U.S. Department of the Interior
Bureau of Land Management

Salem District Office
Tillamook Resource Area
4610 Third Avenue
Tillamook, OR 97141

February 2000

Upper Tualatin-Scoggins Watershed Analysis

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Tillamook Resource Area Office
P. O. Box 404
4610 Third Street
Tillamook, OR 97141

IN REPLY REFER TO:

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December 8, 1999

Attached is a copy of the Upper Tualatin-Scoggins Watershed Analysis prepared through a partnership between Washington County Soil and Water Conservation District and the Bureau of Land Management. The Bureau of Reclamation contributed data and funding that made this watershed analysis possible. The acknowledgments page demonstrates the breadth of cooperation and valuable assistance received during this effort.

This watershed analysis is a combination of current inventory data provided by a BLM interdisciplinary team and information compiled by the principal author John Hawksworth, of Washington County SWCD. The purpose of this watershed analysis is to provide reference information used in project planning. The information in this document is considered the most current data available.

Watershed analysis is a continuing process. This document represents the first iteration of the analysis; updates in the future are expected as additional information is obtained. Additional information and comments are encouraged and will be welcomed at any time on this watershed analysis. The information will be retained with the analysis, used accordingly and eventually evaluated and incorporated into future iterations.

If you have any questions, please contact Katrina Symons at the above address or phone 503-815-1100.

Sincerely,

Dana R. Shuford Date: 12/8/99
Dana R. Shuford, Field Manager
Tillamook Resource Area

Upper Tualatin-Scoggins Watershed Analysis

Washington County Soil and Water Conservation District

J.T. Hawksworth, Principal Author

February 2000

Introduction

The concept of watershed analysis is built on the premise that management and planning efforts are best addressed from the watershed perspective. Better decisions are made, and better actions taken, when watershed processes and other management activities within a watershed are taken into consideration. Issues related to erosion, hydrologic change, water quality, and species are not limited to a specific site. Changes to watershed processes at one site often have effects that extend downstream and elsewhere in the watershed. By addressing these issues at the watershed level, we take the interconnected nature of watershed processes into account. We are thereby enabled to synthesize approaches to planning and management that preserve ecosystem functions. Where these functions have been diminished from reference conditions, we are able to plan activities to restore these functions.

In keeping with the principle of ecosystem analysis at the watershed scale, the Bureau of Land Management (BLM) has formed a partnership agreement with the Washington County Soil and Water Conservation District (SWCD) to prepare the Upper Tualatin-Scoggins Creek Watershed Analysis. The United States Fish and Wildlife Service (USFWS) also participated in production of this watershed analysis. The missions of these agencies are complementary. The BLM manages lands that are mostly in mountainous, forested portions of the watershed. The BLM is charged with several management duties by the people of the United States. As part of its stewardship role, the BLM is mandated to maintain ecosystem functions and processes. This includes maintenance of wildlife habitat. The USFWS has the mandate to protect terrestrial wildlife, aquatic species, and their habitat. As part of its mission, the SWCD works with farmers to conserve the soil resources of the valley, and to protect water quality within the watershed. The Washington County SWCD is mostly active within lower portions of the watershed. Together these agencies cover many of the interests within the watershed. This watershed analysis report is designed to address questions of interest to these agencies. However, in recognition that diverse interests exist in the watershed that are not covered by these agencies, this watershed analysis is also designed to be consistent with the interests of the Tualatin River Watershed Council, as expressed by the Tualatin River Basin Action Plan. Within the time and financial limitations of this report, it has done so.

The framework of this watershed analysis is built according to the requirements of *Ecosystem analysis at the watershed scale: a federal guide for watershed analysis* (REO 1995). This watershed analysis methodology is built up of six complementary parts. The first chapter is a watershed **characterization,** defining the characteristics that distinguish the watershed. The background laid out in this chapter leads to a set of **core topics and key questions** that have to do with watershed processes and their specific interactions with management activities. In response to these questions, the third and fourth chapter are constructed. The third chapter describes the **current conditions** within the watershed, while the fourth chapter reconstructs watershed processes and conditions under **reference conditions** (usually prior to European settlement). Based on the information provided in these chapters, we are able to synthesize the changes in watershed process that have been caused by various management activities. The results of this **synthesis** are included in the fifth chapter. Based on this synthesis, **recommendations** for current management and restoration are formulated.

Within the general framework of the federal methodology, there were opportunities to incorporate many techniques of the 1999 Oregon Watershed Enhancement Board (OWEB) methodology. Where feasible, these analytic techniques were applied to the Upper Tualatin-Scoggins watershed analysis. We believe that combination of the federal approach with techniques endorsed by the State of Oregon has expanded the usefulness of this analysis. Thus, this report is able to address BLM directives (as summarized by the Northwest Forest Plan) while assisting with the watershed preservation and restoration efforts of the SWCD, TRWC and other interested parties.

As a level one analysis using the federal methodology, this watershed analysis report relies heavily upon data collected by other agencies and private sources. This watershed analysis report has relied extensively upon GIS analysis of publicly available data contained in the Tualatin River Watershed Information System (Ecotrust 1998). These data have facilitated the analysis from these reports. However, they are not intended to replace field-based data for site-specific decisions. Although the data were analyzed for obvious flaws, no intensive review was performed on any data used in this report. There may be flaws in the source data and / or analysis performed in this report. This report should be used for general guidelines to point the direction to more site-specific studies.

Acknowledgements

Successful completion of the Upper Tualatin-Scoggins watershed analysis report required the contribution of experts in many disciplines. The following primary team members contributed technical assistance, provided editorial review, and in many cases authored paragraphs specific to their fields of expertise.

Mike Allen, BLM, Project coordinator
Steve Bahe, BLM, Wildlife
Ron Exeter, BLM, Vegetation
Julie Fulkerson, USFWS, Wildlife
Walt Kastner, BLM, Silviculture
Bob McDonald, BLM, GIS
Dean Moberg, NRCS, Soils and agriculture
Larry Scofield (retired), BLM, Vegetation
Lynn Trost, BLM, Roads
Warren Villa, Fire management
Cindy Weston, BLM, Fisheries
Greg White, Tualatin River TAC, Fisheries
Dennis Worrel, BLM, Hydrology
Caolina Hooper, BLM, Forester

People outside the primary team also made substantial contributions to the watershed analysis. Through his efforts, John McDonald, SWCD, facilitated the partnership between BLM and the SWCD that made this cooperative watershed analysis possible. Eric Glover and Mike Beaty, Bureau of Reclamation, provided valueable coordination and support for this watershed analysis. Mike Cole, ABR, provided valuable expertise and field assistance with benthic macroinvertebrate surveys in the watershed (Appendix 5). Kate Menninger provided field and lab assistance with the macroinvertebrate surveys. Mike Mertens, Ecotrust, provided GIS and cartographic services. Finally, experts from many agencies provided information useful to the preparation of this report. Many thanks to all of these people for their assistance with the preparation of this watershed analysis report.

John Hawksworth

November 8, 1999

Abbreviations and Acronyms

ACS	Aquatic Conservation Strategy
AF	Agriculture-Forestry (zoning designation)
AMA	Adaptive Management Area
BA	Bureau Assessment
B-IBI	Benthic Index of Biotic Integrity
BLM	Bureau of Land Management (federal)
BMP	Best Management Practice
BOD	Biological oxygen demand
BOR	Bureau of Reclamation (federal)
BS	Bureau Sensitive
cfs	Cubic feet per second
CREP	Conservation Reserve Enhancement Program
DBH	Diameter at breast height
D.O.	Dissolved Oxygen
DOGAMI	Department of Geology and Mineral Industries (Oregon)
EFU	Exclusive Farm Use (zoning designation)
EPA	Environmental Protection Agency (federal)
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FC2	Federal Candidate species for listing under the ESA, insufficient data for current listing.
FEMAT	Federal Ecosystem Management Assessment Team
FLPMA	Federal Lands Policy and Management Act
FSA	Farm Service Agency
FSEIS	Final Supplemental Environmental Impact Statement
FT	Federal Threatened (under the ESA)
GIS	Geographic Information System
gpm	Gallons per minute
JWC	Joint Water Commission
LSF	Late Successional Forest
LSR	Late Successional Reserve
LSRA	Late Successional Reserve Assessment
LWD	Large woody debris
NFP	Northwest Forest Plan
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODSL	Oregon Division of State Lands
OED	Oregon Employment Department
OGI	Oregon Graduate Institute
OHV	Off-Highway Vehicle
ONHP	Oregon Natural Heritage Program
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
O&C	Oregon and California Railroad
RM	River mile

ROD/RMP	Record of Decision and Resource Management Plan
ROS	Rain on Snow
SB1010	Senate Bill 1010 (Agricultural Water Quality Mgmt. Area Plan)
SEIS	Supplemental Environmental Impact Statement
SM	Stream Mile
SWCD	Soil and Water Conservation District (Washington County)
S&M	Survey and Manage
SV	Sensitive Vulnerable species designation (State of Oregon)
TAC	Technical Assistance Committee
TCOD	Total Chemical Oxygen Demand
TMDL	Total Maximum Daily Load
TPCC	Timber Production Capability Classification
TRWC	Tualatin River Watershed Council
TRWIS	Tualatin River Watershed Information System
TVID	Tualatin Valley Irrigation District
UGB	Urban Growth Boundary
USA	Unified Sewerage Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WAB	Water Availability Basin
WPA	Works Progress Administration
WQI	Water Quality Index

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Chapter 1: Characterization

1.1 Physical

1.1.1 Size and setting

The Upper Tualatin-Scoggins watershed[1] drains 136 square miles (86,900 acres) in the western part of the Tualatin River basin (Map 1-1). From its headwaters in the Coast Range, the Tualatin River flows for about twelve miles through mountainous terrain in a generally easterly direction. The river enters the Patton Valley near Cherry Grove (RM 68). From this point the stream gradient abruptly drops, and the river gradually acquires the characteristics of a lowland floodplain type stream. At River Mile 62, the Tualatin River enters the Wapato Valley, where it abruptly turns northward. The river continues along this trend until the confluence with Gales Creek at River Mile 56.7. The confluence with Gales Creek forms the lower boundary of the watershed.

The watershed is drained by the mainstem Tualatin River and two fourth-order tributaries; Scoggins Creek and Wapato Creek. Scoggins Creek drains the Coast Range in the northwestern portion of the watershed, while Wapato Creek drains the southern portion of the watershed, including parts of the Coast Range and Chehalem Mountains. Mainstem lengths and their drainage areas are given in Table 1-1. Stream mile indices, including tributaries, for these mainstem reaches are given in Appendix 1. The Tualatin River Watershed Information System (Ecotrust 1998) divides the watershed into 21 subwatersheds (6th field watersheds). These subwatersheds are displayed in Map 1-2.

Table 1-1. Major drainages of the Upper Tualatin-Scoggins watershed

Major stream	Area (mi^2)[2]	Mainstem length (mi)[3]	Confluence with Tualatin (RM)
Tualatin River (total)	135.8	24	————
Tualatin River (above Wapato Creek)	51.3	19	————
Wapato-Ayers Creek	26.0	9.8	60.8
Scoggins Creek	45.1	19.2	60.0

[1]Offcially designated by USGS as the Scoggins Creek watershed.
[2]Derived from GIS analysis of Tualatin River Watershed Information System (TRWIS) 6th field watershed layer.
[3]Derived from GIS analysis of Ecotrust's digitized 1:24,000 stream layer.

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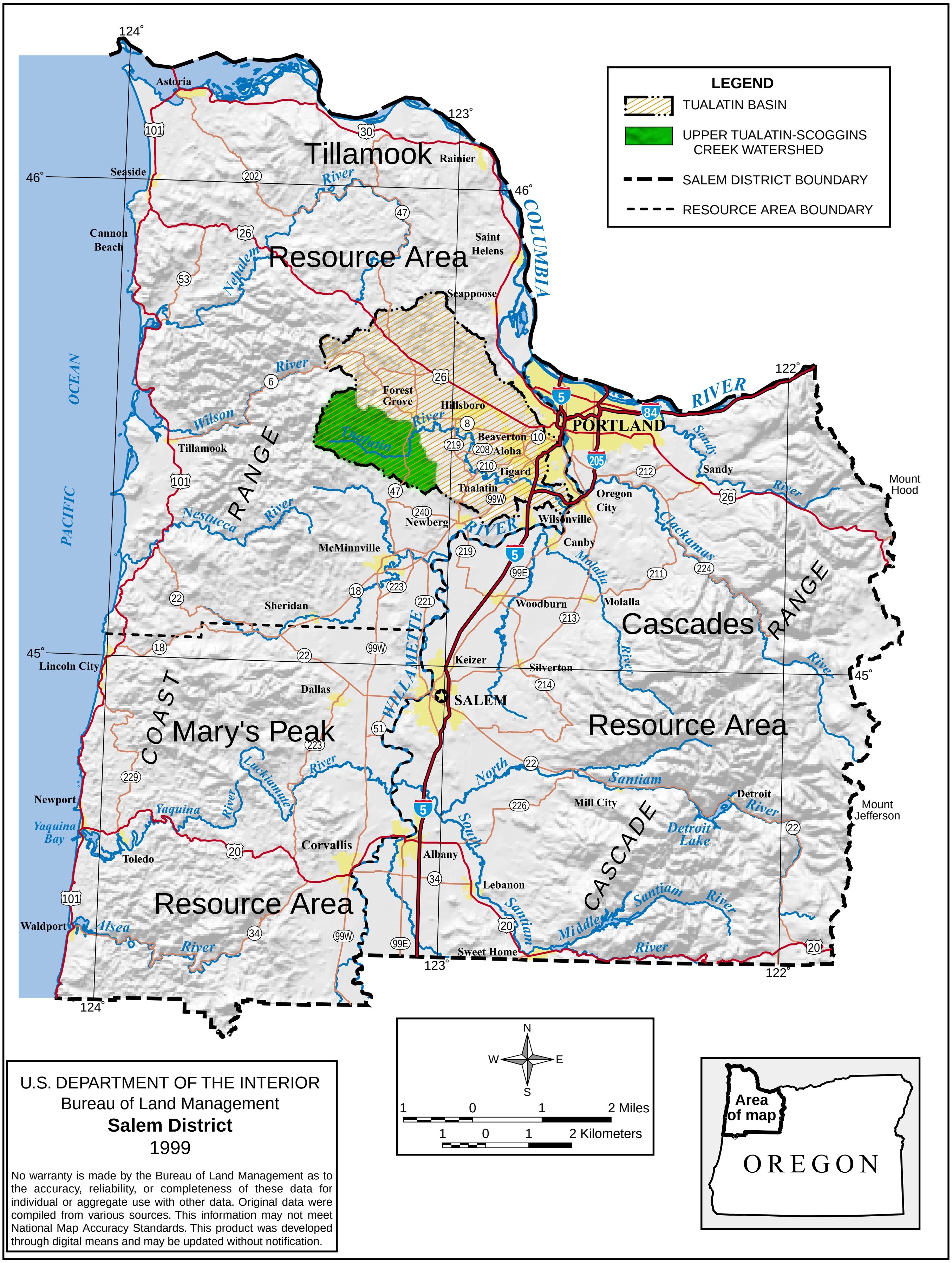

Map 1-1 -- Location of the Upper Tualatin-Scoggins Creek Watershed.

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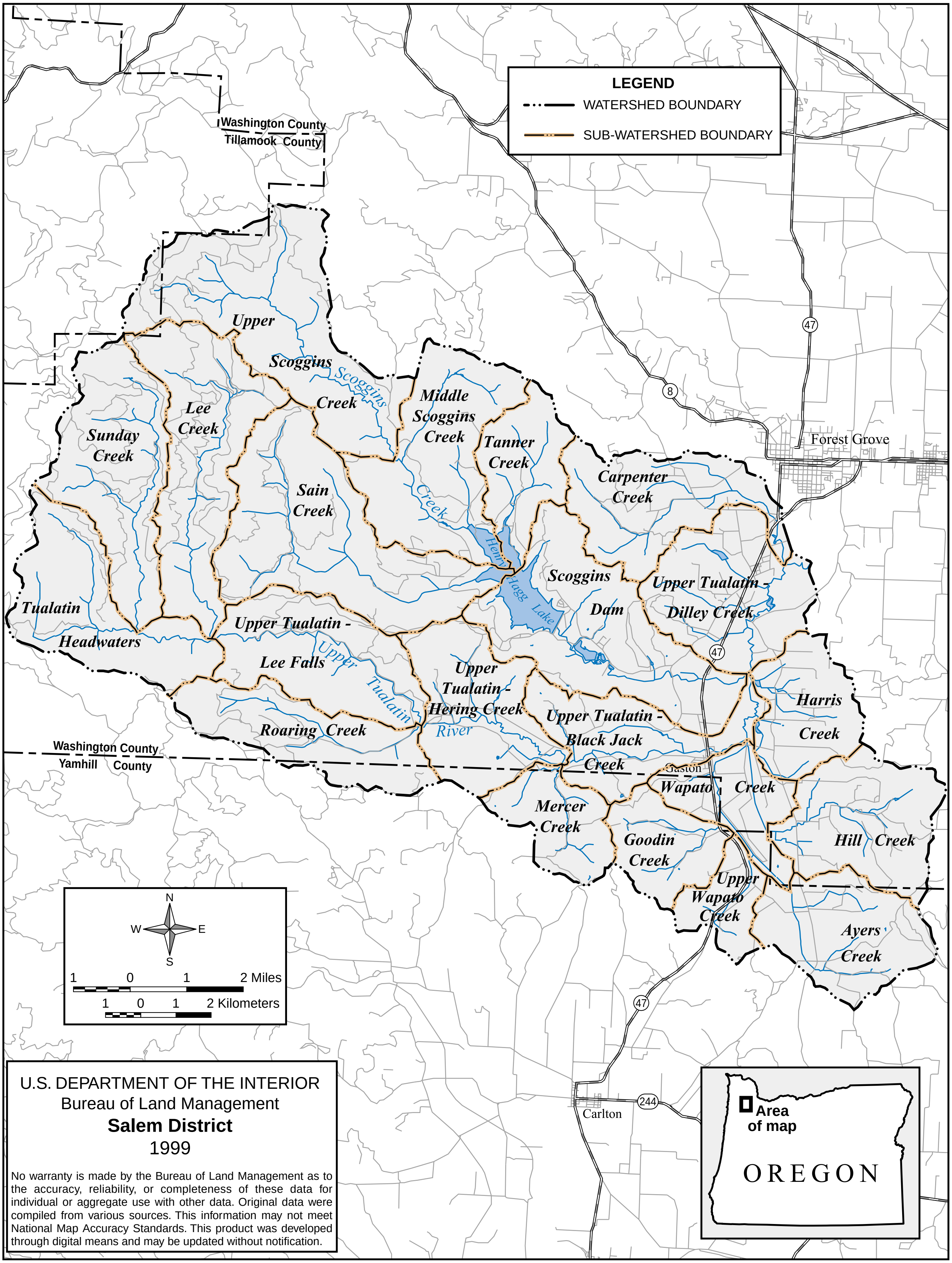

Map 1-2 -- Upper Tualatin-Scoggins Creek Watershed and Sub-Watersheds.

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1.1.1.1 Topography

Most streams within this watershed have their headwaters in the Coast Range to the west and flow in an easterly direction. Peaks along the western divide of the watershed are generally above 2,500 feet in elevation (Map 1-3). The highest elevations are found in the headwaters of Sunday and Lee creeks, where elevation reaches 3,525 feet at Saddle Mountain. Elevation generally decreases in an easterly direction. In the Coast Range, the topography is often rugged and dissected, and characterized by steep canyons. This ruggedness is reflected in the steep streams in the area (Figure 1-1). Stream gradient typically ranges between 4 and 20%, although first order streams can exceed 50%[4].

To the east, the Coast Range meets the flatlands of the Patton, Scoggins, and Wapato valleys. About 10-15% of watershed area is included in these alluvial zones. The first two valleys interfinger into the Coast Range and are generally quite narrow. These alluvial valley areas are generally less than 250 feet in elevation. Topography is generally flat, and is reflected in low stream gradient. Over this part of the watershed, streams flow over a very slight gradient, generally much less than 1%. Near its confluence with Gales Creek, the Tualatin River has a gradient of 0.06%. Ultimately, the Tualatin River leaves the watershed at the confluence with Gales Creek, at an approximate elevation of 148 feet.

The Chehalem Mountains separate the Wapato Valley from the broader Tualatin Valley, and form the eastern boundary of the Upper Tualatin-Scoggins watershed. The southern two-thirds of the main ridge generally exceeds 1,000 feet in elevation, and the maximum elevation of 1,633 feet is reached at Bald Peak. The Chehalem Mountain slopes that face the watershed are steep, and stream gradients exceeding 15% are common.

1.1.1.2 Ecoregions

Recent management theory has attempted to subdivide the landscape into homogenous units based on physical and biotic characteristics. One approach is to designate these units, called ecoregions, on a hierarchical scale, with higher level classifications denoting finer divisions of the landscape. At level IV of the classification system used by the Environmental Protection Agency (EPA), the Upper Tualatin-Scoggins watershed falls within three ecoregions (Map 1-3). The western headwaters of the Tualatin River and Scoggins Creek are located in the Volcanics ecoregion. Below this region, streams flow through the Valley Foothills ecoregion, a region transitional between the mountains and the Tualatin Plain. The Chehalem Mountains on the eastern border of the watershed are also included in the Valley Foothills ecoregion. At the lowest watershed elevations, the alluvial valleys form a portion of the Prairie Terraces ecoregion. Characteristics of these ecoregions are given in Table 1-2.

[4]Measured from bluelines on USGS 1:24,000 topographic maps. The BLM GIS layer contains additional low-order streams not displayed on the USGS maps. These streams tend to have high gradients.

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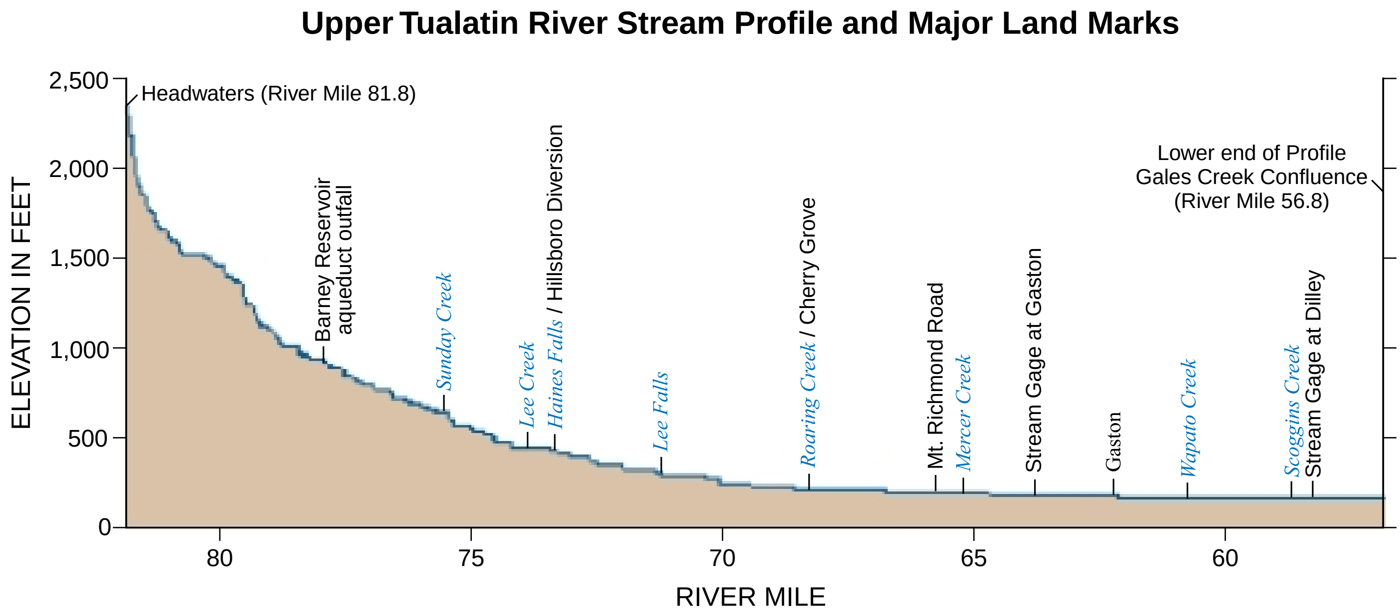

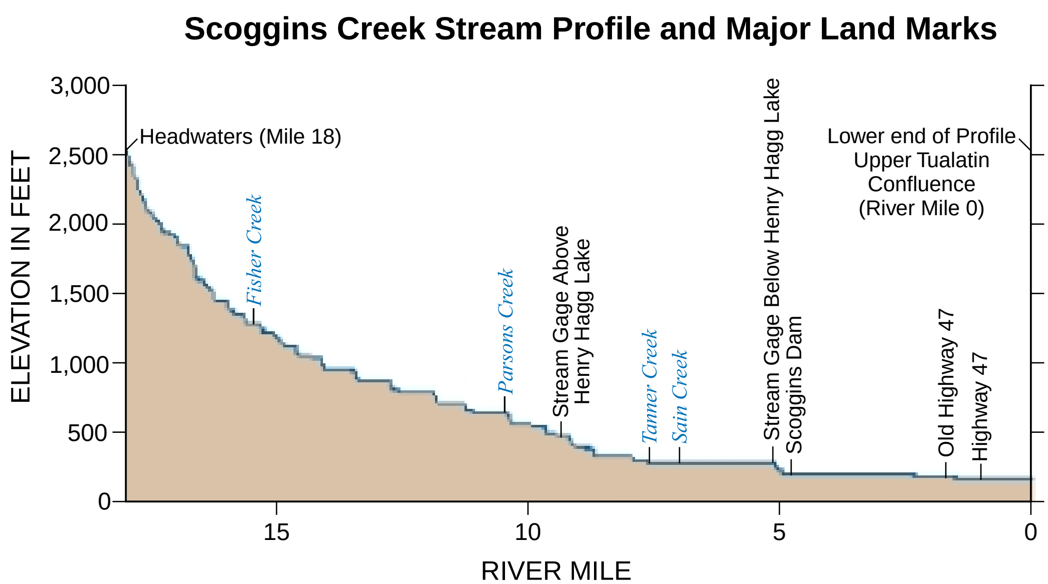

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Figure 1-1 -- Stream Profiles.

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Table 1-2. Characteristics of EPA Level IV ecoregions in the Upper Tualatin-Scoggins watershed. (Adapted from Pater et al. 1998, SCS 1982.)

Level IV ecoregion	Elevation	Physiography	Lithology	Soil Orders	Common soil series	Potential natural vegetation	Land use	Climate
1d. Volcanics	1600-3400 feet	Steeply sloping mountains. Moderate to high gradient streams with stable summer flow.	Basalts, breccias, and tuffs, with mafic intrusives at higher elevations. Minor inclusions of sedimentary rock.	Inceptisols, Ultisols	Olyic, Hembre	Western hemlock, western redcedar, Douglas-fir	Forestry, rural residential development, recreation.	Mesic/Udic
3c. Prairie Terraces	148-260 feet	Nearly level to undulating fluvial terraces with sluggish, sinuous streams and rivers. Historically, seasonal wetlands and ponds were common. Many streams now channelized.	Pleistocene lacustrine and fluvial sedimentary deposits.	Alfisols, Mollisols, Inceptisols	Wapato, Labish, Woodburn	Prairies.	Agriculture. Also urban/ rural residential development and some forested riparian zones.	Mesic/Xeric
3d. Valley Foothills	260-1600 feet	Rolling to steep foothills with medium gradient, straight to sinuous streams.	Miocene andesitic basalt and marine sandstone.	Alfisols, Ultisols, Mollisols, Inceptisols	Melby, Pervina, Saum, Laurelwood	On drier sites: Oregon white oak. On moist sites, western hemlock, western redcedar, and Douglas-fir.	Rural residential development, pastureland, coniferous and deciduous forests, forestry, vineyards, Christmas tree farms, orchards.	Mesic/Xeric

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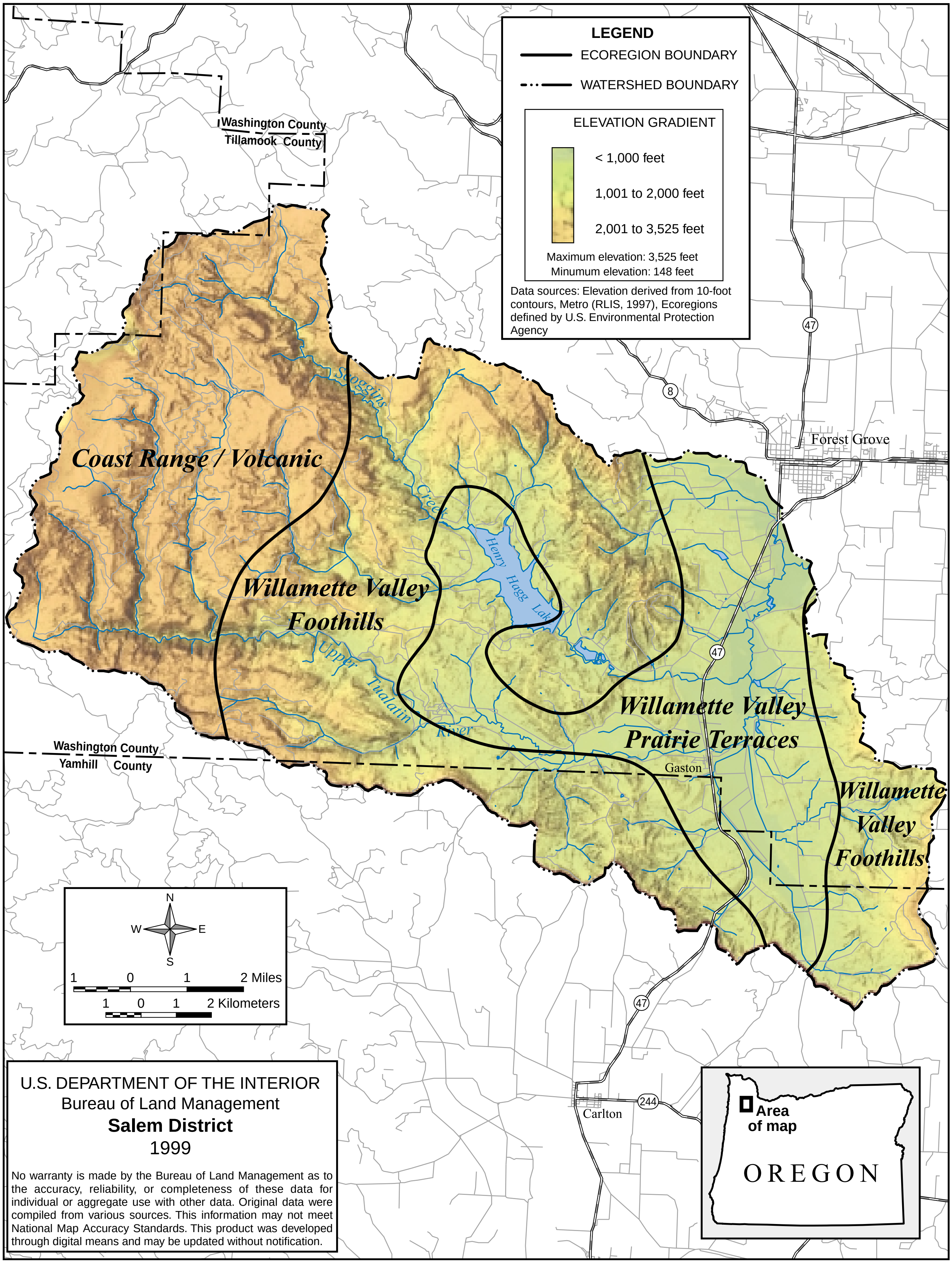

Map 1-3 -- Ecoregions and Terrain Elevation of the Upper Tualatin-Scoggins Creek Watershed.

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1.1.1.3 Geomorphology

The geological structure of the watershed is characterized by volcanic accretion and tectonic folding. The Coast Range portion of the watershed is considered to have been a volcanic island-arc chain that accreted to the mainland, then experienced further folding. The volcanic and sedimentary rocks that comprise the Coast Range were formed in a marine environment. After they accreted to the mainland, they underwent tectonic uplift and folding, and were intruded by mafic[5] material. Terrestrial lava flows overlaid sedimentary formations east of the Coast Range. Further folding of this area resulted in formation of the Chehalem Mountains and the Wapato Valley. Subsequently, alluvial silts and clays settled in the valley. Additionally, sites of impeded drainage accumulated organic matter (Orr et al. 1992, Wilson 1997, Schlicker 1967).

Lithology varies within the watershed (Map 1-4). In headwater reaches of the Coast Range, the highest elevations are underlain by igneous rocks, including intrusives and Siletz River Volcanics. Volcanic rocks of the Tillamook and Siletz River formation dominate throughout most of the Coast Range portion of the watershed, although a sizeable area of Yamhill Formation sedimentary geology exists in the upper portion of the Lee Creek and Scoggins Creek subwatersheds. These volcanic and sedimentary formations were intruded by igneous rocks, which generally form the highest peaks in the watershed. In the foothills, streams begin to develop alluvial floodplains. Alluvial portions of the Patton and Scoggins valleys average about 3,300 feet and 2,200 feet in width, respectively. In the Wapato Valley, alluvial width averages about 6,693 feet[6]. The alluvial fill in these valleys is generally much thinner than that existing in the main Tualatin Valley. In the Wapato Valley, the alluvial deposits have a high organic content. These deposits reflect the marshy environment that prevailed prior to artificial drainage. The Wapato Valley is underlain by about 60 feet of organic clay (Schlicker 1967).

1.1.1.4 Erosion

Erosional processes vary within the watershed. Due to the moist climate, most upland areas within the watershed are highly weathered and covered with a deep, fine-grained, highly erodible soil mantle (USACE 1953). Under natural conditions, a heavy forest cover moderates erosion in these areas. Where human activities lead to clearing and soil disturbance, erosion can be quite high. In the headwater regions of the Tualatin River and Scoggins Creek, the underlying volcanic bedrock is relatively resistant to erosion. This has created a landscape where steep canyons have been incised into these resistant rocks. The high slopes of canyon walls make them susceptible to undercutting by streams, with resulting shallow landsliding. The risk is especially high where these volcanic formations contact weak sedimentary formations, as is the case in upper portions of the upper Lee Creek and upper Scoggins Creek subwatersheds.

In the foothill regions, seceral geologic factors contribute to slope instability. The sedimentary formations are naturally unstable, while the Wanapum/Columbia River basalt readily degrades into highly weathered soils. Additionally, the upper portions of the Chehalem Mountains have a heavy, unstable overburden of silt-clay textured soils. These conditions make the mountains susceptible to slumping and sliding, particularly if slopes are oversteepened (Schlicker 1967). Slumps are also common in the foothill areas adjacent to the Tualatin River, Scoggins Creek, and other west side streams (Schlicker 1967).

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[5]Igneous rocks dominated by minerals with high iron and magnesium content are classified as mafic. In Oregon, basalt is a common example of mafic rock.

[6]Drevied by GIS analysis of Geology layer included in the Tualatin River Watershed Information System. For the analysis, floodplains were defined as stream-adjacent regions underlain by Quarternary Alluvium (Qal). This area varies from the 100 year floodplain. Width was calculated as (polygon area/valley length).

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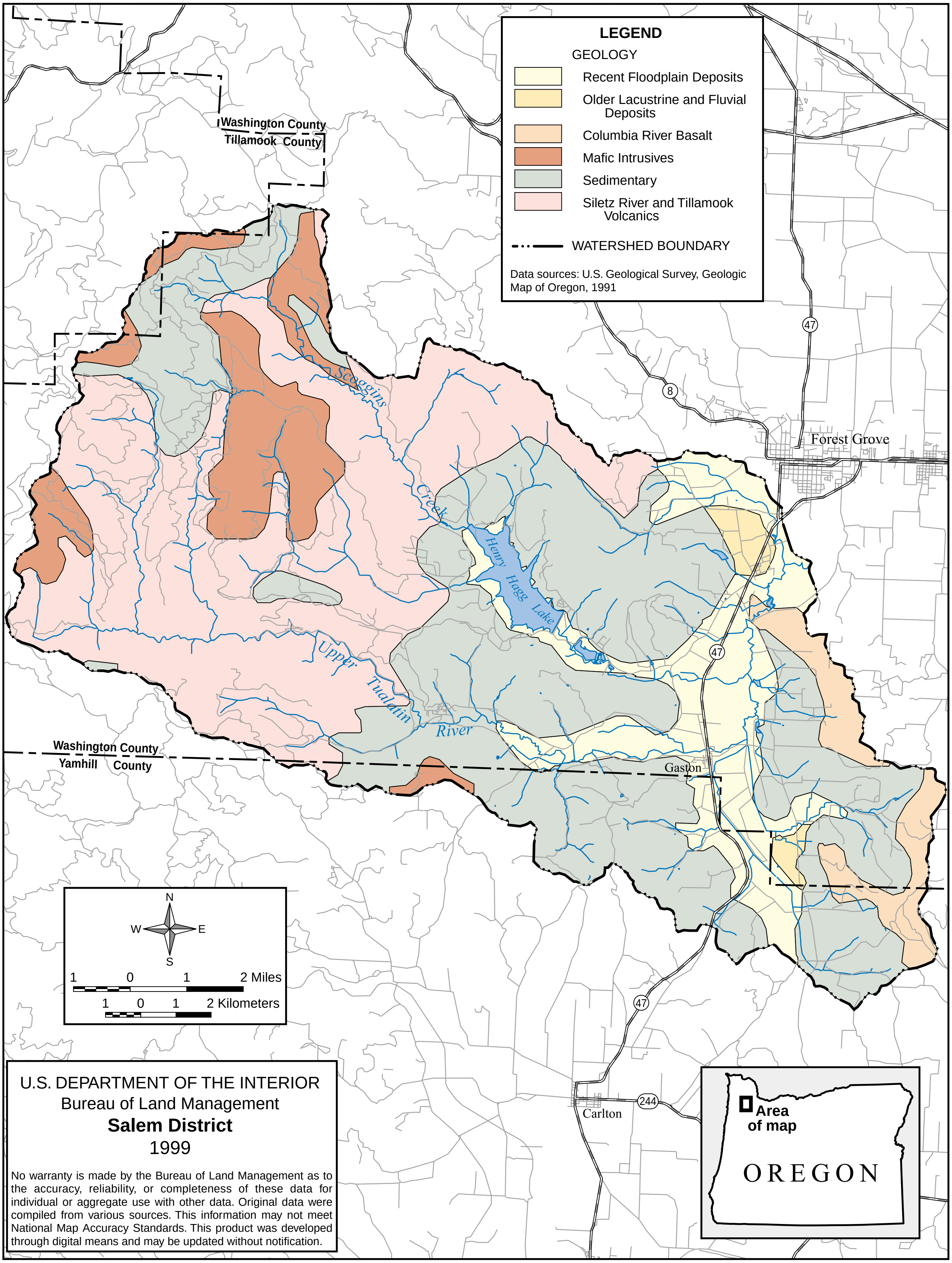

Map 1-4 -- Geology of the Upper Tualatin-Scoggins Creek Watershed.

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In lower portions of the foothill region, and in the prairie terrace region, streambank erosion becomes an important process, as fluvial action erodes the soft alluvium of the banks. In these areas, sheet, rill, and gully erosion are also important. A number of agricultural operations take place on steep slopes within the watershed.

1.1.1.5 Climate and Precipitation

The Tualatin basin lies in a region of moderate climate. Summers are warm and generally dry, while winters are cool and wet. Temperatures are moderated by the moist climate. In the Tualatin Valley, the freeze-free growing season averages 180 days, and the temperature falls below freezing 65 days out of the year (NRCS 1982). Mountainous regions have shorter growing seasons and greater incidence of freezing temperatures than those experienced in the valley. Weather is often cloudy, but precipitation is generally concentrated in the winter months. This precipitation comes mainly in the form of rain, although snow is common at higher watershed elevations. Roughly 73% of precipitation occurs between November and March (Figure 1-2)[7]. Generally speaking, precipitation is greatest in the headwaters regions of the Coast Range, and decreases with decreasing elevation. Annual precipitation ranges from 110 inches at Windy Point (T1S, R6W, S15) to 46 inches near the confluence with Gales Creek (OCS 1998). Precipitation in the Coast Range can be quite intense, especially near Windy Point (OCS 1997). Like total rainfall amounts, precipitation intensity decreases in the valleys.

1.1.1.6 Hydrology

Most of the sizeable streams within the Upper Tualatin-Scoggins watershed are perennial[8]. However, the amount of flow is seasonal, with high peaks in winter and very low flows in summer. The period from November to March accounts for 84% of flow in gaged, unregulated streams (Figures 1-3 and 1-4)[9]. Steep terrain, high precipitation amounts, and high precipitation intensities all contribute to high flood peaks. However, several factors mitigate against high runoff peaks. Rain on Snow (ROS) events are not a major part of the hydrologic regime in the watershed, although they can be important contributors to flood peaks in some years. Additionally, forested portions tend to reduce surface runoff through interception and infiltration. Since construction of Scoggins Dam in 1975, flood retention capability has been enhanced. Flood peaks are attenuated on the valley floor, especially in the Wapato Valley, which was a lake prior to agricultural drainage. During wet years, standing water still occupies the Wapato Valley for substantial parts of the winter.

Relatively abundant long-term hydrologic records exist for the watershed. Sites with long periods of historical gaging include the Tualatin near Gaston (RM 63.8), which has been gaged discontinuously since 1941, and the Tualatin River near Dilley (RM 58.8) and Scoggins Creek near Gaston (Stream Mile 4.8), both of which have been gaged continuously since 1941[10]. Between 1973 and 1977, gages were maintained on Scoggins and Sain Creeks upstream of the current site of Henry Hagg Lake. Streamflow characteristics at these sites are given in figures 1-2 to 1-4 and Appendix 2.

[7]Based on precipitation records at Scoggins Dam.
[8]Based on streams displayed as bluelines on USGS 7.5 minute quads.
[9]Based on measured USGS flow at Tualatin River near Dilley, and Scoggins Creek near Gaston, 1941-1974. Shorter periods of record at other gages give results raging from 81-85%
[10]The site of the gage on Scoggins Creek near Gaston was moved to SM4.8 in 1975. Prior to that time, it was three miles downstream.

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Figure 1-2. Scoggins Dam: Rainfall distribution by month

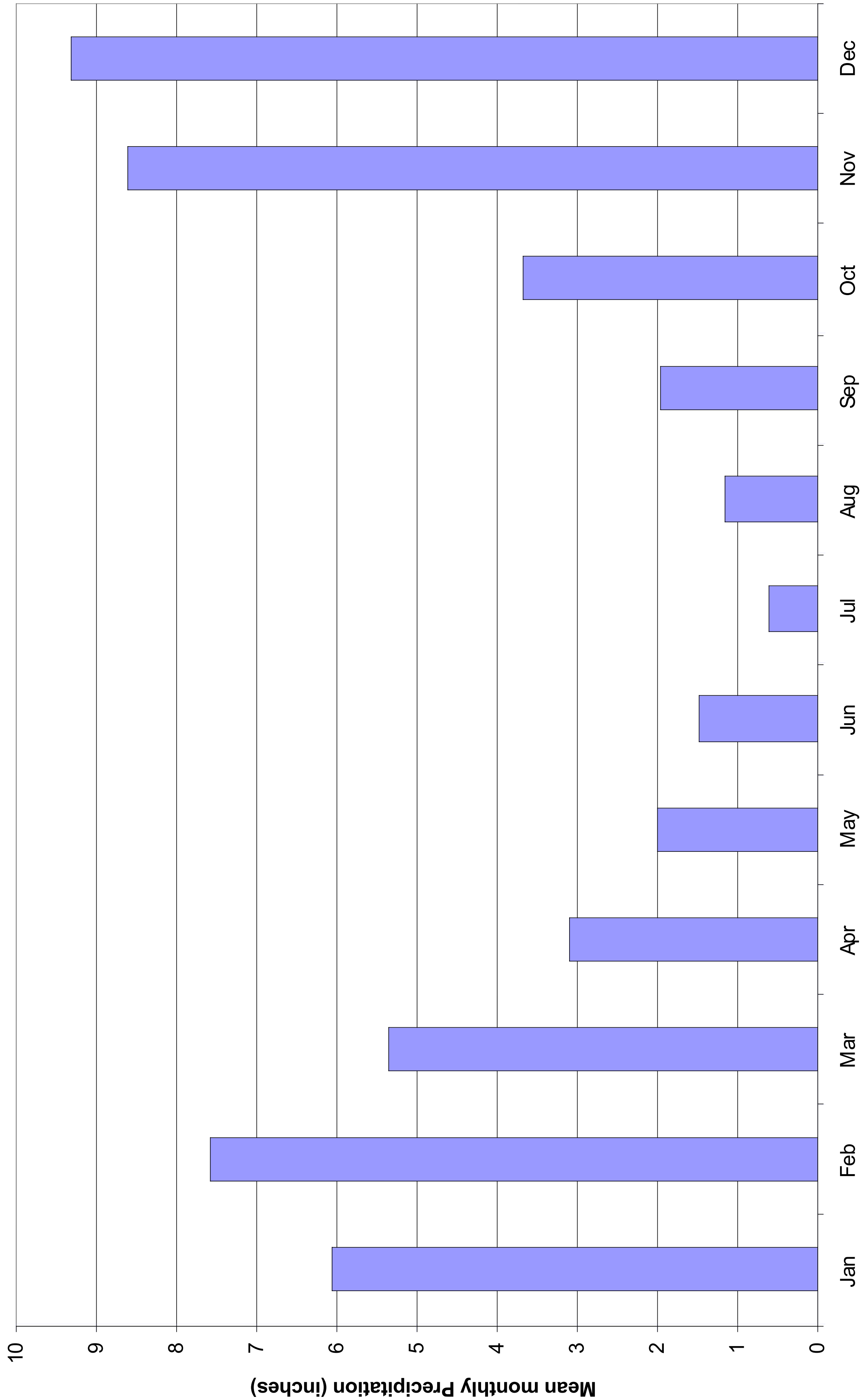

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Figure 1-3. Tualatin River near Dilley, mean monthly discharge WY1941-1974 (before flow regulation)

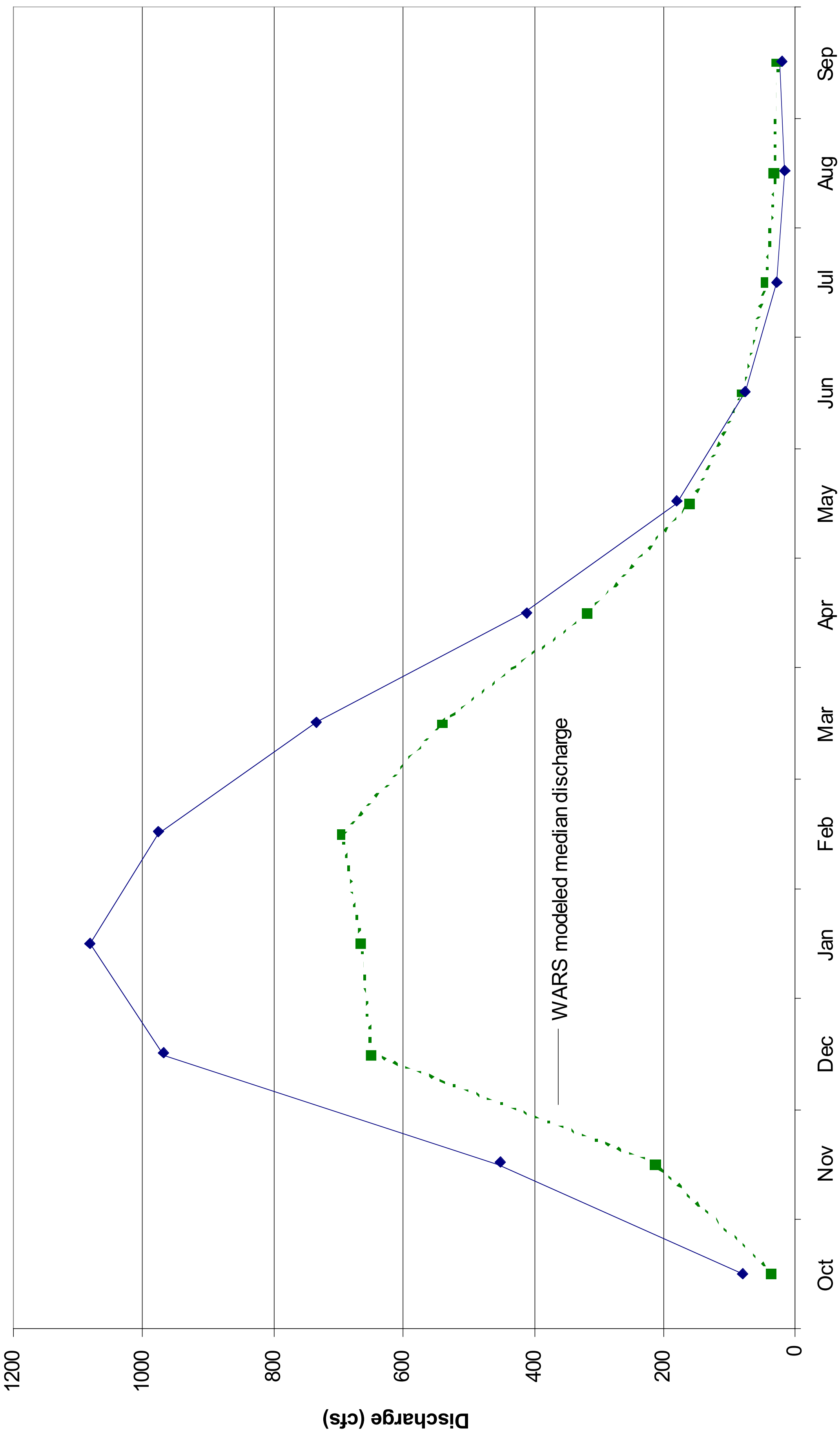

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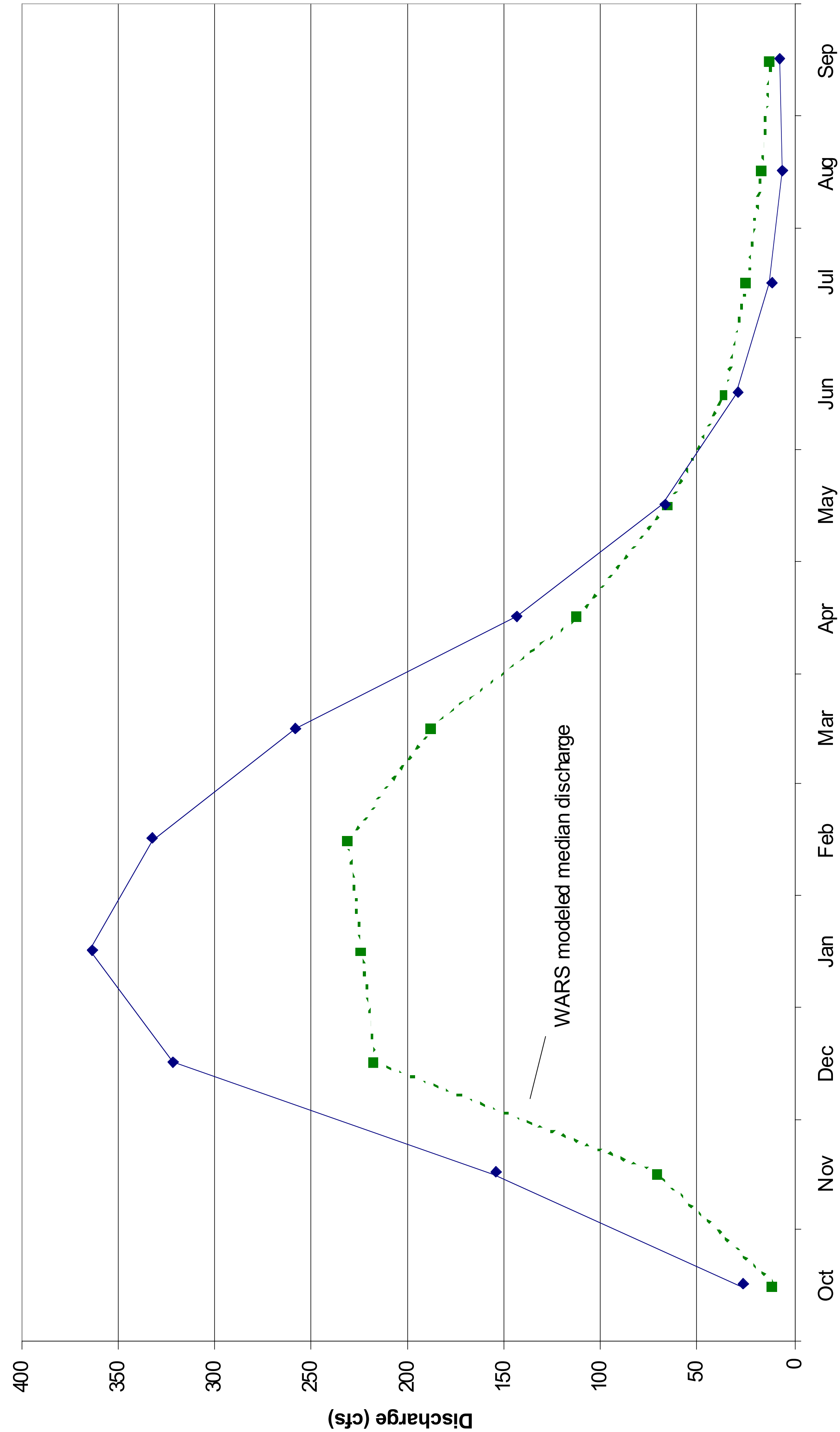
Figure 1-4. Scoggins Creek near Gaston, mean monthly discharge WY1941-1974 (before flow regulation)



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Flooding frequently occurs in the lower, alluvial portions of the Upper Tualatin-Scoggins watershed. During rainfall events, low gradient and poor infiltration combine to create large bodies of standing water in the Wapato Valley. Much of this area was historically part of the Wapato Lake. Subsequent projects drained the lake, but the lakebed is still commonly flooded in winter.

The natural flow characteristics of the watershed have been extensively modified by the Tualatin River project. Diversions from Barney reservoir provide summer flow to the mainstem of the Tualatin River downstream of RM 78. Flow regulations at Scoggins Dam has extensively modified the hydrologic regime on Scogggins Creek. Water stored in winter is released in the summer, with a net effect of lowered winter peak flows and increased summer low flows. Minor amounts of Scoggins Creek water are diverted at the TVID pump house on Scoggins Creek and pumped into the Tualatin River at two sites near RM 64, upstream of Gaston. Unlike the diversions from Barney Reservoir, these diversions usually account for less than 10% of the total flow of the Tualatin River near Gaston. A canal near Gaston diverts water from the Tualatin River to Wapato Creek, providing water for agricultural users in that area.

Both unconfined and confined aquifers provide groundwater to the Upper Tualatin-Scoggins watershed. For the most part, the area lacks large aquifers. In Patton and Wapato valleys, sandstone aquifers underlying the valley fill provide the most important groundwater sources. (Hart and Newcomb 1965; Wilson 1997). Additionally, locally perched water tables occur on clay lenses in the watershed.

1.1.1.7 Stream Channel

Stream channels vary with topography within the watershed. Reaches in the Coast Range and Chehalem Mountains have relatively high gradients. Typical gradients within these reaches average 3-20%. In the Tualatin Headwaters, Lee Creek, Sunday Creek, Upper Scoggins Creek, and Sain Creek subbasins, stream gradient often exceeds 20%, and can be as high as 71%. These high gradient streams have a substantial capacity to carry sediments, with erosion and sediment transport being dominant fluvial processes. Under high flow conditions, only the larger sediment fractions are deposited. These reaches tend to have a rocky substrate, ranging from gravel to bedrock. When the streams reach the alluvial plain, gradient decreases, resulting in a loss of stream power. The streams are less able to carry sediments, and finer sediments are deposited on the alluvial plain. In the alluvial valleys, the dominant substrate gradually becomes dominated fine sand, silt, and clay. In the Tualatin River, the boundary between rocky and fine substrates generally occurs as the river enters the Wapato Valley, although pockets of gravel may be found all the way downstream to Gales Creek (SRI 1990).

1.1.1.8 Water Quality

Recently, increased attention has been focused on water quality in the Tualatin River watershed. Legislation, both on the state and federal level has mandated improvements in water quality. For example, the Federal Clean Water Act requires implementation of Total Maximum Daily Load (TMDL) standards for parameters limiting water quality. In 1987, TMDL standards were implemented in the Tualatin Basin for ammonia nitrogen and phosphorus. More recently, the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (Senate Bill 1010) prohibited certain conditions leading to diminished water quality (OAR 603-095). Implementation of environmental legislation has required monitoring of water quality. Monitoring by the Oregon Department of Environmental Quality (ODEQ), Unified Sewerage Agency (USA), and several other public agencies and private organizations has been conducted at many locations within the watershed.

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[11]Most of these determinations, along with the cited figures, were based on data gathered prior to 1996.

[12]The **cool water** standard is applied to stream reaches that do not support spawning during the applicable time period, but serve as migratory corridors for salmonids. The **cold water** standard is applicable to reaches where salmonid spawning does occur during the applicable period.

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In response to the requirements of the Federal Clean Water Act, the state of Oregon produced the 303(d) list, which identifies streams with water quality limitations potentially impacting beneficial uses[11]. Two streams in the Upper Tualatin-Scoggins watershed are on this list (ODEQ 1998). These include Carpenter Creek and Scoggins Creek below Scoggins Dam. Carpenter Creek has summer bacteria levels, as indicated by *E. coli*, that are considered limiting to water contact recreation. Between May and October, dissolved oxygen concentrations reach levels below the federal cool water[12] standard of 6.5 mg/l for aquatic resources;

- Scoggins Creek below Scoggins Dam, where dissolved oxygen concentrations between November 1 and April 30 reach levels that are below federal cold water standards of 11 mg/l or 95% saturation for spawning salmonids.

- Additionally, Williams Canyon Creek was placed on the potential concern list because the 1995 ODEQ biological assessment indicated impaired conditions. Other stream reaches were considered for listing due to pesticide levels, habitat modification and sedimentation. Due to insufficient data, these factors did not cause any streams to be added to the 1998 list. As additional information becomes available, these issues may become the source of future listings.

In mountainous portions of the watershed, high sediment levels appear to be the greatest water quality parameter of concern. This is particularly true in Henry Hagg Lake, where greatly accelerated sedimentation was observed following the 1996 flood. Recently, limited site specific analyses of potential sediment sources were performed by the U.S. Bureau of Reclamation (BOR). More comprehensive studies of the magnitude and cause of sedimentation are currently being contemplated.

1.1.1.9 Soils

The soils of the Upper Tualatin-Scoggins watershed are largely influenced by their parent material. The soils in the Coast Range are typically Ultisols and Inceptisols. The Olyic, Hembre, and Klickitat series are of volcanic origin, while the Melby and Pervina series are formed in sedimentary material of the Yamhill formation. These soils are typically fine-grained with a large silt component. They are typically silty loams, although Klickitat soils are stony loams, and Pervina soils have a large clay component.

In the Chehalem Mountains, the soils are typically Alfisols of the Laurelwood series, which form on aeolian silts overlying the Columbia River basalt (NRCS 1982). Inceptisols of the Saum series are also common in upland portions of these mountains. Texturally, these soils are silty loams.

Soils in the Tualatin Plain typically consist of fine alluvium in the silt and clay classes. In the northern portion of the watershed, these soils tend to be well drained, and McBee, Woodburn, and Chehalis soils are common. South of the Scoggins-Tualatin confluence, the Wapato Valley is poorly drained, and Wapato silty clay loam and Labish mucky clay soils are dominant.

Although comprehensive soil testing has not been performed in the watershed, it is likely that certain soils in the watershed are naturally high in phosphorus. In the mountains and foothills, these include soils formed on the sedimentary Yamhill formation. Studies by ODF in the nearby Gales Creek and Dairy Creek watersheds found that forest soils developed on sedimentary lithology had a naturally high phosphorus content (Miller and McMillen 1994). In the valleys, organic soils, such as those underlying the Wapato lakebed, potentially have high phosphorus content.

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[13]A list of these Special Attention Species is given in the *Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl* (SEIS) of the NFP.

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Scientific Analysis Team and Forest Ecosystem Management Assessment Team (FEMAT) efforts, it was determined that slightly more than 400 of those species would benefit from extra management provisions. Thus, the Survey and Manage standards and guidelines were developed and adopted as part of the NFP to reduce the possibility of loss of population viability of those species of concern through the implementation of federal actions.

There are four components to the Survey and Manage standards and guidelines and each species is assigned to one or more of the component categories. The component categories are:

1. *Manage known sites.* This component, which went into effect in 1995, requires federal agencies to acquire and use information on known sites of Category 1 species when planning and implementing projects. The most appropriate action in most cases is the protection of relatively small sites but in the case of a few species the protection of fairly extensive areas may be warranted.

2. *Survey prior to ground disturbing activities.* There are 77 Category 2 species that require surveys prior to implementing activities that may disturb the habitat of those species. Survey protocols for these species were to have been developed and surveys completed for projects to be implemented in Fiscal Year 1999 or later. Due to the difficulty of developing field survey protocols for some species, not all protocols are in place as of the beginning of Fiscal Year 1999. There are 32 of the 77 species that cannot be readily identified and/or do not fruit often enough to be adequately surveyed for in a single year. The federal agencies are currently undertaking an effort to reclassify these species into either Category 3 or Category 4, where other survey schedules or techniques may prove more effective for those species.

3. *Extensive surveys.* Broad surveys would be conducted to find high-priority sites for species management. This component is primarily for species whose life histories are such that they may only be found or can be identified when specific climatic conditions exist. Protocols would be developed for these species and surveys for some species would be underway by 1996.

4. *General regional surveys.* The objective of this component is to survey to acquire additional knowledge of poorly understood species and to determine necessary levels of protection. The species intended to benefit from this standard and guideline are arthropods, bryophytes, lichens, and those fungi species that were not classed as rare and endemic.

1.2.2.1.2 Aquatic species

Several native salmonid species inhabit the watershed, including steelhead trout (*Oncorhynchus mykiss*) and cutthroat trout (*O. clarki clarki*). Although coho salmon (*O. kisutch*) is not native, they have been introduced and now spawn naturally within the watershed and are considered an important species.

Much of the upper Tualatin-Scoggins watershed contains salmonid habitat. Although natural waterfalls and artificial impoundments limit the amount of habitat available to anadromous salmonids, the upper watershed is important for maintenance of steelhead

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runs in the Tualatin subbasin. Steelhead trout utilize the Tualatin River downstream of Haines Falls, Roaring Creek, and Scoggins Creek downstream of Henry Hagg Lake for migration, spawning, and rearing. Resident cutthroat trout are also known to be distributed throughout much of the watershed.

Abundance of salmonid species is a matter of concern. Steelhead trout within the Upper Willamette River Evolutionarily Significant Unit (ESU), which includes the Tualatin Basin, have been listed as threatened under the federal Endangered Species Act (ESA). In 1999, the National Marine Fisheries Service (NMFS) determined that coastal cutthroat trout within the Upper Willamette River ESU were not warranted for listing under the ESA. These species are also on the ODFW sensitive species lists.

Many native non-salmonid species are present in streams within the watershed, including sculpin, lamprey, dace, coarsescale sucker, and redside shiner (SRI 1990). Additionally, Henry Hagg Lake and the mainstem Tualatin River below Gaston provide habitat for non-native warm water species, including smallmouth bass, largemouth bass, yellow perch, and bullhead.

1.2.2.2 Habitat

1.2.2.2.1 Wildlife Habitat (terrestrial)

Wildlife habitat has changed along with changes in the vegetation of the basin. Most vegetation in the Upper Tualatin-Scoggins watershed is predominantly in early and mid-successional seral stages, and structurally quite fragmented. Late seral habitat exists in very small patches. The patchiness of the current landscape is favorable to production of game species, such as deer, and other species that prefer “edge” habitat.

On the other hand, these changes have created less favorable conditions for species dependent upon late-successional vegetation. Many of these species require habitat elements most commonly found in old-growth forest, such as snags and down wood. Bats, for example, use snags and down wood for roosting sites. Changes in forest structure have reduced the availability of these habitat elements. The effect of these changes varies by species. The watershed is no longer suitable for late-seral dependent species with large home ranges, such as spotted owls. Other species, such as the marbled murrelet, have also experienced greatly diminished habitat, but remaining small patches of forest bearing late-successional elements can provide suitable habitat for these species. In the latter case, distance from the ocean may limit the potential quality of this habitat for marbled murrelets.

The quality of riparian habitat has declined in many parts of the watershed. The ability of riparian stands to provide large woody debris has been reduced, resulting in a reduction of the amount of down wood and snags within the riparian zones. Many of the large trees that formerly surrounded streams have been cleared, resulting in reduced canopy and increased summer temperatures. This has negatively altered the habitat types available to species, especially those that benefit from cool, humid sites, such as amphibians.

1.2.2.2.2 Aquatic Habitat

The suitability of aquatic habitat for sensitive cold water species is quite variable. Much of the most heavily utilized steelhead habitat within the Tualatin basin is found in this watershed. High temperatures limit the ability of the Tualatin River between Cherry Grove and Scoggins Creek to provide suitable summer rearing habitat for salmonids. Although releases from Scoggins Dam create favorable temperature conditions downstream of Scoggins Creek, fine substrates and lack of habitat diversity make this

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reach unsuitable for salmonid spawning and rearing. Tributary reaches in alluvial portions of the watershed bear similar concerns.

Riparian degradation has contributed to a declining quality of aquatic habitats in the valleys. Loss of large trees has resulted in a reduced supply of large woody debris to streams, thus causing a loss in habitat diversity. Consequently, the stream's ability to form pools has been diminished, resulting in a reduction of the number and size of pools. Additionally, reductions in riparian canopy have led to increased summer water temperatures. The weedy shrub species, such as Himalayan blackberry, that have replaced the native riparian forest canopy in many sites are unable to provide adequate stream shading.

In the foothills and mountains, salmonid habitat improves. Many stream reaches have cobble-gravel substrates, and the forest cover within these areas provides sufficient shading to streams.

1.2.2.2.3 Special Habitats

Certain habitat types in the watershed have special significance through their rarity in Oregon and their importance to sensitive species. One such habitat type is forest with late-successional characteristics[14]. This habitat type can be found in patches, mainly in the Lee Creek subwatershed (Murtagh et al. 1992). On federal lands, the LSR in the Lee Creek and Tualatin Headwaters subwatersheds (T1S, R5W, S19, E1/2) has the greatest contiguous stand of this habitat type.

Another important habitat type is wetland habitat. In the Coast Range, wetland types include small ponds built by beavers or through landslide processes. Larger wetlands are located in the Wapato Valley. Prior to agricultural drainage, Wapato Lake was the only large natural lake in the Tualatin Valley (Hart and Newcomb 1965). Substantial wetland areas are also found at the north end of the watershed near Dilley. Although these wetland areas have been heavily used for agriculture and none of these wetlands fall into preserves, they have the potential to provide important habitat for a number of aquatic, amphibian, and avian species.

1.3 Social

1.3.1 Population

Population within the Upper Tualatin-Scoggins Creek watershed is concentrated in the eastern portion of the watershed (Map 1-5). Gaston, with an estimated 1997 population of 690, is the only incorporated city within the watershed. Density within the watershed is typically low, and half of the watershed has fewer than 10 people per square mile. Densities exceeding 5,000 people per square mile are only found in Gaston. However, the growth of the Portland metropolitan area and increasing employment in high technology has contributed to population growth elsewhere in the watershed. This growth has been of two types: suburban growth adjacent to Forest Grove, and rural residential growth, much of which has been centered in the Chehalem Mountains. Although rural residential activities occur at population densities lower than those in urban areas, there are a number of pressures that this type of growth places upon resources.

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[14]"Four major structural attributes of old-growth Douglas-fir forests are: live old-growth trees, Standing dead trees (snags), fallen trees or logs on the forest floor, and logs in streams. Additional important elements typical include multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory" (NFP page B-2).

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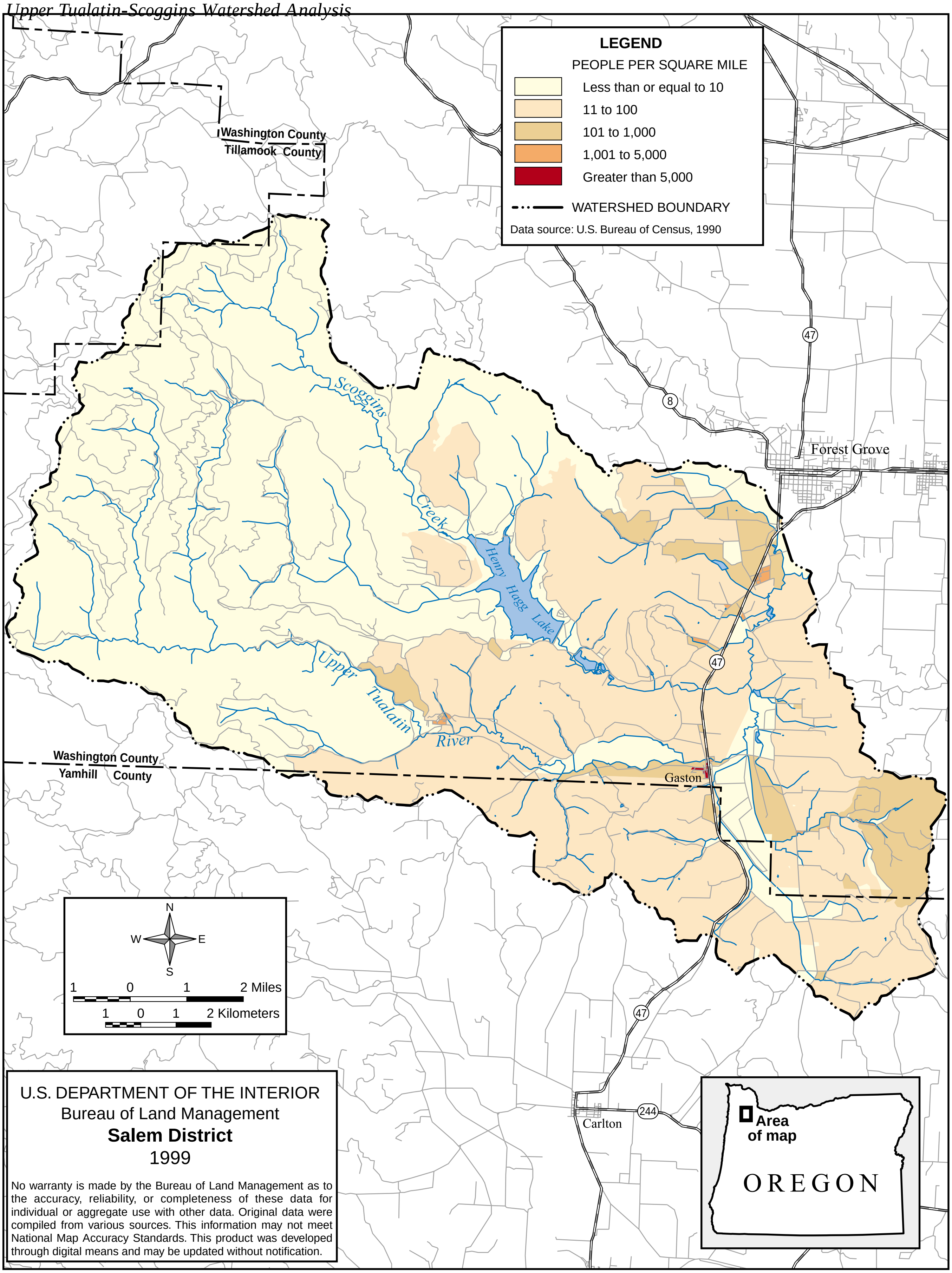

Map 1-5 -- Population Density (1990) of the Upper Tualatin-Scoggins Creek Watershed.

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1.3.2 Ownership

Land in the Upper Tualatin-Scoggins watershed is primarily privately owned (Map 1-6). About 87% of the watershed is in private ownership: 27,800 acres (36.5%) is private industrial timberland, and 43,693 acres (50.3%) in other private lands[15].

Public land managed by the Oregon Department of Forestry (ODF) makes up most of the remaining land within the Upper Tualatin-Scoggins watershed. These holdings comprise 10,280 acres of forested land, roughly 11.8% of the watershed. Most of these lands are managed as the Tillamook State Forest, and are concentrated in the mountainous western portion of the watershed. The Bureau of Land Management (BLM) also manages a substantial portion of the public lands within the watershed. In total, 3,763 acres (4.5%) of watershed lands are managed by BLM. The majority of these lands are Oregon and California Railroad (O&C) lands. Due to this legacy, these lands are distributed in a patchy fashion, rather than a single block. Federal statutes direct the BLM to manage O&C lands for sustained yield forestry in a manner consistent with federal environmental objectives. Other public lands are managed by the Bureau of Reclamation and the City of Hillsboro.

1.3.3 Land Use Allocations

1.3.3.1 BLM Allocations

1.3.3.1.1 Adaptive Management Area

BLM lands within the watershed fall within the Adaptive Management Area (AMA) land use allocation. According to the Salem District Record of Decision and Resource Management Plan (ROD/RMP), the general objective of AMA lands is to "encourage the development and testing of technical and social approaches to achieving desired ecological, economic, and other social objectives." Specific goals related to this objective include "provision of well-distributed late-successional forest, retention of key structural elements of late-successional forests on lands subjected to regeneration harvest, and restoration and protection of riparian zones as well as provision of a stable timber supply". Within the Northern Coast AMA, emphasis is to be on "management for restoration and maintenance of late-successional forest habitat, consistent with marbled murrelet guidelines." Within this AMA, ODF will be "invited to collaborate in development of a comprehensive strategy for conservation of fisheries and other elements of biological diversity."

1.3.3.1.2 Riparian Reserve

Riparian Reserves constitute 1,738 acres, approximately 46% of all BLM lands in the watershed. Riparian Reserves are adjacent to streams, ponds, wetlands, and nearby areas of unstable topography. The extent of these reserves varies based on ecological and geomorphic factors. As a rule of thumb, they extend for a width of two site potential tree heights (usually about 400 feet) from each bank of fish-bearing streams. On other streams, the reserves typically extend for 1 site-potential tree (about 200 feet) from each stream bank.

In these reserves, the management focus is attainment of Aquatic Conservation Strategy (ACS) objectives through restoration and protection of aquatic and riparian-dependent

[15]Derived from GIS analysis of the 1995 OSU layer (contained in Ecotrust 1998) showing timberland ownership.

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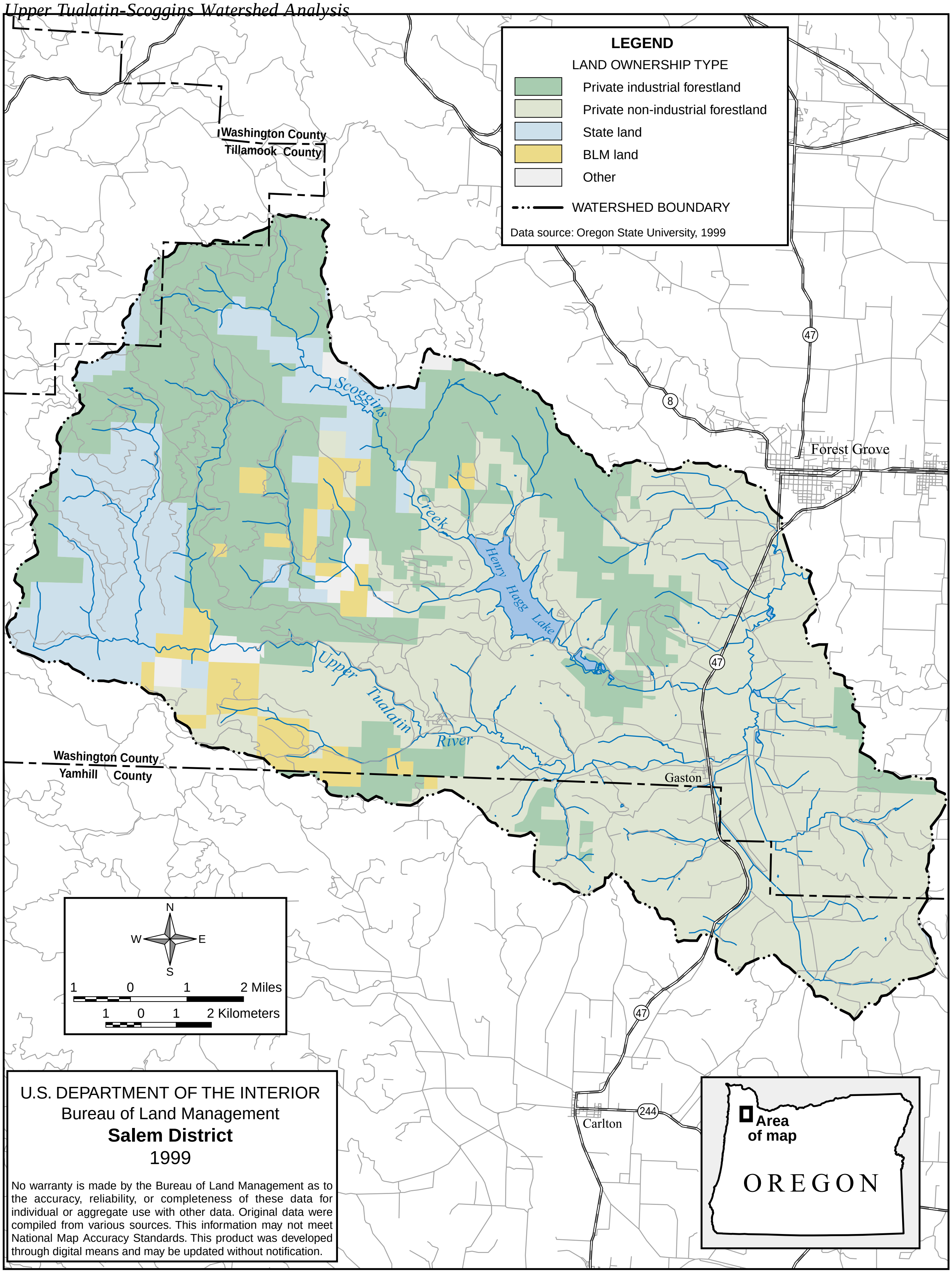

Map 1-6 -- Major Land Ownership Types in the Upper Tualatin-Scoggins Creek Watershed.

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habitats and communities (Appendix 3). Management activities must be conducted in such a manner so as not to conflict with this primary objective. Many species are dependent upon the habitat provided by Riparian Reserves. Additionally, Riparian Reserves assist in maintenance of the aquatic system by providing shade to regulate stream temperature, contributing woody debris to improve structure and diversity of aquatic habitat, and filtering sediments and nutrients supplied by adjacent upland sources.

1.3.3.1.3 Late-Successional Reserve

Late-successional reserves (LSRs) are designed to “protect and enhance the conditions of late-successional and old-growth forest ecosystems” (BLM 1995). These ecosystems provide habitat for many sensitive species, including the spotted owl and the marbled murrelet.

In the Upper Tualatin-Scoggins watershed, about 535 acres of public land are allocated as LSR. Most of this land (480 acres) is contained in the parcel located at T1S, R5W, S19 and currently has about 100 acres of mature timber. The remaining LSR (55 acres) consists of two small stands of mature timber located at T1S, R4W, S3, N1/2.

1.3.3.1.4 The 15 percent rule

The *Salem District Record of Decision and Resource Management Plan* (ROD/RMP) in its direction for AMA lands states, “Provide for old-growth fragments in watersheds where little remains. The Matrix management action/direction for retaining late-successional forest in fifth field watersheds (see Matrix section for details) will be considered as a threshold for analysis in AMA planning rather than a strict management action/direction. The role of remaining late-successional forest stands will be fully considered in watershed analysis before they can be modified.”

The 15% analysis of the Upper Tualatin-Scoggins fifth-field watershed shows that 14% of the federal forest acres within the watershed are at least 80 years old. These late-successional forest (LSF) stands, patches and fragments have been mapped and will be deferred from regeneration harvest for approximately 20-30 years, after which a reevaluation of the LSF within the watershed will be made. Additional stands that are located within Riparian Reserves and are currently less than 80 years old have been identified for management to develop LSF habitat characteristics and at some future date to help meet the 15% retention Standard and Guide.

1.3.3.2 Private Zoning

The Upper Tualatin-Scoggins Creek watershed is near to a rapidly urbanizing region of Washington County. In order to restrict urban sprawl and to preserve historical land uses, the Washington County Comprehensive Plan was created. This plan divides the watershed into zones of forestry, agricultural, and urban uses. Under the plan, forestry uses will continue to be centered in the mountainous portions of the watershed, while agriculture will continue to dominate much of the central and lower portions of the watershed. Urban use will be restricted to an area surrounding Gaston, while other areas along the Highway 47 corridor and in the Chehalem Mountains are zoned for rural residential uses.

Current zoning regulations provide for 65.8% of the watershed to remain in forest use, 10.8% in agricultural use, and 22.2% in mixed forestry-agricultural use, with 1.2% allocated for urban uses and rural residential uses. The vast majority of forest and agricultural lands are zoned for parcels exceeding 10 acres.

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1.3.4 Human Uses

1.3.4.1 Forestry

Forestry is the dominant activity over two-thirds of the watershed, including the Coast Range, and substantial portions of the Chehalem Mountains. Of forested lands, 27,900 acres (47.8%) is industrial forestland. BLM manages 3,760 acres (6.4%), and state lands amount to 10,280 acres (17.6%). Private non-industrial interests own the remaining 16,400 (28.2%) of forested land in the watershed. Management emphasis varies between these entities, but the vast majority of the land has been burned or harvested within the past 80 years.

In addition to timber harvest, forestry entails related support activities, including fertilization, herbicide application, and road construction. The highest road densities on forested lands are found in the Hill Creek subwatershed and in the subwatersheds draining to Henry Hagg Lake. Due to ruggedness of terrain, road densities tend to be low in headwater regions of the watershed, with the notable exception of the Lee Creek subwatershed. However, high stream density leads to a high density of road crossings in the Sunday Creek subwatershed.

1.3.4.2 Agriculture

Agriculture has traditionally been the predominant land use in Patton and Wapato valleys and continues to be economically important in the Upper Tualatin-Scoggins watershed. Many of these activities take place on steep foothill lands adjacent to these valleys. Nurseries are an important agricultural activity within the watershed. Agriculture also carries with it activities that may affect stream water quality. These include tillage, manure storage, fertilization, application of herbicides and pesticides, and encroachment upon the riparian zone. The USDA Natural Resources Conservation Service (NRCS) and Washington County Soil and Water Conservation District (SWCD) work with agricultural land owners to minimize effects of their operations upon streams.

1.3.4.3 Urban and rural residential

Urban lands are very limited within the watershed, and the most developed areas are concentrated around Gaston and in an area adjacent to Highway 47, particularly near Forest Grove. Additional rural residential development is taking place in the Chehalem Mountains, particularly in the Hill Creek subwatershed. As these subwatersheds develop, pressures on water and land resources increase. This gives rise to potential conflicts with aquatic life, agriculture, and other beneficial uses for these resources. Rural residential growth often brings problems in the form of enhanced erosion and inadequate septic systems. Older rural residential development often is built in floodprone areas near streams.

1.3.4.4 Recreation

Many recreational activities are supported within the watershed. These activities include hiking, camping, hunting, fishing, birding, bicycling, and touring. Both authorized and unauthorized driving of off-highway vehicles (OHV's) takes place in western portions of the watershed. State forest lands in the western portion of the watershed provide public access for many of these activities. Where access permits,

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BLM lands can also provide recreational activities. Private timberlands also afford opportunities for recreation. It has been the policy of some timberland owners to allow public access to their lands for activities that are consistent with company operations.

Developed recreational activities within the watershed are relatively uncommon. The most important developed recreational facility is Henry Hagg Lake, which offers opportunities for aquatic-based activities including boating, warm water fishing, and water-skiing. Scoggins Valley Park was built around Henry Hagg Lake, providing opportunities for hiking and picnicking. Other developed recreational facilities are found at Bald Peak State Park, which offers picnicking, and Gaston City Park, which offers facilities for picnicking and sports related activities.

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Chapter 2: Core Topics And Key Questions

This watershed analysis is designed to provide assistance in addressing diverse issues in the Upper Tualatin-Scoggins watershed. A basic understanding of pertinent physical, biological, and social processes is essential to analysis of more specific questions related to watershed issues. For this purpose, it is useful to use a format of Core Topics and Key Questions. Core Topics are general discussions of processes operating within the watershed. Key questions are specifically designed to address these identified issues of concern. As a quick reference, page numbers are provided to direct the reader to report pages that address each key question.

2.1 Aquatic

2.1.1 Erosion issues

Accelerated erosion may exist in some portions of the watershed. Related problems include loss of topsoil, accelerated sedimentation of streams and Henry Hagg Lake, loss of habitat, loss of reservoir storage capacity, and loss of water quality. Under certain conditions, sediment delivery to streams constitutes a "prohibited condition" under SB 1010 and the Oregon Forest Practices Act.

Core topic

What erosion processes are dominant within the Upper Tualatin-Scoggins watershed? Where have they occurred or are they likely to occur? What is the effect of those erosion processes on beneficial uses in the watershed? *See pages: 8, 35*

Key questions

- How have human activities affected erosion processes within the watershed? *See pages: 119*
- What is the distribution of prohibited conditions as defined under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan? What types of prohibited conditions occur in the watershed? What can be done to improve these conditions? *See pages: 42, 129*
- What activities are contributing to accelerated sedimentation in Henry Hagg Lake? What effects do accelerated erosion and associated sedimentation have on this water body? *See pages: 38, 120*

2.1.2 Hydrology and water quantity issues

Management activities have modified the natural flow regime in the watershed. Impacts include an altered flooding regime during high water periods, and changes in the amount of water available for human and fish use during low water periods.

Human and instream needs place a heavy demand on water resources. In some areas, water quantity may be insufficient to meet these needs.

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Core topic

What are the dominant hydrologic characteristics (e.g. total discharge, peak and minimum flows) and other notable hydrologic features and processes in the watershed? *See pages: 43*

Key questions

- How have human activities altered the natural hydrologic regime? What are potential effects of the altered flow regime? *See pages: 123*

- Are water rights allocations sufficient to provide both for human and fisheries needs? If not, where are the deficits greatest? Where are the best sites for purchases of water rights for instream purposes? *See pages: 46, 124*

2.1.3 Stream channel issues

Stream morphology affects the way in which streams transport water and sediments, as well as the stream's ability to provide suitable habitat for aquatic life. Where the channel has been altered through human activity, the ability of the stream to perform these functions will be changed. Furthermore, restoration activities must be appropriate to the natural characteristics of the stream channel.

Core topic

What are the basic stream morphological characteristics and the general sediment transport and deposition processes in the watershed? *See pages: 55*

Key questions

- How have human activities altered stream morphology? In instances where effects have been negative, what sort of restoration activities are appropriate? *See pages: 58, 125, 154*

2.1.4 Water quality issues

Streams within the Upper Tualatin-Scoggins watershed have experienced diminished water quality relative to reference conditions. Two of these streams have been designated on the ODEQ 303(d) list as having characteristics limiting their ability to support aquatic life and provide recreation. Parameters of concern include low dissolved oxygen levels, high water temperatures, elevated phosphorus levels, and high bacteria counts.

Core topic

What are the beneficial uses of water in the watershed, where are these uses located, and which of these are sensitive to activities occurring in the watershed? *See pages: 59, 126*

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Key questions

- What beneficial uses of water occur in this watershed? *See pages: 59*
- How is water quality being impacted by management activities and what can be done to reduce these impacts? *See pages: 126, 155*
- What are probable sources of phosphorus in streams? Where do phosphorus levels exceed TMDL standards? What can be done to reduce aquatic phosphorus levels? *See pages: 67, 127, 156*
- What are the factors causing 303(d) listed streams to exceed water quality criteria? What can be done to improve water quality on these streams? *See pages: 129, 155*
- At which locations are stream temperatures above desirable levels for salmonid production? What measures can be taken to reduce water temperatures? *See pages: 68, 157*
- What is the effect of current water quality upon non-salmonid species? *See pages: 130*
- Where are recreational activities limited by current water quality? What can be done to restore the ability of streams to support recreation? *See pages: 129*

2.1.5 Aquatic species and habitat issues

Salmonid species are an important component of streams within this watershed. These species are sensitive to changes in aquatic habitat. Upper Willamette steelhead trout are listed as threatened under the Endangered Species Act. Additionally, coastal cutthroat trout are an Oregon state sensitive species.

Many species such as frogs, turtles, salamanders and newts are dependent on wetland / marsh and pond areas. It is recognized in the scientific community that frogs are declining worldwide at an unprecedented rate.

Core topic.

What is the relative abundance and distribution of sensitive aquatic and amphibian species in the watershed? *See pages: 70, 76*

What is the distribution and character of their habitats? *See pages: 74, 76*

Key questions related to fisheries.

- What factors are impacting habitat quality, quantity, and diversity for fish species of interest? What management actions can be taken to improve habitat conditions for these species? *See pages: 74*
- Where are barriers to fish passage located? Of the barriers created through human activity, which would be feasible to alter or remove? *See pages: 75*

Key questions related to amphibian species and wetland habitats.

- Where are marsh / wetland areas and ponds in the watershed? *See pages:* 52, 115, 131

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- How have human activities impacted these wetland areas? *See pages: 115, 131*
- What activities could enhance or restore the historic characteristics of these wetland habitats? *See pages: 159*
- What is the relative abundance and distribution of wetland-dependent species in the watershed? *See pages: 132*
- What are the population trends for frogs and other species dependent upon moist and aquatic habitats? Are there any such species have been extirpated, or face imminent extirpation, within the watershed? What is the prognosis for these species? *See pages: 76, 132*

2.2 Terrestrial

2.2.1 Vegetation issues

The structure and composition of vegetation has been extensively altered from reference conditions. This has altered the type and availability of beneficial uses provided by vegetation. Additionally, these changes are likely to have favored certain animal species at the expense of others.

Noxious weeds and other non-native species have colonized many areas within the watershed. These species tend to outcompete native plants, resulting in decreased diversity. Many of these exotic species provide inferior habitat for native wildlife. Additionally, some of these species are poisonous to livestock, and otherwise interfere with agricultural and forest management.

Riparian vegetation has been extensively altered, changing the functions that these areas are able to provide for aquatic and riparian plant and animal species.

Some native plant species are in danger of eradication, are endemic, or are otherwise of special concern. These species include those listed or proposed for listing under the Endangered Species Act (ESA), Survey and Manage Species as identified in the Northwest Forest Plan, and species identified under the BLM Special Status Species Policy.

Core topics

- What is the array and landscape pattern of plant communities in the watershed? How does this compare to reference historical patterns? *See pages: 77, 108*
- What processes caused this pattern? *See pages: 112, 132*

Key questions

- What measures can be taken to retain habitat for terrestrial species and to maintain and enhance forest health? *See pages: 160, 168*
- Are ecosystems losing diversity of native species because of the invasion of exotic/noxious plants? What control measures could be reasonably implemented to reduce the introduction and spread of exotic/noxious plants? What opportunities

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are available for partnerships in controlling the spread and introduction of exotic plants within the watershed? *See pages: 83, 133, 160*

- [BLM only] What kinds of management practices should be implemented in the Riparian Reserves to enhance their function? *See pages: 168, 169, Appendix 9*

2.2.2 Wildlife species and habitat issues

Some terrestrial animal species bear special concern because of diminished numbers or endemic status. Care must be taken to avoid further reduction in numbers of these species. These include species listed or proposed for listing under the Endangered Species Act (ESA), Survey and Manage Species as identified in the Northwest Forest Plan, and species identified under the BLM Special Status Species Policy.

Some species are popular as game. It is important to maintain these species at a sustainable level.

Core topic

What is the relative abundance and distribution of terrestrial species of concern that are important in the watershed? What is the distribution and character of their habitats? *See pages: 84*

Key questions

- Which species are listed or proposed for listing under the Endangered Species Act, identified in the Northwest Forest Plan as Survey and Manage Species, or have status under the Bureau's Special Status Species Policy? What are their relative abundance and distribution? *See pages: 85, 134*

- What are the condition, distribution and trend of habitats required by those species of concern that may occur in the watershed? *See pages: 84*

- What are the current distribution and density of snags and down wood on lands within the watershed? *See pages: 93*

- What are the natural and human causes of change between historical and current species distribution and habitat quality for species of concern in the watershed? *See pages: 112, 132*

- What are the influences and relationships of species and their habitats with other ecosystem processes in the watersheds? *See pages: (dispersed throughout document)*

- What factors contribute to the decline in population levels for those species that are of concern? Given the current ownership pattern, what opportunities exist to manage for these species? How does the ownership pattern affect the potential to preserve and restore quality habitat within the watersheds? *See pages: 134, 92*

2.2.3 Forest resources issues [BLM only]

Key questions

- Given the goals and objectives for management emphasis in the AMA (including the LSR portion) and the past forest stand management activities, what should be

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the order of priority for stands to be treated to promote the development of late-successional forest characteristics through the commercial sale of timber? *See Appendix 9*

- What should be the order of priority for plantations to be treated to promote the development of late-successional forest characteristics through agency-funded projects? *See Appendix 9*

- What stands are currently demonstrating characteristics common to late-successional forests and could contribute to the distribution of older-forest habitats across the landscape if protected? *See pages: 80*

- What range of silvicultural prescriptions appears warranted to assist in meeting goals and objectives of the AMA and what order of priority should be given to these options? *See page 168 and Appendix 9*

- Which forest stands are most suitable to meet the directive to maintain 15% of federal lands in late-successional condition? *See pages:80 and Appendix 9*

- What adaptive or forest management questions can be addressed in this area? *See Appendix 9*

2.3 Social

2.3.1 Issues related to human uses

Important economic and recreational activities take place in the watershed. These activities make demands upon watershed resources and provide potential conflicts with other watershed interests.

BLM lands are typically in small parcels scattered through the western portion of the watershed. Potential conflicts exist between BLM activities and the activities of other rural landowner/ users.

Dumping takes place on unoccupied forest lands.

Core topic

What are the major human uses and where do they occur in the watershed? What demands are changing land uses placing upon the watershed? *See pages: 23, 95, 138*

Key questions

- Is there a conflict between the public and BLM management practices, and what can be done to prevent possible conflicting situations? *See pages: 96, 139, 170*

- What are current recreational opportunities in the watershed? What demands do they place on resources? Can these demands be reduced? Are there opportunities to encourage low-demand activities? *See pages: 98, 162, 170*

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2.3.2 Road-related issues

Roads can contribute to hydrologic change, erosion, and mass wasting. Road-related ditches tend to concentrate flow, facilitating ditch erosion and transport of eroded sediments from the road. In certain cases, roads may contribute to excessive sediment delivery to streams, affecting fish habitat.

Stream crossings usually necessitate placement of culverts or bridges. Poorly placed culverts can alter channel morphology, increase stream density, and impede fish passage. Undersized culverts can wash out during flooding events. Poorly constructed bridges can negatively alter stream hydrology and cause sediment and erosion.

Hazards are not limited to currently maintained roads, but also extend to "legacy roads". These compacted surfaces, railroad grades, and associated culverts, can impede fish passage and disrupt hydrologic and sediment regimes.

Restricted access to certain BLM lands may limit management opportunities. In many cases, physical constraints have prevented road construction. In other cases, existing roads have been closed by slope failures. For these roads, the road may need to be obliterated and another route determined. There may be areas where alternative means of access other than roads should be used.

Key questions

- Where are high risk areas for slope failures due to roads? What resources are potentially at risk as a result of road failures within these areas? What criteria should be used to determine the feasibility of road closures? *See pages: 100, 140, 163, 164*

- What is the overall road density, and the density in each subwatershed, for BLM roads and roads of other ownership? To what degree do legacy roads contribute to the watershed's road density? *See pages: 100, 102*

- How many stream crossings, bridges, and culverts are in the watershed? Which of these structures impede fish passage? *See pages: 101, 102*

- What is the size and condition of existing culverts? Are they likely to withstand a 100 year flood event? *See pages: 101*

- Where are rock pits and other sediment sources located? What measures should be taken to mitigate for impacts of these sites? What funding sources are available for mitigation? *See pages: 97, 140*

- [BLM only] Which BLM-administered parcels lack road access? What factors limit access to these lands? *See pages: 101 and Appendix 9*

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Chapter 3: Current Conditions

3.1 Aquatic

3.1.1 Erosion processes

3.1.1.1 Overview of erosion and sedimentation processes

There are several major subdivisions of the Upper Tualatin-Scoggins watershed in terms of erosion and sedimentation processes. The main body of the Coast Range falls within the Volcanics ecoregion, while the Wapato, Patton, and Scoggins valleys fall within the Prairie Terraces ecoregion. Between the two is a transitional region, termed the Valley Foothills, which also includes the Chehalem Mountains to the east.

Steep terrain, deeply incised canyons, and high gradient streams characterize much of the Coast Range portion of the watershed. The underlying lithology is responsible for the rugged nature of the terrain[16]. The upper portions of the Tualatin River, Scoggins Creek and their tributaries are underlain by volcanic formations of Tertiary age, which typically consist of erosion-resistant basalt flows and breccias, interbedded with less resistant tuffs. Very resistant igneous intrusive rocks dominate the highest elevations. Together these igneous formations comprise 46% of total watershed area. However, much of the upper Lee Creek subwatershed is underlain by the erodible sedimentary Yamhill formation. Both slopes and stream gradients are typically less steep in these areas of sedimentary lithology than in the volcanic regions. Although rates of weathering vary, both the sedimentary and volcanic formations tend to degrade into fine-grained particles. Erosion in the Coast Range is typically dominated by mass wasting processes, including shallow landslides, slumps and mudflows. Under certain conditions, surface erosion can also be important. Highly weathered soils in these mountainous areas typically have relatively high silt content with few coarse fragments, making them particularly vulnerable to erosion. Under natural conditions, the extensive forest cover protects surface soils from erosion. However, where large areas of mineral soil have been stripped of vegetation, surface erosion can be significant, especially on long, continuous, steep slopes.

The fine-grained particles produced from erosion in the incised middle to upper-middle portions of the mountains are often delivered to streams. This is an especially important process in first and second-order reaches, where steep canyon walls often expedite the delivery of eroded material to the streams.

The geology of the watersheds has a strong influence on the amount and size of stream channel gravel deposits. Streams draining soft sedimentary rock tend to have less gravel and a higher proportion of fine sediments in stream channels than those drained from more resistant rock. This occurs because sedimentary formations tend to break down relatively quickly into fine-textured particles.

[16]These are generalizations and should be used with care. The surficial geology of an area is commonly much more complex than shown on general geology maps.

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In the Coast Range foothills and Chehalem Mountains, slumping processes become more important relative to shallow landsliding, as these sites are underlain by interbedded sedimentary formations. In the Chehalem Mountains, resistant layers of Columbia River basalt overlie these formations. This basalt layer is capped by thick layers of silty soils. The interbedded nature, differing strengths, and steep slopes in this region makes the Chehalem Mountains susceptible to slumping and to shallow landsliding. This landsliding is especially common along the contacts between different rock types.

In the valleys, slopes are generally low. Where soils are exposed to rainfall energy, they are readily detached. However, the ability to transport eroded soils to stream systems is limited by the low gradient of the valley floor. Where erosion takes place far from stream channels and roadside ditches, eroded soils are usually deposited prior to delivery to the streams. Localized erosion and delivery to streams occurs on both terraces and streambanks.

3.1.1.2 Mass wasting

Mass wasting (landsliding and related processes) provides substantial sediment inputs to the stream system. In many cases, slides are confined to small, shallow, debris slides from canyon walls into first and second order streams. Most landslides on steep, forested, slopes in Western Oregon are of this type (Dent et al. 1997). However, large, rotational slumps are also important within the watershed, particularly in the foothill portion of the watershed. There are several indicators for determining risk of mass wasting.

The greatest single indicator of susceptibility to shallow debris slides is slope. The vast majority of landslides occur on slopes of greater than 70%. Due to map generalization, such slopes are commonly found in areas expressed as 60% slope or greater on a USGS 7.5-minute quad. These areas can be considered to have high landslide susceptibility. Areas with slopes ranging from 30% to 60% are considered to have moderate landslide susceptibility, while mass wasting potential is low where slope does not exceed 30%. (Dave Michael, ODF, Personal communication).

Topographic maps and GIS layers are often useful for performing a preliminary screening of risk of slope failure. However, it should be noted that decisions should not be made using these tools alone. Due to generalization, maps are typically insensitive to local changes in topography. GIS slope layers often share this insensitivity, and in many cases have errors in the source data. The results of this slope analysis are to be taken as general indicators of landslide susceptibility and are not to be used for site-specific assessments.

Map 3-1 shows areas in the watershed falling into the various slope classes. Slopes exceeding 30% are common throughout the Coast Range. About 28% of slopes in the Upper Tualatin-Scoggins watershed are in excess of 30%. Of this total, about five percent of the watershed exceeds the 60% slope criterion. Most of these steep slopes are found along the inner gorges of the western portion of the watershed, including the Upper Tualatin-Maple Creek, Sunday Creek, Roaring Creek, Tanner Creek, and Upper Scoggins Creek subwatersheds.

Lithology also has a role in determining mass wasting susceptibility. The sedimentary formations are quite weak and susceptible to slumping. Although unweathered volcanic formations are relatively strong, they form steep gradients that render them susceptible to shallow sliding. Landslide hazards are particularly high at the contacts between volcanic and sedimentary formations. Slumping is especially common in the foothills region surrounding Patton and Scoggins Valleys, and the Chehalem Mountains (Schlicker 1967).

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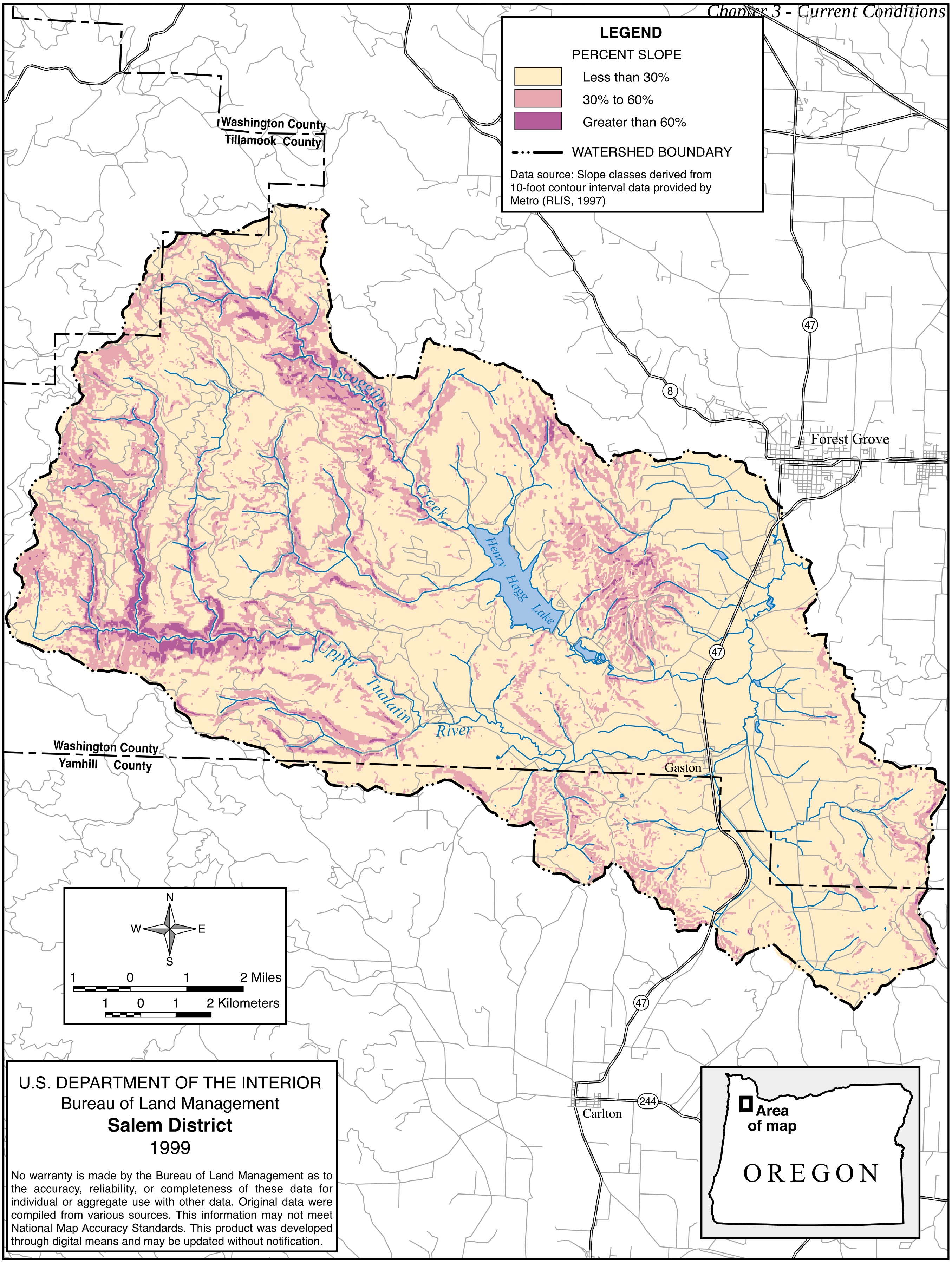

Map 3-1 -- Slope Classes of the Upper Tualatin-Scoggins Creek Watershed.

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Although landslide inventories in the watershed have been inconsistently performed, existing efforts express the susceptibility of certain subwatersheds to landsliding (Table 3-1). The Roaring Creek subwatershed appears especially unstable, with a large proportion of subwatershed area having experienced sliding during the Quaternary period. Spot field observations have confirmed this instability. Sliding, and particularly road-related sliding is common in this subwatershed. The instability of the Roaring Creek subwatershed is particularly significant from a BLM management perspective, as much of the landslide area lies on BLM land. Although most of the landslide area is not currently active, poor management techniques could destabilize these areas.

Sizeable areas of historically and currently active landslides are also found in the subwatersheds contributing to Henry Hagg Lake. This is notable because landslide events that deliver sediment to subwatershed streams eventually contribute to lake sedimentation, thus decreasing the useful life of the reservoir. Concern over potential sedimentation led the United States Bureau of Reclamation (BOR) to review the causes and progress of several landslides in these subwatersheds. In the course of their study, they found that management activities likely contributed to accelerated landsliding in certain cases. However, the degree of human contribution to these events was difficult to ascertain, as sliding also occurred in relatively unmanaged, heavily vegetated areas. It seems apparent, though, that care must be taken with timber harvest and road building activities to avoid hydrologic alteration, ground compaction, and destabilization and oversteepening of slopes.

Many landslides continue to be associated with roads. However, while examining Oregon sites of slides associated with the 1996 flood, Dent et al. (1997) found that the proportion of road-related slides relative to other slides had decreased from numbers quoted in past reports. This decrease was attributed to improved road-building techniques.

3.1.1.3 Surface and streambank erosion

In the Upper Tualatin-Scoggins watershed, the underlying lithology strongly affects the erodibility of the soils. Although the degree of resistance varies, most lithologic units of the watershed are fine-grained, and weather to fine particles. Once this weathering has taken place, these particles are readily erodible. Potential production of fine particles can be expected to be especially high in the weak sedimentary formations of the Foothills ecoregion and the Lee Creek drainage.

Where adequate vegetative cover exists, surface erosion is a minor concern in mountainous portions of the Upper Tualatin-Scoggins watershed. However, where soil exposure and compaction occurs, surface erosion can make substantial contributions to soil loss and stream sedimentation. In these cases, slope, climate, lithology and soil erodibility affect the relative magnitude of surface erosion. The most significant human source of accelerated surface erosion is due to road building activities, although sheet, rill, and gully erosion can be important after a site is logged and before new growth provides adequate ground cover.

The valleys within the watershed are underlain by alluvium of Quaternary age. Erosion within such areas is through streambank, sheet, rill and gully processes.

Streambank erosion occurs throughout the watershed, but is most significant along higher order streams that are not confined by valley walls. Although streambank erosion occurs under natural conditions, the magnitude of erosion has been increased due to altered hydrology, channelization and destruction of riparian vegetation by grazing livestock and other human factors.

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Table 3-1. Documented landslides in the Upper Tualatin-Scoggins watershed.

Source: Wells et al 1994. Slides formed during the quaternary period. Most of these have stabilized.

Quad	Subwatershed	Legal	estimated Area (ac)	owner	comments
Roaring Cr	Upper Scoggins	T1N, R5W, S17, W1/2	52	Private	
Roaring Cr	Scoggins-Parsons	T1N, R5W, S25, SW, and S 30, NE	78	Private	Portion of landslide unmapped. Actual landslide area is substantially larger than indicated.
Roaring Cr	Upper Scoggins	T1N, R5W, S34 SE and S35, SW	140	TSF, Private	
Roaring Cr	Scoggins-Parsons	T1N, R5W, S35, E1/2	64	Private	
Roaring Cr	Scoggins-Parsons	T1N, R5W, S35, NE1/4, and S36, NW1/4	36	Private	
Turner Cr	Sain	T1S, R5W, S16, NE1/4	23	Private	
Turner Cr	Sain	T1S, R5W, S15, E1/2 and S14, SW1/4	95	BLM, Private	
Turner Cr	UT-Lee Falls	T1S, R5W, S21, SE1/4	45	Private	
Turner Cr	Roaring	T1S, R5W, S30, SE1/4, and S31, NE1/4, and S32, NW1/4	160	BLM, Private	Contains two mapped wetland areas
Turner Cr	Roaring	T1S, R5W, S28, SW1/4 and S33, NW1/4	11	BLM, Private	Wetlands upstream of landslide
Turner Cr	Roaring	T1s, R5W, S32, E1/2, and S33, NW1/4	68	BLM, Private	
Turner Cr	Roaring	T1S, R5W, S33, E1/2, and S34, W1/2	220	BLM, Private	
Turner Cr	Roaring	T1S, R5W, S35	20	Private	Apparently active

Source ODF (1995). Recent landslides in the Tillamook State Forest. Most are active.

Quad	Subwatershed	Legal	Area (ac)	owner	comments
Roaring Cr	Upper Scoggins	T1N, R5W, S28	27	TSF	
Roaring Cr	Upper Scoggins	T1N, R5W, S20	3	TSF	
Woods Point	Sunday	T1S, R6W, S2	43	TSF	
Woods Point	UT-Maple	T1S, R6W, S11	13	TSF	
Gobbler's Knob	UT-Maple	T1S, R6W, S23, SE1/4 and S24, SW1/4	15	TSF	

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Table 3-1. Documented landslides in the Upper Tualatin-Scoggins watershed.
Source BOR (1997-1999). Active landslides with potential impacts to Henry Hagg Lake.

Quad	Subwatershed	Legal	Area (ac)	owner	comments
Roaring Cr	Scoggins-Parsons	T1S, R5W, S1, SW1/4	***		Observed sediment delivery to stream; several small debris flows and slumps; appear to be harvest-related.
Roaring Cr	Scoggins-Parsons	T1S, R5W, S12	***		BOR slide 3. BOR attributed this and the other numbered slides surrounding Henry Hagg Lake to seasonal rises in groundwater. Roads and steep slopes also appear to contribute to these slides.
Roaring Cr	Scoggins-Parsons	T1S, R4W, S7, SW1/4	***		BOR slide 2. 40' head scarp
Roaring Cr	Scoggins Dam	T1S, R4W, S18, SW1/4	***		BOR slide 1.
Roaring Cr	Scoggins-Parsons	T1S, R4W, S7	***		BOR slide 4. Cited as an active hazard to the nearby road.
Roaring Cr	Scoggins Dam	T1S, R4W, S8	***		BOR slide 5
Roaring Cr	Scoggins Dam	T1S, R4W, S8	***		BOR slide 6
Tanner Cr	Scoggins-Parsons	T1S, R5W, S11, E1/2	***		Coon Cr Slide. Harvested in 1995.
Tanner Cr	Sain	T1S, R5W, S14, E1/2	***		Sain Cr Slide. Mature trees, vegetated, no apparent human cause for slide. However, nearby changes in land use may have altered hydrology.

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The Tualatin River has developed natural levees along the lower, sinuous portions of its course within the watershed. During flooding events, sediment is deposited, resulting in increased elevation of streambanks. In many places, during peak flow, the stream water is higher in elevation than the surrounding floodplain. These streams often overtop the bank and flow into the floodplain. Where this occurs, the hydraulic energy of the floodwaters erodes the streambank and portions of the nearby floodplain. Such erosion is a part of the natural stream meandering process. This process is restricted, however, by landowners who repair the breaches in the streambank, by bridges (which form hard barriers containing the channel), and by streambank protection projects. The result is that a system of artificial, resistant, levees has developed along many reaches of streams.

Sheet, rill, and gully erosion in the lower foothills and valleys of the watershed, however, probably pose more important threats to water quality and agriculture than does streambank erosion. While streambank erosion occurs throughout the soil profile, the topsoil layers eroded through sheet, rill, and gully processes are the most likely to be enriched with nutrients and pollutants. Although no estimates have been made of relative amounts, sheet, rill, and gully erosion processes are more likely than streambank erosion to carry nutrients, bacteria, organic matter, and pesticides into the stream. Also, topsoil losses due to sheet, rill, and gully erosion represent a more significant resource loss to agriculture than does soil loss from streambank erosion.

Soils classified as "Highly Erodible Land" by NRCS have steep slopes and are mostly located on hillsides that form a transition area between the mountainous areas and the valleys. Rolling lands in valley landscapes, however, are also prone to sheet, rill, and gully erosion. During field visits, substantial amounts of sheet, rill, and gully erosion were noted on steep agricultural lands adjacent to the valleys.

3.1.1.4 Human impacts on erosion processes and sediment production

There is considerable evidence that human activities have altered the erosional characteristics of the watershed. In general, these changes tend to accelerate erosion. However, specific efforts have been made to implement policies that reduce erosion. In the Coast Range, the greatest changes to erosion characteristics have been caused by forestry and road-building operations. In the valleys and adjacent foothills, agriculture has had the greatest influence upon erosion patterns.

Forestry practices affect the amount of soil eroded from hillslopes. Typically, slopes are steeper in forested regions, leading to increased erosion potential. Factors leading to increased erosion include reduced vegetation, road construction, soil disturbance due to skidding and other management activities. Inadequate vegetative buffers can contribute to increased sediment delivery to channels. Additionally, unsound road construction and forest practices on unstable soils can lead to accelerated mass wasting.

Historically, forestry practices accelerated mass-wasting and surface erosion. Two such practices included tractor-yarding, which disturbed the soil layer, and harvest of riparian zones, which reduced bank stability and increased sediment delivery to streams. Recent improvements in the Oregon Forest Practices Act and implementation of the Northwest Forest Plan (NFP) have helped to diminish the impact of forest activities upon erosion and stream sedimentation. Implementation of Best Management Practices that minimize soil compaction and disturbance to the duff layer, as well as implementation of riparian buffers have contributed to reduction of erosion and sedimentation. However, the effects of past practices, including stream aggradation, may still be in effect in downstream portions of the watershed.

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In the past, roads have been identified as a primary contributor to sedimentation from forested lands (Dent et al. 1997, Meehan 1991). Both roads related to timber harvest and other roads have had associated erosion and sedimentation problems. Further examination of the role of roads is given in section 3.3.2.

Increased water yield from forest harvest can lead to increased high flows, which in turn can contribute to increased streambank erosion where insufficient riparian vegetation exists to provide streambank protection (Wolf 1992). These increased high flows are usually of concern in areas subject to Rain-on-Snow (ROS) precipitation. Rainfall dominated areas, such as the Upper Tualatin-Scoggins watershed, typically do not incur massive changes in flood peaks due to timber harvest (Wolf 1992, Washington Forest Practices Board 1997).

Agriculture is potentially a major contributor to erosion and stream sedimentation. Agricultural practices that tend to promote surface erosion include activities that loosen the soil and reduce vegetative surface cover. Where such activities occur near an inadequately buffered stream channel, the risk of sediment delivery to the stream is increased. The situation is made worse when agricultural activities reduce the vegetative buffer in the riparian zone. In such cases, the potential for streambank erosion and sediment delivery to streams is increased. This mechanism seems to be responsible for much of the stream erosion in the Upper Tualatin-Scoggins watershed. In many valley locations, stream buffers are poorly vegetated. On the mainstem of the Tualatin River in Patton Valley, poorly buffered streams are associated with severe streambank erosion. Other examples of poorly buffered streams are prevalent throughout the valleys, and include Carpenter Creek, virtually all channelized stream reaches, and minor tributaries with source waters within the valleys.

In recent years, many agricultural operations have implemented practices that reduce erosion and sediment delivery to the Tualatin River and its tributaries. Partnerships with governmental conservation agencies have been instrumental in this process. For example, the Natural Resources Conservation Service (NRCS), Washington County Soil and Water Conservation District (SWCD), and the Farm Services Agency have worked with farmers to reduce erosion and improve water quality. Methods have included programs to share costs with farmers for implementation of erosion-reduction techniques, incentives to remove riparian lands from agricultural production, educational efforts, provision of technical assistance, implementation of conservation plans, and restoration projects. However, in the Upper Tualatin-Scoggins watershed, levels of landowner participation in these programs are lower than in other parts of the Tualatin basin.

3.1.1.5 Prohibited conditions

Under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan, certain conditions potentially resulting from landowner management activities were specifically prohibited (OAR 603-095). Such prohibited conditions include excessive sheet and rill erosion, excessive gully erosion, lack of ground cover in riparian areas, summer discharge of irrigation water to streams, and placement of wastes where they would be likely to enter streams. An effort is currently underway to evaluate the existence and extent of these prohibited conditions. (Also see section 5.1.4.6.) Recent surveys have detected a high incidence of prohibited conditions related to erosion and waste management in the Hill Creek subwatershed. As survey effort and access varies between subwatersheds, this should not be taken as a definitive proof that practices are different in this subwatershed than in others, but it may indicate that educational efforts would be well spent in the subwatershed.

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Landowners have the option of developing a Voluntary Water Quality Farm Plan in conjunction with the SWCD, delineating an approach to protect water quality on their land. If such a plan is not adopted and a prohibited condition occurs, the Oregon Department of Agriculture (ODA) can take enforcement actions.

3.1.2 Hydrology and water quantity

3.1.2.1 Hydrologic characteristics

The precipitation regime of the Upper Tualatin-Scoggins watershed is rainfall dominated. Snowfall is not a major source of precipitation, except at the highest elevations. Precipitation is seasonal, with most rain falling between November and March (Figure 1-1). Precipitation intensities in the Coast Range portion of the watershed are among the highest in the entire Tualatin Basin. Near Saddle Mountain the 2-year, 24-hour precipitation event in the watershed is approximately 5.7 inches. Precipitation intensity decreases eastward in the watershed, with an estimated minimum 2-year, 24-hour precipitation event of 2.4 inches (OCS 1997).

Due to the lack of storage as snow and groundwater, discharge is seasonal and largely follows the precipitation cycle. Flows are very high in winter and fall to very low levels between July and October. Although these summer flows get quite low, most streams within the watershed are perennial[17]. Only the smallest streams dry up in the summer.

A number of springs are present in the watershed. The most productive springs are located in the Chehalem Mountains at contacts between the Columbia River basalt and sedimentary formations (Schlicker 1967, Wilson 1997). Some of these springs produce in excess of 100 gallons per minute (gpm) (Hart and Newcomb 1965, OWRD 1998). For example, OWRD issued a water right of 448 gpm (1.0 cfs) for a spring in the Hill Creek watershed T2S, R3W, S4).

In the Upper Tualatin-Scoggins watershed, several gaging stations provide continuous monitoring and long-term discharge records. Two gages, located on the Tualatin River near Dilley and Scoggins Creek near Gaston, have been in continuous operation since 1941[18]. A third gage, located on the Tualatin River near Gaston, was operated by USGS periodically between 1941 and 1984. Subsequently, the Oregon Water Resources Department (OWRD) assumed operation of this gage. Intermittent summer monitoring occurs at several sites within the watershed, including a gage operated on the Tualatin River at Lee Falls. Two other gages on Scoggins and Sain creeks were operated for a four year period of the 1970s in connection with the Tualatin Project.

Figures 1-2 and 1-3 show average flow characteristics at the Tualatin River near Dilley and the Scoggins Creek gage sites between the 1941 and 1974 water years, the period prior to flow regulation by Scoggins Dam. During this period, 84% of discharge passing the Dilley gage occurred during the November to March rainy period. Mean monthly January discharge was 1081.1 cfs, while the mean August discharge was 15.5 cfs. The minimum recorded daily flow over this period was 0.1 cfs. The Scoggins Creek gage displayed proportionally similar seasonal flow characteristics.

Figures 3-1 and 3-2 display the changes in discharge at the two gage sites following flow regulation. Since 1977, the flow regime at the Scoggins Creek site has been radically

[17]This was determined by visual estimation of blue line streams mapped on USGS 1:24, 000 topographic maps.
[18]The site of the Scoggins Creek gage was moved 2.5 miles downstream in 1975. No major tributaries occur over the distance between the two gage sites, so discrepancies in flow between the two sites are likely to be minor.

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Figure 3-1. Scoggins Creek below Hagg Lake, Mean monthly discharge WY1977-1997 (Regulated flow vs natural mean monthly flow)

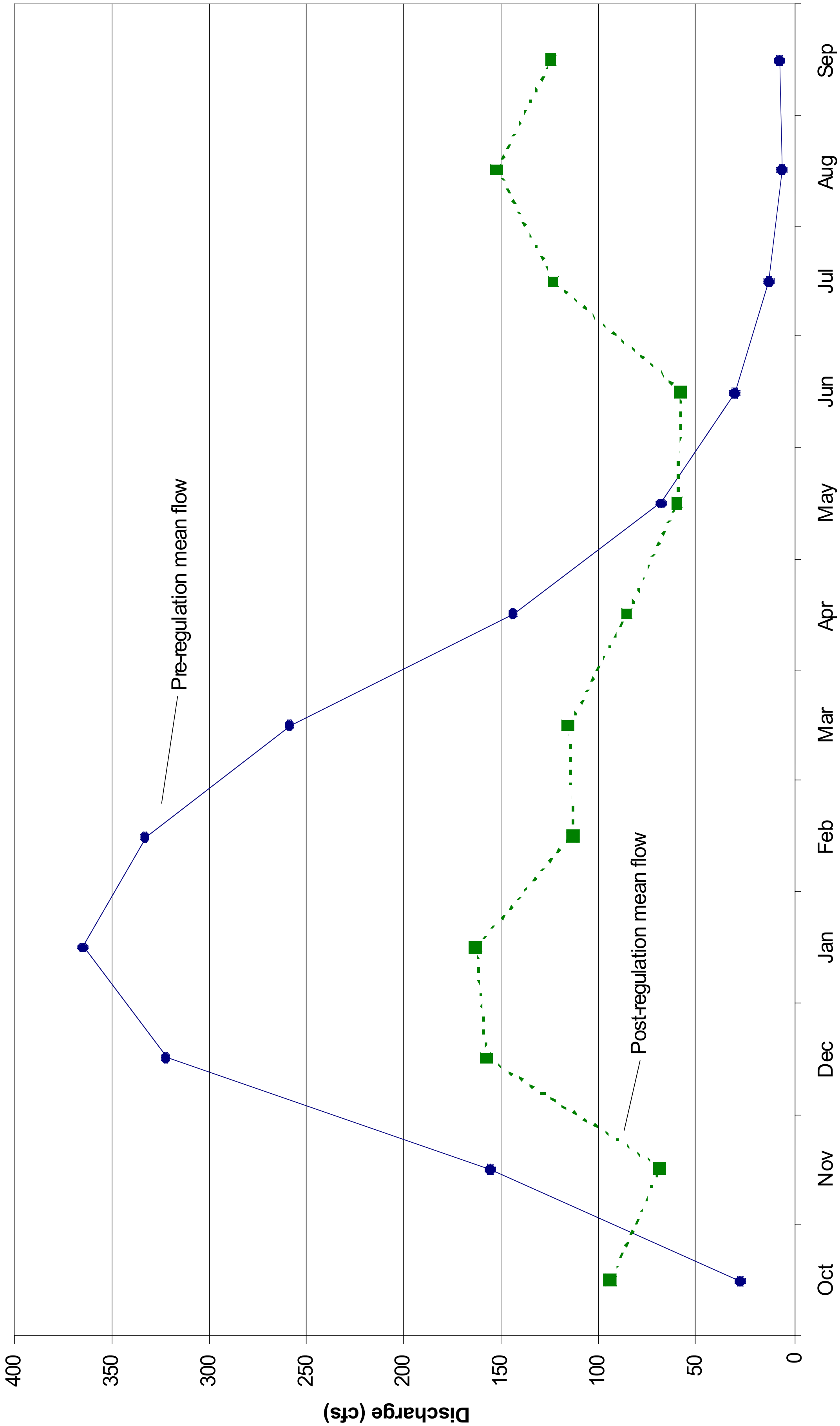

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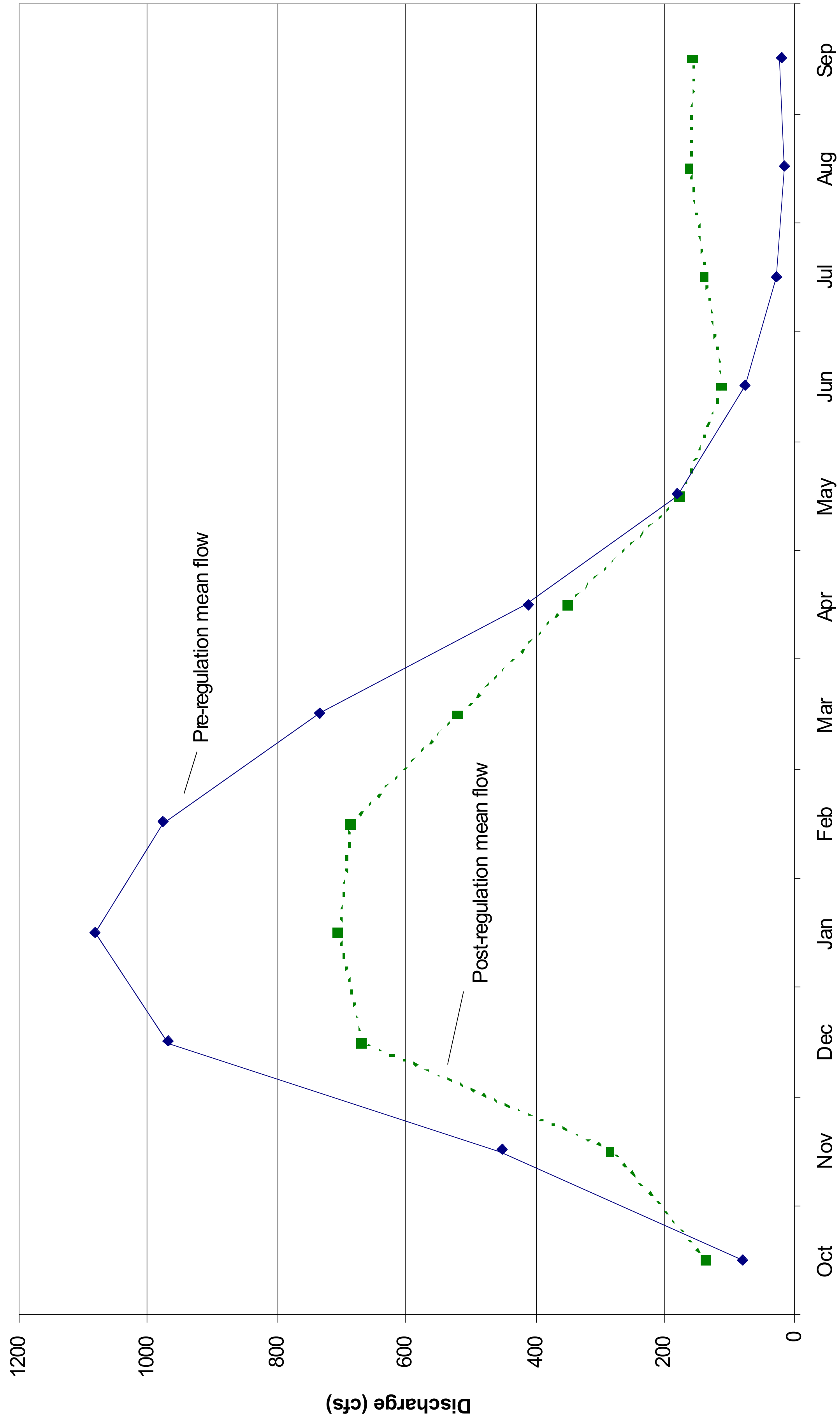
Figure 3-2. Tualatin River near Dilley, Mean monthly discharge WY1941-1997 (Regulated flow (1975-1997) vs natural mean monthly flow (1941-1974))



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altered. The natural winter peak has been greatly diminished, and is supplemented by a peak of nearly equal magnitude during the summer low-flow period. This latter peak represents the flow releases distributed to meet the irrigation and water quality needs of downstream users. At the Dilley site, the flow distribution patterns are similar to those occurring prior to regulation. The highest flows still occur during winter. However, these peak flows have been muted. Mean January discharge is 703.8 cfs, while mean August discharge has been augmented to 161.2 cfs. The proportion of flow passing Dilley during the November to March rainy season has been reduced to 70% by flow regulation.

Athough Scoggins and Sain creeks lack long-term flow measurements, the Oregon Water Resources Department (OWRD) has modeled flows for these creeks. The modeled monthly 50% and 80% exceedance streamflows are given in Appendix 2. Based on this model, Scoggins Creek above Henry Hagg Lake has a median monthly August low flow of 2.6 cfs. In contrast, the highest flows occur in February, with a monthly median flow of 122.0 cfs. The corresponding flows for Sain Creek at its mouth are 1.2 and 66.2 cfs, respectively.

3.1.2.2 Water quantity and water rights

Lack of summer streamflow is an important concern in the Tualatin subbasin. In summer, the flows naturally are quite low. Diversion during these natural low flow periods can create conditions where beneficial uses are not met. Additionally, natural drought cycles lead to a decreased natural pool of available water. Decreased stream volume can have adverse impacts, both to instream life and to human uses. These impacts include higher water temperature, decreased residual pool depth, decreased dissolved oxygen concentrations, and other detrimental impacts to aquatic life. Inadequate streamflow also leads to decreased availability for human uses, and can lead to aesthetically unpleasant water. In the Upper Tualatin-Scoggins watershed, concerns of water quantity take two forms. First, on the reaches downstream of Henry Hagg Lake, these concerns center around export and provision of adequate water for irrigation and water quality concerns in the lower Tualatin River subbasin. Secondly, on the less-regulated reaches of the Tualatin River upstream of Scoggins Creek, as well as tributary streams, the major concern is the local lack of summer water. To a certain degree, this problem has been alleviated by water pumped from the Patton Valley pumping plant to the Tualatin River near Gaston. Nevertheless, based on the 80% exceedance flow, the OWRD has determined that water rights are overallocated in several parts of the watershed (Table 3-2). In the Water Availability Basin[19] comprising the Tualatin River upstream of Farmington, OWRD has restricted new water rights allocations for direct diversion between May and November. Water is even less available for direct diversion in Scoggins, Sain and Tanner creeks. In Tanner Creek in particular, no water rights are available throughout the year. Existing diversions in these creeks, however, is quite low, and the lack of available water in these Water Availability Basins is the result of natural flows insufficient to meet instream water rights.

Table 3-3 shows the magnitude, by subwatershed of permitted water rights for direct diversion from streams within the Upper Tualatin-Scoggins watershed. The heaviest diversions from streams occurs in the eastern portion of the watershed. The largest

[19]OWRD subdivides stream systems into **Water availability Basins** (WABs) specifically for the purpose of determining the availability of water rights. Application for water rights are evaluated relative to water availability within the WAB in which the prospective water right will occur.

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Table 3-2. Water availability summary for sites in or near the Upper Tualatin-Scoggins Watershed. Based on OWRD WARS database.

	Monthly Net Water Available (cfs)											
Water Availability Basin	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tualatin R. at Farmington	952	1190	953	502	171	-22.3	-146	-167	-116	-41.9	49.3	664
Scoggins Cr at mouth	80	-1.3	63	20.9	4.7	-18.3	-34.2	-35.5	-29.1	-20.3	-3.6	72.7
Sain Cr at gage 14202920	4.5	13.8	7	-6.8	-15.9	-3.4	-0.6	-1.6	-1.7	-0.4	-19	-3.3
Tanner Cr at mouth	-2.48	-0.53	-2.23	-4.84	-6.76	1.48	1.31	0.12	-0.31	0.46	-7.66	-3.85
Tualatin R. at Mercer Cr	73	112	80	30.9	-21.2	-0.1	-13.8	-9.38	-10.2	-0.27	-26.3	71

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Table 3-3. Total surface water rights by subwatershed.

Subwatershed	# of rights	diversion cfs	Hagg Lake*	Total allocated cfs.
Ayers Creek	9	0.96		0.96
Carpenter Creek	21	6.07		6.07
Goodin Creek	1	0.20		0.20
Harris Creek	9	1.63		1.63
Hill Creek	12	2.42		2.42
Mercer Creek	4	0.23		0.23
Sain Creek	1	0.05		0.05
Scoggins Dam	15	6.42	4.26	10.68
Scoggins-Parsons	5	10.67		10.67
Tanner Creek	3	0.17		0.17
Tualatin-Blackjack	26	16.65	8.37	25.02
Tualatin-Dilley	28	10.79	24.48	35.27
Tualatin-Hering	10	2.16		2.16
Tualatin-Lee Falls	1	9.00		9.00
Upper Wapato Creek	1	0.10		0.10
Wapato Creek	5	2.54	10.49	13.03

Source: Analysis of OWRD water rights information contained on Tualatin River Watershed Information System.

*The 228 cfs water right at Hagg Lake is apportioned between subwatersheds within the UT-S watershed, and outlying watersheds, based on TVID irrigated acres.

There are no water rights within the Tualatin Headwaters, Sunday Creek, Lee Creek, Roaring Creek, and Upper Scoggins subwatersheds.

single permitted water right for diversion is 222.8 cfs for Henry Hagg Lake. However, most of this water is exported from the Upper Tualatin-Scoggins watershed. If the analysis is restricted to water used within the Upper Tualatin-Scoggins watershed, then diversions total 117.6 cfs[20]. Based on this standard, the agricultural subwatersheds of Wapato Creek, Tualatin-Blackjack Creek, and Tualatin-Dilley Creek accounted for 61% of permitted potential diversion.

Irrigation is the largest single water use within the watershed (Table 3-4). Of 117.6 cfs in permitted instream diversions, 96.1 cfs, or 82%, was allocated to agricultural needs. Given that the majority of these rights are effective during the summer low-flow season, this indicates a potential over-allocation of available water. However, customers of the Tualatin Valley Irrigation District (TVID) use water stored in Henry Hagg Lake, which helps to alleviate demands on direct streamflow during these peak use periods.

Agricultural water rights usually have a maximum cumulative annual withdrawal of 2.5 acre-feet per acre of irrigated land. However, this maximum is not typically fully utilized. In 1987, annual irrigation demand from the Washington County Water Resources Management Plan was estimated at 27,532 acre-feet distributed over 25,491 acres, or 1.08 acre-feet per acre (that is, a mean depth of 13 inches). A more recent study indicates that TVID provided 0.9 acre-feet of water for every acre that it serviced (WMG 1998).

[20]For this analysis, water Henry Hagg Lake was allocated based on the number of TVID-irrigated acres in the watershed divided by the total number of TVID-irrigated acres in the Tualatin Basin. Based on this methodology, 47.6 cfs of water diverted to Henry Hagg Lake was allocated to the watershed.

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In 1956, about 18 inches (1.5 acre-feet / acre) of irrigation water per growing season was considered necessary for optimal growth (Hart and Newcomb 1965). However, only about two-thirds of this total was available at the time, resulting in suboptimal irrigation for growth. Based on current irrigation figures, it appears that actual water use per acre of land has not changed appreciably since the 1950s. However, it is likely that modern farms are deriving more productivity per acre-foot of water. Some additional benefit could be attained by implementing Best Management Practices designed for water conservation.

Under Oregon law, conflicts over water rights are resolved under the doctrine of prior appropriation (OWRD 1997). In effect, water rights obtained first have first priority to available water. For this purpose, each water right permit is assigned a priority date, which is usually the date of the application for the permit. Water rights with earlier dates, thus higher priority, are termed "senior water rights".

On the Tualatin River and several tributary streams, water rights have also been assigned for instream uses. These rights are granted to promote sustenance of fish and wildlife. A list of minimum instream water rights is given in Table 3-5. The largest instream water right occurs on the Tualatin River mainstem. Downstream of Mercer Creek, an instream water right of 100 cfs is applicable throughout the year. Above Mercer Creek, the applicable flows are 65 cfs between November 16 and May 30, and 10 cfs between July 16 and November 15. The water rights during the November to May period allocate additional water for spawning and migration of salmon and steelhead trout. Instream water rights are also regulated for Sain Creek and Tanner Creek.

Table 3-4. Total surface water rights by type of use.

USE		number of water rights	Average (cfs)	Cumulative (cfs)	% of total
AG	Agriculture	3	0.107	0.3200	0.27%
AS	Aesthetic	1	0.010	0.0100	0.01%
DI	Domestic	4	0.088	0.0350	0.03%
DN	Domestic	1	0.010	0.0100	0.01%
DO	Domestic	11	0.016	0.1750	0.15%
DS	Domestic/stock	1	0.010	0.0100	0.01%
FI	Fish	3	0.033	0.1000	0.09%
FP	Fire protection	1	0.005	0.0050	0.00%
I*	Irrig.,domestic,stock	1	0.050	0.0500	0.04%
ID	Irrigation and Domestic	4	0.085	0.3400	0.29%
IM	Manufacturing	2	0.310	0.6200	0.53%
IR	Irrigation	108	0.450	95.7260	81.37%
LV	Livestock	6	0.066	0.3930	0.33%
MU	Municipal	1	9.000	9.0000	7.65%
NU	Nursery Use	1	0.050	0.0500	0.04%
NV	Nursery Use	1	0.670	0.6700	0.57%
PW	Power	1	10.000	10.0000	8.50%
RC	Recreation	1	0.030	0.0300	0.03%
WI	Wildlife	1	0.100	0.1000	0.09%
	Total	152		117.6440	100.00%

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Table 3-5. Minimum perennial streamflows (cfs) as regulated by instream water rights in the Upper Tualatin-Scoggins watershed. Priority for all water rights is May 25,1966, except for Scoggins Creek and Tualatin River RM 58.8-68.5 (August 5, 1993).

Stream Name	Above	OCT	NOV 1-15	NOV 16-30	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL 1-15	JUL 16-30	AUG	SEP
Tualatin R	RM 68.5	10	10	65	65	65	65	65	65	65	20	20	10	10	10
Tualatin R	RM 58.8*	25	30	30	20	30	30	30	30	30	30	21.9	21.9	17.4	17.2
Sain Cr	Mouth	2	2	25	25	25	25	25	25	25	8	2	2	2	2
Tanner Cr	Mouth			9	9	9	9	9	9	9				1	1
Scoggins Cr	Mouth	25	25	25	25	25	25	25	25	25	25	25	25	25	25

*Although the instream water rights between RM 58.8 and RM 68.5 are as indicated, they are not regulated separately from the rest of their Water Availability Basin (WAB). Regulatory determinations for the WAB containing this reach are measured at Farmington (RM 34), where minimum instream flows of 100 cfs are applicable for each month.

Source: OWRD WARS and WRIS databases

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Although these instream water rights are designed to benefit aquatic resources, their effectiveness is limited by their relatively junior priority dates. The priority date for the Tualatin River, Sain Creek, and Tanner Creek is May 25, 1966, while instream rights for Scoggins Creek is August 5, 1993. Water rights holders with priority dates earlier than this date would have priority over these instream rights. This is not a problem on Sain and Tanner creeks, as consumptive uses do not constitute a substantial proportion of streamflow. Because of the large number of senior rights on the Tualatin River and Scoggins Creek, on the other hand, instream water rights on these streams frequently lose regulatory protection from OWRD. In 1998 and 1999, relatively wet water years, instream water rights in the Upper Tualatin-Scoggins watershed were ineffective after June 18 and June 14, respectively. Many of the more recent water rights permits restrict withdrawals between November and March, with the purpose of ensuring adequate water remains instream for salmonids.

Through its instream leasing program, OWRD offers incentives for water rights holders to lease their rights for instream uses. This program is particularly useful for rights holders who are temporarily do not expect to use their full allocation of water. The holder’s water rights are protected throughout the period of the lease. Minimum lease period is two years.

Between 1997 and 2050, municipal and domestic water needs in Washington County are expected to grow by 94%, with an anticipated increase in “peak day demand” of 131%. In 2050, peak daily demand was expected to exceed the present capacity of Washington County to provide water for these needs (WMG 1998). An earlier study indicated that this capacity could be exceeded by 2010 (WAMCO 1989).

3.1.2.3 Flooding

Flooding is another important concern within the watershed. Although flooding is a natural part of a stream’s hydrologic regime, it potentially conflicts with extensive agricultural development within the floodplain. Flooding is largely a function of watershed topography. Much of the eastern portion of the watershed is underlain by poorly-drained alluvial silts and clays. The largest area of poorly drained soils is located in the historical Wapato Lake Bed and nearby areas in the Wapato Valley. These include areas in the Wapato Creek, Hill Creek, Ayers Creek, and Upper Tualatin-Black Jack Creek subwatersheds. Additionally, a substantial area of poorly drained soils is located in the Carpenter Creek subwatershed[21]. Altogether, these soils cover eight square miles, roughly 6% of total watershed area.

Extensive portions of the watershed lie within the 100-year floodplain (Map 3-2). In the Wapato Valley, the vast majority of the area within the 100-year floodplain is frequently inundated by smaller flooding events, indicating that major flooding may have impacts similar to those of the frequent events. In general, land use in the Wapato Valley is conducted to accommodate frequent flooding events, a fact that would mitigate against impacts from major flooding. Impacts might be greater in the Patton Valley and other areas where flooding is infrequent. In the 1996 flood event, the Wapato Valley was inundated, as was the Tualatin River to a point upstream of Black Jack Creek. The area flooded by the 1996 event was much smaller than the delineated “100-year” floodplain.

Retention of floodwaters in the Wapato Valley and other historical floodplain sites helps to moderate flood peaks downstream on the Tualatin River. Stream channelization and

[21]Poorly drained soils were determined by GIS analysis of the soils lwyer from the Tualatin River Watershed Information System, supplemented by attribute information from NRCS soils surveys (NRCS 1974 and NRCS 1982). Poorly drained soils were defined as those classified in hydrologic group D.

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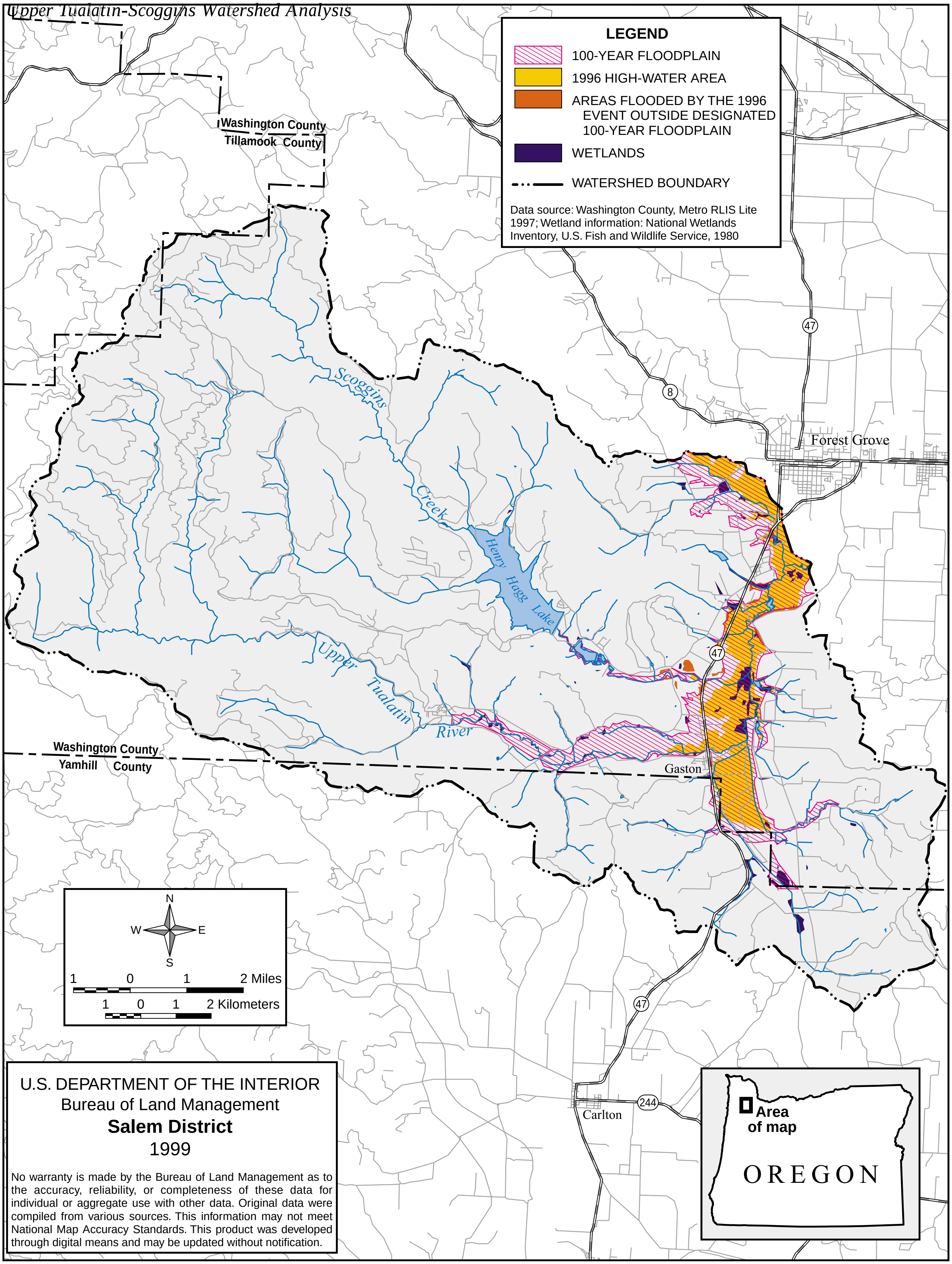

Map 3-2 -- Flood Plains and Wetlands of the Upper Tualatin-Scoggins Creek Watershed.

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drainage projects have reduced the amount of time that water is detained at these floodplain sites. Nevertheless, floodplain storage continues to contribute to flow moderation.

Construction of Scoggins Dam has also helped to moderate downstream flooding. The dam has 20,300 acre-feet of reservoir space allocated to flood control (BOR 1972). This amount is considered adequate to regulate the 50-year flood occurring on Scoggins Creek.

3.1.2.4 Groundwater

Groundwater supplies appear to be more limited in the Upper Tualatin-Scoggins watershed than in most other portions of the Tualatin Valley. The Columbia River basalt, which is the most productive aquifer in the Tualatin Valley, does not extend to the Wapato Valley. Instead, unconfined aquifers in the alluvium of the Wapato Valley provide an important source of groundwater. Volcanic and sedimentary formations in the watershed typically produce low yields of water, and are not considered good aquifers (Hart and Newcomb 1965, Schlicker 1967).

Seasonally high recharge can lead to circumstances where the water table rises to the surface, particularly in December and January. At these times, seasonal wetlands become flooded. Wetlands of this type are found in the Wapato Valley. Much of the valley is underlain by soils of low permeability,which contributes to wetland flooding.

3.1.2.5 Human impacts on hydrology

The natural flow regime has been altered through several human caused influences. These include:

1. Channelization. Many tributary streams in lower portions of the watershed have undergone artificial drainage and extensive channelization for drainage and flood control. The most notable examples are in the eastern part of the watershed, where the Wapato canal and other canals cut through former wetlands. The greatest amount of drainage control has been effected in the Wapato Creek subwatershed (Table 3-6). Although drainage densities in the watershed as a whole average 2.33 miles per square mile of land area, artificial drainage in the Wapato Creek subwatershed has resulted in a drainage density of 4.37 miles/mi^2. Additionally, naturally existing streams have been channelized. As a conservative estimate, 19 miles of stream have been channelized[22]. The Carpenter Creek subwatershed, with 5.8 miles of channelized stream, has been the most heavily impacted. Potential effects of channelization include hydrologic separation of the stream from its floodplain, reduced water detention, and increased downstream flooding. Stream cleaning and straightening associated with channelization reduce resistance to flow and locally increase the stream gradient, resulting in increased velocity and erosion. Additionally, channel straightening tends to destroy riparian vegetation, and reduces the length and diversity of instream and riparian habitats.

2. Diversions. As discussed earlier in this section, water diversions are distributed throughout the valleys. Impacts of these diversions include reduced streamflow, which in turn leads to increased summer water temperatures and decreased

[22]Derived from analysis of GIS 1:24,000 streams layer. Includes current mileage of streams that have been obviously strained, along with canals that may not have been part of the original stream system. Does not include less visibly straightened streams, nor channel clearing unaccompanied by straightening operations.

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Table 3-6. Stream drainage characteristics of subwatersheds of the Upper Tualatin-Scoggins watershed. (Based on GIS analysis using Tualatin River Watershed Information Syster

Subwatershed	Total Area (miles^2)	Total Stream Length (miles)	Drainage Density (mi/mi^2)	Length Channelized (mi)
Ayers Creek	5.87	11.07	1.89	0.34
Carpenter Creek	6.12	14.24	2.33	5.83
Goodin Creek	3.39	9.11	2.69	0.35
Harris Creek	4.28	8.81	2.06	2.27
Hering Creek	6.32	11.83	1.87	0.00
Hill Creek	6.41	14.18	2.21	0.82
Lee Creek	8.69	22.27	2.56	0.00
Mercer Creek	3.37	5.92	1.76	0.00
Roaring Creek	5.74	9.69	1.69	0.00
Sain Creek	11.40	25.43	2.23	0.00
Scoggins Dam	10.10	23.19	2.30	1.08
Scoggins-Parsons Creek	8.16	14.47	1.77	0.00
Sunday Creek	8.02	24.93	3.11	0.00
Tanner Creek	3.83	7.65	2.00	0.00
Tualatin Headwaters	7.08	20.36	2.88	0.00
Tualatin-Black Jack Creek	5.36	14.42	2.69	1.50
Tualatin-Dilley Creek	7.12	14.23	2.00	0.44
Tualatin-Lee Falls	7.00	16.56	2.37	0.00
Upper Scoggins Creek	11.60	22.29	1.92	0.00
Upper Wapato Creek	2.24	5.16	2.30	0.06
Wapato Creek*	3.56	15.55	4.37	15.55

*Wapato Creek subwatershed is drained by approximately 5.87 miles of channelized str and 9.68 miles of artificial canals.

instream habitat for aquatic life. Where these diversions are unscreened, they also pose a hazard to fish populations by diverting them onto agricultural fields. A notable diversion is located at the Patton Valley Pumping plant. A fish screen has been constructed to keep fish from entering into the pump. This screen is currently being upgraded to better accomplish this function.

3. Vegetation changes. Removal of vegetation and large wood from channels reduces resistance to flow, thus increasing the velocity of stream discharge. Although this has the potential benefit of reducing local flooding, it increases the prospect of downstream flooding, reduces the quality and diversity of available riparian and aquatic habitat, and increases erosion.

4. Flow regulation. The Tualatin River project, including Scoggins Dam, has altered flows in the watershed. Most notably, summer flows have been augmented, and winter flows diminished, in affected portions of the watershed. Subwatersheds most affected by this altered flow regime include Scoggins Dam and Upper Tualatin-Dilley Creek. Additionally, 60 miles of the Tualatin River downstream of the Upper Tualatin-Scoggins watershed have been affected by the altered flow regime. Although many of these changes are positive for water quality and human interests, care must be taken not to create negative impacts to aquatic life and other beneficial uses. Other subwatersheds, including Tualatin-Black Jack Creek and

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Wapato Creek, have received minor changes in flow due to the Tualatin River project.

The Trask River diversion has augmented summer flows in the mainstem Tualatin River at RM 78.0. Water from Barney Reservoir, via the Trask River diversion, is introduced into the Tualatin River at this point. This reservoir has recently been expanded to 20,000 acre feet, and provides water for municipal and water quality uses. The City of Hillsboro removes a portion of this augmented flow at the Cherry Grove Intake (RM 73.3). The remainder is passed downstream for water quality purposes. In the summer of 1998, 30 cfs of water from Barney Reservoir was allocated for water quality purposes (TRFMTC 1998, TRFMTC 1999).

4. Drainage. Agricultural areas in valley landscapes throughout the watershed have largely been drained by surface and subsurface (“tile”) drains. This has increased peak winter flows and decreased summer flows in the Tualatin River and its tributaries. This flow alteration can lead to increased streambank erosion and channel sedimentation, resulting in decreased habitat diversity, quantity, and quality for aquatic life.

5. Decreased infiltration rates. Extensive land use changes have taken place in the eastern portion of the watershed, resulting in decreased vegetative cover, decreased soil organic matter and increased area covered by impervious surfaces such as pavement and rooftops. These factors all increase peak runoff rates and may decrease low flow rates in the summer.

3.1.3 Stream channel

3.1.3.1 Stream morphology and sediment transport processes

Major streams in the watershed were channel typed according to size, gradient, and confinement characteristics (Map 3-3)[23]. In order to characterize the channel structure within the watershed, a channel typing methodology patterned after the Oregon Watershed Enhancement Board[24] (OWEB) approach was employed (WPN 1999; see Appendix 4). This approach offered the advantage that the assessment could be performed rapidly using topographic maps, as contrasted with other methods that require more intensive field work. Office-based channel typing using the OWEB methodology is useful for rapid stratification of watershed stream reaches for characterization and preliminary planning. However, field study should precede any site-specific project planning.

Limited ground-truthing was performed, and reports analyzed, to determine the character of channels within the watershed. The analysis revealed recurring stream characteristics.

First and second order headwater streams in the watershed are quite steep, and in the watershed most of these streams have “steep narrow valley channels” (OWEB SV classification) and “very steep headwater channels” (OWEB VH classification). Together, these two channel types comprise 37% of total channel length in the watershed (Table 3-7). This contrasts with the Dairy-McKay Creek watershed, which is dominated

[23]Channels are typed according to their unmodivied characteristics. Where channel structure has been extensively modified, the probable type of the unmodified channel was resonstructed base on gradient and floodplain characteristics. Channel modifications are addressed at a separate stage of the OWEB methodology.
[24]Formerly the Governor’s Watershed Enhancement Board (GWEB).

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Table 3-7. OWEB channel types in the Upper Tualatin-Scoggins watershed (based on bluelines in USGS 7 1/2 minute quads).

Channel Type	Description	Length (Miles)	% Type	Confirmed Fish Use	sitivity to disturbance of: LWD	Fine Sed	Coarse Sed	Peak flow
AF	Alluvial Fan	5.51	2.17%	24.5%	Very High	Mod-High	High	Mod-High
FP2	Large to Medium Floodplain	45.83	18.04%	90.1%	High	Moderate	High	Low
FP3	Small Floodplain	16.89	6.65%	15.0%	High	Mod-High	High	Low
LC	Low Gradient Confined Channel	0.39	0.15%	0.0%	Low-Mod	Low	Moderate	Low-Mod
LM	Low Gradient Moderately Confined	8.63	3.40%	71.5%	Mod-High	Mod-High	Mod-High	Moderate
MC	Moderate Gradient Confined	21.46	8.45%	88.5%	Low	Low	Moderate	Moderate
MH	Moderate Gradient Headwaters	4.86	1.91%	9.0%	Moderate	Moderate	Mod-High	Moderate
MM	Moderate Gradient Moderately Confined	12.68	4.99%	61.0%	High	Moderate	Mod-High	Moderate
MV	Moderate Gradient V-shaped	42.69	16.81%	52.2%	Moderate	Low	Moderate	Moderate
SV	Steep Gradient V-Shaped	62.33	24.54%	11.8%	Moderate	Low	Low-Mod	Low
VH	Very Steep Headwaters	32.72	12.88%	4.9%	Moderate	Low	Low-Mod	Low
Total		253.97	100.00%					

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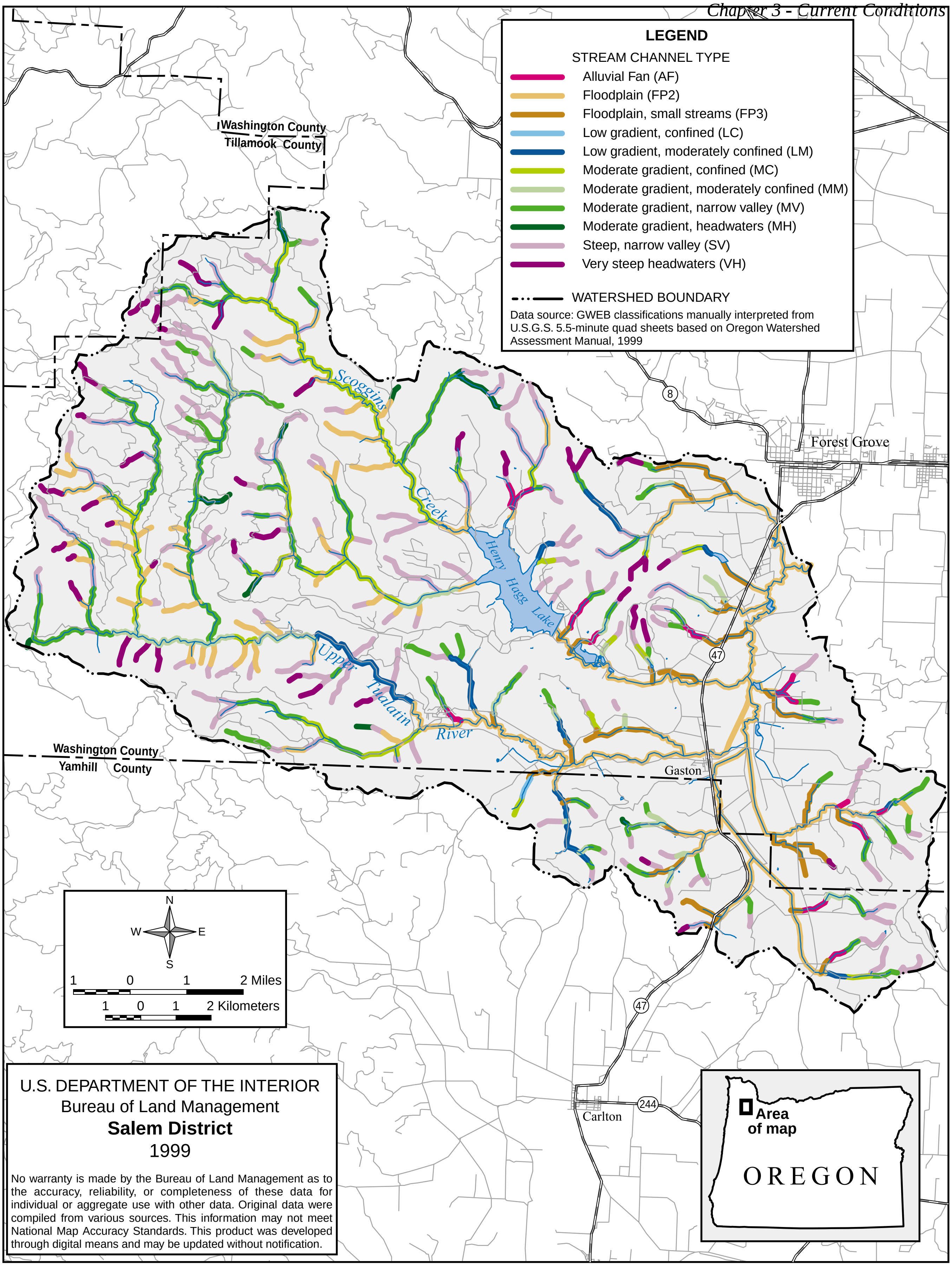

Map 3-3 -- Stream Channel Types in the Upper Tualatin-Scoggins Creek Watershed.

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by moderate gradient channel types in its mountainous reaches. These channel types are sediment source regions. In the Upper Tualatin-Scoggins watershed, this channel type has a variety of potential substrates. Cobbles or larger substrates often dominate these channel types. However, many of the first order streams of these channel type have substantial inputs of fine, colluvial sediments

Downstream of the headwater reaches, most streams transition into "moderately steep, narrow valley channels" (OWEB type MV). This channel type represents about 17% of total stream length within the watershed. Although they are loosely termed as transport reaches, the narrow canyon walls provide a ready source of debris flows and colluvial sediment to the stream channel. Stream channels are confined by these channel walls and thus tend to have a low sinuosity.

On middle reaches of many streams, the canyons widen and the channel type often changes to "moderate gradient constrained channel" (OWEB type MC). This channel type represents about 8% of total watershed stream length. Another transport reach, these areas will be less susceptible to direct colluvial inputs and grade into situations where streambank erosion gains importance. These reaches also have low sinuosity, as hillslopes continue to constrain the channel.

As stream gradient decreases, MV and MC channels tend to grade into "moderate gradient, moderately constrained channels" (Type MM). This channel type represents 5% of watershed stream length. Depositional processes become most important in this type of stream, although streambank erosion is prominent. In this channel type, small gravel and sand become proportionally larger components of the substrate.

In the lower portions of the watershed, low gradient streams with broad floodplains (OWEB types FP2 and FP3) dominate the channel forms. Large and medium streams, including the Tualatin River, and Scoggins, Carpenter, Wapato, Ayers, and Hill creeks are included under the FP2 type designation, while smaller tributaries are designated as FP3. Together, the floodplain types comprise 25% of the total stream length in the watershed. Under natural conditions these streams generally have a high sinuosity and are dominated by depositional processes. Sediments produced in the source and transport reaches are likely to be deposited for long periods of time in the floodplain type reaches, where they will affect channel morphology and substrate characteristics. Commonly, gravel substrates dominate the upper reaches of the floodplain channels, while fine substrates are dominant in the Wapato Valley. Streambank erosion is an important erosional process in these reaches. Where bare soils occur near channels, sheet, rill, and gully erosion are also important contributors of sediments to streams.

3.1.3.2 Effects of human influences upon stream morphology

Human influences have had several effects upon stream morphology. Most notably, channelization has straightened naturally sinuous streams in the alluvial portion of the watershed. This has reduced floodplain and riparian area, and resulted in a general loss of habitat for aquatic and riparian-dependent species. Additionally, channel straightening reduces stream length, thereby increasing local stream gradient and potentially increasing downcutting. In the Tualatin basin, Ward (1995) attributed the lack of undercut banks to the effects of channelization.

Riparian buffers along many of the streams in the watershed have been diminished. In Patton Valley, this has contributed to extensive areas of bank erosion. When sediments produced by such erosion are redeposited, they often change stream morphology by embedding gravels and contributing to pool fill. Clearing of riparian vegetation also

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removes the amount of wood and other roughness elements available to the stream, thus limiting the stream's ability to develop pools.

Below Scoggins Dam, much of the substrate of Scoggins Creek has been characterized as bedrock (SRI 1990). Although it was not specified whether this bedrock substrate existed prior to construction of Scoggins Dam, the dam may have contributed to scouring of the substrate. Winnowing of fine sediments and armoring of the channel bed is a common phenomenon downstream of dams. As it flows downstream, the substrate of Scoggins Creek gradually becomes dominated by fine sediments.

Few efforts have been taken to improve stream morphology within the watershed. In order to counter stream erosion, land owners have attempted to provide bank resistance through rip rap efforts. However, these efforts have been of uncertain value for producing desired channel characteristics. In some locations, such as the Tualatin River in Patton Valley, stream channel entrenchment limits the ability of riparian plantings to provide bank stability.

3.1.4 Water quality

3.1.4.1 Beneficial uses

The major beneficial uses of water in the Upper Tualatin-Scoggins watershed are for domestic and municipal consumption, cold water fisheries, warm water fisheries (in Henry Hagg Lake), water contact recreation, irrigation, maintenance of downstream water quality, livestock watering, and wildlife. Water rights are summarized in the hydrology / water quantity section (Section 3.1.2.2). The water quality parameters that these beneficial uses are dependent on include water temperature, nutrient levels, suspended sediment / turbidity levels, dissolved oxygen and bacterial levels.

3.1.4.2 General indicators of water quality

Generally speaking, the best water quality occurs in the forested portion of the watershed. In these areas, streams are comparatively well shaded, and stream turbulence leads to well-oxygenated waters. However, little consistent water quality monitoring has taken place in this portion of the watershed.

In valley portions of the watershed, water quality typically decreases from that found in the mountains. Decreasing stream gradient and velocity, along with decreased riparian cover typically results in higher temperatures and lower dissolved oxygen concentrations than occur in the mountainous reaches. The erodible silt banks, as well as sediments transported from upland sites, are conducive to heavy sediment loads and high stream turbidity. In these agricultural zones, high levels of nutrients and bacteria are also a potential problem.

Within the Upper Tualatin-Scoggins watershed itself, most water quality problems occur on lower reaches of the tributaries. Although the mainstem Tualatin River does receive thermal and nutrient loads in the Patton and Wapato valleys, the effects of these loads are neutralized downstream of Scoggins Creek by releases of water from Henry Hagg Lake.

To address water quality problems, ODEQ, USA, TVID, and the Oregon Graduate Institute (OGI) are conducting a cooperative study of pollution sources and water quality in the Tualatin Basin. In one portion of this study, USA and ODA measured water quality parameters at tributary sites on Scoggins and Carpenter creeks (Table 3-8). The ODEQ water quality index (WQI) was determined for the two Scoggins Creek sites.

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Table 3-8. USA tributary water quality monitoring sites in the Upper Tualatin-Scoggins watershed. Adapted from Aroner 1998.

USA location code	EPA Code	Stream	Location	Samples per year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3805017	3805015	Scoggins Cr	Old Hwy 47			1	1	1	1	10	15	5		1	15	14	15	37	38	37	25
3805048		Scoggins Cr	Stimson Bridge										11	12	14		13	26	27	25	25
3805050	3805042	Scoggins Cr	Hagg Lake Eff	1	1	1	1	1	1												
3505095	3803003	Scoggins Cr	above Hagg Lake										11								
3806002		Sain Cr	above Hagg Lake										11								
3807001		Tanner Cr	above Hagg Lake										11								
3809011		Carpenter Cr	Hwy 47											25	15						
3809025		Carpenter Cr	D/S OGP														11	16			
3809020		Carpenter Cr	DN OGP											10							
3809030		Carpenter Cr	Stringtown Rd														11	16			
3809060		Carpenter Cr	Plumlee												14						

Non USA monitoring sites

Station	Agency	Stream	Location	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3809012	ODA	Carpenter Cr	Stringtown Road																	12	13
3848010	ODA	Wapato Cr																12			
402164	ODEQ	Scoggins Cr	Old Hwy 47	1						12	6					1					

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Water quality at these sites, as measured by the WQI, was found to be fair to good. Water quality at the Scoggins Creek sites was found to be considerably better than at any other monitored sites in the Tualatin Basin (Aroner 1998). Although the WQI was not determined for Carpenter Creek, examination of the monitoring data revealed that, for several parameters, the water quality was the worst measured among streams monitored in the Tualatin Basin.

3.1.4.3 Macroinvertebrate sampling in the Upper Tualatin-Scoggins watershed

Macroinvertebrate surveys provide an excellent indicator of water quality, sedimentation, habitat diversity, and biodiversity. Although no comprehensive macroinvertebrate surveys have been conducted within the Upper Tualatin-Scoggins watershed, limited surveys conducted in Gales Creek and other watersheds in the Tualatin Basin indicate generally good water quality in mountainous reaches of the watersheds, with lower water quality in downstream alluvial reaches. Because mountainous parts of the Upper Tualatin-Scoggins watershed have experienced less intensive use than most other watersheds of the Tualatin subbasin, it is likely that these reaches have good macroinvertebrate and water quality characteristics similar to those prevailing in mountainous reaches of Gales Creek.

In connection with this watershed analysis, macroinvertebrates were sampled at five sites within the watershed (Appendix 5). The sampling locations included four sites in the Scoggins Creek drainage: three foothill sites just upstream of Henry Hagg Lake and one valley site on lower Scoggins Creek near the Old Highway 47 bridge. Additionally, a mountain site was sampled on Roaring Creek well downstream of the headwaters. The invertebrate sample at the lower Scoggins site indicated substantially more degraded conditions than were present at the other three sites. Ecological impairment at this site was demonstrated by a benthic index of biotic integrity (B-IBI) score of 18 of a possible 50 points. (For details of the B-IBI, see Appendix 5). Species diversity and the proportion of pollution-intolerant species was much lower at this site than at the other sites.

Based on the macroinvertebrate sampling, Roaring Creek and the three sites above Henry Hagg Lake were considered to have slight to moderate ecological impairment. These sites had B-IBI scores ranging between 32 and 40. The main item of concern at these sites was the dominance of benthic populations by few, relatively tolerant, taxa. The top three taxa comprised over 75% of the total invertebrate population at each site. Such dominance generally indicates a stressed community. The source of these stresses was not immediately apparent. To a certain degree, sedimentation may be responsible. The number of sediment intolerant taxa was somewhat lower than is normal for unimpaired watersheds in many parts of Oregon. However, based on metrics developed for the Salmonberry River, communities were considered to have only slight impairment due to sedimentation. (The Salmonberry River was considered to be an appropriate reference site because of its proximity, similarly unstable lithology, and relatively pristine conditions.)

As expressed in Appendix 5, the condition of the benthic invertebrate communities correlated well with the visually assessed condition of instream habitat and the surrounding riparian area. Although more comprehensive studies would be necessary to derive any definitive conclusions, the benthic communities also appeared to relate to land use. Where forestry was the only major land use, community impairment appeared to be slight. However, it appears that more intensive land uses between upstream sites in the Scoggins drainage and the Scoggins at Old Highway 47 site contributed to degraded stream conditions at the downstream site.

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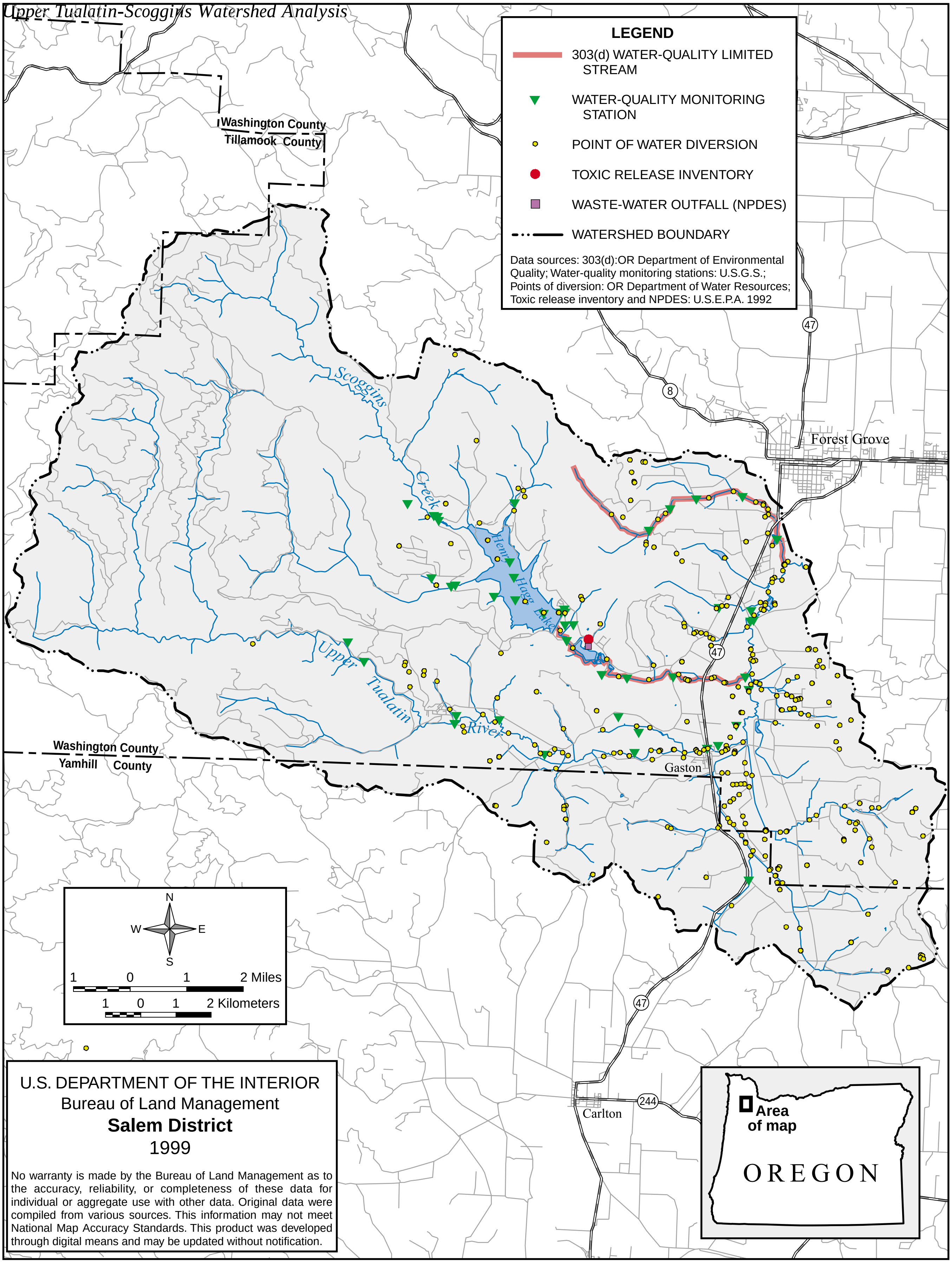

Map 3-4 -- Water Quality and Water Supply for the Upper Tualatin-Scoggins Creek Watershed.

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3.1.4.4 Streams on the 303(d) list

An estimated 11 miles of stream in the Upper Tualatin-Scoggins watershed are on the ODEQ 303(d) water quality limited list (Map 3-4). These include:

- Carpenter Creek has summer bacteria levels, as indicated by *E. coli*, that are considered limiting to water contact recreation. Between May and October, dissolved oxygen concentrations reach levels below the federal cool water[25] standard of 6.5 mg/l for aquatic resources;
- Scoggins Creek below Scoggins Dam, where dissolved oxygen concentrations between November 1 and April 30 reach levels that are below federal cold water standards of 11 mg/l or 95% saturation for spawning salmonids.

Additionally, Williams Canyon Creek was placed on the potential concern list because the 1995 ODEQ biological assessment indicated impaired conditions. Other stream reaches were considered for listing due to pesticide levels, habitat modification and sedimentation. Due to insufficient data, these factors did not cause any streams to be added to the 1998 list. As additional information becomes available, these issues may become the source of future listings (ODEQ 1998).

3.1.4.5 Parameters of concern

3.1.4.5.1 Bacteria

E. coli is an important indicator of inputs of fecal bacteria to stream systems. High bacteria levels can cause disease, and restrict the beneficial uses of water for humans, such as water contact recreation. Studies by USA indicated that elevated bacteria levels in rural areas are largely the result of livestock farms with inadequate manure storage, manure management, or grazing management (Aroner 1998). It is possible that poorly placed septic systems may also contribute to the problem.

Bacteria levels in Carpenter Creek were generally quite low, but reached very high levels during infrequent events. This may either demonstrate an intermittent source of bacteria, or may represent flushing during high precipitation events. However, if bacteria-flow correlations are negative, as is the case with Scoggins Creek, these infrequent events may represent low flows where the steady stream of bacteria has become concentrated in a very low, unsteady stream of water. In 1997, Carpenter Creek exceeded *E. coli* standards more than 25% of the time during the May to October period. Using the criteria of the OWEB manual (WPN 1999), Carpenter Creek would be considered moderately impaired due to bacteria.

Over the past several years, the Joint Water Commission (JWC) has counted total and fecal coliform at selected sites in, and just downstream of, the watershed. Counts between January 1 and July 6, 1999 are given in tables 3-9 and 3-10. The three valley sites (Carpenter Creek, Scoggins Creek at the Highway 47 bridge, and raw water taken in at the Joint Water Commission Treatment Plant) show widespread variation in both total and fecal coliform levels, sometimes reaching very high bacterial levels. Carpenter Creek, in particular, is subject to high coliform levels, which extend well up into the Carpenter Creek subwatershed (Karl Borg, JWC, personal communication). For the most part, high total coliform events were correlated between the valley sites. Fecal coliform counts were generally less well correlated between the valley sites. Although

[25]The **cold water** standard is applied to stream reaches that do not support spawing during the applicable time period, but serve as migratory corridors for salmonids. The **cold water** standard is applicable to reaches where salmonid spawning does occur during the applicable period.

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Table 3-9. Total coliform counts at sampled sites in the Upper Tualatin-Scoggins watershed (JWC 1999).

Sum of TC	Site				
Date	Carpenter Creek	JWTP-Raw Water	Scoggins Creek at Bridge	Scoggins Creek below Dam	Tualatin Intake
1/6/99	800	900	26	82	68
1/11/99	1100	1100	46	72	94
1/20/99	53	330	370	28	52
1/25/99	700	600	36	48	102
2/1/99	92	132	38	88	48
2/10/99	1400	100	500	36	25
2/22/99	3400	900	1200	34	62
3/1/99	900	1000	44	72	38
3/10/99	2300	300	36	24	8
3/17/99	700	300	500	10	4
3/24/99	4500	84	3800	8	16
3/31/99	1600	1300	500	6	126
4/15/99	9999	9999	9999	5	12
4/22/99	590	170	300	9.5	9.5
4/27/99	1540	340	1210	9.5	10
5/4/99	330	310	330	9.5	60
5/11/99	0	390	1700	10	70
5/18/99	900	1130	1360	9.5	40
5/25/99	9999	590	9999	10	9.5
6/1/99	9999	200	120	9.5	120
6/8/99	1040	360	300	9.5	60
6/15/99	1820	870	110	110	30
6/22/99	580	220	180	130	40
6/29/99	520	220	120	60	30
7/6/99	9999	250	280	70	70

*9999 indicates that total coliform were too numerous to count.

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Table 3-10. Fecal coliform counts at sampled sites in the Upper Tualatin-Scoggins watershed (JWC 1999).*

Sum of FC	Site				
Date	Carpenter Creek	JWTP-Raw Water	Scoggins Cr at Bridge	Scoggins Cr blw Dam	Tualatin Intake
1/6/99	16	16	20	30	1.5
1/11/99	44	144	20	14	4
1/20/99	170	46	112	6	6
1/25/99	25	61	19	12	1
2/1/99	16	20	28	2	6
2/10/99	84	33	38	6	1.5
2/22/99	206	62	84	4	12
3/1/99	58	88	4	6	1.5
3/10/99	52	22	10	1.5	2
3/17/99	48	30	32	0	1.5
3/24/99	8417	6	134	4	10
3/31/99	272	128	132	1.5	96
4/15/99	9999	9999	36	35	3
4/22/99	140	30	200	9.5	10
4/27/99	20	70	720	9.5	9.5
5/4/99	80	80	160	9.5	9.5
5/11/99	9.5	70	970	9.5	9.5
5/18/99	300	560	610	9.5	10
5/25/99	9999	220	9999	10	9.5
6/1/99	160	60	40	9.5	40
6/8/99	520	40	40	9.5	20
6/15/99	480	480	100	9.5	9.5
6/22/99	140	80	19.5	20	30
6/29/99	220	50	60	9.5	9.5
7/6/99	120	50	40	0	0

*9999 indicates that total coliform were too numerous to count.

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fecal coliform generally comprised a small proportion of total coliform at these sites, high total coliform counts in Carpenter Creek were correlated with high fecal coliform counts. The source of the Carpenter Creek coliform was unknown (Karl Borg, JWC, personal communication).

3.1.4.5.2 Dissolved oxygen

High levels of dissolved oxygen are essential for most coldwater aquatic species. Dissolved oxygen levels are affected by temperature and aquatic growth. High temperatures lead to lower dissolved oxygen levels, while decomposition of organic matter, such as algae, consume oxygen, leading to low levels of instream dissolved oxygen. As gases are often most easily transferred in turbulent waters, lack of turbulence can also lead to low dissolved oxygen levels.

Different levels of dissolved oxygen (D.O.) are needed for successful spawning and fish rearing. Although Scoggins Creek has relatively high dissolved oxygen levels as compared to most other Tualatin Basin streams, the adequacy of the stream is measured by its ability to provide for the most sensitive beneficial use occurring in the stream. Salmonid spawning is the most sensitive beneficial use occurring in Scoggins Creek, and stream water quality is determined relative to the ability to support that use. By that measure, Scoggins Creek (at Old Highway 47) had an impaired ability to support salmonid spawning. Within the November-April 1997 measurement period, this site had D.O. readings below the federal spawning criterion (11 mg/l or 95% saturation) for cold water streams. In this period, between 10 and 25 percent of all measurements recorded oxygen levels below this standard, with a minimum measurement of 10.10 mg/l (Aroner 1998). By the standards given in the OWEB manual (WPN 1999), the ability of Scoggins Creek to support salmonid spawning would be considered lightly to moderately impaired. The design of Scoggins Dam includes an aerator and water leaving Scoggins Dam is well aerated (BOR 1970; Joe Rutledge, TVID, personal communication). This indicates that reduced D.O. levels at Old Highway 47 may be caused by biological oxygen demands downstream of the dam.

Dissolved oxygen levels at Carpenter Creek were assessed according to the less stringent coolwater, salmonid passage criterion of 6.5 mg/l. Between 25 and 50% of measurements taken at Carpenter Creek near Stringtown Road between May and October, 1997 had dissolved oxygen levels below this standard. The minimum measured concentration during this period was 3.9 mg/l. Using the OWEB criteria, the ability of Carpenter Creek to support salmonid passage would be considered moderately impaired.

3.1.4.5.3 Phosphorus

In many natural aquatic systems, phosphorus is limiting to aquatic growth. When streams are enriched by phosphorus inputs, it can lead to algal blooms, decreased dissolved oxygen concentrations, fish kills, and bad odors.

Phosphorus is a major parameter of concern within the Upper Tualatin-Scoggins watershed. Although phosphorus levels are lower than those prevailing downstream, they exceed TMDL standards in alluvial portions of the watershed. During 1996, monthly median phosphorus levels in the Tualatin River at Cherry Grove exceeded the TMDL of .02 mg/l during May, June, and September. Although TMDL standards increase at downstream sites, phosphorus loadings increase at a higher rate than the TMDL standard. At Dilley, where the TMDL standard was .04 mg/l, the median monthly phosphorus concentration exceeded the TMDL standard throughout the May to September period. The tributaries also had high phosphorus loadings. Scoggins Creek at Old Highway 47 exceeded its TMDL of .06 mg/l between May and June (Aroner 1997). Subsequent measurements showed substantial reductions in phosphorus

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loadings at this site; during 1997 and 1998, median monthly phosphorus loading never exceeded .044 mg/l (Aroner 1998, TRFMTC 1999).

Median phosphorus concentrations at Carpenter Creek were much higher than those measured at Scoggins Creek, but were lower than the concentrations found at points downstream in the Tualatin Basin. However, during infrequent events, the phosphorus loadings attained very high levels, which were exceeded by only a few urban streams. This may indicate a flushing of phosphorus from upland locations during precipitation events.

3.1.4.5.3.1 Potential sources of phosphorus

Timber operations, such as fertilization and slash burning, can add phosphorus to the stream system. However, these activities do not usually provide a significant contribution. If soil disturbance is minimized, particularly on sedimentary formations and high phosphorus soils, forestry-related phosphorus inputs to streams should be minimal. On the other hand, if extensive soil disturbance and sediment production occurs from a forest management activity, adsorbed phosphorus is likely to accompany the sediments (Wolf 1992).

Agriculture is an important source of phosphorus to aquatic systems. Conversion of forest to farmland generally results in increased fertilizer use and soil destabilization (Wolf 1992). Where these fertilizers and soils are able to reach an aquatic system, they often transport a phosphorus load to the stream.

Agriculture and rural residential uses often implement practices that contribute organic material to streams. Contributions of easily decomposed organic matter (e.g. manure, straw, leaves, grass clippings) increases the biological oxygen demand (BOD) of sediments. This can lead to anaerobic conditions in the stream bottom during the summer, which tends to chemically mobilize phosphorus that has been adsorbed to iron and aluminum oxides in the sediments.

3.1.4.5.3.2 Distribution of phosphorus in the Upper Tualatin-Scoggins watershed.

Studies conducted elsewhere in the Tualatin Basin indicate that much of the phosphorus in streams in the Upper Tualatin-Scoggins watershed could arise from natural groundwater sources. Studies conducted in 1990 and 1991 by the Oregon Department of Forestry in forested portions of the Dairy-McKay and Gales Creek watersheds indicated that high phosphorus levels were associated with sedimentary rock formations. The formations present in portions of the Lee Creek subwatershed and in the Coast Range foothills are similar to those sampled in the ODF studies, and could be expected to contribute phosphorus to the stream system.

Alluvial sediments in the valleys could also provide substantial phosphorus contributions to groundwater, as well. Studies in alluvial portions of the Tualatin Valley indicated that many of the sediments were rich in phosphorus (TAC 1997). Groundwater flowing through these sediments became phosphorus enriched and contributed their phosphorus loads to surface streams. Although, for the most part, the sediments in the Tualatin Valley are of different origin than those of Patton, Scoggins, and Wapato valleys, a similar mechanism could be contributing to instream phosphorus

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levels. Soils throughout western Oregon are known to be rich in phosphorus. In the Wapato Valley, in particular, deep layers of organic alluvium are likely to be rich in phosphorus, and could provide phosphorus to groundwater flowing to surface stream systems.

Elsewhere in the Tualatin subbasin, it has been noted that most of the current human generated phosphorus load enters streams during winter surface runoff events, either in the dissolved state or adsorbed to eroding soil particles (TAC 1997). It is unknown how much, if any, of these winter loads of phosphorus remain in the system (e.g. as bottom sediments) and are released during summer months.

The available monitoring records show a pattern of increasing phosphorus loading through the alluvial portions of this watershed. To a certain degree, such loading may be natural and may not be able to be addressed through management actions. However, agricultural loading can be decreased by addressing sediment, fertilizer, and manure issues. Reduced fertilizer use may also effect minor reductions in summer phosphorus concentrations. Throughout agricultural portions of the watershed, it makes sense to match manure and fertilizer phosphorus applications to crop needs. This should reverse the trend toward higher soil test phosphorus levels, thereby reducing the risk of both phosphorus-enriched surface runoff and future phosphorus leaching.

3.1.4.5.4 Stream temperature

In the Tualatin Basin, concern over water temperature generally relates to the fitness of streams to provide suitable conditions for cold water aquatic species, such as salmonids. For most streams in the basin, the cool water standard of 17.8 C (64º F) is applied. This standard is applied based on a seven-day moving average of daily maximum temperatures (OAR 340-41-006).

In conjunction with their monitoring plan, USA measured spot water temperatures at three sites, two on Scoggins Creek and one on Carpenter Creek (Appendix 2). In 1997, May-October temperature at the Scoggins Creek sites was consistently below the 17.8 C cool water standard. These cool temperatures reflected the influence of releases of subsurface water from Scoggins Dam. Carpenter Creek was considerably warmer. Between May and October of 1997, between 10 and 25% of temperature measurements exceeded the 17.8 C standard (Aroner 1998). The highest recorded temperature over this period was 20.4 C. Using the OWEB criteria (WPN 1999), the ability of Carpenter Creek to support salmonid passage would be moderately impaired by these high water temperatures.

In 1997, the Tualatin Basin Watermaster maintained constant summer temperature measurements at three mainstem Tualatin River sites in the watershed. These monitoring sites were located below Lee Falls (RM 70.7), near Gaston (RM 63.9), and at Dilley (RM 58.8). The watershed above the Lee Falls site is maintained in forest land use, while the Gaston and Dilley sites lie in agricultural portions of the watershed. Comparative measurements demonstrated a warming trend between the Lee Falls and Gaston sites. The mean maximum August temperature at Lee Falls was 18.02 C, as compared with 20.9 C at the Gaston station. At Lee Falls, the running 7 day mean of daily maximum temperatures exceeded the 17.8 C standard for 18 days between August 2 and August 19, with a maximum daily temperature of 20.3 C on August 14. Near Gaston, the running 7 day mean was in excess of cool water standards for 76 days, including a continuous stretch between July 2 and September 12. Maximum daily temperature at this station was 23.2 C on August 14. It is likely this warming trend continued until the confluence with Scoggins Creek, where releases from Scoggins Dam reduced the river's water temperature. At the Dilley station, no 1997 water temperatures were in excess of the cool water standard; the maximum recorded water temperature was 17.1 C. The effects of the releases from Scoggins Dam provided benefits to water temperature for a considerable distance downstream of the watershed.

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In 1998, water quality monitoring showed that warm water releases from Barney Reservoir resulted in elevated water temperatures downstream at least as far as Lee Falls. In August and September, mean water temperatures in the Tualatin River rose an average of 4.3 C immediately downstream of the Barney Reservoir outfall. Increased water temperatures from Barney Reservoir water could be detected at the gage on the Tualatin River near Lee Falls. By the time flow reached Gaston, ambient heating appeared to dominate the thermal regime of Tualatin River water. From Cherry Grove downstream, Barney Reservoir water likely helped to maintain cooler water temperatures, as the increased water volume from flow augmentation increases the ability of the river to absorb heat with minimal change in temperature.

The relatively warm water temperatures from the Barney Reservoir outfall appear to be an anomaly caused by abnormally shallow conditions in Barney Reservoir. Under normal conditions, that is, with Barney Reservoir at or near full pool at the beginning of summer, cool water would be expected to flow to the Tualatin River system through the outfall (USACE 1994). Flow augmentation from Barney Reservoir would likely have a net cooling effect upon water temperature along the upper course of the river. In any event, the releases from Barney Reservoir constitute the vast majority of summer flow upstream of Gaston, indicating the importance of these releases toward maintenance of water quality in this reach.

In many valley reaches, streams are exposed to large amounts of summer heating because of impaired riparian canopy. Downstream of Cherry Grove, the canopy becomes more limited as forested lands give way to agriculture. Much of the vegetation is a single row of trees or shrubs. A recent water temperature modeling study noted that virtually all of the vegetation between the Gaston gage and the Scoggins Creek confluence was a single row of vegetation, and that about 40% of this reach had an estimated 50% canopy coverage (Risley 1997). Field trips conducted to the river revealed many reaches with no riparian cover. Additionally, many of the tributary streams in the alluvial areas have no canopy cover. In some portions of the Wapato Valley, the lack of canopy may be a natural result of the wetland hydrology. Current wetland characteristics and historical records indicate that both forested and herbaceous emergent wetlands are natural components of the Tualatin system.

3.1.4.5.5 Other parameters of concern

In 1997, Carpenter Creek had the highest median Nitrate + Nitrite nitrogen levels and the second highest median ammonia levels (after Christensen Creek) of all monitored streams in the Tualatin basin. Instream ammonia levels exceeded water quality standards more than 90% of the time during the May to November period. High ammonia levels are often associated with faulty septic systems and input of animal wastes to stream systems. High nitrogen levels can also be attributable to overfertilization, and there may be a relationship between the nitrogen levels and nearby nursery and livestock operations. Using the OWEB criteria (WPN 1999), Carpenter Creek would be considered to have severely impaired water quality due to high ammonia levels.

3.1.4.6 Water quality trends

The USA study, (Aroner 1998), found several notable water quality trends in the Tualatin Basin. Those shared by Scoggins Creek include:

- Decreasing ammonia (November-April)

Additionally, Scoggins Creek had statistically significant declining trends for Nitrate +

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Nitrite, total soluble orthophosphate, and Total Chemical Oxygen Demand (TCOD), as well as significant increasing trends for total phosphorus and total suspended solids. These characteristics appear to indicate improving water quality, although the causes of increased phosphorus should be determined.

Over the course of the USA cooperative monitoring study, year-round and November to April water quality index (WQI) trends were found to have substantially improved in Scoggins Creek since the early 1970s. Comparison of these results with a previous study conducted by USA and ODEQ (1982) confirmed this trend of improvement in the WQI. During the 1970s, Scoggins Creek near Highway 47 had an Oregon WQI value of 66 (of a possible 100) in 1970-74, and 84 in 1978-79. During the period 1991-1997, mean WQI for this site stabilized at a mean score of 84 (Aroner 1998). Using current ODEQ interpretative standards, the 1970-74 figures would have represented poor water quality, which improved to fair water quality with the start of flow releases from Scoggins Dam.

During the 1970s, the upper Tualatin had the highest WQI scores found in the Tualatin subbasin (92.6 and 90.3). These numbers represent excellent water quality according to ODEQ interpretative standards. However, trend analysis based on the WQI is not possible, as the WQI was not computed for the Upper Tualatin in the 1990's.

3.1.5 Aquatic species and habitat

3.1.5.1 Cold-water fish

3.1.5.1.1 Distribution and life history

The upper Tualatin River and Scoggins Creek are major steelhead supporting streams within the Tualatin River basin (Map 3-5). Additionally, these streams and their tributaries support cutthroat trout, and coho salmon. Cutthroat trout and steelhead trout are native to the system. Coho salmon were first introduced in the 1920's and have since become naturalized (ODEQ and USA 1982). Common native non-salmonids include dace and sculpin. Pacific lamprey and brook lamprey are also present. A list of fish species within the watershed is given in Table 3-11.

Table 3-11. Anadromous and resident fish known to inhabit the Upper Tualatin-Scoggins watershed.

Anadromous Fish		Resident Fish	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Coho salmon	*Oncorhynchus kisutch*	Cutthroat trout	*Oncorhynchus clarki clarki*
Steelhead trout	*Oncorhynchus mykiss*	Western brook lamprey	*Lampetra richardsoni*
Pacific lamprey	*Entosphenus tridentatus*	Reticulate sculpin	*Cottus perplexus*
		Largescale sucker	*Catostomus platyrhynchus*
		Redside shiner	*Richardsonius balteatus*
		Northern pikeminnow	*Ptychocheilus oregonensis*
		Largemouth bass	*Micropterus salmoides*
		Bluegill	*Lepomis macrochirus*
		Warmouth	*Lepomis gulosus*
		Yellow perch	*Perca flavescens*
		Crappie	*Pomoxis sp.*

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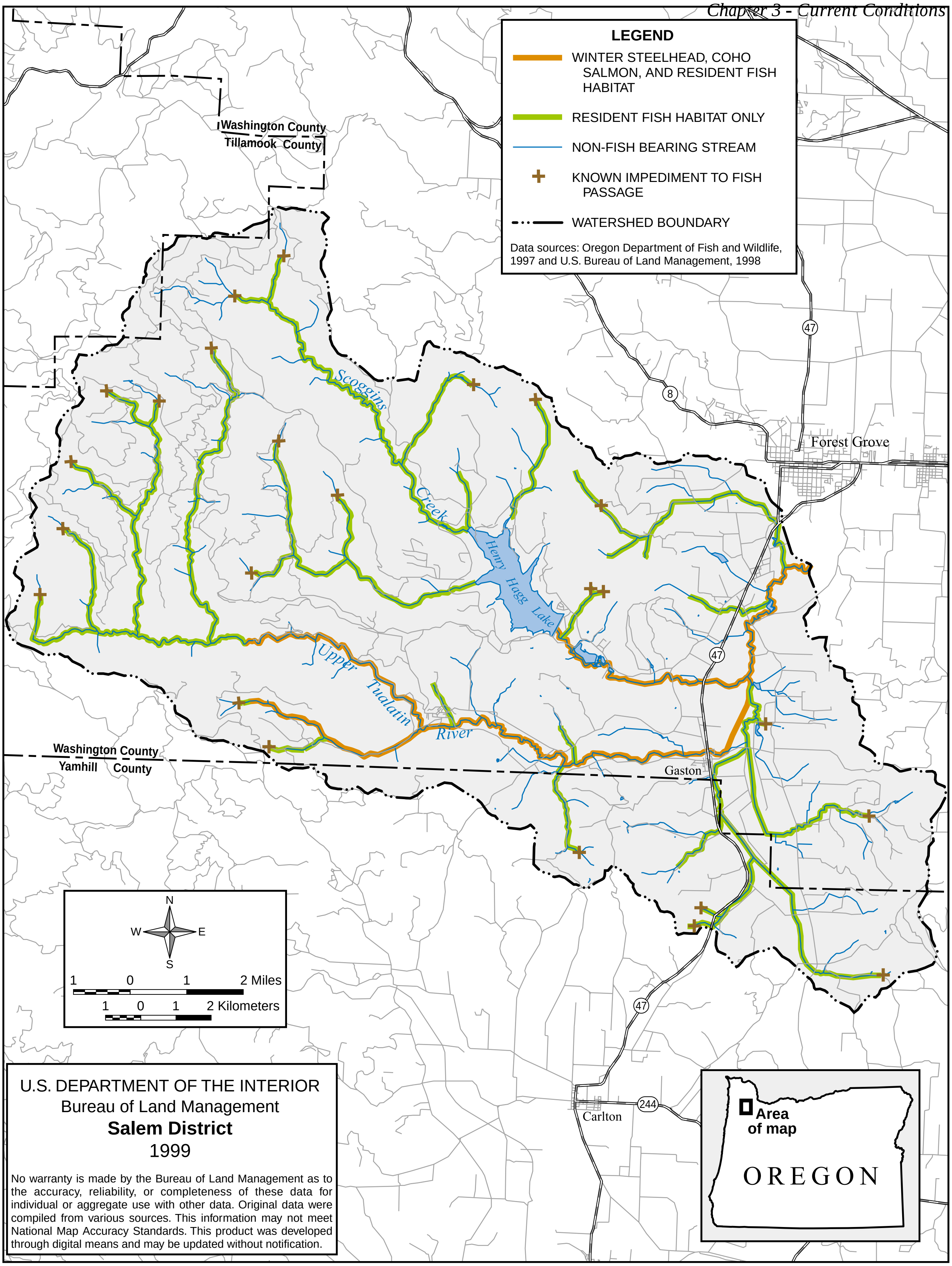

Map 3-5 -- Fish Distribution in the Upper Tualatin-Scoggins Creek Watershed.

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Steelhead trout are known to migrate and spawn in Scoggins Creek below Henry Hagg Lake, the Tualatin River below Haines falls, and Roaring Creek. Originally, Lee Falls was the upper limit for anadromous fish. However, a passageway blasted through Lee Falls made an additional two miles of habitat available to salmonids (Murtagh et al. 1992). In total, an estimated 15-20 miles of rearing and spawning habitat are available to anadromous salmonids within the watershed. Prior to construction of Scoggins Dam, an additional 15 miles of habitat were available (BOR 1970). Following construction of the dam, ODFW maintained a fish trap at Scoggins Dam. In the 1977-78 return year, 163 steelhead trout were recorded as having returned to the fish trap by February (ODFW 1978). However, fewer adult steelhead trout returned to the dam in subsequent years. In the 1983-84 return year, only seven adult steelhead trout had returned by March. Eventually, ODFW ceased to maintain the trap because of lack of returning fish.

Although survey data is limited, it is likely that cutthroat trout are distributed throughout the Upper Tualatin-Scoggins watershed. Using interim procedures described under OAR 629-635-200(11), the Oregon Department of Forestry has designated streams throughout most of the watershed as capable of supporting fish. Resident cutthroat trout are commonly found in higher elevation streams, both above and below migration barriers. Studies conducted by ODF/ODFW found cutthroat trout in most fish-bearing streams in this watershed (Bennett, ODFW, pers. comm.). This agrees with electrofishing surveys performed in the Umpqua basin, where 96% of fish-bearing streams were found to support cutthroat trout (Cramer and Associates 1997).

Historically, chinook salmon were known to spawn in the Upper Tualatin-Scoggins watershed. Chinook salmon sightings in the watershed are very rare and sporadic. However, in September 1999, surveyors found three spring chinook salmon in the Tualatin River near Cherry Grove (Hillsboro Argus, October 14, 1999).

Winter run steelhead trout migrate into the Willamette basin between February and May. Spawning occurs April through June, with peak spawning occurring in May. (Busby et al. 1996). Juvenile steelhead trout rear in streams for two years prior to smolting. Most trout rearing takes place in tributaries. Some migration to mainstem reaches may take place in fall and winter (Ward 1995). After smolting, they migrate to the ocean between April and June. Steelhead trout typically spend two years in the ocean prior to returning to their natal streams to spawn. Steelhead trout do not necessarily die after spawning, but may return in subsequent years to spawn.

Coho salmon migrate into the upper Willamette basin in fall. Spawning occurs in November and December. Juvenile coho salmon rear in streams for one year prior to smolting, with outmigration taking place from March through May. In summer, most rearing takes place in tributaries. Some migration to mainstem reaches may take place in fall and winter (Ward 1995). After smolting, they migrate to the ocean. Coho salmon typically spend three years in the ocean prior to returning to their natal streams to spawn. Following spawning, they die.

In this watershed, cutthroat trout exhibiting both resident and potadromous life histories are present[26]. Potadromous migration occurs between the Upper Tualatin-Scoggins watershed and the Willamette River. Additionally, localized movement will occur in an attempt to find superior habitat conditions. Spawning typically occurs between January and March.

Life history of Pacific lamprey is complex. They typically migrate into the Willamette basin between April and September, and spend one winter in fresh water prior to

[26]*Potadromous* fish practice seasonal migration within a stream system for spawning purposes, but remain in fresh water throughout their life history.

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spawning. Spawning occurs in June and July in stream reaches with abundant gravel. After hatching, lamprey spend four to six years in the larval, or ammocoete, stage. Ammocoetes migrate downstream to lowland reaches with mud substrates, where they remain until attaining juvenile stage. This stage, which is marked by physiological changes including the development of eyes, usually takes place between July and October, and is usually marked by a migration to stream reaches with fast flow and gravel substrate. As juveniles grow to adulthood, they outmigrate to the ocean, usually between late fall and spring. Off of the Oregon Coast, adult lamprey spend 20-40 months in the ocean prior to returning to fresh water to spawn. They die three to 36 days after spawning (Close et al. 1995).

3.1.5.1.2 Potential hazards

The greatest hazard faced by salmonids is generally considered to be the lack of quality habitat. For anadromous fish, in particular, habitat is limiting. There is an estimated 15 to 20 miles of spawning habitat in the Upper Tualatin-Scoggins watershed that is accessible to anadromous fish. Most of the best rearing habitat also lies within the reaches used for spawning. Since the amount of habitat is so limited, any degradation is significant. Threats to salmonid habitat in the watershed include loss of habitat diversity, elevated water temperatures, and low summer and fall streamflow. Further discussion of streamflow and water temperature characteristics occurs in the Hydrology and Water Quality sections (Sections 3.1.2 and 3.1.4).

Migratory impediments, stream diversions, predation, and competition are other factors affecting salmonid populations. Poorly sized and placed culverts, in particular, can impede migration by creating jumps and velocity barriers (See Section 3.1.5.1.6). Stream diversions can entrain migrating and rearing salmonids and remove them from the stream system, often resulting in fish mortality in nearby upland habitats. While predation and competition are natural ecological processes in aquatic systems, human activities can increase pressures from these sources by reducing the amount and diversity of available habitat, accidental predator introduction, and planting of hatchery fish.

3.1.5.1.3 Planting of hatchery salmonids

Steelhead trout were released into the upper Tualatin River and its tributaries between 1976 and 1998 as mitigation for loss of habitat due to construction of Scoggins Dam. Between 1976 and 1980, 50,689 steelhead smolts were planted in Scoggins Creek. Subsequent plantings took place in the upper Tualatin River. Between 1981 and 1991, 118,359 smolts were planted in the Tualatin River. Subsequent plantings occurred at the rate of approximately 10,000 smolts per year (SRI 1990, Murtagh et al. 1992). In 1999, ODFW discontinued planting steelhead trout in response to the listing of upper Willamette steelhead trout as threatened under the Endangered Species Act (ESA).

Coho salmon were planted in the watershed between 1962 and 1999. Prior to 1983, most coho salmon were planted as fry. Between 1962 and 1982, 3,690,468 coho salmon fry were planted in the upper Tualatin river with an additional 209,984 fry planted in Lee and Sunday creeks. Between 1962 and 1972, 2,417 adult coho salmon were also planted in the Tualatin River. Gradually, planting of smolts attained prominence within the watershed. The first coho salmon smolts were released in 1973, and eventually, large numbers of coho salmon smolts were released as mitigation for Scoggins Dam. Between 1973 and 1989, 708,723 coho salmon smolts were released into the upper Tualatin River, and an additional 1,001,297 smolts were released into Scoggins Creek. In 1999, ODFW discontinued planting coho salmon in response to steelhead trout listings under the ESA.

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3.1.5.1.4 Prospects for salmonid populations

The upper Tualatin-Scoggins watershed falls within the upper Willamette Evolutionarily Significant Unit (ESU) for steelhead trout. In March, 1999, steelhead trout within this ESU were listed as threatened under the ESA. Through genetic analysis, the National Marine Fisheries Service (NMFS) determined that the steelhead trout in the Tualatin basin are of native stock, and therefore were included in the ESA listing. Although Nehlsen et al. (1991) did not consider these steelhead trout stocks to be at risk, more recent trends indicate a possible decline in population. Wide population fluctuations make trends difficult to determine. However, low populations indicate a possible risk of extinction (Busby et al. 1996).

On April 5, 1999 coastal cutthroat trout within the upper Willamette ESU were determined by the National Marine Fisheries Service (NMFS) to be "Not Warranted" for listing under the ESA (Federal Register 16397). Population trends for cutthroat trout within the Upper Tualatin-Scoggins watershed are unknown.

3.1.5.1.4.1 Non-salmonid populations and trends.

Little population information is available on cold water non-salmonid fish species in the watershed.

3.1.5.1.5 Distribution of habitat

Coho salmon, steelhead and cutthroat trout vary in their seasonal habitat utilization but all require structurally diverse channels for the maintenance of healthy populations. In general, coho salmon occupy middle stream reaches while cutthroat and steelhead trout occupy upper reaches. During high flow periods associated with winter and spring, juvenile coho salmon, steelhead and cutthroat trout depend on the low velocity habitats provided by pools, backwaters, and off-channel alcoves. Adult salmon and trout also use pools and wood structure for shelter from predators and for resting. During low flow periods zero to one year old steelhead and cutthroat trout inhabit higher velocity areas associated with riffles, while coho salmon continue to use pools. Two year and older steelhead and cutthroat trout generally prefer the deepest pool habitat.

In Coast Range streams, large wood pieces and accumulations play a vital role in maintaining channel complexity and fish populations. Large woody debris (LWD) creates scour, recruits and maintains spawning gravel, creates rearing pools and increases channel complexity. Habitat surveys were conducted by private and public entities in the western portion of the Upper Tualatin-Scoggins watershed, and are included in a database maintained by ODFW (ODFW 1999). These surveys indicate generally desirable conditions (using ODFW benchmarks) for LWD volume in the Tualatin River and its tributaries above (and including) Sunday Creek. Desirable conditions were also found for Lee Creek below 1,450 feet elevation, and Sain Creek above 600 feet elevation.

Undesirable conditions for LWD volume, according to ODFW benchmarks, were noted for virtually the entire surveyed length of Scoggins Creek, Sain Creek below 600 feet elevation, and the mainstem Tualatin River below Sunday Creek. Lee Creek between Skunk Hollow and 1,450 feet elevation was also deficient in LWD volume. The general pattern for other measures of instream LWD, such as number of key pieces, was similar to those reported for LWD volume. It should be noted, however, that all surveyed reaches were above barriers to anadromous fish.

Despite the spotty distribution of instream LWD, the most suitable habitat conditions for cold water fish in the Upper Tualatin-Scoggins watershed are found in the forested

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reaches of the Coast Range and foothills. Habitat surveys, together with spot field observations, indicate that these reaches typically have rocky substrates and fast flowing, well-oxygenated water. They likely offer the best spawning gravels, relatively cool water, better canopy, and more diverse habitats than valley reaches. The portion of these high quality reaches accessible to anadromous fish is quite limited and high quality habitat is most likely to be found in Roaring Creek and in the Tualatin River between Cherry Grove and Haines Falls. Although spawning salmonids are known to return to Scoggins Creek, the amount of suitable habitat in the creek downstream of Scoggins Dam is uncertain.

Lowland reaches typically have eroding banks, high stream turbidity, and fine-textured substrates. In those areas where streamflow has not been substantially affected by releases from Henry Hagg Lake, summer water temperature is generally quite warm. These characteristics generally reduce their suitability for salmonid rearing habitat. However, a limited amount of suitable salmonid rearing habitat may occur within this region. The Tualatin River in Patton Valley, in particular, may afford opportunities for salmonid rearing and spawning. Currently, this reach suffers from severe sedimentation and water temperature problems. With improved riparian cover and instream measures to restore habitat diversity, it is likely that most of Patton Valley could provide high quality salmonid spawning and rearing habitat.

3.1.5.1.5.1 Habitats for non-salmonid species

As described in section 3.1.5.1.1, Pacific lamprey have diverse habitat needs. They prefer cool water temperatures at all life stages. Substrate needs vary by life stage: During the ammocoete stage they utilize stream reaches with mud substrates. On the other hand, juveniles and adults need gravel substrates and flowing, well-oxygenated water. Thus, potential habitat concerns for lamprey involve both mountain and valley stream reaches in the Upper Tualatin-Scoggins watershed.

3.1.5.1.6 Migration barriers

Barriers to fish passage include both natural and human caused factors. On most of the smaller tributaries, stream size, gradient, and naturally occurring low flows are the limiting factors. In most other cases, migration impedance is partially or wholly due to human activities. Diversions can reduce stream depth, block upstream passage, and/or divert fish from the streams. Stream crossings can block fish passage, either through improperly placed culverts, or in some cases a lack of culverting.

The Oregon Department of Transportation (ODOT) performed a survey of 19 culverts within the watershed. Of these culverts, 8 were found to be structurally inadequate because of poor culvert condition, migratory impediment, or inadequate passage of high flows (Appendix 7) Six of these culverts were considered to provide potential barriers to migration of anadromous and/or resident fish. None of these culverts were considered to be a high priority for replacement. Three culverts in the Tanner Creek and Scoggins-Parsons Creek subwatersheds were identified as moderate priorities for replacement. These were located on roads 223600 and 234000 where they crossed Tanner Creek, and road 248600 where it crossed Wall Creek.

During field trips in association with this report, many incidences of private roads with deficient culverts were noted. Deficiencies included blocked culverts, undersized culverts, and culverts with large drops. From these spot observations, it appears that many culverts on private land in the watershed need replacement. Additionally, improperly cleared ditches, impaired drainage and blocked culverts resulted in erosion of runoff channels across the roads, potentially contributing to sediment contributions to downslope channels.

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3.1.5.2 Warm-water fisheries

Henry Hagg Lake supports a warm water fishery comprised of game species including smallmouth bass, largemouth bass, and yellow perch as well as non-game species such as yellow and brown bullhead (Murtagh et al. 1992). Although the bulk of the Henry Hagg Lake fishery is composed of non-game species, these warm water fish now provide important recreational activities within the watershed.

3.1.5.3 Survey and manage mollusks

Of the eight mollusk species potentially found within the Tillamook Resource Area, none are known to inhabit the Tualatin subbasin. However, due to the limited knowledge of the range of many mollusk species the Resource Area does conduct surveys of project areas within the watershed. The eight species thought to occur in the Tillamook Resource Area are:

Cryptomastix devia	Puget Oregonian
Derocerus hesperium	evening fieldslug
Hemphillia burringtoni	keeled jumping slug
Hemphillia glandulosa	warty jumping-slug
Hemphillia malonei	Malone jumping-slug
Megomphix hemphilli	Oregon megomphix
Prophysaon coeruleum	blue-gray tail-dropper
Prophysaon dubium	papillose tail-dropper

3.1.5.4 Amphibians

Many amphibians depend on riparian and wetland habitats. Worldwide, the reduction in area of such habitats has resulted in a corresponding reduction in amphibian numbers. Additionally, native frogs in western states have largely been outcompeted by the introduced bullfrog. Riparian-dependent amphibian species of interest in the Upper Tualatin-Scoggins watershed include the red-legged frog, tailed frog, Columbia torrent salamander, and the western toad. The clouded salamander is also of interest, but it generally is associated with upland forested habitat, specifically snags, fallen trees, and rotten logs.

<u>Red-legged frog</u> (*Rana aurora*) (BS)

The red-legged frog is likely to occur within the Upper Tualatin-Scoggins watershed. They generally breed in marshes, small ponds and slow-moving backwater areas. During the non-breeding season they are highly terrestrial, commonly venturing into forested uplands. Past forest management practices which involved altering cool, moist riparian and forest floor habitats, such as clearcut harvesting of riparian and upland areas, may have adversely impacted the quality and quantity of red-legged frog habitat within the watershed (Csuti et al. 1997).

<u>Tailed frog</u> (*Ascaphus truei*) (BA, SS)

Tailed frogs may be present in this watershed. The most likely locations of the tailed frog are in the western portion of the watershed.

Important habitat types for tailed frogs include cold streams with rocky substrate and adjacent riparian forests. In portions of its range, this frog has experienced a severe

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decline in population. Increased stream temperatures and stream sedimentation from timber harvest and road building activities have been suggested as possible causes for this decline (Csuti et al. 1997).

Columbia torrent salamander (*Rhyacottriton kezeri*) (BS, SS)

It is likely that Columbia torrent salamanders are present in the watershed. The most likely locations of these amphibians exists in the Coast Range subwatersheds.

Western Toad (*Bufo boreas*) (SS)

Western toads may be present within the watershed. It is adaptable to many habitat types, so could be found in any aquatic or wetland setting. Although this amphibian is abundant in Oregon, it has been extirpated from many areas (Csuti et al. 1997).

3.1.5.5 Reptiles

Western pond turtle (*Clemmys marmorata*) (FC, SS)

This reptile is most likely to occur in the valleys of the eastern portion of the watershed, although it may also be found in small ponds and marshes in the Coast Range. Populations in the Willamette Valley have experienced steep declines. Introduced predators including the bullfrog have been implicated in these population declines (Csuti et al. 1997).

Important habitat includes quiet water habitats, such as ponds, marshes, and slow moving floodplain streams. Pond turtles need basking sites, such as logs and rocks, adjacent to these aquatic habitats (Csuti et al. 1997).

3.1.5.6 Other riparian and wetland-dependent species

Riparian and wetland areas provide habitat for many bird species in the Upper Tualatin-Scoggins watershed. These include migratory songbirds, as well as wood ducks and mallards, which nest in riparian areas. Seasonal flooding and farm ponds add to the available habitat for waterfowl. Species using such habitats include Canada geese, tundra swan, mallard, wood duck, American widgeon, ring-necked duck, lesser scaup, green-winged teal, northern pintail, and American coot (ODEQ and USA 1982).

3.2 Terrestrial

3.2.1 Vegetation

3.2.1.1 Array and landscape pattern of vegetation

3.2.1.1.1 Vegetation in the Wapato, Patton, and Scoggins valleys

The watershed's valleys and adjacent foothills are within the interior valley zone described in Franklin and Dyrness (1973). Historically, the valley floors in this zone were dominated by overstories of Oregon white oak (*Quercus garryana*). Interspersed with the white oak were other tree species including bigleaf maple and Douglas-fir. Common understory plants included western hazel (*Corylus cornuta*), swordfern

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(*Polystichum munitum*), Saskatoon serviceberry (*Amelanchier alnifolia*), mazzard cherry (*Prunus avium*), common snowberry (*Symphoricarpos albus*), and Pacific poison oak (*Rhus diversiloba*). These hardwood forests were often interspersed with prairies, some of which were created through human actions such as burning. Under natural circumstances, riparian communities in this zone are often forested, with dominant vegetation consisting of bigleaf maple, black poplar, and various willows.

In the foothills, the oak woodlands of the valleys naturally grade into conifer forest. Douglas-fir is naturally a dominant component of the Willamette Valley foothills conifer forest, and under natural conditions, grand fir (*Abies grandis*) and bigleaf maple are also important components (Franklin and Dyrness 1973).

Currently, the most of the valleys and a portion of the adjoining foothills are in agriculture. These agricultural areas comprise roughly 23% of the watershed[27]. Much of the natural vegetation has been removed from these areas. Where such vegetation exists in upland zones, it is typically comprised of small stands of Oregon white oak and Douglas-fir. The riparian zone is generally narrow and patchy, with vegetation types varying from riparian forest to herbaceous. The riparian forests are generally dominated by Oregon ash, black poplar and large willows, while riparian shrublands are dominated by Himalayan blackberry, red-osier dogwood (*Cornus sericea*), wild rose (*Rosa nutkana*) and willows. Smaller tributaries and highly disturbed reaches are often with reed canarygrass and other herbaceous vegetation.

Width of the riparian buffer in the valleys is usually quite limited (Risley 1997, also see Appendix 8). Although the forested buffer on the Tualatin River between Cherry Grove and Hering Creek is quite wide, the stream channel is also wide and most of the river is exposed to sunlight. Most of the buffer along the Tualatin River east of Hering Creek consists of a single width of trees, and has wide channels all the way to Gaston. Downstream of Gaston, much of the river is channelized with a single width of vegetation, although the vegetation improves downstream of the confluence with Scoggins Creek. Streams in the Wapato and Patton valleys generally have severely compromised buffers, and lack woody vegetation over most of their length. Along its lower course, Scoggins Creek generally had narrow riparian buffers similar to those of the Tualatin River (Risley 1997), although visual examination of aerial photography indicated that the buffers were in better condition than those of the Tualatin River between Cherry Grove and Gaston.

3.2.1.1.2 Vegetation in the Coast Range and Chehalem Mountains

Most mountainous portions of the watershed area are within the western hemlock zone described by Franklin and Dyrness (1973). Over time, and in the absence of major disturbance, the eventual climax community would be dominated by western hemlock along with western redcedar. The few old-growth stands in this zone (400 to 600 years old), however, still retain a major component of Douglas-fir. Over time, insects, blowdown, disease and fire create gaps, releasing young trees and allowing shade-intolerant species to grow. The composition and density of seral forest stands in this zone depend on the type of disturbance, available seed source, and environmental conditions. Riparian and frequently disturbed areas in the western hemlock zone are commonly occupied by hardwood species, including red alder and bigleaf maple.

Currently, subclimax Douglas-fir dominates most stands in the watershed. Development of dense, even-aged stands of Douglas-fir is common in this area. This pattern is encouraged by extensively planting this species following timber harvest and intensively managing competing vegetation in the young developing plantations.

[27]Derived from GAP analysis GIS data. Map scale 1:250,000.

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Several plant associations similar to those described for the Siuslaw National Forest by Hemstrom and Logan (1986) are common in the watershed area. These include western hemlock / salal, western hemlock / vine maple-salal, western hemlock / swordfern, western hemlock / vine maple / swordfern, and western hemlock / dwarf Oregon grape-salal.

In the absence of stand-replacing disturbances such as catastrophic fire, windthrow, or timber harvesting, most forest stands in the watershed can generally be expected to progress through a series of stand conditions after they initiate, leading to the eventual culmination in the old-growth stand condition. The first stand condition is called **grass-forb**. This condition occurs after regeneration timber harvest and slash disposal. The quantity of vegetation on the area is relatively low. The area is dominated by herbaceous vegetation for the first year. Shrubs have typically not yet become dominant, but basal sprouts from a number of shrub species are evident. Although these areas have been planted with conifer seedlings, the trees are typically too small to be apparent at this stage. This stand condition may last from 2 to 5 years. In harvested stands, the amount of snags and down wood and snags is limited to unmerchanteable material left after harvesting, which is in sharp contrast to the large quantity of snags and down wood and snags following a major natural disturbance.

Following the grass-forb stage / condition is the **shrub** stand condition, which can last from 3 to 10 years. Shrubs and trees assume dominance. Tree cover is typically less than 30 percent. Red alder often dominates portions of stands, especially where mineral soil was exposed during logging or other disturbances. Red alder is favored by exposed mineral soil and full sunlight (Harrington et al. 1994). Basal sprouts from bigleaf maple may also attain site dominance. Both of these species readily overtop young conifers because their rapid rates of growth greatly exceed that of young conifers. Both red alder and bigleaf maple can become locally dominant if control measures are not taken.

The **sapling/pole** stand condition is typical of stands between 15 and 35 years of age. When tree densities exceed about 500 trees per acre in the early portion of this stage, conifer stands are typically pre-commercially thinned to densities ranging from 200 to 300 trees per acre to promote rapid tree growth. Thinning at this time prolongs the understory shrub and herbaceous components in the stand, which otherwise would begin to decrease as the amount of light reaching the forest floor is reduced from shading by the overstory trees.

The **small conifer** stand condition is characterized by a closed canopy dominated by conifers in a single layer and sparse ground cover because little light reaches the forest floor. This stand condition can last from about age 35 to 75. As tree densities continue to increase, stands slowly begin to thin themselves, in a process called “self thinning” as slower-growing trees die from suppression. The majority of the snags developed and woody debris added to the forest floor, therefore, are small. Trees growing under these crowded conditions will eventually develop relatively slender boles and small crowns. These trees are vulnerable to damage from breakage and windthrow, especially if an adjacent stand is harvested. Commercial thinning is often practiced at this stage. Thinning increases the windfirmness of the stand. Normally, many of the trees removed in thinnings are those which are suppressed and would have become the source of small snags and small woody debris. Thinning greatly promotes the development of understory vegetation.

In the **mature** stand condition, which usually begins at about age 80, the average diameter of the conifer trees, usually Douglas-fir, is 21 inches or larger. The overstory canopy has opened enough to allow some development of the understory. In intensively managed stands, tree diameters may approach those in some old-growth

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stands. But unless specifically managed for, the number of large snags and down logs in these stands is comparatively low. Natural stands in this condition may have nearly as much standing and down wood as is found in an old-growth stand.

Stands in the **old-growth/mature** condition are characterized by large-diameter overstory Douglas-fir trees, dying live trees, snags, abundant snags and down wood on the forest floor, replacement of Douglas-fir by shade-tolerant climax species such as western hemlock or western redcedar in canopy gaps. Stands often have multiple-layered canopies. The time necessary to develop these characteristics varies between stands, and reference figures for the beginning of the old-growth/mature conditions range between stand ages of 130 and 200 years.

Because of various disturbances and lack of conifer regeneration, some stands may be partly or totally dominated by hardwoods. These stands are referred to as **mixed conifer/hardwood** or **hardwood**. Red alder is the typical dominant species in these stands, with Douglas-fir occurring as a minor component in many stands. Red alder is a relatively short-lived tree, seldom attaining an age of more than 100 years, and alder stands generally maturing at age 60 to 70 (Worthington et al. 1962). Alder stands usually have a dense understory which often dominates these sites as the aging alder canopy begins to disintegrate. Douglas-fir cannot survive for extended periods under a dense alder canopy, so Douglas-fir seedlings persisting in these stands are rare. Shade-tolerant species such as western hemlock and western redcedar, however, can persist underneath the canopy (Harrington et al. 1994).

Stand condition in the watershed is shown in Table 3-12, Map 3-6, and Appendix 8. On lands not managed by BLM, about 10 percent of land area is occupied by stands in the mature structural stage (that is, dominated by trees 20-29 inches diameter at breast height (dbh)). A minute portion (0.1%) of stand area is occupied by trees greater than 29 inches dbh, indicating that stands in the mature/old growth condition are extremely uncommon. The majority of trees exceeding 29 inches dbh are found in small stands along canyons and streams in the Tualatin Headwaters, Sunday Creek, Lee Creek, and Scoggins Dam subwatersheds. The lack of mature, large-diameter stands limits the ability of these forested lands to provide snags, down wood, and instream large woody debris for ecological purposes (Section 3.2.2.3). Younger structural stages dominate forests in the watershed, comprising 58% of total watershed area. The majority of these stands (40% of total watershed area) are in the sapling/pole and small tree stages, which is consistent with the harvest and fire history of the watershed. Trees in this age class cover extensive areas, with older and younger stands being fragmented into small patches. Average patch size decreases in the eastern portion of the watershed as forestlands become intermixed with agricultural and residential land uses.

The distribution of BLM age classes is given in Table 3-13 and Map 3-7. Virtually all BLM lands in the watershed are forested. As is the case with other forested lands in the watershed, small trees represent the dominant stand condition on BLM lands. A total of 261 acres (7%) of BLM lands are in the 90-year age class or older. (This does not take into account a sizeable amount of timber between 80 and 85 years of age. A detailed analysis by the BLM Tillamook Resource Area found that 14% of BLM-managed land in the watershed was forested by structurally mature timber suitable to count toward the 15% requirement.) Although the proportion of this land in old growth is unknown, a stand with late-successional characteristics is located on land allocated as LSR (T1S, R5W, S19). It is likely that this is the best remaining late-successional stand in the watershed. Although it is unclear whether other late-successional stands currently occur on BLM lands, the other LSR in the watershed (T2S, R5W, S3) is also covered by mature timber. Other stands of mature timber are located on BLM parcels allocated as AMA (T1S, R5W, S1, NE1/4, S3, NE1/4, and S15, NE1/4). As previously stated, those late-successional stands that remain will be managed so as to avoid any loss of late-successional forest structure or function. Age characteristics of Riparian Reserves are

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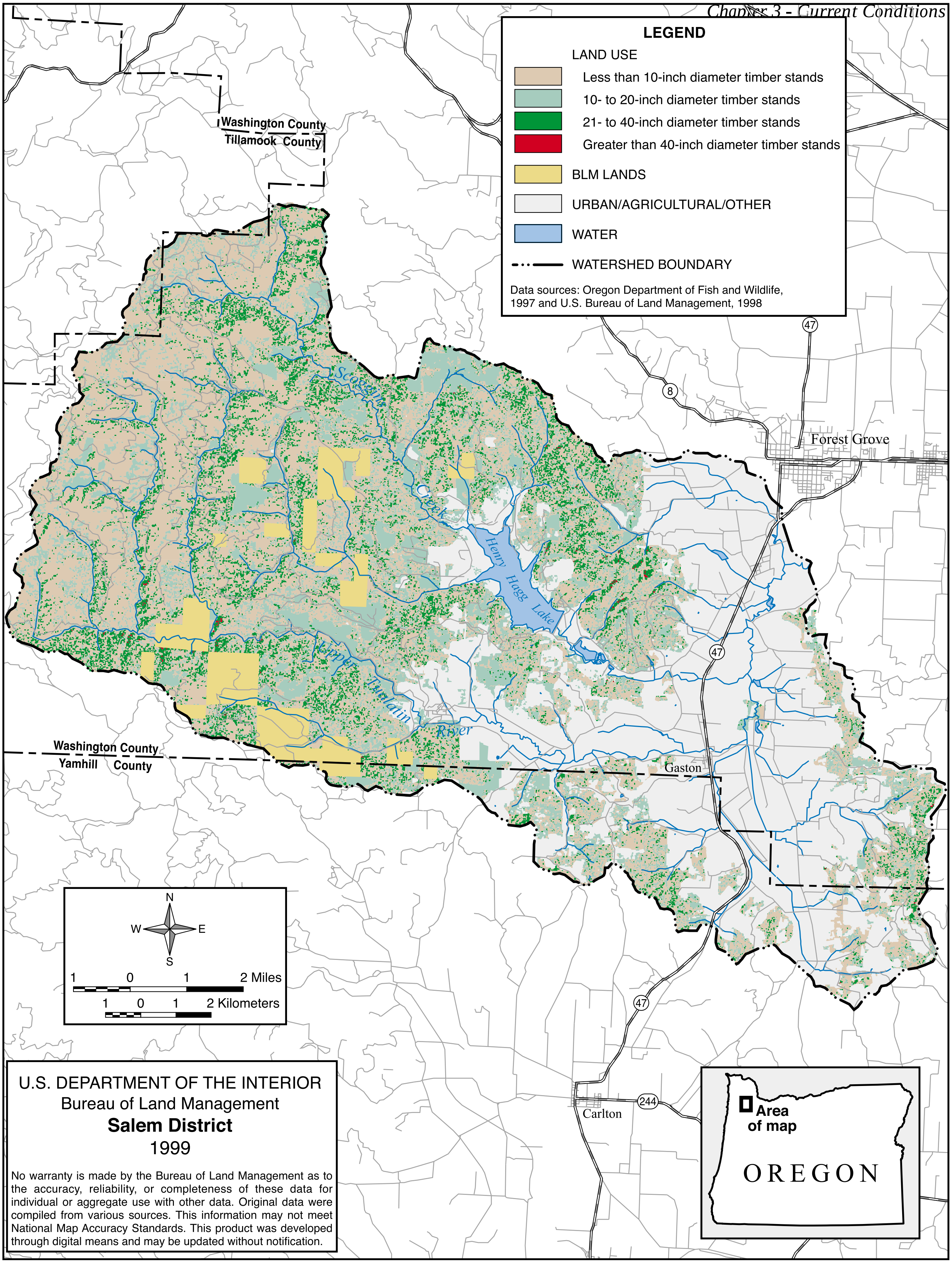

Map 3-6 -- Land Use and Land Cover for non-BLM Lands in the Upper Tualatin-Scoggins Creek Watershed.

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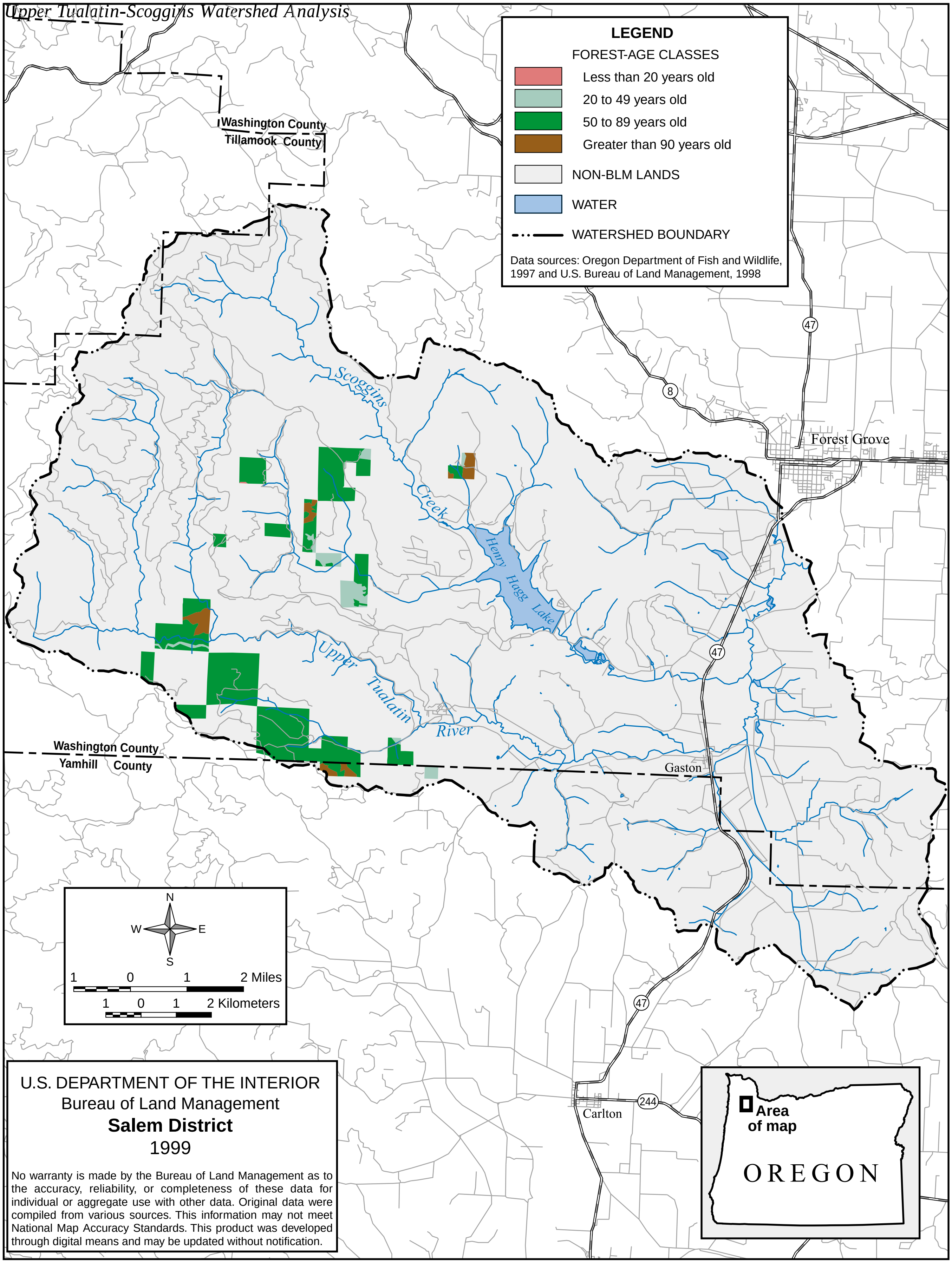

Map 3-7 -- Age Class of Forest Vegetation on BLM Lands in the Upper Tualatin-Scoggins Creek Watershed.

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Table 3-12. Size classes of forested lands on all ownerships.

Size class (inches)	Total area (acres)	percent of watershed
0 to 9	15,189	17.5%
10 to 19	35,087	40.4%
20 to 29	8,516	9.8%
over 29	87	0.1%
urban/agriculture	26,917	31.0%
other nonforested	1,076	1.2%
Total	86,871	100%

Table 3-13. Age classes of forest on BLM lands.

	Total area (acres)		Percent of allocation	
Age Class (years)	Riparian Reserves	Total	Riparian Reserve	Total
0 to 20	11	13	1%	0.3%
30 to 50	1,102	2,561	63%	68.1%
60 to 80	530	928	30%	24.7%
90 to 110	95	261	5%	6.9%
nonforested			0%	0.0%
Total	1,738	3,763	100%	100.0%

similar to those of other allocations, although the Reserves are likely to have a disproportionate amount of hardwoods. Virtually no harvest has occurred within the last 20 years on BLM land in the watershed.

Stand ages and composition of lands of all ownership in the forested subwatersheds have been significantly affected by fire. The human-caused Tillamook fires of 1933, 1939, and 1945 extended across the majority of forested lands within the watershed, and much of this land was burnt multiple times during this period. These fires consumed much of the previously existing vegetation, which, together with replanting efforts, caused the forest to be dominated by even-aged stands of Douglas-fir. At present, most of these stands are in small conifer stage, at an age where they would be suitable for harvesting under the current 50 to 60 year rotations employed by most private industrial operators.

3.2.1.2 Exotic/Noxious Plants

Exotic weeds have become established within both agricultural and forested regions of the watershed. Such species tend to outcompete native species, resulting in diminished populations of these species and reduced diversity. They tend to be aggressive colonizers on disturbed soils, and typically are found in fields, waysides, and other ruderal habitats. Eradication of these exotics is often difficult. In the Upper Tualatin-Scoggins watershed, common exotic plant pest species include Himalayan blackberry (*Rubus discolor*), reed canarygrass (*Phalaris arundinacea*), Scotch broom (*Cytisus scoparius*), and thistles (*Cirsium sp.*).

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These weed problems may be more pervasive in the heavily managed eastern portions of the watershed than in the Coast Range. During field studies in Coast Range subwatersheds, clearcut areas were observed that had not been colonized by Himalayan blackberry. This was notable, as Himalayan blackberry was pervasive in disturbed areas of the Dairy-McKay watershed. In the eastern portion of the watershed, the valleys had abundant Himalayan blackberry, which often formed the dominant vegetation in tributary riparian zones (e.g. Alexander Creek). Reed canarygrass was also common in riparian zones, and was ubiquitous in wetlands. Heavy growth of Scotch broom was noted on a clearcut hillside along Williams Canyon Creek and is also persistent adjacent to logging roads and rights of way.

In agricultural areas, certain exotic species are determined to be toxic to livestock, or otherwise have a substantial detrimental effect to agricultural operations. Many such plants are designated by the Oregon Department of Agriculture (ODA) as noxious weeds. Listed weeds of particular concern in the Upper Tualatin-Scoggins watershed include Scotch broom (*Cytisus scoparius*), tansy ragwort (*Senecio jacobaea*), and spotted knotweed (*Polygonum sp.*). Although gorse (*Ulex europaeus*) has not been found in Washington County, patches have been found in Columbia, Tillamook, and Clackamas counties. As gorse is an ODA Target (priority) noxious weed, any sightings should be brought to the attention of ODA personnel.

Several species may be added to the ODA noxious weed list in the near future. These include nursery plants such as giant reed (*Arundo donax*), and Pampas grass (*Cortaderia selloana*), as well as reed canarygrass and Himalayan blackberry. These species have proved invasive in California, and are currently to be reviewed for the potential for similar problems in Oregon.

Current ODA financing for abatement of noxious weeds is limited. However, financing requests before the Oregon Legislature would provide for funds to finance counties for special weed abatement projects and provide cost-share assistance to private landowners.

3.2.2 Terrestrial species and habitat

3.2.2.1 Abundance and habitat of terrestrial species

3.2.2.1.1 Economically important species

Game hunting is popular in the watershed. Popular big game species include Roosevelt elk, black-tailed deer, and black bear. Principal big game areas include the Tualatin River drainage above Cherry Grove and the Scoggins Creek drainage above Henry Hagg Lake (SRI 1990).

Roosevelt Elk (*Cervus elaphus roosevelti*)

Like most of western Oregon, Roosevelt elk is an important game animal within the watershed. Elk populations appear to be stable to slightly increasing (Tom Thornton, ODFW, personal communication). In the Upper Tualatin-Scoggins watershed, this has resulted in substantial conflicts with agricultural interests. These conflicts are greatest in locations adjacent to forested areas. ODFW is taking meatures to minimize encroachment of elk upon agricultural lands.

The abundance and distribution of Roosevelt Elk within an area is generally dependent on the amount of forage and cover and their distribution in time and space. Timber harvest can benefit elk by providing increased forage, provided that sufficient forested

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area is nearby to provide storage. BLM's checkerboard land ownership pattern within the watershed can benefit elk as the differences in management strategies between the BLM and private landowners is likely to result in the juxtaposition of cover and open foraging areas.

3.2.2.1.2 Special status and special attention species

3.2.2.1.2.1 Botanical Species

Special status species include federally listed species and those species listed by the Oregon Natural Heritage Program (ONHP). The ONHP lists species that are of concern because of diminished population or habitat. Those ONHP-listed botanical species potentially found in the Upper Tualatin-Scoggins Creek watershed are displayed in Table 3-14. Additionally, the NFP mandates that special attention be given to certain species that do not currently have special status. Although several common special status and special attention species are thought to occur in the watershed, their presence has not been confirmed because of the lack of surveys. Until these surveys are completed, little will be known about the distribution of special status and special attention species in the watershed.

Despite the limited survey data, three survey and manage lichen species have been identified in the watershed. All three species were located outside of BLM land in the Roaring Creek subwatershed (T1S, R5W, SW1/4, NW1/4). These lichens include:

- *Lobaria pulmonaria*
- *Nephroma resupinatum*
- *Peltigeria collina*

These nitrogen-fixing lichens are listed as category 4 species in the Salem District ROD/RMP, with the directive to "survey to determine necessary levels of protection and to acquire additional information about the species". Management stipulations for these species are found in Appendix J2 of the Final Supplemental Environmental Impact Statement (FSEIS) of the NFP.

In the Upper Tualatin-Scoggins watershed, special habitats for sensitive species are found both on BLM and private lands. These include wetlands[28]. The values for wetland habitats are especially important because they are a critical source of biological diversity. Wetland types include relatively large lowland marshes and forested wetlands of the valleys, as well as small ponds in the mountains. The location of wetlands identified under the National Wetland Inventory (NWI) is displayed in Map 3-2. Characteristics of these wetlands are summarized in Table 3-15. The NWI represents a conservative estimate of wetland area, as many valley bottom lands that are regularly inundated are not included. Additionally, the western part of the watershed was not included in the inventory. Although these wetlands potentially provide habitat for sensitive botanical species, that potential has been reduced in the valley wetlands because of extensive modification related to human uses. In particular, species composition has been altered and exotics such as reed canarygrass have replaced much of the native vegetation. Although ponds and other wetland areas in the mountains are generally quite small, they are potentially important sites for sensitive botanical species. Although these wetland ponds can arise from several causes, they are often associated with landslide deposits. These habitats are fragile and comprise an extremely small percentage of the public lands administered by the BLM. Wetland habitat protection is featured in BLM programs[29].

[28]For BLM management purposes, wetland habitats are defined by BLM Manual 6740.
[29]FLPMA- Section 102(a)(8) & (11) and enhancement planning Executive Order 11990).

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Table 3-14. List of Oregon Natural Heritage Program listed species that may be found within the Upper Tualatin-Scoggins Creek watershed.

				Federal	ODFW	ONHP
Fungi						
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Amanita novinupta	fungus	CR	Wash	…	…	3
Radiigera bushnellii	fungus	CR	Till, Yam	…	…	3
Vascular plants						
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Allium unifolium	one-leaved onion	WV	Yam	…	…	4
Cimicifuga elata	tall bugbane	CR, WV	Wash, Yam	SC	C	1
Delphinium leucophaeum	white rock larkspur	WV	Wash, Yam	SC	LE	1
Erigeron decumbens var. decumbens	Willamette daisy	WV	Wash, Yam	PE	LE	1
Horkelia congesta ssp. congesta	shaggy horkelia	WV	Wash	SC	C	1
Lupinus sulphureus ssp. kincaidii	Kincaid's lupine	WV	Wash, Yam	PT	LT	1
Montia diffusa	branching montia	WV	Wash	…	…	4
Poa laxiflora	loose-flowered bluegrass	CR	Till, Yam	…	…	4
Poa marcida	weak bluegrass	CR	Till, Yam	…	…	4
Sidalcea campestris	meadow sidalcea	CR, WV	Wash, Yam	…	C	4
Sidalcea nelsoniana	Nelson's sidalcea	CR, WV	Wash, Yam	LT	LT	1
Oligochaetes				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Driloleirus macelfreshi	Oregon giant earthworm	CR, WV	Yam	SC	…	1*
Gastropods				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Megomphix hemphilli	Oregon megomphix (snail)	CR, WV	Till	…	…	1*
Insects				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Mesovelia mulsanti	Mulsant's small water strider	CR, WV	Till	…	…	3
Acupalpus punctulatus	marsh ground beetle	WV	Wash	…	…	3*
Rhyacophila fenderi	Fender's rhyacophilan caddisfly	WV	Yam	…	…	4
Speyeria zerene hippolyta	Oregon silverspot butterfly	CR	Till, Yam	LT	…	1*
Fish				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Lampetra tridentata	Pacific lamprey	CR, WV	Till, Wash, Yam	SC	SV	3
Oncorhynchus clarki clarki	coastal cutthroat trout	CR, WV	Till, Wash, Yam		SV	3*
Oncorhynchus kisutch	coho salmon	CR	Till, Wash, Yam	C	SC	1*
Oncorhynchus mykiss	steelhead trout	CR	Till, Wash, Yam	FT	SV?	1*
Amphibians				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Aneides ferreus	clouded salamander	CR, WV	Till, Wash, Yam	…	SU	3
Ascaphus truei	tailed frog	CR	Till, Wash*, Yam	SC	SV	3*
Bufo boreas	western toad	CR	Wash	…	SV	3
Rana aurora aurora	northern red-legged frog	WV (SV)	Wash	SC	SV	3
Rana pretiosa	Oregon spotted frog	WV	Wash, Yam	C	SC	1*
Rhyacotriton kezeri	Columbia seep salamander	CR	Wash, Yam	…	SC	3*
Reptiles				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Chrysemys picta	painted turtle	WV	Wash, Yam	…	SC	2*
Clemmys marmorata marmorata	Northwest pond turtle	CR, WV	Till, Wash, Yam	SC	SC	2*
Contia tenuis	sharptail snake	CR, WV	Till, Yam	…	SV	4
Birds				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Brachyramphus marmoratus	marbled murrelet	CR	Till, Yam	LT	LT	1*
Branta canadensis leucopareia	Aleutian Canada goose (wintering)	CR, WV	Till, Wash, Yam	LT	LE	1*
Branta canadensis occidentalis	dusky Canada goose (wintering)	CR, WV	Till, Wash, Yam	…	…	4
Chordeiles minor	common nighthawk (SC in WV)	WV	Wash, Yam	…	SC	4
Contopus cooperi	olive-sided flycatcher	CR, WV	Till, Wash, Yam	SC	SV	3
Empidonax traillii brewsteri	little willow flycatcher	CR, WV	Till, Wash, Yam	SC	SV	3
Eremophila alpestris strigata	streaked horned lark	CR, WV	Wash, Yam	…	SC	3*
Haliaeetus leucocephalus	bald eagle	CR, WV	Till, Wash, Yam	LT	LT	1*
Icteria virens	yellow-breasted chat (SC in WV)	WV	Wash, Yam	…	SC	4
Melanerpes foricivorous	acorn woodpecker	CR, WV	Wash, Yam	…	…	3
Pooecetes gramineus affinis	Oregon vesper sparrow	WV	Wash, Yam	…	SC	3*
Progne subis	purple martin	CR, WV	Till, Wash, Yam	…	SC	3*
Sialia mexicana	western bluebird	CR, WV	Wash, Yam	…	SV	4
Strix occidentalis caurina	northern spotted owl	CR	Till, Wash, Yam	LT	LT	1*
Sturnella neglecta	western meadowlark	WV	Wash	…	SC	4
Mammals				Federal	ODFW	ONHP
Scientific Name	Common name	Ecoregion	Counties	status	status	schedule
Arborimus albipes	white-footed vole	CR, WV	Till, Wash, Yam	SC	SV	3
Corynorhinus townsendii townsendii	Pacific western big-eared bat	CR, WV	Till, Wash	SC	SC	2*
Lasionycteris noctivagans	silver-haired bat	CR, WV	Till, Wash, Yam	…	SU	3
Myotis evotis	long-eared bat	CR, WV	Yam	SC	SU	4
Myotis thysanodes	fringed bat	CR, WV	Till	SC	SV	3*
Myotis volans	long-legged bat	CR, WV	Till, Wash, Yam	SC	SU	3*
Sciurus griseus	western gray squirrel	CR, WV	Wash, Yam	…	SU	3

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Table 3-15.. Characteristics of NWI wetlands in the Upper Tualatin-Scoggins watershed. (Source GIS analysis of data on Tualatin River Watershed Information System).

System	Acres	%Type	Class	Acres	%Type	Water Regime	Acres	%Type	Modifiers	Acres	%Type
Lacustrine*	1173.7	65.01%	Aquatic Bed	19.4	1.07%	Permanently flooded*	1200.3	66.48%	Natural	500.9	27.74%
Palustrine	627.9	34.78%	Emergent	322.4	17.86%	Semipermanently flooded	35.4	1.96%	Diked/Impounded*	1176.6	65.16%
Riverine	3.9	0.22%	Forested	197.1	10.91%	Seasonally flooded	412.0	22.82%	Excavated	97.8	5.42%
			Scrub-shrub	34.8	1.93%	Temporarily flooded	134.4	7.44%	Partially Drained/Ditched	30.3	1.68%
			Uncon. Bottom*	1227.7	68.00%	Saturated	0.4	0.02%			
			Uncon. Shore	4.1	0.23%	Artificially flooded	23.1	1.28%			
Total	1805.6	100.00%		1805.6	100.00%		1805.6	100.00%		1805.6	100.00%

*Henry Hagg Lake comprises about 1,100 acres of this wetland type.

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Table 3-16. Agricultural statistics for farms in the Gaston zip code area.

	97119 Gaston	Total	Proportion in class
# Farms	159	159	100%
# , farm size less than 50 acres	109	109	69%
# , market value of agricultural products sold < $10,000	114	114	72%
#, market of agricultural products sold $10,000 to $99,999	31	31	19%
#, market value of agricultural products sold >$99,999	14	14	9%
# nurseries	17	17	11%
# dairy farms	6	6	4%
Operators, principal occupation is farming	66	66	42%
Operators, named other (non-farming) principal occupation	93	93	58%
Farms where crops were harvested	109	109	69%
Farms where cropland was used for pasture or grazing	51	51	32%
Cropland not harvested nor pastured	9	9	6%
Farms with woodland	84	84	53%
Farms with pastureland and rangeland	29	29	18%
Farms where cattle and calves were raised	54	54	34%
Farms where swine were raised	7	7	4%
Farms where sheep and lambs were raised	11	11	7%
Farms where hens and pullets were raised	9	9	6%
Farms where horses and ponies were raised	40	40	25%
Farms where corn for silage was raised	1	1	1%
Farms where wheat was raised	20	20	13%
Farms where barley was raised	4	4	3%
Farms where oats were raised	14	14	9%
Farms where land was used for hay production	45	45	28%
Farms where vegetables were produced for economic purposes	14	14	9%
Farms with orchards	37	37	23%
Farms where berries were produced for economic purposes	5	5	3%

Source: Oregon Agricultural Census, 1992.

Another sensitive habitat for botanical species are the few areas containing vegetation with late successional characteristics. On BLM land, these areas include the Late Successional Reserve (LSR) that is located in the Lee Creek and Tualatin Headwaters subwatersheds (T1S, R5W, S19). The LSR in the Roaring Creek subwatershed (T2S, R5W, S3) also potentially has forest of this type. According to the Salem District Record of Decision and Resource Management Plan, the objective for the designation of LSRs is to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest-related species. Through habitat protection and enhancement, LSRs are intended to develop and maintain a functional, interacting, late-successional and old-growth forest ecosystem.

Other potentially sensitive habitat types on BLM land include oak/ash savanna (because of its rarity on BLM land), rocky outcrops, and areas of thin soil (TPCC withdrawn areas).

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3.2.2.1.2.2 Amphibians

Clouded salamander (*Aneides ferreus)* (BS)

Clouded salamanders are terrestrial amphibians that inhabit large decaying logs, stumps, and snags. Although their presence has not been verified, it is very likely they occur within the watershed. Current management strategies on private lands involve short timber harvest rotations, which could limit the long-term maintenance and/or development of habitat for clouded salamanders on these lands. However, field observations taken in connection with this watershed analysis indicated areas of abundant downed woody debris, even in forest of young age. This abundant debris may be a remnant of the Tillamook Burn and may provide good habitat for clouded salamanders. Management of federal lands within the Upper Tualatin-Scoggins watershed provides for development of late-successional habitat within Riparian Reserve and Late Successional Reserve allocations. Current timber harvest standards and guidelines mandate retention of green trees, snags, and down wood. These policies should provide for the long-term maintenance and/or development of habitat for clouded salamanders on federal lands.

3.2.2.1.2.3 Birds

Northern saw-whet owl (*Aegolius acadius*) (BA)

These small owls have been observed near Henry Hagg Lake (Gillson 1998). They are likely to occupy other densely forested portions of the watershed.

Marbled murrelet (*Brachyramphus marmoratus*) (FT)

Habitat. The forest-dominated portion of the Upper Tualatin-Scoggins watershed lies in a band that is from 23 to 38 miles from the ocean, mostly within Marbled Murrelet Zone 1 as identified in the FEMAT report (FEMAT 1993). There is no designated critical habitat within the watershed.

Based upon stand age, approximately 10% of the watershed (8,864 acres) is potential marbled murrelet habitat[30]. The majority of this potentially suitable habitat (97%) is on nonfederal land, with the remaining 3% (261 acres) being managed by the BLM. Given that industrial timber companies tend to manage on an economic rotation, it is probably safe to assume that much of the potentially suitable murrelet habitat on private land will be harvested within the next 10 years. The majority of federal habitat acres are located on lands allocated as LSR or Riparian Reserves. The largest single block of suitable land lies on land allocated as LSR (T1S, R5W, S19).

The amount of annual rainfall within the watershed (45-110 inches) is the highest within the Tualatin River basin, and in the Coast Ranges is favorable to moss accumulation and has a high potential for the development of future murrelet habitat. Management of federal lands in LSR, Riparian Reserve, and AMA land allocations should favor the development of murrelet habitat on these lands. Intensive management on private lands is expected to limit the development of murrelet habitat.

Opportunities for development of marbled murrelet policies in the Tillamook State Forest will be governed by state policies. According to the draft Western Oregon Habitat Conservation Plan, the state policy is to "promote the conservation of marbled

[30]This assumes that most murrelet habitat will be found in structurally mature forest, the extent of which has been determined by calculating watershed area with stands exceeding 21" (all lands) or greater than 80 years age (BLM).

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murrelets in the appropriate geographic area" by maintaining existing high-quality murrelet habitat and "using silvicultural techniques to accelerate the development of murrelet nesting habitat" (ODF 1999).

Sites – There are no known, occupied or historical marbled murrelet sites within the watershed. The greatest likelihood for murrelet sites would be along the western headwaters of the watershed.

Northern spotted owl (*Strix occidentalis*) (FT)

The spotted owl population within the Oregon Coast Range Province is extremely low and in a significant decline (The Draft Recovery Plan for the Northern Spotted Owl – 1991). Designated as an Area of Concern for recovery of the spotted owl by the US Fish and Wildlife Service (USFWS), this is especially true for the northern portion of the Coast Range Province where habitat is severely limited and poorly distributed. Although the Upper Tualatin-Scoggins watershed is located east of the Coast Range summit and therefore actually in the Willamette Physiographic Province, the situation for spotted owls within the watershed is just as poor. There is commonly a substantial distance between areas of suitable habitat, which may not be in a condition to facilitate dispersal. This general lack of suitable and dispersal habitat within the watershed (especially on private lands) results in localized isolation, which coupled with the larger regional isolation greatly reduces the prospect for owl recovery in the portion of the state containing the Upper Tualatin-Scoggins watershed.

Habitat – The Upper Tualatin-Scoggins watershed contains no spotted owl designated critical habitat.

In general the spotted owl habitat in and around the Upper Tualatin-Scoggins watershed is very poor; it is very highly fragmented and uniformly young; only approximately 10% of the forested stands within the watershed (8,863 acres) are older than 80 years. An undetermined but far smaller portion is older than 130 years. Additionally, large barriers to dispersal, (blocks of non-habitat less than 20 years old, and from 0.5 to 1.5 or more square miles in size) are not uncommon across the landscape.

Sites - There are no known historical or current sites of spotted owl occupancy within the watershed. However, few surveys have been performed to determine the presence of spotted owls. Due to the present lack of unfragmented late successional habitat, it is considered unlikely that spotted owls could successfully occupy the watershed until older-forest conditions improve.

Northern bald eagle (*Haliaeetus leucocephalus*) (FT)

Habitat- Bald eagles utilize snags for roosting and nesting, and prefer sites near open water to ensure food availability. Although snags are not abundant in the Upper Tualatin-Scoggins watershed, some snag habitat is available in the forested western portion of the watershed. Henry Hagg Lake offers forage opportunities, as it provides a concentrated aquatic area well stocked with fish. Current management strategies on private lands involving short timber harvest rotations could limit the development of habitat for bald eagles on these lands. Likewise, state forest management policies emphasize protection of existing bald eagle habitat and development of new habitat (ODF 1999). Management of federal lands within the Upper Tualatin-Scoggins watershed given the Northwest Forest Plan's land allocations (LSR, Riparian Reserve, and AMA) and Standards and Guidelines could provide for some long-term benefit to bald eagles. The long-term benefits to eagles resulting from federal management practices may include the improvement of foraging opportunities as salmonid stocks of concern improve or the development of roosting and nesting habitat on federal lands.

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The actual significance of these potential benefits is questionable given the small percentage of federal ownership within the watershed and adjacent lands.

Sites- Bald eagles are known to nest around Henry Hagg Lake (Gillson 1998).

<u>Pileated woodpecker</u> (*Dryocopus pileatus*) (BA)

Pileated woodpeckers are known to exist within the watershed. They are commonly observed around Henry Hagg Lake (Gillson 1998). During a field visit to the LSR located in the Upper Lee Creek subwatershed (T1S, R5W, S19), a pileated woodpecker was observed by researchers associated with this watershed analysis.

Pileated woodpeckers are dependent on some components of older forests such as large snags for drumming, roosting, nesting and foraging and a good supply of large snags and down wood for foraging. These woodpeckers are often observed foraging in young stands or even clearcuts if large stumps, snags or down wood are present. Current management strategies on the majority of private lands involve shorter timber harvest rotations, which could limit the maintenance or development of habitat for pileated woodpeckers on these lands and potentially lead to local extinction. Management of federal lands within the Upper Tualatin-Scoggins watershed given the Northwest Forest Plan's land allocations (LSR, Riparian Reserve, and AMA) and Standards and Guidelines (green tree, snag and down wood retention) should provide for some long-term benefit to pileated woodpeckers. These long-term benefits include the improvement of foraging and nesting habitat on federal lands.

<u>Red tree vole</u> (*Phenacomys longicaudus*) (S&M)

The red tree vole is a category 2 species under the S&M strategy (survey prior to activities and manage known sites). Being nocturnal and spending most of its life in the canopy of large coniferous trees, it is a difficult species to study. Consequently, abundance, habitat associations and population ecology of the species is not well understood. They are strongly associated with older forests and being poor dispersers are very vulnerable to local extinctions resulting from habitat loss and fragmentation. They require larger blocks of contiguous habitat or corridors connecting areas of suitable habitat; in the Oregon Coast Range, the mean stand size used by tree voles is 475 acres (75 acre minimum) (Maser 1981; Huff, Holthausen and Aubry 1992). The red tree vole is a species which has been identified as significantly benefiting from the Northwest Forest Plan's riparian reserve network to provide connectivity (USDA and USDI 1994c). Although they have been found in stands as young as 62 years old, it is thought, depending upon individual stand characteristics, that stands younger than 100 years old are unable to maintain viable populations (Carey 1991).

The Upper Tualatin-Scoggins watershed is within the range of the red tree vole (Csuti et al. 1997). Given the fact that a low proportion of forest stands are older than 80, the red tree vole certainly is likely to be very rare within the watershed, if it hasn't already been extirpated. The stands which have the highest potential of being occupied by red tree voles are located in the mountainous, forested western subwatersheds.

Current management strategies on the majority of private lands within and adjacent to the watershed involve shorter timber harvest rotations. This will limit the development of habitat for red tree voles on these lands. Since federal lands make up less than 10% of the upper Tualatin-Scoggins watershed, the Northwest Forest Plan does not provide a specific directive to maintain habitat or connectivity for red tree voles (USDA and USDI 1998). However, management of federal lands within the Upper Tualatin-Scoggins watershed, given the Northwest Forest Plan's land allocations (LSR, Riparian Reserve and AMA) and Standards and Guidelines, should provide for some long-term benefits to red tree voles. These benefits may include improved connectivity and the development or improvement of habitat on federal lands. Given the red tree vole's poor dispersal capability, significant increase of vole populations is unlikely.

NFP Bats

One of the leading factors in the decline of worldwide bat populations is the destruction of roost sites and hibernacula. Most bat species occurring in the Pacific Northwest roost, reproduce, and hibernate in protected crevices that fall within a narrow range of temperature and moisture conditions. There is a strong concern that the loss of snags and decadent trees from the widespread conversion of old-growth forests to young, even-aged plantations, human disturbance and destruction of caves and mines, old wooden bridges and buildings have significantly reduced the availability of potential roost sites.

The NFP (Northwest Forest Plan) identifies five species of bats that would benefit from additional habitat protection. Four of these five species have potential of being located within the watershed. These species include the fringed myotis, long-eared myotis, long-legged myotis, and the silver-haired bat. All of these bat species are known to inhabit immature coniferous forest and may forage near riparian areas, open areas, and along forest edges. In addition to caves, mines, and abandoned wooden bridges and buildings, large hollow trees may be used for roosting, hibernating, and maternity colonies. Surveys for these species are required if caves, mines, or abandoned wooden bridges and buildings are within or near a proposed project area.

There is little or no information concerning the population health or distribution of these species within the watershed. However, based upon the low abundance of suitable roosts they are expected to be present in low numbers or even absent from the watershed. To date, (October 1999) no surveys have been conducted within the watershed to determine the presence of Survey and Manage bats. There are no known sites within the watershed although there are a few specific areas that seem to have potential for occupancy.

<u>Long-eared myotis</u> (*Myotis evotis*), <u>Fringed myotis</u> (*Myotis thysanoides*) and <u>Long-legged myotis</u> (*Myotis volans*)

These three NFP species potentially found in the Upper Tualatin-Scoggins watershed are small nonmigratory, crevice-roosting bats with widespread distributions that use snags, decadent trees, buildings, bridges and caves for roosting and hibernating. All three are also identified as Bureau Sensitive (BS) under BLM Special Status Species Policy.

<u>Silver-haired bat</u> (*Lasionycteris noctivagans*)

The silver-haired bat is a relatively large, migratory, widely-distributed snag and decadent tree-roosting bat, although it may occasionally use buildings and caves for roosting.

3.2.2.2 Effect of ownership upon habitat management opportunities

Due to the limited and fragmented extent of federal ownership in the Upper Tualatin-Scoggins and surrounding watersheds, the character of the landscape pattern is strongly influenced by fires and management practices on private and state lands. While agricultural and urban patterns dominate in the valleys to the east, the forested western portion of the watershed is strongly dominated by early and mid-seral stage habitats. As a result, the few patches of mature forest in the watershed are dominated by high

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contrast edge habitat, with the watershed providing virtually no interior late-successional forest habitat. The Tillamook fires in the early part of the century were responsible for much of this pattern, but as timber stands approach harvest age, the pattern is likely to be perpetuated (and further fragmented) by intensive management on private lands. This effect will be mitigated somewhat on the Tillamook State Forest, where lands will be managed to produce a variety of stand conditions, with diverse structural forest components (ODF 1999). These components will include late-successional characteristics such as snags, multi-layered forest canopies, down woody debris, and forest gaps.

As a result of the general landscape pattern the ability of species dependent upon late-successional habitat to disperse within the watershed and the adjacent landscape has been limited. For these species, this has created a high degree of regional isolation.

Successful habitat management depends upon cooperation between landowners. In the mountainous northern and western portion of the watershed, the ownership pattern may facilitate partnership efforts; the state of Oregon, BLM and two industrial landowners own the vast majority of lands above Cherry Grove and Henry Hagg Lake. Lower in the watershed, partnership efforts are complicated by a fragmented ownership pattern. The presence of many owners and, in many cases, small parcels, leads to a fragmentation of ownership and habitat that complicates management efforts.

Industrial landowners, the Tillamook State Forest, and the BLM may present opportunities for cooperative habitat management efforts. The largest contiguous forest parcels are within such ownerships. Success of cooperative efforts with industrial landowners relies upon tailoring of habitat management plans that are consistent with industrial operations. Additionally, differences in management between ownerships may provide opportunities for learning in Adaptive Management Areas.

3.2.2.3 Current distribution and density of snags and down wood

Snags and down wood are characteristically produced by forest stands in mature/old-growth condition. Few of the timber stands in the Upper Tualatin-Scoggins watershed are in this condition. The Tillamook fires of 1933-1945 consumed virtually all of the old growth timber stands in the watershed. Additionally, most forested acreage was logged under practices that discouraged snag retention. Snag incidence in the watershed appears to be correspondingly low. In field observations, greater than expected densities of down wood were noted in young forests on private land. This abundance of down wood may be the result of trees downed during the Tillamook fires and windthrow events.

As with the rest of the watershed, lands managed by BLM have low snag densities. One notable exception is at an LSR (T1S, R5W, S19), where many snags were observed. Down wood also appears to be abundant in this parcel. Present federal timber harvest practices promote retention of snags and down wood, so abundance of these habitat elements is expected to improve in the future.

3.2.3 Forest resources

3.2.3.1 Forest productivity, diseases, and other pathogens

Laminated root rot, caused by the fungus *Phellinus weirii*, is widespread and has a major influence on the character of many Douglas-fir stands in the watershed. *P. weirii* readily infects and kills highly susceptible conifer species such as Douglas-fir and grand fir.

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Western hemlock is considered intermediately susceptible and western redcedar is thought to be resistant to the disease (Hadfield 1985). All hardwood species are immune. Tree-to-tree spread is through root contacts with infected roots or stumps (Hadfield et al. 1986). Affected trees are often windthrown when their decayed root systems are no longer able to provide adequate support (Thies 1984). Other trees often die standing. Douglas-fir beetles often attack and kill infected trees weakened by the disease. This disease, therefore, results in production of snags and down wood.

P. weirii infection centers often appear as openings in the forest containing windthrown, standing dead, and live symptomatic trees, along with a relatively well-developed shrub layer (Hadfield 1985). Centers may also contain hardwoods and less-susceptible conifers. Disease centers range in size from less than one acre to several acres in size. Centers expand radially at the rate of about one foot per year. Douglas-fir timber productivity levels in *P. weirii* infections centers are generally less than one-half of those in uninfected areas (Goheen and Goheen 1988). Timber losses in diseased stands may double every 15 years (Nelson et al. 1981). High levels of *P. weirii* infection (>25 percent of the area infected) generally preclude commercial thinnings in Douglas-fir stands, especially if disease centers are not well defined.

Insects also have the potential to threaten the health of forest stands. The Douglas-fir bark beetle, *Dendroctonus pseudotsugae*, causes most of the insect damage in the Upper Tualatin-Scoggins watershed. This beetle typically attacks trees that have been weakened by other factors (USDA and USDI 1997). Beetle infestations may reach levels of concern at sites where large amounts of dead wood are present.

3.2.3.2 Late Successional Reserves

In developing a conservation strategy for late-successional forest-associated species, the Northwest Forest Plan designated a network of Late-Successional Reserves (LSRs) across the Pacific Northwest. This reserve network is designed to protect habitat for late-successional forest species where habitat conditions are relatively intact, and to promote the development of late-successional forest habitat conditions where such habitat is limited, and the associated plant and wildlife populations are low. Over the next 50 to 100 years, populations of late-successional forest species are expected to stabilize within the larger LSR blocks and eventually increase in response to improving habitat conditions. Populations of late-successional forest species outside of the reserves are expected to decrease over time and may eventually disappear.

Two LSRs blocks are located within the Upper Tualatin-Scoggins watershed. The larger of the two covers 521 acres in the Upper Lee Creek and Upper Tualatin-Maple Creek subwatersheds (T1S, R5W, S19). The smaller parcel is nearby in the Roaring Creek subwatershed (T2S, R5W, S3) and has about 55 acres allocated as LSR. With careful management, there is the possibility that the larger of the two parcels could provide connectivity for species with large home range relying on late-successional habitat, provided that other stands with late-successional habitat were not too great a distance away.
Additionally, these LSRs potentially provide important habitat for species with small home ranges. The abundance of snags and down wood in these LSRs potentially provides roosting habitats for bats. They also contribute toward federal objectives for late-successional forest. Presently, about one-third of the acreage designated as LSR is in late-successional habitat. Within the next 30 years, more than 15% of the BLM lands in the watershed should acquire late-successional characteristics, as those stands now 50 years of age or greater will then be more than 80 years old.

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3.3 Social

3.3.1 Human uses

3.3.1.1 Economic Uses

3.3.1.1.1 Urban/Rural residential

Washington County is the fastest growing county in Oregon in terms of population. Rapid growth has characterized Washington County throughout the latter half of the 20th Century. Between 1960 and 1997, county population grew by 317%. Although most of the growth has taken place outside the watershed, it has generated additional demands upon watershed resources.

The only area within the watershed zoned for urban uses is within Gaston, which represents a minute portion of watershed area. As such, Gaston is not expected to provide large effects on the hydrology of the area, neither is it expected to provide large new demands on infrastructure. However, its position adjacent to the Tualatin River may have some impacts on water quality.

Most growth within the watershed is expected to be associated with rural residential uses. About three percent of the land in the watershed is zoned for rural residential uses. Most such land is located along the Highway 47 corridor north of Scoggins Creek, in the Chehalem Mountains (Hill Creek and Ayers Creek subwatersheds) adjacent to Laurelwood and Bald Peak, and surrounding Cherry Grove. Although land use is less intensive than is the case with urban uses, rural residential uses provide their own challenges. In some cases, they can lead to accelerated erosion and mass wasting. In the Chehalem Mountains, in particular, accelerated erosion was noticed that was associated with rural residential land use. Additionally, rural residential uses also typically rely on septic systems, which, if faulty, can contribute to water quality problems.

3.3.1.1.2 Agriculture

Agriculture is the major economic activity in the watershed's valleys and adjacent hillslopes. In 1997, the total value of crops in Washington County was estimated at $173,914,000, with livestock activities adding $14,003,000 in value (Preliminary data from OSU extension economic information office). As the Upper Tualatin-Scoggins watershed contains about 13% of the agricultural land in Washington County, it is reasonable to believe that the watershed produces about $24,000,000 in agricultural products annually. Statistics from the 1992 agricultural census for the Gaston zip code were analyzed to ascertain the characteristics of farming operations in the watershed (Table 3-16). Gaston was chosen because it was completely within the watershed, while the watershed only represented a minor part of other zip code areas. However, the analysis revealed characteristics similar to those found elsewhere in the Tualatin Basin (e.g. see Hawksworth 1999). It should be noted that these statistics are classified by number of landowners, and not total acres in production. According these records, the vast majority of farms are small, with less than 50 acres in agriculture, and gross annual sales of less than $10,000. The large number of farms with low economic production reflects a large component of part-time farming. (More than 55% of the farmers who took part in the census named a non-farm activity as their primary occupation.) Additionally, it possibly indicates low earning margins and a vulnerability to increases in operating expenses.

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Hay and orchard fruits (including filberts) were the crops most commonly grown within the watershed. Production of nursery crops, wheat, and oats was also widespread. Livestock operations were common, with the majority of these operations raising cattle and calves. Pasture and grazing also were common agricultural activities.

The 1997 agricultural census summarized land area devoted to crop production for Washington County. These figures showed that the most cropland was devoted to wheat (17,020 acres), with hay (14,539 acres), orchard crops (8,403 acres), and vegetable production (8,167 acres) being the most widespread crops. Wheat and vegetables tended to be grown on relatively large farms, with mean plot sizes of 85 and 66 acres, respectively. Hay and orchard crops were typically raised on smaller farms. Twice as many farmers raised these crops as raised wheat, but mean plot sizes for hay and orchard crops averaged 33 and 18 acres, respectively. Although similar information was not summarized for the Upper Tualatin-Scoggins watershed, it is likely that farm characteristics in the watershed would be similar to those for Washington County as a whole.

3.3.1.1.3 Forestry

Forestry is the dominant land use in the Upper Tualatin-Scoggins watershed. Thirty-two percent of the land is industrial forest, of which Stimson Lumber is the largest landowner. Between 1990 and 1995, 606,687 thousand board feet of timber were cut in Washington County. Of this total 64% (390,106 thousand board feet) were cut on private industrial lands. Over this period, the trend has been for increasing timber harvest as forests reach merchantable age.

The effect on local employment of increased harvest in the watershed is uncertain. Between 1996 and 2006, the Oregon Employment Department projects a 17% increase in employment in the agricultural and forestry sectors in Washington and Multnomah counties (OED 1998). However, the OED also expects employment demand for several timber-related positions to decline over the same period. In the two-county region, manufacturing related to lumber registered a slight decline between 1997 and 1998.

3.3.1.1.4 Mining

The most important mineral resource within the watershed is crushed rock. Both basalt and sandstone are quarried, and are commonly used for construction and road maintenance. According to the Oregon Department of Geology and Mineral Industries (DOGAMI) GIS coverage of Oregon mineral resources (contained in Ecotrust 1998) there are currently eleven active quarries in the Upper Tualatin-Scoggins watershed (Table 3-17). Most of these quarries are located in the Carpenter Creek and Ayers Creek subwatersheds. Additionally, there are a number of abandoned rock pits in the watershed (Table 3-18). Clay is extracted at one site in the Carpenter Creek subwatershed. Landfill is extracted from borrow pits at various watershed locations.

3.3.1.1.5 Conflicts between BLM and the public

In the Upper Tualatin-Scoggins watershed there are potential and existing conflicts between public use and federal land management activities. These problems are less serious in this watershed than in others, because no BLM lands are located near residential areas and because most of these lands are not readily accessible by road. However, potential problems exist where BLM lands are accessible from the Tillamook State Forest. In such cases, illegal dumping may be a problem, as it is a widespread problem on lands of all ownerships. In order to counter dumping and vandalism, and to minimize fire danger, many private industrial landowners have adopted a closed gate policy on their roads.

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Table 3-17. Current quarries in the Upper Tualatin-Scoggins watershed.
Source: DOGAMI data on Tualatin River Watershed Information System.

Subwatershed	Site	Product	Lat	Long
Carpenter Cr	Forest Grove Clay	Clay	45-30-25N	123-06-59W
Carpenter Cr	Carpenter Creek Quarry	Stone (Basalt)	45-30-17N	123-10-41W
Carpenter Cr	Vandering Crushed Rock	Stone	45-30-12N	123-10-37W
Carpenter Cr	Carpenter Creek Quarry	Stone (Basalt)	45-20-17N	123-10-41W
Scoggins Dam	Stimson Lumber Co.	Stone	45-29-47N	123-20-01W
Scoggins Dam	Oregon State Hwy. Div.	Stone	45-27-37N	123-10-14W
Tualatin-Hering	Quarry	Stone	45-26-54N	123-14-28W
Harris Cr	Persons Quarry	Stone	45-25-55N	123-06-38W
Ayers Cr	Gaston/Person Quarry	Stone	45-24-27N	123-04-59W
Hill Cr	Laurelwood Quarry	Stone (Basalt)	45-24-06N	123-04-31W
Ayers Cr	Quarry	Stone	45-23-03N	123-04-38W

Table 3-18. Historical quarries in the Upper Tualatin-Scoggins watershed. Source, Schlicker 1967.

T	R	Sec	Subsec	Subwatershed	Site name	Product
1S	5W	36	NE 1/4	Tualatin-Hering	Cherry Grove Quarry	Stone (Basalt)
1S	4W	10	NW 1/4	Carpenter Cr	Elliot Quarry	(not listed)
1S	4W	27	SW 1/4	Tualatin-Blackjack	Patton Valley Sandstone Quarry	Stone (Sandstone)
1S	4W	27	NW 1/4	Scoggins Dam	Scoggins Creek Sandstone Quarry	Stone (Sandstone)
1S	3W	32	SE 1/4	Hill Creek	Zaiger Quarry Prospect	Stone (Basalt)

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An additional potential impact to BLM lands that are accessible from State Forest lands is the possibility of adverse use by Off Highway Vehicles (OHVs). The Tillamook State forest permits use by such vehicles in some nearby lands, and the possibility exists that these vehicles may venture onto federal lands, with potential degradation of roads and nearby soils. OHV use, dumping, unauthorized fishing and swimming, and other conflicting activities have generated substantial problems near Barney Reservoir (USACE 1994). Although the roads adjacent to BLM lands are less heavily used than the Trask Mountain Road, the capacity for similar problems may exist.

3.3.1.2 Recreational opportunities

Recreational opportunities vary between urban and rural portions of the watershed. Urban areas typically have developed recreation opportunities, both indoor and outdoor. Indoor recreation is considered to impose the same types of demands and impacts on watershed resources and are not considered here. Outdoor activities include parks and golf courses.

The greatest amount of recreational activities are associated with Henry Hagg Lake and the surrounding Scoggins Valley Park. In 1997, more than 700,000 people visited Henry Hagg Lake (Washington County 1998). Diverse recreational activities are pursued at the lake, including picnicking, fishing, sightseeing, boating, swimming, water-skiing, sunbathing, jogging, hiking, and bicycling (SRI 1990). Many of these activities cannot be pursued anywhere else in the watershed. Picnicking opportunities also exist at Bald Peak State Park on the eastern edge of the watershed.

Other recreation in the watershed is typically dispersed. Such activities include nonconsumptive activities such as walking, jogging, and wildlife viewing. These activities should generally offer low impacts, although there is potential for wildlife disturbance and localized soil compaction. Additionally, the scenery of the area offers opportunities for pleasure driving. This activity places the same demands and risks upon the watershed as other driving activities. BLM lands offer limited potential for these activities.

Consumptive recreation includes hunting, fishing, and mushroom collecting. The Coast Range offers seasonal opportunities for hunting of Roosevelt elk, blacktailed deer, and bear. Small game species and waterfowl are also hunted in the watershed.

BLM lands afford limited opportunities for recreation. Due to limited access, it is unlikely that the BLM lands receive many visitors. However, recreationalists accessing nearby State Forest lands may use adjacent BLM lands for hiking, off road driving, hunting, and other recreational activities.

3.3.1.3 Cultural resources

Native Americans of the Tuality Tribe were known to occupy portions of the watershed near Wapato Lake (BLM 1979). Numerous artifacts have been found in the Wapato Valley. Additionally, pictographs exist on sandstone formations near Seth School in Patton Valley. The incidence of items of cultural significance is expected to be low in the mountainous western portion of the watershed, as use of this area by Native Americans was low. However, a trade road between the Coast and Wapato Valley did traverse the watershed's mountains, and cultural resources of interest could lie along the path of the road.

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3.3.2 Roads

There are approximately 477 miles of roads within the Upper Tualatin-Scoggins watershed, as listed on the BLM GIS system. Of these roads, 11.6 miles (2.4%) are on BLM lands, with BLM responsible for management of 5.9 miles of these roads. Additionally, BLM manages 1.1 miles of road on private industrial forest lands. BLM-managed roads are typically surfaced with rock, while non-BLM roads may either have natural surface or rock surface. Recently, BLM practice has tended toward construction of temporary natural-surfaced roads specifically for timber sales. After timber harvest is completed, roads where future entry is not considered likely are decommissioned and subsoiled for hydrologic needs. Roads where entry is anticipated often undergo temporary closure, accompanied by methods to restrict access such as waterbarring.

Roads are one of the leading sources of sediments in forestlands. Where poor road siting, construction, and maintenance practices occur, these roads can "contribute as much as 90% of all sediments" delivered to streams (Brooks et al. 1991 as cited in Wolf 1992). These practices are often associated with older roads that were sited on unstable soils, and built with steep vertical side cuts, improperly placed trench fills, road placement on side-hill fills, and improperly spaced and sized culverts. Recent studies indicate that improved road-building practices have resulted in a decrease in road-related landsliding and erosion (Dent et al. 1997). However, this improvement cannot be expected to be universal, as many older roads still remain and some new roads are poorly placed. This potentially poses a sedimentation risk to streams. Field observations in connection with this watershed analysis found numerous incidents of road-related slides from cutslopes and fillslopes on forested terrain.

Among the roads potentially posing a sedimentation risk are old, discontinued roads known are legacy roads. These roads are generally not on mapping systems; thus contributing to a discrepancy between road networks displayed on GIS systems and actual road networks. Many of these legacy roads have road numbers, indicating that they should have been included in the BLM road inventory system. Why they were not included is a data gap.

Legacy roads may be located by examination of old maps, timber sale records, and aerial photography. On aerial photographs, they often can be detected from visual cues such as linearly oriented alder trees. This vegetation typically occurs on the relatively uncompacted side and center of the road, which often accumulates organic material sufficient to offer suitable soil for plant establishment. However, these roads often have a hard pan a few inches below the surface, indicating that hydrologic function has not been restored. Although these roads potentially pose a erosion hazard, the threat of erosion may be mitigated by the vegetation of the road surface and the prior removal of any easily erodible material. On the other hand, where natural-surface roads are deeply cut into the ground, with little vegetation, they tend to channel runoff, leading to erosion and gullies.

There are many miles of existing roads constructed near streams. Some are showing sediment impacts, whereas others are seated into the ground base and are quite stable. Under current BLM standards, roads are located at the most stable feasible location to minimize sediment impacts to streams, with due consideration given to other resource concerns such as special habitats.

3.3.2.1 Condition of roads on BLM lands

Most roads currently existing on BLM lands in the Upper Tualatin-Scoggins watershed were built under old road design and construction standards. In general, these federal lands have not recently been managed for timber harvest, resulting in no new road

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construction. Some of these roads are showing signs of structural failure and slope erosion. For example, the BLM road in T1S, R5W, S33 and 34 has slipped out, and is a source of sediment to Roaring Creek. Most culverts on these roads are undersized and need upgrading. Additionally, a decrease in the land base affected by annual timber sales has resulted in reduced road maintenance, as road maintenance funds are dependent upon revenues from timber sales.

Efforts to improve road conditions on BLM lands are complicated by Reciprocal Right of Way agreements with adjacent landowners. These agreements allow each party the use of the other's roads, and construction of new roads as needed for forest management. Many of these agreements antedate the Northwest Forest Plan, and landowners covered by these older agreements are often not obligated to use current federal standard road construction and maintenance standards. An exception exists in isolated circumstances where the agreement specifically provided for landowners to adapt to changes in road construction and maintenance standards.

3.3.2.2 High risk areas for road-related slope failures

High risk for road-related slope failures can be expected at sites where roads cross sites otherwise identified with high risk for mass wasting. In the Upper Tualatin-Scoggins watershed, criteria for determining high risk include the presence of steep slopes. Typically, high risk sites for slope will be expressed as 60% or greater on the topographic map, and moderate risk slopes are expressed as 30 to 60% (Map 3-1). Both steep sedimentary and volcanic formations are potentially high risk sites for landslides. This risk is especially great at contact points between different lithologic units and bedding planes. The sedimentary formations, in particular, may be subject to rotational slumping at lower gradients.

Mountainous regions throughout the watershed should be considered at risk for landslides. However, the most extensive areas with slopes exceeding 60% are found in the Coast Ranges. The Tualatin Headwaters, Sunday Creek, Upper Scoggins Creek, and Tanner Creek subwatersheds, in particular, have large areas of steep, high risk, slopes. Additionally, the last two subwatersheds have a high potential to provide sediments to Henry Hagg Lake.

3.3.2.3 Road density

Road density provides an indication of the degree of habitat fragmentation caused by roads, as well as potential road-related mass wasting and sedimentation problems. For the watershed as a whole, mean road density was 3.73 miles road per square mile of watershed area. The density of roads varies among the subwatersheds, ranging from 2.11 mi/mi^2 in the Upper Scoggins Creek subwatershed to 5.20 mi/mi^2 in the Wapato Creek subwatershed (Map 3-8). The highest density of roads is found in the eastern corner of the watershed. These figures were determined through use of GIS. Due to legacy roads and new roads, actual road density in forested lands averages about 30 to 40% higher than figures determined through GIS analysis. The low densities on most of the headwater reaches are the result of steep topography and unstable terrain. BLM parcels, at 2.0 mi/mi^2, had lower road densities than other portions of the watershed.

According to the OWEB methodology (WPN 1999) roads have a minor effect in enhancing the peak flow of a subwatershed when roaded area constitutes less than 4% of total subwatershed area. Using the road densities listed on Map 3-8 and the OWEB-recommended default road width of 25 feet, total roaded area was calculated for each subwatershed. Total roaded area in each subwatershed was substantially below the 4% threshold, indicating that roads do not substantially change the hydrologic regime at the subwatershed level.

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3.3.2.4 Stream crossings

Stream crossing density provides an indicator of the potential for road-related sediment delivery to streams. For the watershed as a whole, mean road crossing density was 3.14 crossings per square mile of watershed area. The highest density of roads were found in the Wapato Creek subwatershed, where densities of roads and streams (including canals) are both high. High stream crossing densities were also noticed in some subwatersheds with high proportions of steep, unstable lands. These included Sunday Creek, Upper Lee Creek, Tanner Creek, and Hill Creek subwatersheds. This juxtaposition of road crossings and steep lands indicates a potential for high sediment inputs to streams. During field observations associated with this watershed analysis, researchers noted several sites in these watersheds where sediments were contributed to streams at the crossing sites.

3.3.2.4.1 Culverts

Concerns with culverts exist from both a flood control and a fish migration perspective. The migratory impacts of culverts are addressed in section 3.1.5.1. During culvert surveys, ODOT noted that one of 19 surveyed culverts had corrosion problems. No culverts were identified as insufficient to pass normal high flows (Appendix 7). It is likely that a high proportion of culverts would be insufficient to pass the flows of the 100 year flood. During field observations associated with the watershed analysis, researchers found that most culverts on forest roads were undersized for potential flows, and that they often contributed to sedimentation problems, either through blockage and subsequent channeled flow over roads or through high outfalls that eroded downstream points. At one location, there was a substantial washout downstream of a culvert that appeared to be associated with subsurface water flow. In this case, there was no clear evidence that this washout was associated with upstream blockage of the culvert.

In order to implement the Oregon Plan: Salmon Restoration Initiative, private industrial landowners are replacing undersized and improperly placed culverts to allow fish passage and to prevent washout. Recently placed culverts are 24 inches or greater in diameter and are designed for the 50-year flood event to comply with State Forest Practice Rules. These culverts are designed to reduce water velocity and jump height above pools to facilitate passage by juvenile salmonids.

3.3.2.5 Access to BLM lands

BLM lands are scattered throughout private industrial lands with very little access. There appears to be no existing means of accessing them except by using private industry roads. Generally, at least one side of each block of BLM ownership is adjacent to a private industrial road. The majority of land areas under BLM management do not have interior access by roads mapped on the BLM GIS system. There is a network of legacy roads not on the GIS inventory, which may enable interior access without new construction. Isolated subdivisions of BLM lands in the northern portion of the watershed are not under Reciprocal Rights with private industry for forest-related project needs.

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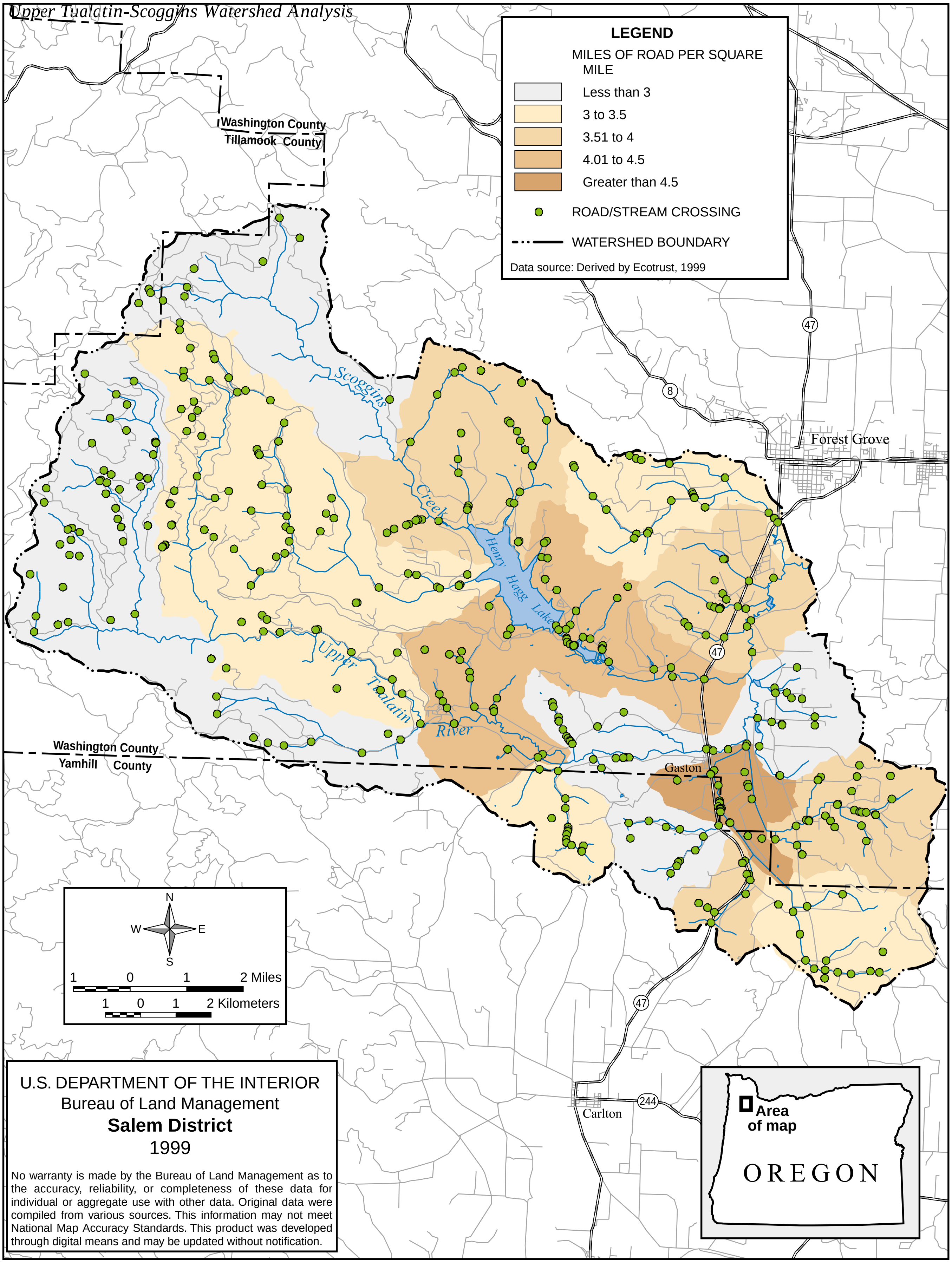

Map 3-8 -- Road Density and Road/Stream Crossings in the Upper Tualatin-Scoggins Creek Watershed.

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Chapter 4: Reference Conditions

4.1 Introduction

Reconstruction of reference conditions largely depends upon two sources. First, limited records are available giving the impressions of explorers and pioneers as they first saw this region. Although their information was not collected according to the scientific method, it offers valuable firsthand insights into the general distribution of landscape characteristics at the advent of Euro-American settlement. To a large degree, their impressions taken at specific locations can be extrapolated to describe strata within the entire watershed. That is, upland characteristics described at a specific valley location would be expected to be similar to nearby upland valley sites, and would likely be different from the characteristics of valley riparian zones.

The second source is the extrapolation of these impressions based upon geographical, geomorphic, and biological principles. For purposes of this report, the reference conditions are assumed to describe the period immediately prior to European settlement. At that time, geological and climatic influences would be similar to those currently experienced. Given pioneer accounts of the vegetational structure of the watershed, and assumptions of negligible human impact prior to this period we can formulate reasoned deductions related to erosion, hydrology, stream channel, and water quality parameters. Such deductions form a major part in the formulation of the reference conditions described below. They are not to be taken as absolute truth, but rather a reasonable description of assumed watershed condition prior to extensive human impact.

4.2 Erosion

Prior to human settlement, the vast majority of the Upper Tualatin-Scoggins watershed was heavily forested, with a large proportion of the watershed in old-growth timber. Such conditions would have provided little opportunity for surface erosion. Most surface erosion would occur in episodic pulses for about 20-40 years following stand replacement fire events. In the nearby North Yamhill watershed, such events were estimated as occurring every 200 years (BLM 1997). Thus, it is reasonable to believe that low surface erosion rates characterized the watershed about 80-90% of the time. Additionally, local increases in surface erosion would have been effected at locations where the tree canopy had been disturbed by large storms, wind, or disease.

Mass wasting processes would also have been episodic, being mainly associated with fires and major storm events. The rate of mass wasting (as well as surface erosion) would have been lower than present rates due to the lack of roads. The heavily timbered stands were probably less susceptible to mass-wasting than current clearcuts. However, recent studies by ODF show that mature timber can have landsliding rates similar to those for clearcut stands (Dent et al. 1997).

Streambank erosion would probably have occurred at lower rates than those presently observed. Most evidence from the early 1800s indicate that near-stream areas of the

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Tualatin subbasin were heavily vegetated. Similarly, most riparian areas would have been covered with dense vegetation, with the exception of the most poorly drained areas of the Wapato Valley. Although natural stream meandering would have resulted in bank erosion, the increased resistance provided by vegetation, roots, and large wood in streams would have slowed this process.

Where erosion did occur, less sediment would probably have been delivered to streams than is presently the case. Due to high relative humidity and lower fuel temperatures, many riparian zones were more resistant to fire than upland sites (BLM 1997). This effect was strongest in lower watershed elevations. Where riparian vegetation and surface cover remained intact, it would have provided resistance to surface flow and encouraged deposition. Substantial wetland areas and floodplains would also have provided opportunity for sediments to settle outside the active channel.

4.3 Hydrology and water quantity

4.3.1 Coast Range and Chehalem Mountains

In the Coast Range and Chehalem Mountains, hydrologic processes would probably have been similar to those currently occurring in forested portions of the watershed. Forested conditions would have led to high rates of interception. Thick layers of forest duff would readily have allowed infiltration. Evaporation rates were probably quite high, but it is not clear that these rates would have been different than those under present forested conditions.

Infrequent stand replacement fires (both natural and human-caused) would have altered the surface hydrology. Diminished soil infiltration capacity, along with decreased ground cover would have resulted in increased surface storm runoff. Reductions in evapotranspiration rates could have increased the quantity of water available to streams for up to 40 years (BLM 1997). During this period, increased summer flow would likely have resulted. These flows would gradually diminish as the fire-stricken areas revegetated themselves. Where these stands were replaced with deep-rooted hardwoods, evapotranspiration rates may have been above original levels, resulting in decreased streamflow (Meehan 1991).

Given the low frequency of natural disturbances, it is likely that much less of the watershed was covered with hardwoods than is presently the case. With fewer hardwoods, less evapotranspiration would have occurred, resulting in increased water availability for aquatic life.

4.3.2 Wapato, Patton, and Scoggins valleys

The hydrology of the valleys was substantially different than that now experienced. In the absence of regulated flow provided by water from Henry Hagg Lake and Barney Reservoir, summer low flows in the Tualatin River mainstem were much lower than those currently encountered. Similarly, winter peak flows downstream of Scoggins Dam were much higher, resulting in a higher frequency and duration of flooding. To a certain degree, the difference in summer low flow would have been compensated by the lack of flow diversion. The effects of diversion are substantial, as illustrated by changes in low flow in downstream reaches of the Tualatin River. In 1895, prior to both flow regulation and most diversion, the depth of the Tualatin River downstream of Hillsboro always exceeded 3 feet (Cass and Miner 1993). In the years immediately prior to creation of Henry Hagg Lake, the river was known to dry up (water rights seminar, Pacific

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University, October 3, 1998). These extremely low flows were not entirely attributable to flow diversion. In years of severe drought, very low flow conditions prevailed upstream of most diversion points. For example, in September of 1963, the Tualatin River at Little Lee Falls (immediately upstream of Cherry Grove) was diminished to 16 inches wide and a depth of four inches (Nixon and Tupper 1977).

Peak flows would likely have been lower due to retention in floodplains and wetlands. During winter flooding events, water would have been stored for substantial periods of time in floodplains, in Wapato Lake, and in other wetlands. In addition to benefits for sediment control and wildlife, these detained waters would have seeped slowly back into the creeks, thus moderating flood peaks and increasing the water available during lower flows. Some of this water would also have become available to replenish subsurface supplies. Additionally, greater in-channel vegetation and large woody debris would have reduced flow velocity and dissipated stream energy during high flows.
Although floodplains and wetlands would have helped to moderate flood peaks, downstream flooding would have been a frequent occurrence. Factors contributing to the flooding of the Tualatin River include the low gradient of the stream, and under reference conditions would have included the congested nature of the channels.

4.3.2.1 Extent of wetlands in the early Upper Tualatin-Scoggins watershed

Early trapper reports note that most lowland portions of the Tualatin subbasin, including the Wapato Valley, were wet and swampy (Cass and Miner 1993). Physical factors played the greatest role in creating these wetlands. Flat topography impeded the flow of surface water, while low soil permeability decreased infiltration. Additionally, locally high water tables would rise to the surface in the winter, creating standing pools of surface water (Hart and Newcomb 1965).

Large beaver populations in the Tualatin subbasin significantly contributed to wetland area (Cass and Miner 1993). Beaver dams blocked streamflow, resulting in decreased water velocity and extensive flooding. The ponds and marshes created by these dams improved water quality by removing sediments and nutrients from the water column. The nutrients stored in the wetlands were subsequently processed to forms more useful to many types of aquatic life (Shively 1993). These shallow wetland areas provided habitats suitable for many amphibian, aquatic and botanical species.

No record exists of the exact extent of wetlands under reference conditions. However, the former extent of lowland wetlands can be estimated by determining the total amount of the watershed underlain by hydric soils. By this measure, about 4,600 acres of the watershed was wetland under reference conditions. About _ of this wetland area would have been contained within Wapato Lake. Based on historical records, this wetland would have been seasonally flooded. Like almost all of the wetlands in the watershed, depth of water would have been shallow. The largest wetlands in the watershed would have varied from saturated to seasonally flooded regimes, with some beaver ponds and other small wetlands having permanently and semi-permanently flooded regimes.

4.4 Stream Channel

Stream channel characteristics would have been relatively stable prior to the time of human influence. Large inputs of woody debris during major storms were relatively stable over time, and would likely have persisted through the periods between

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disturbances. Sediment would have been input to streams and transmitted through the stream system in pulses corresponding to periods of high landslide rates. The routing of water and sediment through the watershed was controlled by the extent and condition of riparian vegetation, especially in the lower watershed where gradients are lower and the floodplain more developed.

As was historically the case throughout the Tualatin subbasin, most stream channels throughout the Upper Tualatin-Scoggins watershed likely had abundant riparian vegetation. In all but the most poorly drained areas, the natural vegetation would have been riparian forest. Riparian trees and their roots restricted channel width (Shively 1993). Additionally stream channels commonly had jams of woody debris. At times, these log jams were very extensive, both in mountainous and valley reaches of the Tualatin River. Jams ranging from 300 to 5,000 feet in length were observed in the valley reaches (Sedell and Luchessa 1982). The abundance of woody debris would have contributed to diverse instream structure. Hydraulic scour adjacent to instream wood would have created pools, resulting in high pool frequency. The large woody elements would also have retained spawning gravels, resulting in a greater amount of high quality spawning habitat than is currently encountered. These differences between the reference stream channel characteristics and current conditions would likely have been greatest in the valley reaches of the watershed.

There is little recorded information referring to channel dimensions and planform during early days of settlement. However, geomorphic theory indicates that valley streams within the watershed would have been naturally sinuous. This agrees with the current pattern on the least channelized streams in the valleys. The high silt-clay content of channel banks and substrate indicates that then, as now, channels had a low width to depth ratio.

4.5 Water Quality

Water quality prior to human intervention was partially a function of the condition and extent of riparian vegetation. Water quality characteristics would have varied widely across the landscape and over time as a result of the extent of disturbance of the riparian zone.

Under undisturbed conditions, abundant stream canopy would have provided for stream temperatures cooler than those currently experienced. It is unclear what the temperature regime would have been for wetland areas, nor for water contributed to streams from these wetlands. Although water stored in Wapato Lake and other wetlands would have received solar heating, most wetland contributions to streamflow would usually have proceeded through subsurface pathways, where temperature would have been moderated by the adjacent soil. During periods of major disturbance of riparian vegetation from fire or windthrow, water temperatures were elevated. In the periods between those major disturbances, water temperature was suitable for cold-water aquatic life in those areas with adequate riparian vegetation.

Sediment levels were similarly affected by disturbance events. Where the riparian vegetation was intact, it would tend to restrict sediment delivery to streams, both through binding of soil, and detention of sediment-laden runoff. Following disturbance, these factors limiting sediment contributions would be reduced, leading to accelerated sediment contribution to streams.

Nutrient levels in streams are likely to have been low under reference conditions. This is indicated by the low erosion rates, lack of human inputs, and the large amount of wetland storage that is considered to be prevalent at the time. Although some

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phosphorus would have been contributed through groundwater inputs from sedimentary rocks, valley sediments, and wetlands, surface inputs from erosion and runoff would have been low. For the same reasons, instream concentrations of nitrogen would have been low. Limited amounts of nitrogenous compounds would have been available from naturally occurring organic detritus. However, contributions of these substances from fertilizers, livestock, sewage and urban runoff would have been absent. The aforementioned factors indicate that stream water had relatively high concentrations of dissolved oxygen. Lower water temperatures would have increased stream capacity for oxygen, while reduced inputs of organic waste and nutrients would have reduced the biochemical demand for oxygen.

Contributions of bacteria would have been supplied by wildlife. However, these contributions were probably much lower than those presently attributable to livestock raising and septic systems.

4.6 Aquatic Species and Habitat

4.6.1 Fish

Historical fish habitat information is not available at this time. The amount and condition of fish habitat can be inferred from general vegetation descriptions of the land and estimated human impacts. It can be assumed that prior to extensive timber harvest, road construction and settlement, fish habitat was in better condition. For example, the prevalence of large woody material in stream channels created diverse instream structure and pools desirable for fish production and survival. Fish passage was not impeded by dams, water diversions, and culverts. Water quality was generally better except after major fires, landslides, and other large-scale catastrophic events.

Due to the mature state of most of the riparian timber in the watershed, streams received ample contributions of large woody debris. This is demonstrated by observations during the latter half of the 19^{th} century, when log jams 300-5,000 feet in length were noted on the Tualatin River (Sedell and Luchessa 1982). This would have contributed to higher pool development and greater instream habitat diversity, which would have been beneficial to aquatic life. Additionally, the mature riparian timber provided ample shade for streams. The resulting low water temperatures and high dissolved oxygen levels would have benefited salmonids and many other cool-water aquatic organisms.

Benefits from large woody debris would have extended to streams within the valleys. Although the extent of spawning substrates would probably have been similar to those currently occurring, the increased incidence of LWD-induced pools, as well as lower temperatures, would have provided better salmonid rearing habitat than is now currently available.

Prior to stream clearing and channelization, stream meanders would have provided greater length of total aquatic habitat. Additionally, this habitat would have been more complex. Instream wood provided cover elements for fish, as would tree roots in the banks and hanging vegetation.

It is likely that steelhead were the only native anadromous salmonid species with substantial populations in the Upper Tualatin-Scoggins watershed during the reference period. The presence of Willamette Falls restricted the distribution of sea-run cutthroat trout. Although chinook salmon have been known to utilize valley reaches of the Tualatin River and Scoggins Creek, it is unlikely that the watershed ever supported a

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large population of chinook salmon (Ward 1995).

Other streams throughout Western Oregon have documented declining trends for most salmonid species over the last century. This, along with the availability of better habitat, indicates that the watershed's historic populations of cutthroat trout and steelhead were larger than those occurring today. However, historical references to fish populations and habitat within the watershed are difficult to find.

4.6.2 Wetland and riparian dependent species

The relatively large extent of wetland and riparian areas would have provided a high carrying capacity for species dependent on seasonal, shallow wetland habitats. Historical accounts from nearby watersheds indicate that great numbers of waterfowl utilized these habitats (Fulton 1995). The smaller wetlands created by beavers provided particularly important habitat for pond turtle populations. Trees felled by beavers would have provided habitat for basking, foraging, and refuge (Altman et al. 1997). These extensive wetland habitats could also have sustained large amphibian populations. Amphibian communities would have consisted of native frog and salamander species. Many of these species, as well as the Western pond turtle, have dwindled since the introduction of the exotic bullfrog.

4.7 Vegetation

4.7.1 General regional characteristics

Most of the watershed area is within the western hemlock zone described by Franklin and Dyrness (1973). Old-growth stands in this zone still retain a major component of the seral species, Douglas-fir. In 1850, nearly 80 percent of the land area in the Oregon Coast Range north of Tillamook was essentially a continuous block of forest over 200 years old (Teensma et al. 1991). These extensive tracts of old-growth forest were broken by patches of 100- to 200-year-old stands and a very small amount of recently burned area. According to Oliver and Larson (1990), the general structural features of these old-growth stands typically include large, live trees; large, standing dead trees; variation in tree species and sizes; large logs on the forest floor in various stages of decay; and multiple-layered canopies. These stands also have a great deal of horizontal and vertical diversity.

To gain an appreciation of the characteristics of these forests, we can refer to the interim minimum standards for old-growth Douglas-fir described by Franklin et al. (1986). These include:

- Two or more species of live trees with a wide range of sizes and ages.
- Eight or more large (>32 inches diameter at breast height (DBH)) or old (>200 years) Douglas-fir trees per acre; however, most stands have 15 to 45 trees per acre, depending on stand age and history.
- Twelve or more individuals of associated shade-tolerant species per acre, such as western hemlock or western redcedar, that are at least 16 inches DBH.
- More than 15 tons of down logs per acre, including 4 pieces per acre more than 24 inches in diameter and greater than 50 feet long.
- Four or more conifer snags per acre. To qualify for counting, snags must be greater than 20 inches in diameter and more than 15 feet long.

Other features of these old-growth forests include a dense, multiple-layered canopy;

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decadence in dominant live trees as evidenced by broken or multiple tops and decay; and shade-tolerant climax species, such as western hemlock or western redcedar, in canopy gaps created through the death of the dominant Douglas-fir trees.

Wildfire, wind, and disease were the primary disturbance agents influencing the development of these stands. Wildfire appears to have been the most significant of these agents (BLM 1997). Although fire frequency in the Coast Range has not been determined, it probably occurs at intervals ranging from 150 to 350 years and was associated with east wind events (Teensma et al. 1991). These rather infrequent fires, however, were high-intensity, catastrophic, stand-replacement events. Although the proportion of the fires attributable to human action is uncertain, it seems likely that human-caused fires dominated the pattern of fire occurrences in the Coast Range both before and after European settlement. Lightning was probably not a major cause of fires, especially since fire protection and cause determination began in 1908.

Fire results in both the creation and loss of down wood from the system. Large pulses of down wood have been noted following stand-replacement fire events (Spies et al. 1988). Following fire in an old-growth western hemlock / Douglas-fir forest, there was a 10-fold increase in snags. In addition, the total biomass of down wood increased from 244 tons / acre in the old-growth stand to 565 tons / acre in the newly burned stand (Agee and Huff 1987).

Major wind events associated with winter storms also may have influenced the development of these stands. Windthrown trees add down wood to the forest floor, as well as creating various-sized canopy gaps that support species such as western hemlock and western redcedar. In addition, major windthrow events create conditions for population build-up of the Douglas-fir beetle. Subsequent tree killing by these beetles further adds to the snag and down wood component of these forests as well as creating additional canopy gaps.

Laminated root rot, caused by the fungus *Phellinus weirii*, is widespread and probably had an important influence on the structure of many stands in the watershed. *P. weirii* is a native root pathogen that readily attacks and kills Douglas-fir (Thies and Sturrock 1995). *P. weirii* and similar pathogens creates snags and gaps in the canopy where shrubs, hardwoods, or shade- and disease-tolerant conifer species occupy these various-sized openings. In addition, infection predisposes trees to windthrow. Live infected trees are susceptible to attack and killing by the Douglas-fir beetle. This disease, therefore, is a major source of down wood and snags.

Prior to European settlement, exotic weed species were not abundant on the landscape. There were, no doubt, a few populations of exotic species introduced through animal migration and Native American travel. Many of the exotic species currently within the watershed were brought into the area as ornamentals, to control erosion processes, or entered as seeds or spores on vehicles or clothing.

4.7.2 Vegetational characteristics of the Coast Range and Chehalem Mountains

Prior to European settlement, vegetation characteristics for the Coast Range would have been similar to those described in the previous section. The land would have been mostly forested with timber in the mature / old-growth structural stage. Interspersed in this sea of old-growth were stands of younger timber where stand-replacement fires had occurred. Survey maps from the 1850’s describe the Coast Range in the western portion of the watershed as mountainous land with “first and second rate timber” consisting of “fir, cedar, and hemlock”. Portions of these forests were described as “partly burnt”,

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indicating the importance of fire to local vegetational characteristics.

Fire appeared to have played an important role in development of the 1850's era Chehalem Mountain vegetation pattern, as well. An 1852 survey map describes the Chehalem Mountains within the watershed as being vegetated with "timber principally fir, considerably burnt and fallen with dense undergrowth of hazel, vine maple and fern". However, Joseph Gaston, when describing the Chehalem Mountains terrain of the 1830's, indicates that the portion of the mountains along the Indian (Jason Lee) trail was not brush covered at that time (Gaston 1912). The fact that this trail to the Yamhill Valley traversed these rugged hills, rather than being routed directly through Chehalem Valley, may indicate that the countryside was more open than that of the lowlands. Alternatively, the trail may have been routed to avoid marshy conditions in the valleys, although the Tuality tribe had many villages surrounding Wapato Lake.

4.7.3 Vegetational characteristics of the valleys

In the mid-1800s, the Tualatin Plain was a forested region interspersed with wetlands and prairies. These prairies were described by the Hillsboro Argus in 1859 as ranging from two to seven miles in length and one to two miles in width (Bourke and DeBats 1995). These prairies provided valuable grazing and farm land, and were often bordered by riparian forests. One such prairie extended up to Dilley, at which time it appears to have given way to wetlands bordered by forested terrain. Joseph Gaston, an early resident of the area, described the Wapato Valley of 1865 as homesteads "just about a mile apart along the county roads which were cut through the thick brush and timber, just wide enough to pass a horse and wagon" (Gaston 1912).

4.7.4 Wetland vegetation

The vegetational characteristics of the wetlands within the watershed would have varied with wetland type and period of flooding. Riparian forests in the valleys were likely similar to those identified downstream near Cornelius, where 1852 surveys characterized Tualatin Valley bottomland as thickly forested with fir, ash, maple and vine maple, with many swamps thickly wooded with 10- to 20-foot willow (Shively 1993). Cass and Miner (1993) state that western hemlock, western red cedar, hazel, dogwood, salal, and Oregon grape were also important components of wetland habitats. Forested and shrubby swamps and emergent marshes were both likely to have been present in the watershed, although the relative proportion of each type is uncertain. The largest of these wetland areas, Wapato Lake, was probably mainly of the emergent type, although this cannot be stated with certainty. The common designation of this wetland as a "lake" indicates that this wetland presented the visual impression of a lake, that is, an expanse of water with little woody vegetation. The emergent species wapato (*Saggitaria latifolia*) and camas (*Camassia quamash*) are closely identified with this wetland. These species often grow in open wet meadows and other environments dominated by emergent species, although they can also exist in forested settings.

4.7.5 Sensitive plant species

It is difficult to reconstruct the abundance and distribution of sensitive plant species during the reference period. Factors complicating historical information regarding survey and manage species and other sensitive plants are as follows:

- These species were only recently designated as sensitive or endangered. Thus, they would not have attracted special attention from biologists;
- Many of these species were not discovered or described until recently;

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- Survey and inventory in the past has predominantly been limited to vascular plants (even vascular plant surveys are very limited);
- Sightings are few and widespread for most plant species, indicating large gaps in range information;
- Only the most rudimentary of ecology data is available for many species; therefore, habitat requirements are essentially unknown for most of these species, historically and presently; and,
- Sighting location information is often general, with little specific information available.

Those species dependent upon old-growth forest habitat, as well as riparian and wetland species, would have had a large area of available habitat relative to current conditions. It is likely, therefore, that these species were more abundant, and more broadly distributed, than is currently the case.

4.7.6 Terrestrial species and habitat

Prior to European settlement, the Northern Oregon Coast Range which forms the western portions of the Upper Tualatin-Scoggins watershed was made up of larger blocks of later seral stage forests comprised of a wide range of tree sizes, large amounts of down wood, and abundant large snags. This situation undoubtedly provided habitat for those species dependent upon, or which would utilize larger blocks of interior forest old-growth habitat. Species that are presently of concern within the watershed such as the spotted owl, pileated woodpecker, and red tree vole benefited from the historical habitat condition.
The contiguous nature of the landscape pattern facilitated the free movement of these species throughout the watershed and throughout the region. Old-growth habitat conditions extended down into moist riparian areas and shaded the streams which contained numerous pools as a result of many large logs and debris jams. These riparian areas functioned as corridors for wildlife including amphibians, otter, elk, and cougar.

Abundant habitat suitable for spotted owl existed prior to European settlement. The owls benefited from extensive old-growth forest that would have provided many sites for nesting and roosting.
The structure of these forest stands would have provided habitat for other sensitive avian species. Habitat for marbled murrelet would have been abundant in the watershed, as the vast majority of stands would have been in the mature to old-growth stages. These forests would also have provided abundant snags for bald eagle nesting. This, together with abundant fish stocks, would have contributed to bald eagle populations.

Due to the limited amount and/or distribution of early-successional stands, forage habitat may have limited deer and elk populations within some portions of the watershed. These species would probably have occupied territories near recent burns, and probably would have had a substantial presence near the prairies of the valleys.

The Columbian white-tailed deer (*Odocoileus virginianus*) occupied prairie habitat throughout the Willamette Valley and the valleys of its tributary streams (Verts and Carraway 1998). Shortly after settlement, these deer were extirpated from most of their range in Oregon. Remnant populations are found in Clatsop, Columbia, and Douglas counties. The Columbian white-tailed deer is currently listed as endangered under the federal Endangered Species Act.

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4.8 Human

4.8.1 Historical changes in landscape pattern

Human occupancy in the Upper Tualatin-Scoggins watershed has been a major source of change (Table 4-1). The progression of some of the activities leading to changes in watershed conditions is given below.

4.8.1.1 Human uses prior to European settlement

The Tualatin Indians (also known as the Twality, or Atfalati), occupied a number of small villages in the Tualatin subbasin, especially around Wapato Lake. Almost all of the eight to nine winter villages located within the Upper Tualatin-Scoggins watershed were located near Wapato Lake (Cass and Miner 1993). Another village was located in Patton Valley. A number of artifacts and burial sites have been found in the vicinity of these villages (Beckham 1975, Follansbee and Musick 1977). A particularly notable pictograph site has been found near the winter village in Patton Valley.

In many parts of Oregon, Native Americans modified the landscape through burning. Fires were set to maintain land in a herbaceous state, which facilitated hunting and travel, and created browse for deer and elk. The Twality tribes, whose diet mainly consisted of large game, do not appear to have utilized agricultural burning to the same extent as some other tribes. They did, however, harvest vegetables, such camas, tarweed, and berries. Fishing was also part of their subsistence base. Portions of the Tualatin valley floor was maintained as marsh grassland, but this may have been the result of natural flooding, rather than field burning (Cass and Miner 1993).

4.8.1.2 European settlement and agricultural conversion

The first recorded European visit to the watershed was the Jason Lee expedition of 1834, although fur trappers and Hudson's Bay Company employees may have traversed the watershed prior to this date. Early settlement in the Tualatin Valley was concentrated east of Dairy Creek, and settlers did not arrive in the Upper-Tualatin Scoggins watershed until the 1840's (WCHS 1975, Cass and Miner 1993, Fulton 1995). The first settlements occurred in the Wapato Valley, and settlement of Patton Valley did not begin until 1850 (Nixon and Tupper 1977).

During European settlement, the pace of change accelerated. Settlers converted the woodlands and prairies of their land claims to agriculture. Due to the sparse population, dense vegetation and wetlands of the valleys, this conversion proceeded much more slowly than eastward in the Tualatin Valley. By 1865, isolated homesteads were still divided by densely forested tracts (Gaston 1912).

Early agriculture in the watershed emphasized production of livestock and wheat. Settlers also planted orchards on better-drained lands, with the fruit being used for domestic consumption. In 1872, construction of the railroad through Gaston facilitated transport of perishable products, and the types of crops grown commercially rapidly diversified. By 1937, a wide variety of crops was produced in the watershed, including berries, prunes, hazelnuts, walnuts, grapes and potatoes. Truck crops such as tomatoes, sweet corn, and lettuce were also produced (Nixon and Tupper 1977).

The production of wheat necessitated the construction of flour mills. At least two flour mills were located in the watershed. One such mill was at Dilley. In order to power this mill, a 14 foot high dam was built across the Tualatin River at this site (Farnell 1978).

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Table 4-1. Timeline of events in the Upper Tualatin-Scoggins watershed since the 1830s.

Date	Event
1833	Smallpox and measles epidemic decimates Tuality tribe.
1834	Jason Lee expedition
1840s	First settlers arrive. William Doughty settles Yamhill County near Wapato Lake.
mid 1800s	LWD jams 300-5,000 feet in length observed on Tualatin River.
1850	Washington County has white population of 2,652.
1851	Treaty establishes 44 square mile Tualatin Indian reservation along Wapato Lake. Congress does not ratify the treaty.
1852	James Lee operates sawmill on Tualatin River at Lee Falls.
1856	Road built from Hinman Donation Land Claim to Lee's Mill. Another road is laid out from Hinman DLC to Yamhill County.
1862	Patton Mill dam built near future site of Cherry Grove.
1865	Joseph Gaston surveys route for railroad through Wapato Valley. Homesteads 1 mile apart separated by dense forest and brush.
1872	West side railroad built through Wapato Valley.
1870s	Gaston area becomes popular hunting site. Special weekend passenger trains are run to facilitate hunting.
1879-1913	Log drives take place on Scoggins Creek and the Tualatin River.
1880	Joseph Gaston retires to Gaston, commences draining of Wapato Lake.
1889	Water-powered flour and feed mill starts operation at Gaston.
1889	Contract to clear Tualatin River between Dilley and Scoggins Creek, and Scoggins Creek to head of log navigation.
1889	Surveys in conjunction with the clearing contract find "little good timber available for cutting."
1890s	Patton and Holscher operate large sawmill on Scoggins Creek near RM 7.
1891	Hod Parsons builds "flood dam" on his property to drive logs to mill. The dam includes fish ladders.
1895	A report notes a 14-foot high dam across the Tualatin River at Dilley. The dam is used to power a flour mill.
1895	Drainage of Wapato Lake is nearly complete.
1896	Pattons contract for 10 million feet of logs to be delivered from McLeod homestead ("RM 76") to Patton Mill ("Rm 74").
	"Flood dam" was necessary to transport these logs.
1898	Drainage of Wapato Lake continues.
1891	Miller and Hawley rebuild "flood dam" at "RM 76".
c 1900	Patton Mill dam is dismantled by Fish Commission.
Early 1900s	Wallin and Nyland operate mill on south side of Patton Valley.
Early 1900s	Karl Hering and John Callahan operate mill on stream along Hering Road.
Early 1900s	Prune production begins along Williams Canyon and northern Patton Valley.
1890-1905	Large log drives on Scoggins Creek to sawmills at Dilley and Cornelius.
1901	Power plant constructed on Tualatin River at Haines Falls.
1903	Washington County Commissioners allow removal of gravel bar on Scoggins Creek.
1911	Cherry Grove is founded by August Lovegren as a Swedish cultural town.
1911	Lovegren builds railroad from Gaston to Cherry Grove. Second-growth timber along South Road is harvested for railroad ties.
1911	Large lumber mill at Cherry Grove with capacity of 25,000 board feet is operating by September.
1911	Hydraulic ram is installed in Tualatin River near Little Lee Falls to provide water for Cherry Grove.
1912	Rock quarry is opened near Cherry Grove to facilitate dam construction.
1913	Lovegren completes large milldam across the Tualatin River at Cherry Grove in September, forming a 70 acre pond upstream.
1913	The Lovegren timber harvest operations are currently in Roaring Creek canyon.
1913	Photograph shows forest Cherry Grove to be in mature/old growth condition.
1913	"Much of the timber in the Cherry Grove" area is described as "over-ripe" from a commercial timber perspective.
1914	Lovegren dam washes out during January storm. Stream course changes at dam site.
1913-1920	Wallin and Nyland operate mill in Tualatin River Canyon below Lee Falls.
1915	Ross Quarry on Scoggins Road (2.5 miles NW of Gaston) is in operation.
1915	Haskell-Carpenter buys Lovegren operations.
1916	Large Haskell-Carpenter sawmill is in operation on Roaring Creek.
1916	Raines Brothers sawmill is operated on Scoggins Creek near Scoggins Junction. Soon after, the mill is moved 2 miles upstream.
1918-1958	Extensive logging on canyons along the upper Tualatin River.
1919	Raines Brothers sawmill is moved to the Laurelwood area.
1933	First Tillamook fire. Salvage loggins and associated broadcast burning ensues.
1939	Saddle Mountain (second Tillamook) fire.
1945	Third Tillamook fire.
1945-1957	Koennecke family operates mill at Cherry Grove, cuts timber in upper Tualatin subwatersheds.
1957	Five dairies are in operation in Patton Valley.
1962	Columbus Day storm fells many trees adjacent to Tualatin River between Cherry Grove and Gaston.
1963	Tualatin Valley has 72 consecutive days without rain between July and September.
	Tualatin River near Little Lee Falls is at very low levels.
1964	Christmas Flood results in a mile-long jam in Patton Valley. Extensive stream cleaning ensues.
After 1964	Accelerated erosion occurs in Patton Valley.
1970-1980	Tualatin River channel in Patton Valley moves "laterally as much as 250 feet". About 15 acres of farmland are lost.

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This dam may have provided a migratory barrier to anadromous salmonids. Another flour mill was built at Gaston in 1889. This flour mill remained in operation for 30 years (Nixon and Tupper 1977).

The settlers also accelerated the pace of vegetation change through fire. In Western Oregon, it was estimated that "approximately seven times as much land was burned from 1845 to 1855 as in any of the three previous decades." (Morris 1934 as cited in USDA and USDI 1997). By 1850, the portions of the watershed lying within the Coast Range foothills and Chehalem Mountains had been recently burned, although the degree to which human activity was responsible for this burnt land is not immediately clear (ODF 1996).

4.8.1.3 Timber operations

Beginning in the late 1800s, the watershed was extensively logged. Timber extraction started first in the Wapato and Patton valleys. Initially, logging was performed to clear homesteads. However, commercial logging began soon afterward. A commercial sawmill was present at Lee Falls above the head of Patton Valley as early as 1855 (Nixon and Tupper 1977). Beginning in 1890, commercial logging expanded to Scoggins Valley (Farnell 1978).

Early transport of logs was most efficiently performed by water. Between 1879 and 1913 numerous log drives occurred along streams within the Upper Tualatin-Scoggins watershed. Log driving occurred both on the Tualatin River and on Scoggins Creek (Farnell 1978). To facilitate the drives, streams would be cleared of obstructions and streams would be blocked off from wetlands and secondary channels (Shively 1993). Splash dams were built on reaches of these streams where natural flow was insufficient to drive logs. Sedell and Luchessa (1982) identified four splash dams that were built on Scoggins Creek and another two that were built on the Tualatin River upstream of Roaring Creek.

In 1872, the railroad was completed through Gaston. This would have facilitated transport of lumber products from the watershed to Portland and other urban centers. However, logs continued to be driven by water to Dilley and Cornelius for 33 years following construction of the railroad. In 1911, August Lovegren built a railroad from Gaston to the newly formed town of Cherry Grove. For the following two years, this railroad transported passengers and lumber. The Lovegren operation collapsed with the destruction of the company mill dam in 1914. In 1915, Haskell-Carpenter purchased the Lovegren operations and expanded the railroad into the Roaring Creek canyon above Cherry Grove. However, the rugged terrain rapidly became too steep for continuation of the railroad (Nixon and Tupper 1977). Eventually, roads were built through the watershed and trucks became the dominant mode of transportation.

Although minor logging in the Tualatin River Canyon had occurred prior to 1911, the Lovegren operation signaled the beginning of extensive forest harvest in this rugged region. Much of the Lovegren and subsequent operations focused on the Roaring Creek watershed. Between 1911 and 1958, extensive logging took place in the rugged watersheds above Patton Valley. At the beginning of this period, much of the timber in the area was mature and old-growth timber exceeding 30 inches in diameter. One photograph taken near Cherry Grove in 1913 showed a tree with an estimated diameter of eight feet. Subsequent logging and fires decimated these old-growth forests in this canyon.

Extensive salvage logging took place in the western portion of the watershed following the Tillamook fires of 1933, 1939, and 1945. During these salvage operations, a considerable amount of woody debris was left on the ground (Fick and Martin 1992).

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Although this debris presented a fire hazard, it also potentially contributed to habitat for terrestrial species. Much of this debris found its way into streams, where it potentially contributed benefits to stream channel structure and habitat. Many snags also remained following salvage logging. Due to the large amount of debris and snags left by the fires, the Oregon Department of Forestry decided that complete wood removal would not be feasible, and instead, these elements were removed from firebreaks on Tillamook National Forest lands.

Extensive road building accompanied salvage logging. Given the lack of ground cover and the road construction practices extant at the time, these roads undoubtedly accelerated sediment contributions to streams. It is also quite likely that culverts associated with these roads were undersized from a flood and fish passage perspective.

Following 1958, forest production in the upper Tualatin Canyon dropped off. This corresponds to a general decline in timber production in the Tualatin sub-basin as the supply of timber became depleted. At this time Hart and Newcomb (1965) remarked that the only timber left was in the steeper, more inaccessible portions of the Tualatin subbasin.

4.8.1.4 Stream cleaning and wetland conversion

In order to reduce flooding and to facilitate log drives, debris jams, beaver dams, and obstructions caused by tree roots were cleared from streams. It might be assumed that this practice began around 1879, when log driving started in the area. However, a contract written in 1889 to clean the Tualatin River between Dilley and Scoggins Creek, as well as a portion of Scoggins Creek indicate that these stream reaches had not recently been cleaned. It is unclear to what degree this contract was fulfilled (Farnell 1978).

Another example of stream cleaning occurred in 1965 following the “Christmas flood”. In Patton Valley, the Columbus Day storm of 1962 and the 1964 flood had left a “mile-long” log jam in the Tualatin River (SWCD 1983, Nixon and Tupper 1977). Government contractors and logging crews cleared the log jam over the subsequent year.

The wetlands covering much of the valley floors covered potentially productive agricultural lands, and wetland drainage followed settlement. The largest of these wetlands was the Wapato Lake. In 1880, Joseph Gaston first attempted to drain Wapato Lake, although accounts differ on his success in this effort (Gaston 1911, Follanbee and Musick 1977). According to Cass and Miner (1993) the lake was substantially drained by 1895, at which time it was still in Gaston’s possession. Other accounts indicate that drainage efforts continued in 1898, after Gaston had sold the land (Beckham 1975). Yet another account indicates that 700 acres of the lake were diked in 1936 (Benson 1975). In addition to Wapato Lake, other wetlands have been drained over the course of European habitation.

These drainage projects resulted in an extensive loss of wetland habitat. Comparison of hydric soils to current NWI wetland area indicate that as many as 2,800 acres, or 61% of historic wetland area may have been lost due to wetland conversion and drainage. However, it should be noted that the NWI is a conservative measure of current wetland area, and indeed, much of the Wapato Valley continues to experience ponding and flooding in winter. Aside from Henry Hagg Lake, most remaining wetlands continue to be located in the Wapato Valley. The type, function, and condition of the remaining wetlands has been substantially changed. Where many wetlands were typically inundated for four months of the year, by 1953 they were more typically inundated for 60 to 90 days (USACE 1953). Where wetlands prior to settlement either had saturated

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soils or experienced seasonal, shallow inundation, the largest single wetland is the deep, permanently flooded Henry Hagg Lake. Additionally, wetlands prior to settlement provided habitat for many native species, but the remaining wetlands at this time currently sustain populations of exotic weeds.

4.8.1.5 Roads

The advent of roads created changes in the landscape. Early roads were naturally surfaced and typically followed the courses of paths created by Native Americans. Initial road-related impacts would have been minor, as these roads were infrequently spaced. However, proximity to aquatic habitats may have contributed to stream sedimentation.

Impacts increased as additional roads were created to facilitate access to logging sites and farms. During these early years, there was little concern about the environmental impacts of road placement. Such factors as road steepness, stream crossings, wetland crossings, and culvert placement were left to the engineer's discretion, and decisions were often dominated by economic considerations. Roads often cut through unique habitats, thus destroying them or reducing their effectiveness. Many of the primary arterial routes were located close to streams because of ease of construction and low construction costs. Many of these streamside sites were naturally cut to a gentle grade that could be used without much alteration, and wide floodplains required little preparation beyond brush removal. Stream courses also presented relatively moderate-gradient entrances into mountainous terrain that otherwise was often too steep to traverse.

Early road construction practices also employed little concern for environmental impacts. When building roads along steep slopes, material removed from cuts in the hillslope was often pushed downslope to build up the bank for the driving surface. Additionally, it was not unusual for waste materials to be pushed over the side of the road. Where these materials were deposited adjacent to a waterway, they posed a significant sedimentation threat to the adjacent stream. These materials often entered the stream directly through gravitational and erosional processes. Additionally, the weight of these sidecast materials also destabilized the underlying slope, increasing the landslide risk for many years following construction of the roads. A large proportion of currently occurring landslides is caused by failure of water-saturated roads built using these historic construction techniques.

These road designs usually involved improperly placed and sized culverts. Often these ends of these culverts jutted out over the underlying ground. The water shooting out of these culverts would plunge to the ground below, cutting into the soil and loosening rocks and vegetation, resulting in massive erosion problems. Additionally, fish passage was not a consideration in culvert design and placement. Roads on steep timberlands were often routed with steep slopes that offered the shortest route to the timber harvest site. This routing took less ground out of the resource base and had less of an impact on groundwater percolation than did more circuitous road designs, but the steepness of the roads could promote raveling, erosion, and sediment runoff.

Many forest roads had a rock surface, and went directly to a landing for the harvest area. It was believed the roads would be reused to harvest the next rotation, and that these roads would be valuable for fire suppression and other management needs. Consequently, these roads remained as permanent fixtures on the land. Often, they were allowed to deteriorate through lack of maintenance. Additionally, many of these roads were not included as area maps were updated.

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In 1969, the desire for proper road siting on forestlands resulted in the development of Forest Practice Rules by the State of Oregon. The intent of these rules was to regulate road construction and maintenance on non-federal land. Although the Forest Practice Rules were open for interpretation in their early years, their intent is now clearer and their requirements are increasingly more stringent. However, due to understaffing, the Oregon Department of Forestry (ODF) is dependent on citizen reporting of infractions. In the watershed, much of the land is gated to the public and ODF is dependent on the cooperation of the private landowner to follow the rules. The federal agencies have developed standards that go beyond the rules, and some private industrial companies are applying standards they consider to be more stringent than those required by the Forest Practice Rules.

Many of the problems arising from early road building practices may be found on BLM roads. Records show engineered forest roads dating back to the early 1940's on BLM lands. It is not unusual to find roads originating well before the 1940's that were built in trespass. When ownership became important, the landowner claimed the road. The mid 1950's was an active period of road construction for timber removal, and the Reciprocal Right-of-Way program was actively utilized to assure the right of BLM and private landowners to construct and use roads on each other's lands. The lands encompassed by the agreement were put on a "schedule of lands". These old agreements are still in use and come under the provisions in effect at the time of the signing of the agreements. They might be considered as one of the last remnants of practices prevalent before the Endangered Species Act or BLM requirements for surveys. In some agreements, to assure the unencumbered transport of timber between drainages, large blocks of land were also mapped and enclosed with the agreement contract even though the lands were not part of the contract. Today, when portions of the original lands governed by the original Right-of-Way agreement are transferred between private entities and the BLM, the amended and assigned lands fall under the policy, regulations, and laws in force at the time of the change. However, if the lands are assigned in total, they can continue to be governed by the policies and laws in effect at the time of the original agreement. If lands are added to an existing agreement (schedule of lands), their inclusion must undergo NEPA analysis.

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Chapter 5: Synthesis

5.1 Aquatic

5.1.1 Erosion issues

5.1.1.1 Changes in erosion processes following settlement

The current condition for erosion processes varies from the reference condition in the rate and timing of erosion. Under reference conditions there were large increases in erosion rates associated with major disturbances such as fires and large storms, after which erosion rates dropped to relatively low levels. Removal of vegetation and compaction and displacement of soil from logging and road construction have created an increase in erosion rates that has been going on for a much longer time than under natural conditions. Conversion of forest to agriculture has resulted in local increases in sheet, rill, and gully erosion. In addition, the type of material delivered to stream channels and riparian areas from landslides has changed. Landslides were a major source of large woody debris in historical times, when there were large areas of older timber in the watershed. The large wood supplied through these processes was relatively stable in the stream system, providing structure and altering flow patterns to contribute to pool formation. With the younger timber that dominates the watershed today, there is a reduced potential for large wood input to the channels from landslides. In many parts of the watershed, this is reflected in a lack of large wood and structure in the channel. The smaller wood provided by young timber is readily transported during high stream flows, and provides little lasting benefit to habitat structure.

5.1.1.2 Management impacts on erosion, Coast Range and Chehalem Mountains

These changes in watershed process have largely been the result of changes in management practices since Euro-American settlement. In the Coast Range, these changes were largely the result of timber operations. These changes came gradually, as initial logging operations focused on relatively accessible valley locations and adjacent foothills. Although sporadic logging in the Coast Range began in the late 1800's, the greatest impacts in this region would have occurred between 1900 and 1957, at which time most forests in this region were effectively depleted. During this period, timber operations proceeded with little regulation and little regard for watershed condition. Skidding practices common during this period caused extensive disturbance of the surface soil and litter layer, resulting in greatly accelerated surface erosion. Additionally, unsound logging practices on steep slopes resulted in increased incidence of mass wasting. No riparian buffers were utilized during this period, resulting in increased bank erosion and sediment delivery to the channel. Doubtless, this would have resulted in increased instream sedimentation, leading to reduction of pool volume and siltation of spawning gravels.

Since passage of the Oregon Forest Practices Act in 1973, forest practices have substantially improved. Subsequent changes in Forest Practice Rules have mandated

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practices designed to reduce disturbance of soils and riparian vegetation during forestry operations. For example, current forest practice rules require high-lead yarding on steep slopes and provide for riparian buffer zones where special timber harvest rules apply. Although these changes have resulted in diminished surface erosion, mass wasting, and sediment delivery from forest operations, effects of past practices still persist.

Despite improved forest management practices, steep and geologically unstable lands in the watershed remain susceptible to debris slides and slumping. Although such lands are distributed throughout mountainous portions of the watershed, certain subwatersheds seem especially susceptible. Both geologic mapping and field observations show the Roaring Creek subwatershed to be exceptionally prone to landsliding, with several identified landslides occurring on BLM land (Wells, et al. 1994). The various subwatersheds contributing to Scoggins Lake are also particularly prone toward landslides, with numerous landslides having been identified in these subwatersheds (Wells, et al. 1994, BOR 1998). Of these slides, one slide in the Sain Creek subwatershed (T1S, R5W, S15, E1/2) affects BLM lands. These landslides are particularly significant as they contribute sediments to Henry Hagg Lake, potentially reducing the useful life of the lake. The degree of reduction is uncertain because of the lack of bathymetric data.

Although recent landslide surveys have not extended east into the Coast Range foothills or the Chehalem Mountains, the literature indicates that these areas are also subject to mass wasting. Schlicker (1967) identified several slumps in the Scoggins Dam subwatershed downstream of the current location of Henry Hagg Lake. Additionally, he noted the instability along the Chehalem Mountain face, especially along the contacts between the Columbia River basalt and adjacent silt and sedimentary formations. Mud flows and silts were observed to be unstable at slopes as low as 15-20%. Such instability would be of greatest concern in the Hill Creek and Ayers Creek subwatersheds.

The degree to which these landslides are due to management related factors is subject to debate. Although forestry related management has contributed an unspecified amount to accelerated sliding, many of these slides and slumps occur in well-timbered lands, indicating susceptibility toward mass wasting under natural conditions (BOR 1998).

Many management-related erosional impacts in the Coast Range are caused by roads. Most of the road mileage in the mountains consists of roads surfaced with rock or compacted earth. These roads are subject to surface erosion of cutslopes, treads, and fillslopes. In unstable areas, roads exacerbate the risk of slope failure, as road fill increases the burden upon underlying slopes, while road cuts reduce the strength of the slope above the road. Additionally, drainage ditches create channeled flow, resulting in increased erosive power of runoff and increased sediment delivery to streams. Hazard of sediment delivery is greatest where roads lie within 200 feet of streams (WPN 1999, Washington Forest Practices Board 1997). Stream crossings also provide a ready source of road-related sediment contributions to streams. Subwatersheds with the highest concentration of nearstream roads include Mercer Creek, Upper Tualatin-Lee Falls, and Roaring Creek. Additionally, Road 1-5-16 within the Sain Creek subwatershed follows Sain Creek within the 200 foot zone for three miles. Sunday Creek is the only Coast Range subwatershed with greater than 3.5 stream crossings per square mile. Toward the foothills, Mercer and Upper Wapato creeks also have high incidence of stream crossings.

In the Chehalem Mountains and the foothills of the Coast Range, lands are managed more intensively than in the more rugged portions of the Coast Range. Both rural residential and agricultural uses tend to reduce surface cover, resulting in increased surface runoff. The rural residential uses also tend to increase the area of impermeable surfaces, although generally this increase does not result in an appreciable change in hydrology within this watershed. Generally, these activities generate more ditches, thereby increasing the ability to transport sediment to channels. Additionally, these

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activities reshape the land in ways that tends to make it more erodible. The net effect of agricultural and rural residential activities in these areas is to accelerate erosion, particularly where slopes are steep. These concerns prevail throughout numerous subwatersheds where hillslopes lie adjacent to the valleys. The Hill Creek subwatershed, in particular, appears to have a combination of slope, high erodibility soils, and land uses that render it particularly susceptible to accelerated erosion and mass wasting. This subwatershed also has a high incidence of stream crossings and streams within 200 feet of roads.

5.1.1.3 Management impacts on erosion, Wapato and Patton valleys

European settlement caused extensive changes to erosional processes within the Upper Tualatin-Scoggins watershed. With settlement came a number of land use activities that exposed land surfaces to rainfall impacts, increased surface runoff, and reduced the strength of streambanks. Most of these new land use practices resulted in accelerated erosion.

An early contributor to erosion in the watershed's valleys and adjacent foothills was the extensive conversion of forestland to agricultural purposes during the latter half of the 19th century. Such conversion exposed extensive acreage to raindrop impacts and increased sheet, rill, and gully erosion. These effects would have been greatest on steep slopes and on highly erodible soils. As the conversion has largely been permanent, increased erosion remains to the present.

The degree of erosion risk is partially attributable to the natural erodibility of the underlying soils. The preponderance of highly erodible soils, as identified by NRCS, are located in foothills regions adjacent to the Wapato, Scoggins, and Patton valleys, with much of the remainder consisting of silts along the ridge of the Chehalem Mountains. In particular, the Hill Creek, Upper Tualatin-Dilley, Wapato Creek, Harris Creek, and Carpenter Creek subwatersheds have large proportions of highly erodible soils. These erosional regimes of these subwatersheds will be particularly susceptible to the effects of land use and management.

Following settlement, extensive modifications were made to stream channels. On the upper reaches of the Tualatin River and Scoggins Creek, splash damming resulted in channel erosion. The lower courses of these streams were cleaned to facilitate transport for log drives. Although these modifications were temporary, they may have created long-term channel changes with persistent effects upon the erosion regime of the watershed. More permanent modifications related to wetland drainage and flood control occurred throughout the Wapato Valley, but were most extensive in the Wapato Creek, Carpenter Creek, and Harris Creek subwatersheds. Channels were straightened and cleared of brush, and access to floodplains was cut off. The increased peak stream velocity and water depth resulting from these changes have increased the erosive capability of the streams, likely resulting in increased channel entrenchment. Additionally, vegetation clearing has reduced bank resistance to erosion. Some of these changes can be considered permanent, as many reaches are likely to remain in the channelized state with continued floodplain disconnection. Due to lack of study, it is unclear whether channel entrenchment is currently occurring.

Streambank erosion is an important concern within the valleys. The most severe examples of streambank erosion occur along the Tualatin River in the Patton Valley. A 1983 erosion control study conducted by the SWCD identified sites for erosion control projects. Due to lack of funding, these projects never took place.

Other alluvial stream reaches are at a high risk for streambank erosion. Two soil types within the watershed, Chehalis and McBee, are susceptible to severe streambank erosion

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(NRCS 1982). Of the two, the McBee soil type is the most abundant. These soil types are abundant throughout the Wapato, Scoggins, and Patton valleys, with the greatest proportion of these soils occurring in the Upper Tualatin-Blackjack and Upper Tualatin-Dilley subwatersheds. The erosion hazard should be considered high throughout the valleys, particularly where a vegetative buffer is lacking.

Prior to 1996, there was little regulation of farming activities in riparian zones. Riparian vegetation was often removed to the edge of the stream, resulting in increased delivery of surface sediments to streams, decreased bank stability and increased bank erosion. Recent changes in the administrative rules administered by the Oregon Department of Agriculture mandate increased ground cover in winter along streams in agricultural lands.

In many parts of the Tualatin subbasin, erosion due to agricultural sources has been reduced by implementation of agricultural Best Management Practices (BMPs). These practices are usually implemented as part of conservation plans administered by the Washington County Soil and Water Conservation District (SWCD) and NRCS. Certain BMPs, including planting of winter cover crops, mulch tillage, and filter strips, are designed to reduce erosion and sediment delivery to streams. Implementation of these practices has been accompanied by improvements in water quality, indicating that these practices are effective. However, the degree of effectiveness of individual practices is unclear, as no systematic methodology has been implemented to monitor effectiveness of the BMPs. Such a methodology, along with systematic data collection, would be valuable for improving the effectiveness of management systems. Despite the lack of this methodology, it seems apparent that further reductions in erosion and sediment delivery would be achieved by bringing a greater percentage of the agricultural community under Voluntary Farm Water Quality Management Plans. The Upper Tualatin-Scoggins watershed, in particular, has a high potential for improvement, as few landowners in the watershed currently participate in these plans.

Effective erosion control in the valley portion of the watershed will largely concentrate on reduction of source sediments from agricultural operations, and from riparian restoration. The former objective is most efficiently achieved through voluntary efforts spearheaded by the NRCS/SWCD. These agencies have a long history of working together with farmers to reduce soil loss. Additionally, these agencies are able to offer economic incentives and cost-sharing programs to implement BMPs. Although enhanced riparian buffers would be beneficial throughout the watershed, the greatest return on effort would probably occur where the riparian buffers are most severely compromised. Such areas include **Upper Tualatin-Blackjack, Upper Tualatin-Hering, Carpenter Creek, and Goodin Creek** subwatersheds.

Certain agriculturally related conditions that lead to accelerated erosion and sediment delivery to streams are prohibited under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (OAR 603-095). Such “Prohibited Conditions” are discussed in the Water Quality section (Section 5.1.4.6). Although these surveys haven’t comprehensively been performed throughout the watershed, the relatively high incidence of those conditions related to erosion control in the Hill Creek subwatershed suggest that this might be priority area for education on appropriate erosion control.

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5.1.2 Hydrology and water quantity issues

5.1.2.1 Management effects on hydrology

Stream hydrology has been altered from reference conditions. In general, these changes have tended to increase winter peak flows, decrease summer low flows, and increase surface runoff.

Current changes in the hydrologic regime are likely to be minor in the Coast Range. Most of the watershed has a rain dominated climatic regime. Forest management typically does not significantly affect the magnitude and timing of peak flows within watersheds with that type of regime (WPN 1999, Washington Forest Practices Board 1997). The proportion of the watershed susceptible to rain on snow (ROS) events is very small, and ROS events typically do not significantly affect any particular subwatershed. Road density in each forested subwatershed is well below the level considered to induce hydrologic change at the subwatershed level. Where road density is high, however, extension of channel networks and compaction of road surfaces may lead to locally accelerated surface runoff and increased peak flow. Other hydrologic changes related to current timber harvest practices are usually minor and temporary (Washington Forest Practices Board 1997). Residual effects of past timber harvest practices on channel morphology may continue to affect hydrology.

The greatest impacts on hydrology have been experienced in valley portions of the watershed. Under reference conditions, the stream channel was hydrologically connected with extensive floodplains and wetlands. The floodplains served to moderate the volume and velocity of peak flows. While floodwaters and ponded waters were stored in floodplains and wetlands, some of the stored water infiltrated to recharge groundwater supplies. Much of the rest was subsequently released to the stream to augment lower flows. Following Euro-American settlement, stream channelization cut off many portions of the stream channel from the floodplain, thus removing the ability of the floodplain to store and moderate flows. This resulted in higher peak flows, a reduction in low flows, and increased flow velocity. Additionally, channel straightening and brush removal associated with channelization also contributed to increased flow velocity. Channel straightening increased stream gradient, while brush removal removed resistance to flow. Stream channelization also reduced the amount of recharge to groundwater, resulting in a lower water table, and diminished low flows. These changes are relatively permanent, as these channels are maintained with an artificially straightened configuration and with impaired hydrologic connection to their floodplains. Channelization and its effects are most apparent in the Carpenter Creek, Harris Creek, and Upper Tualatin-Blackjack subwatersheds. Additionally, limited channel straightening and clearing took place in lower reaches of the Tualatin River and Scoggins Creek to facilitate log drives and flood control. Hydrologic effects from these projects would extend for a considerable distance downstream of these sites.

The effects upon hydrology of wetland drainage projects was similar to those of stream channelization. Like stream channelization, wetland drainage normally involved ditching to drain ponded water into the stream system. In effect, this extended the channel system, thus contributing to peak flows while reducing the amount of recharge to groundwater. Where streams naturally had surface hydrologic connection with wetlands, wetland drainage was often associated with stream channelization. The most extensive change in wetland hydrology in the watershed occurred through drainage of Wapato Lake, which occupied most of the Wapato Creek subbasin. About 1,100 acres of seasonally and temporarily flooded wetlands were converted to agricultural uses with greatly diminished flooding periods[31]. Substantial wetland areas have also been lost elsewhere in the valleys.

[31]Based on comparison of hydric soils with current NWI maps, supplemented by references from Hart and Newcomb (1965) and USACE (1953).

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To a certain degree, storage ponds at traditional wetland sites provide a detention function. However, this stored water does not serve to recharge groundwater storage or augment instream flow, but instead is diverted for agricultural uses. A portion of this water could be expected to return to the aquatic system as return flow. This return flow is often degraded, with increased temperature, decreased dissolved oxygen, and enriched with nutrients and chemicals.

Prospects for restoration of the hydrologic functions attributable to floodplains and wetlands appear to be limited. Economic activity in the watershed has adapted to the current channel configuration and disconnection from wetlands. Efforts to restore floodplains and wetlands to their original extent are likely to be expensive. The most effective policy given current constraints is to protect existing floodplain and wetland resources, inventory and prioritize high-potential areas for wetland restoration and/or enhancement, and prevent encroachment of new activities that are incompatible with floodplain and wetland function.

The Tualatin River Project has also created substantial changes to natural watershed hydrology. Most notably, Henry Hagg Lake stores water during the winter peakflow season, thus reducing the volume of peakflows downstream of the Scoggins Dam. In the summer, water is released, resulting in an increased volume of summer low flows at downstream sites. Additionally, a series of canals augments summer water flow to the Upper Tualatin-Blackjack and Wapato Creek subwatersheds.

Similarly, the Trask River diversion has augmented summer peak flows for virtually the length of the whole Tualatin River. Although a portion of the water is removed at the JWC diversion, most of the extra flow remains instream, where it helps to maintain water quality.

Other major changes to stream hydrology have been effected by instream diversions. The vast majority of these diversions have been for agricultural purposes. These diversions generally take place in the summer low-flow season. Where flow has not been augmented by water from Henry Hagg Lake, these diversions diminish stream flows below natural conditions. Diversions are common throughout agricultural portions of the watershed, with the greatest cumulative diversion occurring in the Upper Tualatin-Blackjack and Upper Tualatin-Dilley subwatersheds.

5.1.2.2 Water rights allocations

Water rights appear to be fully allocated many parts of the year. In most cases the period where no water is available for a period of five to seven months centered around the summer low-flow season. The Tualatin River above Mercer Creek has no available allocations from May to November, while Scoggins Creek and the Tualatin River below Mercer Creek have no available water between July and October. Consumptive uses are not solely responsible for the lack of available water. On the Tualatin River above Mercer Creek, consumptive uses exceed the 80% exceedance flow only in September, while Scoggins Creek and the Tualatin River below Mercer Creek, the period of exceedance is July through September. Instream flow requirements are responsible for the lack of available water in other months. On Sain and Tanner creeks, instream water rights exceed the natural flow for many months of the year.

USA has specified a target flow of 300 cfs at Farmington gage as desirable to achieve water quality objectives. This target flow is roughly twice USA's current flow targets. Although the Farmington gage is outside the Upper Tualatin-Scoggins watershed, achievement of this goal would involve substantial additional summer releases from Scoggins Dam (WMG 1998).

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During formulation of its action plan, the Tualatin River Watershed Council considered the purchase of additional water rights to supplement current instream water rights. The Watermaster, District 18, has determined that fish in valley portions of the watershed would benefit from additional instream water rights. However, these streams have a lower priority than in many portions of the Tualatin River subbasin (Darrell Hedin, personal communication). The present watershed analysis report did not identify a specific need for additional water rights. If such a need exists, it would likely be in the Tualatin River between Cherry Grove and Gaston. In this reach, additional instream rights to increase fish production would likely be ineffective without efforts to improve instream habitat structure. Further field study is necessary to establish a need for enhanced instream water rights and to determine the best location to acquire these rights.

5.1.3 Stream channel issues

5.1.3.1 Management effects upon stream morphology

Current stream channel conditions have changed from reference conditions. In some stream reaches in the Coast Range, increased sedimentation and reduced riparian vegetation from past forest practices resulted in pool fill and shallower streams. Where valley walls permitted, such as along OWEB type MM channels, channels probably became shallower. Along some valley reaches, streams have been channelized and confined rather than allowing natural meandering.

The most extensive change in channel process throughout lower portions of the watershed has been the loss of large woody debris elements from the stream system. Under reference conditions, mature forests along the streams supplied large woody debris to the channel, creating hydraulic characteristics suitable for pool formation and increased hydraulic diversity. Following settlement, timber harvest removed large wood from the riparian zone. Splash dams hydraulically stripped wood and other roughness elements from many portions of the upper Tualatin River and Scoggins Creek. Further down on these streams, channel clearing and removal of roughness elements was considered productive to facilitate log drives. Forest practices continued to emphasize clearing of wood from channels until the 1980's. These policies and practices have combined to generate a system severely deficient in large wood and lacking the roughness elements necessary to generate adequate numbers of pools. These circumstances have been major contributing factors to the lack of channel structure that currently characterizes many portions of the Upper Tualatin-Scoggins watershed.

In the upper portion of the watershed, some subwatersheds appear to have ample amounts of instream Large Woody Debris. Much of the current instream wood may have been contributed by salvage logging activities following the Tillamook burn. However, near-term recruitment potential is limited by the young age of the existing timber stands in most areas.

Changes in forest practices have improved long-term prospects for restoration of large woody debris recruitment potential in the mountainous portions of the watershed. Forests in Riparian Reserves and (possibly) other riparian buffer zones will gradually attain size characteristics suitable to produce large woody debris. Over the short term, however, prospects for recruitment potential are bleak. Most forest stands do not currently have large trees suitable for production of large woody debris. Additionally, deciduous stands have replaced conifers in many riparian areas. This has diminished the potential effectiveness of large wood contributed to streams. Conifers provide

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durable wood that is likely to provide beneficial effects over long periods of time. Although deciduous stands will eventually contribute large wood to the stream, the wood decays rapidly, and its effect on instream structure will typically last less than five years.

Future prospects for large woody debris recruitment in the valleys are not favorable. Most streams in the valley lack riparian forested cover or have a canopy of young hardwoods. Additionally, any prospects for downstream transport of wood in Scoggins Creek are limited by Scoggins Dam. As there is little available nearby seed stock for natural recruitment of conifers, it is unlikely that the characteristics of these riparian zones will change. Thus, it is unlikely that any substantial natural recruitment of large woody debris will occur in the forseeable future. It may be necessary to supplement long-term development of natural recruitment with interim measures such as artificial placement of large wood. Planting of conifers in riparian areas will also contribute to long-term prospects for recruitment of large woody debris.

Channel morphology in the valleys has been heavily impacted by channelization efforts. These impacts have been most apparent along Carpenter, Wapato, and Harris creeks, as well as the Upper Tualatin-Blackjack Creek subwatershed. Primary effects of channelization have been stream straightening, local increase in gradient, and removal of roughness elements from the channel. These, in turn, lead to secondary effects, such as channel incision and disconnection from the floodplain. Current land uses and economic considerations limit prospects for restoration of reference stream functionality in channelized reaches. The most effective channel restoration strategies in the valleys will focus on preservation of existing channel characteristics at relatively high quality sites and gradual improvement and enhancement of nearby and adjacent sites.

5.1.4 Water quality issues

5.1.4.1 Management effects on water quality

Management activities have had substantial impacts on water quality. Under reference conditions, riparian forests provided shade to streams. Shading regulated water temperatures, resulting in cooler summer water temperatures and increased stream capacity for dissolved oxygen. Additionally, riparian forests provided stability to streambanks, minimizing erosion and accompanying contributions of fine sediments. Subsequent to settlement, many of these riparian forests were removed. As practices prior to 1980 made no allowance for riparian buffer strips, this removal increased stream exposure to sunlight, leading to higher temperatures and reductions in dissolved oxygen levels. Additionally, forest removal led to increased streambank erosion and reduced filtration of sediments from upland runoff. This resulted in increased turbidity and suspended solids.

Agriculture contributed to many of the changes in water quality in the valleys and adjacent foothills. Conversion of lands from forest to agriculture resulted in increased exposure of soils to energy from precipitation. Cultivated soils were more susceptible to erosion, leading to greater sediment loads in surface runoff. Together with compromised riparian buffers, these factors contributed to higher delivery of sediments, adsorbed nutrients, organic matter, bacteria and pesticides to streams. Fertilization also led to contributions of nutrients to streams, while livestock access to streams increased inputs of bacteria and ammonia nitrogen. Surface and subsurface drains increased peak runoff. Continual improvements in management practices have reduced the impacts of these activities upon water quality.

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Other land-use conversion activities affected water quality. Filling of wetlands reduced their ability to filter out pollutants, sediments and nutrients prior to stream entry. This resulted in increased inputs to the active channel. Stream channelization destabilized banks and increased stream velocity, resulting in increased erosion rates and concentrations of suspended sediments.

With increased settlement came an increased need for waste disposal. Many of these waste disposal systems did not possess adequate safeguards against contributions of pollutants to surface water. It is likely that septic tanks associated with rural residential development have contributed bacteria and ammonia nitrogen to stream systems within the watershed.

Roads are notable contributors of sediment to surface water supplies. Drainage ditches associated with roads produce channeled flow, leading to increased erosion. Where these ditches lead to streams, or where roads are built in riparian zones or cross streams, an effective mechanism is created for accelerated sediment delivery and pollutant loading. This leads to higher levels of instream sediments, total suspended solids, and adsorbed particulates.

In general, flow augmentation from the Tualatin and Barney Reservoir projects has had beneficial effects on water quality. Water released from Henry Hagg Lake has helped to maintain cooler water temperatures on lower Scoggins Creek and the Tualatin River downstream as far as the Rock Creek treatment plant (Risley 1997). Additionally, the water released from the lake is lower in nutrients than many downstream sources, and the flow releases provide a dilution effect on streamflow at downstream points. These releases have been instrumental in helping to achieve water quality objectives over sizeable portions of the mainstem Tualatin River.

Diversions from Barney Reservoir have also contributed to water quality objectives by providing extra water during low-flow periods. The increased volume from these diversions has reduced the sensitivity of streamflow to solar heating, likely resulting in cooler water temperatures downstream of Cherry Grove. Although low water levels in Barney Reservoir led to contributions of relatively warm water to the Tualatin River system in 1998, this situation is considered anomalous. The newly expanded reservoir is expected to contribute to substantially cooler water temperatures and improved water quality in the Tualatin River in future years.

In general, water quality in Scoggins Creek and the upper Tualatin River is relatively good, leaving less room for improvement than is the case with other watersheds in the Tualatin subbasin. For most water quality parameters, there is little or no apparent water quality trend for these streams. However, the mainstem Tualatin at Dilley appears to be improving in November-March bacteria levels, while lower Scoggins Creek appears to have a weak trend for decreasing phosphorus concentrations (Aroner 1996). After 1988, increased summer flow releases from Henry Hagg Lake contributed to the improvements in phosphorus load (Aroner 1996). Water quality improvement also seems to be correlated with changes in timber, agricultural, and wastewater management practices. This suggests that expanded implementation of Best Management Practices in forestry and agriculture would lead to a continued improvement in water quality.

5.1.4.2 Factors leading to high aquatic phosphorus levels

Most phosphorus occurring in the upper Tualatin River and Scoggins Creek appears to come from natural sources. During 1992, baseline phosphorus concentrations taken on upper Lee Creek and in the Tualatin River at Cherry Grove ranged from .024 to .027 mg/L, levels that are similar to current concentrations in lower Scoggins Creek and

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the Tualatin River at Dilley. Given the correlation between sedimentary formations and phosphorus found elsewhere in the Tualatin subbasin (Wolf 1992), this suggests that the bulk of the phosphorus in Scoggins Creek and the Upper Tualatin River is provided by groundwater flowing through regions underlain by sedimentary rock. Between Cherry Grove and Dilley, a minor increase in median phosphorus level indicates that some phosphorus is picked up from the underlying alluvium and from human sources, but the relative degree of these inputs is unknown.

Measurements taken on Carpenter Creek indicate that human activities have a greater impact on phosphorus levels in the tributary streams. These high levels are likely correlated with livestock, agricultural, and nursery operations in the lower half of the watershed.

Some ODA data indicates that summer phosphorus levels have decreased after implementation of agricultural BMPs in the Christensen Creek watershed. These BMPs involved point source reduction from a container nursery and a confined animal feeding operation. It is likely that point source loads of phosphorus also exist in the Upper Tualatin-Scoggins watershed, especially on Carpenter Creek, where phosphorus levels are considerably above baseline levels. Although most other tributary stations are unmonitored, it is likely that they also have these point source loads.

A considerable amount of uncertainty surrounds the magnitude of phosphorus loads attributable to various causes. As previously explained, the amount of winter phosphorus load that affects summer phosphorus concentrations is unknown. Manure from animals grazing in wetlands and riparian areas also provides an unknown phosphorus load to aquatic systems. The effect of the infrequent summer runoff events is also unknown. Additionally, it is unknown to what extent inadequate septic systems add a phosphorus load to streams. This load would logically play a role in both summer and winter. Finally, there is a potential for future saturation of phosphorus sorption capacity on soils receiving large amounts of phosphorus fertilizer and/or manure. This could lead to leaching of phosphorus to tile drains, which flow to streams well into summer months. Organic soils, such as the Labish soils found in the Wapato Valley, generally have very low sorption potentials for phosphorus. Thus, even in summer, there is a risk of fertilizer phosphorus leaching through these organic soils into drainage systems and out to the Tualatin River.

Thus, although reductions of aquatic phosphorus concentrations will vary between streams, it is still important for farmers and rural landowners to implement BMP's for phosphorus.

5.1.4.3 Temperature

During summer low flows, water temperature on the Upper Tualatin River above Scoggins Creek periodically exceeds the cool water standard for fish. The periods of exceedance vary between stream reaches, with high temperatures prevailing for the greatest amount of time between Cherry Grove and Scoggins Creek. Although this reach is not on the 303(d) list, these high water temperatures are detrimental to salmonids and other cold water fish. Below Lee Falls, impaired stream shading is apparently the greatest human influenced impact on water temperature. Canopy restoration and streambank protection (to prevent widening) are potential strategies to promote temperature moderation in this reach. Many perennial tributary streams also have inadequate shading and would benefit from canopy restoration/erosion control projects. Notable examples include Williams Canyon Creek, Goodin Creek, and Harris Creek. Extensive reaches of these streams lack any canopy cover.

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5.1.4.4 Streams on the Oregon 303(d) water quality limited list

Management-related factors have largely been responsible for problems leading to stream placement on the 303(d) water quality limited list. Although more intensive study would be necessary to determine causality, it appears that the following factors are probable causes for diminishment of water quality.

- Carpenter Creek. High *E. coli* levels are probably caused by livestock operations and/or faulty septic systems. Low dissolved oxygen levels are likely caused by a combination of high temperatures and high nutrient levels. Large reaches of lower Carpenter Creek have inadequate canopy, leading to high water temperatures. Possible causes of high nutrient levels include runoff from nursery and livestock operations, and near-stream storage of refuse. Potential corrective strategies include minimization of runoff to streams, canopy restoration, improved management of animal waste, restriction of livestock access to streams, and improvement of septic systems.

- Scoggins Creek. Potential causes of reduced dissolved oxygen levels include biological oxygen demand from industrial and agricultural land uses downstream of Henry Hagg Lake.

5.1.4.5 Effects of water quality on recreation

Most aquatic recreational activities occur on Henry Hagg Lake. Generally, water quality on the lake is considered to be adequate to support these uses. However, there are indications that water quality may limit recreational opportunities elsewhere in the watershed. For example, bacterial concerns on Carpenter Creek and on the Tualatin River near Dilley may limit the ability of these streams to support water contact recreation. High nutrient levels in Carpenter Creek could also lead to eutrophic conditions that diminish the desirability of this stream for water contact recreation. Conditions on unmonitored tributaries within the watershed may also have diminished recreational capacity.

Diminished water quality also has indirect impacts on recreation. Poor water quality is one of the factors contributing to diminished salmonid populations, which in turn reduces cold water fishing opportunities. Conversely, relatively warm surface water temperatures in Henry Hagg Lake have generated warm water fishing opportunities.

Strategies to improve recreation opportunities are similar to those given to obtain other desirable water quality objectives. Implemention of water quality strategies to reduce nutrient loads, sediments, and bacterial inputs will create conditions more desirable for stream-related recreational activities.

5.1.4.6 Prohibited conditions

Agricultural portions of the Carpenter and Hill Creek subwatersheds were surveyed by SWCD personnel to determine the prevalence and location of conditions prohibited under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (OAR 603-095). During this initial survey, problems related to waste management (i.e. placement of wastes or animals where waste has the potential to enter streams), nearstream soil erosion, and riparian condition (i.e., farming operations inside of the 25 foot buffer, as well as active bank erosion) were surveyed. Prohibited conditions were found in all surveyed subwatersheds. The highest incidence of these conditions was found in the Hill Creek subwatershed, and consisted of improper waste management

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and nearstream erosion. Although this high incidence may be an artifact of greater sampling density, it suggests that educational efforts toward proper erosion management and waste disposal would be advisable in the subwatershed.

5.1.5 Aquatic species and habitat issues

5.1.5.1 Fisheries

Winter steelhead trout and cutthroat trout make up the major focus for habitat and water quality issues in the Upper Tualatin-Scoggins watershed. In addition to their intrinsic value, these species are sensitive to changes in habitat and water quality, thus functioning as indicator species of the condition of the stream ecosystem. Cutthroat trout are well distributed throughout the watershed and do not appear to be overly threatened. However, preemptive action should be taken to maintain good habitat for cutthroat trout. Declining steelhead trout trends in the upper Willamette ESU, of which the Upper Tualatin-Scoggins watershed is a part, indicate that steelhead trout within the watershed are at risk. Additionally, the reduced amount and quality of available habitat suggest a steelhead trout population reduced from original numbers. Trends in coho salmon populations since the end of planting efforts are unknown. For all of these salmonid species, habitat quality (including water quality) and quantity are likely to be limiting factors. The best spawning and rearing habitat for anadromous salmonid species is found in the Upper Tualatin-Lee Falls and Roaring Creek subwatersheds and is quite limited in extent. The Upper Tualatin-Blackjack and Scoggins Dam subwatersheds also provides spawning and rearing opportunities for anadromous salmonids. Due to management practices, the quality of much of this habitat is diminished from reference conditions. Increased sedimentation and decreased large woody debris inputs have created channels with reduced habitat diversity, including reduced pool frequency and diminished instream cover.

Riparian zone conditions also influence prospects for salmonid habitat in the Coast Range. Most forested stands lack large-diameter trees. Riparian forests in this region largely provide a shading function, but they are unlikely to provide appreciable amounts of large woody debris during the near future. Although some subwatersheds currently appear to have sufficient levels of instream wood, there is little recruitment potential to replace this wood when it leaves the system. For most of the watershed, this indicates that habitat conditions similar to those existing during the reference period will not be produced naturally during the next 50 years. If riparian forests are allowed to develop mature timber stands, they will eventually regain their ability to provide large woody debris to the stream system.

Mainstem sites in the Wapato Valley are mainly used for migratory corridors with some limited winter rearing (ODFW 1997 data as displayed in TRWC 1998). Substrates in these streams naturally lack spawning gravels except in isolated pockets. The greater prevalence of large woody debris in the valley during the reference period indicates that there may have been greater numbers of pools and better stream shading than is currently the case. Under such circumstances, more extensive rearing may have taken place in these streams than is currently observed. However, flow in this region would have been naturally slow, making these streams subject to heating and low dissolved oxygen levels, even under reference conditions.

Lamprey species are susceptible to many of the same habitat concerns as salmonids. Increases in water temperature have provided conditions detrimental to lamprey populations. Additionally, Pacific lamprey in their larval stages make extensive use of fine substrate portions of the watershed. Thus, high water temperatures in stream reaches in the valleys upstream of Scoggins Creek are likely to have substantial

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detrimental impacts to lamprey populations. Conversely, the cool water conditions promoted by summer flow releases from Scoggins Dam may promote lamprey development in Scoggins Creek and portions of the Tualatin River above Rock Creek.

Migration by anadromous fish has been impeded relative to reference conditions. The largest single barrier is Scoggins Dam, which cut off access to 15 miles of spawning and rearing habitat (BOR 1970). Roads and culverts also provide impediments to migration. An ODOT culvert survey found that most surveyed culverts on county roads within the watershed provided sufficient passage for anadromous fish. Nevertheless, during spot field observations in the Coast Range, numerous culverts were noted to provide insufficient passage to fish. These observations indicated that undersized and improperly placed culverts tended to be concentrated on spur roads and other little-used routes, while newly installed culverts on mainline roads were sized and placed so as to provide adequate passage. The degree of impedance caused by these culverts was unknown.

Migration may be inhibited by low water due to diversions. As upstream migration occurs prior to the irrigation season and enhanced instream water rights are in effect during migratory periods, migratory delay due to diversion may be minor. However, there are likely numerous unscreened diversions in the watershed, potentially providing a hazard to fish migrating and rearing in the valley channels. In order to minimize this hazard, TVID maintains a fish screen at its Patton Valley pumping plant.

5.1.5.2 Wetlands: Management impacts

The location, extent, and functionality of wetlands have been greatly changed from reference conditions. Under reference conditions, most wetlands were shallow, seasonally flooded lakes, ponds, marshes and swamps in the Wapato Valley. Now, the greatest extent of wetlands is contained within Henry Hagg Lake. The vast majority of this wetland area is permanently flooded. Although it provides aquatic habitat for many species, it almost certainly provides less aquatic vegetation and habitat for amphibian species than did Wapato Lake and other wetlands of the Wapato Valley. Drainage projects in the late 1800s and the early 1900s have severely diminished the extent of wetlands from pre-settlement levels. The remaining wetlands in the Wapato Valley are greatly diminished in size, and wetland area within the watershed has been reduced by 2,800 acres, or 61%. (This includes Henry Hagg Lake, but excludes numerous small wetland ponds in the mountains.) The remnant riparian forests are the least modified wetland type. Marshes have typically been collected into impoundments with little wildlife value. Although winter ponding of traditional wetland areas still occurs, the period of inundation is greatly reduced from natural conditions, and these areas are generally no longer considered to be wetlands.

The habitat functionality of many of the remaining wetlands has been degraded. This degradation is evidenced by the encroachment of non-native noxious species upon the wetland habitats. Reed canarygrass (*Phalaris arundinacea*) is nearly ubiquitous in wetlands. Purple loosestrife (*Lythrum salicaria*), an ODA schedule B noxious weed, is also a common invader of wetland habitats. Programs to restore native plant species would help to improve the ability of wetlands to provide habitat for native animal species.

In the mountains, small wetlands and ponds likely experienced less modification than is the case for the valleys. Although these wetland areas would have been subject to accelerated sedimentation and other impacts from logging, management was generally less intensive in these areas. Relatively few of these wetlands are mapped, but they are most likely to occur in regions of unstable lithology, as well as areas with high beaver activity. Despite their small size, these wetland areas potentially provide habitat for sensitive botanical and amphibian species.

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5.1.5.3 Riparian habitat: Management impacts

Non-wetland riparian habitat is also diminished in extent and quality from reference conditions. During reference conditions, most valley streams had wide riparian forests. Following settlement, timber and agricultural activities often removed these forests up to the stream channel, leaving no buffer. Riparian habitat would have been completely lost during such periods. Current Oregon forest practice rules provide for a riparian buffer strip along streams. Although such a buffer is of value, it has resulted in a tenuous, thin strip of riparian habitat surrounded by habitat adverse to many riparian species. Thus, the current scenario represents a massive loss of riparian habitat relative to reference conditions.

There are no current regulations requiring trees along streams in the agricultural zone, except insofar as logging in the agricultural zone is also under the auspices of the Oregon Forest Practices Act. Clearing of riparian vegetation for farming, however, is not regulated unless logs are sold commercially.

5.1.5.4 Impacts of wetland and riparian changes upon species

Loss of habitat has undoubtedly reduced the abundance of wetland and riparian dependent species in the Upper Tualatin-Scoggins watershed. However, few to no population surveys have been performed to verify this conclusion.

Although population status of many amphibian and aquatic species is unknown, it is assumed that they have declined with declining habitat. It is hoped that stabilization of habitat amounts will result in a stabilization of populations.

5.2 Terrestrial

5.2.1 Vegetation issues

5.2.1.1 Post-settlement effects on landscape characteristics

Due to settlement, the pattern of vegetation has changed extensively from reference conditions. The reference landscape consisted of massive expanses of late-successional forest interspersed with occasional patches of early- and mid-successional vegetation where stand-replacement fires had occurred. In the valleys, there were also patchy prairies where frequent flooding occurred. Following European settlement, the vegetation pattern was changed to the current highly fragmented landscape. Although large stands of midseral forest continue to exist in the mountains, late-successional forest only exists in small patches, usually much less than 100 acres. The foothills are covered by a mosaic of many small (<100 acre) patches of early and mid-successional forest, interspersed with very few small patches of late-successional forest. The valleys within the watershed were mostly transformed to agriculture. Rural residential uses have also contributed to fragmentation, especially in the Hill Creek subwatershed and along the Highway 47 corridor.

5.2.1.2 Potential vegetation management strategies

Given current ownership and landscape patterns, it would be difficult to manage the watershed for large blocks of late-successional forest. Prospects are better for species dependent on small patches of late-successional forest, or on specific late-successional

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habitat elements. Suitable habitat for these species is an important, achievable objective in the AMAs, LSRs and Riparian Reserves of federal lands. On private lands, potential to provide habitat for these species will depend upon the management emphases of the landowners. Partnership opportunities with these landowners may be available on a case by case basis. Exploring these opportunities is an important objective for federal AMA lands.

As the AMA moves closer to an older forest condition, private lands are anticipated to increase their relative contribution to maintaining habitat for species dependent on early- and middle-successional habitats, as well as edge habitats.

Federal, state, and private lands all provide habitat for riparian-dependent species. Forest practice rules for all types of ownerships emphasize retention of a riparian buffer strip. Assuming current management practices, the width of this buffer on private land is likely to remain narrow, and only minimal habitat will be afforded. Some of these stands will develop mature structural characteristics, providing habitat for riparian species that prefer late-successional habitats or habitat features associated with late-successional habitats.

5.2.1.3 Noxious and exotic plants

Ecosystems in the upper Tualatin-Scoggins watershed appear to be losing native species richness due to the invasion of exotic and noxious plants. Much of this threat to native species is on privately owned lands. Himalayan blackberry, Scotch broom, and reed canarygrass all provide major impacts within the watershed's foothills and valleys. In the mountains, Scotch broom is the most widespread noxious weed. It dominates entire hillsides, as is the case in Williams Canyon, and it is established adjacent to many forest roads in the western portion of the watershed. In some cases, non-native, exotic weeds on these lands can adversely impact federal lands. Adjacent private lands are often so contaminated with exotic/noxious weeds (especially Scotch broom) that BLM-administered lands can also become easily infested unless preventative measures are enlisted to curtail it from happening. Also, the spread of exotic/noxious weeds along BLM-administered roadways need to be curtailed now so that future management actions will not have a good share of these species to contend with. Examples of such nuisance species include Canada thistle, bull thistle, reed canarygrass, and tansy ragwort. Interior forests in the watershed do not appear to have weed problems.

5.2.1.3.1 Potential strategies for control of noxious and exotic plants

The checkerboard ownership pattern and differing management goals within the watershed make it difficult to have a coordinated program to promote and preserve native plant populations, and limit the spread of exotic plants and noxious weeds. The diversity of native plants on adjacent private timberlands, especially the industrial lands, is very often negatively impacted by the application of herbicides to control competing vegetation. Himalayan blackberry and Scotch broom are two aggressive exotic plant species that are favored by soil disturbing activities, which include road building and timber harvesting. On industrial private lands, however, these plants are often controlled with herbicide applications as a part of their regular vegetation management programs. Herbicide application often results in net loss of native plant diversity, and may have additional detrimental impacts when applied near aquatic systems. Additionally, exotic plants tend to be more aggressive than natives and reinvade treated areas sooner than many native plants, therefore often requiring multiple herbicide treatments to be effective. Native shrub species that are commonly greatly reduced by the invasion of exotic plants include elderberry, cascara,

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thimbleberry and salmonberry. Loss of these species has the potential to impact the distribution or abundance of wildlife species such as band-tailed pigeon, Swainson's and varied thrushes and black-tailed deer.

Success of eradication efforts will vary. Due to the widespread distribution and persistent nature of Scotch broom and Himalayan blackberry, it may be necessary to prioritize areas for abatement efforts, rather than attempting complete eradication within the watershed.

Preemptive action can be taken to detect potential problem plants and prevent their introduction to the watershed. The giant reed (*Arundo donax*), for example, has created substantial problems in California and is sold as an ornamental here. Concerns have been voiced that *Arundo* might become a nuisance weed in the Tualatin Valley.

5.2.1.4 [BLM only] Potential management strategies within the Riparian Reserves

Watershed-wide, the amount of habitat available to riparian-dependent species is severely limited. For that reason, any portion of the Riparian Reserves affording cool, shaded, moist, habitat for riparian-dependent species should be retained in a condition where they fulfill that function. These areas, and those with potential to provide habitat, should be managed to promote the development of desirable habitat features. Similarly, late-successional habitat is severely deficient in the watershed. Thus any riparian areas that afford such habitat, or are capable of developing such characteristics, should be retained. Often, implementation of no cut buffers will assist in habitat retention. In some cases, thinning and projects to create snags and down wood may help in development of these important habitat characteristics. Thinning would also help to establish windfirmness within the Riparian Reserves, thereby helping to reduce future windthrow.

Portions of the Riparian Reserves occur in areas of steep, unstable terrain. Due to the risk of landslides and sediment contributions to streams, harvest activities may not be advisable in such areas.

5.2.2 Species and habitat issues

5.2.2.1 Factors affecting the distribution of sensitive species

Timber operations and their associated roads have had a significant effect upon the character of the stands within the watersheds. Consequently, the landscape of this watershed is largely made up of second-growth conifers that are frequently deficient in habitat requirements for sensitive plant species.

BLM-administered lands are found in a checkerboard pattern in the watershed. Forest fragmentation and loss of native plant diversity is far greater on private lands due mainly to consistent logging and associated road building and herbicide application, as well as the draining of wetlands. Noxious/exotic weed invasions on these disturbed lands have also increased immensely, thus compounding the loss of natural habitats. Since habitat loss for species of concern is an important factor in this watershed, it is of increased importance that remaining habitats on federal lands be maintained. The value of these habitat preservation efforts will be enhanced if a partnership can be formed with the Oregon Department of Forestry and private landowners to manage adjoining lands for these species.

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According to the *Late-Successional Reserve Assessment (LSRA) for Oregon's Northern Coast Range Adaptive Management Area* (USDA and USDI 1998), BLM lands in the watershed are located in the Buffer Landscape Zone. Late successional stands within this landscape zone are not considered likely to develop large, contiguous blocks of late-successional habitat, but are considered important for connectivity, dispersal, and provision of refugia for species dependent on late-successional habitat characteristics.

Many sensitive species are dependent upon late-successional habitat or specific features associated with late-successional habitat. Such habitat will continue to be limited in the watershed. Most appropriate habitat will eventually be developed in the federal AMAs, LSRs, and Riparian Reserves. Depending upon management policies, suitable habitats may be developed in riparian areas in the Tillamook State Forest and on private lands. Thus, species dependent on late-successional habitat are likely to be restricted to these strips and patches of suitable habitat. The characteristics of these areas will tend to favor species with small home ranges unless partnership agreements can be achieved between land managers to manage for species with large home range. Habitat for species dependent on mid- and early-successional conditions is expected to remain abundant.

The amount of snags and down woody debris available for species dependent on these habitat elements varies within the watershed. In some mountainous subwatersheds, such as Lee Creek, down woody debris is locally abundant. In most areas, current levels of snags and down wood are greatly diminished from reference conditions. Due to the lack of mature and old growth forest, few snags and little down wood now exists, and future recruitment potential is limited for a number of years to come. Most recruitment potential is in small, scattered stands of mature timber on BLM, state, and private lands. Such potential is not expected to increase on private lands, as forest harvest continues. Federal Riparian Reserves and other protected riparian buffers are expected to increase levels of down wood in riparian zones in the future. Additionally, leave-tree requirements on federal AMA and LSR are likely to result in continued supplies of snags and down wood. Active management efforts to increase levels of snags and down wood would benefit many species, including primary cavity nesters such as woodpeckers and secondary cavity nesters such as bats, flying squirrels and saw whet owls.

Due to loss of habitat, the populations of many species of concern have diminished. The spotted owl, for example, may have been eradicated from the watershed due to lack of habitat. Populations of the pileated woodpecker have been reduced. If the red tree vole is currently present in the watershed, its population has been greatly diminished.

The marbled murrelet is not known to have utilized the watershed. However, there is potential murrelet habitat here. Much less of such habitat exists than under reference conditions.

Appendix J2 of the Northwest Forest Plan and Management Recommendations for Fungi, Version 2.0, September 1997; and present protocols for category 1 and 2 lichens and bryophytes lists the ecosystem requirements for those species. The influences and relationships of these species and their habitats with other natural or human caused processes are often fragile. The ROD/RMP requires that certain protection and management procedures be followed for an array of 4 categories of Survey and Manage species. BLM manual 6840 gives details on the protection and management of Bureau Sensitive, Assessment, and Tracking species. Those species potentially found in the Upper Tualatin-Scoggins watershed are listed in sections 3.1.5.1, 3.1.5.2, and 3.2.2.1.2.

Prospects for a uniform habitat management strategy among landowners in the mountainous portions of the watershed are uncertain. The majority of these lands are owned by two public agencies and two private landowners. The concentration of land

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between a few landowners would tend to facilitate formation of habitat management partnerships. The ability to form these partnerships may be limited by the differing management emphases of these entities.

5.2.3 Forest resources issues [BLM-specific]

5.2.3.1 Management of snags and down wood

The quantity and quality of snags and down wood on BLM lands is variable. Snags appear to be deficient in all areas except some stands occupied by mature timber, such as the LSR Block at T1S, R5W, S19. Down wood on BLM lands is somewhat more abundant. In some parcels the amount of down wood exceeds expectations based on stand age. Nevertheless, there are areas where it would be appropriate to increase the amount of down wood by placement of fresh down Douglas-fir trees. When leaving these trees, the potential impacts to the residual stand from the Douglas-fir beetle should be considered. In westside forests, when there are more than three windthrown Douglas-fir trees per acre greater than 12 inches DBH, infestation and mortality of standing live Douglas-fir trees can be expected (Hostetler and Ross 1996). For every two down Douglas-fir trees per acre greater than 12 inches DBH, beetles will likely attack one standing live Douglas-fir tree. Not all beetle attacks will result in tree killing, however. As a general guideline, the number of standing Douglas-fir trees killed in the years following wood placement will be about 60% of the number of fresh down Douglas-fir trees added to the forest floor. However, there is some new information indicating that the number of trees killed may be as low as 25%. Tree vigor is an important factor determining whether a given tree can withstand beetle attack. Trees infected with root disease are especially at risk from beetle-related mortality. It is also important to note that the threat to the surrounding trees is much less when the down trees are exposed to direct sunlight as opposed to being shaded. Beetle attacks and subsequent brood production from exposed down trees are substantially lower than when they are shaded. Wood placed between July and September is also less likely to lead to beetle infestations.

There are sites where moderate levels of tree mortality due to Douglas-fir beetle activity can be beneficial. Such mortality increases diversity of stand type and structure. These potential benefits should be taken into account on a site-specific basis when placing down wood.

5.2.3.2 Laminated root rot

Laminated root rot (*Phellinus weirii*) is a natural part of forest ecosystems in Western Oregon. At moderate levels, it is a beneficial ecosystem component, as it helps to promote structurally diverse stands composed of multiple stories and species. It can also contribute to creation of snags and down wood, although the snags produced by *P. weirii* tend to be short-lived.

Damage caused by *Phellinus weirii* root rot will likely be higher in most managed stands than in natural stands. Most of the harvested lands in the watershed have been reforested with Douglas-fir, which is readily infected and killed by this root disease. Once young Douglas-fir trees reach about 15 years of age, disease centers become apparent and root-to-root spread occurs from the original infection site. On-the-ground surveys in commercial-sized stands in this area are consistent with the findings of Thies and Sturrock (1995), which have shown that Douglas-fir volume production in *P. weirii*

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root rot centers is less than half of that in healthy stand portions. Disease centers are believed to expand radially at the rate of about one foot per year (Nelson and Hartman 1975) and losses in diseased stands may double every 15 years (Nelson et al. 1981). It is generally not recommended to commercially thin in stands of highly susceptible species, such as Douglas-fir, when disease is present in 20 percent or more of the stand (Thies and Sturrock 1995). High levels of *P. weirii* infection (more than 25 percent of the area in disease centers) are of special concern when considering commercial thinning, especially if the disease centers are not well defined. Specific locations have been identified on photographs, but treatments will be performed on a site-by-site basis.

5.2.3.3 Management of hardwood stands

A sizeable but indeterminate portion of the watershed is in the mixed conifer/hardwood or pure hardwood stand condition. Red alder is by far the most abundant hardwood in forested subwatersheds. Many of these sites once supported western redcedar and other conifers, but because of site disturbance during past timber harvesting activities and inadequate conifer reforestation, alder has become a dominant stand component. Some of these sites are capable of supporting conifers at this time. Others are best left in alder for a while to help relieve soil compaction and increase the site nitrogen level. Some sites, such as wet areas, are probably best left in alder and not intensively managed to restore full conifer stocking. In sites currently suitable for conifer production, however, continued alder domination will delay the development of late-seral habitat.

The proportion of the watershed dominated by red alder has increased in comparison to the reference conditions as a result of ground disturbance from timber harvesting and associated road building activities. Historically, most alder was restricted to areas along streams on lower slope positions. Alder currently dominates many upland areas where soils have been disturbed, and is very prevalent along roads. It also aggressively competes with young conifers for growing space.

5.2.3.4 Achievement of late-successional goals in Late Successional Reserves

Late successional goals in the LSRs and other allocations have been determined as part of the *Late Successional Reserve Assessment for Oregon's Northern Coast Range Adaptive Management Area,* also referred to as the LSRA (USDA and USDI 1998). Goals listed in the LSRA included maintenance and development of late-successional habitat connectivity, dispersal habitat, and refugia for species dependent on habitat with late-successional characteristics. Additionally, conservation of biodiversity within these lands was identified as a goal.

As is the case with other land use allocations in the watershed, little habitat with late-successional characteristics presently exists in LSRs. Thus, the ability of this land use allocation to provide refugia and connectivity for species dependent on these characteristics is very limited. Achievement of late-successional goals will depend upon future development of late-successional characteristics. According to the LSRA, much of the LSR was not likely to develop these structural characteristics in the near future. Based on this fact, the LSRA suggested the use of this LSR to test silvicultural treatments to accelerate the development of late-successional forest habitat. Potential projects designed to achieve late-successional goals within the watershed are listed in Appendix 9.

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5.3 Social

5.3.1 Issues related to human uses

5.3.1.1 Agriculture

The amount of farmland is expected to decrease slowly within the watershed. In its comprehensive plan, Washington County recognized the importance of agriculture to the quality of life in the region and designated Exclusive Farm Use (EFU) zones. Most lands presently in agriculture fall within this zoning, or under the mixed Agriculture-Forestry (AF) designation. At present, there is little additional land zoned for rural residential or urban growth within the watershed. Most future losses of agricultural land to other uses are expected to occur along the Highway 47 corridor and on rural residential lands within the Hill Creek subwatershed.

Agricultural operations impact watershed resources, often creating conflicts with other beneficial uses within the watershed. Most particularly, they are the greatest single use of surface water resources. Operations also can contribute to water quality problems, creating potential conflicts with fishery and recreational resources. With improved practices, negative impacts and conflicts are being reduced. Many of these improvements have been achieved with the assistance of the Farm Service Agency (FSA), the Natural Resources Conservation Service (NRCS), and the Washington County Soil and Water Conservation District (SWCD). Through implementation of farm conservation plans and other programs, farmers in conjunction with these agencies have been able to reduce soil loss, water consumption, and inputs of sediments, nutrients, and other pollutants to streams. Since many farms in the watershed operate without fully utilizing these services, further opportunities for improvement exist within the watershed. However, these agencies and programs lack the funding to fully meet the demand in a timely fashion.

Although total agricultural production is a substantial portion of the watershed economy, the results of the 1997 agricultural census indicate that many farms operate on a slim profit margin. This should be taken into account when implementing new programs to address conflicts with other beneficial uses in the watershed.

5.3.1.2 Timber

Timber operations within the watershed are expected to remain constant or produce more wood in the near term[32]. Many of the forest resources that were depleted in the first half of the century (both through timber harvest and through fire) have regrown to harvestable age, indicating that abundant opportunity exists for increased logging within the watershed. This opportunity has been reflected in the increased timber harvest that has occurred in the Tualatin subbasin since 1990. The large private ownership within the watershed, coupled with diminished output from public lands, indicates that the watershed may be an important supplier of timber in the present and near future.

With increased harvest comes a renewed potential for conflicts with other beneficial uses of the watershed. In the past, timber harvest contributed to significant problems related to erosion and sedimentation, leading to channel changes and diminished fishery resources. Reductions of wildlife populations dependent on late-successional and riparian habitats have also occurred due to the history of disturbance within the

[32]Based on stand characteristics, and harvest policies on federal lands. No timber economists were consulted.

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watershed. With the improved forest practice rules currently in effect, riparian and stream problems related to timber harvest are expected to be lower than past levels. However, problems for species dependent upon late-successional habitat are expected to persist.

Several strategies have the potential to reduce conflict between timber operations and wildlife. Species diversity will be encouraged if timber stands are managed in multiple stages of development. As lands within the watershed are seriously deficient in late-successional habitat, enhanced protection of stands in late-successional condition would help to maintain populations of species dependent upon this habitat type.

Because of young stand age and the need to retain all currently mature timber, only 25% of BLM lands are currently suitable for harvest. A portion of this land is likely to be managed to develop late-successional characteristics to satisfy the 15% rule. Over the next thirty years, an additional 68% of federal lands will become suitable for harvest.

5.3.1.3 Rural residential and urban uses

Increasing population is probably the greatest change creating a demand on watershed resources. As population grows, demands for housing space, recreation, and workspace increase, as well as demands on water and contributions of wastewater. Population trends in Washington County indicate that these demands and pressures will continue to persist into the next century. Although these pressures are expected to be less severe in the Upper Tualatin-Scoggins watershed than elsewhere in the Tualatin subbasin, development of land for rural residential and a limited amount of urban uses is expected to continue. Given current zoning, this growth is expected to be concentrated in the Highway 47 corridor and in the Hill Creek subwatershed. Much of this growth will occur near streams, increasing potential hazards to stream resources. With this growth, there is an enhanced potential for problems related to accelerated erosion and faulty septic systems.

5.3.1.4 Rural interface

Rural interface problems are hard to gauge. Most BLM parcels within the watershed are not easily accessible to the public. This tends to reduce the amount of conflicts between BLM and public uses. However, tracks made by OHVs were noted on poorly accessible lands in the Roaring Creek subwatershed.

Due to the remoteness of the BLM parcels, BLM management activities are not expected to conflict with residential uses. Only 120 acres of BLM land lie within 1/4 mile of land zoned for residential parcels less than 20 acres in extent. These lands are located at T1S, R5W, S1, NE1/4, and T1S, R5W, S35, SE1/4, NW1/4.

5.3.1.5 Recreation

Most recreational activities in the watershed lie along Henry Hagg Lake. These include boating, fishing, hiking, picnicking, and swimming. Hiking and hunting also take place on public lands and some private timberlands in the Coast Range. Fishing is also a popular activity along streams in the watershed. Certain areas of the Tillamook State Forest are designated for OHV use, which sometimes spills over into lands not designated for that use.

The availability of public lands for these activities is limited by access. Many BLM parcels either do not have public road access or have such access closed by landslides. Performance of recreational activities on such lands are limited to the more ambitious recreationalists.

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Aside from Henry Hagg Lake, developed parks are uncommon within the watershed. Gaston City park affords an opportunity for recreational activities, while a portion of Bald Peak Park falls occurs at the edge of the watershed boundary in the Hill Creek and Ayers Creek subwatersheds.

5.3.2 Cultural resources

Numerous artifacts of cultural importance have been found near locations of Tuality winter villages in Patton Valley and around Wapato Lake. Among the most significant of these are the pictographs near the old Seth School in Patton Valley. Great care should be taken when conducting activities that will disturb the ground around Wapato Lake. Additionally, Beckham (1974) noted a number of structures built by pioneer settlers that might potentially be of historical significance.

Generally, speaking, Native Americans did not spend much time in the mountainous portions of the watershed where BLM lands are located, and there are not anticipated to be many cultural resources in these areas.

5.3.3 Road-related issues

Roads can be beneficial because they facilitate access into forest lands for utilization of resources, fire suppression, and recreation. However, they also have potentially negative effects. Roads frequently conflict with Aquatic Conservation Stategy (ACS) objectives by contributing sediment to streams. Exposed road surfaces are often readily erodible, while sidecasts and cutslopes are often susceptible to landsliding. Sediments are readily delivered to streams by near-stream roads and at stream crossings. The culverts at these stream crossings also frequently conflict with ACS objectives by impeding the migration of anadromous fish.

Roads also potentially conflict with other objectives listed under the Northwest Forest Plan. They can interfere with attainment of Late Successional Reserve (LSR) objectives by enabling the transport of exotic and noxious invasive plant species into interior forest areas. On all allocations they open lands to trespass, vandalism, poaching, and forest product theft, and contribute to fragmentation of wildlife habitat. A problem of growing magnitude is their use as garbage dump sites, which introduce exotic garden plants into the forest ecology. These sites also leach contaminants into groundwater and nearby surface waters. Road-related concerns are also discussed in sections related to erosion, hydrology, stream channel, and aquatic habitat.

The highest risk for road-related slope failures occur on steep lands in the Coast Range and Chehalem Mountains. The Roaring Creek subwatershed, in particular, has had a particularly high incidence of road related slope failures. However, other such failures have been distributed on other roads in the watershed. These failures potentially create opportunities for accelerated sediment inputs to streams.

Stream crossings potentially create migratory hazards to anadromous fish. Additionally, insufficiently sized culverts may lead to road washouts, contributing to sedimentation problems. Recent field surveys found many inadequate culverts on forest roads. Although mainline roads have, in many cases, received properly sized and placed culverts, many older and little-used roads continue to have inadequate culverts.

Road surfacing led to a need for rock pits. Current quarries are concentrated in the Carpenter Creek subwatershed and in the Chehalem Mountains (Harris, Hill, and Ayers

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Creek subwatersheds). These sites, along with historic quarries, may pose sediment risks to nearby streams. They also may create a safety hazard due to their depth and/or sheer wall faces.

5.3.3.1 Considerations related to road design

The useful life of roads generally ranges between 20 and 25 years with continual maintenance. Most culverts need replacing at the end of this period. Usually, road design standards have changed over this time, and the replacement roads are built according to the new standards. In the past, many of these changes in design standards reflected a trend toward facilitation of traffic movement with little regard given to environmental impacts. This was reflected in excavation and clearing limit widths for forest roads in excess of 40 feet. Road alignment was generally straight with nominal steepness.

Increasing concern for the environmental impacts of forest roads has resulted in a trend toward road designs that reduce ground disturbance. This often includes narrower road design, with 18 to 25 foot clearing limits being explored on a site by site basis. The need for excavation, fill, and road grading is minimized by road designs that follow the contour of the slope. Although these designs are generally more restrictive of traffic movement, they reduce ground disturbance per unit length of road that is built. This can be beneficial to ACS and other objectives delineated under the Northwest Forest Plan, provided that use of these designs does not necessitate substantial increases in road length.

As was the case elsewhere in Oregon, it is likely that many of the older forest roads in the watershed were built using construction standards that led to high risks for erosion and stream sedimentation. These include roads that were built on unstable slopes, incorporated side fill construction on steep terrain, or ran parallel to water bodies for long distances. In some cases, road drainage culverts were undersized or spaced too infrequently to provide adequate drainage. Old roads build under these undesirable standards can be expected to be an ongoing monetary and resource expense until they are removed from the land base.

The majority of culverts on BLM land are too small to handle the volume of water in a flood event. Most culverts are placed with the intent of removing frequent, relatively small flows in an economic and efficient manner. This results in a large percentage of culverts sized at 18 to 24 inches in diameter. Larger culverts are unusual except for those placed in the largest streams.

The average culvert spacing on forest roads within the watershed is unknown. However, culverts observed during preparation of this report were often spaced more infrequently than the 500-foot standard. In many cases, culverts spaced at the 500-foot standard are insufficient to dissipate the energy of flowing ditch water in a flood event or heavy downpour. Where dissipation of energy and flow is not provided, the potential for erosion of the fill slope, as well as ditch and road surfaces, is increased. These situations also frequently result in erosion of the natural slope below the culvert outlet. The effects of these erosional processes can lead to complete road failure (Piehl et al. 1988). Additionally, on BLM roads the majority of ditches became filled with side-hill materials. This reduced the capacity of the ditches to carry storm runoff to culverts, resulting in water running across road surfaces.

Although it is tempting to cut corners with respect to road construction, this is often a false economy. When road failures do occur, the cost of repair frequently far exceeds the cost of using appropriate designs and road construction methods.

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Opinions differ on whether the active or proactive approach to maintenance is relevant on this watershed in areas of unstable soils or landforms. The argument against a proactive approach is the benefit received may not economically warrant the removal of fills or the upgrading of the existing culverts to handle the 100-year flood event.

Many of the internal roads within each section are not being maintained. Deterioration of these roads is leading to a substantial erosion problem. The result may be unacceptable sediment loads entering surface waters. Field reconnaissance in the Upper Tualatin-Scoggins watershed confirmed that side bank failures were occurring where roads or culverts were not maintained.

In many cases, road closure may be the appropriate means to reduce sedimentation hazards. Closure includes pulling culverts, subsoiling and re-vegetating with native plant species. Newer techniques are being considered which includes partial re-contouring the ground by pulling back side fill construction, or stockpiling construction materials and re-spreading the excavation materials, (realizing there is a 30 % loss in volume due to settling). In order to re-vegetate these sites, relocation of adjacent vegetation to the site, and collection of nearby seeds for on-site planting, are often preferable to importation of seeds from other locales. There are several considerations to apply for a road to be a candidate for closure. A road is considered for closure if it is not needed for administrative needs, it can not be extended to access distant ground, if it is contributing unacceptable levels of impacts to the resource. However, if it is within a Reciprocal Right of Way Agreement or non-exclusive easement, its closure would be upon agreement with those with permit to use the road.

Rocked roads are surfaced with 8 to 12 inches of compacted rocked on a compacted subsurface. In an effort to remedy the concerns of the impacts a rocked road had on the hydrologic function, natural surfaced roads (i.e. a compacted dirt surface) became preferable. These roads were designed to be used for one timber harvest, after which they were to be decommissioned. However, managers have recently become aware that a deep dust layer builds up within the road prism during very dry months. Should it rain, this sediment is entrained into runoff, by which means it is transported to streams. Additionally, the driving surface develops thick layers of mud, which impedes the passage of traffic and increases potential soil transport from the road surface. A middle ground between a rocked road and a natural surfaced road is the method of placing one lift of pit-run rock on a ground surface which has been compacted by the road construction equipment driving on it rather than a compacting vibrator. The benefit of this method is the rock offers a protective cover to the road when holding over winter, as well as it stops the dirt surface becoming dust when driven on in dry weather and the consequences should it rain. It is also less compacted, and can also be decommissioned about as easily as can a dirt surfaced road.

On forest roads, new non-vegetated ditches and catch basins with vertical faces are potential sediment sources. Due to the soil’s property to ravel and slough on vertical faces, these will likely slough sediment materials. Although these structures are intended to reduce sediment transport, their benefit of these structures will be reduced if these sloughing processes cause sediment to be introduced to ditch and culvert systems. Furthermore, the effective life of the catch basins will be reduced as they fill with sediment.

5.3.2.2 Siting of Roads in Riparian Reserves

Federal land managers are directed to try to minimize new road construction in a Riparian Reserve. The width of a Riparian Reserve is determined by measuring from the edge of the stream a slope distance of one site-potential tree height on a non-fish bearing stream, and two site-potential tree heights on a fish bearing stream. Collectively,

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two site-potential tree heights may be greater then 400 feet. The intent of the direction is to minimize sedimentation into the adjacent body of water and to help meet the Aquatic Conservation Strategy; however, the impacts of constructing a road in a Riparian Reserve may be less then constructing one outside the reserve.

Road placement should look at the topography and soils, not just a lineal distance. There is often less impact caused by constructing a road 100 feet away from a stream on flat ground than above a stream on a hillside even if it by definition is not in the Riparian Reserve. Additionally, because the Riparian Reserve width is a guideline, there will be occasions where a road should be placed as far away as body of water as possible, which may be beyond the Riparian Reserve boundary, or not be built at all.

5.3.3.3 Road Location

Road density (the amount of road mileage in a given area) is often used as a surrogate to determine the relative hazards imposed by roads within a subwatershed. Although this allows a place to begin analysis, road density does not give a complete picture of the relationship between roads and watershed processes. The effects of a given mile of road upon these processes will depend on the position and construction standards of the road. An 800 foot road which rolls with the terrain, which requires nominal quantities of earth work, and in the best of circumstances, uses water dips rather then cross drainage, should be considered in preference to the short, steep road, requiring large quantities of excavation to make it usable. Certainly the longer road will be a barrier to water absorption on the compacted road surface. However, on the road which rolls with the land shape, the surface water will flow toward the outside of the road, resulting in a equitable volume of water running off of the road at any one place into the adjacent ground. Additionally, the natural topography of the ground has not been altered. Waterdips are placed at topographic low points where water would naturally flow. In contrast, a shorter road designed to require a large quantity of excavation will have potentially substantial impacts on watershed hydrology and erosion processes. Although there will be less ground base acting as a barrier to water absorption, excavation renders the land surface vulnerable to erosion and interrupts subsurface water networks, resulting in an increased need for maintenance. The surface water will need to be directed into ditches and associated culverts, many of which are likely to discharge directly to streams. This can result in erosion of ditch walls, with associated sediment transport and deposition to streams. If, instead, these nutrient-poor sediments discharge onto depressional land surfaces, they can accumulate and act as a barrier to plant growth. Additionally, in time the cutslope faces may slide into the road, requiring maintenance to remove the materials. If these slides are neglected, they will contribute massive quantities of sediment during precipitation events.

5.3.3.4 Road Construction

The newly constructed forest roads showing the least impact to the ground are those placed near the ridge top or with “roll with the ground” siting; and those roads designed with a side cut low enough (generally four feet or less in height) to allow a back slope of 1.5 feet (horizontal) to 1 foot (vertical) which acts as a shelf on which grasses and small brush plants can become established. The colonizing plants hold the soils and slow water runoff, thereby preventing the soils from eroding. Roads shaded by mature trees growing within branch reach of the road appear to promote the re-vegetation process, thereby exponentially countering the impacts from the new road construction.

In contrast, roads located requiring a steep side-hill cut show the greatest impact to the associated ground. The high cuts have vertical faces in which the re-vegetation cannot take root. Without vegetation, the soils are left open to the inclement weather, and the

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shading factor which promotes further growth does not happen. Also, roads of this type generally do not have any existing trees nearby to break the intensity of the rain hitting the soils. The lack of vegetation results in loss of soil to ditches during precipitation events. In soils that contain rock, the heavier rock materials remain where they fall, creating a "rocked ditch".

Although road construction along ridges is preferable, some road construction will be necessary on side hills in order to access the ridge top. Additionally, access considerations will likely necessitate road construction in Riparian Reserves. In these cases, road construction should implement Best Management Practices for road construction, as well as the recommendations in Chapter 6, to minimize road-related impacts.

5.3.3.5 Ditches

In these highly erodible soils, ditches cut with a rounded back slope and a bowled bottom erode much less than ditches constructed with a "box" shape. The latter type has vertical faces that slough sediment until they become rounded and "green" with vegetation. The placement of irregular shaped large rocks as a ditch liner appears to act as a water-energy dissipater. Additionally, the larger rocks are not so tightly meshed as to prevent vegetation from becoming established between their joints. If the rock lining is thin and flat, this shape of rock can mesh so tightly as to block vegetation from taking root. It can also act as a low-friction conduit in which the sediment-laden water gathers momentum. When the water is released into an adjacent stream, the hydraulic force often erodes the outlet side of the channel.

5.3.3.6 Road Closure

The closure of a location or road to OHV recreation results in the users going to adjacent open areas, thereby centering the ground disturbing impacts from OHVs rather then spreading the impacts over a greater land base. Closing roads is a complex decision of weighing the beneficial and detrimental effects of the closure. Benefits potentially include lower road maintenance expenditures, reduction of potential road failures, and possible limitation of garbage dumping, vandalism and unauthorized OHV use. On the other hand, closures may have detrimental effects on the lands of adjacent neighbors.

5.4 Data Gaps

During preparation of this watershed analysis, several data gaps were identified. Data collection in these areas will provide potential benefits to management, planning, and restoration efforts.

Erosion Processes

- Magnitude, location, and causes of mass-wasting processes. This watershed analysis supplied slope-based indicators of high landslide potential and locations of several notable landslides. A comprehensive landslide inventory based on aerial photography and field visits would enhance our knowledge in this area, as well as determining present and potential sediment sources.

- The relative magnitude of natural and human contributions to landsliding.

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- Magnitude and location of sheet, rill, gully, and bank erosion. This watershed analysis identified stream reaches and subwatersheds where such erosion was observed or would be likely. Site-specific field surveys and quantitative modeling would enhance our knowledge of these processes in the watershed.

- Magnitude of erosion reduction effected by implementation of specific BMPs and relative effectiveness of these BMPs.

- Riparian conditions in forested lands and impacts of forestry near streams. Although this watershed analysis noted improvements in Oregon Forest Practice Rules that reduced erosion, it did not address the adequacy of these rules and current enforcement practices to attain erosion-control and water quality objectives.

- Rate of sedimentation of Henry Hagg Lake. A bathymetric survey needs to be performed to determine the magnitude of the sedimentation problem.

Hydrology and Water Quantity

- Adequacy of current instream water rights to protect aquatic life and other instream beneficial uses. This report identified existing instream water rights, but did not attempt to determine whether these rights provided adequate protection for aquatic resources. More intensive field study would be necessary to answer this question.

- The best locations for potential purchases of instream water rights.

- The extent of illegal water diversions.

Stream Channel

- Field verification of OWEB channel types. Field study would also provide insights on characteristics not visible from maps and photography, and would aid in restoration planning. Additionally, channel types should be updated to reflect ongoing changes in the OWEB channel typing methodology.

- Ongoing changes in channel characteristics. Field study aimed at detection of current channel migration, widening, and entrenchment would aid in planning efforts.

Water Quality

- Location of inadequate septic systems in the watershed.

Aquatic Species and Habitats

- Macroinvertebrate distribution. Comprehensive macroinvertebrate surveys would enhance understanding of water quality and ecological characteristics of the watershed, and would help to identify potential trouble spots.

- Distribution of anadromous fish habitat. Although comprehensive surveys have been performed in reaches populated by resident fish, little habitat survey data

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exists for reaches accessible to anadromous fish. A better understanding of the quantity and quality of habitat for anadromous salmonids and other species of interest would be gained from a comprehensive habitat survey.

- Amount and distribution of salmonid spawning. Redd counts and spawning surveys would be beneficial to determine actual usage patterns by salmonids.

- Population and distribution of amphibian species. Comprehensive amphibian population surveys would help determine the distribution of sensitive species and the potential impacts of habitat loss and exotic species upon native amphibians.

- Population and distribution of special status and special attention species dependent on riparian and wetland habitats.

- Present extent, types, functions and condition of specific wetlands. Analysis of present wetland extent was based on surveys performed as part of the National Wetlands Inventory (NWI). Additional information could be gained if the NWI delineation were refined using current aerial photographs and field research. Field study would also help to determine the condition of specific wetlands and locate priority sites for restoration. The small wetland areas in the Coast Range might be of particular interest.

Vegetation

- Amounts and distribution of sensitive botanical species. These include bryophytes, lichens, and fungi, as well as vascular plants. Comprehensive botanical surveys would facilitate planning efforts for these species.

- Distribution and densities of noxious/exotic weed species. No weed surveys have been completed to date.

- Canopy cover and density of riparian stands in the valleys. Access considerations restricted the amount of survey work that could be performed.

Terrestrial Species and Habitats

- Distribution of snags, large woody debris, and other late-successional habitat characteristics used by species dependent on these characteristics. Based on stand age and size, this report concluded that these habitat characteristics are uncommon in the watershed. Field surveys would be useful to verify this conclusion and find locations of such habitat characteristics.

- Distribution of sensitive species dependent on late-successional habitat characteristics. Population surveys would contribute to management efforts for these species.

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Human Uses

- Potential mitigation and funding sources for mitigation of rock pit sites.

- Size and condition of culverts in eastern portion of the watershed. Complete bridge inventory, including specifications. Ability of culverts to withstand major floods.

- Specific roads needing repair or closure.

- Extent of dumping on BLM and private lands within the watershed.

- Historically, railroads and logging roads were built on sites throughout the watershed. Many of these "legacy roads" may continue to provide erosion and/or sedimentation hazards. However, determination of the locations of these roads, as well as potential mitigation opportunities, was beyond the scope of this report.

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Chapter 6: Recommendations

Watershed needs and opportunities are most effectively addressed by a consistent, cooperative effort between landowners and government agencies. In keeping with that principle the following recommendations are intended as general guidelines for cooperative efforts that can be undertaken to achieve watershed objectives. (Recommendations specific to BLM lands are given later in this chapter.) These recommendations are not intended to mandate what state and private landholders should do with their own land, but instead to identify potential opportunities for improvement of conditions within the Upper Tualatin-Scoggins watershed. Implementation of these recommendations is completely voluntary on the part of the private landowner. Opportunities will be available through cooperation with private landowners to create partnerships to implement these recommendations. As the nexus of many different interests, the Tualatin River Watershed Council plays a vital role in facilitating these partnerships.

The nomenclature for these recommendations was designed with this concept of partnership in mind. Three groups have been identified. The actual implementation of these recommendations and objectives is performed by a large and varied group of individuals, grassroots organizations, and corporations. They voluntarily organize educational activities, donate material, contribute labor and expertise, and manage their lands to achieve desirable watershed objectives. Although the people in this group represent diverse interests, they work toward similar beneficial objectives, and here they are described collectively as **partners**. Another group, that of governmental **agencies**, has specific duties to achieve watershed objectives. Although they are also important partners in the watershed restoration efforts, when performing their official duties they will be referred to as agencies. Finally, the **Tualatin River Watershed Council** acts as facilitator to promote implementation of these recommendations. In this role, the council acts to coordinate efforts between partners to achieve beneficial watershed objectives.

Success of many programs delineated within these recommendations is contingent upon funding. There are several sources of expertise and funding for projects on private lands that could be used for the opportunities identified below. Oregon Department of Fish and Wildlife and state Restoration and Enhancement funds are available for restoration of riparian and stream habitat. The Natural Resources Conservation Service and the Washington County Soil and Water Conservation District have access to federal funds for improvement, particularly of agriculturally related problems in the lower watershed. The U.S. Fish and Wildlife Service, through its Partners for Fish and Wildlife program, also funds wildlife habitat restoration and improvement projects for wetland, riparian, and instream areas on non-federal lands. This availability of state and federal funding should encourage private landowners to join in the effort to improve the Upper Tualatin-Scoggins watershed ecosystem. Furthermore, the Watershed Council and various agencies should pursue additional funding to address the identified needs within the watershed.

Through the watershed analysis process, several stream reaches and wetland areas were identified as priorities for preservation and restoration activities (Table 6-1). These priorities were generally based on the degree of degradation and the potential to restore specific beneficial uses (e.g., potential for salmonids to utilize improved habitat). Areas with relatively good habitat were earmarked for preservation.

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Table 6-1. Priority subwatersheds for preservation, restoration, and monitoring activities.

Reach/subwatershed	**Type of activity**	**Rationale**
Upper Tualatin: Cherry Grove-Gaston	• Bank stabilization • Riparian reforestation • Habitat survey • Instream habitat restoration	• High potential for improved utilization by anadromous fish • Severe erosion problems • Riparian cover and shading very poor • Very poor LWD recruitment potential
Roaring Creek	• Control of road-related erosion • Salmonid habitat surveys	• Very unstable terrain • High incidence of nearstream roads and road washouts • Important spawning stream for anadromous salmonids
Carpenter Creek	• Nutrient control • Sediment control • Bacteria control • Temperature control • Riparian revegetation	• Very poor water quality • High incidence of roads near streams.
Scoggins Creek (Scoggins Dam to mouth.)	• Habitat survey • Riparian reforestation • Erosion control • Monitoring and control of inputs of organic compounds	• Anadromous spawning stream • Highly turbid water • Dissolved oxygen periodically below levels optimal for spawning fish. • Biological criteria indicate impairment due to organic and sediment inputs.
Tanner Creek, Sain Creek, Scoggins Creek (above Scoggins Dam).	• Erosion reduction • Sediment control structures	• Unstable soils • Substantial sediment inputs to Henry Hagg Lake
Hill Creek	• Erosion monitoring/control • Nutrient monitoring/control • Bacteria monitoring/control	• High proportion of land is steep, unstable, and highly erodible • High rural residential use • Underlying lithology poses potential septic system problems
Wapato Creek	• Pesticide monitoring/control • Nutrient monitoring/control • Soil loss reduction	• Intensively farmed. • Extensive channelized network adjacent to roads
Mercer Creek	• Riparian restoration • Scotch broom abatement	• Extensive length of road near stream • Very poor riparian cover • Hillsides covered with Scotch broom
Harris Creek	• Erosion monitoring/control	• High proportion of land is steep, unstable, and highly erodible.

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6.1 General recommendations

6.1.1 Aquatic

6.1.1.1 Erosion issues

Issue #1: Soil disturbing activities on steep and unstable forested lands lead to increased hazards for surface erosion, mass wasting, and sediment delivery. Roads are a major contributor to erosion. Stream crossings facilitate sediment delivery.

Solution Strategy: Erosion control efforts in the mountainous portions of the Upper Tualatin-Scoggins watershed would best be concentrated in areas of steep slope and subbasins with high densities of roads and stream crossings. Ideally, total road mileage should be reduced within such areas. Avoidance of soil disturbing activities on steep and unstable lands would also reduce erosion.

Specific Recommendations.

- Land owning partners in the mountains are encouraged to implement the following road-related practices: Avoid building new roads on steep and unstable lands. Evaluate currently existing roads for usefulness to current management activities. Where feasible, decommission or obliterate unnecessary or undesirable roads (including legacy roads) by pulling back sidecast material, removing culverts, outsloping where needed, subsoiling to restore infiltration, and revegetating the road surface and other disturbed areas with native species. Priority roads for obliteration include those built on midslopes with sidecast construction. Subwatersheds where these recommendations are particularly applicable include **Roaring Creek, all subwatersheds contributing to Henry Hagg Lake, Lee Creek, Carpenter Creek, and Hill Creek**.

- Drainage-related erosion will be reduced if land owning partners and agencies with road maintenance authority maintain or improve road drainage by cleaning culverts, replacing decaying culverts, and installing downspouts on culverts that have outfalls at a substantial distance above the hillslope. Any culverts that are installed should be designed to withstand the 100-year flood event.

- In order to reduce erosion and sediment contribution to streams, landowning partners and agencies with road maintenance authority should maintain a vegetative cover on drainage ditches.

- Land owning partners and agencies with road maintenance authority can reduce sediment contribution to streams by implementing the following practices where high densities of roads and stream crossings exist: Decommission unnecessary roads. Survey remaining roads for areas with high risk of erosion from cutslopes, fillslopes, and road treads. Minimize such hazards, using methods such as outsloping and endhauling sidecast materials. Locate culverts or drainage dips to avoid excess accumulations of water in ditches or on road surfaces. Minimize connectivity between drainage ditches and streams to minimize sediment delivery potential. These recommendations are particularly applicable to the following subwatersheds: **Roaring Creek, Lee Creek, Sunday Creek, and Scoggins Dam.**

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Issue #2: Sheet, rill, and gully erosion from fields and streambank erosion is widespread in the valleys and adjacent foothills. The greatest problem from surface erosion occurs when soil is inadequately protected from rainfall. Bank erosion is greatest in areas of impaired riparian vegetation. Where riparian vegetation is lacking, accelerated sediment delivery to streams also occurs.

Road drainage ditches provide channels that facilitate transport of eroded sediments and associated pollutants from fields, and delivery of these substances to streams.

Systematic methodologies to assess the effectiveness of Voluntary Water Quality Farm Plans and agricultural Best Management Practices (both individually and in combination) are lacking.

<u>Solution Strategy</u>: Effective erosion control in the valley portion of the watershed will emphasize riparian restoration, residue management, cross-slope farming, rotations with sod-building crops, cover crops, filter strips and grassed waterways on agricultural operations. The former objective is most efficiently achieved through voluntary efforts spearheaded by the NRCS/SWCD. These agencies have a long history of working together with farmers to reduce soil loss. Additionally, these agencies are able to offer economic incentives and cost-sharing programs to implement Best Management Practices. When developing conservation plans, erosion predictions should be based on the most erodible slopes rather than average slopes in a field. Implementation of a systematic methodology and database to keep track of specific components of Water Quality Management Plans would assist agency sources in refining future prescriptions.

Specific Recommendations:

- NRCS/SWCD and other agencies should continue to promote implementation of Best Management Practices by agricultural interests. NRCS/SWCD should determine locations in the watershed where BMPs are least often used, and focus efforts on these areas. Together with the Tualatin River Watershed Council and the Farm Bureau, NRCS/SWCD should determine outreach measures to improve land owner interest in implementation of BMPs. These entities should actively seek funding to provide expanded assistance toward these objectives. They should pursue greater funding for cost-share programs and incentives to retain greater widths of riparian vegetation. Local governmental agencies should request a greater role in designing programs such as the Conservation Reserve Enhancement Program (CREP), so that these programs best meet local needs.

- Public agencies responsible for road maintenance should maintain a vegetated lining in road ditches. Similarly, land owning partners will benefit from reduced erosion if they incorporate a vegetated design in drainage ditches on their property.

- When designing conservation plans, NRCS and SWCD should keep a database of practices implemented in each plan, and enhance monitoring of farms under such plans to determine the effectiveness of various prescriptions (This will partially fulfill Tualatin River Watershed Action Plan Item 6A.). As part of this effort, they should design a standardized format for the database so that information collected by different agencies can be easily interchanged. Although these recommendations are applicable to all agricultural subwatersheds, priority should be given to **Carpenter Creek, Upper Tualatin-Blackjack, Upper Tualatin-Hering, Scoggins Dam, Upper Tualatin-Dilley, and Hill Creek** subwatersheds.

- The Tualatin River Watershed Council should continue to coordinate efforts to restore and enhance riparian vegetation. As part of this effort, the Council should continue to coordinate programs with community groups to plant riparian vegetation. The Council, together with the NRCS and SWCD, should assist

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landowners with restoration efforts. From an erosion standpoint, the areas of highest priority for revegetation include: **Carpenter Creek subwatershed (valley portions), and the Tualatin River between Cherry Grove and Gaston** (see Appendix 6). In order to be effective, vegetation enhancement on the Tualatin River between Cherry Grove and Gaston will need to be accompanied by streambank improvement projects.

- The Tualatin River Watershed Council and its partners should adopt a policy to protect all currently existing riparian vegetation. As part of this policy, they should advertise currently existing incentives and cost-share programs to remove riparian lands from agricultural production. Where these programs provide inadequate incentive for riparian restoration, the Tualatin River Watershed Council and its partners should work with the federal and state government to provide additional incentives.

- The NRCS and SWCD should continue efforts to work with agricultural landowners to remove prohibited conditions under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (OAR 603-95).

6.1.1.2 Hydrology and water quantity issues

Issue #3: Wetland and floodplain area is greatly diminished from historical levels. This has resulted in loss of hydrologic regulation of flows on the Tualatin River upstream of Scoggins Creek and on tributaries. Scoggins Dam has largely replaced this function at downstream sites, and some tributaries have small dams that control flow.

<u>Solution Strategy</u>: The most effective policy given current constraints is to protect existing floodplain and wetland resources, and to prevent encroachment of activities that are incompatible with floodplain and wetland function. Where incompatible uses do not exist, there may be opportunity to restore the functionality of degraded wetlands. Additionally, there may be partnership opportunities with sympathetic landowners to create or re-establish wetlands where they do not currently exist.

Specific Recommendations:

- Planning agencies should restrict further residential and industrial development within the 100-year floodplain.

- The Tualatin River Watershed Council, partners and NRCS/SWCD should sponsor a study to determine priority sites for preservation or restoration of historic floodplain and wetland function. For each site, appropriate protection, restoration, or enhancement strategies should be identified. Information gained in this study should be systematically maintained in a database, where it can be referenced for future funding opportunities.

- Partners and appropriate agencies should acquire property or habitat conservation easements to protect or expand existing wetlands. They should also evaluate opportunities for land acquisition with which to create new wetlands. If wetland creation appears to be a viable option, they should purchase lands for this purpose.

- The Tualatin River Watershed Council (TRWC) and its partners should institute programs to restore functionality to degraded wetlands. This should include replacement of reed canarygrass and other exotics with native vegetation. Subwatersheds where opportunities for wetland enhancement and restoration exist include valley subwatersheds such as **Upper Tualatin-Dilley**, **Scoggins Dam** (Lower), **Upper Tualatin-Blackjack Creek**, **Wapato Creek**, **Upper Wapato Creek**,

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and **Ayers Creek**. Additionally, some potential restoration opportunities exist in **Tanner Creek** subwatershed.

- Agencies and partners should conduct post-project monitoring to determine the success of wetland restoration efforts

Issue #4: Over much of the year, surface flow may be insufficient to support all beneficial uses at some locations. Current instream water rights may be inadequate to protect resources.

Solution Strategy: Water conservation is a necessary part of any strategy designed to optimize water supply for all beneficial uses. As irrigation is the largest use of surface water within the watershed, conservation efforts would benefit greatly if agriculture employs technological solutions to minimize waste during irrigation.

During formulation of its action plan, the Tualatin River Watershed Council considered the acquisition of additional water rights to supplement current instream water rights. If the decision is made to acquire supplementary instream water rights, consideration should be given to the OWRD instream leasing program. Several considerations should go into any decision to acquire instream water rights. Seniority, of course, is a prime consideration. However, location of these water rights is also important. In order to protect cold-water fishery resources, any additional water rights purchases should protect instream flows in the Coast Range and the upper portion of the plain, where most summer rearing is likely to occur. Downstream of these locations, enhanced flow will have some value for thermal moderation of streams, but is unlikely to provide direct benefit to salmonids outside of migration periods. Other native fish species, such as lampreys, would benefit from resulting improvements in water quality.

Specific Recommendations:

- TRWC, partners, and agencies should encourage irrigation water management, including the use of technological soil moisture sensing devices and the conversion of sprinkler to drip systems on appropriate crops.

- TRWC, partners, and agencies should conduct a study to determine the adequacy of current instream water rights to provide adequate conditions for fish and other aquatic life. This analysis should focus on tributaries where augmented flows are not currently available. If current instream water rights are found to be inadequate, locations of greatest need for supplementary water rights should be noted. Priority for water rights acquisition should be given to the most senior rights available at these locations. When acquiring water rights, strong consideration should be given to use of the OWRD instream leasing program.

6.1.1.3 Stream channel issues

Issue #5: Most valley and some foothill and mountain stream channels are severely deficient in large wood. This has limited the development of pools, which provide essential habitat for fish and other aquatic life. Little potential exists for recruitment of large wood to streams.

Solution Strategy: Long-term development of large woody debris recruitment potential should be supplemented by short-term tactics. Potential elements of this strategy include re-introduction of conifers to hardwood stands, thinning within riparian zones to promote development of tree mass, and artificial placement of instream structures. Location of these restoration activities will depend on management objectives. Channel structure throughout the watershed would benefit from placement of large wood. However, wood placement to improve habitat for salmonids would be more effective in the mountains and nearby areas than in lower reaches in the Tualatin Plain. Effective

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channel restoration strategy throughout the watershed will focus on preservation of existing channel characteristics at relatively high quality sites.

Specific Recommendations:

- As an interim measure, partners performing stream restoration should place large wood in channels, and construct instream structures to create pools in degraded habitat with high fisheries potential. Restoration projects should include substantial post-project monitoring to determine the effectiveness of restoration techniques. Channel structure throughout the watershed would benefit from this recommendation. Sub-basins where placement of large wood would have the greatest benefit for salmonids are listed in the aquatic species and habitat section (Section 5.1.5).

- Landholding partners should manage riparian areas to develop late-successional characteristics so that they can eventually develop large wood for potential delivery to streams. This can include re-introduction of conifers to hardwood stands and some thinning within riparian zones.

6.1.1.4 Water quality issues

Issue #6: In many portions of the watershed, sediments are delivered to streams at levels well above reference conditions. These sediments often carry adsorbed pollutants.

Solution Strategy: Strategies to combat sedimentation are described under the erosion section (Section 6.1.1.1).

Specific Recommendations:

- NRCS/SWCD should continue efforts to expand implementation of agricultural Best Management Practices to reduce sediment discharge to streams (see under Erosion).

- Agencies, partners, and TRWC should work together to restore riparian buffers (see under Erosion).

- Landowning partners and agencies with road maintenance responsibility should minimize connectivity of road drainage ditches to stream channels (see under Erosion). Where necessary, they should build a sediment settling system to detain runoff prior to stream entry.

Issue #7: High levels of bacteria and ammonia have adversely impacted streams within the watershed. In some cases, inputs of these constituents have caused streams to be listed under section 303(d) of the Clean Water Act.

Solution Strategy: The management strategy for problems related to bacteria and ammonia nitrogen should focus on keeping animal and human waste away from aquatic systems. Successful nitrogen management also relies on effective fertilizer management.

Specific Recommendations:

- Agencies should intensify efforts to identify and improve faulty septic systems near streams. In order to facilitate improvement of these systems, homeowners should be offered incentives such as cost-share opportunities. Due to its demonstrable water quality problems, the **Carpenter Creek** subwatershed is a high

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priority for these activities. Although water quality in the **Hill Creek** subwatershed has not been monitored, topographic, soil related, and geological considerations lead to the conclusion that this subwatershed is also susceptible to septic problems and should be monitored.

- Agencies and animal-owning partners should intensify efforts to keep sources of animal waste from entering streams. NRCS/SWCD should continue efforts to identify sources of animal waste to aquatic systems and to work with land owners to eliminate these sources. Together, they should implement appropriate measures, potentially including livestock exclusion, vegetation buffers, and proper storage and application of waste. NRCS/SWCD should continue efforts to publicize available cost-share programs to implement these measures. In order to remove streams from the 303(d) list, these efforts should be concentrated in the **Carpenter Creek** subwatershed.

- Agencies and partners should work together to improve fertilizer management for agricultural, forestry, and urban applications. NRCS/SWCD, other appropriate agencies, and educational institutions should seek funding to continue studies to determine optimal fertilizer application levels. As funding becomes available, they should conduct these studies expeditiously. They should distribute findings of these studies to applicable agency personnel and private agriculture, forestry, and landscaping businesses. Additionally, they should update publicly accessible literature to include the most current findings and create a distribution system to ensure that the literature makes its way to applicable personnel.

- NRCS/SWCD should continue to work with land owners to implement agricultural BMPs that reduce nutrient laden runoff to streams.

Issue #8: Phosphorus levels in portions of the watershed exceed established TMDLs.

<u>Solution Strategy</u>: Due to high natural groundwater levels of phosphorus, massive declines in summertime phosphorus loads are unlikely. However, continuing efforts will be essential to retaining instream phosphorus at or slightly below current levels. Measures taken to minimize sediment delivery to streams, as well as effective nutrient and animal waste management will limit inputs of adsorbed phosphorus. Reductions in readily decomposable organic matter will reduce anaerobic streambed conditions that release phosphorus from sediments.

Specific Recommendations:

- NRCS/SWCD should continue implementation of rural BMPs and educational programs, especially with respect to nutrient management, animal waste management, livestock grazing, and erosion control.

- Partners and agencies should implement measures to reduce inputs of sediment, manure, grass clippings and other non-woody organic matter to streams.

- Agencies and partners should avoid practices that resuspend stream bottom sediments.

- ODEQ or another agency source should conduct a study to investigate the role of inadequate septic systems in contributing to phosphorus loads. In stream reaches where inadequate septic systems are found to be a significant contributor of phosphorus, the source should be identified, and a cost-share program should be implemented to upgrade the septic system to adequate standards.

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Issue #9: The Tualatin River between Haines Falls and Scoggins Creek, as well as Carpenter Creek, have temperatures detrimental to salmonids and other aquatic life preferring cool water conditions. Additionally, unmonitored tributary streams in the valleys and foothills likely have similarly elevated water temperatures.

Solution Strategy: Strategies for temperature moderation should focus on protection and restoration of the riparian canopy. Some stream reaches would also receive local reduction of water temperature through leasing of additional instream water rights.

Specific Recommendations:

- The Tualatin River Watershed Council, partners, and agencies should work together to implement programs to restore canopy cover through revegetation of the riparian zone with appropriate species. (See under Erosion). (section 6.1.1.1)

- The Tualatin River Watershed Council should explore leasing options for additional instream water rights (See under Hydrology / Water quantity). (section 6.1.1.2)

Issue #10: Winter dissolved oxygen levels in [illegible] *are below optimal levels for spawning salmonids. This has caused this reach to be listed on the ODEQ 303(d) list.*

Solution Strategy: Water leaving Henry Hagg Lake is well aerated (Joe Rutledge, TVID, personal communication). This indicates that reductions in dissolved oxygen occur because of biological oxygen demand introduced between the dam and the Old Highway 47 bridge. Efforts should be made to detect the source of this BOD. Meanwhile, it is recommended that TVID consider the use of extra measures to aerate water during the steelhead and coho spawning seasons.

Specific Recommendations:

- ODEQ should conduct a study to determine the source of BOD in lower Scoggins Creek. Once the source is found, corrective measures should be taken.

- TVID should consider the use of special aeration techniques to increase dissolved oxygen in water downstream of Scoggins Dam.

- NRCS / SWCD should work with land and animal owners to implement measures for management of waste and organic debris that have been recommended to address dissolved oxygen and nutrient issues.

Issue #11: Sedimentation appears to be impairing biological function in the watershed. Although biological sampling indicates that some impairment exists in [illegible] *subwatersheds, sediment-related impairment is expected to be present in other subwatersheds. Besides its effects on stream ecology, sedimentation also threatens to reduce the useful life of Henry Hagg Lake.*

Solution Strategy: Sediment reduction strategies are indicated. Although the problem is only partially related to human management, that part can be addressed by implementing measures to address sedimentation due to roads, timber harvest, and other human activities.

Specific Recommendations:

- Agencies, the Tualatin River Watershed Council, and concerned partners should work together to implement measures recommended to address erosion issues.

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- Where erosion is occurring, concerned parties should consider the construction of sediment control structures and/or wetlands to prevent sediment delivery to stream systems or, alternatively, to remove sediments from streams.

6.1.1.5 Aquatic species and habitat issues

Issue #12: Salmonid populations are declining. A large proportion of this decline can be attributed to degradation of habitat and water quality.

Solution Strategy: Attempts to restore salmonid populations should focus on habitat preservation and restoration. These efforts should concentrate on the mountains and adjacent narrow valleys, where most existing salmonid spawning and rearing habitat is located. However, the role of valley sites in providing salmonid passage should not be neglected.

Habitat restoration can also provide an important role in the watershed. However, restoration should not substitute for preservation of currently suitable habitats. A likely restoration site is lower Roaring Creek. Additionally, restoration of the Tualatin River between Cherry Grove and Gaston would be useful, provided that measures were taken to stabilize banks within this reach.

Compared to the mountains, habitat restoration of most streams in the Wapato Valley have less potential for direct benefit to salmonids. In these reaches, the substrate is generally unsuitable for spawning and salmonid rearing is very limited. However, other native fish and amphibian species could derive benefit from restoration at these sites. Appropriate restoration strategies for valley plain sites should focus on development of appropriate habitat characteristics for these native non-salmonid fish and amphibian species, as well as minimization of obstacles to migration of anadromous fish.

Restoration strategies should focus on restoring channel structure, roughness elements, and habitat diversity. Lack of large woody debris (LWD) seems to be an important factor impacting channel structure. Current LWD recruitment potential is poor. LWD placement is a viable short-term option, but should not replace riparian protection and other measures that will provide for long-term recruitment potential. Other measures, such as restoration of stream canopy and improvement of water quality, coincide with objectives of other modules. If efforts are taken to address concerns related to erosion, hydrology, water quality, and stream channel characteristics, benefits to fish will accrue.

Specific Recommendations:

- TRWC, partners, and agencies should work together to preserve existing salmonid spawning and rearing habitat. They should conduct surveys to determine the location and condition of such habitat. During these surveys, appropriate restoration sites should be noted. For optimal results, surveys for steelhead trout habitat should be concentrated within the **Roaring Creek, Upper Tualatin-Lee Falls, Upper Tualatin-Hering, Upper Tualatin-Blackjack, and Scoggins Dam** subwatersheds. Additional habitats for resident cutthroat trout may be found in other tributaries. Murtagh et al. (1992) identified Roaring Creek as a stream in particular need of habitat surveys.

- TRWC, partners, and agencies should work together to restore instream habitats for salmonids. Such restoration may include placement of large woody debris and/or instream channel structures. Restoration projects should be accompanied by monitoring to determine the most effective techniques. Portions of lower Roaring Creek and the Upper Tualatin River between Haines Falls and Gaston are potential sites for restoration.

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- TRWC, partners, and agencies should work together to restore riparian vegetation. Partners should plant appropriate native tree species where the natural riparian canopy has been removed. Where non-native shrub and herb species such as Himalayan blackberry and reed canarygrass have invaded riparian habitats, partners should replace these species with appropriate native trees and shrubs. This recommendation applies throughout the watershed. Areas where riparian restoration would provide the greatest potential benefit for fisheries includes the **Tualatin River between Haines Falls and Gaston**.

- Landowning partners and appropriate agencies should remove obstructions to fish migration. They should replace culverts and other stream crossing structures that do not provide adequate passage. In some cases, road decommissioning[33] and culvert removal may be a desirable option.

- Conservation organizations, other partners, or agencies should acquire land or conservation easements in crucial riparian habitats. Agencies should promote incentives for private land owners to implement BMPs designed to protect aquatic habitat. The TRWC, partners, and agencies should strive to form cooperative fisheries enhancement projects across ownership boundaries that maximize habitat improvement.

Issue #13: Reductions in wetland area have led to depletion of habitat for wetland and riparian species. This has adversely impacted populations of these species, especially amphibians.

<u>Solution Strategy</u> (Wetlands): The most effective policy given current constraints is to protect existing wetland resources, and to prevent encroachment of activities that are incompatible with wetland function. As financing becomes available, procurement of additional lands and conservation easements will also assist in providing wetland habitat. Where incompatible uses do not already exist, there may be opportunity to restore the functionality of degraded wetlands. For example, eradication of reed canarygrass and restoration with native vegetation may enhance the habitat values of these wetlands. Additionally, opportunities may exist to enhance habitat values within storage ponds. Many of these ponds already provide open water habitat for waterfowl. Emergent species could be planted along pond margins to increase habitat values for amphibians and other species dependent on shallow water habitat. However, this approach may cause conflicts with other interests using the ponds.

Where feasible, wetland creation could be encouraged by promoting beaver activity. It is anticipated that this approach would work best in the Tualatin Mountains, where fewer conflicts between beavers and management activities exist.

<u>Solution Strategy</u> (Riparian habitats): Strategies for riparian dependent species should emphasize increasing the amount of suitable riparian habitat. Programs are currently underway to meet this objective. One such program is the Conservation Reserve Enhancement Program (CREP). Administered by the NRCS, this program provides financial incentives for farmers to establish buffer strips along streams. It is hoped that this and similar programs will increase the amount and quality of habitat available to riparian dependent species.

Specific Recommendations:

- The TRWC should coordinate with partners and agencies to perform population surveys to determine the extent of amphibian species, as well as other riparian and wetland-dependent species.

[33]FEMAT (1993) defines road decommissioning as removing “those elements of a road that reroute hillslope drainage and present slope stability hazards. Most of the road bed is left in place”. This contrasts with “full site restoration”, where the complete roadbed is obliteratred and the hillslope is restored to its original contours.

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- The TRWC, partners, and agencies should evaluate and implement programs to restore wetland functionality. These are discussed in the section titled "Hydrology and Water Quantity" (Section 6.1.1.2). Opportunities for wetland enhancement may be available on lands along **Tanner Creek**.

- Conservation organizations, other partners, or agencies should acquire habitat conservation easements in riparian areas.

- The TRWC should facilitate a forum to explore opportunities for beaver production of wetland habitats, as well as means of resolving potential conflicts between beavers and socio-economic interests.

6.1.2 Terrestrial

6.1.2.1 Vegetation issues

Issue #14: Management practices have resulted in a change in vegetational characteristics. Amounts of vegetation in late-successional stages has been severely reduced from reference levels. Hardwoods have invaded areas formerly dominated by conifers.

<u>Solution Strategy</u>: The ability to resolve these problems will depend on the management emphases of different landowners. Portions of federal lands are managed under a specific directive to manage for old-growth characteristics. Generally, private lands are not managed under such a directive. Often, restoration of conifers to hardwood areas is in the management interests of both federal and private landowners.

Specific Recommendations:

- Where feasible, landowners are encouraged to reestablish conifers on sites where hardwoods have invaded.

- Large landowning partners are encouraged to manage currently mature stands of private forests to develop late-successional characteristics including stand complexity, snags, and down wood.

Issue #15: Native species richness within much of the watershed has been compromised by invasive exotic and noxious weeds. This problem is most extensive in the eastern valleys and foothills.

<u>Solution Strategy</u>: Solutions are best achieved by creation of partnerships between agencies and landowners. The ownership pattern is most conducive to partnership opportunities in the western portion of the watershed, where weed problems are less substantial. Such opportunities could include a cooperative agreement between:

The Bureau of Land Management;

Oregon Department of Agriculture, which is contracted by BLM for weed eradication work;

Oregon Department of Forestry; and

Industrial owners.

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In the eastern portion of the watershed, fragmented land ownership makes formation of weed abatement partnerships difficult. However, cooperative efforts between the Tualatin River Watershed Council, Oregon Department of Agriculture, and Washington County would provide a major step in forming effective partnerships.

To prevent recolonization by weed species, planting and cultivation of desirable species should accompany weed eradication.

Specific Recommendations:

- The watershed council should facilitate contact between the BLM, Farm Bureau, ODA, NRCS, SWCD, private industrial landholders, and other entities representing landholders to form partnerships to combat noxious weeds. The Council should coordinate efforts by other groups with current efforts being conducted by the Oregon Department of Agriculture. If feasible, eradication efforts should emphasize non-chemical methods near aquatic systems. Non-chemical methods should also be considered for other areas.

- NRCS, SWCD, and other applicable agencies should advertise the availability of educational pamphlets encouraging eradication of noxious weeds. These pamphlets should be updated as necessary to address problems specific to the Tualatin Valley.

- TRWC, ODA, SWCD, and concerned partners should form a committee to determine which plants have the capability to become noxious weeds within the Tualatin Basin. The committee should work with the appropriate agencies, nurseries, and consumer groups to restrict the ability of these plants to become naturalized within the basin. In particular, scrutiny should be given to giant reed (*Arundo donax*) and Pampas grass (*Cortaderia selloana*).

6.1.2.2 Terrestrial species and habitat issues

Issue #16: Many plant and animal species in the watershed are sensitive to management-induced habitat changes. The Bureau of Land Management has included many of these species on its list of sensitive species. Habitat for many of these species has been reduced from former levels.

<u>Solution Strategy</u>: Proper management strategies for sensitive species will vary by the species. The Bureau of Land Management has identified management strategies for species considered by the Bureau to be sensitive[34].

Knowledge of species distribution is an important prerequisite for successful management for sensitive species. In order to gain this knowledge, systematic surveys should be conducted where habitats are suitable for these species.

Specific Recommendations:

- The watershed council should act as a facilitator to formulate uniform habitat management policies.

- Government policy makers should consider providing incentives for landowners to manage forests for recruitment of snags and down wood.

- The watershed council should seek funding and facilitate partnerships to conduct systematic surveys for sensitive species.

[34]These are given in BLM Manual 6840, Appendix J2 of the NFP, and in ths Salem District ROD/RMP.

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6.1.3 Social

6.1.3.1 Issues related to human uses

Issue #17: Timber, agricultural, domestic, industrial, and wildlife interests often come into conflict for limited resources. As population increases, this competition will intensify.

Solution Strategy: A cooperative approach between various interests is necessary to resolve competing watershed demands. The Tualatin River Watershed Council plays a major role in facilitating this cooperation.

Specific Recommendations:

- In order to achieve Oregon's environmental policy objectives, the Governor's Watershed Enhancement Board should continue funding for the Tualatin River Watershed Council.

6.1.3.1.1 Recreation

Issue #18: Nearstream recreational activities can lead to disturbance of the riparian zone. Support activities associated with recreational facilities can contribute pollutants to streams.

Solution Strategy: Measures should be taken to minimize the effects of recreational activities upon streams. These include regulation of stream access, maintenance of vegetated buffer strips between streams and activities detrimental to the aquatic system, and monitoring to determine the location, nature, and magnitude of recreation-associated impacts on streams.

Specific Recommendations:

- TRWC, agencies, and partners should work together to conduct a survey to determine specific sites of impacts due to recreational access to streams. Determine whether recreational benefits outweigh impacts at these sites. Where continued access is considered beneficial, consider armoring the streambank or otherwise constructing facilities to minimize impacts.

- Agencies should monitor parks to ensure that they do not contribute appreciable inputs of fertilizers, pesticides, and herbicides to stream systems. Managers of these facilities should be encouraged to develop conservation plans through NRCS/SWCD.

Issue #19: Poor access limits recreational opportunities in the western portion of the watershed. Such natural features as Lee Falls are not accessible.

Solution Strategy: The public perception of recreational opportunities within the watershed is unknown. Although access to points of natural beauty such as Lee Falls would be desirable, this must be balanced against problems that increased access would cause, such as littering and vandalism. Metro is currently evaluating sites along the Upper Tualatin for potential greenspace acquisition.

Specific Recommendations:

- The Tualatin River Watershed Council or other entity interested in recreation should conduct a survey to determine the public perception of recreational needs.

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- The Tualatin River Watershed Council should monitor greenspace acquisition efforts by Metro.

6.1.3.1.2 Cultural resources

Issue #20: Native Americans were known to utilize the area surrounding Wapato Lake. Excavation activities surrounding the lake may disturb artifacts. Similarly, pictographs near Patton Valley may be sensitive to vandalism.

Solution Strategy: Government regulations already require archaeological surveys for certain ground-disturbing activities. The Patton Valley pictographs are on private property and have been protected by the landowner against violation.

Specific Recommendations:

- No additional recommendations are necessary at this time.

6.1.3.1.3 Road-related issues

Issue #21: Roads are significant contributors to problems related to erosion, water quality, stream channels, and aquatic life (see respective sections).

Solution Strategy: A diversified strategy is necessary to deal with road-related problems. This strategy will consist of a combination of road closures, road upgrades, and measures to restrict road-related impacts upon streams.

Specific Recommendations:

- Landowning partners should avoid building new roads on steep terrain (e.g. steep portions of the **Roaring Creek** subwatershed). Where feasible, roads in these areas should be decommissioned. (See Erosion). Potential criteria for road closure are given on page 145.

- Surveys should be conducted to locate "legacy roads" and abandoned railroad grades that may be posing problems to watershed resources. Additionally, funding should be sought to reduce impacts from these roads.

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6.2 Recommendations on BLM lands

The following recommendations were specifically designed to fulfill management objectives on BLM lands. Many of these recommendations may be potentially useful on other ownerships, as well.

6.2.1 Aquatic

6.2.1.1 Erosion and hydrology issues

Issue *#1*: *Portions of the BLM lands in the fifth field watershed have soils which are naturally erodible and unstable. Extra care must be taken on those lands, when planning and implementing management activities such as road building and timber harvesting. Improperly designed, placed or unmaintained roads have contributed to soil loss and stream sedimentation, with potential negative impacts to the attainment of the Aquatic Conservation Strategy Objectives.*

Recommendations:

- Incorporate considerations related to slope, soils, habitat objectives, and hydrologic function into the decision-making process when planning and designing roads, especially when they are proposed to be located within Riparian Reserves.

- When considering methods to provide access to lands without currently maintained roads, consider upgrading and using legacy roads rather than constructing new roads. In sensitive areas and in the LSR, if no mapped roads or legacy roads access the management area, consider other access alternatives in preference to construction of new roads.

- Road management should focus on the control and prevention of road-related run-off and sediment production. Roads identified as no longer needed for resource management should be closed and stabilized with the method (i.e., decommission, full decommission, obliteration; as defined in the *Western Oregon Transportation Management Plan*, dated June 1996) determined on a site-specific basis. Other roads may require road upgrading (e.g., removing soil from locations where there is a potential of triggering landslides, modifying road drainage systems, reconstructing stream crossings) or road maintenance (e.g., surfacing, cleaning culverts).

- In prioritizing roads for treatment (i.e., close and stabilize, upgrade, maintain), considerations should include those roads that are located in drainages where the average relief is greater than 30 percent; located in a valley bottom or mid-slope position on the landscape; have an inordinate number of stream crossings; have a history of failure; have extensive lengths of cut and fill; and have a high incidence of dumping and vandalism.

- Road construction, upgrading, maintenance, and closure should be performed in accordance with Best Management Practices, as listed in Appendix C of the *Salem District Record of Decision and Resource Management Plan*. BLM 1995

Issue #2: Poorly designed and implemented management activities, including timber harvest and road construction, can lead to soil compaction and may result in reduced soil productivity, increased water runoff and erosion, and altered stream flows.

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Recommendations:

- Where appropriate, reduce existing soil compaction levels by closing and stabilizing roads that are not needed for future management and by treating previously compacted areas such as natural surface roads, skid trails, and landings with a winged subsoiler.

- Rocked roads, in particular, should be considered for subsoiling. This will help to re-establish hydrologic function while awaiting the next harvest entry. The top three to four layers of rock surface should be removed prior to decommissioning, and used elsewhere as the base course.

- Carefully evaluate the trade-off in meeting AMA and LSR objectives between relieving soil compaction and root damage to residual trees before recommending subsoiling in forest stands.

- As applicable, use the Best Management Practices for timber harvest and road construction as described in Appendix C of the *Salem District Record of Decision and Resource Management Plan* BLM 1995 to minimize soil compaction.

6.2.1.2 Stream channel issues

Issue #3: Coarse wood and larger snag recruitment potential is poor along some stream reaches because the stand age is relatively young, stand density is high causing the trees to be smaller, and conifers are reduced or absent.

Recommendations:

- Conduct surveys to determine appropriate sites for restoration projects to increase the amount and size of large woody debris in stream channels, floodplains, and riparian areas.

- The highest priority areas for instream and floodplain wood placement are low gradient stream reaches deficient in large wood.

- The highest priority for riparian restoration projects are those streamside areas that are dominated by hardwoods or overstocked conifer stands that would benefit from thinning or underplanting.

- Where a few scattered understory conifers are growing within riparian areas strongly dominated by alder or other conifers, consider treatments to increase understory and overstory conifer growth, vigor, and exposure to sunlight.

- Consider possible conversion or pocket planting of conifers along stream segments that are dominated by hardwoods.

- Plant appropriate vegetation in unstable areas, such as landslides along streams and flood terraces.

6.2.1.3 Water quality issues

Issue #4: Appreciable reduction in canopy cover within riparian zones could affect water temperature downstream.

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Recommendations:

- When doing enhancement projects in Riparian Reserves, avoid removal of vegetation along perennial streams that will result in increases in stream temperature.

- When conducting forest density management projects inside Riparian Reserves, leave a no-cut vegetation buffer along all intermittent and perennial stream channels, lakes, ponds, and wetlands. The width of this buffer should be determined on a site-specific basis. Additionally, the buffer should include stream-adjacent slopes with a high potential for landsliding. The purpose of this is to protect the streams and riparian zones from any direct or indirect disturbance from project activities, and to ensure that existing shading is not reduced.

6.2.1.4 Aquatic species and habitat issues

Issue #5: BLM lands only comprise a small portion of the watershed and efforts to restore aquatic species and habitat are unlikely to succeed unless BLM forms partnerships with other landowners.

Recommendations:

- Maintain active participation in the Tualatin River Watershed Council. Continue to have a BLM employee act as liaison with the council. Participate and cooperate in projects when possible and requested to do so by the council.

- Explore partnership opportunities with other landowners to evaluate best areas for stream restoration.

Issue #6: Sedimentation along some stream reaches is degrading fish and aquatic habitat.

Recommendations:

- When implementing silvicultural prescriptions in Riparian Reserves, consider use of logging systems and site preparation methods that would reduce site disturbance, and maintain a “no-cut buffer” appropriate to site specific conditions along stream channels.

- Where feasible, avoid road-building activities within Riparian Reserves. Where these activities are necessary, use practices that meet the Aquatic Conservation Strategy objectives.

- When yarding within or through Riparian Reserves, yard away from and require full log suspension over all stream channels, lakes, ponds, and wetlands. Limit soil disturbance by selecting appropriate yarding systems and restrictions based on site analysis.

- Evaluate all stream segments capable, or potentially capable, of supporting salmonid spawning and rearing for potential stream habitat improvement projects.

- Take an active role in fisheries information collection and cooperatively distribute information to other land or resource managers. Develop a system to conduct follow-up stream habitat inventories to assess habitat trends over time.

- Evaluate existing OHV trails and address any problem areas which may be in conflict with Aquatic Conservation Strategy management objectives. Possible projects could

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include closing or re-routing problem trails. This work should be done in cooperation with local OHV groups.

- Evaluate existing roads and address any problem areas which may be in conflict with Aquatic Conservation Strategy management objectives. Possible projects could include closing, stabilizing or in some cases recontouring problem roads.

Issue #7: Poorly designed and improperly placed stream crossings can impose migratory barriers to aquatic life, contribute sedimentation to streams and increase the concentration of flow.

<u>Recommendations:</u>

- Conduct surveys to identify fish migration barriers and prioritize barriers for corrective action.
- When constructing or improving roads, place culverts in a manner where they will not create velocity barriers for migrating salmonids.
- Culvert spacing should be evaluated. On steep road grades or erodible soils, culvert distance should be more frequent than the standard of every 500 feet.
- Calculations to determine culvert size should include the volume of water attributed to runoff from insloped roads that flows in the ditch and out of the culvert.

6.2.2 Terrestrial

6.2.2.1 Vegetation issues

Issue #8: Road networks provide a corridor for introduction of Scotch broom and other non-native, exotic plants.

<u>Recommendations:</u>

- Where appropriate, develop "Memoranda of Understanding" (MOUs) with adjacent landowners and state and county agencies in order to expedite weed control goals.
- Where consistent with safety and management considerations, protect existing native vegetation along roads. When building new roads, keep the clearing limit as narrow as safely possible to reduce available growing sites for invasive species.
- Consider cleaning heavy equipment that will be used on BLM land for management activities, with a high-powered sprayer. Cleaning should occur before entering BLM land, and discarded seeds should not be allowed into open water courses.
- Consider information from the Oregon State University Weed Survey Report, Spring 1998, to control and prevent exotic/noxious weeds (and invasions of such weeds) on BLM administered lands in the watershed.
- Control noxious weed infestations through appropriate control measures (manual labor, biological controls, herbicides, prescribed fire) where consistent with ecological objectives.

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6.2.2.2 Species and habitat issues

Issue #9: The area is currently inadequate to sustain populations of many species dependent upon late-successional forest. Little interior habitat is present, and habitat connectivity is poor for ground-based species dependent on late-seral habitat.

Recommendations:

- Evaluate stands in the AMA, those in the LSR under 110 years old, and Riparian Reserves to consider the application of silvicultural prescriptions to benefit the development of late-seral stage habitat. Potentially beneficial treatments include thinning to encourage rapid growth and enhance the development of late-seral stage habitat, creating snags (eventual down woody debris), and underplanting with long-lived coniferous species in areas where they are largely absent.

- Consistent with project objectives, consider the use of logging systems and site preparation methods that would reduce disturbance to reserve trees, existing snags and down wood, especially when operating in Riparian Reserves.

- The watershed currently has 14 % identified in "deferral" status. 1%, or approximately 37 acres still needs to be identified. This evaluation should be done at the earliest opportunity.

Issue #10: High road densities allow for the introduction of non-native plant species, disrupts the normal hydrological flow, and compromises available habitat for some wildlife species.

Recommendations:

- Close and stabilize roads that are no longer needed for resource management. This will have the effect of enhancing the recreational hunting experience for some hunters and improve habitat for big game and other wildlife. In older forest conditions, this action will be beneficial to late-successional species that might be sensitive to disturbance associated with road use.

- Roads that are closed and stabilized should be revegetated with native vegetation and will help to restore normal hydrologic flow.

- Depending upon site-specific conditions, consider providing "visual buffers" adjacent to density management harvest units to limit disturbances to wildlife as well as help with limiting the spread of noxious weeds.

- Where feasible, maintain an uncut strip of dense native vegetation along roadsides, which may include existing young conifers, salmonberry, thimbleberry or other native shrubs.

Issue #11: Some areas are deficient in both snags and down logs. Both primary and secondary cavity nesters, as well as a variety of other vertebrate species depend on these structural components for their livelihood.

Recommendations:

- When planning projects, measure actual CWD levels in the project area and consider performing some of the following to make progress to achieving CWD goals:

- Coarse woody debris that is already on the ground should be retained and protected from disturbance to the greatest extent possible.

- The entire fifth field should be managed for a renewable supply of large (greater than 20") down logs that are well distributed across the landscape.

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- Existing snags should be protected in harvest areas to the extent possible. A good technique is to place a buffer of green trees around the snag to protect it from damage.

- When planning density management thinnings, evaluate adjacent areas that are not being considered for silvicultural treatment, for snag or CWD creation projects. Stands with lower stocking that won't be treated with density management thinning, Riparian Reserves or TPCC withdrawn areas would all be good candidates for evaluation.

6.2.2.3 Forest resources issues

Issue #12: Many stands, including some in Riparian Reserves, are too densely stocked to efficiently develop late-successional characteristics.

Recommendations:

- Consider density management thinning of well-stocked and over-stocked mid-aged conifer stands, both inside and outside of riparian reserves, to accelerate size development and promote windfirmness in remaining conifers. Variable-density thinning could also be used to enhance structural complexity of relatively dense conifer stands depending on stand density and characteristics of potential "leave" trees.

  Treatments within 30-50 year old stands (which dominate BLM lands in the watershed) should take place within the next 15 years (BLM 1998). Most stands should be treated within the next 10 years.

- In young (non-commercial) conifer stands, consider using thinning to maintaining appropriate conifer stocking and species composition adjacent to stream channels or other areas with water.

- In all management operations, maintain a buffer of trees and brush along stream channels (both intermittent and perennial) sufficient to provide adequate shade to the stream and protect the stream banks and channel.

- Because grand fir, western redcedar, and western hemlock are normally only a small component of these stands, select these trees as leave trees in density management thinning. Natural regeneration from these species following density management can help to initiate a more diverse understory and form the basis for another canopy level that could be developed through further management actions. Bigleaf maple should also be maintained in these stands.

Issue #13: In stands with high concentrations of fresh, down Douglas-fir wood, elevated Douglas-fir bark beetle populations have the potential to cause substantial Douglas-fir mortality.

Recommendations:

- When creating woody debris, try not to leave more than three fresh down Douglas-fir trees per acre greater than 12 inches DBH at any one time. This is especially true when the down trees are shaded and where tree vigor of the remaining trees is reduced because of root disease or other causes. Where down trees are exposed to full sunlight, the number of trees left for down wood could probably be doubled without posing an undue risk to the surrounding trees. Because the efficiency of beetle breeding in standing dead trees is about one-half of that in down logs, about twice as many snags could be created to enhance coarse woody debris without undue risk to stand health.

- When there is a need to add large amounts of fresh down Douglas-fir trees or logs to increase the amount of down wood or create snags, add them in a series of events spaced at about five years apart. Always consider the creation of snags rather than falling live Douglas-fir as a way of increasing woody debris over time.

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- When creating down logs or snags, fell Douglas-fir trees no earlier than July and no later than the end of September. This will avoid beetle breeding and dispersal periods for the current year and reduce the suitability for beetle breeding the following year.

- In cases where subsequent beetle killing may be desirable for snag creation, such as in Riparian Reserves or LSRs it may be appropriate to fell the trees before July or fell additional trees for down wood.

Issue #14: Parts of the watershed have high levels of the root rot fungus, Phellinus weirii. *This fungus can contribute to excessive mortality of Douglas-fir, either directly or indirectly because diseased trees are highly prone to killing by Douglas-fir beetles.*
Recommendations:

- *P. weirii* spreads from tree to tree through root contact between susceptible host species. To reduce disease spread where infection centers are well defined, create small patch cuts in root disease centers and reforest these areas with species that are tolerant, resistant, or immune to *P. weirii*.

- Retain tolerant, resistant, or immune tree species that may have naturally regenerated in the patch cut areas. Disease-created Douglas-fir snags and down logs can remain in the patch cut areas.

- Islands of trees that appear to be relatively free of disease can receive density management thinning. To reduce the probability of disease spread to these islands of "leave trees," remove susceptible host trees along the outer edge of the islands in a one-tree (leave tree) spacing to disrupt root continuity to susceptible trees in the islands.

- In density management thinnings in the presence of *P. weirii*, select resistant, tolerant, or immune species in disease centers as leave trees in preference to Douglas-fir or grand fir—both of which are highly susceptible to this disease.

6.2.3 Social

6.2.3.1 Issues related to human uses

Issue #15: Given the existing land ownership patterns and differing management objectives between land owners, management options on BLM land can be affected by the cumulative impacts resulting from non-federal land practices, and access to public land can be blocked.

Recommendations:

- BLM employees should make themselves available for 1 to 1 contact with user groups in the areas and other state agencies. This would be an opportunity to distribute information about nationally recognized and established programs such as "Tread Lightly", and inform the public about their rights and responsibilities when using and accessing public land.

- Enter into Cooperative Agreements and collaborative Stewardship Projects with adjacent landowners such as Stimson Timber Co., Willamette Industries or the Oregon Department of Forestry. Work with these and other partners on the Tualatin River Watershed Council to maximize the benefit of BLM land to all interested users.

- Explore options for land exchanges to block up BLM ownership. This could include purchasing easements to protect important habitat on private land immediately adjacent to BLM land.

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Appendices

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Appendix 1

Stream mile indices for the upper Tualatin River and Scoggins Creek. Major tributaries and other landmarks are used as reference points. Information comes from the Washington County Watermaster's office and is based on OWRD GIS overlay of Washington County Assessor Maps.

TUALATIN RIVER RIVER MILE INDEX -211400300

Mile	Description	Drainage Area square miles	Elevation feet - 0.00 gage datum
56.80	Gales Creek (LB-02114003000560) - index available	78.6	
57.38	Carpenter Creek (LB-02114003000580)		
57.84	Dilley Creek (LB-02114003000600)		
58.04	Johnson Creek (LB-02114003000602)		
58.82	Springhill Road Bridge		
	Tualatin River at Dilley Stream Gage (LB) (USGS 14-2035.00)	125	147.57
59.02	O'Neil Creek (LB-02114003000620)		
60.00	Scoggins Creek (LB-02114003000640) - index available		
60.80	Wapato Creek (RB-02114003000670)		
	Wapato Creek Improvement District Return Flow		
62.00	Wapato Improvement District Headgate (RB)		
62.24	Southern Pacific RR Bridge		
62.25	State Highway 47 Bridge (Gaston)		
62.30	Bates Road Bridge		
62.80	Black Jack Creek (LB-02114003000700)		
62.90	Overhead BPA Transmission Line; Forest Grove-McMinnville		
63.13	TVID Patten Valley Pump Station Outfall #1		
63.87	Tualatin River at Gaston Recording Stream Gage (14202500) - RB	48.5	
64.26	TVID Patten Valley Pump Station Outfall #2		
65.34	Williams Canyon (RB-02114003000730)		
65.90	Mt. Richmond Road Bridge		
67.30	Hering Creek (LB-02114003000760)		
67.83	South Road Bridge (Cherry Grove)		
68.44	"Roaring Creek (RB-02114003000790) "		
69.42	Little Lee Falls		
70.70	Raines Bridge- Tualatin River below Lee Falls Rated Staff Gage for Stream Flow (LB)		
71.07	Lee Falls		
73.28	Haines Falls		
73.30	City of Hillsboro Haines Falls Intake - LB		
74.00	Lee Creek (LB-02114003000860)		
74.05	Patten Creek (RB-02114003000870)		
75.70	Sunday Creek (LB-02114003000900)		
76.60	Maple Creek (LB-02114003000940)		
76.95	Ki-A-Cut Falls		
78.00	Barney Reservoir Aqueduct Outfall (RB)		
79.3+	Headwaters of Tualatin River		

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SCOGGINS CREEK STREAM MILE INDEX - 2114003000640

Mile	Description
0.00	Confluence with Tualatin River at mile 60.00 - (0211400300)
0.94	RR Bridge
1.00	State Highway 47 Bridge
1.70	Old State Highway 47 Bridge
1.71	Former USGS Gage 14203000 (10/1940 to 9/1974)
	Scoggins Creek near Gaston, OR
	Drainage Area = 43.3
4.80	USGS Gage 14202980 (1/1975 -
	Scoggins Creek below Henry Hagg Lake, near Gaston, OR
	Drainage Area = 38.8
5.10	Scoggins Dam
7.00	Sain Creek (RB-02114003000640170)
7.62	Tanner Creek (LB-02114003000640200)
8.40	Wall Creek (LB-02114003000640220)
9.00	Lake Loop Road Bridge
9.30	Gage 14202850 (10/1972 -
	Scoggins Creek Above Henry Hagg, near Gaston, OR
	Drainage Area = 15.9
10.52	Parson Creek (LB-02114003000640240)
15.50	Fisher Creek (LB-02114003000640300)

River Miles based on OWRD GIS Database overlay
on Washington County Assessor Maps
Prepared by:
Tualatin Basin Watermaster - May 1996
111 NE Lincoln, 220L MS 49
Hillsboro, OR 97124
(503) 693-4881 with corrections or omissions

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Appendix 2

Hydrologic data from the Upper Tualatin-Scoggins Watershed. Source, USGS and OWRD data.

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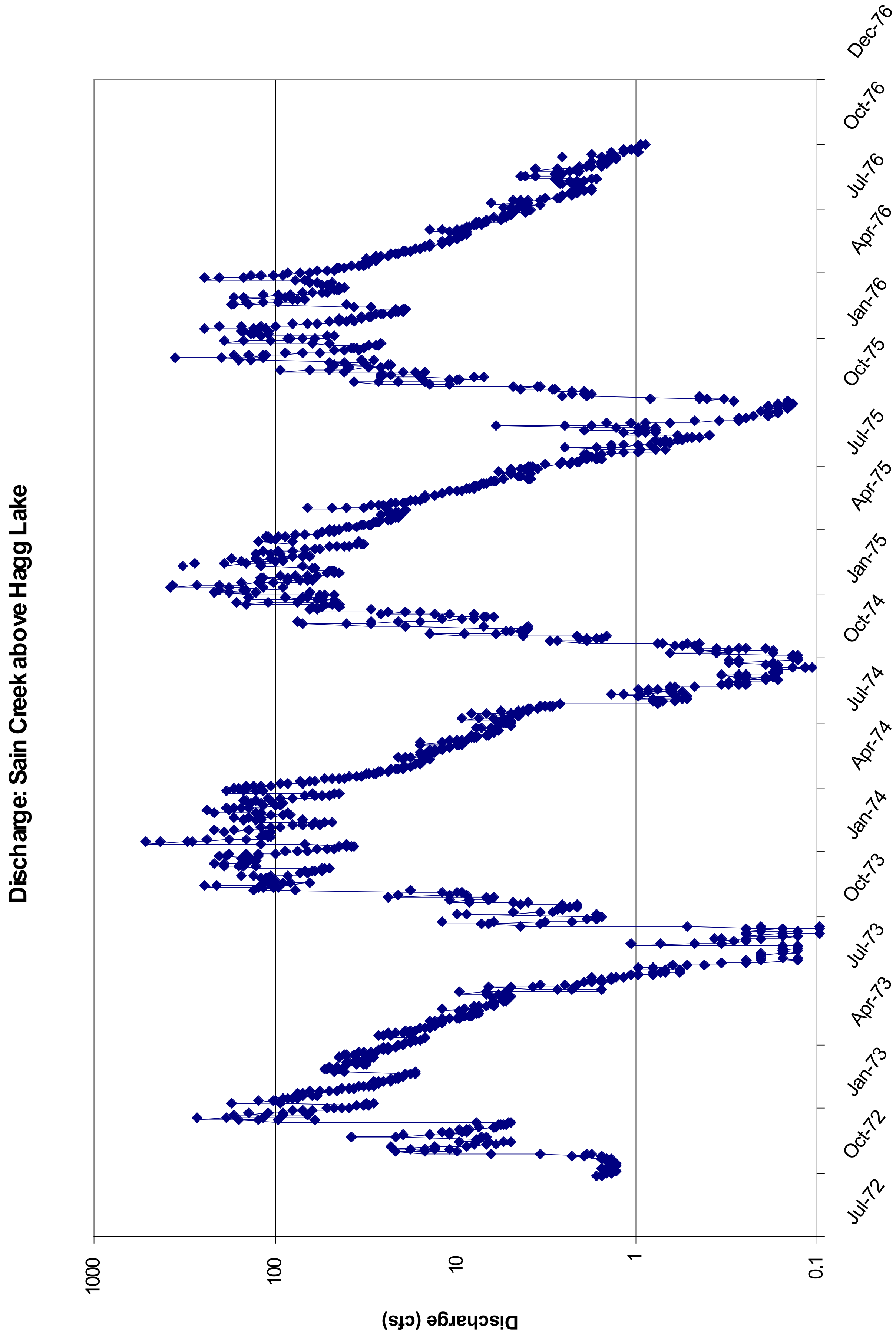

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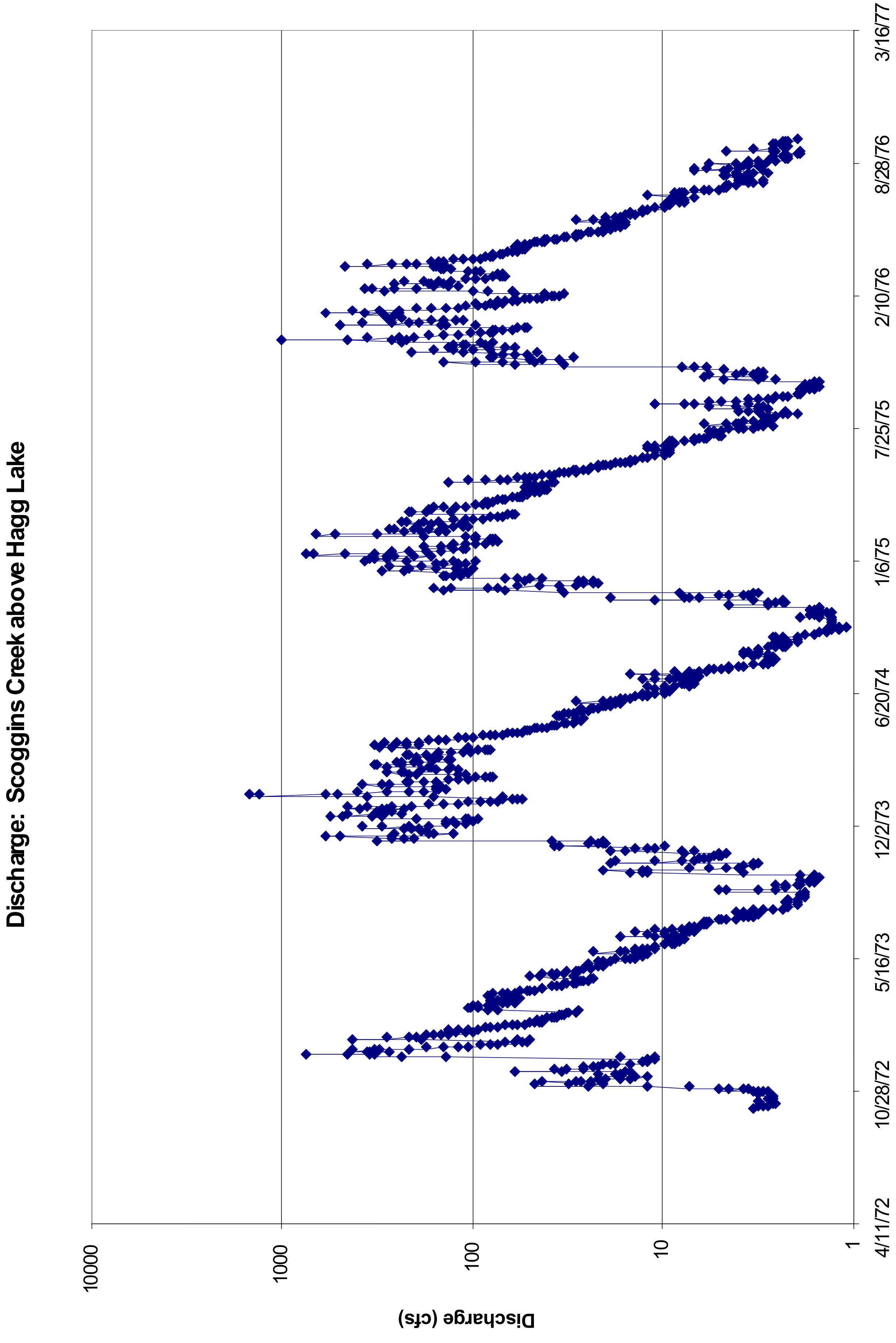

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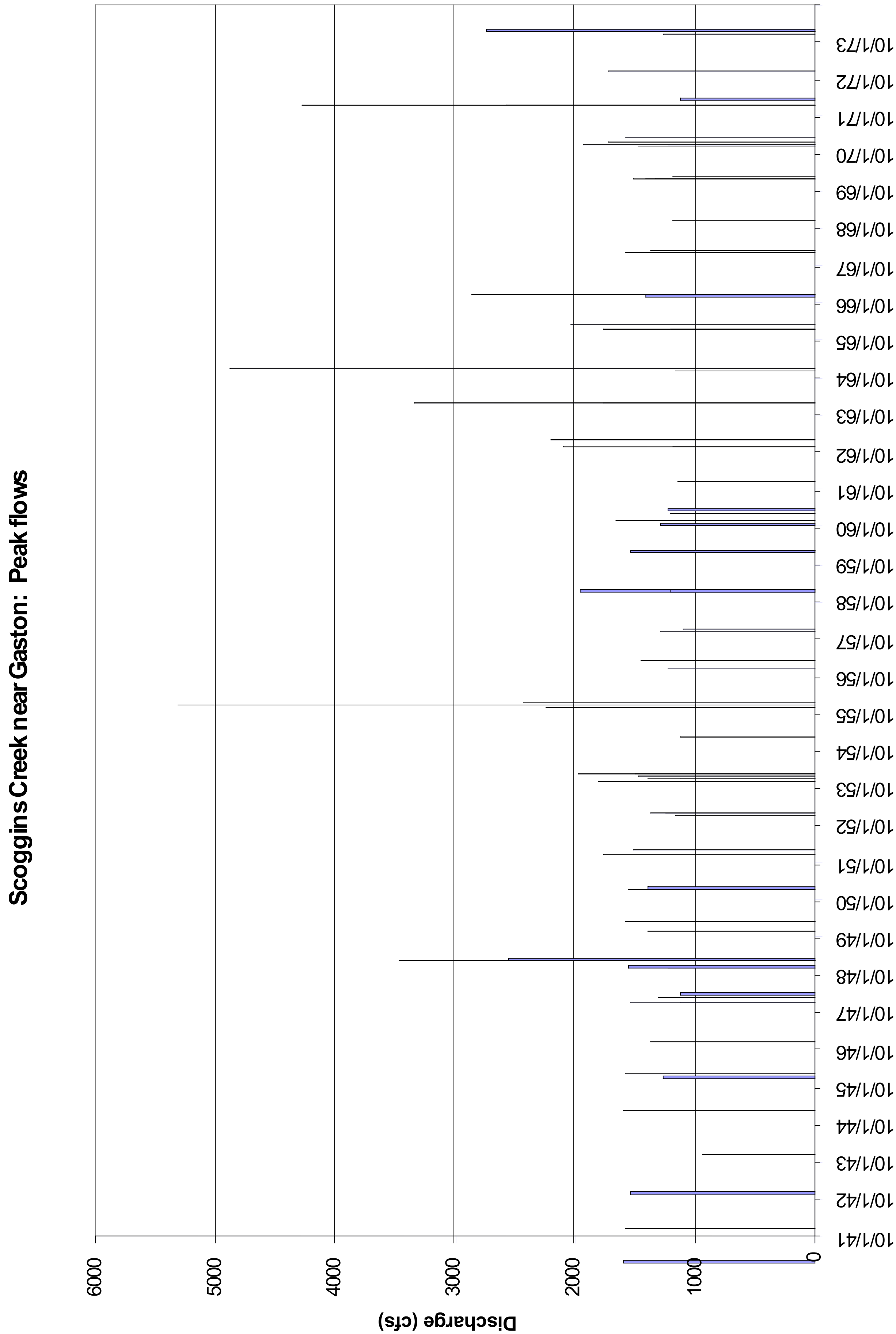

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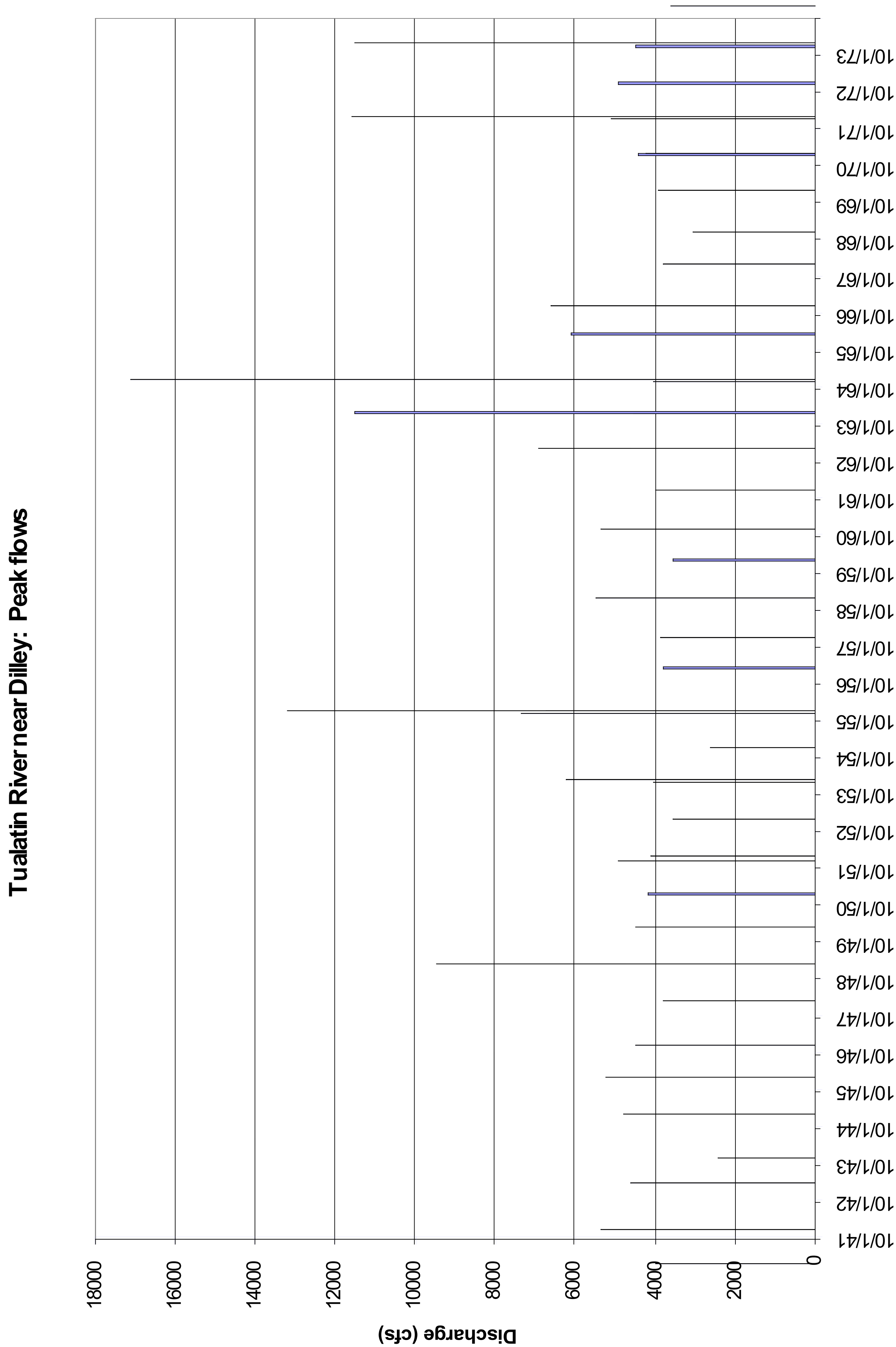

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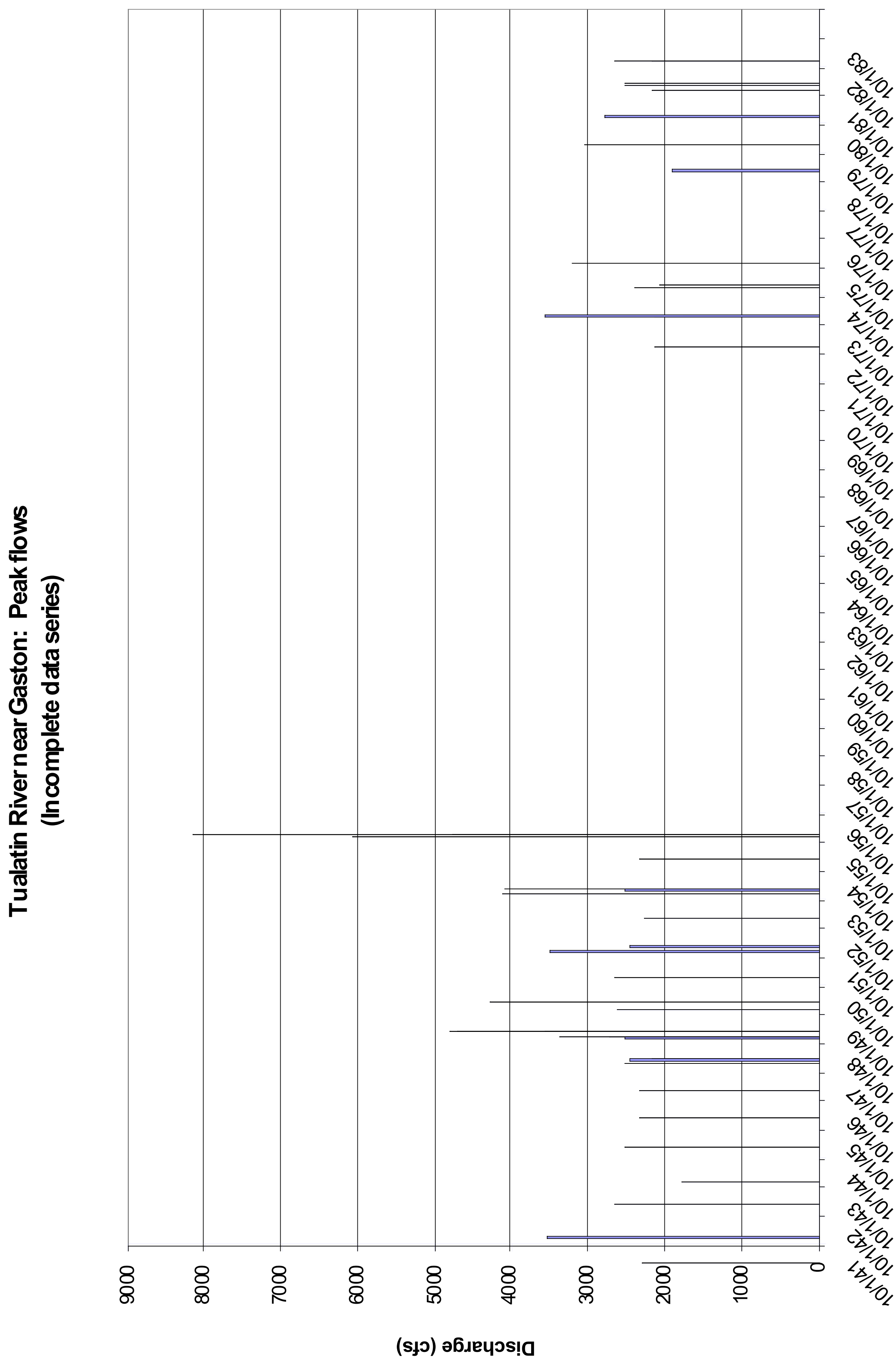

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Monthly Exceedance streamflows as modeled by the OWRD WARS database.

Tualatin River near Dilley

	exceedance flows	
Month	80% (cfs)	50% (cfs)
January	325.0	666.0
February	397.0	695.0
March	313.0	541.0
April	204.0	318.0
May	109.0	158.0
June	60.3	80.9
July	30.7	44.6
August	23.2	30.3
September	17.9	27.5
October	17.5	34.9
November	71.8	213.0
December	294.0	650.0

Tualatin River near Gaston

	exceedance flows	
Month	80% (cfs)	50% (cfs)
January	161.0	325.0
February	203.0	325.0
March	166.0	263.0
April	111.0	166.0
May	55.9	80.9
June	31.1	41.4
July	17.8	23.8
August	12.0	19.3
September	10.5	18.9
October	20.4	26.5
November	49.3	132.0
December	153.0	305.0

Scoggins Creek at Mouth

	exceedance flows	
Month	80% (cfs)	50% (cfs)
January	110.0	229.0
February	138.0	236.0
March	114.0	192.0
April	77.5	114.0
May	46.9	65.7
June	27.6	36.6
July	20.3	24.9
August	14.9	17.1
September	9.4	12.4
October	6.6	11.4
November	23.3	70.4
December	99.6	221.0

Scoggins Creek above Hagg Lake

	exceedance flows	
Month	80% (cfs)	50% (cfs)
January	57.6	115.0
February	70.2	122.0
March	61.4	91.1
April	36.9	56.2
May	19.0	27.6
June	9.8	13.2
July	4.1	6.0
August	1.8	2.6
September	1.7	3.0
October	2.6	5.8
November	13.6	41.2
December	48.7	104.0

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Appendix 3

Aquatic Conservation Strategy Objectives

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. The network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

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Appendix 4.

OWEB Channel Habitat Types (From WPN 1999).

Code	CHT Name	Gradient (%)	Channel Confinement	Size
ES	Small Estuary	<1	Unconfined to Moderately Confined	Small to Medium
EL	Large Estuary	<1	Unconfined to Moderately Confined	Large
FP1	Low Gradient Large Floodplain	<1	Unconfined	Large
FP2	Low Gradient Medium Floodplain	<2	Unconfined	Medium to Large
FP3	Low Gradient Small Floodplain	<2	Unconfined	Small to Medium
AF	Alluvial Fan	1-5	Variable	Small to Medium
LM	Low Gradient Moderately Confined	<2	Moderately Confined	Variable
LC	Low Gradient Confined	<2	Confined	Variable
MM	Moderate Gradient Moderately Confined	2-4	Moderately Confined	Variable
MC	Moderate Gradient Confined	2-4	Confined	Variable
MH	Moderate Gradient Headwater	1-6	Confined	Small
MV	Moderately Steep Narrow Valley	3-10	Confined	Small to Medium
BC	Bedrock Canyon	2-20+	Confined	Variable
SV	Steep Narrow Valley	8-16	Confined	Small
VH	Very Steep Headwater	>16	Confined	Small

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Appendix 5

Upper Tualatin-Scoggins Watershed Macroinvertebrate Assessment

Michael B. Cole[1] , John T. Hawksworth[2] , and Kate Menninger[3]

Introduction

Water quality monitoring in the Tualatin sub-basin has historically focused on the measurement of physical and chemical stream characteristics. Although these measurements are valuable for identifying factors potentially affecting aquatic life, they are no longer recognized as a substitute of the direct measure of the biological condition of a watershed. For this reason, surface water monitoring programs now often supplement physical and chemical measurements with biological assessments of ecosystem health. These biological indicators are also useful in the rapid survey and assessment of stream health by identifying biologically-impaired reaches. Benthic macroinvertebrates are particularly useful indicators of biological conditions because they are sensitive indicators of local conditions and short-term environmental variations, they integrate habitat and chemical disturbances over time, they are relatively easy to sample, and they are important food sources to salmonids and other fish species (Barbour et al. 1997).

To aid in the assessment and characterization of the Upper Tualatin-Scoggins watershed, an assessment of the macroinvertebrate communities was conducted in June 1999. The Upper Tualatin-Scoggins watershed is characterized by forestry, agricultural, and low density land uses, and remains among the least developed of the watersheds within the Tualatin River sub-basin. Little detailed information exists regarding the health of macroinvertebrate communities within the watershed. As such information is becoming more widely used to assess and monitor watershed conditions, this study was conducted to begin to gather such information for this watershed. The objectives of the assessment were:

- To characterize and compare macroinvertebrate communities in a number of locations throughout the watershed, and to relate gross changes in macroinvertebrate community structure to land use type and intensity.
- To provide a baseline set of data against which future improvement or degradation in the biological condition of the watershed can be evaluated.

1 ABR Inc, Forest Grove, OR
2 Washington County SWCD, Hillsboro, OR
3 Contact through Washington County SWCD

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Methods

Macroinvertebrates were collected at five sites within the Upper Tualatin-Scoggins watershed on June 25, 1999 (Figure 1). Four sites were located in the Scoggins Creek drainage. Three of these sites, located on Tanner Creek, Sain Creek, and Scoggins Creek, occur upstream of Henry Hagg Lake. The dominant land use above all three of these sites is forestry, with a limited amount of residential and agricultural use. The lower site, on Scoggins Creek at Old Highway 47, is characterized by more diverse and intensive land uses, including agriculture, industry, and the various land uses associated with Henry Hagg Lake. Macroinvertebrates were sampled at one site (Roaring Creek) in the upper Tualatin drainage. Forestry is the dominant land use at this site as it was above the "upstream" sites in the Scoggins Creek drainage.

At each site, two sampling locations were randomly selected within each of two riffles using a random number table and following ODEQ protocols (Oregon Department of Environmental Quality 1998). Macroinvertebrates were collected with a 500-mm mesh, D-frame kicknet at each sampling location. At each location, a 0.18 square-meter section of the stream bottom was disturbed in front of the net to a depth of approximately 2-3 inches. The four samples from each site were aggregated into a single composite sample and preserved in 80% isopropyl alcohol for later sorting and analysis .

A qualitative habtitat evaluation was then conducted at each site using visual-based habitat assessment protocols as described in Barbour et al. (1997). This procedure uses visual assessment of riparian and instream characteristics to provide a general characterization of habitat quality at each site. Habitat characteristics visually assessed included: substrate quality and heterogeneity, embeddedness, water velocity and depth, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, bank vegetation, and riparian zone width.

Sub-samples of approximately 300 macroinvertebrates were sorted from each composite sample using a gridded tray or by splitting the sample in a 500-mm sieve. Unsorted fractions were examined for large or rare macroinvertebrates that had not been included in the sorted fraction. Residue from which macroinvertebrates had been sorted was preserved for future examination for quality assurance purposes.

Macroinvertebrates were identified using Merritt and Cummins (1996) under 25-75X magnification to the lowest practical taxonomic level. These data were then used to calculate ten biometrics for each site (Table 1). Four metrics were related to taxa richness and composition, five metrics described the relative tolerance or intolerance to organic pollution and sedimentation, and one metric quantified community dominance by the three most abundant taxa. Individual metrics were selected based on their previous use in western Oregon. Tolerance values of each taxon to organic pollution and to sedimentation were determined using standardized values assigned by ODEQ.

Each metric was assigned a score of 1, 3, or 5, with 1 representing a poor condition and 5 representing relatively undisturbed conditions (Table 1). Scoring boundaries were selected based on their prior use in western Oregon. Individual metric scores were then summed for each site to derive a multi-metric composite score called a Benthic Index of Biotic Integrity (B-IBI). A high score indicates a healthy stream condition and lower scores indicate degradation of stream conditions.

Results

B-IBI scores for the sampled sites ranged from 18 to 40, indicating that macroinvertebrate community condition ranged widely among sites (Table 2). Four of the five sites received scores greater than 30, indicative of only slight impairment in

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these four streams at the sampling locations. At all sites, at least 75% of the macroinvertebrate community was composed of one or more of three taxa: the relatively tolerant mayfly *Baetis tricaudatus*, and the dipteran families *Chironomidae* and *Simuliidae.* Such dominance by one or a few taxa is usually indicative of a stressed community. *B. tricaudatus* was dominant in two of the three sites above Henry Hagg Lake, as well as in the Roaring Creek site. *B. tricaudatus* was not dominant at only one site, upper Scoggins Creek, where simuliids were dominant. Even at this site, *B. tricaudatus* comprised more than a quarter of the sample.

Stream conditions, as expressed by both the B-IBI composite and by the visual habitat evaluation (Table 2 and Figure 2), were best at the Roaring Creek site. Land use at this site is restricted to forestry and associated activities, with a limited amount of recreation. Although the subwatershed is unstable and subject to inputs of road-related sediments, impacts to water quality appear to be minor to moderate. Water and habitat quality in Roaring Creek is significant, as this is an important steelhead spawning stream. Impacts to Roaring Creek could be better evaluated by establishing a biomonitoring site further upstream, at the present location, and perhaps near the mouth of Roaring Creek.
The Upper Scoggins and Sain Creek sites were relatively similar in their biological condition and physical habitat quality (Table 2). Although the total number of taxa was high, the high dominance displayed by baetid, chironomid, and simuliid taxa indicated some degree of past or present impairment. As with the Roaring Creek site, sedimentation (both natural and anthropogenic) is likely responsible for these impaired community characteristics. This is corroborated by the limited number of sediment-intolerant taxa present at the sites. The invertebrate sample from Tanner Creek indicated that biological conditions were worse than at the other two “upstream” sites (Table 2). The Tanner Creek site had fewer *Trichoptera* and intolerant taxa than did the Upper Scoggins and Sain Creek sites. The cause for this discrepancy was not immediately apparent.

The Lower Scoggins site received the lowest B-IBI score of 18, indicative of a high level of disturbance to the stream in this reach (Table 2). The macroinvertebrate community at this site showed characteristics quite different from the other sites. While chironomids comprised 8-18% of the total sample in the other sites, they were clearly the dominant taxon at the Lower Scoggins site, where they comprised 57% of the total macroinvertebrate sample. *B. tricaudatus* was proportionally far less important at this site than in the other sampled sites.

As would be expected from land use patterns in the watershed, the benthic community characteristics at the Lower Scoggins site indicated substantially degraded conditions below Henry Hagg Lake relative to the three sites above the lake. The lower Scoggins site received the lowest physical habitat score and every metric of taxa richness and composition was lower than those of upstream sites. Higher proportions of individuals in tolerant and sediment-tolerant taxa at the lower Scoggins site indicate that problems of sedimentation, organic pollution, and water temperature exceed those of upstream sites.

Conclusions and opportunities for future study.

Although the data gathered for this study provide insights into the condition of streams in portions of the Upper Tualatin-Scoggins watershed, their usefulness is restricted by the limited scope of the survey. The results indicate that stream conditions upstream of Henry Hagg Lake are relatively healthy, although several metrics reflect some degradation in macroinvertebrate communities throughout the watershed from past or ongoing land uses. A general trend of increasing B-IBI scores with increasing habitat quality scores indicated that our set of metrics was able to, in a broad sense, relate macroinvertebrate community health to physical conditions and therefore land use

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intensity in the watershed. Sedimentation in the upper watershed would be suspected as the primary cause of macroinvertebrate community degradation, yet sediment-tolerance metrics indicated only minor sediment-related effects on macroinvertebrate communities. Sediment-related effects, as indicated by tolerance metrics were severe only below Henry Hagg Lake.

Linking macroinvertebrate community attributes to specific human-induced disturbances is beyond the scope of this limited survey. In order to make definitive conclusions about anthropogenic impacts on biological conditions in the watershed, the scale of macroinvertebrate monitoring would need to be expanded, both spatially and temporally, and more quantitative evaluations of water chemistry and physical habitat would be needed. Finally, although the sampled sites represent varied land uses, none of the sites could be considered representative of baseline, or undisturbed conditions. In future monitoring studies, if feasible, additional sites with minimal upstream land use effects should be chosen to characterize undisturbed conditions.

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Table 1. Biometrics and scoring boundaries used to determine ecological condition of sampled streams in the Upper Tualatin-Scoggins watershed, June 1999. (Sources: * Mauger, 1995; **Plotnikoff and Polayes, 1999; * ODEQ, 1998)**

Metric	Response to Degradation	Scoring Boundaries 1	3	5	Source
Taxa Richness/Composition					
Total Number of Taxa	Decrease	<19	19-35	>35	***
Number of Ephemeroptera Taxa	Decrease	<4	4-8	>8	***
Number of Plecoptera Taxa	Decrease	<3	3-5	>5	***
Number of Trichopera Taxa	Decrease	<2	2-5	>5	*** modified
Tolerants and Intolerants					
Number of Intolerant Taxa	Decrease	<0.5	0.5-2	>2	**
Number of Sediment-Intolerant Taxa	Decrease	0	1	≥2	***
% of Individuals in Tolerant Taxa	Increase	>45	15-45	<15	***
% of Individuals in Sed-Tol Taxa	Increase	15-100	5-15	<5	*
Modified HBI	Increase	>5	4-5	<4	***
Dominance					
% Dominance (of 3 most abundant taxa)	Increase	>75	50-75	<50	**

Table 2. B-IBI and visual habitat assessment scores of streams sampled in the Upper-Tualatin-Scoggins watershed on June 25, 1999.

Metric	B-IBI Scores Upper Scoggins	Sain	Tanner	Roaring	Lower Scoggins
Taxa Richness / Composition					
Total Number of Taxa	3	3	3	3	1
Number of Ephemeroptera Taxa	3	3	3	3	1
Number of Plecoptera Taxa	3	3	5	3	1
Number of Trichopera Taxa	5	3	3	5	3
Tolerants and Intolerants					
Number of Intolerant Taxa	3	5	1	5	3
Number of Sediment-Intolerant Taxa	5	3	3	5	1
% of Individuals in Tolerant Taxa	5	5	5	5	3
% of Individuals in Sed-Tol Taxa	5	5	5	5	3
Modified HBI	3	3	3	5	1
Dominance					
% Dominance (of 3 most abundant taxa)	1	1	1	1	1
B-IBI Composite	36	34	32	40	18
Visual Habitat Assessment Score	153	166	169.5	183	145

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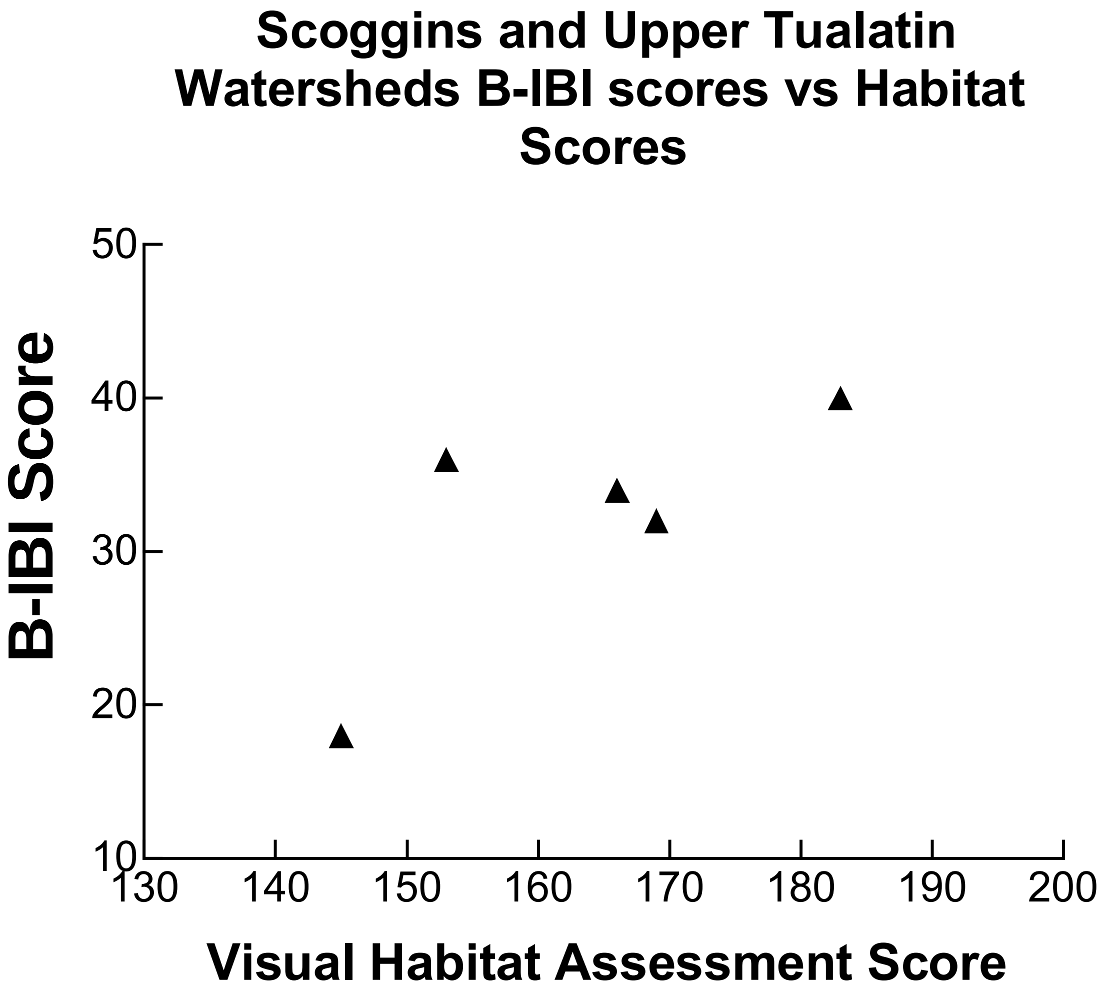

Figure 2. B-IBI scores versus visual habitat assessment scores for sites sampled in the Upper Tualatin-Scoggins watershed on June 25, 1999.

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Appendix 6. Analysis of riparian vegetation

Methodology

Aerial photography was analyzed to delineate riparian vegetation in the Upper Tualatin-Scoggins watershed. For the majority of the watershed, the analysis was based on examination of 1994 USGS black and white digital ortho-quarter-quads (DOQQ's) with 1 meter pixel resolution. The area covered by this digital orthophotography corresponded to the following USGS 7.1/2 minute topographic quadrangles: Woods Point, Forest Grove, Roaring Creek, Turner Creek, Gobbler's Knob, and Gaston. Minor overlaps also enabled analysis of streams at the far western edge of the Laurelwood quadrangle. For streams with DOQQ coverage, analysis was performed directly in ArcView®. A GIS representation of streams in the Upper Tualatin-Scoggins watershed (SCOGSTR24) was extracted from the 1:24,000 streams shapefile (str24.shp) contained in the Tualatin River Watershed Information System (Ecotrust 1998). SCOGSTR24 was overlaid onto the DOQQ imagery, and riparian buffers were classified according to riparian vegetation type and width. Because SCOGSTR24 did not overlay perfectly with the photograph, visual corrections, supplemented by use of the ArcView® measuring tool, were made during the classification process. The classifications thus obtained were entered as attribute data into SCOGSTR24 and converted to OWEB riparian zone classifications (OWEB 1999).

Because we did not have DOQQ coverage for the Laurelwood quad, we were unable to perform DOQQ-based analysis in the Harris Creek, Hill Creek, or Ayers Creek subwatersheds. Additionally, eastern portions of the Carpenter Creek and Upper Tualatin-Dilley subwatersheds lacked DOQQ coverage. An analysis of stream riparian areas in these watersheds was performed using Farm Service Agency (FSA) slide reproductions of aerial photography. For each slide, tracing paper was overlaid upon the projection plane and the boundaries of the riparian zone were transferred to the tracing paper. The riparian zone was subdivided into vegetational types based upon the structural characteristics of the riparian vegetation. As recommended by the OWEB manual, a minimum unit of 1,000 foot length was used in classification. This resulted in a loss of resolution in summarized data relative to the data summaries contained in the *Dairy-McKay watershed analysis* (Hawksworth 1999). Classification data was subsequently transferred to SCOGSTR24.

Stream reaches analyzed both from DOQQs and FSA photography were classified using the OWEB riparian zone classifications (WPN 1999), with the following modifications. Speed of analysis was facilitated by introduction of an "F" (forested, undifferentiated by tree type) type classifier, and an "X" (forested, tree size undifferentiated, usually medium to large) size classifier. Additionally, an "E" (Exposed) type classifier was introduced for stream reaches that were exposed to insolation because of degraded morphology. Riparian vegetation along these "Type E" streams was unable to provide shading.

For all analyzed stream reaches, each vegetation type was further classified according to the width of riparian vegetation. In order to form classes consistent with various regulatory buffer zones, width classes were based upon 25-foot increments. Six width classifications were used: Less than 25 feet, 25-50 feet, 50-75 feet, 75-100 feet, 100-200 feet, and greater than 200 feet. Forested riparian buffers that bordered on upland forest (greater than 200 feet in width) were placed in the "greater than 200 feet" class,

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regardless of the actual width of riparian forest species. Contiguous areas of similar vegetative type and width class were defined as riparian units.

The length of each riparian unit was determined using GIS length-calculation functions. For areas covered by DOQQs, riparian characteristics were summarized by subwatershed. Additionally, riparian condition was summarized for specific stream reaches on the Tualatin River and Scoggins Creek. Complete subwatershed analysis was not feasible for those areas analyzed from FSA aerial photography; instead, characteristics were summarized for specific stream reaches in agricultural areas.

Data were tabulated and analyzed for the presence of the shading function along each stream reach. For purposes of this analysis, the forested vegetation classes were used. To simplify data presentation, the numerous non-forested riparian classes identified from the aerial photography were aggregated into a class designated as "other". The ability of each stream reach to provide shading was determined by summing the two narrowest tree width classes (<25 feet and 25-50 feet) with the "other" class. These classes were considered to provide suboptimal stream shading. Stream reaches with greater than 25% of their length providing suboptimal stream shading were assigned to classes denoting various stages of impairment[1]. Reaches with 25-49% of their length in this condition were considered moderately impaired, reaches with 50-74% were considered severely impaired, and reaches with 75% or greater of their length in such condition were considered very severely impaired. These reaches were also prioritized according to the degree of impairment. It should be noted that these impairment classes are general guidelines. Actual shading will vary locally with such factors as the direction of the stream and stream entrenchment.

Results and discussion

The results of the subwatershed-scale analysis are given in Appendix Table 6-1.

The ability of riparian zones to provide wildlife habitat, filtration, thermal moderation, and other functions varies with the type and width of the riparian vegetation. Generally, riparian functionality increases with width, but the rate of functional increase becomes smaller with distance. Eventually, a threshold is reached where little additional benefit is gained with increasing width. The distance of this threshold varies by function and is subject to debate. One commonly used set of curves describing riparian functions is discussed by FEMAT (1992). Optimal riparian widths for the Upper Tualatin-Scoggins watershed will depend upon a balance of ecological and social objectives. Currently existing characteristics of riparian types are described in subsequent paragraphs.

Forested riparian zones. (OWEB types CXD, MXD, HXD, where X represents various size classes)

Riparian zones in most subwatersheds are dominated by forest type vegetation (OWEB types FXD, FSD, MXD, CXD, and FSD). Subwatersheds that have less than 50% of stream length bordered by riparian forest include Carpenter Creek, Goodin Creek, Upper Tualatin-Hering Creek, and Wapato Creek. Subwatersheds with large, but unquantified amounts of non-forested area include the Harris Creek, Hill Creek, and Ayers Creek subwatersheds.

Although the composition of riparian forests was not quantified for this exercise, stand composition varies between the mountains and the valleys. The riparian forests in the mountains typically are composed of conifers and hardwoods in varying amounts. Red alder is typically the dominant hardwood in many mountainous riparian areas. Riparian forests in the valleys are typically dominated by deciduous hardwoods such as

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Appendix table 6-1. Riparian vegetation types by subwatershed.

Subwatershed	Percent of total subwatershed area in type						
	Forested	Herbaceous	None	Brush	Sparse trees	Exposed	Unclassified
Carpenter	48.43%	14.43%	0.00%	25.28%	4.46%	0.00%	7.39%
Goodin	42.09%	2.18%	40.05%	6.33%	3.66%	0.00%	5.69%
Lee	95.71%	4.30%	0.00%	0.00%	0.00%	0.00%	0.00%
Mercer	54.83%	0.00%	24.20%	19.44%	0.00%	0.00%	1.53%
Roaring	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sain	79.04%	1.11%	5.48%	4.46%	0.00%	0.00%	7.90%
Scoggins Dam	77.54%	0.66%	9.12%	6.16%	2.30%	0.00%	0.00%
Scoggins-Parsons	70.42%	0.29%	5.31%	3.02%	0.00%	0.00%	11.80%
Sunday	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tanner	85.10%	0.00%	0.41%	2.40%	7.57%	0.00%	0.00%
Tualatin HW	99.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.12%
Upper Scoggins	89.83%	0.00%	10.06%	0.00%	0.00%	0.00%	0.11%
Upper Wapato	55.13%	0.00%	21.52%	10.37%	12.99%	0.00%	0.00%
UT-Blackjack	53.47%	3.54%	20.09%	11.49%	3.28%	7.32%	0.41%
UT-Dilley	53.86%	6.30%	10.96%	10.46%	1.83%	0.00%	16.58%
UT-Hering	49.68%	0.00%	8.19%	12.79%	2.13%	21.95%	5.28%
UT-Lee Falls	83.16%	0.00%	7.71%	7.02%	0.98%	0.00%	1.14%
Wapato	17.64%	0.86%	67.02%	0.00%	0.00%	0.00%	14.48%

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Oregon ash. Size of these hardwoods is quite variable; although large diameter trees are present and represent potential contributions of large wood to the stream systems, they represent a small proportion of the trees in the riparian zone.

The percent of total subwatershed area in each forested riparian width class is given in Appendix Table 6-2. As might be expected, both the greatest proportion and width of forested riparian areas is found in the mountainous western subwatersheds. The eastern subwatersheds typically have narrower riparian buffers. This is largely a result of the more intensive agricultural and residential land uses in these areas, but in some cases, the lack of forest may reflect natural conditions.

An analysis of the riparian shading function was conducted on subwatersheds within the Upper Tualatin-Scoggins watershed. As was the case for the *Dairy-McKay watershed analysis*, non-forested riparian zones and riparian buffers less than 50 feet in width were considered to provide suboptimal shade (see Hawksworth 1999 for details). It should be noted that actual shading and related benefits are dependent upon site-specific conditions. For each subwatershed, the total stream length with suboptimal shade was totaled. Where this total exceeded 25% of stream length, the stream shading function was considered to be impaired. The degree of impairment varied with the proportion of stream length with suboptimal conditions. Subwatersheds with 25-49% of their length in this condition were considered moderately impaired, those with 50-74% of riparian length in suboptimal condition were considered severely impaired, and those with 75% or greater of riparian length in suboptimal conditions were considered extremely impaired. Impairment of each subwatershed is described in the last two columns of Appendix Table 6-2.

In addition to its shading function, forested riparian areas are also important for bank stabilization, nutrient contributions to aquatic systems, contributions of instream wood for aquatic habitat structure, and wildlife support. These functions are supported to varying degrees in the watershed.

Brush-dominated riparian zones (OWEB type BNN)

Brush-dominated riparian zones are most abundant in the Carpenter Creek and Mercer Creek subwatersheds. These habitats are capable of providing bank stabilization and a limited amount of shade. Many native shrub species are capable of providing food and nesting habitats for wildlife. However, many of the brush-dominated riparian zones in the Upper Tualatin-Scoggins watershed are dominated by Himalayan blackberry, which provides a low habitat value and tends to outcompete native plant species. This reduces the diversity of both plant and, indirectly, wildlife species. Brush-dominated riparian zones usually border on agricultural, residential, and other intensive land uses. Width characteristics of brush-dominated zones are given in Appendix Table 6-3.

Grass-dominated riparian zones and riparian zones lacking a vegetated buffer (OWEB types GNN and NNN)

These two types are grouped together because consistent classification from aerial photography is difficult. Although an area may appear to lack a riparian buffer, field examination often shows that there is a narrow herbaceous layer. Unless they overhang very narrow streams, grass-dominated riparian zones provide very little shading value. However, they do provide values for erosion control and nutrient filtration. In some areas, such as portions of the Upper Tualatin-Dilley, Upper Tualatin-Blackjack, and Lee Creek watersheds, wide areas of grass-dominated riparian zone indicate herbaceous wetlands. Nevertheless, subwatersheds with large expanses of riparian zone in the GNN and BNN types are usually candidates for riparian improvement projects. The subwatersheds in the Upper Tualatin-Scoggins watershed with the highest proportion of

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these riparian types include Wapato Creek, Goodin Creek, Mercer Creek, and Upper Wapato Creek. The Hill Creek and Harris Creek subwatersheds also have substantial amounts of this riparian type, although the amounts were not quantitatively determined.

Analysis of specific stream reaches

Riparian characteristics were calculated for the complete mainstem length, excluding reservoirs, of the Tualatin River and Scoggins Creek. Results of this analysis are given in Appendix Table 6-4.

Portions of stream reaches in the Harris and Hill Creek subwatersheds were analyzed to determine riparian characteristics. Land use in the sampled stream reaches was largely agricultural with some rural residential use. Most of the upper, forested portions of these subwatersheds were not analyzed; therefore, these analyses should not be taken as representative of the complete subbasin. The results of the analysis are displayed in Appendix Table 6-5. These results show that riparian forest is lacking along most streams in agricultural portions of these subwatersheds. This trait is representative of many small and medium sized streams in valley portions of the Upper Tualatin-Scoggins watershed. In most cases, this represents a diminished amount of riparian shading from reference conditions. Along some streams, however, these vegetation types may reflect a naturally herbaceous condition.

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Appendix Table 6-2. Characteristics of forested riparian areas.

Subwatershed	Percent of total subwatershed area in type and width class (ft)						Shading	
	0-25	25-50	50-75	75-100	100-200	>200	Total suboptimal	Impairment Class
Carpenter	7.65%	5.41%	4.74%	1.12%	3.46%	26.04%	65%	Severe
Goodin	3.66%	1.64%	1.76%	0.49%	5.58%	28.96%	63%	Severe
Lee	0.33%	2.79%	1.18%	2.42%	5.45%	83.55%	7%	
Mercer	0.88%	9.28%	8.08%	2.91%	7.64%	26.04%	55%	Severe
Roaring	0.00%	0.00%	0.97%	7.62%	7.27%	84.15%	0%	
Sain	0.00%	0.44%	0.00%	0.17%	4.13%	74.29%	21%	
Scoggins Dam	1.11%	8.73%	17.59%	0.00%	5.94%	44.18%	32%	Moderate
Scoggins-Parsons	0.00%	2.07%	0.64%	2.83%	8.78%	56.10%	32%	Moderate
Sunday	0.00%	0.00%	0.40%	1.08%	3.15%	95.38%	0%	
Tanner	0.00%	5.66%	0.00%	0.00%	4.48%	74.95%	21%	
Tualatin HW	0.00%	0.00%	0.37%	0.00%	1.50%	98.01%	0%	
Upper Scoggins	0.67%	2.18%	2.55%	1.42%	1.32%	81.70%	13%	
Upper Wapato	7.74%	1.43%	9.37%	1.34%	7.03%	28.23%	54%	Severe
UT-Blackjack	0.99%	17.04%	22.49%	2.73%	1.64%	8.59%	65%	Severe
UT-Dilley	3.48%	5.06%	8.39%	3.52%	4.60%	28.81%	55%	Severe
UT-Hering	2.21%	10.49%	16.17%	1.59%	2.30%	16.92%	63%	Severe
UT-Lee Falls	1.60%	2.30%	4.19%	1.26%	7.84%	65.96%	21%	
Wapato	1.91%	1.17%	0.00%	1.80%	6.95%	5.81%	85%	Extreme

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Appendix Table 6-3. Characteristics of brushy riparian areas.

Subwatershed	Percent of total subwatershed area in type and width class (ft)					
	0-25	25-50	50-75	75-100	100-200	>200
Carpenter	14.51%	2.35%	1.78%	0.00%	6.64%	0.00%
Goodin	6.33%	0.00%	0.00%	0.00%	0.00%	0.00%
Lee	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mercer	12.11%	3.66%	0.00%	0.00%	0.00%	3.66%
Roaring	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sain	4.43%	0.00%	0.03%	0.00%	0.00%	0.00%
Scoggins Dam	0.00%	1.96%	2.66%	0.00%	0.16%	0.00%
Scoggins-Parsons	0.00%	2.56%	0.00%	0.00%	0.46%	0.00%
Sunday	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tanner	0.00%	1.86%	0.00%	0.00%	0.00%	0.00%
Tualatin HW	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Upper Scoggins	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Upper Wapato	9.63%	0.27%	0.00%	0.74%	0.00%	0.00%
UT-Blackjack	4.17%	1.06%	2.51%	0.84%	0.27%	2.63%
UT-Dilley	1.59%	4.64%	0.98%	0.98%	0.91%	1.35%
UT-Hering	5.80%	3.24%	2.68%	1.07%	0.00%	0.00%
UT-Lee Falls	0.00%	0.81%	2.30%	0.00%	1.50%	2.41%
Wapato	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

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Appendix Table 6-4. Riparian characteristics by reach.

	length	Forested (FXD)						Other	Shade %	Shade
Tualatin River	(miles)	0-25	25-50	50-75	75-100	100-200	>200		suboptimal	Impairment
Mouth to Dilley Creek*	1.52	0.00%	36.06%	38.20%	25.74%	0.00%	0.00%	0.00%	36.06%	Moderate
Dilley Creek to O'Neil	0.92	17.55%	0.00%	60.45%	0.00%	7.37%	14.62%	0.00%	17.55%	
O'Neil to Scoggins	1.26	0.00%	13.26%	32.44%	0.00%	13.33%	16.43%	24.55%	37.81%	Moderate
Scoggins to Wapato CN	1.57	0.00%	32.76%	13.37%	0.00%	0.00%	7.35%	46.53%	79.28%	Extreme
Wapato Can to Blackjack	0.89	0.00%	57.88%	42.12%	0.00%	0.00%	0.00%	0.00%	57.88%	Severe
Blackjack to trib 1S4W34SW	1.18	0.00%	13.36%	37.39%	20.01%	0.00%	0.00%	29.24%	42.60%	Moderate
trib 1S4W34SW to trib 1S4W33SE	0.89	0.00%	31.43%	31.43%	0.00%	16.26%	0.00%	20.88%	52.31%	Severe
trib 1S4W33SE to Mercer Cr	0.65	0.00%	0.00%	8.35%	0.00%	8.35%	0.00%	83.29%	83.29%	Extreme
Mercer Cr-trib 1S4W31	2.48	3.79%	10.06%	10.98%	0.00%	2.88%	0.00%	72.29%	86.15%	Extreme
trib 1S4W31 to Hering Cr	0.45	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
Hering Cr to trib 1S4W31W	0.48	0.00%	0.00%	41.49%	0.00%	0.00%	0.00%	58.51%	58.51%	Severe
trib 1S4W31W to Roaring Creek	0.89	0.00%	0.00%	50.57%	10.42%	0.00%	39.01%	0.00%	0.00%	
Roaring Creek to trib 1S5W26NE	1.33	0.00%	0.00%	21.26%	6.03%	33.08%	39.63%	0.00%	0.00%	
trib 1S5W26NE to trib 1S5W27NNE	1.14	0.00%	9.79%	22.54%	0.00%	51.31%	16.36%	0.00%	9.79%	
trib 1S5W27NNE to trib 1S5W22SW	1.02	0.00%	22.88%	0.00%	10.34%	10.31%	56.48%	0.00%	22.88%	
trib 1S5WS22SW to trib 1S5W21SSW	1.39	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
trib 1S5W21SSW to Lee Creek	0.98	0.00%	0.00%	0.00%	4.12%	0.00%	95.88%	0.00%	0.00%	
Lee Cr to Sunday Cr	1.89	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
Sunday-Maple	0.96	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
Maple-HW	2.84	0.00%	0.00%	1.41%	0.00%	3.21%	95.37%	0.00%	0.00%	

composition of nonforested classes	Brush				Grass		Exposed
	25-50	50-75	75-100	>200	50-75	100-200	
O'Neil to Scoggins			15.66%		4.44%	4.44%	
Scoggins to Wapato CN		26.32%		20.21%			
Blackjack to trib 1S4W34SW							29.24%
trib 1S4W34SW to trib 1S4W33SE	20.88%						
trib 1S4W33SE to Mercer Cr							83.29%
Mercer Cr-trib 1S4W31							72.29%
trib 1S4W31 to Hering Cr							100.00%
Hering Cr to trib 1S4W31W							58.51%

*The Tualatin River between Gales Creek and Dilley Creek was determined from FSA photographs.
All other reaches were analyzed using USGS DOQQs.

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Appendix Table 6-4. Riparian characteristics by reach.

Scoggins Creek	length (miles)	Forested (FXD) 0-25	25-50	50-75	75-100	100-200	>200	Other	Shade % suboptimal	Shade Impairment
Mouth to trib 1S4W26	1.07	0.00%	27.63%	8.22%	0.00%	0.00%	20.87%	43.27%	70.90%	Severe
trib 1S4W26 to trib 1S4W27NE	1.10	0.00%	53.66%	15.87%	0.00%	3.17%	10.00%	17.30%	70.96%	Severe
trib 1S4W27NE to trib 1S4W21SW	2.31	0.00%	10.20%	79.60%	0.00%	0.00%	8.53%	1.67%	11.87%	
trib 1S4W21SW to Hagg Lake	0.68	0.00%	0.00%	21.26%	0.00%	0.00%	0.00%	78.74%	78.74%	Extreme
Hagg Lake to trib 1S5W12	0.52	0.00%	7.79%	0.00%	0.00%	21.77%	38.58%	31.87%	39.66%	Moderate
trib 1S5W12 to Parsons	1.34	0.00%	0.00%	0.00%	5.53%	35.31%	59.15%	0.00%	0.00%	
Parsons to trib 1N5W35NW	1.38	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
trib 1N5W35NW to trib 1N5W27	1.96	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
trib 1N5W27 to Fisher Cr	1.59	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	
Fisher Cr to HW	3.06	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	

composition of nonforested classes	Brush 25-50	50-75	75-100	100-200	Grass/ no buffer 0-25	25-50	>200*	small trees 50-75	100-200
Mouth to trib 1S4W26	43.27%								
trib 1S4W26 to trib 1S4W27NE					15.81%			8.65%	8.65%
trib 1S4W27NE to trib 1S4W21SW				1.67%					
trib 1S4W21SW to Hagg Lake		62.93%							
Hagg Lake to trib 1S5W12						14.13%	17.74%		

*Wide grass buffers were associated with lake/wetland habitat.

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Appendix Table 6-5. Riparian characteristics by reach of sampled streams in agricultural portions of the Harris an Hill Creek subwatersheds.

		length	Forested (FXD)						Other	Shade %	
		(miles)	0-25	25-50	50-75	75-100	100-200	>200		suboptimal	Impairment
trib 1S4W25NE	Wapato Cr to first trib (S branch)	0.22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	first trib to trib 1S4W30 (M branch)	0.22	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	M branch to order1 confl.	0.47	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	S branch: Mouth to HW	1.73	0.00%	0.00%	0.00%	7.89%	36.73%	0.00%	55.38%	55.38%	Severe
Harris Cr	Mouth to HW, excluding pond	2.11	0.00%	0.00%	0.00%	0.00%	0.00%	5.83%	94.17%	94.17%	Extreme
	North Trib	1.55	0.00%	0.00%	0.00%	0.00%	38.12%	0.00%	61.88%	61.88%	Severe
Hill Creek	Wapato Cr to trib 2S3W06SW	1.91	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	trib 2S3W06SW to trib 2S3W06NE	0.78	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	Trib 2S3W06NE to trib 2S3WO5NW (N)	0.86	0.00%	0.00%	14.84%	0.00%	0.00%	0.00%	85.16%	85.16%	Extreme
	trib 2S3W05NW to trib 2S3W05SE	0.71	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	trib 2S3W05SE to trib 2S3W04NW	0.52	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	trib 2S3W05SE(SW): mouth-HW	1.75	0.00%	0.00%	0.00%	0.00%	14.37%	0.00%	85.63%	85.63%	Extreme
	trib 2S3W05NW (N): mouth-HW	1.21	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	
	trib 2S3W05SW: mouth-HW	1.18	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	trib 2S3W06NE: mouth-(partial)	0.86	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme
	trib 2S3W06NE: all, including tribs	2.25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	Extreme

	composition of nonforested classes	Brush						Grass/ no buffer		
		0-25	25-50	50-75	75-100	100-200	>200	0-25	25-50	50-75
trib 1S4W25NE	Wapato Cr to first trib (S branch)				16%		16%	68%		
	first trib to trib 1S4W30 (M branch)							100%		
	M branch to order1 confl.							100%		
	S branch: Mouth to HW					4%		52%		
Harris Cr	Mouth to HW, excluding pond						94%	0%		
	North Trib			7%				40%		
Hill Creek	Wapato Cr to trib 2S3W06SW		21%					100%		
	trib 2S3W06SW to trib 2S3W06NE	35%						20%	8%	13%
	Trib 2S3W06NE to trib 2S3WO5NW (N)							50%		
	trib 2S3W05NW to trib 2S3W05SE							100%		
	trib 2S3W05SE to trib 2S3W04NW							44%		56%
	trib 2S3W05SE(SW): mouth-HW							46%		
	trib 2S3W05NW (N): mouth-HW							0%		
	trib 2S3W05SW: mouth-HW			18%		18%		65%		
	trib 2S3W06NE: mouth-(partial)							100%		
	trib 2S3W06NE: all, including tribs							100.00%		

Analysis based on FSA aerial photographs

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Appendix 7

Appendix 7. Culverts in the Upper Tualatin-Scoggins watershed that were surveyed by ODOT (ODOT 1998).

OK?	Road	RM	?	Stream	Subbasin	Basin	Owner	Type	Length	Diam	Drop	Depth	Slope	Above	Below
FALSE	231400	1.75	FALSE	Knighten Cr	Carpenter Cr	Gales Cr	WASH	CMP	40	48	10	12	3	3	3
FALSE	223600		FALSE	Un Cr	Scoggins Cr	Tualatin R	WASH	CMP	180	48	50	2	4		30
FALSE	156100	0.1	FALSE	Un Cr	Tualatin R	Willamette R	WASH	CCL	32	48	18	8	6	3	2
FALSE	206400		FALSE	Herig Cr	Tualatin R	Willamette R	WASH	RCBC	40	72	24	12	0.5	3	2
FALSE	159000	0.45	FALSE	Un Cr	Un Cr	Wapato Cr	WASH	CCL	75	24	2	8	2	2	2
FALSE	223600		FALSE	Tanner Cr	Henry Hagg Lk	Scoggins Cr	WASH	CMP	120	72	22	8	1	3	1
FALSE	234000	0.4	FALSE	Tanner Cr	Henry Hagg Lk	Scoggins Cr	WASH	RCBC	30	60	72	12	0.5	1	10
FALSE	248600		FALSE	Wall Cr	Henry Hagg Lk	Scoggins Cr	WASH	CMP	120	65	10	14	2	3	3
TRUE	Blooming-fern Hill Rd		FALSE	Un Cr	Tualatin R	Willamette R	WASH		0	0	0	0			
TRUE	Richey Rd		FALSE	Knighten Cr	Carpenter Cr	Gales Cr	BENT		0	0	0	0			
TRUE	Stringtown Rd		FALSE	Carpenter Cr	Gales Cr	Tualatin R	BENT		0	0	0	0			
TRUE	223600		FALSE	Un Cr	Tanner Cr	Henry Hagg Lk	BENT		0	0	0	0			
TRUE	Hwy 47	22.44	FALSE	Un Cr	Tualatin R	Willamette R	ODOT		0	0	0	0			
TRUE	Iowa Hill Rd		FALSE	Un Cr	Tualatin R	Willamette R	WASH		0	0	0	0			
TRUE	Iowa Hill Rd		FALSE	Un Cr	Tualatin R	Willamette R	WASH		0	0	0	0			
TRUE	159000		FALSE	Un Cr	Harris Cr	Wapato Cr	WASH		0	0	0	0			
TRUE	159000		FALSE	Harris Cr	Wapato Cr	Tualatin R	WASH		0	0	0	0			
TRUE	159000		FALSE	Hill Cr	Wapato Cr	Tualatin R	WASH		0	0	0	0			
TRUE	Laurelwood Rd	1.5	FALSE	Hill Cr	Wapato Cr	Tualatin R	WASH		0	0	0	0			

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Appendix 7. Culverts in the Upper Tualatin-Scoggins watershed that were surveyed by ODOT (ODOT 1998).

Below	Species	StmMile	HabQual	Priority	Comment
3	ct	1	P	L	1.75 mi. from north end. Juv. step bar., adults may be prohibited in low flows. Landowner says "no fish". Typically dry July-October.
30	ct	1	F	L	2.5 miles west of Old Patton Rd.
2	ct	3.1	P	L	Step falls over boulders for 5' before pool. Dry except isolated pools. Twigs hit in pool below, too murky to identify.
2	ct	0.5	F	L	1.7 miles from Mt Richmond Rd. Step bar. Creek dry except isolated pools.
2	ct	1	P	L	Water cascades down rock for 3' before reaching pool. Velocity barrier.
1	ct	0.2	F	M	Lower 10' of culvert rusted w/ holes. 0.1 mile west of Rd 234000.
10	ct	3.8	F	M	Step bar.
3	ct	1.4	F	M	0.1 mile west of Scoggins Cr Rd. Juv. step bar. Velocity bar.
		0			0.4 miles west of Course Rd.
		0			0.8 miles from Stringtown Rd.
		0			0.3 miles south of Richey Rd.
		0			0.2 miles west of Rd 234000.
		0			
		0			0.1 miles north of Blooming Cemetary Rd.
		0			0.2 miles south of Dober Rd.
		0			0.5 miles south of Burgarsky Rd.
		0			0.6 miles south of Burgarsky Rd.
		0			0.1 mile south of Laurelwood Rd.
		0			

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Appendix 8

Appendix 8. Stand condition within the Upper Tualatin-Scoggins watershed.

	Acres of land in size class (inches)								
Subwatershed	0-9	10 to 19	20 to 29	>29	Barren	Urban/Ag	Water	Other	Total
Ayers	277.899	788.386	122.561	2.007		2516.322		37.444	3744.619
Black Jack	292.626	485.663	79.665	1.093		2567.170	1.39		3427.607
Carpenter	518.554	982.581	361.175	9.644		1948.806	18.687	52.664	3892.111
Goodin	313.668	598.832	132.492	0.772		1122.812			2168.576
Harris	163.567	346.809	55.77			2146.59	8.185		2720.921
Hill	523.8	895.83	240.567	4.169		2409.884	2.934	1.932	4079.116
Lee	693.904	4097.949	757.301	5.559		0.309			5555.022
Mercer	525.916	651.174	136.365	2.15		832.404			2148.009
Roaring	803.654	2047.479	770.336	3.397		34.959			3659.825
Sain	1668.467	4151.205	1025.37	1.698		356.129	103.923	3.088	7309.88
Scoggins Dam	1197.443	1759.178	508.355	14.601		2422.115	574.314	30.732	6506.738
Scoggins-Parsons	1751.973	2198.308	591.991	1.39		448.167	213.714	4.941	5210.484
Sunday	856.541	3776.536	479.374	8.03					5120.481
Tanner	518.556	1075.555	368.353	2.471		340.108	139.246	2.779	2447.068
Tualatin Headwaters	724.87	2998.427	775.913	19.836		0.154			4519.2
Tualatin-Dilley	277.05	381.771	69.382	1.235		3805.856	12.355		4547.649
Tualatin-Hering	839.614	749.017	194.409			2258.534	0.927		4042.501
Tualatin-Lee Falls	1533.874	2034.906	640.395	4.257		262.337			4475.769
Upper Scoggins	1493.715	4775.208	1152.536	4.169					7425.628
Upper Wapato	189.996	246.299	40.652	0.154		948.249			1425.35
Wapato						2277.049			2277.049
Unclassified	22.955	45.558	12.919			219.104			300.536
Total	15188.642	35086.67	8515.881	86.632	0	26917.06	1075.675	133.58	87004.14

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Appendix 8. Stand condition within the Upper Tualatin-Scoggins watershed.

	Percent of land area in size class (inches)								
Subwatershed	0-9	10 to 20	21 to 30	>30	Barren	Urban/Ag	Water	Clouds	Total
Ayers	7%	21%	3%	0%	0%	67%	0%	1%	100%
Black Jack	9%	14%	2%	0%	0%	75%	0%	0%	100%
Carpenter	13%	25%	9%	0%	0%	50%	0%	1%	100%
Goodin	14%	28%	6%	0%	0%	52%	0%	0%	100%
Harris	6%	13%	2%	0%	0%	79%	0%	0%	100%
Hill	13%	22%	6%	0%	0%	59%	0%	0%	100%
Lee	12%	74%	14%	0%	0%	0%	0%	0%	100%
Mercer	24%	30%	6%	0%	0%	39%	0%	0%	100%
Roaring	22%	56%	21%	0%	0%	1%	0%	0%	100%
Sain	23%	57%	14%	0%	0%	5%	1%	0%	100%
Scoggins Dam	18%	27%	8%	0%	0%	37%	9%	0%	100%
Scoggins-Parsons	34%	42%	11%	0%	0%	9%	4%	0%	100%
Sunday	17%	74%	9%	0%	0%	0%	0%	0%	100%
Tanner	21%	44%	15%	0%	0%	14%	6%	0%	100%
Tualatin Headwaters	16%	66%	17%	0%	0%	0%	0%	0%	100%
Tualatin-Dilley	6%	8%	2%	0%	0%	84%	0%	0%	100%
Tualatin-Hering	21%	19%	5%	0%	0%	56%	0%	0%	100%
Tualatin-Lee Falls	34%	45%	14%	0%	0%	6%	0%	0%	100%
Upper Scoggins	20%	64%	16%	0%	0%	0%	0%	0%	100%
Upper Wapato	13%	17%	3%	0%	0%	67%	0%	0%	100%
Wapato	0%	0%	0%	0%	0%	100%	0%	0%	100%
Unclassified	8%	15%	4%	0%	0%	73%	0%	0%	100%
Total	16%	35%	9%	0%	0%	40%	1%	0%	100%

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Appendix 9

Appendix 9. The following table displays a list of 61 projects that the team recommends be implemented in the Upper Tualatin-Scoggins 5th field watershed. This list is intended to serve as a reservoir of potential projects that could be done in the watershed on BLM land. Whether these projects are implemented, and the order in whic they occur, is entirely dependent upon BLM management discretion.

Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
1.	T1S R6W Section 25	Silviculture	This section would benefit from density management and density management with small openings in patches of *Phellinus weirii*. Openings would be reforested with species that are tolerant, resistant or immune to *P.weirii*. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration.	12,14	1, 9	2	2
2.		Wildlife	Opportunities exist to create both snags and down logs in the area that will be treated silviculturally.	11	2,8,9	2	3
3.	T1S R5W Section 19	Silviculture	This is the only part of the Watershed planning area that has a Late Successional Reserve designation. It contains stands that have individual old-growth trees and several tracts of 50-year-old forest. The areas of well-stocked 50-year-old Douglas-fir stands could benefit from density management. The thinnings would emulate the natural spacing of the trees as found in the older forest sections.	12	1, 9	1	1
4.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 19.	11	2,8,9	1	3
5.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	1	3
6.	T1S R5W Section 29	Silviculture	There are a lot of good opportunities to do density management throughout section 29. Areas that are very dense or are infected with *P. weirii* will require special provisions. Overly dense areas may have to be thinned relatively lightly at this time to increase windfirmness, with a subsequent thinning to develop late-seral forest characteristics at a faster rate. In areas impacted with *P. weirii*, where disease centers are well-defined, openings could be reforested with tolerant, resistant or immune species. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration.	12,14	1, 9	2	2
7.		Botany	Scotch broom eradication project: Eradicate individual scotch broom plants that have recently become established on the road system in section 29.	8,10	8,9	2	4
8.		Recreation	OHV management: Motorcycles and other off-road vehicles are causing deep ruts in some roadways in the riparian areas. In areas this is	2,6,10	4	1	?

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Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
			placing sediment into the headwaters of Roaring Creek and its tributaries. Trails should be managed to reduce sediment input into streams. Project planning could be produced in cooperation with local OHV clubs and ODF.				
9.		Soils/Hydrology	Road decommissioning: Pull the culverts and get the water off of the road in the major problem areas of road -29.1 and road 1-5-29. The culverts could be replaced when and if they are needed in the future. Road stabilization: Consider restructuring road -29. It already has one major landslide and will probably have more soon.	1,2,6,7	1,4,5,6	1	2
10.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 29.	11	2,8,9	2	3
11.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	2	4
12.	T1S R5W Section 31	Silviculture	There are a lot of good opportunities to do density management throughout section 31. Areas that are very dense or are infected with *P.weirii* will require special provisions. Overly dense areas may have to be thinned relatively lightly at this time to increase windfirmness, with a subsequent thinning to develop late-seral forest characteristics as a faster rate. In areas impacted with *P. weirii*, where disease centers are well-defined, openings could be reforested with tolerant, resistant or immune species. Large acreages in the remainder of this section outside of the watershed analysis area should also receive density management.	12,14	1, 9	1	1
13.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 31.	11	2,8,9	2	3
14.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	5	5
15.	T1S R5W Section 33	Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	1	3
16.		Silviculture	There are good opportunities to do density management, enhance diversity and reduce disease spread through treating *P. weirii* infection centers in the western part of section 33. This harvesting would occur away from the actual riparian zones, but possibly in the upland parts of Riparian Reserves. Road building would occur in some Riparian Reserves. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration.	12,14	1,9	2	2
17.		Soils/Hydrolog	Recontouring and obliterating Roaring Creek Road between roads 2-5-5 and 2-5-31. Emergency funds should be used to get the water off the	1,2,6,7	1,4,5,6	1	1

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Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
		y	road surface in critical areas as a stop gap measure until funding is secured to do the entire project.				
18.		Botany	Scotch broom eradication project: Either pull or spray herbicides on individual scotch broom plants that have recently become established on the road system in section 33.	8,10	8,9	1	?
19.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 33.	11	2,8,9	2	3
20.		OHV	Several areas have been identified where OHVs are negatively impacting riparian areas. Trails should be managed to reduce impacts to riparian resources. There is an opportunity to produce project planning in cooperation with local OHV clubs and ODF.	1,2,6	1,3,5,	1	3
21.	T2S R5W Section 3	Silviculture	There are opportunities to do density management in parts of section 3. Areas that are very dense or are infected with *P.weirii* will require special provisions. Overly dense areas may have to be thinned relatively lightly at this time to increase windfirmness, with a subsequent thinning to develop late-seral forest characteristics as a faster rate. In areas impacted with *P. weirii*, where disease centers are well-defined, openings could be reforested with tolerant, resistant or immune species. Some shrub control would be necessary for the first few years to help. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration. Several areas in the south are in 15% deferral status and are not recommended for treatment at this time.	12,14	1, 9	2	2
22.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 3.	11	2,8,9	2	3
23.	T1S R5W Section 34	Silviculture	There are a lot of good opportunities to do density management in the southern part of section 34. Areas that are very dense or are infected with *P.weirii* will require special provisions. Overly dense areas may have to be thinned relatively lightly at this time to increase windfirmness, with a subsequent thinning to develop late-seral forest characteristics as a faster rate. In areas impacted with *P. weirii*, where disease centers are well-defined, openings could be reforested with tolerant, resistant or immune species. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration.	12,14	1,9	2	2
24.		Soils/Hydrolog y/Fish	Recontouring and obliterating Roaring Creek Road between roads 2-5-5 and 2-5-31. Emergency funds should be used to get the water off the road surface in critical areas as a stop gap measure until funding is secured to do the entire project.	1,2,6,7	1,4,5,6	1	1

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Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
25.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	1	3
26.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
27.		OHV	Several areas have been identified where OHVs are negatively impacting riparian areas. Trails should be managed to reduce impacts to riparian resources. There is an opportunity to produce project planning in cooperation with local OHV clubs and ODF.	1,2,6	1,3,5,	1	3
28.	T1S R5W Section 35	Silviculture	This drier stand would benefit from some density management and in areas impacted with *P. weirii*, where disease centers are well-defined, openings could be reforested with tolerant, resistant or immune species. Some shrub control would be necessary for the first few years to help disease resistant tree regeneration.	12,14	1,9	3	3
29.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	1	3
30.		Road work	Put non-system roads in the GIS system and replace culverts as needed.	1,2,7	5	3	5
31.		Wildlife	Wildlife trees, snags and down logs could be created in appropriate areas of section 35.	11	2,8,9	2	3
32.	T2S R5W Section 1 (lower)	Silviculture	This is a fairly dense stand of Douglas-fir that should be treated with density management within the next five years. After this time the options for performing density management become limited as crown ratios decrease and height/diameter ratios increase.	12	1,9	2	2
33.		Road work	Subsoil old skid trails and replace defective culverts as needed.	1,2	1	2	3
34.		Wildlife	Create wildlife trees, down logs and snags as needed.	11	2,8,9	2	3
35.	T1S R5W Section 1 (upper)	Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	1	3
36.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	3	5
37.	T1S R5W Section 3	Silviculture	The 50-year-old Douglas-fir dominated stands are generally quite dense and should have received a high priority for treatment. Height/diameter ratios are increasing as a result of intense competition. In some cases, it may be necessary to thin rather lightly and relatively uniformly to establish windfirmness and plan on doing a more aggressive treatment to achieve structural diversity in a future stand	12	1, 9	1	1

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Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
			entry. Density management in the Riparian Reserves away from the actual riparian zones would be beneficial to encourage development of late-seral forest conditions.				
38.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	4	5
39.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
40.		Road removal	Old roads that could be used in upcoming density management treatments could be de-commissioned after use.	1,2	1	4	5
41.	T1S R5W Section 5	Silviculture	The 50-year-old Douglas-fir dominated stands are generally quite dense and should have received a high priority for treatment. Height/diameter ratios are increasing as a result of intense competition. In some cases, it may be necessary to thin rather lightly and relatively uniformly to establish windfirmness and plan on doing a more aggressive treatment to achieve structural diversity in a future stand entry. Density management in the Riparian Reserves away from the actual riparian zones would be beneficial to encourage development of late-seral forest conditions.	12	1, 9	1	1
42.		Wildlife	There are good opportunities to create wildlife trees and snags in the 80-year old stand type.	11	2,8,9	2	3
43.	T1S R5W Section 8	Silviculture	Parts of this section have a well-stocked 50-year old stand type which should receive density management at this time, both within and outside of the Riparian Reserves, but away from the actual riparian zones.	12	1, 9	1	1
44.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
45.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	5	5
46.	T1S R5W Section 9 (west)	Silviculture	The well-stocked 50-year-old Douglas-fir stands are at an optimum time for density management, which could be done in a variety of ways including variable-spaced thinning.	12	1, 9	1	1
47.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
48.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	4	5
49.	T1S R5W Section 9 (east)	Silviculture	Density management opportunities exist in the well-stocked 40 and 50-year old Douglas-fir stands.	12	1, 9	2/3	1

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Project #	Location	Resources Affected	Description	Issues* addressed	ACS ** objectives	S/T *** rating	RA **** rating
50.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
51.	T1S R5W Section 15 (NW)	Silviculture	The well-stocked 40-year-old Douglas-fir stand along the rather broad flat ridge in the northwest part of the western parcel could benefit from density management thinning.	12	1, 9	1	1
52		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	4	5
53..	T1S R5W Section 15 ((SE)	Silviculture	Density management thinning opportunities exist in the well-stocked 40-year-old Douglas-fir stand along the rather broad flat in the southwest part of the eastern parcel.	12	1, 9	1	1
54.		TPCC	The middle portion of this area contains an unstable area that consists of a large old landslide. Consider changing the TPCC to reflect this unstable condition.	1,2	1,2,3,4,5,6	1	?
55.		Wildlife	There are good opportunities to create wildlife trees and snags.	11	2,8,9	2	3
56.		Fish	Aquatic habitat and fish presence/absence surveys. Form partnerships with private landowners, where possible, to survey entire reaches.	3, 4, 5, 6, 7	1,2	3	5
57.	WA wide	OHV	Damage to the riparian resource was observed in several areas of Section 29 and Section 33 by OHVs. Trails should be managed to reduce impacts to riparian resources. There is an opportunity to produce project planning in cooperation with local OHV clubs and ODF.	1,2,6	1,3,5,	1	2
58.		Access	We currently do not have complete legal access to sections 3,5,8,9,10 and 19. These parcels are surrounded by Stimson Timber Company and our right-of-way agreements have expired. If we plan to haul logs out of these sections we need to get the appropriate agreements.	15	n/a	1	1
59.		Land Exchange	Explore the possibility of acquiring the western part of section 20 from Stimson Timber Company. This area borders Lee Creek and there are several small patches of old-growth that would help form a larger contiguous block of LSR	5,9,15	1,2	n/a	4
60.		Roads inventory	A complete inventory of non-system roads would allow us to update the GIS system and strategically prioritize which roads to use during density management, which to restore and which to decomission.	1,2,6,8,10	1,2,5,	1	1
61.		Property boundary survey	Many of the property boundaries in this watershed have not been surveyed for years. There are undoubtably trespasses and a variety of other property boundary issues which would need to be resolved before density management begins.	5,15	n/a	1	1

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* Each potential project responds to at least one or more of the issues identified in Chapter 6: "Recommendations on BLM lands". The number of the issues(s) is written in the column.

** Most of the projects directly respond to one or more of the Aquatic Conservation Strategy (ACS) Objectives. A list of these objectives can be found Appendix 3. The number of the ACS objective is written in the column.

*** The BLM interdisciplinary team ranked each potential project as to its *relative priority* for the resource area affected, within the Upper Tualatin-Scoggins fifth field watershed. The scale is from 1 to 5. With 1 being those projects that are most important to be implemented soon, and 5 signifying the lowest priority project. All of the identified projects are worthwhile to accomplish.

**** The BLM interdisciplinary team ranked each potential project as to its *relative priority* for the resource area affected, within the Tillamook Resourc Area. The scale is from 1 to 5. With 1 being those projects that are most important to be implemented soon, and 5 signifying the lowest priority project. All of the identified projects are worthwhile to accomplish

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
SALEM DISTRICT OFFICE
Tillamook Resource Area
4610 Third Street
Tillamook, Oregon 97141

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

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Permit No. G-76

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