically imperiled; 2= imperiled and vulnerable to extinction; 3= rare but not immediately imperiled, 4= not rare but of long-term concern, 5= widespread and secure
Number following the semicolon: 1= extinction threatened or presumed, 2= extirpation from Oregon threatened or presumed, 3= insufficient information, 4= of concern but not immediately imperiled

Weed Species

Weeds comprise only a small percentage of all plant species, but can severely affect most others. Weed species listed as “noxious” by the Oregon Department of Agriculture which are known to occur (or are likely to occur) in the Luckiamute Watershed are shown in Table 38. Note that some of these species have positive as well as negative attributes. For example, Scotch broom has colorful flowers, may control erosion on steep slopes, and benefits soil productivity by fixing nitrogen. Fruits of the Himalayan blackberry are used by wildlife as well as people, and dense thickets formed by this species may provide sensitive breeding birds with isolation and small mammals with cover.

Table 47. Plants known or likely to occur in the Luckiamute Watershed and legally designated as “noxious weeds” by Oregon Department of Agriculture.

Scientific Name	Common Name	Habitat
Abutilon theophrasti	Velvetleaf	croplands, lawns, pastures
Alopecurus myosuroides	Blackgrass	croplands, lawns, pastures
Carduus pycnocephalus	Italian thistle	croplands, lawns, pastures
Centaurea pratensis	Meadow knapweed	croplands, lawns, pastures

Table 47. Plants known or likely to occur in the Luckiamute Watershed and legally designated as "noxious weeds" by Oregon Department of Agriculture.

Scientific Name	Common Name	Habitat
Cirsium arvense	Canada thistle	croplands, lawns, pastures
Convolvulus arvensis	Field bindweed	riparian, woodland edge
Cuscuta pentagona	Field dodder	croplands, lawns, pastures
Cytisus scoparius	Scotch broom	woodland edge, clearcuts
Daphne laureola	Spurge laurel	woodland edge
Digitaria sanguinalis	Large crabgrass	croplands, lawns, pastures
Hedera helix	English ivy	riparian, woodlands
Lythrum salicaria	Purple loosestrife	wetlands, riparian
Orobanche minor	Small broomrape	woodland edges
Phalaris aquatica	Aquatic canarygrass	wetlands, riparian
Phalaris arundinacea	Reed canarygrass	wetlands, riparian
Polygonum cuspidatum	Japanese knotweed	riparian, woodland edge
Rubus discolor	Himalayan blackberry	riparian, woodland edge, lawns
Senecio jacobaea	Tansy ragwort	croplands, lawns, pastures
Silybum marianum	Milk thistle	croplands, lawns, pastures
Ulex europaeus	Gorse	woodland edge, clearcuts

Additional species, although not officially listed as noxious weeds, can be problematic in even small amounts when they contaminate ryegrass harvested for grass seed, due to strict standards for purity of ryegrass sold commercially. Some landowners consider mistletoe (*Phoradendron villosum*), a plant that parasitizes mostly oaks, to be undesirable, so kill it or harvest it for sale. However, several studies have documented the outstanding value of its berries to wintering wildlife, especially bluebirds (this is also true of madrone). Also, some Luckiamute weeds highly damaging to native plant communities have not yet made it onto official agency lists of noxious weeds due to administrative delays or limited information. One example is false-brome, *Brachypodium sylvaticum,* See:*http://www.appliedeco.org/FBWG.htm* and *http://www. nativeseednetwork. org/about/feature_detail.php?id=387*

Information on noxious weeds and their control also is available from several sources, such as*: http://www. biodiversitypartners. Org /pubs/ Campbell/ Landownerguide.pdf, http://www. nwcb. wa.gov/ weed_info /contents.html, http://invader. dbs.umt.edu/, http://tncweeds. ucdavis.edu/* or *http://www. cof.orst.edu/ resfor/cameron/demo5.php*

Important Habitats and Communities

Under Oregon's Natural Heritage Program (ORNHP), the BLM's 32ha, Little Sink Research Natural Area (in the upper Luckiamute) contains the Willamette Valley ecoregion's designated representative of two "ecological cells" (ORNHP 2003). According to BLM's assessment (Licata *et al.*, 1998),

"Little Sink ACEC [Area of Critical Environmental Concern] is a low elevation Douglas-fir forest occupying an area of marine siltstone which has undergone considerable landsliding. The ACEC's primary values derive from its geological instability, which has produced slump benches, scarps, basins and ponds. Most of the ACEC is covered with hummocks. This varied topography supports great biotic diversity within a relatively small area, providing exceptional opportunities for community-level studies of its flora and fauna. A large portion of the ACEC is covered with old-growth Douglas-fir with mixtures of grand fir, red alder, Oregon maple, and vine maple. Many of the unusually large Douglas-fir trees lean, indicating that massive slumping has occurred because of the area's unstable substratum. A wide variety of plants cover the ground; ferns, Oregon grape, and salal are the most common. There are two perennial ponds within the ACEC, a third perennial pond on its western boundary, and many intermittent ponds. These ponds are in a transitional stage, filling up with organic debris preliminarily to forming bogs. Many animal species have been observed within the ACEC."

The Luckiamute River itself contains the ORNHP's designated representative of two other ecological cells (ORNHP 2003): Pacific willow shrub swamp, and Oregon ash / Pacific willow woodland.

An ORNHP survey of 172 wetland and riparian sites in the Willamette Valley named the lower Luckiamute as one of the 21 highest-quality areas, chiefly from a botanical perspective (Titus *et al.*, 1996)

More broadly, almost any area of the watershed that has experienced minimal soil disturbance and retains predominantly native vegetation could be important for maintaining the watershed's overall plant diversity. In particular, oak woodlands, prairies, stands of mature madrone, springs, seasonal wetlands, riparian areas, and rock ledges are most likely to support plant species not found elsewhere in the watershed. These are discussed in Section 6 of this report.

Conservation and Restoration Potential: Groups or landowners interested in restoring native plant communities can employ a variety of restoration techniques, depending on the habitat that is being restored. Restoration may consist simply of making a long-term commitment to continually remove invasive species. Or, in the case of

prairie and oak woodlands, it may involve controlled burns, mowing, restriction of severe grazing, selective thinning, or other techniques. In the valley bottom and foothills, selective removal of Douglas-fir often benefits oaks and other native plants. For oaks, hot underburns decrease the acorn crop the following year, but in subsequent years acorn production is greater than it was during the pre-burn period. Open-grown trees, and trees with wide crowns, are the best acorn producers. Crowded trees collectively may produce well, but there are fewer acorns per tree. For more information on oaks and oak management in Oregon, see:

http://www.biodiversitypartners.org/pubs/Campbell/Landownerguide.pdf

http://www.wa.gov/wdfw/hab/oakfinal.pdf and *www.fs.fed.us/pnw/olympia/ silv/oak* and *http://www.dfw. state. or.us/public/WoodlandArc/WhiteOak.pdf* .

Replanting with native species characteristic of the intended habitat often speeds the restoration process, but only if conditions are suitable. In many cases, seeds of native species remain in the soil long after land has been cleared and cultivated or overrun by weeds, and may germinate decades later, given the proper conditions. Additional information on prairie restoration strategies and seed sources can be found at:

http://www.biodiversitypartners.org/pubs/Campbell/Landownerguide.pdf, http://www. appliedeco.org/ Restoration Conference2003/ Conference Proceedings 03.htm, http:// publicworks. co.marion.or .us/parks/SERConf_Min110901.asp, http://publicworks.co.marion.or.us/environment/restoration/restorationtypes.asp http://www.nativeseednetwork.org/home/index.php

However, conservation of relatively intact remnants of native plant communities is ultimately a more successful strategy than restoration. Policies that minimize application of herbicides along roadsides and cropland, as well as minimize soil tillage, compaction, and draining, are most likely to benefit watershed health in the long run.

Table 48. Native plant species that collectively often characterize *upland prairie or oak savanna* in the Willamette Valley.

Note: Upland prairie restoration projects strive to favor these species through seeding, burning, mowing, and other practices. List provided by Kathy Pendergrass, US Fish & Wildlife Service. Luckiamute records are from ORNHIC (OH), OSU Herbarium (U), and Beazell County Park (B) and may include a few records from outside the watershed in Polk/Benton County. For additional species (including mosses) characteristic of this habitat, see: http://oregonstate.edu/~wilsomar/Index.htm and http://www.biodiversitypartners.org/pubs/Campbell/Landownerguide.pdf

Scientific Name	Common Name	Habit	Luckiamute
Achillea millefolium	western yarrow	Perennial	U, B
Achnatherum lemmonii (Stipa lemmonii)	Lemon's needlegrass	Perennial	B
Allium accuminatum	tapertip onion	Perennial	U

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Scientific Name	Common Name	Habit	Luckiamute
Allium amplectens	slimleaf onion	Perennial	U
Amelanchier alnifolia	western serviceberry	Perennial	U
Apocynum androsaemifolium	spreading dogbane	Perennial.	U, B
Asclepias speciosa	showy milkweed	Perennial	U
Aster curtus	Curtus' aster	Perennial	
Aster hallii/chilensis ssp. chilensis	Hall's aster/ Pacific aster	Perennial	U, B
Berberis aquifolium	tall Oregon grape	Perennial	
Brodiaea (Dichelostemma) congesta	field cluster lily	Perennial	U, B
Brodiaea coronaria	harvest brodiaea	Perennial	
Bromus carinatus	California brome	Perennial	U
Bromus sitchensis	Sitka brome	Perennial	U, B
Calochortus tolmiei	cat's ear	Perennial	B
Camassia leichtlinii	tall camas	Perennial	U
Cardamine oligosperma	little western bittercress	Annual	U, B
Carex tumulicola	foothill sedge	Perennial	U, B
Chamomilla suaveolens (Matricaria sp.)	pineapple weed	Annual	
Clarkia amoena var caurina	fairwell to spring	Annual	B
Clarkia purpurea ssp quadravulnera	small-flowered godetia	Annual	U
Collinsia grandiflora	large-flowered blue-eyed Mary	Annual	U, B
Collomia grandiflora	large-flowered collomia	Annual	
Comandra umbellata	bastard toad-flax	Perennial	U
Danthonia californica	California oatgrass	Perennial	B
Delphinium leucophaeum	pale larkspur	Perennial	
Delphinium menziesii	Menzie's larkspur	Perennial	B
Delphinium oreganum	Oregon larkspur	Perennial	U

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Scientific Name	Common Name	Habit	Luckiamute
Delphinium pavonaceum	peacock larkspur	Perennial	U
Dodocatheon hendersonii	broadleaf shooting star	Perennial	U, B
Elymus glaucus	blue wildrye	Perennial	U, B
Elymus trachycaulus	slender wheatgrass	Perennial	
Erigeron decumbens var. decumbens	Willamette Daisy	Perennial	U
Eriophyllum lanatum	wooly sunflower	Perennial	U, B
Erythronium oreganum	giant fawn lily	Perennial	U, B
Festuca californica	California fescue	Perennial	B
Festuca roemeri	Roemer's fescue	Perennial	B
Fragaria virginiana	blue-leaf strawberry	Perennial	B
Fritillaria affinis	chocolate lily	Perennial	
Geranium oreganum	Oregon geranium	Perennial	B
Heterocodon rariflorum	heterocodon	Annual	
Horkelia congesta ssp. congesta	shaggy horkelia	Perennial	U
Iris tenax	Oregon iris	Perennial	U, B
Juncus tenuis	slender rush	Perennial	U
Koeleria cristata	prairie junegrass	Perennial	B
Lathyrus holochlorus	thin-leaved peavine	Perennial	U, B
Linanthus bicolor	bicolored linanthus	Annual	
Lithofragma parviflora	smallflower woodland star	Perennial	
Lomatium bradshawii	Bradshaw's lomatium	Perennial	
Lomatium dissectum	fern-leaved lomatium	Perennial	U
Lomatium nudicaule	barestem desert-parsley	Perennial	U, B
Lomatium triternatum	nine-leaf lomatium	Perennial	
Lomatium utriculatum	common lomatium	Perennial	U, B

Table 48. Native plant species that collectively often characterize *upland prairie or oak savanna* in the Willamette Valley.

Note: Upland prairie restoration projects strive to favor these species through seeding, burning, mowing, and other practices. List provided by Kathy Pendergrass, US Fish & Wildlife Service. Luckiamute records are from ORNHIC (OH), OSU Herbarium (U), and Beazell County Park (B) and may include a few records from outside the watershed in Polk/Benton County. For additional species (including mosses) characteristic of this habitat, see: http://oregonstate.edu/~wilsomar/Index.htm and http://www.biodiversitypartners.org/pubs/Campbell/Landownerguide.pdf

Scientific Name	Common Name	Habit	Luckiamute
Lotus micranthus	small-flowered deervetch	Annual	B
Lotus purshianus	Spanish-clover	Annual	
Lupinus micranthus	field lupine	Annual	
Lupinus polyphyllus	bigleaf lupine	Perennial	
Lupinus rivularis	stream lupine	Perennial	
Lupinus suphureus ssp. kincaidii	Kincaid's lupine	Perennial	
Madia elegans	showy tarweed	Annual	U
Madia sativa	coast tarweed	Annual	U, B
Montia howellii	Howell's montia		
Navarretia squarrosa	skunkweed	Annual	U
Nemophila menziesii	baby blue-eyes	Annual	U
Nemophila parviflora	small flower nemophila	Annual	B
Plagiobothrys scouleri	Scouler's popcorn-flower	Annual	U
Plectritis congesta	rosy plectritis	Annual	B
Poa scabrella	pine bluegrass	Perennial	
Polystichum munitum	western swordfern	Perennial	U, B
Prunella vulgaris var. lanceolata	self-heal	Perennial	B
Pteridium aquilinum	western bracken fern	Perennial	B
Quercus garryana	Oregon white oak	Perennial	U, B
Quercus kelloggii	California black oak	Perennial	
Ranunculus occidentalis	western buttercup	Perennial	B
Rosa nutkana	Nootka rose	Perennial	B
Salix scouleriana	Scouler willow	Perennial	B
Sanicula bipinnatifida	purple sanicle	Perennial	U, B
Sanquisorba occidentalis	Annual burnet	Ann./bi	
Sidalcea campestris	meadow sidalcea	Perennial	U

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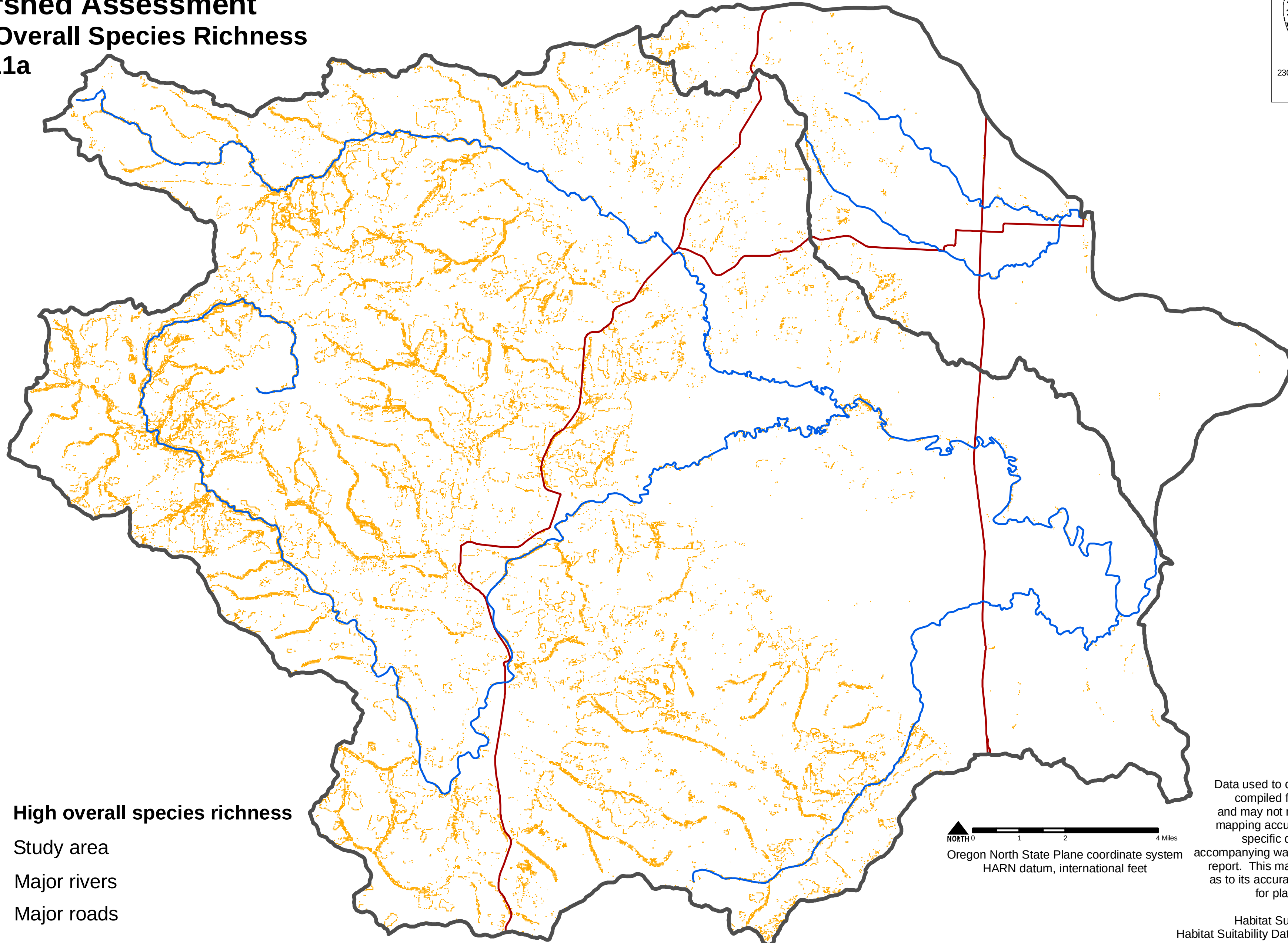
Scientific Name	Common Name	Habit	Luckiamute
Sidalcea nelsoniana	Nelson's checkermallow	Perennial	
Sidalcea virgata	rose checker-mallow	Perennial	U, B
Silene hookeri	Indian pink	Perennial	U, B
Solidago canadensis	Canada goldenrod	Perennial	U
Trifolium tridentata	tom-cat clover	Annual	
Trifolium variegatum	white-tip clover	Annl/Per	
Vicia americana v. trruncata	American vetch	Perennial	
Viola nuttallii var. praemorsa	canary violet	Perennial	
Wyethia angustifolia	narrow-leaf mule's ears	Perennial	U

Map 11a. Areas of highest species richness in the Luckiamute / Ash Creek study area. Data are from Weight Species Richness (WSR) grids. Source: P. Adamus, Pacific Northwest Ecosystem Consortium and U.S. EPA

Luckiamute/Ash Creek/American Bottom Watershed Assessment

High Overall Species Richness
Map 11a



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High overall species richness

Study area

Major rivers

Major roads

NORTH 0 1 2 4 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Habitat Suitability Data Source:
Habitat Suitability Data. Pacific Northwest Ecosystem Consortium. Contact: Haggarty, Patti (US EPA, Western Ecology Division).
(http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Map 11b. Areas of highest Amphibian and Reptile species richness in the Luckiamute / Ash Creek study area. Data are from Weight Species Richness (WSR) grids. Source: : P. Adamus, Pacific Northwest Ecosystem Consortium and U.S. EPA

Luckiamute/Ash Creek/American Bottom Watershed Assessment

High Amphibian and Reptile Species Richness
Map 11b

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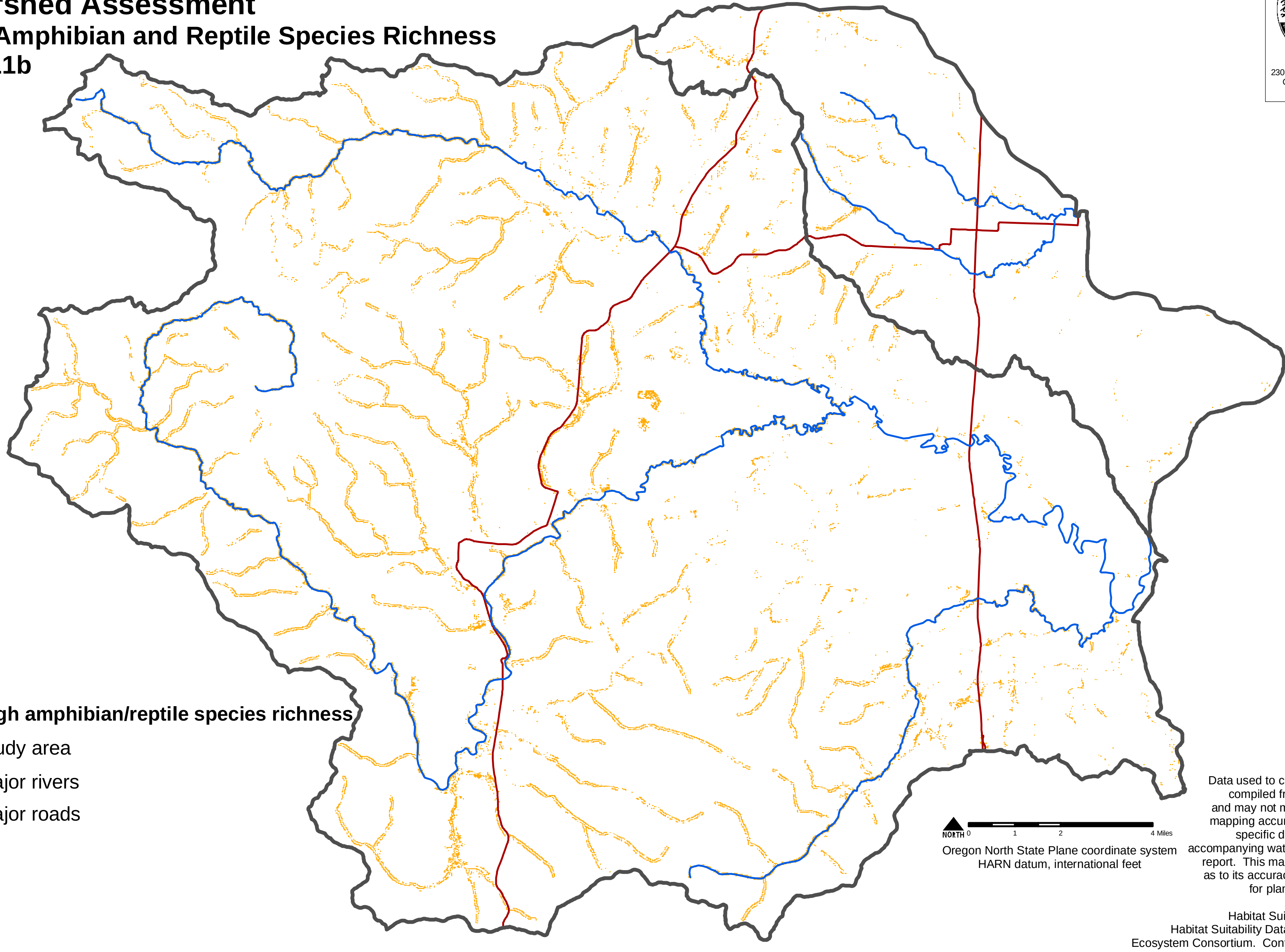

High amphibian/reptile species richness

Study area

Major rivers

Major roads

Oregon North State Plane coordinate system
HARN datum, international feet

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Habitat Suitability Data Source:
Habitat Suitability Data. Pacific Northwest Ecosystem Consortium. Contact: Haggarty, Patti (US EPA, Western Ecology Division).
(http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Map 11c. Areas of highest Mammal species richness in the Luckiamute / Ash Creek study area. Data are from Weight Species Richness (WSR) grids. Source: : P. Adamus, Pacific Northwest Ecosystem Consortium and U.S. EPA

Luckiamute/Ash Creek/American Bottom Watershed Assessment

High Mammal Species Richness
Map 11c

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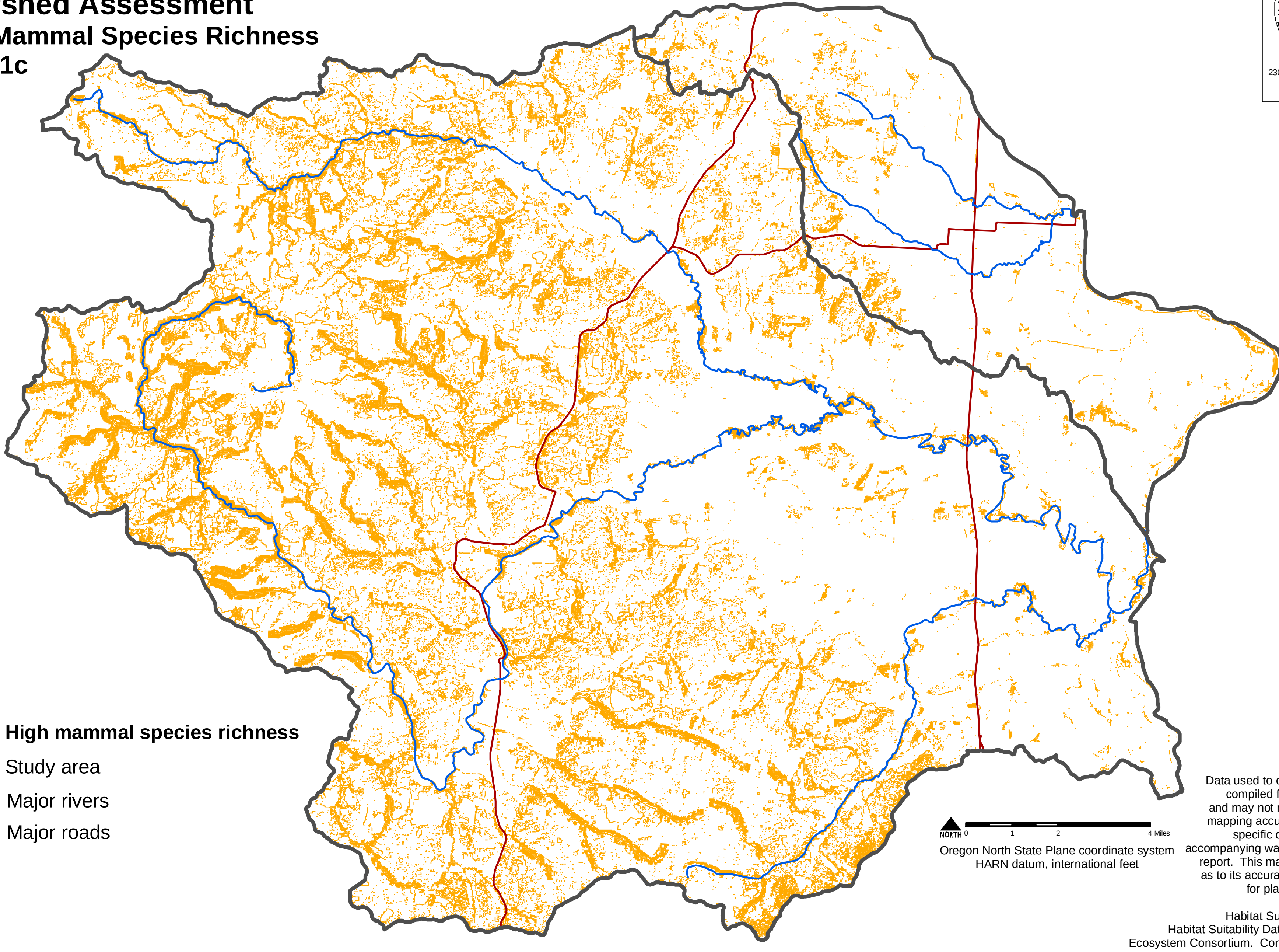


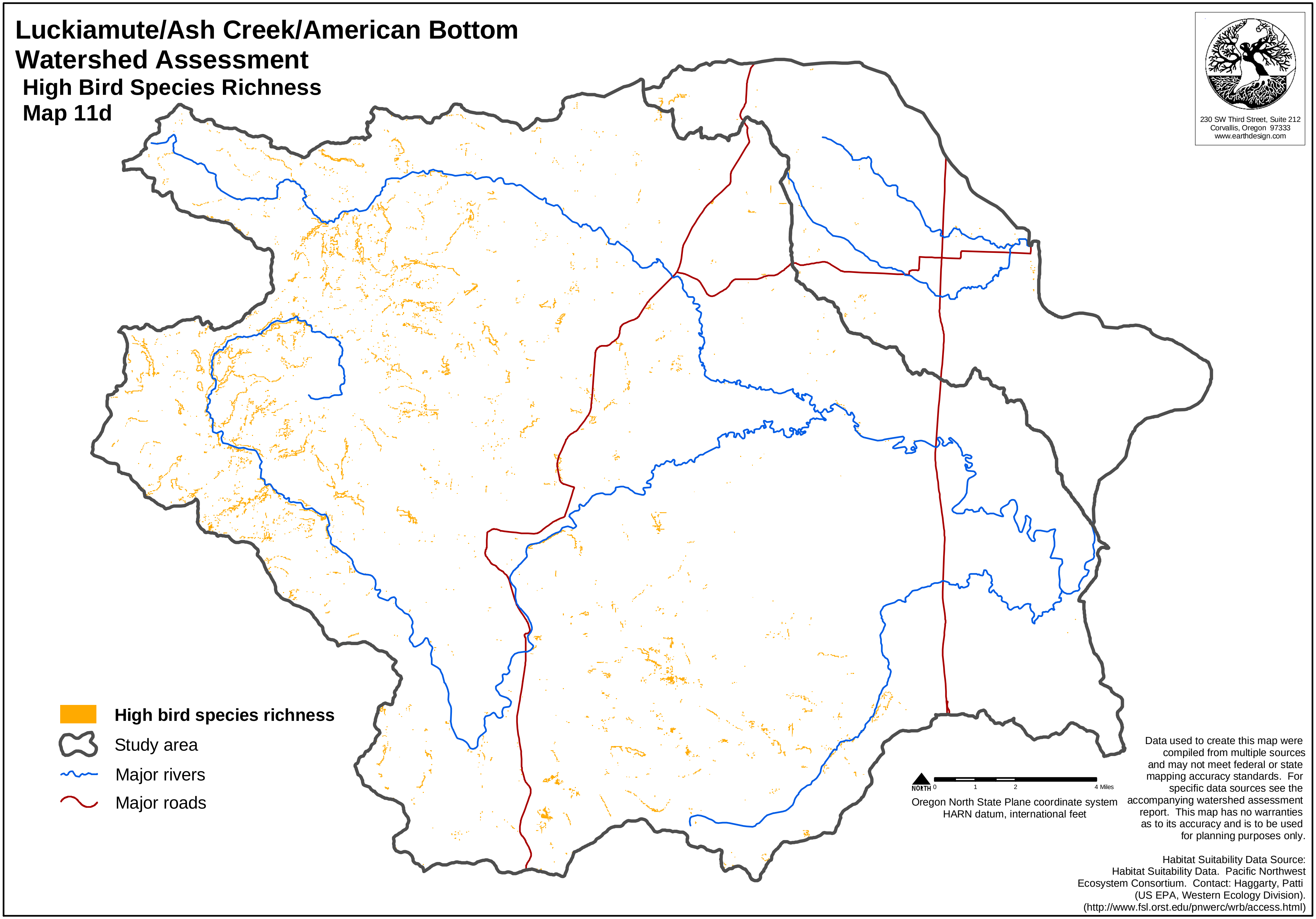
High mammal species richness
Study area
Major rivers
Major roads

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Habitat Suitability Data Source:
Habitat Suitability Data. Pacific Northwest Ecosystem Consortium. Contact: Haggarty, Patti (US EPA, Western Ecology Division).
(http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Map 11d. Areas of highest Bird species richness in the Luckiamute / Ash Creek study area. Data are from Weight Species Richness (WSR) grids. Source: : P. Adamus, Pacific Northwest Ecosystem Consortium and U.S. EPA



Luckiamute/Ash Creek/American Bottom
Watershed Assessment
High Bird Species Richness
Map 11d
230 SW Third Street, Suite 212
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High bird species richness
Study area
Major rivers
Major roads
NORTH
0
1
2
4 Miles
Oregon North State Plane coordinate system
HARN datum, international feet
Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.
Habitat Suitability Data Source:
Habitat Suitability Data. Pacific Northwest Ecosystem Consortium. Contact: Haggarty, Patti (US EPA, Western Ecology Division).
(http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Historic Land Cover Conditions

Analysis of pollen and written records from early settlers and surveyors allow us to characterize the vegetation in the region from those earlier times.

Pollen studies show that after the peak of the last glaciation, the climate of the Willamette Valley shifted from cool and wet to warmer and drier. There was a time of transition between 9,000 and 7,000 yrs before present (BP) when trees which thrived in cool, wet conditions, such as Sitka spruce (*Picea sitchensis*) and white pine (*Pinus* sp.), declined in number. By 4,000 years BP, there was an even greater decrease in the abundance of cool-climate species, and an increase in the abundance of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*), which thrived in warmer, drier conditions. White Oak, common to drier climates, increased greatly in abundance during this period (~4,000 BP). After 4,000 BP, the climate became slightly cooler and wetter again, leading to the establishment of forest conditions like those seen today, with Douglas-fir forests and some ponderosa pine on the surrounding hills, and oak and other deciduous species on the valley floor (Aikens, 1986).

Information regarding more recent history can be inferred from the archaeological and historical record. Archaeological information describing the Kalapuyan Indians' use of plants indicates that hazelnut, Oregon grape, salmonberry, elderberry, and ninebark were present in the study area before European settlement (Aikens, 1992).

Descriptions by European-American settlers also give a glimpse of what the Willamette Valley looked like in the years before present. The settlers began arriving in the Luckiamute valley in the mid 1800s, drawn by promises of free land, fertile soils, and a mild climate. One of the earliest European-American settlers to the Luckiamute valley, Anna King, described her impression of the landscape as follows:

"It is a beautiful country as far as I have seen… Soda springs are common and fresh water springs without number. It is now the 1st of April and not a particle of snow has fallen in the valley…There are thousands of strawberries, gooseberries, blackberries, whortleberries, currants, and other wild fruits but no nuts except filberts and a few chestnuts." (Aikens, 1992).

Early cadastral surveys in the valley show the hilly regions in the southwestern portion of the watershed as forested with fir and oak. As noted by Yamhill Basin Council (2001).

Historical accounts from the early 1800s and more recent analyses indicated that open prairie was the dominant feature in the Willamette Valley before settlement (Taft and Haig, 2003). Given hydric soils in this area, it is likely that a large portion of the prairie was wet prairie. Historic accounts written before the 1880s mentioned that the prairies in the winter and spring were "wet and muddy", "covered with water" and "too wet to plow" (Taft and Haig, 2003). These conditions could have been one of the reasons early settlers chose donation land claims in the more hilly, forested areas rather than the valley lowlands, as described in (Barnhart, 1915). By 1871, after continued settlement and the introduction of railroads along the valley floor, farming activities began to increase in the valley lowlands (Taft and Haig, 2003). In order to improve the ability to farm this area, the land was drained through surface ditching between 1860 and 1880. By the early 1900s, more lands were drained by tile drains, as advocated by the State of Oregon (Taft and Haig, 2003). Thus, land use changes between 1800 and 1900 dramatically altered the extent of wet prairies and bottomlands, and facilitated the establishment or spread of several non-native plant species.

Analysis of the Pacific Northwest Ecosystem Research Consortium (PNERC) pre-settlement vegetation layer indicated that the coniferous forests dominated the western, higher elevations of the watershed and a large area along the south central boundary of the Luckiamute/ Ash Creek study area (Map 12). The pre-settlement vegetation of Oregon project was initiated in 1993 and funded by multiple groups including: the Oregon Division of State Lands, the Bureau of Land Management, the Environmental Protection Agency, the Army Corps of Engineers, the Bonneville Power Administration, the Oregon Community Foundation, The Nature Conservancy, and the City of Portland. The GIS layer depicts "pre-settlement" vegetation. According to the metadata file, this layer was created from descriptions made by "surveyors for the General Land Office between 1851 and 1909, when surveying township and section lines. Most low-elevation sites with arable land were surveyed between 1851 and 1865, while most foothill and mountainous areas were surveyed between 1865 and 1895."

We used the PNERC pre-settlement vegetation GIS layer to summarize vegetation in each of the 7^{th} field watersheds in the study area (Table 49). We found that coniferous forests covered approximately 31.9% (76,000 acres) of the study area. Interestingly, shrubby areas were just as common as coniferous forests. Upland and wetland shrubby areas covered much of the eastern, low areas in both the Luckiamute and Ash Creek watersheds covering about 76,114 acres (32.0% of the study area). Much (53,674 acres or ~22.5% of

the study area) of the remaining area was dominated by herbaceous plant communities, wet prairies and natural grasslands. Mixed and deciduous forests (which included Oak Savanna) covered 7.3% and 5.8% of the study area, respectively.

Map 12. Presettlement Land Cover in the Luckiamute/ Ash Creek Study Area. Source: PNERC

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Presettlement Land Cover
Map 12

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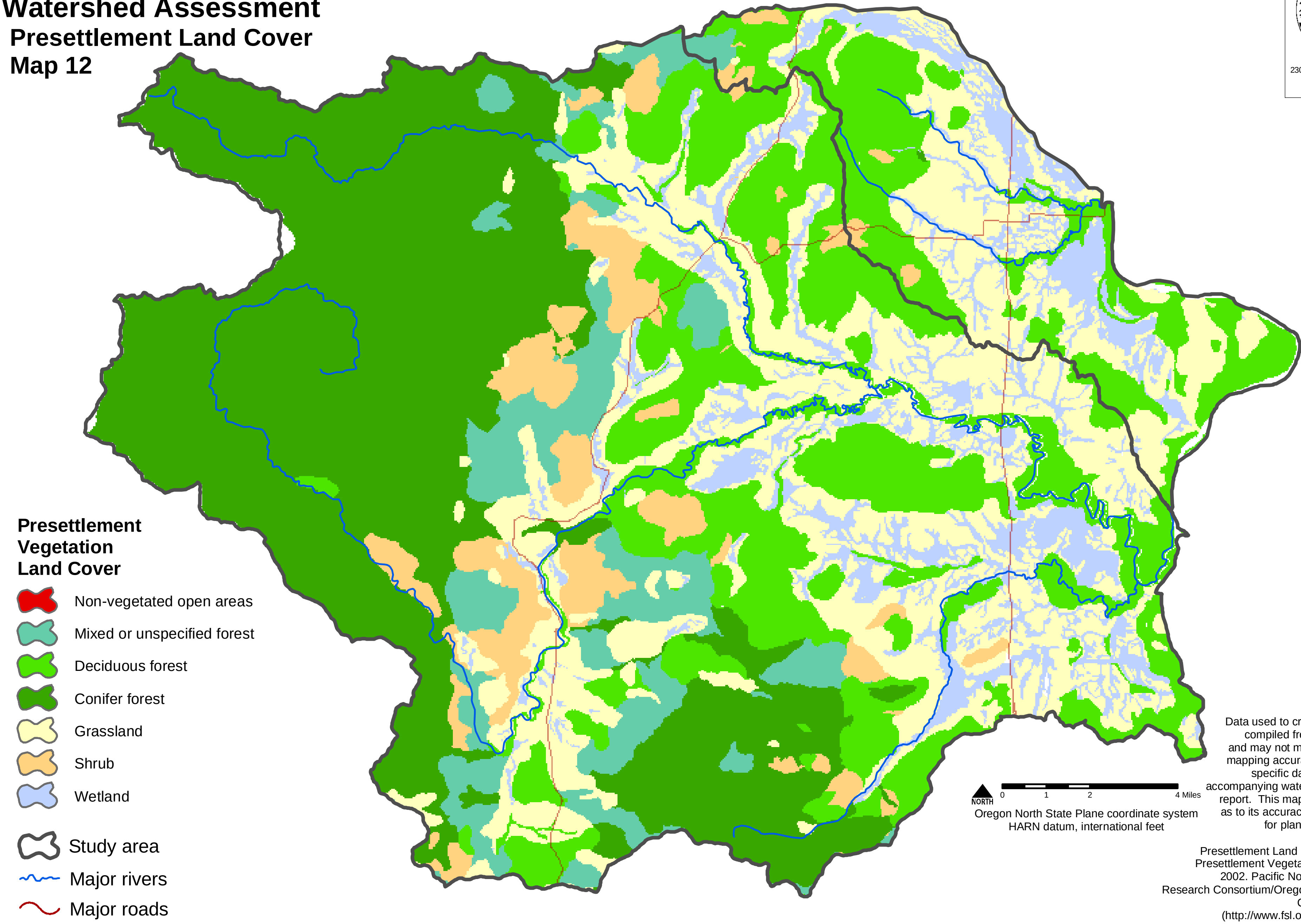


Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Presettlement Land Cover Data Source: Presettlement Vegetation (veg1851_v6). 2002. Pacific Northwest Ecosystem Research Consortium/Oregon State University, Contact: S. Gregory. (http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Table 49 Major habitat cover classes for each of the 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the 7th field watershed IDs and the number of acres for the water, mixed forest, shrub, deciduous and coniferous forest and herbaceous cover classes. Derived from the PNERC pre-settlement vegetation data layer.

Watershed Name	7th Field HUC Name	Water	Forest (unspecified or mixed)	Shrub	Forest (deciduous)	Forest (conifer)	Herbaceous
American Bottom	7020501	319.7	0.0	48.2	1219.1	0.0	980.3
Black Rock Creek	3060603	0.0	0.0	0.0	0.0	3421.6	0.0
Bridgeport	3060704	0.9	75.4	475.0	2021.0	0.0	1015.4
Buena Vista	7020404	260.1	0.0	795.4	110.5	0.0	835.7
Bump Creek	3060305	0.0	1577.9	1093.3	114.8	323.8	1142.8
Clayton Creek	3060403	0.0	831.4	0.0	0.0	1507.5	132.1
Cold Springs	3060602	0.0	0.0	0.0	0.0	1811.3	0.0
Cooper Creek	3060903	0.0	0.0	3713.9	25.9	0.0	1219.5
Cougar Creek	3060202	0.0	0.0	78.8	178.7	5422.3	0.0
Duck Slough	7020502	4.1	0.0	1598.2	255.6	0.0	1127.9
E.E. Wilson	3061301	3.8	0.0	2578.7	104.4	0.0	1908.2
Falls City	3060702	0.0	468.5	621.9	0.0	1556.8	709.9
Fern Creek	3060901	0.2	0.0	3301.4	647.1	0.0	1121.2
Grant Creek	3060803	0.0	266.0	870.1	82.6	705.4	137.9
Harman Slough	7020503	122.0	0.0	1691.8	549.5	0.0	834.1
Helmick	3061003	103.5	0.0	1271.3	783.2	0.0	721.4
Hoskins	3060203	0.5	1094.4	1509.8	69.1	3994.2	621.7
Ira Hooker	3060501	0.0	721.1	556.4	654.8	269.6	472.7
Jont Creek	3060504	1.8	832.3	2922.3	392.2	499.1	959.2
Lower Berry Creek	3061204	0.0	0.0	1456.9	108.9	0.0	1793.9
Lower Little Luckiamute	3060902	4.5	787.3	1769.4	1231.7	0.0	2758.3
Lower North Fork Ash Creek	7020603	0.0	0.0	1892.5	168.8	0.0	1427.2
Lower Pedee Creek	3060401	0.0	1592.8	1590.3	11.0	1820.3	1098.2
Lower South Fork Ash Creek	7020606	0.0	0.0	1762.0	0.0	0.0	1579.1
Lower Teal Creek	3060802	0.0	455.9	785.9	54.5	3049.9	638.1
Luckiamute Landing	3061005	155.3	0.0	1449.5	746.6	0.0	995.9
Maxfield Creek	3060304	0.7	1239.1	1111.5	2.5	2195.6	1368.5
McTimmonds	3060502	0.0	1311.8	2612.3	322.9	195.1	1066.1
Middle Fork Ash Creek	7020604	0.0	0.0	2225.7	85.1	23.6	2124.5

Table 49 Major habitat cover classes for each of the 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the 7th field watershed IDs and the number of acres for the water, mixed forest, shrub, deciduous and coniferous forest and herbaceous cover classes. Derived from the PNERC pre-settlement vegetation data layer.

Watershed Name	7th Field HUC Name	Water	Forest (unspecified or mixed)	Shrub	Forest (deciduous)	Forest (conifer)	Herbaceous
Middle Fork Ash Creek	3060503	0.0	0.0	2642.9	9.7	0.0	1009.8
Middle Luckiamute	7020602	19.6	0.0	4669.4	1224.0	0.0	2516.6
Middle Soap	3061102	0.0	0.0	3152.7	3.6	71.1	1177.0
Palestine	3060102	41.4	0.0	1904.6	37.8	0.0	2212.0
Parker	3061302	4.1	0.0	1395.5	1.8	0.0	2434.3
Peterson Creek	3061004	0.0	0.0	2180.7	63.7	0.0	1502.3
Plunkett Creek	3061203	0.0	651.8	756.7	138.6	316.4	1564.7
Price Creek	3060301	0.0	637.4	282.4	5.2	2012.9	455.0
Rifle Range	3060303	0.0	2.3	1155.6	454.5	189.9	1310.2
Ritner Creek	3061103	0.0	5.2	763.7	1.1	5193.5	479.0
Simpson	3060404	74.3	0.0	2510.3	299.0	0.0	1579.5
Socialist Valley	3061001	0.0	430.0	0.0	0.0	4586.0	7.9
Springhill	3060701	2.5	0.0	1612.6	396.0	0.0	905.2
Staats Creek	3061303	0.0	0.0	1865.5	35.6	0.0	607.7
Uppder Pedee Creek	3061202	0.0	2.7	687.4	0.0	3969.0	21.8
Upper Berry Creek	3061201	2.9	961.7	1010.3	12.4	1157.4	370.8
Upper Little Luckiamute	3060601	0.0	0.0	0.0	0.0	6064.0	0.0
Upper Luckiamute	3060101	0.0	0.0	0.0	0.0	5677.9	0.0
Upper Luckiamute	7020601	0.0	0.0	0.0	0.0	5980.1	0.0
Upper North Fork Ash Creek	3060402	0.0	420.3	1735.0	318.2	0.0	314.3
Upper Soap Creek	3061101	0.0	140.2	1258.9	66.6	4373.8	144.9
Upper South Fork Ash Creek	7020605	1.6	0.0	3033.0	527.9	0.0	2214.0
Upper Teal Creek	3060801	0.0	0.0	0.0	0.0	2232.9	0.0
Vincent Creek	3060204	0.0	1554.8	2026.4	151.0	1725.8	1837.1
Waymire Creek	3060703	0.0	818.6	543.8	122.0	532.1	459.5
Wolf Creek	3060201	0.0	0.0	0.0	0.0	3267.7	0.0
Woods Creek	3060302	0.0	427.7	149.0	0.0	1856.7	346.1
Zumwalt	3061002	0.2	0.0	996.5	12.8	0.0	1415.9

Current Land Cover Conditions

Information on the current land cover/ land use is available from many sources. We selected two commonly used sources for this assessment, land cover/ use from the Institute for a Sustainable Environment and from digital orthoquads photographs (DOQ). These sources illustrate some of the difference in available data. The data from the Institute for a Sustainable Environment are provided as a GIS data file that is the result of the interpretation of multiple data sources. The DOQ, also provided as GIS data files, are aerial photographs that have not been interpreted.

We acquired current land cover/land use data for the study area from the Institute for a Sustainable Environment. This data set was created from data compiled from multiple sources including satellite data and other sources of land use information. There were about 40 land cover categories in the data file. Many of the categories were very specific. For example, numerous crop cover classes were defined including berries and vineyards, hops, mint, radish seed, grains and others. To complete a generalize summary of the land cover/ land use in the study area, we aggregated multiple cover classes. For example, we created an ‘agricultural’ cover class by combining the crop cover classes listed above. In addition, we aggregated the remaining cover classes to create super classes for Forests, Industrial/ Commercial, Flooded/Marsh, Natural Grasslands, Natural Shrub Lands, Residential, Rural, Urban, Roads, and Bare/Fallow Land. These cover classes are summarized in Table 50 and in Map 13. We found that land cover/land use in the study area is currently dominated by forested and agricultural areas.

More information on the cover classes can be found at *http://www.fsl. orst.edu/pnwerc/wrb/ accessNoNewSets.html.*

We summarized existing land cover from the PNERC LULC_90 (LULC is Land Use Land Cover) data set (Table 51). We grouped 60 cover classes into nine major cover classes (and a background class). These data were generated from researchers using satellite imagery, aerial photographs, and other data sources. These data were last updated in 1999. We found that coniferous forests dominate the current Luckiamute and Ash Creek watersheds, covering ~76,153 acres or about 32% of the study area (Map 13). Interestingly, current coniferous forests cover approximately the same extent as pre-settlement coniferous forests. Herbaceous cover classes, including crops, hay fields, pasture, hops and mint fields, as well as natural grasslands, are the second largest cover class in the study area covering 70,623 acres. Mixed and deciduous forests, shrubs and urban areas account for 42,550 acres, 19,606 acres, 18,185 acres, and 8,210 acres, respectively.

Digital orthophotos are another important resource for understanding and interpreting land cover. For this project, digital orthophoto quads (DOQs) were obtained from the Oregon Geospatial Data Clearinghouse (formerly the State Service Center for GIS). This imagery was collected in 2000 and covers the entire study area with a resolution of 1m. A digital orthoquad is an aerial photograph, which has been corrected for the horizontal displacement that occurs when using aerial photography and has been spatially referenced for use in a GIS. Because the data are spatially referenced photographs, the DOQs give a bird's eye view of the entire study area, in this case, as it looked in around 2000. Because they are spatially referenced, other GIS data layers, such as roads or vegetation, can be placed "over" the DOQs in a GIS for mapping or data verification (Fig. 7, Map 14). These datasets can be very useful for detecting specific types of land cover such as riparian areas and infrastructure. **We recommend that the DOQs be used to evaluate and map future monitoring and restoration sites. Since the DOQ photographs are already georeferenced, new information can be entered into the LWC GIS by locating sites on the DOQs.**

Table 50. Land cover/Land use for the study area as summarized from ec90 (Institute for a Sustainable Environment, 1999).

Land Cover/Land Use	Area (acres)	% of Total Area
Agriculture	72,721.5	30.9
Forested	133,144.2	56.6
Industrial/Commercial	281.8	0.1
Flooded/Marsh	704.3	0.3
Natural grassland	3,120.7	1.3
Natural shrub	15,572.2	6.6
Residential	1,692.8	0.7
Rural	3,002.6	1.3
Urban	654.8	0.3
Roads	2,601.7	1.1
Water	1,072.9	0.5
Bare/fallow	860.3	0.4
Topographic Shadow	14.0	0.0

Table 51. Current major land cover classes for each of the 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the 7th field watershed IDs and the number of acres for the coniferous forest, herbaceous, mixed forest, deciduous forest, shrub, urban, water, non-vegetated open, and wetland cover classes. Derived from the PNERC LULC_90 vegetation data layer.

7th Field Watershed Name	Forest (conifer)	Herbaceou s	Forest (unspecifie d or mixed)	Forest (deciduous)	Shrub	Urban	Water	vegetated open areas	Wetland	Background
Vincent Creek	4,025.5	427.5	2,064.6	329.4	385.9	51.1	4.3	3.8	2.7	0.2
Upper Soap Creek	2,770.4	119.7	2,455.9	456.3	157.7	17.6	0.5	4.1	2.05	0.2
Woods Creek	892.6	307.1	1,165.3	265.5	133.7	11.9	0.2	1.4	1.1	0.7
Price Creek	1,186.4	333.0	1,324.1	373.5	142.2	13.1	0.2	19.1	1.1	0.0
Middle Soap Creek	1,691.1	1,165.3	761.2	254.5	441.9	66.6	0.0	6.8	17.1	0.0
Plunkett Creek	913.1	830.7	915.8	213.3	402.1	98.1	0.2	47.7	7.2	0.0

Table 51. Current major land cover classes for each of the 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the 7th field watershed IDs and the number of acres for the coniferous forest, herbaceous, mixed forest, deciduous forest, shrub, urban, water, non-vegetated open, and wetland cover classes. Derived from the PNERC LULC_90 vegetation data layer.

7th Field Watershed Name	Forest (conifer)	Herbaceou s	Forest (unspecifie d or mixed)	Forest (deciduous)	Shrub	Urban	Water	vegetated open areas	Wetland	Background
Palestine	31.5	2,826.5	50.6	324.2	700.4	202.5	3.2	18.0	38.9	0.0
Springhill	32.6	2,021.4	59.9	213.5	295.9	224.8	14.6	3.8	49.5	0.2
Rifle Range	815.0	1,398.2	308.5	271.8	266.0	34.0	0.0	3.2	16.0	0.0
Maxfield Creek	2,049.5	755.3	2,001.8	504.0	440.3	91.6	9.2	57.6	7.9	0.5
Upper Berry Creek	1,753.2	455.4	1,088.8	124.7	65.9	14.4	2.9	6.8	3.2	0.2
Bump Creek	2,066.4	444.6	938.0	249.8	422.3	72.2	0.0	49.1	10.1	0.0
Staats Creek	765.5	982.4	327.2	166.1	200.7	34.4	0.0	26.3	6.3	0.0
Hoskins	3,041.8	549.2	2,827.8	501.3	310.1	43.4	1.6	6.5	7.9	0.0
E.E. Wilson	62.8	3,724.7	47.9	269.3	293.0	178.0	0.2	2.5	16.9	0.0
Lower Berry Creek	220.7	2,778.3	58.3	125.8	106.0	49.3	13.5	0.7	7.2	0.0
Ira Hooker	1,071.7	259.9	815.6	235.8	227.9	49.5	0.7	8.8	4.7	0.0
Luckiamute Landing	3.2	2,534.4	85.1	247.3	180.0	126.7	136.6	0.5	33.5	0.0
Peterson Creek	137.9	2,327.6	54.5	365.0	625.1	185.2	0.5	46.6	4.5	0.0
Cougar Creek	2,833.4	50.4	2,079.5	646.4	62.6	5.4	0.2	3.4	0.5	0.5
Jont Creek	2,091.2	1,446.5	925.2	479.5	452.3	160.7	1.4	35.1	15.1	0.0
Helmick	15.5	1,930.3	68.0	385.9	200.5	123.3	102.4	14.9	38.7	0.0
Clayton Creek	1,139.4	60.5	983.0	230.6	50.4	5.4	0.0	0.7	0.9	0.0
Buena Vista	0.5	1,071.7	44.6	320.0	226.8	118.8	194.0	6.8	18.0	0.7
Ritner Creek	3,924.9	242.1	1,791.2	320.9	123.3	36.2	0.0	0.7	3.15	0.0
Middle Luckiamute	1,329.8	4,615.2	818.3	520.0	769.5	316.1	0.2	15.5	45.0	0.0
Lower Pedee Creek	2,861.1	619.9	1,460.0	572.2	483.5	89.1	0.2	14.6	12.0	0.0
Wolf Creek	1,726.7	3.8	1,154.7	370.4	9.5	0.0	0.0	1.8	0	0.9
Zumwalt	53.1	1,899.5	51.1	135.5	195.8	82.8	0.2	1.6	6.1	0.0
McTimmonds	2,518.0	494.1	1,546.7	399.8	404.1	119.5	0.5	17.8	7.7	0.0
Ira Hooker	0.2	1,361.7	70.4	331.2	535.1	52.2	193.5	0.5	21.0	1.6
Miller Creek	3,530.7	4.1	1,733.2	390.6	20.0	0.0	0.0	0.7	0.0	0.5
Upper Pedee Creek	2,484.2	20.0	1,791.7	351.2	32.9	0.9	0.0	0.0	0.0	0.0
Simpson	247.3	2,662.9	260.1	701.3	411.1	63.7	72.5	17.8	26.6	0.0
Upper Luckiamute	3,674.9	11.0	1,660.3	589.1	33.5	0.0	0.0	6.1	0.0	0.2
Grant Creek	993.6	68.6	751.1	144.7	96.1	5.4	0.2	0.5	0.9	0.9
Lower South Fork Ash Creek	0.0	2,334.4	14.0	74.5	223.9	679.1	0.2	7.4	7.7	0.0
Harman Slough	0.0	2,103.5	46.8	183.4	197.8	398.9	224.8	18.5	23.4	0.2
Lower North Fork Ash Creek	4.1	2,293.0	51.3	152.1	250.9	639.5	86.4	5.2	6.1	0.0
Upper Teal Creek	1,919.3	0.0	266.0	46.6	0.0	0.0	0.0	0.0	0.0	1.1
Lower Little Luckiamute	1,061.6	3,126.6	705.6	717.3	630.9	239.0	3.6	17.1	49.5	0.0
Cold Springs	1,633.5	0.0	117.9	60.3	0.0	0.0	0.0	0.0	0.0	0.0

Table 51. Current major land cover classes for each of the 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the 7th field watershed IDs and the number of acres for the coniferous forest, herbaceous, mixed forest, deciduous forest, shrub, urban, water, non-vegetated open, and wetland cover classes. Derived from the PNERC LULC_90 vegetation data layer.

7th Field Watershed Name	Forest (conifer)	Herbaceous	Forest (unspecified or mixed)	Forest (deciduous)	Shrub	Urban	Water	vegetated open areas	Wetland	Background
Lower Teal Creek	2,850.1	470.3	1,061.6	260.6	229.1	91.1	0.2	9.2	10.6	1.6
Cooper Creek	327.8	2,153.3	452.9	918.5	908.3	150.8	0.0	15.1	32.6	0.0
Upper South Fork Ash Creek	265.7	3,203.6	359.1	827.3	829.8	238.5	2.3	36.7	13.5	0.0
Falls City	1,230.5	457.2	531.9	263.0	347.0	508.3	0.0	14.2	4.7	0.2
Black Rock Creek	2,748.2	7.0	555.1	102.6	7.0	0.0	0.0	0.9	0	0.9
Middle Fork Ash Creek	161.8	2,375.6	194.0	547.7	596.9	532.4	12.6	27.0	11.0	0.0
Fern Creek	480.2	2,080.6	271.8	833.9	1,071.2	216.9	1.6	93.4	20.5	0.0
Bridgeport	628.2	1,240.0	428.2	403.2	671.2	139.1	1.6	58.7	17.6	0.0
Upper Little Luckiamute	4,883.9	0.0	1,035.7	142.9	0.0	0.0	0.0	0.0	0.0	1.1
Socialist Valley	3,733.7	45.9	1,003.5	170.6	57.8	9.7	0.0	1.8	0.0	0.9
Waymire Creek	784.4	302.2	574.0	323.8	384.8	77.2	0.2	26.3	3.2	0.0
Middle North Fork Ash Creek	173.3	1,737.7	69.3	347.6	634.1	659.3	0.0	32.9	8.3	0.0
Upper North Fork Ash Creek	310.3	677.3	193.5	372.2	680.4	505.4	0.2	39.2	9.5	0.0
Duck Slough	0.2	2,155.1	64.8	377.6	228.2	122.9	3.4	0.0	33.3	0.5
Parker	1.8	3,066.5	14.0	101.5	332.8	259.2	17.3	15.5	27.0	0.0

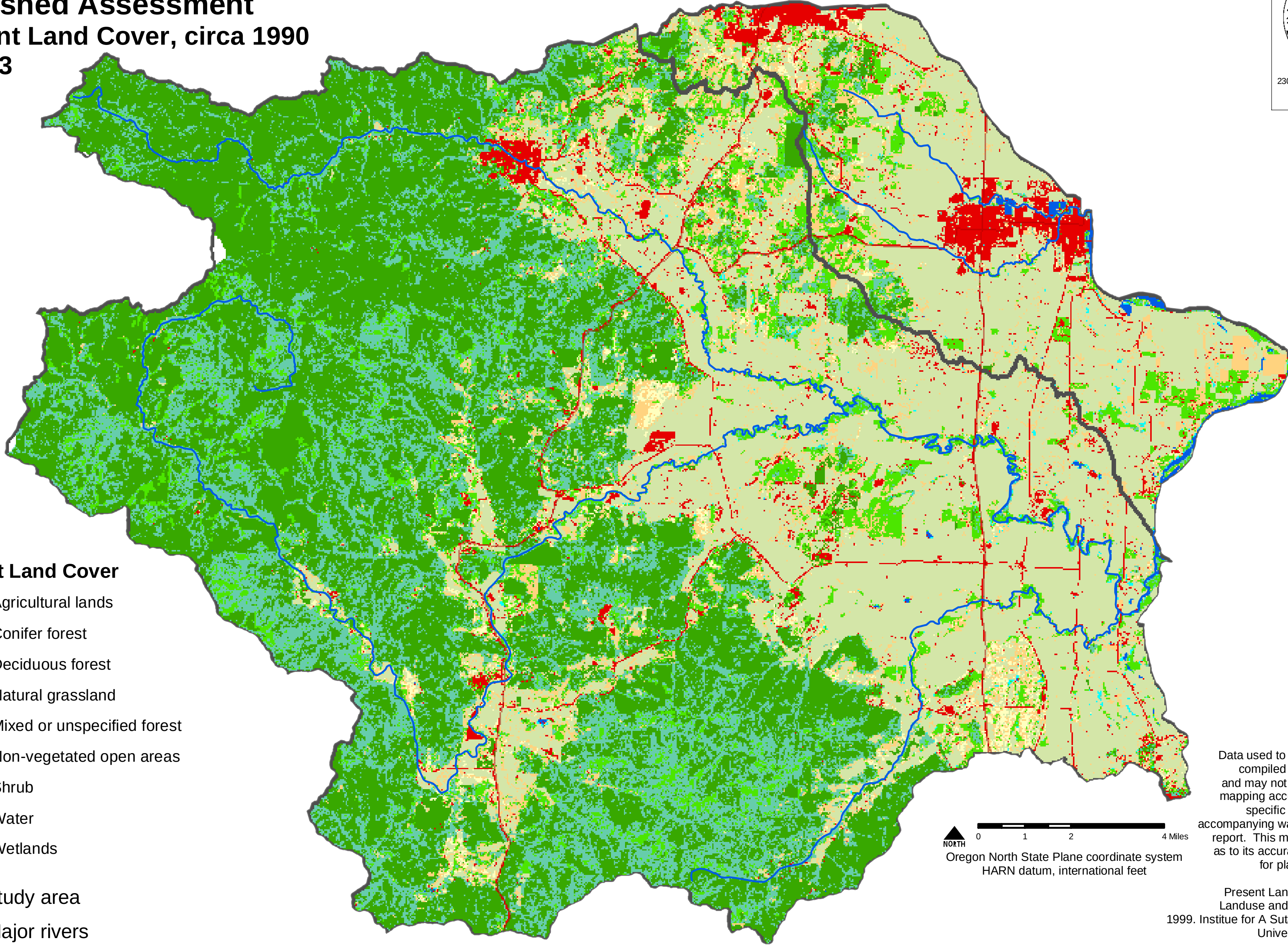
Map 13. Present land cover, circa 1990. Shown are major land cover classes, major rivers, and major roads. Source: Institute for a Sustainable Environment.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Present Land Cover, circa 1990

Map 13

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Present Land Cover

- Agricultural lands
- Conifer forest
- Deciduous forest
- Natural grassland
- Mixed or unspecified forest
- Non-vegetated open areas
- Shrub
- Water
- Wetlands

- Study area
- Major rivers
- Major roads

NORTH

0 1 2 4 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Present Land Cover Data Source: Landuse and Landcover ca. 1990. 1999. Institue for A Sutainable Environment, University of Oregon (ISE), Contact: D. Hulse. (http://www.fsl.orst.edu/pnwerc/wrb/access.html)

Map 14. Example roads on Digital Orthoquads (DOQs). Notice how access to forested lots can be planned using DOQ and available roads layers.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Digital Orthophoto Quadrangles (DOQs)

Map 14

Roads

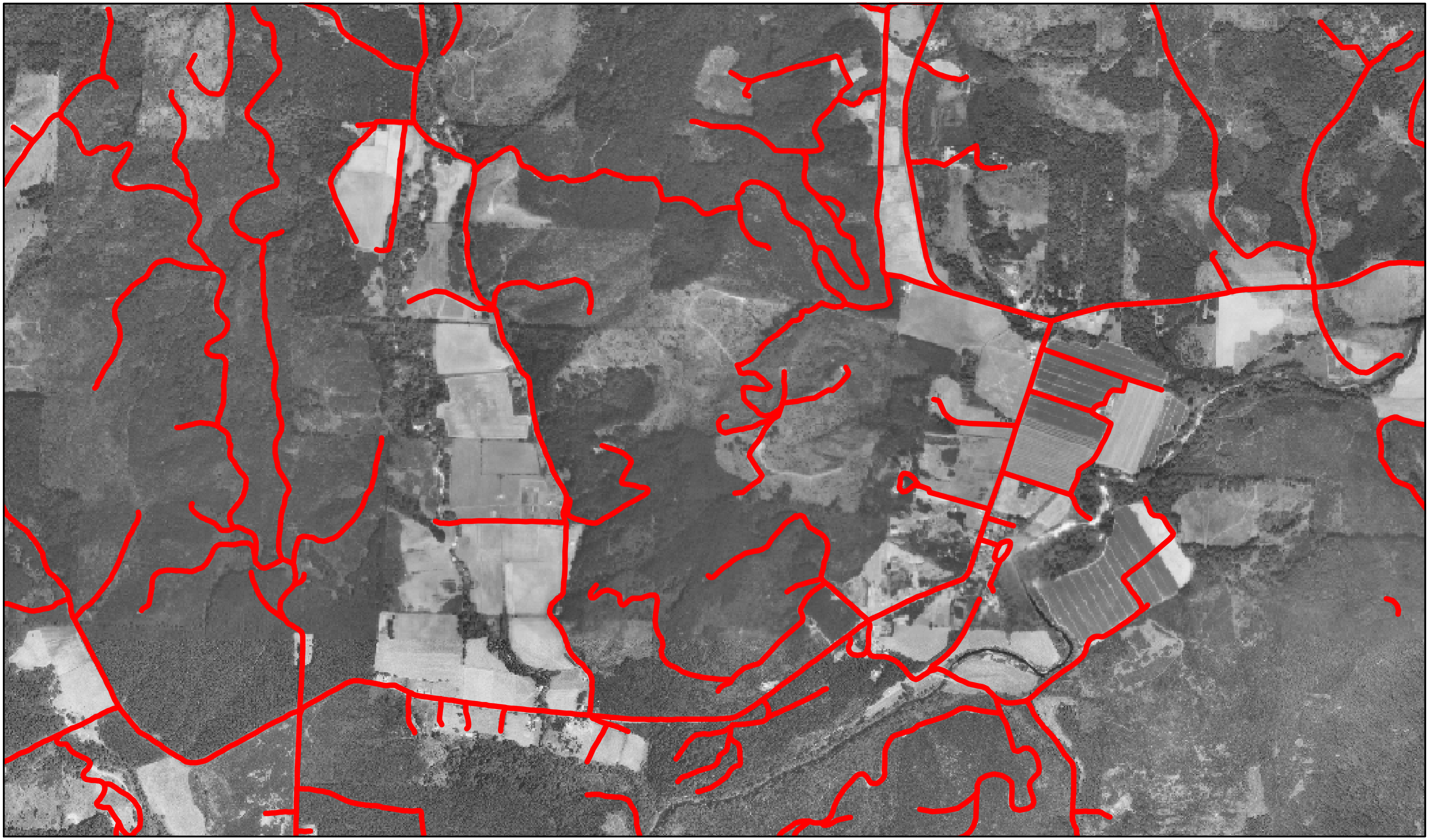
NORTH 0 0.125 0.25 0.5 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Digital Orthophoto Quad (DOQ) Data Source:
Courtesy of Polk County, Oregon
contact: PInotti, B.
(http://www.co.polk.or.us/)

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Change in Forested and Non-Forested Areas

We were interested in quantifying the amount of change that occurred in the study area in the major land cover classes. Using GIS, we combined cover classes from the pre-settlement vegetation and current vegetation data layers and calculated the change that has occurred in the spatial extent of these major cover classes (Table 52)

Table 52. Change in major vegetation cover classes from pre-Settlement to present day. Shown are acres and percent change.

			Change	
	Pre-Settlement Cover	Current Cover	Change (Acres)	Percent Change
Forest (Unspecified or Mixed)	17,306.1	42,550.2	25,244.1	10.6%
Herbaceous	53,674.9	70,632.7	16,957.8	7.1%
Urban	0.0	8,210.5	8,210.5	3.4%
Forest (Deciduous)	13,821.1	19,606.7	5,785.6	2.4%
Forest (Conifer)	76,002.5	76,153.3	150.8	0.1%
Water	1,123.4	1,107.9	-15.5	0.0%
Shrub	76,114.6	18,185.4	-57,929.2	-24.3%

The proportion of area covered by many of the cover types is surprisingly similar to pre-settlement areas. The largest changes are in the shrub category (a large amount of wetland shrub communities existed at the time of settlement) and in the mixed forested classes. Judging from the results presented in Table 52, shrubby areas have been replaced by all of the other cover classes (which experienced net increases). Of course, the distribution of these major cover classes have changed on the landscape even though the total areas remained similar (see Maps 11 and 12). The fragmented modern landscape has profound implications for wildlife.

Not only has the spatial extent of forest changed, but so has its composition and structure. Logging in the past 150 years has manipulated the vegetation towards the younger seral stages (less than 80 years-old). Late-seral and old growth forests once occupied 60 to 80% of the Coast Range landscape [Agee 1993, in (Licata *et al.*, 1998)], In contrast, 96% of the Luckiamute and Rickreall watersheds are currently in early and mid-seral stages (Licata *et al.*, 1998).

Oak Savanna

The LWC identified oak savanna as a community of interest. According to our summary of historic landcover, oak savanna (as part of a deciduous forest), covered about 7% of the Luckiamute/ Ash Creek study area. As previously described, there is a difference between oak savanna and oak forests. Unfortunately, it is impossible to determine how much of the 7% of the deciduous forest was actually oak savanna using the existing data. Nevertheless, we do know that modern oak stands have become increasingly dominated by Douglas-fir in many parts of the watershed. This may be a consequence of fire suppression (Ferguson and Miller, 2002). Also, in the absence of fire many oak stands have become crowded, leading to slower growth rates, stunting, smaller diameters, and fewer tree cavities essential to several nesting birds and mammals. A survey of nine Willamette Valley oak stands (not just in the Luckiamute watershed) found two-thirds had measurable Douglas-fir in the canopy and subcanopy (Hagar and Stern, 2001).

The LWC members recognized the importance of oak savannas and expressed an interest in mapping the current extent of Oak savanna within the study area. We were unable to find a data source describing the extent of this type of habitat. After reviewing a number of data sets, we provided the council with a series of maps that should help them to develop their own data set. **We recommend that the locations on the maps be visited and observations recorded and that oak forests be separated from 'true' oak savannas. These observations can be use to refine the GIS data sets which describe the extent of oak savannas.**

Wetland Analyses

As previously mentioned, there are no good data sets describing the spatial extent of wetlands for the entire study area. National Wetland Inventory maps exist for portions of the study area and we used land cover and hydric soils to describe the current distribution of 'potential' wetlands.

Wetland conservation and restoration will most likely be an important component of the LWC action planning process. **Since it was not the intention of this analysis to select individual sites for consideration, we recommend that when it comes time to prioritize sites, the floodplain, riparian, soils, and wildlife WSR grids be used to prioritize sites.**

Riparian Analyses

We were unable to find a data set describing the current riparian conditions with in the Luckiamute/ Ash Creek study area. Information on riparian condition can be used for planning monitoring and restoration actions. Therefore, at the request of LWC we created a GIS data layer describing 11 cover classes within the riparian zone. We defined the riparian zone as extending 100ft on either side of the streams. In this case, we used the 1:24,000 streams layer. In GIS, we use the digital orthoquads (black and white photographs) to identify and outline areas belonging to the following cover classes: bare areas having little or no vegetation; developed areas with obvious buildings, structures or parking lots; coniferous forests both dense and sparse categories; deciduous forests both dense and sparse categories; mixed forests (not readily identifiable as coniferous or deciduous) both dense and sparse categories; treed-strips areas with a narrow strip of large trees along the river (may provide shade) but predominantly non-forested; and water.

All cover classes were subjectively interpreted from the photographs (Fig. 7). Due to time constraints, no assessment of classification accuracy was made. **We recommend that LWC ground truth the riparian vegetation layer created in this assessment.**

In general, vegetation in the riparian areas mirrors patterns in land cover in the rest of the watersheds. The Luckiamute watershed is dominated by dense conifer forests (43.5% of the riparian zone) and dense deciduous forests (19.4% of the riparian zone). About 18.4% of the riparian zone is herbaceous land cover indicating that there may be ample opportunity for stream side planting wherever appropriate. In contrast, the Ash Creek watershed is dominated by herbaceous cover (45.3% of the riparian zone) and only 13.5% and 12.9% of the riparian zone is covered with dense coniferous and deciduous forests, respectively.

We then examined the condition of the riparian zone within each 7th field watershed by tallying the area covered by each of the cover classes. Cover data are expressed as a percent of the total riparian zone area for each 7th field watershed (Table 53).

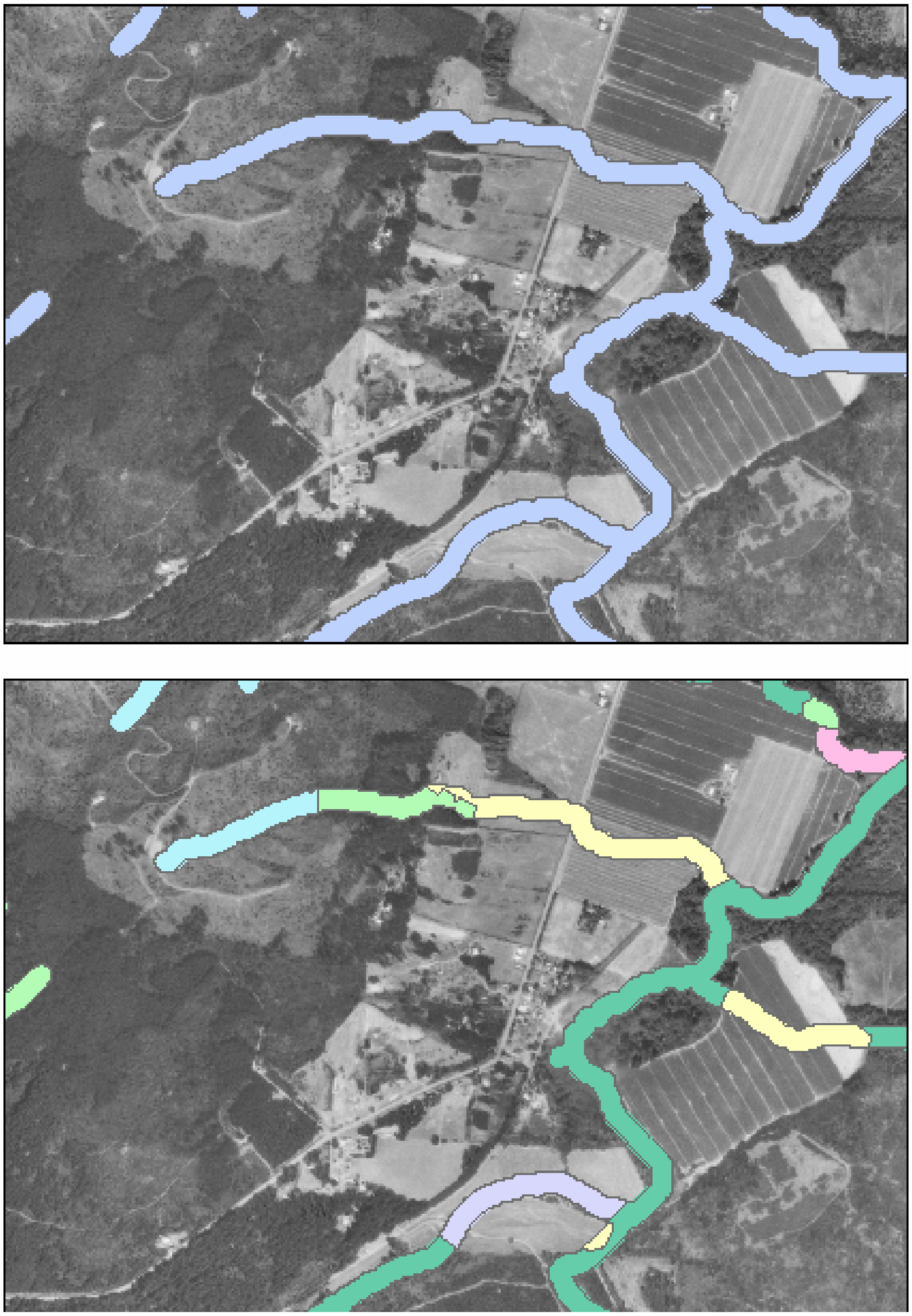


Figure 7. Example of how riparian areas were interpreted from black and white DOQs. Top shows 100ft buffer strip. Bottom shows areas of different cover classes: dark green is dense deciduous forest, yellow is herbaceous, blue is sparse coniferous forest, and pink is sparse mixed forest (see text for details).

Table 53. Land cover within the riparian zone for each of the 7th field watersheds in the study area. Shown are the % of the total riparian zone by cover class for each 7th field watershed.

				Forest								
				Conifer		Deciduous		Mixed				
7th Field HUC	Name	Bare	Developed	Dense	Sparse	Dense	Sparse	Dense	Sparse	herbaceous	treed-strip	water
3060101	Upper Luckiamute	0.0%	0.0%	69.0%	6.2%	3.1%	0.0%	16.3%	0.0%	5.4%	0.0%	0.0%
3060102	Miller Creek	0.0%	0.0%	72.8%	12.0%	9.6%	0.0%	0.0%	0.0%	5.6%	0.0%	0.0%
3060201	Wolf Creek	0.0%	0.0%	74.2%	2.3%	12.0%	0.6%	0.0%	0.0%	11.0%	0.0%	0.0%
3060202	Cougar Creek	0.0%	7.2%	70.7%	0.4%	11.6%	0.2%	0.0%	0.0%	9.8%	0.0%	0.0%
3060203	Hoskins	0.0%	5.4%	43.5%	3.1%	21.4%	4.4%	2.5%	0.8%	17.7%	0.8%	0.3%
3060204	Vincent Creek	0.0%	0.0%	61.2%	15.3%	10.2%	1.5%	0.0%	0.0%	11.4%	0.4%	0.0%
3060301	Plunkett Creek	0.0%	0.6%	25.8%	5.2%	27.2%	4.6%	15.3%	0.4%	12.5%	8.5%	0.0%
3060302	Woods Creek	0.0%	0.0%	16.6%	5.7%	33.3%	2.3%	15.2%	0.0%	20.5%	6.0%	0.4%
3060303	Price Creek	0.0%	0.0%	18.9%	40.7%	19.6%	1.1%	0.0%	1.9%	17.2%	0.6%	0.0%
3060304	Maxfield Creek	0.0%	0.0%	25.1%	25.4%	22.2%	4.6%	1.4%	1.0%	12.1%	7.5%	0.6%
3060305	Bump Creek	0.0%	0.2%	62.8%	8.0%	15.2%	0.4%	7.2%	0.0%	3.5%	2.6%	0.1%
3060401	Lower Pedee Creek	0.0%	0.0%	52.3%	6.9%	21.2%	3.1%	1.8%	1.3%	12.4%	1.0%	0.0%
3060402	Upper Pedee Creek	0.6%	0.0%	87.5%	0.1%	3.8%	0.0%	2.7%	0.0%	4.7%	0.6%	0.1%
3060403	Clayton Creek	0.0%	0.0%	90.5%	1.1%	4.2%	0.7%	0.0%	0.0%	3.4%	0.0%	0.0%
3060404	Ritner Creek	0.0%	0.2%	71.9%	8.0%	10.3%	0.8%	0.0%	1.6%	6.8%	0.5%	0.0%
3060501	Ira Hooker	0.0%	0.0%	41.3%	2.8%	31.4%	8.4%	2.3%	0.1%	13.9%	0.0%	0.0%
3060502	McTimmonds	0.0%	0.3%	41.4%	16.5%	11.4%	0.6%	2.1%	1.8%	22.4%	3.5%	0.0%
3060503	Middle Luckiamute	0.0%	0.1%	17.4%	7.6%	38.0%	2.3%	0.0%	0.0%	27.5%	6.9%	0.1%
3060504	Jont Creek	0.0%	0.0%	33.7%	7.0%	16.6%	6.3%	6.7%	1.9%	25.9%	1.9%	0.1%
3060601	Upper Little Luckiamute	0.1%	0.0%	80.3%	9.9%	0.0%	0.1%	1.3%	0.0%	8.3%	0.0%	0.0%
3060602	Cold Springs	0.0%	0.0%	68.3%	13.4%	8.9%	4.3%	0.4%	0.0%	4.8%	0.0%	0.0%
3060603	Black Rock Creek	0.0%	0.0%	56.1%	10.1%	7.3%	1.1%	0.4%	0.5%	24.4%	0.0%	0.0%
3060701	Socialist Valley	0.0%	0.1%	65.0%	3.1%	10.9%	0.0%	0.0%	0.0%	18.5%	2.5%	0.0%

Table 53. Land cover within the riparian zone for each of the 7th field watersheds in the study area. Shown are the % of the total riparian zone by cover class for each 7th field watershed.

				Forest								
				Conifer		Deciduous		Mixed				
7th Field HUC	Name	Bare	Developed	Dense	Sparse	Dense	Sparse	Dense	Sparse	herbaceous	treed-strip	water
3060702	Falls City	0.0%	0.0%	35.5%	2.4%	35.5%	13.8%	1.7%	0.0%	5.8%	5.2%	0.0%
3060703	Waymire Creek	0.0%	0.0%	57.5%	2.7%	8.5%	15.1%	0.0%	0.0%	9.7%	6.6%	0.0%
3060704	Bridgeport	0.5%	0.1%	28.5%	9.2%	13.8%	11.0%	6.3%	3.3%	15.8%	11.0%	0.4%
3060801	Upper Teal Creek	0.2%	0.0%	62.1%	6.4%	8.4%	3.3%	0.0%	4.0%	15.6%	0.0%	0.0%
3060802	Lower Teal Creek	0.0%	0.5%	41.1%	2.8%	29.1%	3.7%	5.0%	0.0%	16.7%	0.9%	0.1%
3060803	Grant Creek	0.0%	0.0%	47.1%	11.0%	23.5%	0.0%	9.8%	0.0%	8.7%	0.0%	0.0%
3060901	Fern Creek	0.0%	0.2%	21.3%	10.5%	5.9%	8.5%	0.0%	1.2%	40.3%	11.9%	0.2%
3060902	Lower Little Luckiamute	0.0%	0.7%	12.0%	5.3%	41.7%	3.1%	0.6%	0.8%	27.4%	7.3%	1.0%
3060903	Cooper Creek	0.0%	0.0%	11.2%	2.5%	24.8%	6.1%	0.0%	0.3%	37.7%	17.4%	0.0%
3061001	Simpson	0.0%	0.6%	10.5%	1.9%	51.0%	7.2%	0.0%	0.7%	16.7%	11.4%	0.0%
3061002	Zumwalt	0.0%	0.0%	13.7%	1.2%	17.6%	3.9%	0.0%	0.0%	35.6%	28.0%	0.0%
3061003	Helmick	0.0%	1.8%	0.0%	0.0%	73.1%	1.2%	0.0%	0.0%	23.9%	0.0%	0.0%
3061004	Parker	0.0%	1.4%	9.9%	0.0%	9.3%	14.2%	0.0%	0.0%	55.3%	9.9%	0.0%
3061005	Luckiamute Landing	0.0%	0.0%	0.6%	1.8%	71.0%	0.0%	0.0%	0.0%	21.5%	0.0%	5.1%
3061101	Upper Soap Creek	0.0%	0.1%	41.7%	11.4%	17.3%	1.6%	17.3%	0.0%	9.3%	1.3%	0.0%
3061102	Middle Soap Creek	0.0%	0.0%	31.9%	3.5%	33.6%	7.2%	0.0%	0.0%	14.4%	9.5%	0.0%
3061103	Rifle Range	0.0%	0.6%	30.3%	1.3%	30.8%	2.4%	0.0%	0.0%	21.7%	12.9%	0.0%
3061201	Upper Berry Creek	0.0%	0.0%	72.2%	1.7%	8.5%	2.2%	2.9%	0.0%	11.4%	1.1%	0.0%
3061202	Staats Creek	0.0%	0.0%	26.5%	7.0%	8.9%	3.4%	0.0%	0.0%	48.1%	5.9%	0.2%
3061203	Peterson Creek	0.0%	0.0%	11.3%	0.6%	2.1%	4.4%	0.0%	0.0%	78.0%	3.6%	0.0%
3061204	Lower Berry Creek	0.0%	0.1%	9.0%	1.9%	12.3%	5.6%	0.0%	0.0%	66.9%	2.1%	2.2%
3061301	E.E. Wilson	0.0%	0.2%	0.0%	0.0%	83.1%	1.6%	0.0%	0.0%	10.9%	4.3%	0.0%

Table 53. Land cover within the riparian zone for each of the 7th field watersheds in the study area. Shown are the % of the total riparian zone by cover class for each 7th field watershed.

				Forest								
				Conifer		Deciduous		Mixed				
7th Field HUC	**Name**	**Bare**	**Developed**	**Dense**	**Sparse**	**Dense**	**Sparse**	**Dense**	**Sparse**	**herbaceous**	**treed-strip**	**water**
3061302	Palestine	0.0%	1.4%	0.0%	0.0%	24.3%	21.0%	0.0%	0.0%	48.8%	4.5%	0.0%
3061303	Springhill	0.0%	1.7%	1.7%	3.5%	29.6%	12.2%	0.0%	0.0%	42.9%	8.6%	0.0%
7020404	Buena Vista	0.0%	1.3%	0.0%	0.0%	16.8%	0.0%	0.0%	0.0%	78.6%	3.2%	0.2%
7020501	American Bottom	0.0%	0.0%	0.0%	0.0%	50.2%	9.3%	0.0%	0.0%	24.8%	0.0%	15.7%
7020502	Duck Slough	0.0%	0.2%	3.2%	4.2%	9.6%	2.6%	3.2%	0.0%	61.9%	15.2%	0.0%
7020503	Harman Slough	0.0%	0.0%	5.5%	0.0%	11.0%	8.2%	0.0%	0.0%	61.6%	12.8%	0.8%
7020601	Upper North Fork Ash Creek	0.0%	1.4%	16.7%	20.4%	1.2%	8.4%	0.0%	3.2%	25.2%	23.2%	0.4%
7020602	Middle North Fork Ash Creek	0.0%	4.7%	5.7%	3.9%	4.3%	17.9%	0.0%	0.0%	49.5%	13.9%	0.0%
7020603	Lower North Fork Ash Creek	0.0%	4.1%	0.6%	5.0%	30.6%	6.7%	0.0%	0.0%	53.0%	0.0%	0.0%
7020604	Middle Fork Ash Creek	0.0%	0.4%	24.7%	11.1%	14.9%	5.1%	0.0%	0.0%	32.0%	11.7%	0.0%
7020605	Upper South Fork Ash Creek	0.0%	0.1%	24.0%	3.1%	9.3%	3.3%	0.6%	0.0%	51.5%	7.7%	0.4%
7020606	Lower South Fork Ash Creek	0.0%	0.0%	7.5%	0.3%	40.7%	9.2%	3.6%	4.6%	26.8%	4.8%	2.4%

Stream Channel Percent Shade

Vegetation and landforms provide shade to streams thereby keeping water temperatures cool. We used the riparian GIS layer described above to rank 7th field watersheds by the amount of dense forests (either coniferous or deciduous) in the riparian zones. Table 54 shows the proportion of dense forest, either coniferous, deciduous, or mixed, in the riparian buffer zone. We calculated the proportion of dense forest by summing the total percentages for each of the dense forest classes and dividing by 3. Lower ranked watersheds would be those watersheds that may benefit from riparian plantings. Using the same data set, we also mapped stream reaches that were open (*i.e.*, were not shaded). Some of these areas may be prioritized for stream side plantings (Map 15).

Table 54. List of 7th field watersheds ranked according to the amount of dense forest occurring within the riparian zone.

Name	7th Field HUC	Proportion of Dense Forest
Clayton Creek	3060403	31.6%
Upper Pedee Creek	3060402	31.3%
Upper Luckiamute	3060101	29.4%
Wolf Creek	3060201	28.7%
Bump Creek	3060305	28.4%
Upper Berry Creek	3061201	27.9%
E.E. Wilson	3061301	27.7%
Miller Creek	3060102	27.5%
Cougar Creek	3060202	27.5%
Ritner Creek	3060404	27.4%
Upper Little Luckiamute	3060601	27.2%
Grant Creek	3060803	26.8%
Cold Springs	3060602	25.9%
Upper Soap Creek	3061101	25.4%
Socialist Valley	3060701	25.3%
Lower Pedee Creek	3060401	25.1%
Lower Teal Creek	3060802	25.1%
Ira Hooker	3060501	25.0%
Helmick	3061003	24.4%
Falls City	3060702	24.2%
Luckiamute Landing	3061005	23.9%
Vincent Creek	3060204	23.8%
Upper Teal Creek	3060801	23.5%
Plunkett Creek	3060301	22.8%
Hoskins	3060203	22.5%
Waymire Creek	3060703	22.0%
Middle Soap Creek	3061102	21.8%
Woods Creek	3060302	21.7%
Black Rock Creek	3060603	21.3%
Simpson	3061001	20.5%
Rifle Range	3061103	20.4%
Jont Creek	3060504	19.0%
Middle Luckiamute	3060503	18.5%
McTimmonds	3060502	18.3%
Lower Little Luckiamute	3060902	18.1%
Lower South Fork Ash Creek	7020606	17.3%
American Bottom	7020501	16.7%
Maxfield Creek	3060304	16.2%

Table 54. List of 7th field watersheds ranked according to the amount of dense forest occurring within the riparian zone.

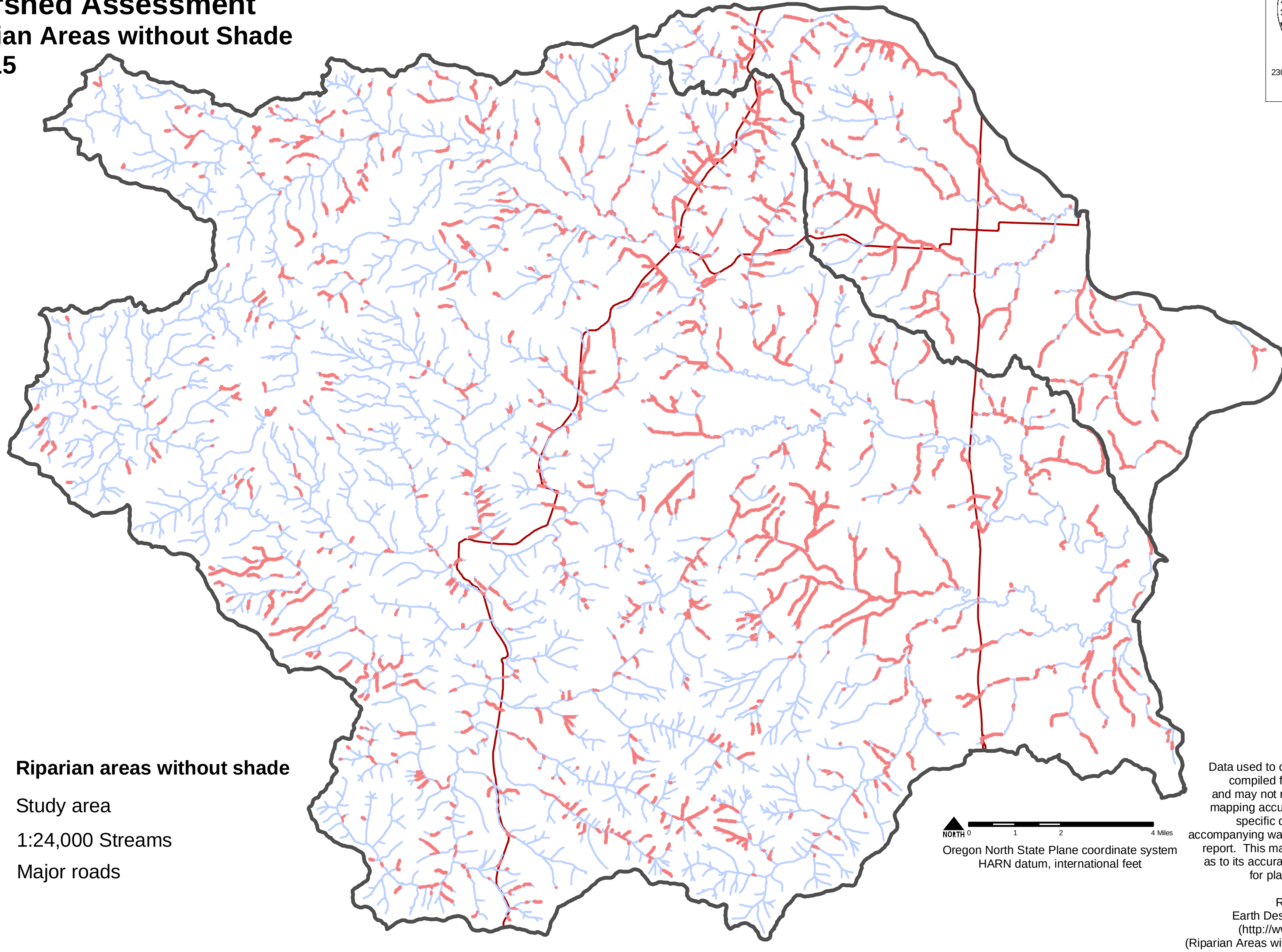
Name	7th Field HUC	Proportion of Dense Forest
Bridgeport	3060704	16.2%
Middle Fork Ash Creek	7020604	13.2%
Price Creek	3060303	12.8%
Cooper Creek	3060903	12.0%
Staats Creek	3061202	11.8%
Upper South Fork Ash Creek	7020605	11.3%
Zumwalt	3061002	10.4%
Springhill	3061303	10.4%
Lower North Fork Ash Creek	7020603	10.4%
Fern Creek	3060901	9.1%
Palestine	3061302	8.1%
Lower Berry Creek	3061204	7.1%
Parker	3061004	6.4%
Upper North Fork Ash Creek	7020601	6.0%
Buena Vista	7020404	5.6%
Harman Slough	7020503	5.5%
Duck Slough	7020502	5.3%
Peterson Creek	3061203	4.4%
Middle North Fork Ash Creek	7020602	3.4%

Map 15. Stream reaches that lack shade providing tree cover. Source: riparian GIS layer developed for this study.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Riparian Areas without Shade
Map 15

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Riparian areas without shade

Study area

1:24,000 Streams

Major roads

NORTH 0 1 2 4 Miles

Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Riparian Data Source:
Earth Design Consultants, Inc.
(http://www.earthdesign.com)
(Riparian Areas without Shade includes the following classes: bare, herbaceous, developed and water)

7.2 Wildlife

Insects

Although not generally regarded as "wildlife," terrestrial and aquatic invertebrates (including insects) are numerically the largest component of the Luckiamute's biodiversity. Moreover, many insect species help control weeds and pest insects, as well as pollinate plants, aerate soil, support fish and other wildlife, serve as indicators of ecosystem health, and provide aesthetic enjoyment (*e.g.*, butterflies).

Data Availability

No comprehensive surveys have been undertaken of invertebrate or insect diversity in the Luckiamute watershed, or of the distribution and prevalence of particular insect pests. Lists of aquatic invertebrates may be available based on samples collected in a few Luckiamute tributaries and wetlands by DEQ, EPA, OSU, and WOU investigators.

Species Status and Geographic Patterns

Of particular concern are invertebrate species that are rare or believed to have declined severely or disappeared entirely from the region in recent years. The ORNHIC database includes six such species that have been reported specifically from the Luckiamute Watershed (Table 55). It is virtually certain that other rare or declining invertebrate species are present in the watershed but are not included in this table because of the lack of a survey covering all watershed lands.

Table 55. Notable invertebrate species or subspecies from the Luckiamute Watershed reported in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
Driloleirus (Megascolides) macelfreshi	Oregon giant earthworm	G1 S1; 1 Fed=SOC	Last reported before 1985
Icaricia icarioides fenderi	Fender's blue butterfly	G5T1 S1; 1 Fed=LE	Foothill meadows (upland prairies) with Kincaid's lupine. See: http://www.epa.gov/fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm
Speyeria zerene bremneri	Valley silverspot butterfly	G5T3T4; 2 SH	No recent records; presumed extirpated. Wet prairies and marshes.
Speyeria callippe *ssp.*	Willamette callipe fritillary butterfly	G5TH SX; 1	No recent records; presumed extirpated
Euphydryas editha taylori	Taylor's checkerspot butterfly	G5T1 S1; 1 Fed=SOC	Dry prairies, open oak stands
Rhyacophila fenderi	Fender's caddisfly*	unlisted	Rapid streams

Table 55. Notable invertebrate species or subspecies from the Luckiamute Watershed reported in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments

* LE= legally listed as Endangered; LT= legally listed as Threatened; SOC= Species of Concern; SU= status undetermined; SV= vulnerable; SC= critical. Critical habitat can be protected legally only for LE and LT species.
G= global status (ONHP), S= state status (ONHP). 1= critically imperiled; 2= imperiled and vulnerable to extinction; 3= rare but not immediately imperiled, 4= not rare but of long-term concern, 5= widespread and secure
Number following the semicolon: 1= extinction threatened or presumed, 2= extirpation from Oregon threatened or presumed, 3= insufficient information, 4= of concern but not immediately imperiled

Important Habitats and Communities

Almost any area of the watershed that has experienced minimal soil disturbance, is distant from areas of pesticide application, has unpolluted water, and/or retains predominantly native vegetation could be important for maintaining the watershed's overall diversity of native invertebrates. Remnant native prairie – a particularly rare habitat -- is especially important to several species. Just north of the Luckiamute Watershed, the conversion to wheat field of part of one such prairie near Buell in the mid-1990's is believed responsible for the disappearance of a rare species in that area (US Fish & Wildlife Service: *http://www.epa.gov /fedrgstr/EPA-SPECIES/1998/January/Day-27/e1851.htm*).

Conservation and Restoration Potential

Projects to restore native prairies, wetlands, and oak woodlands are especially beneficial to rare invertebrate species. Improvements in stream water quality will benefit a wide variety of aquatic invertebrates. Efforts to encourage retention of downed dead wood and planting of a diversity of native vegetation in yards and other horticultural settings will benefit many species.

Amphibians and Reptiles

This section covers turtles, lizards, snakes, salamanders, frogs, and toads. Species in these groups not only contribute to the Luckiamute Watershed's biodiversity, but also help reduce pest insects and maintain healthy aquatic and terrestrial ecosystems.

Data Availability

No comprehensive surveys have been undertaken of amphibian and reptile diversity in the Luckiamute watershed. Surveys of amphibians and reptiles have been conducted at specific locations in the watershed, such as the Camp Adair Military Training Area west of Coffin Butte (Henny *et al.*, 1999). Also, reports covering larger regions that include the Luckiamute have been published [*e.g.*, (St. John, 1987; Vesely *et al.*, 1999; Adamus, 2003; Adamus *et al.*, 2003)], and anecdotal observations of amphibians and reptiles have been recorded at the E.E. Wilson Wildlife Area, portions of Boise timber land, and a few other locations.

Species Status and Geographic Patterns

A total of 14 amphibian and 13 reptile species are known to occur within the Luckiamute watershed. Table 56 shows species for which the watershed provides better (or worse) habitat than other watersheds in the Willamette Basin.

Although no field data are available to depict the overall distribution of reptiles and amphibians within the watershed, we used a modeling approach to tentatively identify patterns of "weighted species richness" (WSR) (Map 11b). Areas with higher WSR scores (colored orange or red on the accompanying maps) can be assumed to individually be providing better habitat to a larger number of amphibian and reptile species. In general, western parts of the watershed have greater WSR, as do riparian areas, and the WSR of the Luckiamute watershed is mostly greater that that of the Rickreall (Ash Creek) watershed.

To compute WSR, the author (P. Adamus, with subsequent review by a team of herpetologists) rated the land cover type predominating in each 30 x 30 m square (pixel). The land cover type was rated on a 1-10 scale with regard to its suitability for each of the 14 amphibians and 13 reptiles, and then those scores of the 27 species were (a) summed, and (b) averaged. Only the summed scores are depicted in (Map 11b). This spatial modeling approach allowed us to systematically consider the adjacency of each pixel to other pixels and features (*e.g.*, streams) of synergistic habitat types when scoring each species in each pixel. Image analysts at the Forest Sciences Laboratory, Oregon State University, had initially assigned each pixel to one of about 30 land cover types based on its condition as detected by satellite imaging in the spring and summer of 1992. Note that many features important to reptiles and amphibians cannot be detected directly by satellite imagery. Also note that some cover types, while not supporting large numbers of species, may provide the only quality habitat for a few species and so may be quite significant; this is not reflected by the modeling approach. Maps for individual species could be generated if desired.

Of particular concern are species that are rare or believed to have declined severely or disappeared entirely from the region in recent years. The ORNHIC database includes four such species that have been reported specifically from the Luckiamute Watershed (Table 56). It is likely that other rare or declining amphibians and reptiles are present in the watershed but are not included in this table because of the lack of a survey covering all watershed lands.

In addition to the reptiles and amphibians listed below, D. Anderson and S. Burgett report that the following species have been seen on or very near Boise in the Luckiamute watershed: Northwestern Salamander, Clouded Salamander, Roughskin newt, Pacific Giant Salamander, Torrent, Tailed Frog, Pacific Treefrog, Red-legged frog, N. Alligator Lizard, and Rubber Boa (personal communication).

Table 56. ORNHIC database records of notable amphibian and reptile species reported from the Luckiamute Watershed.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
Emmys marmorata marmorata	Northwestern pond turtle	G3T3 S2; 1 ODFW= SC Fed= SOC	Ponds or wetlands near permanent water, especially where only partially surrounded by woodland.
Chrysemys picta	Painted turtle	G5 S2; 2 ODFW= SC	Ponds or wetlands near permanent water, generally in wooded areas
Contia tenuis	Sharptail snake	G5 S3; 4 ODFW= SV	Meadows, prairies, woodland edges
Ascaphus truei	Coastal tailed frog	G4 S3; 2 ODFW= SV Fed= SOC	Large, wooded, moderately steep streams

* SOC= Species of Concern; SU= status undetermined; SV= vulnerable; SC= critical. These state (ODFW) and federal (Fed) designations are advisory only and confer no additional legal protection to the species.
G= global status (ONHP), S= state status (ONHP). 1= critically imperiled; 2= imperiled and vulnerable to extinction; 3= rare but not immediately imperiled, 4= not rare but of long-term concern, 5= widespread and secure
Number following the semicolon: 1= extinction threatened or presumed, 2= extirpation from Oregon threatened or presumed, 3= insufficient information, 4= of concern but not immediately imperiled

Pest Species

The watershed hosts no reptile or amphibian species that cause significant economic harm. Bullfrogs are not native to the Willamette Valley, but because of their status as predators are believed to be having major effects on some native amphibians and reptiles, *e.g.*, red-legged frog, sub-adult pond turtles. Also, a variety of non-native turtles kept as pets have been illegally released into the wild, and are believed to sometimes harbor diseases that harm native species.

Important Habitats and Communities

Almost any area that has experienced minimal soil disturbance and retains predominantly native vegetation could be important for maintaining the watershed's overall reptile and amphibian diversity. In particular, mature conifer forests, oak woodlands, prairies, springs, wetlands, ponds, riparian areas, unpolluted streams, and rock ledges and quarries are particularly likely to support species not found broadly in the watershed.

Conservation and Restoration Potential

Projects that restore native prairies, wetlands, and oak woodlands will benefit many native reptiles and amphibians. Efforts to encourage landowners to retain and pile (rather than burn) brush and downed dead wood on their land also will be a help. Root wads and large limbs from logging operations could be donated to pond owners willing to provide essential basking sites for rare western pond turtles (Adamus, 2003). Additional practices beneficial to turtles are described at: *http://www.dfw. state.or.us/ ODFWhtml/springfield/W_Pond_Turtle.htm*

Table 57. Amphibians and reptiles documented as occurring within the study area.

Common Name	**Scientific Name**	**Documentation of local occurrence**
<u>Amphibians</u>		
Northwestern Salamander	*Ambystoma gracile*	1;2;4
Long-Toed Salamander	*Ambystoma macrodactylum*	1;2;3a;4
Clouded Salamander	*Aneides ferreus*	1;2;4
Ensatina	*Ensatina eschscholtzii*	1;2;4; 6
Dunn's Salamander	*Plethodon dunni*	1;2
Western Red-Backed Salamander	*Plethodon vehiculum*	1;2;4
Roughskin Newt	*Taricha granulosa*	1;2;3c; 4; 6
Pacific Giant Salamander	*Dicamptodon tenebrosus*	2; 4
Southern Torrent Salamander*	*Rhyacotriton variegatus*	1;2
Tailed Frog*	*Ascaphus truei*	5
Pacific Treefrog (Chorus Frog)	*Pseudacris regilla*	1;2;3a; 4; 6
Red-Legged Frog*	*Rana aurora*	1;2;3u; 4; 6
Bullfrog	*Rana catesbeiana*	1; 3a; 4; 6
<u>Reptiles</u>		
Painted Turtle*	*Chrysemys picta*	1; 4; 5
Western Pond Turtle*	*Clemmys marmorata*	1;2;3u; 4; 5
Northern Alligator Lizard	*Elgaria coerulea*	1;2; 6
Southern Alligator Lizard	*Elgaria multicarinata*	1;2;3r; 4
Western Fence Lizard	*Sceloporus occidentalis*	1;2;3r; 4; 6
Western Skink	*Eumeces skiltonianus*	1; 2;4; 6
Rubber Boa	*Charina bottae*	1; 3c;4
Racer	*Coluber constrictor*	1;2;3c; 4
Sharptail Snake*	*Contia tenuis*	1;2;3u; 4; 5
Ringneck Snake	*Diadophis punctatus*	1;2;3a; 4
Gopher Snake	*Pituophis catenifer*	1;2;3a; 4; 6
Northwestern Garter Snake	*Thamnophis ordinoides*	1;2;3c; 4
Common Garter Snake	*Thamnophis sirtalis*	1;2;3a; 4; 6

NOTE 1: Western Rattlesnake (*Crotalus viridis*) was formerly reported at Coffin Butte and west of Dallas but no verified records exist for recent years.
NOTE 2: Western Terrestrial Garter Snake (*Thamnophis elegans*) has been reported rarely from the adjoining Yamhill watershed in habitat similar to that existing in the Luckiamute.
*1= documented in Polk Co. by Nussbaum *et al*. (1983); 0= not documented in Nussbaum *et al.* 1983
2= documented by St. John (1987) in Luckiamute watershed
3= on E.E. Wilson Wildlife Area list, based on reports by Russell Oates, John Crawford, Richard Hoyer, and/or David Budeau (A= abundant, C= common, U= uncommon, R= rare)

Table 57. Amphibians and reptiles documented as occurring within the study area.

Common Name	Scientific Name	Documentation of local occurrence
<u>Amphibians</u>		

4= on Willamette Valley National Wildlife Refuges list (not necessarily in Luckiamute)
5= Oregon Natural Heritage Program database
6= Henny *et al.* 1999 (Camp Adair Military Training Area)

Birds

Birds not only contribute to the Luckiamute Watershed's biodiversity, but also help reduce pest insects and maintain healthy aquatic and terrestrial ecosystems. Several species are legally hunted, and a few damage crops. All provide recreation and aesthetic enjoyment to birders and the public generally.

Data Availability

Although no watershed-wide surveys have been undertaken of birds, more data are available for birds than for other wildlife groups, *e.g.*:

- Breeding Bird Atlas
- Breeding Bird Survey route
- OBOL and BirdNotes archives
- Winter Waterfowl Surveys
- Christmas Bird Counts: Dallas, Airlie-Albany
- Baskett Slough & E.E. Wilson & Camp Adair
- Hagar & Stern 2001, theses
- MacForest
- Camp Adair
- Boise

Species Status, Trends, and Geographic Patterns

A total of 232 bird species have been documented within or near the Luckiamute watershed. Of these, 131 (56%) breed somewhat regularly (Appendix J, K, L), 87 (38%) are year-round residents (although numbers may change greatly seasonally), 20 (9%) have been recorded only as migrants, and 25 (11%) have been recorded only in winter. Table 58 shows species for which the watershed provides better (or worse) habitat than other watersheds in the Willamette Basin.

Bird species that likely were common in the vicinity of the watershed around the time of pioneer settlement, but now are absent or nearly so, include Snow Goose, Greater White-fronted Goose, California Condor, Sandhill Crane, Long-billed Curlew, Say's Phoebe, Lark Sparrow, Black-crowned Night-heron, and Yellow-billed Cuckoo (Taft and Haig, 2003). In addition, Short-eared Owl, Wilson's Snipe, and Lewis's Woodpecker may no longer nest in the watershed but do occur in winter. Total numbers of herons, egrets, geese, ducks, swans, and shorebirds were much greater than presently. Declines in many other species (and increases in others) from their pre-settlement abundance levels can be presumed based on documented changes in land cover types and patterns, but documentation is lacking.

As we did with amphibians and reptiles, we used a modeling approach to tentatively identify patterns of "weighted species richness" (WSR) for birds (Map 11d). Areas with higher WSR scores (colored orange or red on the maps) can be assumed to individually be providing better habitat to a larger number of bird species. In general, western parts of the watershed have greater WSR, as do riparian areas, and the WSR of the Luckiamute watershed is mostly greater that that of the Rickreall (Ash Creek) watershed. Modeling procedures and limitations were described in the Amphibians and Reptiles section.

Of particular concern are species that are rare or believed to have declined severely or disappeared entirely from the region in recent years. The ORNHIC database includes seven such species that have been reported specifically from the Luckiamute Watershed (Table 58). It is possible that other rare or declining birds are present in the watershed but are not included in this table because of the lack of a survey covering all watershed lands.

Table 58. ORNHIC database records of notable bird species reported from the Luckiamute Watershed.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
Branta canadensis leucopareia	Aleutian Canada Goose	G5T3 S2N; 1 Fed= LE ODFW= LT	open land
Oreortyx pictus	Mountain Quail	G5 S4; 4 Fed= SOC ODFW= SU	foothill forests, clearcuts
Brachyramphus marmoratus	Marbled Murrelet	G3G4 S2; 2 Fed= LE ODFW= LT	old-growth forest and stands
Strix occidentalis caurina	Northern Spotted Owl	G3T3 S3; 1 Fed= LE ODFW= LT	multi-layered mature and old-growth forest
Eremophila alpestris strigata	Streaked Horned Lark	G5T2 S2; 2 Fed= SOC ODFW= SC	sparsely-vegetated fields, prairie, overgrazed pastures
Pooecetes gramineus affinis	Oregon Vesper Sparrow	G5T3 S3B; 2 Fed= SOC ODFW= SC	young tree plantations
Progne subis	Purple Martin	G5 S3B; 2 Fed=	large snags near water

Table 58. ORNHIC database records of notable bird species reported from the Luckiamute Watershed.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
		SOC ODFW= SC	

* LE= legally listed as Endangered; LT= legally listed as Threatened; SOC= Species of Concern; SU= status undetermined; SV= vulnerable; SC= critical. Critical habitat can be protected legally only for LE and LT species.
G= global status (ONHP), S= state status (ONHP). 1= critically imperiled; 2= imperiled and vulnerable to extinction; 3= rare but not immediately imperiled, 4= not rare but of long-term concern, 5= widespread and secure
Number following the semicolon: 1= extinction threatened or presumed, 2= extirpation from Oregon threatened or presumed, 3= insufficient information, 4= of concern but not immediately imperiled

A significant number of other rare or declining bird species with special status (according to federal or state agencies) are known to occur in the watershed, at least sporadically, but have not been registered yet in the ORNHIC database:

Table 59. Other rare or declining bird species with special status (according to federal or state agencies) which are known to occur in the watershed, at least sporadically, but have not been registered yet in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
Ammodramus savannarum	Grasshopper Sparrow	G5 S2B; 2 ODFW= P	see Altman (1997)
Chlidonias niger	Black Tern	G4 S3B; 4 Fed= SOC	large permanently-flooded marshes
Chordeiles minor	Common Nighthawk	G5 S5; 4 ODFW= C	gravel bars, large clearcuts, young tree plantations
Columba fasciata	Band-tailed Pigeon	G5 S4; 4 Fed= SOC	Conifer forests, large cottonwoods. Declining statewide.
Contopus cooperi	Olive-sided Flycatcher	G5 S4; 4 Fed= SOC ODFW=V	Tall open conifer forest. Declining statewide.
Cypeseloides niger	Black Swift	G4 S1B ODFW= P	waterfalls
Dryocopus pileatus	Pileated Woodpecker	G5 S4; 4 ODFW=V	woods with large-diameter trees
Empidonax traillii brewsteri	Willow Flycatcher	G5TU SUB; 4 ODFW=V	Riparian shrubs, clearcuts. Declining statewide.
Falco peregrinus	American Peregrine Falcon	G4T3 S1B; 2	open land, wetlands, cliff faces

Table 59. Other rare or declining bird species with special status (according to federal or state agencies) which are known to occur in the watershed, at least sporadically, but have not been registered yet in the ORNHIC database.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
anatum		Fed= LE	
Icteria virens	Yellow-breasted Chat	G5 S4; 4 Fed= SOC ODFW=C	brushy fields; see Altman (1997). The E.E. Wilson Wildlife Area supports one of the largest concentrations of nesting chats in the Willamette Valley.
Melanerpes formicivorus	Acorn Woodpecker	G5 S3; 4 Fed= SOC	oak woodlands
Melanerpes lewis	Lewis's Woodpecker	G5 S3; 4 Fed= SOC ODFW= C	oak woodlands, riparian areas
Sialia mexicana	Western Bluebird	G5 S4; 4 ODFW=V	uncultivated fields, clearcuts, and pasture near oak woodlands
Sturnella neglecta	Western Meadowlark	G5 S5; 4 ODFW= C	uncultivated fields and pasture with widely spaced shrubs; see Altman (1997). Declining statewide.

Some bird species occurring in the watershed are recognized as "priority species" by the U.S. Bureau of Land Management (U.S. Bureau of Land Management, 2003). They include (in addition to some of those listed above) Trumpeter Swan, Blue Grouse, Western Screech-Owl, Vaux's Swift, Rufous Hummingbird, Pacific-slope Flycatcher, Cassin's Vireo, Hutton's Vireo, Chestnut-backed Chickadee, Golden-crowned Kinglet, Swainson's Thrush, Wrentit, Black-throated Gray Warbler, Hermit Warbler, MacGillivray's Warbler, and Black-headed Grosbeak.

Also, some Luckiamute species may be of particular concern because of statistically-significant declines in their regional or local breeding populations, as suggested by annual Breeding Bird Survey (BBS) data, 1966-2002 (Sauer *et al.*, 2003), see Appendix J, K, L). The following declining species have not already been mentioned and meet this criterion: Cinnamon Teal, American Kestrel, Ring-necked Pheasant, Killdeer, Mourning Dove, Western Wood-Pewee, Barn Swallow, Red-breasted Nuthatch, Ruby-crowned Kinglet, Hermit Thrush, Orange-crowned Warbler, Chipping Sparrow, Fox Sparrow, Song Sparrow, White-crowned Sparrow, Brewer's Blackbird, and both American and Lesser Goldfinches. A comparison of nine oak stands throughout the Willamette Valley, 1967-68 *vs*. 1994-96, suggested a decrease has occurred in species commonly associated with open-stand oaks, such as Bushtit and Chipping Sparrow (Hagar and Stern, 2001). The widely-noted and nearly complete disappearance of Lewis's Woodpecker from the Willamette Valley (as documented in part by the Dallas Christmas Bird Count) may be attributed partly to the loss of mature large-diameter oak stands which the species depends on for acorn storage. A preliminary analysis of data from the Dallas Christmas Bird Count (Adamus, unpublished, see Appendix J, K, L) also suggests the possibility that wintering populations of the following year-round resident species might be declining significantly in or near parts of the Luckiamute watershed: Ring-necked Pheasant, Northern Flicker, Black-capped Chickadee, White-breasted Nuthatch, American Dipper, Dark-eyed Junco, Brewer’s Blackbird, and Evening Grosbeak. In addition, the following visiting species from other regions are now being found in fewer numbers than 30 years ago, in or near the Luckiamute watershed: Northern Pintail, Rough-legged Hawk, Northern Shrike and Ring-billed Gull.

Past and future decline in the extent and quality of oak stands is causing local declines in many bird species. When oak stands are invaded by Douglas-fir, their avifauna is replaced mostly by species that already occur widely in coniferous forests of the adjoining Oregon coast range. Many oak woodland inhabitants do not regularly use coniferous stands. These include Mourning Dove, Acorn Woodpecker, Downy Woodpecker, White-breasted Nuthatch, Western Wood-Pewee, Bewick’s Wren, House Wren, Western Scrub-Jay, Cassin’s Vireo, Lazuli Bunting, and American Goldfinch. More species of Neotropical migrants – a bird group of particularly high conservation concern – use oak stands than coniferous forests (Hagar and Stern, 2001).

Neotropical migrants are a conservation priority because many of these species which winter in the Neotropics have declining populations. Population declines may be due partly to the many hazards they encounter over lengthy migration routes, habitat destruction on both breeding and wintering grounds, and general sensitivity of many to fragmentation of the forest canopy

In the Luckiamute watershed, surveys specifically targeting particular legally-listed threatened, endangered, and sensitive species have been published only for the Camp Adair Military Training Area (Schreiber, 2002) and Beazell County Park (Schreiber, 2001). Using recognized survey techniques in habitat of at least minimal suitability, the surveys at Camp Adair had no breeding-season detections of Spotted Owl, Common Nighthawk, Western Meadowlark, or Horned Lark, but did detect Northern Pygmy-Owl, Pileated Woodpecker, Yellow-breasted Chat, Willow Flycatcher, Olive-sided Flycatcher, and Western Bluebird (Schreiber, 2002). The briefer survey at Beazell County Park found Pileated Woodpecker but no Spotted Owl or other sensitive species, although habitat conditions for many seemed promising and further surveys were recommended (Schreiber, 2001).

Pest Species

There are no bird species that cause major, widespread economic damage to crops or property in the watershed. Waterfowl and blackbirds cause sporadic damage to crops in some areas. Jays, crows, woodpeckers, and a few other species occasionally damage filbert and fruit orchards. Starlings and robins can inflict damage at vineyards and other places where berries are grown. Minor annoyances are caused by Vaux's swifts that sometimes fly down (and occasionally nest in) chimneys, as well as swallows, starlings, barn owls, and house sparrows that nest in or on barns and other structures. However, all of these species are very useful as controllers of insect or rodent pests. Information on dealing with wildlife damage can be found at: *http://www.dfw.state. or.us/springfield/ wildlifeandpeople.html*

Game Birds

Birds subject to legal hunting as game in the Luckiamute watershed include waterfowl (29 species), quail (2 species), grouse (2 species), wild turkey, pheasant. pigeons (2 species), and mourning dove. Harvest data specific to the watershed are not available. For Polk County as a whole, wintering waterfowl numbers based on aerial surveys are given in Table 60.

Table 60. Waterfowl numbers in Polk County from annual winter waterfowl survey by the US Fish & Wildlife Service.

	January 2000	January 2001	January 2002	January 2003
Ducks	36,662	34,297	24,404	24,896
Geese	32,946	30,975	8371	22,701
Swans	105	206	218	205
Total*	69,713	65,478	32,993	47,802

* at Baskett Slough NWR alone, roosting geese numbered 14,204 (in 2001), 16,400 (in 2002), and 26,240 (in 2003)

Important Habitats and Communities

In the Luckiamute watershed, some of the rarest birds are associated with mature conifer forests, oak woodlands, prairies (or uncultivated fields), wetlands, and riparian (especially cottonwood) areas. Within these habitats, large snags are particularly important. Some types of built structures also are important. Barn owls depend on open abandoned buildings and barns and silos near pasture or wetlands. Beneficial swallows and bats use these structures as well as larger buildings and bridges for nesting or roosting. Tall, weathered, unused chimneys provide essential roosting habitat for large congregations of Vaux's Swift during late summer. Just prior to migrating south, thousands of swallows sometimes depend on large, lowland, unharvested corn fields for roosting and feeding.

Conservation and Restoration Potential

Activities to conserve and restore native plant communities will generally benefit native bird communities. However, when mowing or burning is used to restore native prairies, it should be done after July 15 or before April 15 in order to minimize harm to nesting species. Planting willows and other native woody species along waterways, as an alternative to Himalayan blackberry, will benefit most bird species. Also especially important to birds is the retention of standing and downed dead trees (snags). In areas where large snag densities are fewer than 1 per acre, creation of snags by intentionally killing standing trees, at least those of lower commercial value, is warranted where they do not pose a hazard to humans. This provides longer-term benefits than the construction and deployment of bird boxes, but boxes nonetheless may be worthwhile in areas with few trees, *e.g.*, edges of fields. Where abandoned buildings do not pose a safety hazard, they should be allowed to remain standing for the shelter they sometimes provide to swallows, swifts, and barn owls. Maintaining water sources (small seeps, ponds, natural drainages) is important to all wildlife species, so plans to extract groundwater for irrigation or other uses should be carefully considered for their potential impacts to near-surface water tables.

Mammals

This section covers rodents, canids, ungulates, bats, and other wild mammals. Species in these groups not only contribute to the Luckiamute Watershed's biodiversity, but also help reduce pest insects and maintain healthy aquatic and terrestrial ecosystems. Several species are legally hunted, and some cause damage to crops and livestock.

Data Availability

No comprehensive surveys have been undertaken of mammal diversity in the Luckiamute watershed. Limited surveys of mammals have been conducted at specific locations in the watershed, such as the Camp Adair Military Training Area west of Coffin Butte (Henny *et al.*, 1999) and in Mcdonald-Dunn Forest. Also, reports covering larger regions that include the Luckiamute have been published (*e.g.*, (Verts and Carraway, 1998), and anecdotal observations of mammals have been recorded at the E.E. Wilson Wildlife Area and a few other locations.

Species Status and Geographic Patterns

A total of 69 mammal species are known or likely to occur within the Luckiamute Watershed. Table 61 shows species for which the watershed provides better (or worse) habitat than other watersheds in the Willamette Basin.

As we did with birds, amphibians, and reptiles, we used a modeling approach to tentatively identify patterns of "weighted species richness" (WSR) for mammals (Map 11c). Areas with higher WSR scores (colored orange or red on the accompanying maps) can be assumed to individually be providing better habitat to a larger number of mammal species. In general, western parts of the watershed have greater WSR, as do riparian areas, and the WSR of the Luckiamute watershed is mostly greater that that of the Rickreall (Ash Creek) watershed. Modeling procedures and limitations were described in the Amphibians and Reptiles section.

Of particular concern are species that are rare or believed to have declined severely or disappeared entirely from the region in recent years. The ORNHIC database does not include any records of such species specifically from the Luckiamute Watershed. However, the following mammal species that could potentially occur (or are known to occur) in the watershed would be of particular note:

Table 61. ORNHIC database records of notable mammal species reported from the Luckiamute Watershed.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
Sciurus griseus	western gray squirrel	G5 S4; 3 ODFW= SU	oak woodlands; residential areas
Thomomys bulbivorus	Camas pocket gopher	G3G4 S3S4; 3 Fed= SOC	open land
Antrozous pallidus pacificus	Pacific pallid bat	G5T3T4 S3; 2 Fed= SOC ODFW= SV	ranges widely over areas with large sustained outputs of flying insects
Arborimus (Phenacomys) albipes	white-footed vole	G3G4 S3; 4 Fed= SOC ODFW= SU	riparian deciduous shrubs in conifer forest
Corynorhinus (Plecotus) townsendii townsendii	Pacific western big-eared bat	G3T3T4 S2; 2 Fed= SOC ODFW= SC	ranges widely over areas with large sustained outputs of flying insects, and caves or abandoned buildings for roosting
Lasionycteris noctivagans	silver-haired bat	G5 S4; 4 Fed= SOC ODFW= SU	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting
Lasiurus cinereus	hoary bat	G5 S4; 4	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting
Myotis evotis	long-eared myotis (bat)	G5 S3; 2 Fed= SOC ODFW= SU	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting
Myotis thysanodes	fringed myotis (bat)	G4G5 S2; 2 Fed= SOC ODFW= SV	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting
Myotis volans	long-legged myotis (bat)	G5 S3; 4 Fed= SOC	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned

Table 61. ORNHIC database records of notable mammal species reported from the Luckiamute Watershed.

Scientific Name	Common Name	Listing Status*	Habitat/ Comments
		ODFW= SU	buildings for roosting
Myotis yumanensis	Yuma myotis (bat)	G5 S3; 4 Fed= SOC	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting
Tadarida brasiliensis	Brazilian free-tailed bat	G5 S2; 2	ranges widely over areas with large sustained outputs of flying insects and caves or abandoned buildings for roosting

* SOC= Species of Concern; SU= status undetermined; SV= vulnerable; SC= critical. These state (ODFW) and federal (Fed) designations are advisory only and confer no additional legal protection to the species.
G= global status (ONHP), S= state status (ONHP). 1= critically imperiled; 2= imperiled and vulnerable to extinction; 3= rare but not immediately imperiled, 4= not rare but of long-term concern, 5= widespread and secure
Number following the semicolon: 1= extinction threatened or presumed, 2= extirpation from Oregon threatened or presumed, 3= insufficient information, 4= of concern but not immediately imperiled

In addition the species listed above D. Anderson reports that mountain beaver occurs in many of the forested parts of the watershed. They are frequently trapped by foresters. On 10 June 1998 a mountain beaver was seen at T9S R 7W sec 28 (D. Anderson, personal communication).

Game and Furbearer Species

Species in the Luckiamute watershed that can be trapped commercially for their fur are muskrat, nutria, mink, river otter, beaver, bobcat, fox (2 species), coyote, raccoon, and opossum. Mammals harvested as game include black bear, elk, deer, cougar, squirrels (3 species), and rabbits (4 species).

Pest Species

Several mammals cause (or have the potential to cause) widespread economic damage or damage to habitat of other species. Deer, elk, bear, opossum and rodents frequently cause damage to crops, tree plantations, landscaping shrubs, and/or gardens. Beaver plug culverts and in doing so, flood property. Nutria alter wetland vegetation structure and thus potentially affect habitat quality for many species. Feral cats prey on many native mammals and birds.

Important Habitats and Communities

In the Luckiamute watershed, some of the rarest mammals are associated with mature conifer or oak woodland, and riparian areas. Within these habitats, areas with extensive downed wood and large standing stags are particularly important.

Conservation and Restoration Potential

Activities to conserve and restore native plant communities will generally benefit native mammals. Planting willows and other native woody species along waterways, as an alternative to Himalayan blackberry, will benefit many mammal species. However, in some instances new plantings may be removed by beaver. Just as important to mammals as to birds are adequate densities of snags (for roosting bats) and downed wood (used by numerous rodents). In areas where large snag densities are fewer than 1 per acre, creation of snags by intentionally killing standing trees, at least those of lower commercial value, is warranted where they do not pose a hazard to humans. Where natural snags are few (due to early successional stage of the forest), installation of boxes designed for bats is warranted. Bats using buildings and other structures should be accommodated whenever possible and not harassed. Maintaining water sources (small seeps, ponds, natural drainages) is important to all wildlife species, so plans to extract groundwater for irrigation or other uses should be carefully considered for their potential impacts to near-surface water tables.

Table 62. Mammals documented as occurring (or potentially occurring) within the study area

Common Name	Scientific Name	Documentation of local occurrence
American Beaver	*Castor canadensis*	3c;4;6
Virginia Opossum	*Didelphis virginiana*	1;2;3c;4;6
Vagrant Shrew	*Sorex vagrans*	1;2;3a;4;6
Pacific Shrew	*Sorex pacificus*	2;6
Pacific Water Shrew	*Sorex bendirii*	1
Trowbridge's Shrew	*Sorex trowbridgii*	1;2;3u;4;6
Baird's Shrew	*Sorex bairdi*	2
Fog Shrew	*Sorex sonomae*	1;2
Shrew-Mole	*Neurotrichus gibbsii*	1;2;4
Townsend's Mole	*Scapanus townsendii*	1;3c;4;6
Coast Mole	*Scapanus orarius*	1;2;4
Little Brown Myotis	*Myotis lucifugus*	4;6
Yuma Myotis	*Myotis yumanensis*	1;6
Long-Eared Myotis	*Myotis evotis*	1;4;6
Fringed Myotis	*Myotis thysanodes*	0
Long-Legged Myotis	*Myotis volans*	6
California Myotis	*Myotis californicus*	4;6
Silver-Haired Bat	*Lasionycteris noctivagans*	1;4
Big Brown Bat	*Eptesicus fuscus*	1;4;6
Hoary Bat	*Lasiurus cinereus*	0;4
Townsend's Big-Eared Bat*	*Corynorhinus townsendii*	7
Pallid Bat	*Antrozous pallidus*	0
Brazilian Free-Tailed Bat	*Tadarida brasiliensis*	0
Brush Rabbit	*Sylvilagus bachmani*	1;2;3c;4;6
Eastern Cottontail	*Sylvilagus floridanus*	1;3a;4;6
Snowshoe Hare	*Lepus americanus*	0
Black-Tailed Jackrabbit	*Lepus californicus*	1;3r;4;6
Mountain Beaver	*Aplodontia rufa*	0
Townsend's Chipmunk	*Tamias townsendii*	1;2;3u;4;6
California Ground Squirrel	*Spermophilus beecheyi*	1;2;3a;4;6
Western Gray Squirrel	*Sciurus griseus*	1;3u;4;6;7
Douglas' Squirrel	*Tamiasciurus douglasii*	1;2;4;6
Northern Flying Squirrel	*Glaucomys sabrinus*	1;2;4;6
Western Pocket Gopher	*Thomomys mazama*	1
Camas Pocket Gopher	*Thomomys bulbivorus*	3a;4;5;6

Table 62. Mammals documented as occurring (or potentially occurring) within the study area

Common Name	Scientific Name	Documentation of local occurrence
Deer Mouse	*Peromyscus maniculatus*	1;2;3a;4;6
Dusky-Footed Woodrat	*Neotoma fuscipes*	1;2;3c;4;6
Bushy-Tailed Woodrat	*Neotoma cinerea*	1;2;4
Western Red-Backed Vole	*Clethrionomys californicus*	1;2;4
White-Footed Vole	*Phenacomys albipes*	7
Red Tree Vole	*Phenacomys longicaudus*	1;4
California Vole	*Microtus californicus*	0
Townsend's Vole	*Microtus townsendii*	1;2;3a;4;6
Long-Tailed Vole	*Microtus longicaudus*	1
Creeping (Oregon) Vole	*Microtus oregoni*	1;2;3c;4;6
Gray-Tailed Vole	*Microtus canicaudus*	1;3a;4;6
Muskrat	*Ondatra zibethicus*	3c;4
Black Rat	*Rattus rattus*	4
Norway Rat	*Rattus norvegicus*	1;3c
House Mouse	*Mus musculus*	1;3c;4
Pacific Jumping Mouse	*Zapus trinotatus*	1;2;3u;4;6
Common Porcupine	*Erethizon dorsatum*	3r;4
Nutria	*Myocastor coypus*	3c;4
Coyote	*Canis latrans*	1;3c;4;6
Red Fox	*Vulpes vulpes*	3u;4
Gray Fox	*Urocyon cinereoargenteus*	1;3r;4
Black Bear	*Ursus americanus*	1;3r;4
Raccoon	*Procyon lotor*	1;3c;4;6;7
Ermine	*Mustela erminea*	1;2;3r;4
Long-Tailed Weasel	*Mustela frenata*	1;4;7
Mink	*Mustela vison*	3u;4
Western Spotted Skunk	*Spilogale gracilis*	4
Striped Skunk	*Mephitis mephitis*	3c;4;6
Northern River Otter	*Lutra canadensis*	3u;4
Mountain Lion	*Felis concolor*	3r;4;7
Feral House Cat	*Felis catus*	4;6
Bobcat	*Lynx rufus*	3u;4;6
Elk	*Cervus elaphus*	3r;4;6;7
Black-Tailed Deer	*Odocoileus hemionus*	1;3c;4;6;7

*0= is potentially present but no documented records
1= documented in Polk Co. by Verts & Carraway 1998
2= documented in McDonald-Dunn State Forest by Dave Waldien (personal communication)
3= on E.E. Wilson Wildlife Area list, based on reports by Russell Oates, John Crawford, Richard Hoyer, and/or David Budeau (A= abundant, C= common, U= uncommon, R= rare)
4= on Willamette Valley National Wildlife Refuges list (not necessarily in Luckiamute)
6= Henny *et al.* 1999 (Camp Adair Military Training Area)
7= observed by or reported to Paul Adamus

7.3 Recommendations

Land Cover/ Land Use

- Develop a GIS data set that describes Oak Savanna. Develop protocols that separate oak forests from 'true' oak savannas.
- Develop or obtain up to date land cover information that reflects current conditions in the watershed.
- Ground-truth and update riparian vegetation information, especially in areas known to have spawning salmonids. Coordinate with DEQ's efforts for riparian vegetation monitoring.
- Locate and map exotic plant species.
- Determine the condition of fences along riparian corridors.

- Incorporate tax lot and building information into the GIS when it becomes available.
- Update and map changing land use information, *e.g.* timber harvest plans, pesticide application areas, construction projects.
- Update or map floodways along rivers.
- Educate landowners to make long-term commitments to continually remove invasive plant species.
- Whenever possible use native vegetation to landscape.

We recommend that the Polk Co. plant species check list be compared to noxious weed lists and a master list of weeds present in Polk Co. be generated. Once identified, information on the location of weedy species observations can then be tracked using the LWC GIS and a suitable management plan be developed.

We recommend that the DOQs be used to evaluate and map future monitoring and restoration sites. Since the DOQ photographs are already georeferenced, new information can be entered into the LWC GIS by locating sites on the DOQs.

We recommend that the locations on the maps be visited and observations recorded and that oak forests be separated from 'true' oak savannas. These observations can be use to refine the GIS data sets which describe the extent of oak savannas.

Since it was not the intention of this analysis to select individual sites for consideration, we recommend that when it comes time to prioritize sites, the floodplain, riparian, soils, and wildlife WSR grids be used to prioritize sites.

We recommend that LWC ground truth the riparian vegetation layer created in this assessment.

Wildlife

- Monitor existing restoration sites.
- Consider controlled burns or mowing on remnant prairies or oak woodlands. Avoid burning or mowing before 15 April or after 15 July to avoid disturbing breeding birds.
- Gather information on roadless areas and consider performing a roadless areas analysis.
- Identify areas with minimal soil disturbance having native vegetation: these areas are important refugia for insects and wildlife.
- Educate land owners not to burn brush piles; leave dead standing wood (if it will not cause damage or be a safety issue) for wildlife.

8 AQUATIC RESOURCES AND ANALYSES

This section presents information on the historic and current condition of the aquatic and in-stream salmon habitat in the Luckiamute / Ash Creek study area. Current information on fish abundance and distribution are also presented.

8.1 Historic Aquatic Resource Conditions

The characteristics of aquatic resources in the Willamette Valley were historically much different than they are today. Dynamic river processes, such as frequent flooding events, maintained off channel habitat including side channels, alcoves, sloughs and shallow lakes (Taft and Haig, 2003). Prior to the early 1800s, when the fur trade expanded into this area, beaver contributed to stream complexity by ponding water. Fallen snags and debris jams also created pools of standing water (Taft and Haig, 2003). As farming took hold in the valley and wetlands were drained, much of the side channel habitat was reduced. Large wood was also removed from the streams in order to straighten channels and aid navigation.

Before Himalayan blackberry became omnipresent in bottomlands in the mid-20th century, the dominant riparian shrubs were probably hawthorn (*Crataegus.*), hardhack (*Spiraea*), serviceberry (*Amelanchier*), alder (Alnus), dogwood (*Cornus*), snowberry (*Symphocarpos*), and willow (*Salix* spp.). Before reed canary-grass blanketed nearly every channel bank and wetland, sedges (*Carex* spp.) and rushes (*Juncus* spp.) were probably more widespread than at present. In the overstory, huge cottonwoods (*Populus*), Douglas-fir (*Pseudotsuga*), and grand fir (*Abies*) were more prevalent than today.

Several early logging practices relied on rivers as holding areas and transport system, and greatly affected stream habitat and riparian areas. Small dams known as "splash" dams were built in streams to transport logs down the river (Theurer, 2003). Splash dams got their name from the wave of water preceding the logs as they rushed downstream. Dams were used to create ponds where the logs could float until a log-drive began. To release the logs, some splash dams were dynamited, which resulted in a torrent that carried the logs downstream.

Other dams were released in a more controlled fashion, and used repeatedly. Log drives involved creating rafts of logs that were then sent down river. The logs, driven by high, fast water, removed riparian vegetation and scoured the stream bottom leading to erosion and loss of in-stream habitat (Theurer, 2003).

The advantage of splash dams was that it did not require sophisticated tools or machinery to move logs from the forests to the mills. The disadvantage was that the use of splash dams was damaging to stream ecosystems in many ways; many streams in Oregon still bear the signs of splash damming. Unintended results of splash damming included: the down-cutting of stream channels, scouring the creek bottoms, sometimes to bedrock; loss of natural logjams; loss of deep pool habitat; stream channelization; loss of stream side vegetation and eroded stream banks; and barriers to migrating salmon. The damage must have been quite apparent because there are reports of farmers in the valley complaining that the log drives were causing erosion along the banks of their land on the river (Frantz and Brandon, 1976). The number of complaints eventually led to legal battles to stop log drives beginning in 1914; however, log drives continued until 1925 (Theurer, 2003).

Historic records indicate that there were from 80-100 splash dams on the Luckiamute River (Licata *et al.*, 1998), with some major ones documented on Pedee Creek and Ritner Creek (Theurer, 2003). A larger dam was located near the mouths of the north and south fork of the Luckiamute River, where "the water backed up nearly to Camp Walker" (Theurer, 2003).

Splash dams were not the only log transport tool associated with stream degradation. Another tool in early logging, the donkey engine, also affected in-stream habitat. These steam-driven engines were set up in a canyon or stream bottom. Logs were attached to the engine and dragged along the ground and along streambeds. This probably resulted in loss of structure in stream bottoms. The use of donkey engines may have increased landslide frequency and contributed to sediment delivery in streams (Licata *et al.*, 1998).

Other early settlement practices such as allowing livestock to trample streamside vegetation and enter waterways, and clearing of vegetation for homesteads and agriculture also affected stream habitat. Many of these practices continue today. The clearing of the land eliminated most large riparian conifers which had a potential to fall into streams to serve as large woody debris (Licata *et al.*, 1998).

8.2 Stream Channel Morphology

Available Data

DEM data

Many key data sets were not available for the entire study area. Therefore, we used GIS to develop surrogate or stand-in data sets for our analyses. The advantage to using these data sets is that they are comparable across the entire study area and are of a uniform spatial scale. The disadvantage is that without field verification it is impossible to know how well these data represent the actual watershed condition. **We highly recommend that these data sets be field checked or that the analyses be re-run if better data sets become available.**

Like any other data set, DEM (Digital Elevation Models) are appropriate for answering some questions and not so good for answering others. DEM files are computer representations of topography. In a 10m DEM grid, approximately a 30ft X 30ft square is assigned a single elevation. These are the same data that are used to generate the familiar paper USGS 7.5' topographic quadrangles. These data are frequently used at the scale of the stream reach or watershed because general trends in topography are apparent. These data are perhaps not appropriate to use if one is interested in mapping subtle elevation changes along narrow first order streams.

We used DEMs to derive slopes, stream gradients, and stream confinement, and to describe elevations within the study area.

These data cover the entire study area at 1:24,000. LWC asked that we concentrate on the AHI data for this assessment. However, additional queries can be made using the data derived from the DEMs. **<u>We recommend that, to the extent possible, the DEM-derived stream gradient, confinement, can channel typing be field checked. We also recommend that these data be used to prioritize monitoring and restoration locations.</u>** For example, using GIS all low gradient unconfined streams could be identified. These areas could then be surveyed for spawning gravel or identified for riparian planting projects.

Stream Confinement

Stream confinement refers to the extent to which streams are confined by hills, cliffs, terraces or other landscape features. Confinement is not the same as stream entrenchment. Stream confinement is an important factor in many watersheds because it is directly related to watershed characteristics and functions, such as presence and formation of wetlands, floodplain connectivity, availability of off-channel habitat, and flooding and peak flows. Since stream confinement information was not available for the study area, we used ARCGIS to generate a stream confinement layer from the 30ft DEMs. We visually classified the 1:24,000 scale streams layer with a slope map that was classed into flat (<= 4% slope) and non-flat areas (>4% slope). Table 63 shows the parameters that were used to generate unconfined and confined stream reaches. This information was also used to determine channel type. These data were supplied to the LWC.

The following table outlines the distances used to determine the channel type:

Table 63. Parameters that were used to generate stream confinement. Shown are stream order and distances from the stream that were examined (see text for explanation).

Order	Unconfined	Confined
1-2	> 30 feet (1 pixel)	<= 30 feet (1 pixel)
3-4	> 60 feet (2 pixels)	<= 60 feet (2 pixels)
5-7	>120 feet (4 pixels)	<= 120 feet (4 pixels)

We found that streams in the study area are approximately evenly distributed between the confined (49% of the total stream length) and unconfined (51% of the total stream length) categories. The GIS layer can be used to evaluate (modeled) stream confinement within individual drainages, if necessary.

Stream gradient

Stream gradient, the slope of the streambed, is an important watershed attribute and is an important component of salmonid habitat. Typically, steeper stream gradients have faster water velocities than flat streambeds. As water velocity increases, so does the water's capacity to transport sediment and other materials, including large gravel, suspended sediments and large woody debris.

There are several ways to measure stream gradient. In the field, stream gradient can be measured directly with a clinometer. More commonly, stream gradient is measured from USGS 7.5' topographic maps by measuring the change in vertical elevation (rise) over the stream segment length (run). One method is to count the number of contour intervals within a given map distance on a topographic map (Watershed Professionals Network, 1999). Stream gradient can be expressed two ways, as a percent slope (length of rise over length of run) or as the number of degrees of slope (ranges from 0° or horizontal, to 90° or vertical). We used the former.

Existing stream gradient information was not available for the entire study area. We used GIS and the DEMs to calculate stream gradients.

We found that most of the streams in the study area are low gradient streams: 56.7% (of the total stream length) are 0-2% slope and 21.5% are 2-4% slope. About 18% of the total stream length is between 4-8% slope and 3.4% is between 8-16% slope. **We recommend that LWC field check the information in this GIS layer and then use it to identify areas for restoration and monitoring sites.**

Channel Types

The relationship between a stream channel and its gradient, floodplain, and the shape of its valley are the main physical factors that structure in-stream fish habitat. Steep sided, constrained valleys and high stream gradients can result in rapidly moving water which is capable of transporting gravel and large wood within the stream network. Low gradient streams with unconstrained, broad floodplains are areas where transported sediment, gravel and organic debris are deposited. The relatively low gradient streams are areas where salmon spawn and juveniles rear. It is important to consider that the gravel, organic, and woody debris in these spawning and rearing stream reaches come from lower order, headwater streams. The interplay between erosion, transport and deposition is largely a function of the landforms through which a stream network flows (see Appendix B).

Recognizing the different roles that various types of stream channels play in salmonid habitat, the OWEB manual recommends that a channel type classification be performed as part of the assessment. Channel type information was not available for the entire study area. We used GIS to classify stream channel types based on the stream order, DEM-derived stream gradient and stream confinement. This information was provided to the LWC as part of this assessment.

For this assessment, the derivation of stream channel types was dependent on DEM-derived stream gradients and DEM-derived stream confinement. The digital elevation model (DEM) cells are 10m X 10m is size and are, therefore, too large to detect small but biologically important topographic detail such as 1 or

2 m slope breaks that form confining stream terraces. As a result, the GIS methods used to derive confinement and gradient probably obscure important topographic information necessary to better describe these two stream attributes. Nevertheless, the DEM-approximated stream channels should be as good as those derived from USGS 7.5’ topographic maps. The first approximation of these important stream characteristics generated from the DEM will serve as a stand-in until comprehensive data are available and have been field-checked for accuracy. **We recommend that these data be field checked as soon as possible. If necessary, the technique described herein can be modified and stream channels be re-classified.**

We assigned stream channel types to each stream reach using information on stream order, stream gradient and stream confinement (Map 16). Due to limitations with existing data, we were not able to distinguish between moderately confined and confined streams; therefore, we did not classify moderately confined stream channel types (*i.e.*, LM and MM). Moreover, we did not attempt to classify Bedrock Canyons (BC) or Alluvial Fan (AF) channel types using existing information. Finally, to assign all stream reaches to a channel type, we found that it was necessary to create several new categories that are not described in the OWEB manual (Table 64). These categories represent areas where the stream channel is not confined in the upper watershed; these unconfined upper watershed stream reaches accounted for about 26.2% of the study area stream length.

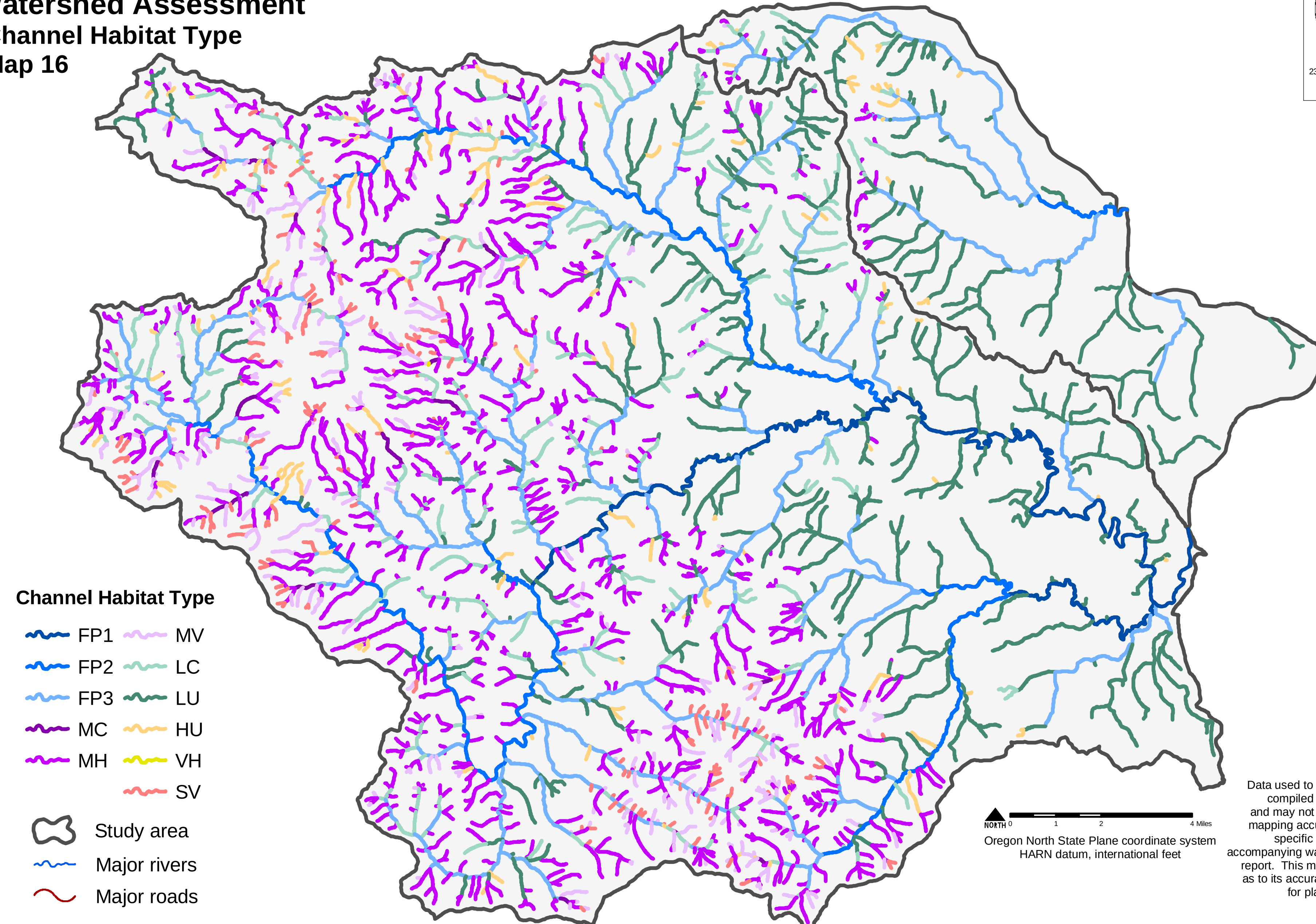
Since stream channel types blend into one another and some channel types may fit into more than one category; therefore, the order in which we assigned channel types was important. We focused on the two ends of the stream channel continuum first, the Floodplain and Headwater stream channel types. We felt that these stream channel classes were most clear-cut. Stream channel types were assigned to stream reaches in the following order: (1) Floodplain; (2) Steep Narrow Valley and Very Steep Headwater; (3) Low Gradient Confined; (4) Moderate Gradient Headwater; (5) Moderate Steep Narrow Valley; and (6) Moderate Gradient Confined (Tables 63 & 64).

Map 16. Types and locations of DEM-derived stream channels in the Luckiamute/ Ash Creek Study Area. See text for details. Also shown are the major rivers and major roads.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Channel Habitat Type
Map 16

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

CHT Data Source:
Developed by Earth Design Consultants, Inc.
in accordance with the OWEB Watershed
Assessment Manual

Table 64. Types of stream channels recognized in the OWEB manual. Shown are the length and proportion of streams in the study area by stream channel type. Note that the estuarine channel types (ES & EL) were not present in the study area, and it was not possible to classify AF, LM, MM, BC using the data available.

Stream Channel Type	Description	Slope (%)	Stream Confine-ment	Stream Order	% of Study area
FP1	Low gradient large floodplain	< 1	Unconfined	6-7	3.7
FP2	Low gradient medium floodplain	< 2	Unconfined	5	5.2
FP3	Low gradient small floodplain	< 2	Unconfined	3-4	15.9
LC	Low gradient confined	< 2	Confined	variable	9.7
LU*	Low gradient unconfined	< 2	Unconfined	variable	22.2
MC	Medium gradient confined	2-4	Confined	variable	0.8
MH	Medium gradient headwater	1-6	Confined	1-2	28.5
MV	Medium gradient steep narrow valley	3-10	Confined	1-3	6.6
HU*	High gradient unconfined	> 2	Unconfined	variable	4.0
SV	Steep narrow valley	8-16	Confined	1-2	3.4
VH	Very steep headwater	>16	Confined	1-2	0.0

* Category added to accommodate unclassified stream segments

We found the study area to be dominated by streams with Moderate Gradient Headwater (MH) channel types. This is not surprising since this stream channel category has one of the broadest definitions. It is characterized by stream gradients ranging from 1-6 degree slopes and is variable in stream order. The MH, MC, and MV channel type classes were among the most difficult to separate because of these broad definitions. The Floodplain channel types, characterized by low gradient, unconfined streams, were also well represented in the study area (24.8%). Of particular interest are the low stream order, unconfined streams (both HU and LU) that were identified in our analysis. **We recommend ground truthing these reaches to see if they can be classified using more convention stream channel types.**

AHI data

An alternative to using the GIS to model stream characteristics are the AHI data that exist for a portion of the study area. AHI data are collected by field teams. Unfortunately, because of steps taken by ODFW staff to calibrate the AHI data, the AHI data have been generalized and are not directly comparable to the DEM-derived stream characteristics described above.

We were asked to summarize salmonid habitat using existing Aquatic Habitat Inventory (AHI) data. As previously mentioned, only 12.2% (1:100K) of the streams in the study area have been surveyed by AHI crews (Map 17). In addition, the dates of some surveys are more than nine years old. Because only a limited proportion of the stream network is surveyed and much of the existing information is quite old, we urge caution when interpreting summaries of these data.

We acquired AHI data GIS data files from Streamnet. We contacted ODFW and were told that the most up-to-date files available for distribution were posted on the Streamnet web site.

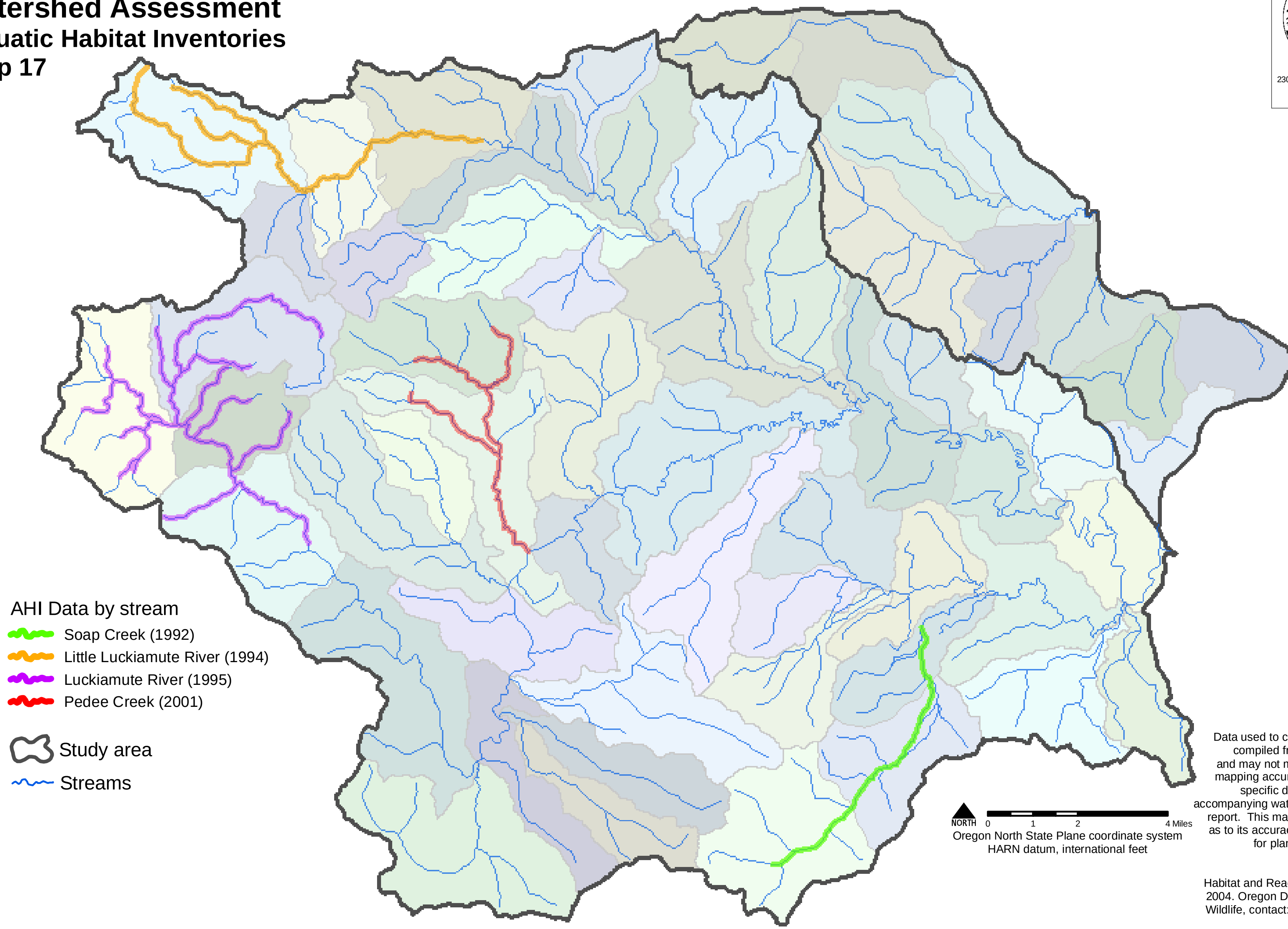
The following section describes some of the information that is available in the AHI data sets. For a complete description please see Moore *et al*. (2002).

Map 17. Extent and Year of AHI Surveys in the Luckiamute / Ash Creek study area.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Aquatic Habitat Inventories

Map 17



Oregon North State Plane coordinate system
HARN datum, international feet

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

AHI Data Source:
Habitat and Reach Data Coverages. 2004. Oregon Department of Fish & Wildlife, contact: Kim Jones (Aquatic Inventories Project). (http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm)

8.3 In-Stream Structure

Side Channel/Secondary Channel Habitat

Side channels and secondary channels are important to salmonids because they provide refuge from rapid stream velocities during high flow events. The ODFW stream survey protocols define each habitat unit as either a primary (mainstem) or secondary (side) channel.

Riffles

The occurrence of riffle areas in streams is useful in evaluating fish habitat, particularly for steelhead. Under ODFW protocols, riffles are defined as areas of fast, shallow flow. The ODFW protocol divides riffles into two types, "Riffle" and "Riffle with pockets."

Percent pools

Pools are important to salmonids because they provide a diversity of habitats in the stream system. The variety of channel bed form and flow characteristics provided by pools give salmonids many different environments for foraging, shelter from predators and high stream velocities, and resting. Water temperatures in pools are often layered in summer, providing deeper, cooler water for escape from high surface temperatures. ODFW stream survey protocols define pools as areas of little or no water surface gradient, having a hydraulic control such as a log, impinging streambank, boulder, bedrock wall, or other obstruction.

Channel Widths per Pool

Pool frequency expresses how many pools are found per unit of stream length or stream area. "Channel widths per pool" is an inverse measure of pool frequency. A higher value of channel widths per pool represents a lower pool frequency, *i.e.*, a less desirable condition (fewer pools).

Channel Width-to-Depth Ratio

Channel width-to-depth ratio is of interest in watershed assessment because it is one way of describing stream channel morphology. A high width-to-depth ratio is considered undesirable because shallow water can be warmed rapidly by sunlight and surrounding warm soil and air in summer, creating temperatures too high for salmonids.

Pool Complexity

Pool complexity is an estimated area of pool that has cover from wood, large substrate, and undercut banks.

Large Woody Debris

Large wood in streams provides shelter for salmon and contributes organic material. Large woody debris (LWD) and Key LWD (defined by ODFW as pieces of woody debris over 60 cm in diameter) are important components of stream structure. Large wood provides cover that can shelter salmonids from predators, and contributes organic material to the aquatic food chain. Logs provide stream structure to help reduce stream velocities, create pools, and generally diversity in the stream environment

LWD Frequency

Large woody is measured during AHI surveys and the frequency that large wood is encountered is recorded. During stream surveys, the quantity of large woody debris in a stream is expressed as "wood frequency", or pieces of wood per 100m of stream length.

LWD Source Areas

The importance of large woody debris is recognized in Pacific Northwest forests. Woody debris can directly affect the organisms that inhabit our forests by serving as shelter or as a food source. In addition, woody debris and other organic material can affect the physical environment of the forest (thus, indirectly affecting organisms) by slowing down water moving over the forest floor and into streams. Reduction of water velocity can lead to reductions in sediment delivery to forest streams. Therefore, large wood can play a role in establishing the complex terrestrial and in-stream environments favorable for many organisms, such as salmon. Of all the structural components in the terrestrial ecosystem, woody debris is one of the slowest components of the forest ecosystem to recover after disturbance (Spies *et al.*, 1988). A watershed management strategy should strive to (1) identify and preserve areas that serve as large wood sources and (2) regenerate areas where large wood may no longer be present.

Many salmon habitat restoration actions involve the short-term measure of placing large wood directly in streams to enhance salmonid habitat. Longer-term strategies can also be used to manage watersheds. For example, watershed managers can plan for large wood recruitment by allowing trees to reach larger sizes in areas that may be prone to mass wasting events. Under the current Forest Practice Act landowners are required to leave all trees and brush in a buffer area that extends 20 feet on either side of a fish bearing stream Jerry Piering (ODF, personal communication). Additionally, a riparian management area (RMA) of 50, 70, or 100 feet must be retained with additional leave requirements for trees, snags in the RMA, depending on the size of the stream Jerry Piering (ODF, personal communication). These trees will be future sources for LWD into the streams.

Charlie Dewberry (1997) describes a process where small "hollows" were identified in Knowles Creek. Dewberry recognized that these hollows accumulate sediments over thousands of years. During winter storms, debris torrents can originate in these hollows leading to the delivery of sediments and large wood to the stream network. Therefore, the restoration of Knowles Creek not only called for the placement of large woody debris in streams, but also planted and planned for the maturation of trees in and down slope from these hollows. These actions focused on both watershed structure and watershed function (the ecological process of sediment and large wood delivery to streams).

An analysis, such as that described by Dewberry is beyond the scope of this assessment. However, the data exist to perform this analysis and should the placement of LWD become a dominant management tool by the LWC, **we recommend conducting a LWD source area analysis.**

Substrates

AHI survey crews estimate the percent of the streambed covered by each substrate particle size (silt and fine organic matter, sand, gravel, cobble, boulder, and bedrock). These data are available in the ODFW habitat-unit-level GIS layer.

Channel Modification Assessment

The only source of channel modification data were the AHI surveys. Since the AHI surveys covered so little of the study area, we did summarize the data. Channel modifications are visible from the ground in many places. We recommend that the LWC develop a channel modification survey to collect this information. Ideas that have been used in other watersheds include a day where citizens and land owners walk streams along their property and record observations and take photographs. Results can be displayed in a public place, such as a library or school. Alternatively, aerial photographs can be reviewed and channel modifications can be recorded. Such an analysis was beyond the scope of this study. **We recommend that LWC examine the raw AHI data for comments on channel modifications and condition**.

8.4 Fish

Fish are of interest to the Luckiamute Watershed Council because of their aesthetic, recreational, and economic importance. In addition, particular groups of species, such as PNW salmon, are also of interest because they act as indicators of environmental quality. PNW salmon have complex life history strategies which depend on the presence of suitable environmental conditions in freshwater, estuarine, and marine environments in order to successfully complete their life cycles. If the ecological requirements in any one of their life history stages (*e.g.*, spawning, rearing, migration, or growth) are not met, their populations will decline. Thus, salmon are sensitive to conditions in streams where they spawn and rear in the upper watershed, tidal marshes in the estuary, and the ocean environment. Several species, including several species of salmonids, are legally identified for protection.

Information on the fish species present in the study area, protection status and salmonid in-stream habitat is presented in this section.

Endangered/Threatened Fish Species and Species of Concern

Within the region that the Luckiamute / Ash Creek watersheds are located, spring chinook salmon and winter steelhead trout are listed as Threatened (Licata *et al.*, 1998; McElhany *et al.*, 2003). The Oregon chub is listed as Endangered (Wevers *et al.*, 1992).

Much of what is being done to manage and restore watersheds in Oregon is the result of the Oregon Plan. The Oregon Plan can be traced back to 1996 when then Governor John Kitzhaber initiated Oregon's Coastal Salmon Restoration Initiative (OCSRI). The goal of OCSRI was to develop a plan to restore the vitality of wild salmon, steelhead, and cutthroat trout in coastal watersheds. The OCSRI fostered active partnerships between state and federal agencies, local governments, conservation organizations, industry representatives, watershed councils, and private landowners. The goal of OCSRI was to develop a plan to restore the vitality of wild salmon, steelhead, and cutthroat trout in coastal watersheds.

Elements of the OCSRI Plan included:

- specific actions to conserve "core" populations of salmon;
- procedures to provide continuing leadership and improve interagency cooperation;
- adjustments in harvest management and hatchery programs;
- goals for riparian management in land-use planning;
- measures to improve the condition of streams and riparian habitats;
- proposals for funding and economic incentive programs;
- opportunities to improve compliance with existing environmental laws;
- public education programs;
- a proposal describing a comprehensive monitoring program; and
- descriptions of watershed council restoration projects.

The multifaceted OCSRI was later renamed the Oregon Plan for Salmon and Watersheds (Oregon Plan). The Oregon Plan now forms the basis for salmon recovery strategies in Oregon.

Table 65 shows the current status, state and federal, as well as sensitive species designated by ODFW.

Table 65. Current status of selected fish species.

Species	Scientific Name	Oregon State Status	Federal Status[AD]
Coastal Steelhead	*Oncorhynchus mykiss*	Sensitive (Upper Willamette Basin)[A]	Threatened[D]
Cutthroat Trout	*Oncorhynchus clarki*	ODFW species of concern[B]	
Spring Chinook	*Oncorhynchus tshawytscha*	Not Listed for Upper Willamette	Threatened[D]
Oregon Chub	*Oregonichthys crameri*	Sensitive[A]	Endangered[D]
Pacific Lamprey	*Lampetra tridentata*	Species of Concern	Species of Concern
Sandroller	*Percopsis transmontana*	ODFW stock of concern[c]	

[A]=ODFW. 2000. Listed Species of Fish in Oregon. [B]=BLM Watershed Analysis [C]=Wevers *et al.* 1992. [D]= Listed under Federal ESA but not under Oregon ESA (Source': ODFW Webpage, 2004).

8.5 Life Histories of Key Salmonid Species

Chinook Salmon (*Oncorhynchus tshawytscha*)

Spawning chinook populations can be found around the Pacific Rim, from northern California through Alaska and the USSR, to Japan (Healey, 1991). Chinook salmon may return to spawn during almost any month of the year; however, there are typically one, two or three peaks of activity. Southern runs tend to occur progressively later than northern runs. A late August run dominates Columbia River runs. The Columbia River also has spring and summer runs, but the late August run is the largest (Healey, 1991). Spring chinook are the only salmon native to the Willamette River above Willamette Falls (Wevers *et al.*, 1992).

Adult chinook tend to achieve larger sizes than coho or chum salmon and generally range from 10-40lbs (Kostow (Ed) *et al.*, 1995). However, chinook salmon weighing 70lbs are not unknown from coastal areas (Kostow (Ed) *et al.*, 1995).

Spawning can occur in relatively small tributaries (2-3m wide) to the main stems of large rivers. Water depth varies from a few centimeters to a several meters at spawning beds. However, adult chinook require deep pools within the proximity of spawning gravels (Kostow (Ed) *et al.*, 1995). The female excavates a shallow depression in the stream bed. It is speculated that the fish key in on sub-gravel water flow when selecting sites for egg laying (Healey, 1991). Gravel and sand accumulate in a mound on the downstream side of the depression. One to five egg pockets, clusters of eggs, are laid by the female in the depression, or redd, over the course of a few days. Redds can range in size from 1-2m^2 to 40 or more square meters (Healey, 1991). Females are known to defend their redd for a period of a few days to a few weeks, while males do not seem to be faithful to a single redd (Healey, 1991).

A number of factors can cause significant egg mortality including temperature, oxygen concentration, siltation, desiccation, disturbance and predation. Chinook fry emerge in either Feb-Mar or Mar-May depending on when the eggs were laid. Some of the fry immediately migrate downstream while others can rear near their place of emergence. Most of the downstream movement of fry occurs at night and from February through May. The time of migration also varies. Some fry move quickly out of the watershed while others may hold in an area for periods ranging from a few weeks to a year or more (Healey, 1991). There is a period of fingerling migration, those first-year fish that have remained in the watershed, in April through June. In Columbia River tributaries, juvenile chinook salmon are known to hold in the watershed as late as October (Healey, 1991).

Loss of deep pools and warm water temperatures have been implicated in the decline of this species (Wevers *et al.*, 1992). In the Willamette River, fall chinook are known from the tributaries of the Clackamas River. Fall chinook were introduced to the Willamette drainage above Willamette Falls. Spring chinook from the Clackamas, Santiam, and McKenzie Rivers (Kostow (Ed) *et al.*, 1995). Both fall and spring chinook populations have been reduced by land use changes, dams, loss of holding pools (Kostow (Ed) *et al.*, 1995).

Steelhead *(Oncorhynchus mykiss)*

Steelhead salmon exhibit a diverse suite of life history traits. Populations of steelhead can be either anadromous or freshwater resident. Anadromous can spend up to 7 years in fresh water prior to smoltification, and then spend up to 3 years in salt water prior to first spawning. Resident populations are called rainbow, or redband trout. Like the cutthroat trout, this species may to spawn more than once (iteroparity).

There is a high degree of overlap in spawn timing between populations regardless of run type. Spawning occurs from December to March. Southern, California steelhead populations generally spawn earlier than those in areas to the north. Columbia River populations from tributaries upstream of the Yakima River spawn later than most downstream populations.

The most widespread run of steelhead is the winter steelhead. In fact, the only native Willamette River steelhead is the late-run or winter steelhead (Wevers *et al.*, 1992). Winter steelhead mature in the ocean. Winter steelhead occur in all coastal rivers of Washington, Oregon, and California, south to Malibu Creek. Summer steelhead mature in streams and include spring and fall steelhead in southern Oregon and northern California. Summer steelhead are not common on the Oregon coast. Only the Rogue, Umpqua, and Siletz Rivers have natural populations of summer steelhead. Summer steelhead are not considered desirable in tributaries of the Willamette River because it is believed that they compete with winter steelhead for resources (Wevers *et al.*, 1992).

The female selects a site with gravel substrate and good under gravel water flow. Females frequently excavate multiple redds. The length of time it takes for eggs to hatch is dependent on water temperature. Eggs hatch after 30 days at a temperature of 51° F. After hatching, the steelhead will remain in the gravel for four to six weeks as alevins. After emerging from the gravel, fry move to shallow, protected areas along stream margins. Fry establish feeding areas which they defend. Most juveniles can be found in riffles, although larger ones will move to pools or deep runs.

Hatchery conditions usually allow steelhead to smolt in 1 year; this difference is often used by biologists to distinguish hatchery and wild steelhead. North American steelhead most commonly spend 2 years (2-ocean) in the ocean before entering fresh water to spawn. Populations in Oregon and California have higher frequencies of age-1-ocean steelhead than populations to the north, but age-2-ocean steelhead generally remains dominant.

Steelhead populations are threatened by warm water temperatures and low water levels (Wevers *et al.*, 1992) and irrigation diversions and cattle grazing (Kostow (Ed) *et al.*, 1995).

Cutthroat Trout *(Oncorhynchus clarki*)

There are multiple life history strategies exhibited in Columbia River Basin cutthroat trout populations, both sea-run and non-migratory. Anadromous stocks do not occur above Willamette Falls (Wevers *et al.*, 1992).

The life history strategies exhibited by cutthroat trout are:

Fluvial cutthroats are found in larger river systems. These fish remain in the rivers for most of their adult lives; however, they may leave to migrate into smaller tributaries to spawn or to seek refuge in winter months.

Adfluvial populations spawn in tributaries; however, juveniles and postreproductive adults migrate to coastal lakes rather than the ocean or large rivers. Lakes may be connected to the ocean.

Anadromous (or sea-run) populations of cutthroat migrate as juveniles to estuaries and the ocean in the spring. Fish remain in the estuaries or nearshore waters and usually return to freshwater later that same year in summer or fall. Rarely do they migrate more than 40 miles offshore,

Mature fish may range in size from 6 inches, in small headwater stream populations to 20 inches, in populations that migrate to and from the ocean (Fitzpatrick, 1999).

Migration begins in July and peaks in August-September. Fluvial and adfluvial cutthroats migrate to spawning streams in the spring and spawn in winter (Wevers *et al.*, 1992). Upper Willamette River cutthroat trout migrate within streams and rivers and use the larger rivers to accelerate their growth (Wevers *et al.*, 1992). Unlike other salmonids present in the watershed, adults are iteroparous and first spawning occurs at 4-5 years of age.

The eggs hatch in summer, depending on water temperature. Resident cutthroat fry emerge in spring or summer and remain in their natal streams. Fluvial and adfluvial cutthroat fry also emerge in spring or summer and may remain in their natal streams or migrate to other streams, rivers, or lakes. Juvenile cutthroat trout depend on the presence of stream bank vegetation and abundant in-stream structure created by logs and root wads.

Coho Salmon *(Oncorhynchus kisutch)*

Wild coho salmon are not native to the Luckiamute Ash Creek watershed. They have been introduced into the basin.

The following discussion was adapted from *http://www.dfw .state.or.us/odfwhtml /infocntrfish/reports/bkgcoho.txt* and (Stillwater Sciences, 1997).

For anadromous runs, coho typically return to spawn as four year old adults (1 year in freshwater and 3 years at sea); however, a small number of one year old male ‘jacks’ may return to spawn after one year. Coho typically enter streams to spawn during September and October. Adult upstream migration occurs during the daytime rather than at night. Returning coho salmon may be more than two feet in length and weigh about 8 lbs. Coho spawn in relatively low gradient streams or lakes, typically higher in the watershed than chinook salmon. Spawning occurs in December. As with other salmonids, females excavate redds over a period of a few days. Redds are approximately 2.5-3.0 m^2.The female may lay multiple egg packets in a single redd. The female will guard the redd for a week or so until she dies.

Eggs incubate for 35-50 days depending on water temperature. During the first few weeks following hatching, alevins (fish with yoke sac attached) remain in the gravel. Survival of alevins is strongly related to the dissolved oxygen concentration in the water and siltation. Emergence begins 2-3 weeks after hatching, generally at night.

The availability of juvenile habitat is thought to be the factor that limits coho populations. Juvenile coho prefer low velocity water as they rear. They overwinter in backwater channels or alcoves to escape winter high flows and they prefer streams with lots of structure.

After emerging, smolts typically migrate out of the watershed in the spring of their second year. The behavior of coho salmon is variable. A small proportion of the population migrates out of the watershed during its first year and sometimes, coho spend an additional year in freshwater before migrating out to sea. Coho may hold in estuaries for a few months before moving out to sea. It is thought that even a short residency time in estuaries increases the chance of survival.

While at sea, coho initially consume zooplankton and then switch to consuming fish as they grow.

8.6 Distribution of Salmonids and Other Fish Species

An understanding of both natural and anthropogenic (human influenced) factors is necessary to explain the current distribution of fish species in the Luckiamute / Ash Creek study area. For example, in the past Willamette Falls (at RM 48 on the Willamette River) has selectively blocked runs of anadromous fish from reaching upriver areas including the Luckiamute study area. While anadromous runs of winter steelhead and spring chinook are able to pass Willamette Falls during seasonal high water flows, other runs are not (Mattson and Gallagher, 2001). Archeological evidence suggests that this has been the case since pre-historic times. Archeological sites in the Willamette Valley show evidence of prehistoric fishing, including bone points that represent parts of composite harpoons or fish spears, and grooved pebbles that may have served as sinkers (Aikens, 1986); however, salmon did not seem to be as important a food source to the early peoples in Willamette Valley as they were to the peoples living along the Columbia River and coastal Oregon. Moreover, early accounts of European-American travelers in the Willamette

Valley rarely mention fish (Aikens, 1986) suggesting that salmon were not as abundant in the Willamette Valley as they were in other parts of the state.

Fish species found in the Luckiamute / Ash Creek study area today either occur there naturally or they were stocked in the watershed (or nearby areas). In all cases, environmental conditions within the watershed must fulfill the ecological requirements of each species for populations to persist. For example, fall chinook salmon, not naturally occurring in the basin, were released into the Luckiamute and Little Luckiamute Rivers in May 1974 and 1976; however, these populations failed to become established, perhaps due to the low flows and high water temperatures characteristic of the subbasin (Wevers *et al.*, 1992).

The Luckiamute Watershed Council Technical Advisory Team asked for information on the fish species shown in Table 66. This table is not meant to include all the fish species known from the watershed.

Table 66. Important fish in the study area. Shown are common name, scientific name, whether the fish is native to the study area, where it occurs in the watershed and other notes. Sources are ODFW (2000) Listed Species of Fish in Oregon and (Wevers *et al.*, 1992).

Species	Scientific Name	Native to Luckiamute	Stocked	Watershed Use	Notes
Salmonids					
Winter Steelhead	*Oncorhynchus mykiss*	Y	1964-1982	Occur in upper reaches	
Cutthroat Trout	*Oncorhynchus clarki*	Y	1920's	Occur in most perennial steams and some intermittent streams.	Not anadromous above Willamette Falls. Isolated populations occur above barriers in Little Luckiamute, Teal, Burgett and Rock Pit Creeks.
Coho	*Oncorhynchus kisutsh*	N	1920-1980's	Occur in most streams including small first and second order streams. Currently, coho are known to occur in 2nd and 3rd order streams; however, no coho were found during recent rapid Bioassessment surveys (D. Anderson, personal communication)	Coho may compete with native cutthroat and winter steelhead in the basin.
Spring Chinook	*Oncorhynchus tshawytscha*				No spawning in the basin. Juveniles originating in other basins may seasonally use lower stream reaches (S. Mamoyac, personal communication).
Fall Chinook	*Oncorhynchus tshawytscha*	N	1974; 1976		Not believed to be in basin today. Failed to become established due to low flows and high temps. However, they have been reported in the Santiam and may possibly stray into the

Table 66. Important fish in the study area. Shown are common name, scientific name, whether the fish is native to the study area, where it occurs in the watershed and other notes. Sources are ODFW (2000) Listed Species of Fish in Oregon and (Wevers *et al.*, 1992).

Species	Scientific Name	Native to Luckiamute	Stocked	Watershed Use	Notes
					Luckiamute (C. Vandenberg, personal communication).
Rainbow Trout	*Oncorhynchus mykiss*	N	1920's-1990's		Stocked in Luckiamute and Little Luckiamute Rivers.
Other Species					
Pacific Lamprey	*Lampetra tridentata*	Y			
Western Brook Lamprey	*Lampetra richardsoni*	Y			
Whitefish	*Prosopium williamsoni*	Y			Member of the trout family and have been observed in the Little Luckiamute River.
Oregon Chub	*Oregonichthys crameri*	Y	No		Found is sand and gravel pools and backwaters of creeks and small rivers, often in vegetation. Currently there are no known populations of the Oregon Chub in the study area. This is a species of special interest.
Sandroller	*Percopsis transmontana*	Y	No		Found in low gradient streams, active at night.
Speckled Dace	*Rhinichthys osculus*	Y			Native non-game fish.
Sculpin (several species)		Y			Native non-game fish.
Northern Pikeminnow	*Ptychocheilus oregonensis*	Y			Native non-game fish. The Northern Pikeminnow (formerly known as the Northern Squawfish) is a member of the carp and minnow family (family Cyprinidae).

Table 66. Important fish in the study area. Shown are common name, scientific name, whether the fish is native to the study area, where it occurs in the watershed and other notes. Sources are ODFW (2000) Listed Species of Fish in Oregon and (Wevers *et al.*, 1992).

Species	Scientific Name	Native to Luckiamute	Stocked	Watershed Use	Notes
Largescale sucker	***Catostomus macrocheilus***	Y			Native non-game fish. It occurs in the slower-moving portions of rivers and streams, and in lakes.
Chiselmouth	***Acrocheilus alutaceus***	Y			Native non-game fish. It is a western species of the minnow family found in the Columbia and Fraser River (British Columbia) systems, and the Malheur basin of eastern Oregon. It inhabits moderate to slow-flowing streams of all sizes, but can be found in lakes.
Peamouth chub	*Mylochelius caurinus*	Y			Native non-game fish. This species is endemic to western North American and are commonly found in the weedy shallows of rivers and lakes, and grow to a maximum of about 35 cm. Peamouth Chub are one of the most abundant cyprinid species in the Columbia Basin.
Redside shiner	*Richardsonius balteatus*	Y			Native non-game fish. Redside Shiners are native to the pacific slope of North America, where they are abundant and widespread in lakes, ponds and slow rivers.
Warm Water Fish					
Largemouth Bass	*Micropterus salmoides*	N	Stocked by Permit ONLY	Shallow weedy lakes and backwater areas of large rivers.	Prefers water temps 60^oF

Table 66. Important fish in the study area. Shown are common name, scientific name, whether the fish is native to the study area, where it occurs in the watershed and other notes. Sources are ODFW (2000) Listed Species of Fish in Oregon and (Wevers *et al.*, 1992).

Species	Scientific Name	Native to Luckiamute	Stocked	Watershed Use	Notes
Smallmouth Bass	*Micropterus dolomieui*	N	Introduced to US West in late 1800's	Streams with alternating pools and riffels, lakes and reservoirs.	Prefers water temps 55-65°F
Black Crappie	*Pomoxis nigromaculatus*	N	Stocked by Permit ONLY		
White Crappie	*Pomoxis annularis*	N			
Bluegill	*Lepomis macrochirus*	N			
Pumpkinseed	*Lepomis gibbosus*	N			
Warmouth	*Lepomis gulosus*	N			
Yellow Perch	*Perca flavescens*	N			
Brown Bullhead	*Ameiurus nebullosus*	N			

Hatcheries

The following discussion on hatcheries is based on information presented in Wevers *et al*. (1992). No hatcheries are located in the Coast Range Subbasin, the area in which the Luckiamute and Ash Creek Study area is located. No hatchery cutthroat trout or whitefish have been released in the study area. However, several nearby hatcheries supplied smolts in the recent past which were released in or near the study area. Winter Steelhead were released from the Big Creek and Klaskanine (sic) hatcheries or the Roaring River Hatchery. Coho released into the subbasin were supplied from the Bonneville, Oxbow, Eagle Creek, Cascade, and Sandy hatcheries. Coho eggs used in the Salmon and Trout Enhancement Program (STEP) were supplied by the Sandy Hatchery or from the Cowlitz Hatchery (WA). Fall Chinook were introduced to the Luckiamute in the mid 1970's from the Cowlitz Hatchery. Rainbow not currently released in area; warmwater gamefish not released in streams, they are stocked in privately owned ponds which are screened to prevent their entry into natural waterways.

Rainbow trout once released into the subbasin were supplied by the Roaring River Hatchery: rainbow trout are no longer released into the basin (S. Mamoyac, personal communication). Non-native warmwater game fish are obtained from hatcheries and released into privately owned ponds within the subbasin (Wevers *et al.*, 1992); however, ponds are screened to prevent entry into natural waterways.

ODF Fish Limits Maps

As a part of its role in regulating timber harvest activities on Oregon lands, the Oregon Department of Forestry maintains maps of fish use in streams. These maps show the known or estimated upstream limits of game fish presence in many coastal streams. All game fish are considered, including resident cutthroat trout.

Salmonid Core Areas

According to the Oregon Plan, "Core Areas are reaches or watersheds within individual coastal basins that are judged to be of critical importance to the sustenance of salmon populations that inhabit those basins. Core Areas contain habitat needed to sustain populations. Furthermore, Core Areas provide a source for repopulating habitats as restoration programs are implemented." Core areas were identified by a Scientific Panel assembled to create and review the Oregon Plan. Therefore, these areas are based on their best professional judgment. Core areas should be considered high priority areas for watershed protection and enhancement activities.

Core areas were only established for coastal populations of salmon; therefore, there are no 'official' core areas in the Luckiamute / Ash

Creek study area. The mapping of core areas built on previous efforts undertaken by groups including: FEMAT Key Watersheds (selected by federal biologists as part of the Presidents Forest Plan; all located on federal lands); AFS Aquatic Diversity Areas (selected by committee of members from the Oregon Chapter of the American Fisheries Society), and DSL Essential Salmonid Habitat; and ODFW Source Watersheds (both selected by Oregon Department of Fish and Wildlife).

We were asked to follow up on draft maps circulated by NMFS showing critical habitat in the Luckiamute/ Ash Creek watersheds. We contacted S. Stone and learned that the draft maps have not been released. Therefore, at this time, there are no designated core or critical areas within the study area. **We recommend that the LWC develop a list of 'core' areas from local biologists and persons familiar with the area.**

Fish Barriers

Fish barriers have been important to Oregon's citizens since before Oregon was a state. In 1848, the new Oregon Territory constitution prohibited the obstruction of salmon streams; if a project did obstruct a salmon stream, it required the construction of fish passage facilities. Oregon's first game laws, passed in 1872, included requirements for fishways to take precedence over dams. Current laws give the Oregon Department of Fish and Wildlife authority to require maintenance of fish passage at all man-made in-channel obstructions in streams where fish are present (ORS 498.268 and ORS 509.605 through 509.645). These laws make dam owners and operators responsible for installing and maintaining adequate fish passage facilities, with some exceptions (*http://www .dfw. state.or.us/ odfwhtml/ infocntrfish/ management/ fishpassage.txt*). Barriers to fish passage can be physical, chemical or behavioral. There is also a temporal component to barriers: landslides and debris flows can temporarily block fish passage until the stream cuts through or around the obstacle. Sometimes permanent natural blockages can form (*e.g.*, as a result of landslides or in other areas volcanoes or glaciers) and some fish runs become landlocked. Most frequently, fish barriers are thought of as the artificial structures in stream channels that may restrict or eliminate the ability of fish to move up and downstream. For example, culverts that create water velocities exceeding the swimming ability of the fish (especially for juvenile fish), or dams. However, obstacles other than physical structures can also block fish passage. Stream reaches with chronically low dissolved oxygen concentrations, high temperatures, or toxic contaminants can also impede fish passage (see Section 6.1 and Map 7).

Some of these barriers are currently upstream of the known distribution of some of the fish present in the study area. For example, new data indicate that a natural barrier at RM 56 prevents winter steelhead from reaching about 10,000 ft of streams shown on the current ODFW winter steelhead distribution map (see below). In addition, these data indicate that winter steelhead distribution extends about 9,000 ft more on the west fork of the Luckiamute and Miller Creek reaches (D. Anderson, personal communication). Therefore, we recommend that barriers be re-evaluated as new information becomes available.

Culverts

Several sources of culvert data exist; however, not all sources are up-to-date. From the Streamnet database, we found information on a single a culvert that acts as a fish barrier on the South Fork of Pedee Creek at RM 2 (*www.streamnet.org*). The streamnet data, however, are known to be incomplete. Therefore, we contacted both Benton and Polk Counties. We obtained the data from Benton County but not from Polk County. **We recommend that LWC acquire and review all existing culvert data. If these data continue to be unavailable, we recommend that LWC undertake a culvert survey. LWC could locate and map culverts on main roads or use a simple GIS model to predict where culverts are likely to occur.**

Dams

We gathered available information on dams from ODFW. There are several dams that are recorded for the Luckiamute/ Ash Creek study area including the dam that forms a reservoir at river mile (RM 3) on Price Creek. Other dams are listed below in Table 67. These dams should be field checked to ensure that they have not been removed.

Table 67. Dams listed in the ODFW dams database. Revised 6/28/2002.

Dam Name	Owner	Maximum Storage Acre-feet
Unnamed dam	Unknown	Unknown
Unnamed dam	Unknown	Unknown
Unnamed dam	Unknown	Unknown
Mulkey, Gylan Reservoir Dam	Gylan Mulkey	50.0
Kennel Reservoir Dam	Earl Kennel	160.0
Unnamed dam	Sam Oberg	Unknown
Emory Moore Dam	James Heggemeir	166.0
Unnamed diversion dam	Unknown	Unknown
Unnamed diversion dam	Unknown	Unknown
Unnamed dam	Unknown	Unknown

Unnamed dam	Unknown	Unknown
Whispering Winds Dam (Lake of the Winds Dam)	Girl Scout Camp	100.0
Unnamed dam	Unknown	Unknown

In addition to the dams listed in Table 67, we have also provided a list of reservoirs (see Section 6.1). **These reservoirs should be checked to see if they have dams present that could block fish passage.**

The LWC asked for information on the dam located on Ash Creek. Ash Creek lies on relatively flat topography in the Willamette River floodplain in the west-central Willamette Valley (Map 1). The primary source of water in this area is from the South Fork of Ash Creek. A dam located just south of F Street backs up flow within the creek and forms a pond near and along the southern and eastern site boundaries that was used to float logs during mill operation.

About one-half mile north of dam, the South Fork joins the main stem of Ash Creek, which flows approximately 4,000 feet northeast to the Willamette River. Storm water runoff from the site is conveyed to the log pond through a series of ditches and underground culverts. The first known industrial use of the site occurred in 1939 or 1940, when J.F. Cooper built a sawmill and constructed an earthen dam on the south fork of Ash Creek to create the log pond. Cooper operated the mill until 1946 (*http://www. deq.state. or.us/ wmc/rods/MtnFir Lumber.pdf*).

Since 1983 the Northwest Power Planning Council has directed studies of existing salmonid habitat. In 1988, the Council concluded that: 1) the studies had identified fish and wildlife resources of critical importance to the region; 2) mitigation techniques cannot assure that all adverse impacts of hydroelectric development on these fish and wildlife populations will be mitigated; 3) even small hydroelectric projects may have unacceptable individual and cumulative impacts on these resources; and 4) protecting these resources and habitats from hydroelectric development is consistent with an adequate, efficient, economical, and reliable power supply. Consequently, the Council also has considered alternative means of habitat protection.

As a result, the Council has designated certain river reaches as "protected areas." Protected areas are stream reaches where the Council believes hydroelectric development would have unacceptable risks of loss to fish and wildlife species of concern, their productive capacity, or their habitat. River reaches to be protected are those reaches or portions of reaches listed on the "Protected Areas List" adopted by the Council on August 10, 1988. Table 68 shows river reaches considered and those appearing on the Protected Areas List. No dams exist on the Luckiamute system (Wevers *et al.*, 1992).

Table 68. Protection status adopted by the Northwest Power Planning Council in 1988. Shown are status (1=Anadromous and Resident Fish or Wildlife; 2=Anadromous; and 3=Unprotected), stream, start reach and end reach and number of miles. Source was Streamnet.org, December 2003.

Status	Stream	Start Reach	End Reach	River Mile (Reach Length Mi)
1	Little Luckiamute R	Waymire Cr	Berry Cr	2.5
2	Clayton Cr	Mouth	Headwaters	3
2	Little Luckiamute R	Berry Cr	Dutch Cr	0.1
		Black Rock Cr	Headwaters	0.5
		Cooper Cr	Fern Cr	6
		Dutch Cr	Sams Cr	2.1
		Farley Cr	Waymire Cr	1.2
		Fern Cr	Teal Cr	1.3
		Mouth	Cooper Cr	1.5
		Sams Cr	Black Rock Cr	1.2
		Teal Cr	Farley Cr	1
2	Luckiamute R	Beaver Cr	Boulder Cr	0.5
		Bonner Cr	Cougar Cr	9.4
		Boulder Cr	Headwaters	0.5
		Cougar Cr	Rock Pit Cr	1.5
		Jont Cr	Mctimmonds Cr	7.8
		Little Luckiamute R	Jont Cr	2
		Maxfield Cr	Price Cr	1.2
		Mctimmonds Cr	Pedee Cr	2.5
		Miller Cr	Beaver Cr	0.5
		Mouth	Soap Cr	2.5
		Pedee Cr	Ritner Cr	1
		Price Cr	Vincent Cr	2
		Ritner Cr	Maxfield Cr	3
		Rock Pit Cr	Wolf Cr	0.5
		Soap Cr	Little Luckiamute R	15.5
		Vincent Cr	Bonner Cr	1.4
		Wolf Cr	Miller Cr	0.4
2	Maxfield Cr	Mouth	Headwaters	2.8
2	Pedee Cr	Mouth	Pedee Cr, S Fk	2.5
		Pedee Cr, S Fk	Pedee Cr, N Fk	1.7
2	Pedee Cr, N Fk	Mouth	Headwaters	2
2	Pedee Cr, S Fk	Mouth	Headwaters	2

Table 68. Protection status adopted by the Northwest Power Planning Council in 1988. Shown are status (1=Anadromous and Resident Fish or Wildlife; 2=Anadromous; and 3=Unprotected), stream, start reach and end reach and number of miles. Source was Streamnet.org, December 2003.

Status	Stream	Start Reach	End Reach	River Mile (Reach Length Mi)
2	Ritner Cr	Mouth	Clayton Cr	2.2
2	Soap Cr	Berry Cr	Baker Cr	1.6
		Mouth	Berry Cr	5.5
2	Teal Cr	Grant Cr	Headwaters	3.5
		Mouth	Grant Cr	1.5
2	Waymire Cr	Mouth	Headwaters	2
2	Willamette R	Ash Cr	Luckiamute R	12
		Luckiamute R	Santiam R	0.4
3	Ash Cr	Ash Cr, M Fk	Ash Cr, N Fk	0.1
		Mouth	Ash Cr, M Fk	1.2
3	Ash Cr, N Fk	Mouth	Headwaters	1.2
3	Ash Cr, S Fk	Mouth	Headwaters	1.7
3	Baker Cr	Mouth	Headwaters	0
3	Beaver Cr	Mouth	Headwaters	0
3	Berry Cr	Berry Cr, S Fk	Berry Cr, M Fk	0.5
		Mouth	Headwaters	0
			Peterson Cr	2
		Peterson Cr	Berry Cr, S Fk	2.5
3	Black Rock Cr	Mouth	Headwaters	0
3	Bonner Cr	Mouth	Headwaters	0
3	Boulder Cr	Mouth	Headwaters	0
3	Clayton Cr	Mouth	Headwaters	1
3	Cooper Cr	Mouth	Headwaters	0
3	Cougar Cr	Mouth	Headwaters	0
3	Dutch Cr	Mouth	Headwaters	0
3	Farley Cr	Mouth	Headwaters	0
3	Fern Cr	Mouth	Headwaters	0
3	Grant Cr	Mouth	Headwaters	0
3	Jont Cr	Fuller Cr	Headwaters	0
		Mouth	Fuller Cr	0
3	Little Luckiamute R	Black Rock Cr	Headwaters	3
3	Maxfield Cr	Mouth	Headwaters	4.7
3	Mctimmonds Cr	Mouth	Headwaters	0
3	Miller Cr	Mouth	Headwaters	0
3	Pedee Cr	Pedee Cr, N Fk	Headwaters	2.7

Table 68. Protection status adopted by the Northwest Power Planning Council in 1988. Shown are status (1=Anadromous and Resident Fish or Wildlife; 2=Anadromous; and 3=Unprotected), stream, start reach and end reach and number of miles. Source was Streamnet.org, December 2003.

Status	Stream	Start Reach	End Reach	River Mile (Reach Length Mi)
3	Pedee Cr, N Fk	Mouth	Headwaters	2.5
3	Pedee Cr, S Fk	Mouth	Headwaters	1.5
3	Price Cr	Mouth	Woods Cr	5.2
		Woods Cr	Headwaters	6
3	Ritner Cr	Clayton Cr	Sheythe Cr	1
		Sheythe Cr	Headwaters	3.8
3	Rock Pit Cr	Mouth	Headwaters	0
3	Sams Cr	Mouth	Headwaters	0
3	Sheythe Cr	Mouth	Headwaters	4
3	Soap Cr	Baker Cr	Headwaters	10.5
		Berry Cr	Baker Cr	8.1
3	Teal Cr	Grant Cr	Headwaters	2.4
3	Vincent Cr	Mouth	Headwaters	4
3	Waymire Cr	Mouth	Headwaters	1.5
3	Wolf Cr	Mouth	Headwaters	0
3	Woods Cr	Mouth	Headwaters	5

Natural Barriers: Rapids, Falls

There are a number of barriers documented in the Luckiamute system on StreamNet (*www.streamnet.org*) and from knowledgeable persons. Two natural barriers may block fish runs on the Luckiamute River, one at river mile (RM) 56 (a 12 ft debris jam) and one at RM 56.5 (D. Anderson, personal communication). There are falls at RM 1 on Berry Creek, RM 0 on Grant Creek, RM 0 on the North Fork of Teal Creek, RM 0 on the South Fork of Teal Creek, at RM 13, 19 and 20 on the Little Luckiamute. The barrier on Teal Creek has isolated populations of cutthroat trout ((Licata *et al.*, 1998). There are unnamed cascades (although this may actually be a 15 ft waterfall, D. Anderson, personal communication) on Ritner Creek (RM 5) , and the Little Luckiamute at RM 20 and 21. **We recommend that barriers be field checked and observations recorded.**

Photo 14 Natural debris jam in the Luckiamute Watershed Study Area.

Abundance of Key Species

Fish and wildlife populations can be characterized in several different ways. Abundance and distribution can be directly observed either anecdotally (casually) or through scientific study. In many cases, biologists qualitatively assess environmental conditions and use their best professional judgment to determine where populations of organisms are likely to be (see Section 7.1). Alternatively, populations can be indirectly assessed by understanding the relationship that exists between an organism and its habitat through the use of a habitat suitability model. Numerous habitat suitability index models have been developed. Some models have been rigorously developed using quantitative data and empirical species-habitat relationships [see (Johnson and O'Neil, 2001)] and others tend to be more descriptive and of unknown accuracy. Finally, historic population levels of fish and wildlife are known through archeological studies. For this report, we have acquired and evaluated information developed using all of these approaches.

The abundance and distribution of the fish species occurring in the study area is not well known. A recent watershed assessment by the BLM states that, "There are no known data pertaining to populations of these resident fish. However, it is believed that many second-order, and all third-order streams (*i.e.*, those having gradients < 8 percent) and below have fish present." (Licata *et al.*, 1998). Stream orders 2-7 equate to approximately 51% of the total stream length in the study area. To further complicate matters, uncertainty pertaining to the origin of stocks arises when past stocking practices supplemented naturally occurring species with stocked varieties of the same species. For example, juvenile coho were found in the Luckiamute River prior to 1955 before any releases were made and the origin of these fish remains unknown: they were most likely strays from other subbasins (Wevers *et al.*, 1992).

The distribution of salmonids in the watershed is not well known. The Oregon Department of Fish & Wildlife (ODFW) publishes several fish distribution maps showing their best professional judgment on the current distribution of coho, spring chinook, and winter steelhead salmon (Maps 15-17). In general, the distribution of fish would be limited by unfavorable environmental conditions or by a barrier. In the Luckiamute River basin, winter steelhead are distributed along the Little Luckiamute and Luckiamute Rivers, and along Soap Creek. Winter steelhead also occur along the lower reaches of Ash Creek. S. Mamoyac reports that Ash Creek is used by juvenile steelhead that originate outside of the Luckiamute/ Ash Creek study area. juvenile steelhead are only present in the winter and spring. Winter steelhead are believed to be distributed along 25.5% and 0.7% length of the streams (1:100K) in the Luckiamute and Ash Creek basins, respectively (Map 18). However, new data indicate that a natural barrier at RM 56 prevents winter steelhead from reaching about 10,000 ft of streams shown on the current ODFW winter steelhead distribution map In addition, these data indicate that winter steelhead distribution extends about 9,000 ft more on the west fork of the Luckiamute and Miller Creek reaches, steelhead are known from 3,700 ft of a main stem tributary not shown on Map 18 (D. Anderson, personal communication). The distribution of coho are also mapped by ODFW although they are not native to the Luckiamute and Ash Creek study. Coho distribution in the Luckiamute is similar to that of winter steelhead, occupying slightly less (20.1% of the length of the 1:100K streams) of the available stream length (Map 19). Coho do not occur in Ash Creek.

Juvenile spring chinook are distributed seasonally along the lower reaches of the Luckiamute River, and Soap and Ash Creeks. Spring Chinook do not spawn in the basin. Spring chinook are distributed along approximately 2.5% of the streams (1:100K) in the Luckiamute and 0.6% of the streams in the Ash Creek watersheds (Map 20).

Interestingly, cutthroat trout are widely distributed in the study area, even above some of the barriers that block other species. In fact, isolated populations of cutthroat exist in the Little Luckiamute drainage. Population densities of cutthroat above the falls on the Little Luckiamute are much greater than other streams in the study area (Wevers *et al.*, 1992).

Historic Catch Records (steelhead, cutthroat)

There is information on the status of salmonid populations in the Pacific Northwest; however, much of this information is anecdotal. Fish populations are frequently assessed using a variety of different survey methods, including catch data, dam counts, and more formalized juvenile counts and spawning surveys. Unfortunately, many of these survey methods, like most sample methods, include some sort of sampling bias. For example, catch data may be influenced by conditions other than the abundance of fish. Catch records are frequently used to assess the status of game fish populations. Catch data also are difficult to standardize; however, catch data are often expressed as the number of fish caught per level of effort, usually per angler hour. However, many factors can influence the number of fish that are actually caught. This makes catch records an unreliable tool to assess populations.

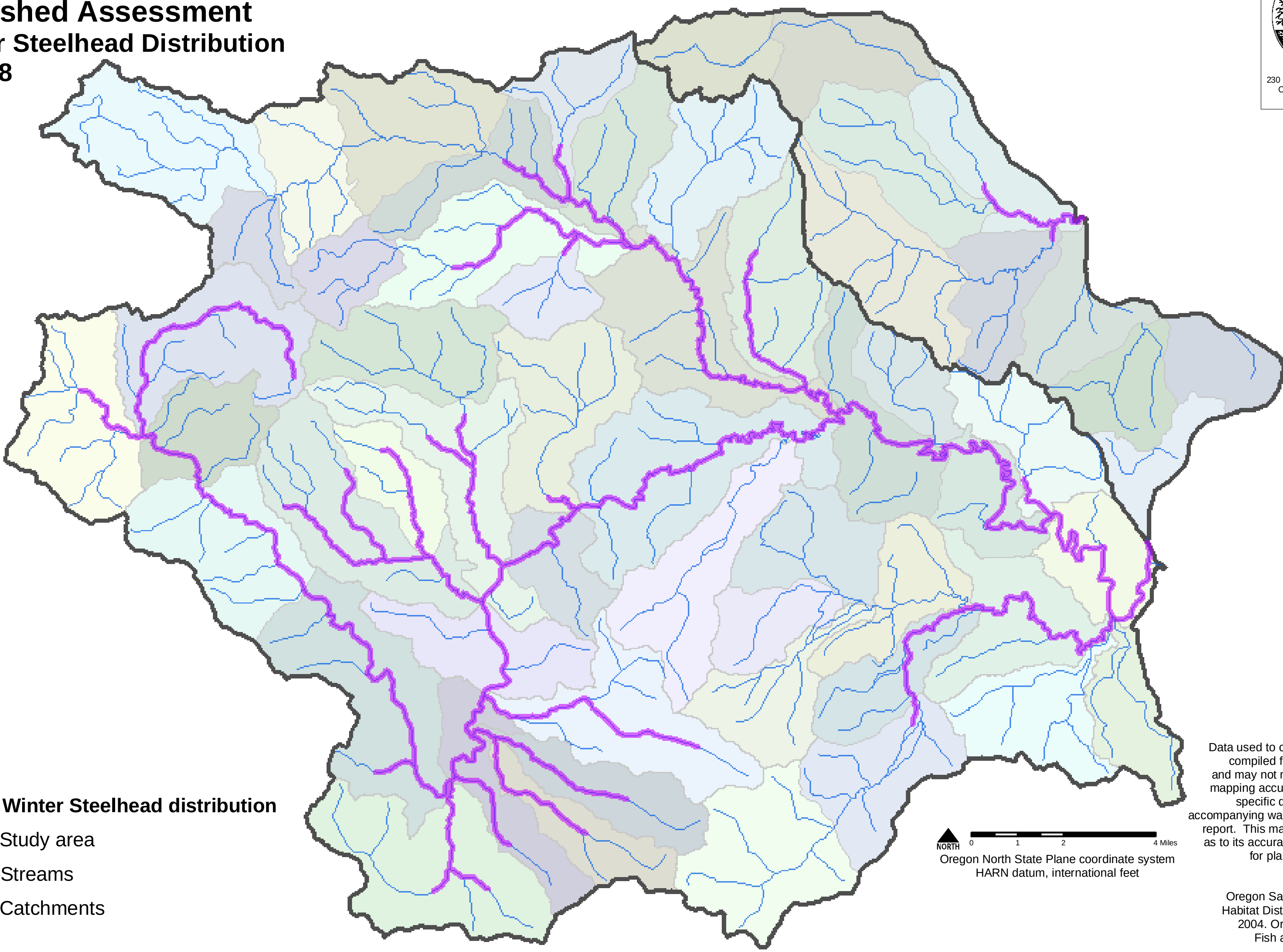
Many other survey techniques also have sampling bias. For example, some spawning surveys are frequently conducted along subjectively selected stream segments and therefore are not suitable for use in developing accurate, basin-wide estimates of fish populations. In addition, reported results from many surveys may incorporate some sort of "correction factor" intended to account for sample bias. Examples of correction factors commonly used include mortality estimates, exploitation rates, and/or bias correction (Botkin *et al.*, 1993). While correction factors are not entirely bad, these factors are often employed without being defined or their assumptions being documented. This makes it very difficult to determine and interpret what was actually measured. Most importantly, one has to accept population size estimates at face value without know how accurate or representative they are (see Section 3.4).

Maps 15, 16, and 17: Distribution of Winter Steelhead, Coho, and Spring Chinook salmon in the Luckiamute / Ash Creek Study Area. Shown also are 7^{th} field HUC and major streams. Source: Oregon Department of Fish and Wildlife.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Winter Steelhead Distribution
Map 18

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Winter Steelhead distribution
Study area
Streams
Catchments

NORTH
0 1 2 4 Miles
Oregon North State Plane coordinate system
HARN datum, international feet

Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

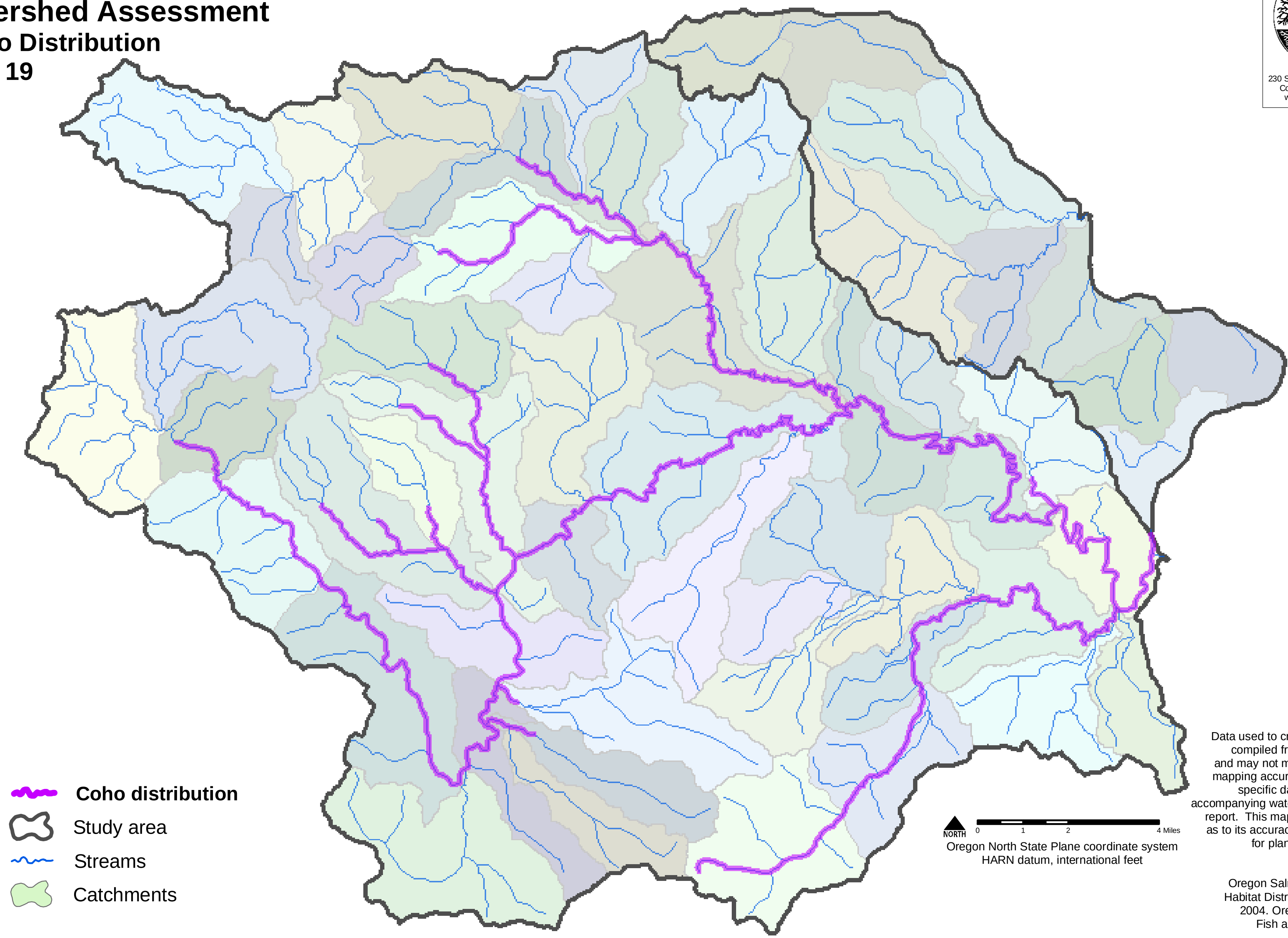
Fish Data Source:
Oregon Salmon and Steelhead Habitat Distribution (1:100,000). 2004. Oregon Department of Fish and Wildlife, Contact: J. Lloyd, J. Bowers. (http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm)

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Coho Distribution

Map 19

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Oregon North State Plane coordinate system
HARN datum, international feet

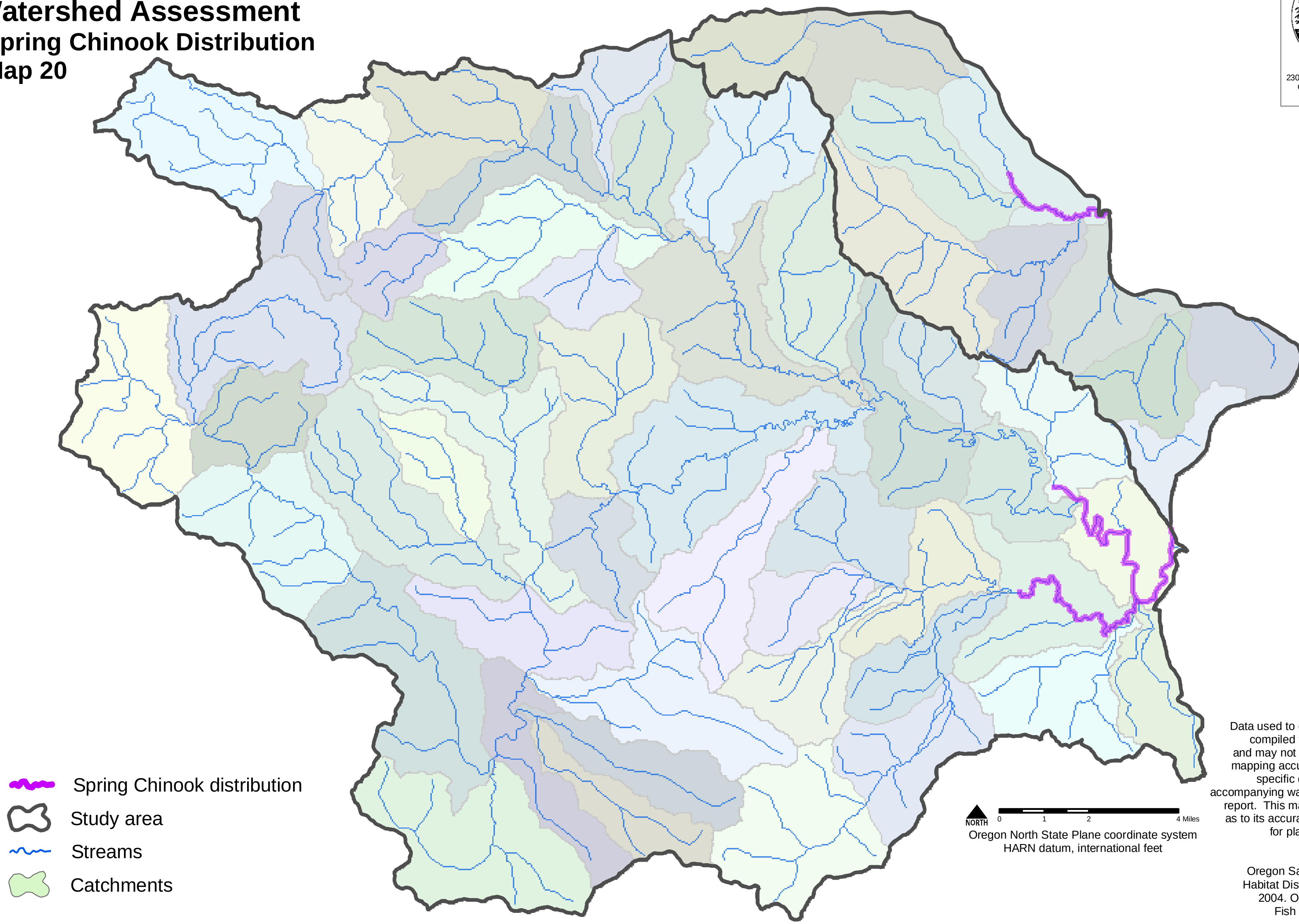
Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Fish Data Source:
Oregon Salmon and Steelhead Habitat Distribution (1:100,000). 2004. Oregon Department of Fish and Wildlife, Contact: J. Lloyd, J. Bowers. (http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm)

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Spring Chinook Distribution

Map 20



Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Fish Data Source: Oregon Salmon and Steelhead Habitat Distribution (1:100,000). 2004. Oregon Department of Fish and Wildlife, Contact: J. Lloyd, J. Bowers. (http://rainbow.dfw.state.or.us/nrimp/information/fishdistdata.htm)

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com

Winter steelhead harvest, determined from catch records, in the Coast Range subbasin ranged from 24 to 262 tags during 1977 to 1989. Catch records for winter steelhead for the Luckiamute River are shown in Fig. 8.

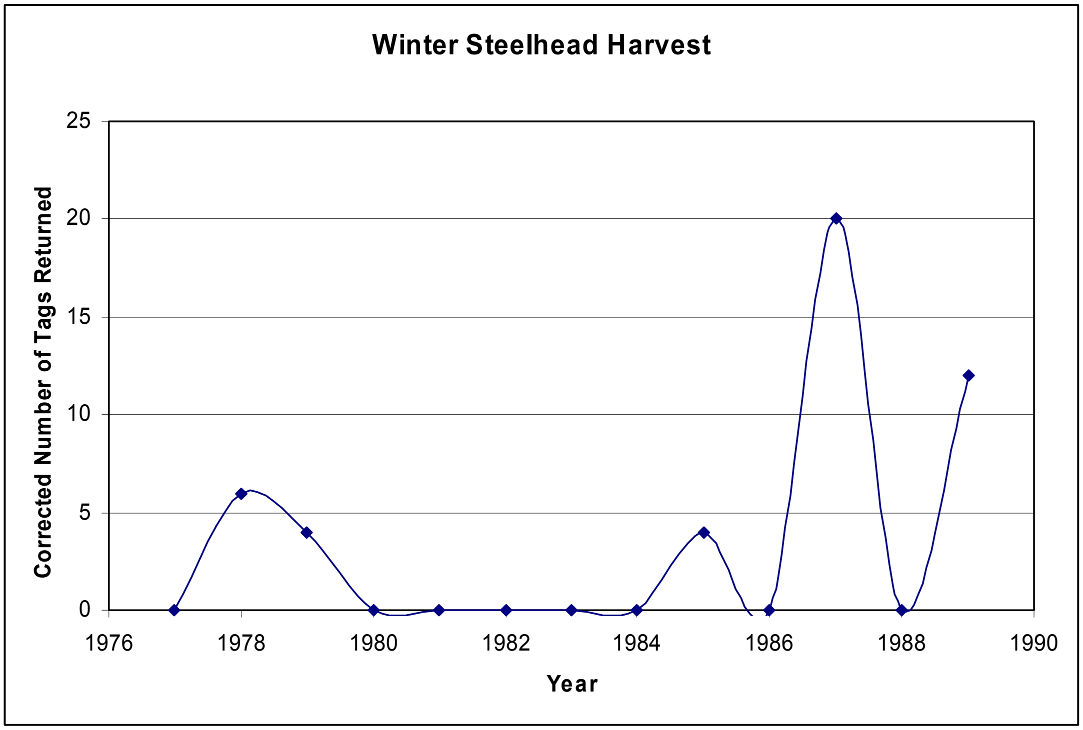


Figure 8. Corrected Winter Steelhead Harvest in the Luckiamute River from 1976-1989.

Historic/Recent Juvenile and Spawner Surveys

Surveys of both juvenile and spawning adults are also used to assess fish populations. Many of these techniques also have bias, and knowledge of protocols and data handling methodologies are necessary before results can be interpreted and compared. This criticism was recognized by ODFW personnel in 1980 when they made several recommendations to improve accuracy and precision of coho surveys. These improvements included the expansion of the number of index streams, to replace peak counts with estimates derived from Area-Under-the-Curve (AUC) techniques, and to separate indices from streams influenced by hatchery fish from others (Wemple, 1994). Therefore, care must be taken when interpreting and comparing earlier records.

Unfortunately, for the Luckiamute / Ash Creek study area not much is known about recruitment of winter steelhead and cutthroat. Moreover, the release of winter steelhead into the basin from 1964 to 1982 and cutthroat stocking in the early 1920s would make trend analysis of juvenile counts problematic.

One way to estimate potential recruitment is from the number of redds. (Wevers *et al.*, 1992) identified suspected spawning areas for winter steelhead in the Luckiamute. These areas were RM 40-48 on the Luckiamute, RM 11-13 on the Little Luckiamute, RM 0-5 on Teal Creek, and RM 0-4.2 on Pedee Creek. Actual spawning surveys summarized from 1985 and 1991 recorded the number of reeds per mile on the Luckiamute River. The number redds per mile peaked in 1988 but dropped to the lowest number during the period of record in 1990 (Figure 9). The average number of reeds per mile during the period of observation was 10.6. According to Wevers *et al*. (1992) steelhead production had been ‘documented’ on the Luckiamute and Little Luckiamute Rivers. According to Steve Mamoyac, more recent information on steelhead spawning may now be available from ODFW. The ODFW basin plan did not include information for cutthroat.

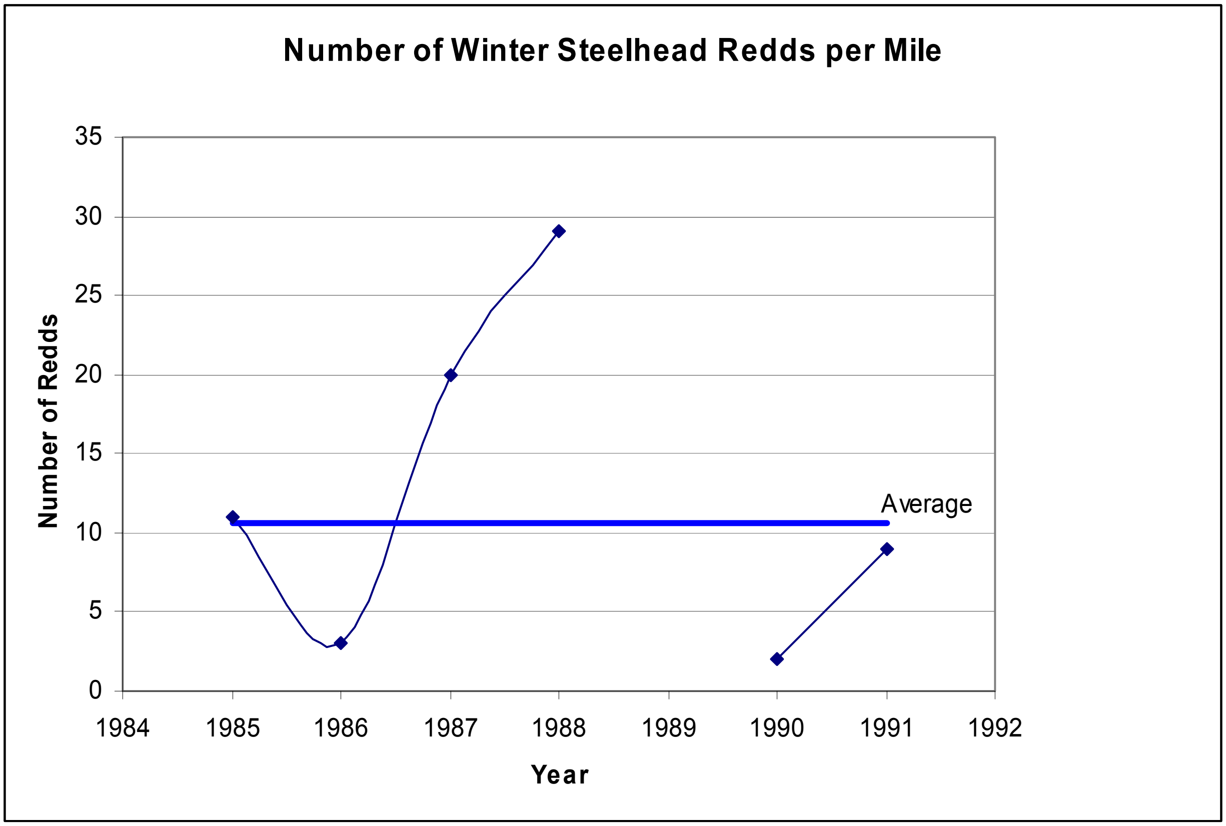


Figure 9. Number of winter steelhead redds per mile for the Luckiamute River (Wevers *et al.*, 1992). The average number of redds per mile was 10.6.

General Fish Habitat Summary

For an individual salmonid to hatch, grow and return to a stream to spawn specific ecological conditions must be met during each of its life history stages. Typically, the following life history stages are recognized for salmonids: spawning, incubation, emergence, summer rearing, and overwintering. Each species of salmonid has different ecological requirements and may be more or less vulnerable in each of these stages than another species in a particular watershed. The interplay between a salmonid's life history requirements and its environment (*i.e.*, watershed, estuary, and ocean) lead to a diversity in life history strategies among different populations of salmon. These differences permit one species of salmonid to do better than another within the same basin, or one basin to support higher populations of a particular species than an adjacent basin. The relationship between salmonid populations and their environments lead to genetically distinct and locally adapted populations.

Fisheries biologists generally determine the habitat requirements of salmonids by

matching abundance and distribution data with the physical and biological characteristics of where the fish are observed. Observed habitat-species relationships guide much of the salmonid restoration plan in the PNW. In addition to observational data, laboratory studies can also be used to determine the physiological response to fish to environment factors. For example, lethal and sub-lethal water temperature guidelines were probably determined from laboratory and field jstudies. In all cases, biologists are particularly interested in determining what environmental factors limit the abundance and distribution of salmonid species. In-stream complexity (used by salmonids to escape periods of high water flows, to forage, and to escape predation) is generally believed to be the factor that most frequently limits salmonid populations in the PNW. For this reason, most salmonid habitat restoration efforts center on enhancing or creating in-stream structure. In-stream structure, in turn, can lead to the development of pools and can trap and sort substrates (gravel beds used for spawning).

One source of information describing the condition of salmonid habitat is the ODFW Aquatic Habitat Inventory (AHI) data sets. AHI data are gathered in the field by county, state and federal agencies and by private industrial groups using similar protocols. Field teams make measurements and observations on stream gradient, substrates, channel form, stream-side vegetation, and other measurements [see Moore *et al*. (2002) for more information]. Data are organized on USGS topographic maps at 1:24K. ODFW then converts field data to GIS data sets. There are two things to be aware of when using AHI GIS data. First, there are two different data sets, habitat unit-level and reach-level GIS spatial data sets. Habitat units, the fundamental surveyed units, are defined by the surveyor based on breaks in geomorphology, flow characteristics, *etc.* (Moore *et al.*, 2002). Reach-level summaries, produced by ODFW, are based on summaries of habitat unit data. Second, all field data are ‘calibrated’: calibration consists of converting field measured distances to map distances. Therefore, AHI GIS layers should not be viewed as spatially accurate descriptions of in-stream habitat, but rather a generalized description of the patterns of in-stream habitat.

The area of the Luckiamute and Ash Creek basins covered by AHI data is quite limited (Map 17): approximately 12.2% of the streams (1:100K) have been surveyed by AHI field crews. Aquatic habitat conditions can reflect watershed processes that occur over large areas. However, when only a limited proportion of the stream network is surveyed, it is possible that the conditions found may not be typical of the entire watershed. In addition, some of the surveys from the Luckiamute / Ash Creek study area are more than nine years old. While these data will remain useful until they are replaced by more recent surveys, it is important to note that the Coast Range of Oregon is a dynamic environment where the conditions reported in some of the older surveys may no longer be accurate. **We**

recommend that AHI or some other stream survey be performed to inventory stream conditions in the study area.

The primary advantage of using AHI data is that the condition of streams across the state can be evaluated as salmonid habitat by matching the ecological requirements of salmonids with in-stream conditions. Scientists at ODFW and NMFS are currently working on a model that ranks data collected during AHI into 'good', 'fair' or 'poor' habitat for steelhead, chinook and sockeye salmon. Although this model is being developed for the Middle Deschutes River Basin it is "intended for general application to the Pacific Northwest Basins" (Burke *et al.*, in prep). An advantage of this model is that it can be tied to existing GIS coverages created from AHI data to give a quick overview of habitat quality in a particular area for each of three life stages: spawning (spawning+ incubation+ emergence), summer rearing and overwintering.

Burke *et al*. (in prep) have reviewed the literature and developed a set of optimal habitat requirements for various life stages of steelhead, chinook, and sockeye salmon. For steelhead, Burke *et al*. summarized ecological requirements for substrate, pool area and depth, temperature, flows, large woody debris, and cover and developed a Habitat Quality Rating Model (HabRate). This model was developed as a decision making tool and is "intended to provide a qualitative assessment of the habitat potential of stream reaches" (Burke *et al.*, in prep). This spreadsheet model is ideally suited for interpreting AHI data. We developed a reach-level ranking of AHI data from the Luckiamute and Ash Creek study area using criteria established in this model for steelhead.

Unfortunately, a similar model was not available for cutthroat trout, chinook or coho, the other salmonids found in the Luckiamute / Ash Creek study area. However, protecting steelhead will generally benefit other salmonid species. Cutthroat trout are the only native trout in the Coast Range subbasin that persist through natural production (Wevers *et al.*, 1992). They widely distributed in the Luckiamute and Ash Creek basins. They occur in most perennial streams and occasionally in intermittent streams. Spawning occurs in November in the Luckiamute River although they are known to spawn at different times in other areas (Table 69). Many cutthroat drop back to the Willamette River in late March following spawning. However, not all cutthroat move back to the main stem (D. Anderson, personal communication). Cutthroat have been observed to spawn in Soap Creek from January through May [see (Wevers *et al.*, 1992)].

Fall chinook salmon require higher water flows and lower water temperatures than those occurring in the study area. Releases of fall chinook failed to establish viable populations in the Luckiamute and Little Luckiamute rivers in the mid 1970's (Wevers *et al.*, 1992). This species is included in this report because of its history in the basin.

Coho have similar ecological requirements to cutthroat and winter steelhead in the Coast Range Basin. Competition between coho and native salmon is believed to have limited the successful establishment of coho populations in the study area (Wevers *et al.*, 1992).

Table 69 shows generalized spawning times for many of the fish found in the study area.

Table 69. Spawning times for selected fish found in the Luckiamute and Ash Creek watersheds.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winter Steelhead	Spawning											
Cutthroat Trout	Spawning									Spawning		
Coho										Spawning		
Rainbow Trout	Historically Stocked in the Study Area but are no Longer											
Oregon Chub			Spawning									
Sandroller					Spawning							
Warm Water Fish	Stocking is now by permit only											
Largemouth Bass				Spawning								
Smallmouth Bass				Spawning								

Salmonid Habitat Analysis

A number of factors can regulate and control the distribution of organisms in their habitats. The science of ecology is concerned with identifying the factors that control and regulate the abundance and distribution of organisms. At any one time there is exactly one factor that limits the growth of a biological population. This is called the limiting factor. Different species have different factors that limit their populations and a single population can be limited by different factors at different times. It is difficult to actually measure limiting factors in nature; however, an understanding of the potentially limiting factors is absolutely essential to successfully manage biological resources.

Consider salmon. Anadromous salmonids spend part of their life cycle in streams, estuaries, and the sea. Therefore, a salmonid's habitat consists of stream, estuaries and the ocean **plus** all the factors that structure stream, estuary and oceanic ecosystems. In addition to physical habitat constraints, biological interactions between fish and between fish and other organisms, including disease-causing organisms, can also affect the distribution of salmon. It is the complex life history and all of the possible interactions between salmon and their fresh-brackish-salt water environments, and between salmon and other organisms, which make the management and recovery of depressed salmon populations such a difficult problem.

Ideally, natural resource managers would identify the factor that limits salmon population growth and supply more of that limiting factor. For example, large wood is added to streams because natural resource managers believe that salmon populations are limited by a lack of in-stream complexity. Adding more wood, the suspected limiting factor, should result in more salmon. It is true that current in-stream complexity is dramatically different than historic accounts (this is supported by information presented in Sections 5 & 7); however, it is unlikely that the same factor (in this case, in-stream complexity) limits all salmon populations. **For this reason, we recommend that LWC develop a diverse suite of restoration strategies and that they work with fisheries managers to develop the scientific underpinnings of the factors that truly limit salmonid populations.**

A first step in developing an understanding of salmon habitat requirements is to develop a list of the factors that are believed to control and regulate salmon distribution in the Luckiamute/ Ash Creek study area. We searched for information describing the current distribution of salmon species in the study area. During a July 2003 meeting with the LWC technical team, a short list was developed of the most important factors (according to LWC). This list included: shade, stream gradient, pool & riffle information, temperature, flows, substrate, nutrients, carbon, and stream complexity.

Dataset Discussion

The first step to understanding what controls the abundance and distribution of any population is to know its current distribution.

Multi-Factor Analyses of Salmonid Habitat

We used a multi-factor approach to examine patterns in stream conditions within the Luckiamute / Ash Creek study area. Geographic information systems are ideal tools for simultaneously querying multiple spatial data sets to answer specific questions about the watershed. It is important to keep in mind that GIS is simply a data manipulation tool. Like any other tool, it can be used or abused: results must always be viewed critically. Results of the multi-factor analysis are predominantly affected by the quality of each data set used in the analysis.

As mentioned in earlier sections of this report, salmon populations are influenced by a wide variety of factors, both inside and outside of the Luckiamute and Ash Creek watershed study area, and operating at multiple spatial and temporal scales. Understanding the factors that control the abundance and distribution of salmon populations is a complex problem. Nevertheless, general benchmarks have been established for physical and biological factors by ODFW and others for in-stream habitat (Table 70).

At the request of the LWC, we evaluated existing AHI data for the Luckiamute /Ash Creek study areas using two different approaches. In the first approach, we evaluated each of the 12 - 7th field watersheds according to criteria established by ODFW. We were limited by available data, *i.e.*, those stream reaches that were surveyed by AHI field teams. Each 7th field watershed was evaluated separately using several of the ODFW benchmarks selected from Table 70. Recall, that only 12.2% of the streams in the study area were surveyed by AHI teams (see Map 17). In all cases, AHI survey extents did not cover the entire stream (1:100K) network in any individual 7th field watershed. In addition, stream data were not recorded for all stream reaches by field teams. Therefore, the level of sampling effort was not standardized between 7th field watersheds. Nonetheless, general habitat quality patterns for the areas surveyed can be summarized. Since most of the Luckiamute / Ash Creek study area has not been surveyed, the following results should not be considered to be representative of the study area. Instead, we provide these summaries to demonstrate what could be done if appropriate data were available and to provide a starting place for action planning discussions.

Table 70. Benchmarks recommended in the OWEB Watershed Assessment Manual (Watershed Professionals Network, 1999) are from the Oregon Department of Fish and Wildlife.

Stream characteristic	Undesirable	Desirable
Pools		
Pool area (percent of total stream area)	<10	>35
Distance between pools (# of channel widths)	>20	5-8
Residual pool depth (meters)		
Small streams (<7m width)	<0.2	>0.5
Medium streams (≥7m & <15m width)		
Low gradient (slope <3%)	<0.3	>0.6
High gradient (slope >3%)	<0.5	>1.0
Large streams (≥15m width)	<0.8	>1.5
Complex pools/km (pools w/wood complexity>3)	<1.0	>2.5
Riffles		
Width:Depth ratio (Western Oregon)	>30	<15
Substrate		
Gravel substrate (% area)	<15	>35
Silt+sand+organic substrates (combined % area)		
Volcanic parent material	>15	<8
Sedimentary parent material	>20	<10
Channel gradient <1.5%	>25	<12
Shade		
Shade (reach average %)		
Stream width <12m (western Oregon)	<60	>70
Stream width >12m (western Oregon)	<50	>60
Woody debris		
Large woody debris (15cm X 3m minimum size)		
# of pieces/100m stream length	<10	>20
Volume/100m stream length (cubic m)	<20	>30
'Key' pieces (>60cm X 10m) per 100m stream length	<1	>3
Riparian conifers		
Riparian conifers within 30m of stream		
Number >20in dbh/1000 ft stream length	<150	>300
Number >35in dbh/1000 ft stream length	<75	>200

Source: (Watershed Professionals Network, 1999)

Table 71 summarizes the ODFW habitat benchmarks for pools in each of the 12 7th field watersheds. Of all the watersheds, only Lower Pedee Ck (#17090003060401) ranks high in terms of desirable pool characteristics although, like the other basins, none of its stream reaches meet ODFW benchmark criteria for distance between pools. This indicates that, for these areas, habitat quality could be improved by adding structural complexity to the streams that would increase pool formation.

Table 71. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are total length (ft) and proportion of AHI surveyed stream for each 7th field HUC falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name	7th Field HUC	Total Length (ft)	Pool area		Complex pools		Distance between pools	
			% U	% D	% U	% D	% U	% D
Upper Luckiamute	3060101	51462.2	14.7	55.7	100	0	14.7	0
Miller Creek	3060102	38635.4	27.4	72.6	100	0	49	0
Wolf Creek	3060201	39843.5	19	40.1	100	0	23.1	0
Cougar Creek	3060202	25845.1	28.3	7	100	0	20.2	0
Lower Pedee CK	3060401	38628.7	0	89.4	0	64.3	0	0
Upper Pedee CK	3060402	20139.6	38.1	0.2	11.9	42.4	49.3	0
Upper Little Luckiamute	3060902	59225.6	43.2	2.7	58.6	5	5.9	0
Black Rock CK	3060603	11405.3	0	0	100	0	0	0
Socialist Valley	3060701	14259.1	0	0	35.8	64.2	0	0
Upper Soap CK	3061101	12437.8	0	100	100	0	0	0
Middle Soap CK	3061102	19360	0	100	100	0	0	0
Rifle Range	3061103	7357.5	0	100	100	0	0	0

We also evaluated each of the 7th field watersheds for large wood using the ODFW habitat benchmarks for key pieces of large wood, number of large wood pieces and large wood volume (Table 72). Results show that overall, large wood is scarce in the stream reaches surveyed. Only two of the watersheds have any stream reaches that meet the desired criteria for key pieces of large wood. Several of the watersheds have reaches that meet desirable benchmarks for the number of pieces and large wood volume, but over all the majority of habitat surveyed falls into the undesirable category. Finally, Upper Pedee Ck (7090003060402) stands out as having the highest proportion of stream reaches meeting the desirable criteria for large wood.

One source of large woody debris is the riparian zone. We summarized the number of conifers and shade in the riparian zone. Unfortunately, none of surveyed stream reaches met the ODFW-benchmarks for riparian conifers. Most of the streams were unshaded by trees within 12m of the stream edge (Table 73). **This indicates the restoration strategy developed by LWC should include riparian plantings as well as supplying wood from some other source.**

We also evaluated stream gradient and substrate data from the AHI data set. Unlike previous examples, may of the 7th field watersheds had many stream reaches that met the benchmark for stream gradient and percent gravel substrate. Fewer watersheds met criteria for silt, sand and organics (Table 74). The Upper Little Luckiamute (17090003060601) and Socialist Valley (17090003060701) are among the top watersheds surveyed. Results suggest that stream gradient is suitable for salmon habitat and that in-stream structure may be needed to capture and sort gravel and sediments.

Table 72. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the proportion of AHI surveyed stream falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name/	7th Field HUC	LWD key pieces		Number of LWD pieces		LWD volume	
		% U	% D	% U	% D	% U	% D
Upper Luckiamute	3060101	95.8	0	45.6	0	45.6	18.9
Miller Creek	3060102	91	0	65.9	1.3	70.1	10.4
Wolf Creek	3060201	60.2	0	54.9	25.8	31.4	35.1
Cougar Creek	3060202	80.2	0	69.5	0	69.5	19.8
Lower Pedee CK	3060401	78.3	10.6	82.5	10.6	89.4	10.6
Upper Pedee CK	3060402	45.7	11.9	45.7	38.1	45.7	54.3
Upper Little Luckiamute	3060902	26.5	0	40.5	35	59.9	20.3
Black Rock CK	3060603	0.4	0	0.4	0	100	0
Socialist Valley	3060701	100	0	35.8	64.2	100	0
Upper Soap CK	3061101	100	0	100	0	100	0

Table 72. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the proportion of AHI surveyed stream falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name/	7th Field HUC	LWD key pieces		Number of LWD pieces		LWD volume	
		% U	% D	% U	% D	% U	% D
Middle Soap CK	3061102	100	0	100	0	100	0
Rifle Range	3061103	100	0	100	0	100	0

Table 73. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are the proportion of AHI surveyed stream falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name/ 7th Field HUC	7th Field HUC	Riparian conifers >20 in		Riparian conifers >35 in.		Shade <=12m stream width		Shade >12m stream width	
		U	D	U	D	U	D	U	D
Upper Luckiamute	3060101	100	0	100	0	0	0	0	74.9
Miller Creek	3060102	100	0	100	0	0	0	0	91.9
Wolf Creek	3060201	100	0	100	0	0	0	9.4	72.2
Cougar Creek	3060202	80.2	0	80.2	0	0	60.7	0	39.3
Lower Pedee CK	3060401	100	0	100	0	0	0	18	53.2
Upper Pedee CK	3060402	100	0	100	0	0	0	0	100
Upper Little Luckiamute	3060902	80.7	0	100	0	0	0	0	94.1
Black Rock CK	3060603	100	0	100	0	0	0	0	99.6
Socialist Valley	3060701	100	0	100	0	0	0	0	64.2
Upper Soap CK	3061101	100	0	100	0	0	0	0	100
Middle Soap CK	3061102	100	0	100	0	0	0	0	100
Rifle Range	3061103	100	0	100	0	0	0	0	100

Table 74. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are total length (ft) and proportion of AHI surveyed stream falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name	7th Field HUC	Gradient		Percent gravel substrate		Silt, sand, and organics	
		U	D	U	D	U	D
Upper Luckiamute	3060101	0	85.3	0	39.7	100	0
Miller Creek	3060102	0	100	0	47.5	100	0
Wolf Creek	3060201	0	81	17.4	26.1	77.1	22.9
Cougar Creek	3060202	0	79.8	20.1	0	26.3	73.7
Lower Pedee CK	3060401	0	100	0	21.5	100	0
Upper Pedee CK	3060402	0	100	0	0	100	0

Table 74. Evaluation of in-stream aquatic habitat using ODFW habitat benchmarks for 12 7th field watersheds in the Luckiamute and Ash Creek study area. Shown are total length (ft) and proportion of AHI surveyed stream falling into undesirable (U) and desirable (D) categories for selected stream characteristics.

Watershed Name	7th Field HUC	Gradient		Percent gravel substrate		Silt, sand, and organics	
		U	D	U	D	U	D
Upper Little Luckiamute	3060902	0	96.7	0	23.6	2.7	94
Black Rock CK	3060603	0	100	0	0.4	0	100
Socialist Valley	3060701	0	100	0	35.8	0	100
Upper Soap CK	3061101	0	100	0	100	100	0
Middle Soap CK	3061102	0	100	0	100	100	0
Rifle Range	3061103	0	100	0	100	100	0

In the second example, we used criteria established for steelhead by Burke *et al.* (in prep) to rank stream reaches from the AHI data set. These criteria were developed from a more recent survey of the scientific literature review than the ODFW benchmarks presented in the OWEB manual. In this example, we used criteria developed for a particular life stage of steelhead salmon, spawning habitat. Since this analysis used the AHI data, the same caveats apply. We urge caution in interpreting these results.

At the request of LWC, we evaluated ODFW-defined stream reaches within each of the 12 - 7th field watersheds which were surveyed by AHI field teams. Each stream reach was evaluated separately according the criteria listed below.

Substrate:

- Fines (good ≤ 10%; fair 10%- 20%; poor >20%)
- Gravel (good ≥30%; fair 15%-30%; poor < 15%)
- Cobbles (good ≥10% and ≤ 30%; fair 30% - 60%; and poor < 10% or > 60%)

Pools:

- Tailouts (good 40% - 60%; fair 20% -40%; and poor < 20% or > 60%)
- Residual Depth (good ≥0.2m and poor = no pools)

Temperature:

- Temperature (good 6-12.5^{o}C; fair 4-6^{o}C and 12.5-16^{o}C; and poor <4^{o}C or >16^{o}C)

Table 75 shows the results for each stream reach surveyed. Some of the summary information is expressed for each habitat unit (a subset of a stream reach according to the ODFW method) and some of the information is expressed for the entire stream reach. For variables that were recorded for each habitat unit, we evaluated each habitat unit according to the criteria proposed by (Burke *et al.*, in prep). Numbers in Table 75 are the number of habitat units meeting the 'good', 'fair' and 'poor' criteria. For summaries that are expressed for the entire reach, we recorded 'good', 'fair' or 'poor' for the entire reach.

Table 75. Evaluation of Steelhead Spawning Habitat: Stream segments of AHI surveyed streams ranked according to criteria developed by (Burke *et al.*, in prep). Shown are stream reach ID, length (ft), and the number of stream segments ranked as 'good', 'fair', and 'poor' steelhead spawning habitat. Also shown are reach-level ranks for pool frequency, residual pool depth and maximum temperature.

			Fines[A] (# habitat units/reach)			**Gravel**[A] (# habitat units/reach)			**Cobble**[A] (# habitat units/reach)					
Stream	**Reach ID**	**Length (ft)**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Pool Frequency**[B]	**Residual Pool Depth**[B]	**Temp. (max)**[B]
Little Luckiamute River	123287844891401	9153.06	14	1		5	9	1	8	7		Poor	Good	Fair
	123287844891402	5147.21	11	2		9	3	1	2	9	2	Fair	Good	Fair
	123287844891403	15257.89	30			8	13	9	24	4	2	Poor	Good	Good
	123287844891404	22705.54	56		2	19	32	7	14	41	3	Poor	Good	Good
	123287844891405	2969.34	23	3	2	26	2		11	16	1	Poor	Good	Fair
	123287844891406	1289.53	3			1	2			3		Poor	Good	Fair
	123287844891407	1380.23	8			6	2		3	5		Poor	Good	Good
	123287844891408	1956.46	12	2	1	15			8	6	1	Poor	Good	Fair
	123287844891409	1577.30										Fair	Good	Good
	123556944867701	2152.56	3	1		2	1	1	2	2		Poor	Good	Fair
	123556944867702	4125.89	13		2	3	6	6	6	5	4	Poor	Good	Fair
	123556944867703	1336.05	4				2	2	1	1	2	Poor	Good	Fair
	123556944867704	5407.97	11		2	7	2	4	10	2	1	Poor	Good	Good
	123556944867705	1935.38	8			4	1	3	5		3	Poor	Good	Fair
	123564544867001	8495.66	21	1		18	2	2	14	1	7	Poor	Good	Fair
Luckiamute River	123148044755901	2236.24	10			6	3	1	5	4	1	Poor	Good	Poor
	123148044755902	1796.71	2			1	1			2		Good	Good	Fair
	123148044755903	11653.14	21				11	10	5	3	13	Fair	Good	Poor
	123148044755904	7027.36	1					1	1			Fair	Good	Poor

Table 75. Evaluation of Steelhead Spawning Habitat: Stream segments of AHI surveyed streams ranked according to criteria developed by (Burke *et al.*, in prep). Shown are stream reach ID, length (ft), and the number of stream segments ranked as 'good', 'fair', and 'poor' steelhead spawning habitat. Also shown are reach-level ranks for pool frequency, residual pool depth and maximum temperature.

			Fines[A] (# habitat units/reach)			**Gravel**[A] (# habitat units/reach)			**Cobble**[A] (# habitat units/reach)					
Stream	**Reach ID**	**Length (ft)**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Pool Frequency**[B]	**Residual Pool Depth**[B]	**Temp. (max)**[B]
	123148044755905	8795.87	21			13	4	4	7	9	5	Good	Good	Poor
	123148044755906	15918.30	26			21	5		5	16	5	Fair	Good	Poor
Luckiamute River	123148044755907	12878.55	12			11	1		8	3	1	Poor	Good	Fair
	123565844758201	2769.81	2			2			1	1		Poor	Good	Good
	123565844758202	2078.69										Poor	Good	Good
	123565844758203	5109.77										Poor	Good	Good
	123568644762701	2313.62										Poor	Good	Good
	123568644762702	3254.21	7			5	2		3	4		Poor	Good	Good
	123568644762703	3729.78	1		1	2				2		Good	Good	Good
	123568644762704	2111.11		1		1			1			Poor	Good	Good
	123585844772501	9351.79	8	2	5	11	3	1	9	5	1	Poor	Good	Good
	123589544776901	3985.03	19	2	2	17	1	5	1	1	21	Poor	Good	Poor
	123589544776902	4895.20	7			7			5		2	Poor	Good	Fair
	123593144793601	2379.57	25	7	3	32	1	2	27	7	1	Fair	Good	Fair
	123593144793602	7550.57	3	1		3	1		2	2		Poor	Good	Fair
	123593544776601	11724.18	18			16	2		11	2	5	Poor	Good	Poor
	123593544776602	7526.66	2	1		2	1		2		1	Good	Good	Fair
	123596744788901	5398.63	1	5	4	7	1	2			10	Poor	Good	Fair
	123596744788902	2180.78	1		3	4					4	Good	Good	Fair
	123600444776901	2859.25	18	2		20			13	6	1	Good	Good	Fair
Luckiamute River	123600444776902	7338.72			1	1			1			Poor	Good	Good
	123608244774201	2440.31	3		1	3	1		3	1		Poor	Good	Good
	123608244774202	824.09										Poor	Poor	Good

Table 75. Evaluation of Steelhead Spawning Habitat: Stream segments of AHI surveyed streams ranked according to criteria developed by (Burke *et al.*, in prep). Shown are stream reach ID, length (ft), and the number of stream segments ranked as 'good', 'fair', and 'poor' steelhead spawning habitat. Also shown are reach-level ranks for pool frequency, residual pool depth and maximum temperature.

			Fines[A] (# habitat units/reach)			**Gravel**[A] (# habitat units/reach)			**Cobble**[A] (# habitat units/reach)					
Stream	**Reach ID**	**Length (ft)**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Good**	**Fair**	**Poor**	**Pool Frequency**[B]	**Residual Pool Depth**[B]	**Temp. (max)**[B]
	123610444765001	1643.38	3	2	1	6			3		3	Fair	Good	Good
	123624444790701	520.92	2	2		4			2		2	Poor	Good	Fair
	123624444790702	3494.09	6	4		9	1				10	Poor	Good	Fair
Pedee Creek	123432744740001	2665.45	4	5	2	10	1		5		6	Good	Good	Fair
	123432744740002	5654.95	15	7	8	26	2	2	3	1	26	Poor	Good	Fair
	123432744740003	6952.29	12	12	2	25	1		9	10	7	Poor	Good	Fair
	123447844771101	5758.87	14			2	11	1	1	12	1	Fair	Good	Fair
	123447844771102	4269.30	2			2			1	1		Fair	Good	Fair
	123447844771103	4102.77	4	2	3	5	3	1	7		2	Poor	Good	Good
	123447844771201	5473.68	12	6	1	13	4	2	9	7	3	Poor	Good	Good
	123447844771202	3783.81	14			1	12	1	5	8	1	Good	Good	Fair
	123447844771203	7409.76	22	6		24	2	2	13	11	4	Fair	Good	Fair
	123447844771204	2507.99										Poor	Good	Good
	123449244794201	1768.12	9			1	5	3	3	3	3	Poor	Good	Fair
	123449244794202	3264.68	9	1		9	1		4		6	Poor	Good	Poor
	123449244794203	2767.56	6	2	3	7	2	2	7	1	3	Poor	Good	Fair
	123449244794204	2389.07										Poor	Good	Poor
Soap Creek	123163044730501	33934.21	169	9	8	174	5	7	21	1	164	Poor	Good	Poor
	123163044730502	5221.11	46	2		48			39	3	6	Good	Good	Poor

[A]= data summarized from habitat unit AHI data; [B]=data summarized from reach-level AHI data

In order to combine these various statistics into one value, we developed a numeric index. The Index in the following manner: for criteria that were expressed as the number of habitat units per stream reach, we multiplied 'good' values by 2 and 'fair' values by 1 and 'poor' values by 0; and for criteria that we expressed at the reach level, we added 10 for 'good', 5 for 'fair' and 0 for 'poor'. These values were added for each stream reach. This resulted in a single number that indicates the over all condition of the stream reach. Since reaches vary in length, the number is not scaled to the area surveyed: it is intended to show the relative rank of each stream reach in comparison with the others. The higher the number the better the conditions are, overall. Table 76 and Map 21 identifies the 'best' stream reaches for each of the major river basins.

Multi-Factor Salmonid Habitat Analyses: Synthesis

In general, the factors that control the abundance and distribution of salmonids in the Luckiamute / Ash Creek watersheds are not well known. The distribution of salmonid species is known in a broad sense. Although there is a sense of the factors that may affect the distribution and abundance of salmonids in the study area, data are lacking.

For the areas surveyed, in-stream structure is lacking. Evidence for this comes from the lack of pool complexity, large woody debris, and substrates. There is also evidence that riparian shade (and potential for large wood to enter streams) is of concern. From the previous section, we saw that current salmonid distributions coincide with water quality limited streams. Nevertheless, we did identify 7th field watersheds and stream reaches where one or more environmental variables were found to be desirable.

Additional data is needed to better manage salmon in the Luckiamute/ Ash Creek study area. We recommend that fish populations be measured to get quantitative population measurements. From population number, the success of restoration actions can be evaluated. We recommend that benchmarks or reference conditions be established from areas within the watershed identified in this section or from nearby areas. Future restoration actions can be modeled after these reference sites.

We recognize that some of the watersheds/ stream reaches identified as good habitat may not be accessible to salmon because of barriers. These areas, however, can still be used as areas to illustrate the desirable condition of the ODFW benchmarks.

Table 76. Ranked list of ODFW-defined stream reaches for each of the major river basins for which AHI data were available. Shown are stream reach ID and rank score. See text for a description of how rank scores were assigned.

ODFW Stream Reach	score		ODFW Stream Reach	score
Luckiamute River			**Little Luckiamute River**	
123593144793601	198		123564544867001	271
123148044755906	135		123556944867703	161
123600444776901	125		123287844891403	156
123148044755905	105		123287844891406	125
123593544776601	104		123287844891401	93
123589544776901	88		123287844891407	86
123585844772501	86		123556944867704	80
123148044755907	81		123556944867701	73
123148044755903	76		123287844891405	70
123148044755901	59		123287844891408	61
123568644762702	56		123287844891409	50
123589544776902	53		123556944867705	33
123624444790702	50		123556944867702	28
123610444765001	46		123287844891404	28
123608244774201	40		123287844891402	20
123596744788901	37		**Pedee Creek**	
123593144793602	35		123447844771203	152
123624444790701	33		123432744740003	130
123565844758201	31		123432744740002	113
123593544776602	29		123447844771201	105
123568644762703	28		123447844771202	75
123568644762704	25		123447844771101	72
123596744788902	25		123449244794203	60
123148044755902	24		123432744740001	59
123600444776902	24		123447844771103	57
123565844758202	20		123449244794202	56
123565844758203	20		123449244794201	49
123568644762701	20		123447844771102	26
123608244774202	20		123447844771204	20
123148044755904	14		123449244794204	10
			Soap Creek	
			123163044730501	753
			123163044730502	281

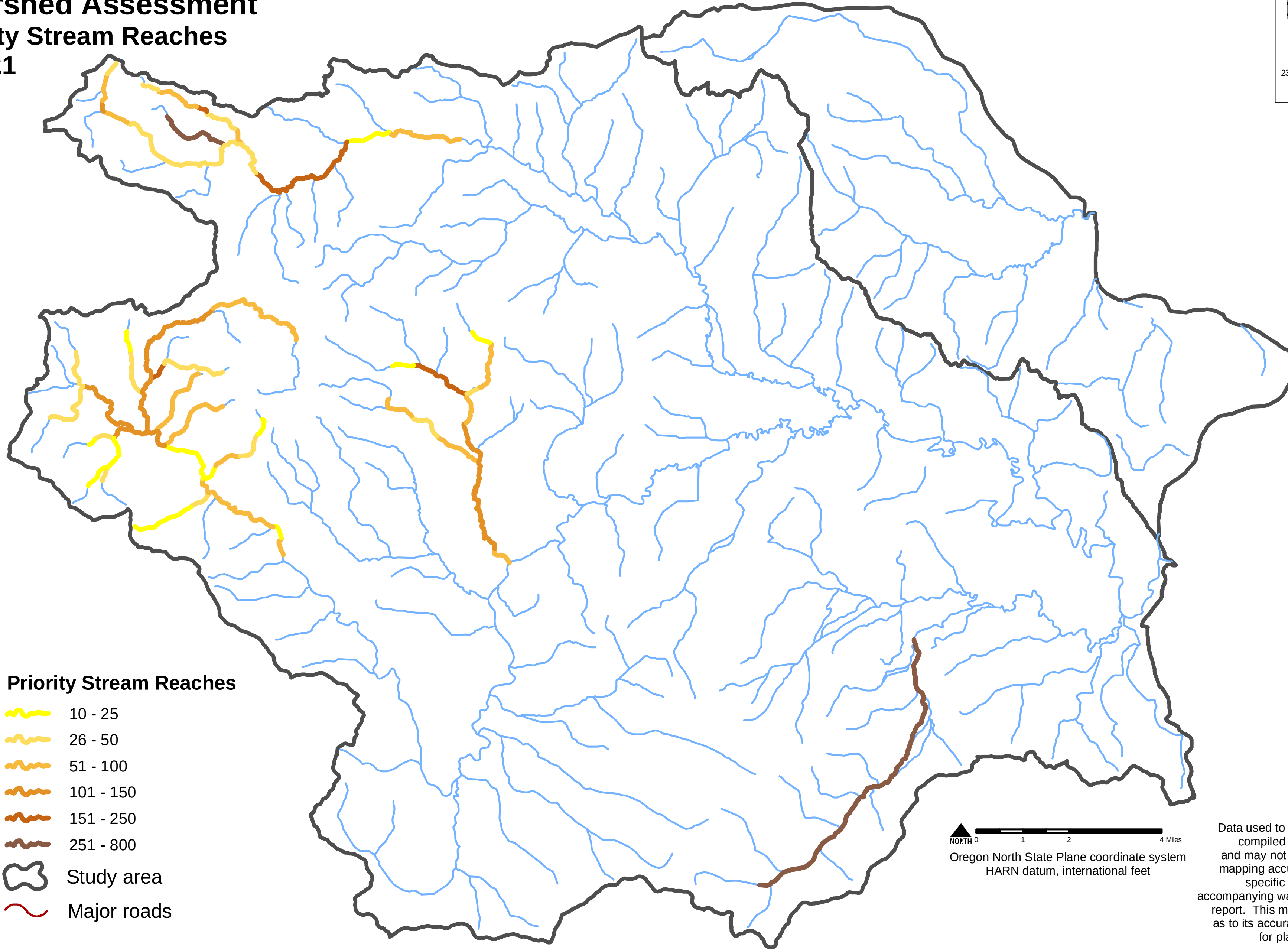
Maps 19: Prioritized stream reaches in the Luckiamute/ Ash Creek study area. Shown also are major roads. See text for details.

Luckiamute/Ash Creek/American Bottom Watershed Assessment

Priority Stream Reaches

Map 21

230 SW Third Street, Suite 212
Corvallis, Oregon 97333
www.earthdesign.com



Data used to create this map were compiled from multiple sources and may not meet federal or state mapping accuracy standards. For specific data sources see the accompanying watershed assessment report. This map has no warranties as to its accuracy and is to be used for planning purposes only.

Priority Stream Reaches Data Source: Oregon Department of Fish and Wildlife.

8.7 Recommendations

We highly recommend that DEM-derived data sets be field checked or that the analyses be re-run if better data sets become available.

We recommend that, to the extent possible, the DEM-derived stream gradient, confinement, can channel typing be field checked. We also recommend that these data be used to prioritize monitoring and restoration locations. For example, using GIS all low gradient unconfined streams could be identified. These areas could then be surveyed for spawning gravel or identified for riparian planting projects.

We recommend that LWC field check the information in this GIS layer and then use it to identify areas for restoration and monitoring sites.

We recommend that these data be field checked as soon as possible. If necessary, the technique described herein can be modified and stream channels be re-classified.

We recommend ground truthing these reaches to see if they can be classified using more convention stream channel types.

We recommend conducting a LWD source area analysis.

We recommend that LWC examine the raw AHI data for comments on channel modifications and condition.

We recommend that the LWC develop a list of 'core' areas from local biologists and persons familiar with the area.

We recommend that LWC acquire and review all existing culvert data. If these data continue to be unavailable, we recommend that LWC undertake a culvert survey. LWC could locate and map culverts on main roads or use a simple GIS model to predict where culverts are likely to occur.

These reservoirs should be checked to see if they have dams present that could block fish passage.

We recommend that AHI or some other stream survey be performed to inventory stream conditions in the study area.

We recommend that LWC develop a diverse suite of restoration strategies and that they work with fisheries managers to develop the scientific underpinnings of the factors that truly limit salmonid populations. For example, the restoration strategy developed by LWC should include riparian plantings as well as supplying wood from some other source.

9 OTHER WATERSHED ANALYSES, EXISTING PRESERVE AND WATERSHED RESTORATION PROJECTS IN THE LUCKIAMUTE / ASH CREEK

9.1 Existing Watershed Analyses

U.S. Bureau of Land Management

In 1998 the BLM conducted a watershed assessment of the Rowell Creek/Mill Creek/Rickreall Creek/Luckiamute River Watershed (Licata *et al.*, 1998).

Western Oregon University

The biology and earth and physical sciences departments of Western Oregon University created a manual for environmental educators to use in studying the Luckiamute River watershed (Taylor *et al.*, 2003).

Rickreall Watershed Assessment

The Rickreall Watershed Council completed a watershed assessment for the Rickreall Creek watershed in January 2001. A small portion of the land examined in the Rickreall Watershed Assessment is included in the northeast corner of the present Luckiamute Watershed Assessment area (Mattson and Gallagher, 2001).

Midcoast Watershed Assessment

This assessment, completed by Earth Design Consultants, Inc. and Green point Consulting, covers a portion of Polk and Benton Counties (Garono and Brophy, 2001). This report is available online at *www.midcoastwatershedcouncil.org*.

Yamhill Watershed Assessment

The Yamhill River Basin contains eight sub-watersheds: Willamina, North Yamhill River, Chehalem Creek and South Yamhill River. All of these sub-basins are contained primarily in Yamhill and Polk Counties. For more information visit ***http://www.co.yamhill.or.us/ybc/assessments.htm***

Existing Preserves and Watershed Restoration Projects

E.E. Wilson Wetlands, ODFW

http://wetlands.dfw.state.or.us/projects/willamette.html

Photo 15: E.E. Wilson Wildlife Area

These wetlands are on land managed by the Oregon Department of Fish and Wildlife (ODFW). ODFW began restoring wetlands here in 1992. By 1995 several dozen small ponds and wetlands were constructed or enhanced, totaling 170 acres of improvements. The area is still managed to control non-native vegetation, especially reed canary grass.

Fort Hoskins, Benton County
http://www.co.benton.or.us/parks/fh_final_plan.htm
The land around the historic Fort Hoskins site (1856 – 1865) is now a park owned by Benton County. The County's goals for the property include 1) active restoration of pre-settlement native oak savanna, 2) sustainable forest management using environmentally sensitive techniques, and 3) creating reserve areas to protect unique resources. Promoting recreation activities and public education are also major goals for projects in the park.

Luckiamute Landing State Park
http://wetlands.dfw.state.or.us/pdfs/willamette_valley_draft.pdf
This restoration project is in an area just north of Albany, at the confluence of the Luckiamute, Santiam and Willamette Rivers. The Western Rivers Conservancy and State Parks have proposed to acquire and protect a large block of floodplain habitats around Luckiamute Landing.

In addition to these preserved lands, there are also numerous small preservation and restoration projects going on within the basin. We checked the REO web site for information on existing watershed restoration projects. We found one restoration site from this database: It was listed as a culvert upgrade in the headwaters of the Luckiamute (IRDS_ID: 444729612331517). The Greenbelt Land Trust, a volunteer non-profit organization in the mid-Willamette Valley, involved in the protection of open space, has organized and compiled a list of regional restoration projects. Table 77 lists the restoration sites compiled by the Greenbelt Land Trust. It is not clear whether some of these sites are being routinely monitored or not. We highly recommend incorporating these sites into the LWC monitoring plan.

The Oregon Watershed Enhancement Board also maintains several databases containing information on restoration projects. Data are collected by means of a standardized reporting form which is broadly distributed on an annual basis. Respondents are asked to submit project information on a standardized reporting form and attach a map. The spatial data may be incomplete. The Luckiamute projects implemented from 1995-2002 are available from Bobbi Rigger (503-986-0059) in an Access database. These data were not available at the time that this report was written. **We recommend that LWC contact OWEB and acquire restoration project locations and that a spatial data set be created.**

Table 77. List of restoration sites compiled by the Greenbelt Land Trust. Shown are watershed ID code, type of restoration, habitat affected, a brief description, partners, whether the site is being monitored or not and the number of acres.

HUC	TYPE	HABITAT	DESC RIPTION	PARTNERS	MON	ACRES
Bridgeport				ODFW		41.0
Bridgeport				ODFW		5.0
Fern Creek		wetlands		ODFW		5.0
Fern Creek				ODFW, S*, owner		6.0
Fern Creek		woodlands		ODFW, B*, owner		12.0
Bridgeport		woodlands		ODFW, K*, owner		9.0
Bridgeport		oak woodlands		ODFW, D*, owner		20.0
Lower Teal Creek				ODFW, R*, owner		1.0
Parker				ODFW, P*, owner		9.0
Middle Luckiamute				ODFW, W*, owner		22.0
Zumwalt	wetland restoration	wetlands		USFWS, R*, owner	y	15.0
Zumwalt	oak restoration	oak woodlands		USFWS, R*, owner	y	0.0
Zumwalt	wetland restoration	wetland, oak		USFWS, J*, owner		20.0
Parker	oak restoration	oak woodlands		USFWS, J*, owner		0.0
Parker	wetland restoration	wetland		ODFW, R*, owner, USFWS	y	25.0
Luckiamute Landing	wetland restoration	wetland		ODFW, S*, owner, NRCS		40.0
Luckiamute Landing	easement	riparian, upland		ODFW, B*, owner		60.0
Luckiamute Landing	wetland restoration	wetland		ODFW, K*, owner	y	40.0
Springhill	wetland restoration	riparian, wetland		NAWCA state park, Vanderpool, USFWS	y	230.0
Palestine	wetland restoration	wetland		ODFW, USFWS, G*,owner	y	15.0
Springhill	wetland restoration	wetland		ODFW, USFWS, U*, owner	y	20.0
Lower Berry Creek	wetland restoration	wetland		ODFW, USFWS, O*, owner	y	76.0
Palestine	wetland restoration	wetlands		ODFW, OWEB, Winter Creek	y	52.0
Palestine	riparian	riparian		ODFW, OWEB, Winter Creek	y	0.0
Vincent Creek				Benton County		0.0
Plunkett Creek	wetland restoration	wetlands		ODFW, USFWS, E*, owner, OWEB	y	120.0
Plunkett Creek	oak	oak		ODFW, USFWS, E*,	y	0.0

Table 77. List of restoration sites compiled by the Greenbelt Land Trust. Shown are watershed ID code, type of restoration, habitat affected, a brief description, partners, whether the site is being monitored or not and the number of acres.

HUC	TYPE	HABITAT	DESCRIPTION	PARTNERS	MON	ACRES
	restoration	savanna		owner, OWEB		
Upper Soap Creek	easement			Greenbelt Land Trust	yes	0.0
Luckiamute Landing	riparian		riparian planting	OPRD, ODFW, farmer		0.0
Rifle Range	easement	wetlands		NRCS, owner		58.0
Waymire Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	2.0
Socialist Valley	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.6
Socialist Valley	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.1
Socialist Valley	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	6.1
Socialist Valley	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.6
Socialist Valley	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	34.0
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.0
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.0
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.0
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.5
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.9
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.7
Black Rock Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.1
Black Rock Creek	riparian	forest	riparian tree	Willamette Industries, Inc.	no	1.2

Table 77. List of restoration sites compiled by the Greenbelt Land Trust. Shown are watershed ID code, type of restoration, habitat affected, a brief description, partners, whether the site is being monitored or not and the number of acres.						
HUC	TYPE	HABITAT	DESC RIPTION	PARTNERS	MON	ACRES
			retention			
Upper Little Lickiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.9
Upper Little Lickiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.2
Upper Little Lickiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.0
Upper Little Lickiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.3
Upper Little Lickiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.0
Upper Teal Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.7
Lower Teal Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.8
Grant Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.7
Lower Teal Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.3
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	4.6
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.5
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.5
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.2
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	2.2
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	6.3
Lower Little	riparian	forest	riparian	Willamette Industries,	no	2.1

Table 77. List of restoration sites compiled by the Greenbelt Land Trust. Shown are watershed ID code, type of restoration, habitat affected, a brief description, partners, whether the site is being monitored or not and the number of acres.

HUC	TYPE	HABITAT	DESCRIPTION	PARTNERS	MON	ACRES
Luckiamute			tree retention	Inc.		
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	2.5
Lower Little Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	3.9
Middle Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	2.2
Middle Luckiamute	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	1.0
Middle Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.5
Middle Luckiamute	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.0
Ira Hooker	riparian	forest	riparian tree retention	Boise Cascade	no	1.4
Ira Hooker	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	8.4
Ira Hooker	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.1
Ira Hooker	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	3.2
Ira Hooker	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	2.0
Ira Hooker	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.9
Upper Pedee Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	0.7
Upper Pedee Creek	riparian	forest	riparian tree retention	boise	no	4.2
Ritner Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	1.2

Table 77. List of restoration sites compiled by the Greenbelt Land Trust. Shown are watershed ID code, type of restoration, habitat affected, a brief description, partners, whether the site is being monitored or not and the number of acres.

HUC	TYPE	HABITAT	DESC RIPTION	PARTNERS	MON	ACRES
Vincent Creek	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	1.1
Vincent Creek	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	0.6
Wolf Creek	riparian	forest	riparian tree retention	Boise Cascade	no	4.0
Middle Soap Creek	riparian	forest	riparian tree retention	Willamette Industries, Inc.	no	2.0
Upper Soap Creek	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	0.5
Upper Soap Creek	riparian	forest	riparian tree retention	Starker Forests, Inc.	no	2.0

9.2 Existing Groups

Oak Conservation Project/ Oak Working Group

The Oregon Oak Communities Working Group is a volunteer organization whose aim is to foster conservation and restoration of oak ecosystems and recognize the threats faced by diverse oak habitats. Threats include habitat destruction due to loss from urbanization to disease. The group in based in Oregon and works throughout the state (see *http://www.open.org/~admdmg/index.shtml*)

The group's goals include:

- knowledge and research on biological and ecological topics such as silviculture, wildlife habitat, understory interactions, spatial patterns and recruitment;.
- laws, policies and legislation affecting oak habitat;
- recognizing and understanding Native and Euro-American cultural connections to oak plant communities;
- restoration methods, activities and projects;
- forming partnerships with other organizations who share our interests in habitat conservation and restoration; and
- participants of this group come from varied governmental agencies, public organizations, private citizens, non-profit groups and small businesses.

American Bird Conservancy

American Bird Conservancy (ABC) is a 501(c)3 not-for-profit organization, whose mission is to conserve wild

birds and their habitats throughout the Americas (see *http://www.abcbirds.org*). They deal with such topics as a growing human population, resource consumption, habitat destruction and direct mortality from pesticides and the introduction of destructive species.

ABC works in cooperation with the North American Bird Conservation Initiative, Partners in Flight, the ABC Policy Council, and ABC's growing international network. ABC is supported by individual donors as well as foundations, corporations, organizations and government sources. ABC has offices in The Plains, Virginia and Washington, D.C., and staff in Colorado, Missouri, Montana, and Oregon.

Oregon Water Trust

The Oregon Water Trust works in the state to acquire water rights for fish & wildlife use.

10 RECOMMENDATIONS

10.1 Working toward an Action Plan

This watershed assessment sets the stage for prioritizing and planning restoration and monitoring activities in the Luckiamute / Ash Creek watersheds. Using existing data, we have characterized the natural resources of the watershed and identified ecological connections between important watershed components. The first step in developing an action plan is to decide what role data will play in managing watershed resources.

In this assessment we have seen that, in some cases, our understanding of study area features do not mesh with key data sets. This is the case with the importance of large wood in streams and perspectives on log jams, with the importance of oak savannas and data sets depicting pre-settlement vegetation. Often, our perceptions are based on incomplete or anecdotal information. We recommend using objective, quantitative methods (*i.e.*, a scientific approach) to assess resources and measure change.

10.2 A Strategy for Data and GIS

We recommend that the Luckiamute Watershed Council make the decision to adopt a data-driven assessment and monitoring strategy. We recommend that the GIS built as part of this assessment take a central role in action planning. This can be accomplished by following these steps: (1) before undertaking any restoration or monitoring action, the watershed council should query the GIS to determine what is known about the area for which actions are planned; (2) field work or monitoring should be conducted so that data collected are added into the GIS; and (3) all data from all actions should be entered into the GIS in a timely fashion so that future actions can benefit from what has accomplished. This will insure that the data housed within the GIS becomes an integral part of the action planning process.

We also recommend that council members take the time to familiarize themselves with GIS and the data contained therein.

The Watershed Council should also develop standard data guidelines. These guidelines should be incorporated into future contracts and data gathering activities. For example, we recommend that all data be collect at a spatial scale of 1:24,000 or better. We recommend that global positioning systems (GPS) be used whenever possible to record the locations of features and observations. We also recommend that data be collected using standardized collection methodologies (or that methodologies be fully documented) and kept with collected data.

This assessment has identified key data gaps. To fill those data gaps, we recommend collecting data to answer specific questions, which often includes developing an experimental design, rather than simply collection numbers in the field. For example, water quality can be assessed upstream and downstream of a particular land use or discharge pipe. Measurements could be made at predetermined times. Analysis of the data would then tell whether the land use or discharge affected water quality. In contrast, sending volunteers out into the watershed to collect pH, dissolved oxygen concentration and temperature (for example) at irregular intervals and widely spaced locations will not lead to a better understanding of watershed processes or effectiveness of restoration actions.

The next step is to plan specific actions in specific places in the watershed and to determine how effective the Council's actions are at achieving their goals. We recommend establishing general goals to guide action planning. We also recommend using the GIS to ask specific questions about specific places in the watershed, selecting sites where observations will be made, collecting the data, entering the data into the GIS, and then using the GIS draw conclusions.

Finally, we recommend that the Watershed Council learn more about the various initiatives in the state to develop spatial models, *e.g.*, temperature models, habitat suitability models, water quality models, and water quantity. We recommend that data be collected to help these efforts. Recognize that the data developed by the Watershed Council are valuable. We recommend that the LWC coordinator be contacted before any of the data are distributed from this assessment (this will insure that restricted data sets are not re-distributed). We also recommend that data users sign a data use agreement so that the LWC is credited with data generation.

10.3 Filling Key Data Gaps

We recommend that the LWC develop a more accurate roads layer from USGS topographic maps and other sources. The first step would be to contact parties that may have more complete roads layers (*e.g.*, private timber companies, county governments). These data could then be used to develop detailed coverages for specific areas. We recommend that data layers contain data of uniform spatial scale produced using similar methods.

We recommend detailed ownership information (*e.g.*, tax lots) be incorporated into the project GIS. Since most of the watershed is privately owned, it is reasonable to assume that restoration and monitoring activities will occur of private lands with willing land owners. Detailed ownership data would help to identify restoration and monitoring sites.

The following sections identify specific actions that are recommended to the Council. We recommend that the council prioritize this according to their goals and objectives. Lists in each of the following sections are in decreasing order of importance.

Suggested Analyses / Recommendations from Section 6

We recommend that first order streams be evaluated for shade and for the potential to deliver large wood to the stream networks. Areas that may be important to stream recruitment of wood should be identified. This can be accomplished using the DOQs or through field surveys.

We recommend that LWC inventory streams. Areas where channels have been modified or are eroding should be mapped. This can be accomplished through a standardized field survey procedure. We recommend that the LWC map areas where stream banks are eroding as part of its future monitoring program (see Table 35). Photographs should be taken and locations recorded using a USGS topographic map or a GPS, and entered into the project GIS. We recommend that existing log jams be mapped. This can be accomplished using digital orthoquads or through field surveys. For field surveys, land owners can be contacted and stream walked to record log jams and other stream channel elements (*i.e.*, riprap, boat launches, bridge supports, *etc.*). Comment fields from Aquatic Habitat Inventory data can be queried for observations of AHI field crews.

Establish a water quality monitoring program. Decide what variables are to be measured, the frequency of the observations and the locations to be monitored (using GIS) to answer specific questions. To start, we recommend that water quality locations be established on 303(d) stream reaches. As previously mentioned, consider establishing paired monitoring locations upstream and downstream of suspected problem areas (*e.g.*, land use, discharge pipes) or within areas draining sub-basins representing particular land uses. Stream temperature is important in the study area. We recommend that LWC use the available water temperature data at the stream reach and basin planning scale to prioritize project sites. It is difficult to use temperature data alone. Consider developing a water temperature model. We recommend that LWC check on ODEQ's work in developing temperature models in the region.

Consider adding stream gauging stations, weather stations and rainfall gages to the monitoring program to improve knowledge of water availability.

Evaluate areas that impact peak flows and sediment delivery to streams. In this assessment, we identified areas where roads could potentially contribute to peak flows and sediment loads. We recommend that the areas identified in Tables 32, 33, and 34 be evaluated for mechanisms to keep water and sediments from entering the stream networks. This can be accomplished by increasing watershed water storage through the use of vegetated buffer strips or detention ponds.

We have also identified areas adjacent to streams lack vegetation. We recommend that floodplain areas be evaluated for wetland restoration and riparian planting areas. Preference could be given to those areas occurring on hydric soils. In any case, one of the most widespread problems in the study area is the lack of connection between floodplains and the stream network.

This can be accomplished by undertaking actions that decrease water velocities in the stream channels (increasing channel roughness) and minimizing the amplitude of peak flows. Floodplain restoration of wetlands, mentioned above, would also tend to reconnect floodplains. In addition, land cover could also be managed to increase watershed water storage by decreasing the amount of impervious cover and fostering mature vegetation. We also recommend that 7th Field HUCs be evaluated for debris flow hazard risk when planning for large wood source areas and in-stream restoration projects. Land cover can also be evaluated on those areas prone to flow to evaluate potential for large wood recruitment to the stream network.

We recommend that reservoirs be inventoried. This can be accomplished using that lat/ longs provided in this report. In any case, field observation or use of DOQs could be used to verify location, measure size, and evaluate the potential for water quality problems. Many larger reservoirs can be sources of water of poor quality (*i.e.*, low oxygen concentration, nutrient enriched, and sites of harmful algae). These sites may be targeted for water quality monitoring. These reservoirs should be checked to see if they have dams present that could block fish passage.

A springs layer should be developed. All spring sites provided in this report need to be verified through field visits (in cooperation with willing land owners) and that the condition of the springs be recorded. Ownership of springs should also be recorded.

We recommend that the Watermaster be contacted before POD data are used for detailed planning purposes. The Watermaster should also be contacted before the well withdrawal data are used for planning purposes: the data need to be carefully reviewed.

We recommend that the EPA web site be checked again in the future and discharge permits be carefully monitored. In addition, the location of discharge pipes into receiving waterways should be verified and photographed. Consider situation water quality monitoring stations upstream and downstream of selected discharge points.

We recommend that local watershed groups work towards increasing awareness of nonpoint pollution sources, and take action to reduce these pollution sources. Examples of actions that can reduce pollutants entering streams from surface water runoff include riparian fencing, riparian plantings, grazing management and pasture rotation, and education for responsible pesticide use.

We recommend that LWC keep abreast of and participate in the TMDL process. Information collected in the Luckiamute watershed is already being used in TMDL development.

We recommend the development of a GIS-based hydrologic model. A tool can be developed, which builds on information already collected, that will link land use and water quality.

Should the LWC action planning involve the long-term protection of water rights, we recommend that they contact the Oregon Water Trust (*www. owt.org*) for more information on their programs.

10.4 Recommendations from Section 7

We recommend that LWC ground truth the riparian vegetation layer created in this assessment. The GIS layer can be adjusted accordingly.

The Watershed Council identified oak savannas as a priority community type for management and inventory. We provided maps to be ground checked to the watershed council as part of this assessment. We recommend that the locations on the maps be visited and observations recorded and that oak forests be separated from 'true' oak savannas. These observations should be entered into GIS. Observations can then be used to refine current locations of oak savannas.

It was not the intention of this analysis to select individual sites for restoration or monitoring. However, much of the data necessary to prioritize sites is contained in the GIS delivered as part of this assessment. We recommend that when it comes time to prioritize sites, the floodplain, riparian, soils, and wildlife WSR grids be used. The DOQs can also be used to evaluate and map future monitoring and restoration sites. Since the DOQ photographs are already georeferenced, new information can be entered into the LWC GIS by locating sites on the DOQs.

We recommend that the Polk Co. plant species check list be compared to noxious weed lists and a master list of weeds present in Polk Co. be generated. Once identified, information on the location of weedy species observations can then be tracked using the LWC GIS and a suitable management plan be developed.

10.5 Recommendations from Section 8

Several surrogate or stand-in data sets were generated as part of this assessment because better data sets were not available. We highly recommend that DEM-derived data sets be field checked or that the analyses be re-run if better data sets become available. We recommend that, to the extent possible, the DEM-derived stream gradient, confinement, can channel typing be field checked. We also recommend that these data be used to prioritize monitoring and restoration locations. For example, using GIS all low gradient unconfined streams could be identified. These areas could then be surveyed for spawning gravel or identified for riparian planting projects.

We recommend that LWC acquire and review all existing culvert data. If these data continue to be unavailable, we recommend that LWC undertake a culvert survey. LWC could locate and map culverts on main roads or use a simple GIS model to predict where culverts are likely to occur.

Although there are no 'official' core salmonid population areas recognized in the Luckiamute / Ash Creek study area, we recommend that the LWC compile a list of hotspots from local biologists and persons familiar with the area. These areas can be entered into the GIS and be used to prioritize monitoring and restoration sites.

10.6 Recommended Analyses and Mapping Exercises

The list below represents data that would have been useful in completing this assessment, if they were available. Future questions asked by the Council may include some of these exercises.

- Map active floodplains and wetland areas.

- Collect data from landowners on flood frequency, areas of inundation, alternate stream channels and backwater wetlands.

- Map areas of dynamic (frequently changing) stream channels.

- Map locations where streams are entrenched.

- Map locations of exposed bedrock along streams.

- Map locations of algal blooms, indictors of nutrient enrichment and low dissolved oxygen concentration.

- Use the results of this report to prioritize areas in which AHI surveys need to be conducted or updated. To improve spatial accuracy of AHI surveys, measure habitat unit lengths with hip chains from landmarks that are visible on the DOQ photographs or the USGS topographic base maps. Use GPS if possible. Calibrate observers to maximize spatial accuracy. Ensure that data are quickly processed and incorporated into the MCWC GIS at an appropriate spatial scale.

- Map the locations of exotic plants.

- Map the locations of beaver dams. Review the AHI data for locations of beaver dams and beaver activity (in the AHI comment columns). Consider beaver dam locations when planning riparian plantings, especially conifers.

- Work with ODFW and others to develop reliable estimates of the populations and distribution (including fish limit maps) for species of concern, such as salmon, lamprey, and mussels. Volunteers can be used to expand agency surveys provided that established protocols are followed. The lack of data on the distribution and abundance of aquatic organisms is a major impediment to developing a successful watershed enhancement strategy.

- Design data collection strategies that include biological sampling. For example, water quality monitoring data should include sampling for benthic macroinvertebrates, which can be good indicators of water quality and environmental change.

- Map physical and behavioral barriers to fish passage. Culvert data should be collected from county, state and private timber groups. Information describing the diameter, drop of outfall, pool below, gradient, road condition, and ditch conditions should be organized for each culvert. Consider following ODFW and ODF culvert survey guidelines if new surveys are to be conducted. When developing a water quality monitoring plan, consider stream reaches where high water temperature and low dissolved oxygen concentrations may act as a fish barrier.

- Map areas where there are buildings in the riparian zone and determine if monitoring is warranted at that location; educate landowner about water quality.

- Verify mapped points of water diversions.

- Map (or verify) spring and well locations.

- Document areas of ground water shortages and water quality problems from well logs.

- Map water table level. Subsurface water flow entering streams may help to maintain cool water temperatures necessary for good salmonid habitat.

- Map locations of potential water contamination sources, *i.e.*, underground storage tanks and agricultural chemical storage areas.

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