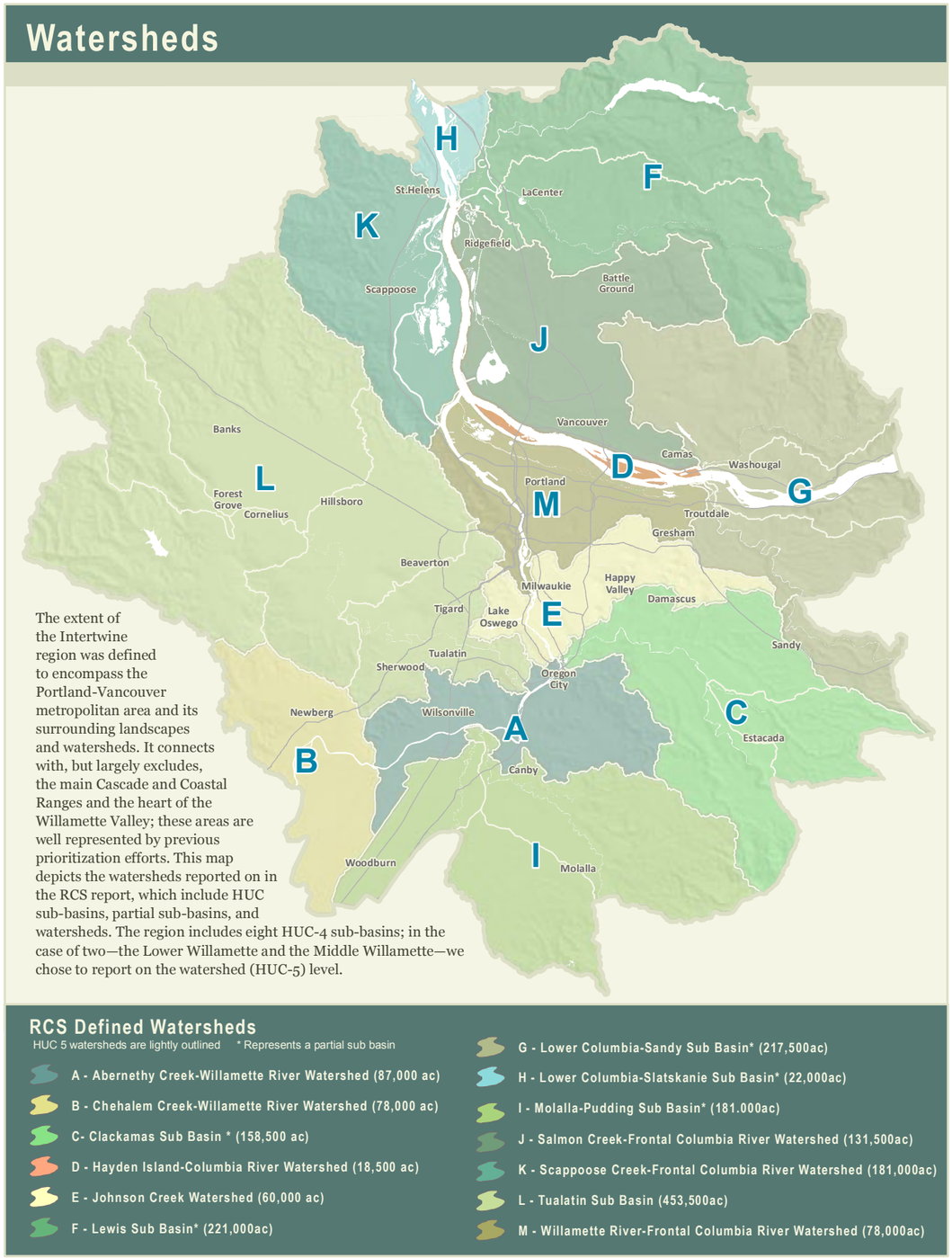
APPENDIX I: WATERSHEDS
CONTENTS

FIGURE I-1



The extent of the Intertwine region was defined to encompass the Portland-Vancouver metropolitan area and its surrounding landscapes and watersheds. It connects with, but largely excludes, the main Cascade and Coastal Ranges and the heart of the Willamette Valley; these areas are well represented by previous prioritization efforts. This map depicts the watersheds reported on in the RCS report, which include HUC sub-basins, partial sub-basins, and watersheds. The region includes eight HUC-4 sub-basins; in the case of two—the Lower Willamette and the Middle Willamette—we chose to report on the watershed (HUC-5) level.

I. Watersheds

APPENDIX I

Conservation biology is scale dependent. As one zooms in from the scale of the entire Earth down to continents, countries, and states and further down to neighborhoods and even backyards, the ecological role, function, and importance of the geography being viewed keep changing. What is critically important at one scale may not be at larger or smaller scales. Providing an understanding of the importance, ecology, and connection to watershed and landscape health at multiple scales was an important motivation in developing the *Regional Conservation Strategy* and *Biodiversity Guide*. This chapter presents the view at the scale of the individual watershed (USGS HUC 4 and HUC 5; see Chapter 1). Some issues are common among many or all watersheds; however, given the geographic and socio-economic diversity within the region, each watershed also has unique elements and challenges.

The short descriptions of watersheds in this chapter are introductions that lead to other resources that have been developed by local, state, and federal organizations and agencies (especially watershed councils in Oregon). Where a watershed crosses the boundary of the greater Portland-Vancouver region (as defined in this *Biogeography Guide* and the *Regional Conservation Strategy*) we try to distinguish between issues relevant in the entire watershed and those relevant to the area within the greater Portland-Vancouver region. Table I-1 lists the watersheds in the region.

1. Clackamas River Subbasin

Cheryl McGinnis, Clackamas River Basin Council, and Carol Murdock, Clackamas County Water Environment Services

Includes these named USGS HUC watersheds:
Eagle Creek
Lower Clackamas River

Lower Clackamas River

The Clackamas River subbasin is located in Clackamas and Marion counties, Oregon, east and south of the Portland metropolitan area. The Clackamas River is a tributary of the Willamette River that enters the Willamette at approximately River Mile (RM) 25, the last major tributary stream downstream of Willamette Falls. Elevations in the watershed range from approximately

TABLE 9-1

Watersheds in the Greater Portland-Vancouver Region, Organized by U.S. Geological Survey Subbasin

Subbasin	Watersheds Included in the Greater Portland-Vancouver Region	Watershed Acres within the Region
Clackamas	1. Clackamas Subbasin (partial)	158,300
Lewis	2. Lewis Subbasin (partial)	220,800
Lower Columbia – Clatskanie	3. Lower Columbia-Clatskanie Subbasin (partial)	22,000
Lower Columbia – Sandy	4. Lower Columbia-Sandy Subbasin (partial)	217,200
Lower Willamette	5. Johnson Creek	60,100
	6. Salmon Creek-Frontal Columbia R	131,400
	7. Scappoose Creek-Frontal Columbia R	123,100
	8. Willamette R-Frontal Columbia R (includes Hayden Island – Columbia River)	78,700 (Willamette R-Frontal Columbia) 18,600 (Hayden Island – Columbia River)
Middle Willamette	9. Abernethy Cr-Willamette R	87,100
	10. Chehalem Creek-Willamette R	78,200
Molalla-Pudding	11. Molalla-Pudding Subbasin (partial)	181,000
Tualatin	12. Tualatin Subbasin	453,200
	Total	**1,829,600**

Clackamas Subbasin (partial) 158,279 acres	
Land cover	**% of Watershed**
Agriculture	22%
Regen. forest	3%
Developed	8%
Low Veg	7%
Tree Cover	59%
Water	1%
Forest Patches*	55%
Jurisdictions	
Estacada	2%
Metro UGB**	9%
Sandy	1%
Rural	88%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB.

10 feet, at the confluence with the Willamette River, to more than 7,200 feet, at Olallie Butte located along the southeast boundary of the subbasin. The subbasin totals 941 square miles, of which about 250 are within the greater Portland-Vancouver region.

Land cover in the entire Clackamas subbasin is predominately (90 percent) forest and shrubland.

KEY FACTS: The Clackamas subbasin within the greater Portland-Vancouver region:
Includes 59 percent tree cover, behind only the Lewis and Lower Columbia-Sandy subbasins. Regionwide, the average percent tree cover is 49 percent.

- Contributes 8 percent of the total area but 11 percent of the region's forest patches (of which 15 percent is publicly owned).
- Is only 9 percent publicly owned.
- Has 4,228 acres within Federal Emergency Management Agency (FEMA) 100-year floodplains.
- Includes about 1,500 acres of mapped wetlands.

The majority is privately owned, although agencies including the U.S. Bureau of Land Management, U.S. Forest Service, Oregon Parks and Recreation Department, and Metro own some significant natural areas in the region. Portions of the cities of Sandy, Gladstone, Oregon City, Estacada, Happy Valley, and Damascus are located within the Clackamas subbasin.

A variety of habitat types can be found in the Clackamas subbasin. The U.S. Environmental Protection Agency (EPA) has developed the concept of ecoregions. Three Level IV ecoregions are represented within the portion of the Clackamas subbasin that falls within the greater Portland-Vancouver region: prairie terraces, valley foothills, and Western Cascades lowlands and valleys.

Prairie Terraces. This area, which is located along the Clackamas River downstream of River Mill Dam, consists primarily of the lower Clackamas mainstem and lower tributary areas. This area is nearly level, slightly depressional, or includes undulating fluvial terraces with sluggish, meandering tributary streams. Historically, seasonal wetlands and ponds were common. Many streams are now channelized (for example, portions of Goose and Foster creeks), as is the mainstem of the Clackamas River.

Valley Foothills. This area includes the headwater portions of the lower Clackamas tributaries, Rock and Richardson creeks, and the lower portions of Clear, Deep, and Eagle creeks. The area is characterized by rolling foothills with medium-gradient sinuous streams that are deeply incised in some areas. The areas of greatest relief often occur in the lower to middle portions of these watersheds, where the largest streams have incised into the underlying geology,[1] with the headwater areas having relatively flat or rolling topography. A few buttes (such as the Boring lava domes) occur in this area.

Western Cascades Lowlands and Valleys. This area includes most of the mainstem Clackamas River and floodplain upstream of River Mill Dam; the upper extent of the Deep, Clear, and Eagle creeks; North Fork Eagle Creek; and the lower elevation portions of the middle and upper Clackamas tributaries, i.e., Fish Creek, Roaring River, Oak Grove Fork, Collawash River, and Hot Springs Fork. The area is characterized by low mountain ridges, buttes, valleys, and medium-gradient rivers and streams.

Humans have occupied the Clackamas subbasin for thousands of years. The original Native American inhabitants were bands from two major tribal groups, the Clackamas Chinook and the Northern Molalla. Populations of both tribal groups were decimated in the early 1800s by a series of epidemics thought to have been brought to the area by fur trappers. The Clackamas Chinook primarily occupied the lower lying and northern parts of the subbasin, while the Northern Molalla occupied the higher elevation and southern parts.

Historically, the Clackamas Basin was about 65 percent conifer forest and 27 percent prairie and savanna, with only about 3 percent oak. Most of the oak and approximately 20,000 acres of prairie and coniferous forest were converted to agriculture, while about 10,000 acres of conifer forest and the remainder of oak and prairie were converted to urban cover in portions of Clackamas, Boring, Estacada, Gladstone, and Sandy. A 42 percent increase in the area covered by water in the basin could be attributable to classification error, but it may also reflect the creation of flooded gravel pits near urbanized areas.

The Clackamas supports a significant population of winter steelhead, resident and anadromous cutthroat trout, and native lamprey. The subbasin also sustains one of the last two

[1] The lower lying areas of the Clackamas subbasin were inundated during a series of floods—the "Missoula" or "Bretz" floods—during the last ice age The floods deposited a relatively thick layer of loose boulders, rocks, and soil. As a result, for some Clackamas tributaries, headwaters initiate on the buttes or in flatter areas and create deeper canyons close to the mouth of the stream.

remaining wild late-fall coho runs in the lower Columbia Basin. This run, which is part of the Lower Columbia River coho salmon evolutionarily significant unit (ESU), was federally listed as threatened in 2005. The Lower Columbia River steelhead and Chinook ESUs were listed as threatened under the federal Endangered Species Act in 1998 and 1999. The *Clackamas River Basin Action Plan*, the *Willamette Subbasin Plan*,[2] and current Oregon Department of Fish and Wildlife recovery planning [3] have identified the Clackamas as critical habitat and one of the highest priorities for recovery of the Lower Columbia River and Willamette ESUs.

Limiting factors for anadromous salmon identified in the Clackamas River Basin Action Plan include lack of habitat complexity and off-channel habitats, sediment, hatcheries, hydropower turbines, water temperature, bacteria, fish passage, nutrients, flow, pesticides, and inadequate macroinvertebrates. Historically, lower Clackamas streams played a key role in contributing to the subbasin's fish population abundance and diversity. Confinement of the lower Clackamas River channel, loss of large wood, reduced recruitment of rock, and reduced streamside trees and other riparian vegetation has contributed to the loss of side channels and other habitats important to aquatic life. The mainstem would benefit from additional side-channel habitat. In many locations, important channel features such as side channels and pools have been lost or disconnected.

In addition to anadromous salmon, the Clackamas subbasin supports a diverse array of wildlife, including elk, deer, northern flying squirrel, spotted owl, bald eagle, osprey, bats, about 250 native bird species, and a good selection of reptiles and amphibians. Plant and animal species in the subbasin that are considered to be sensitive, threatened, or endangered at state or federal levels include the following:

- Bull trout (*Salvelinus confluentus*)
- Nelson's sidalcea/Nelson's checkermallow (*Sidalcea nelsoniana*)
- Northern spotted owl (*Strix occidentalis caurina*)
- Oregon chub (*Oregonichthys crameri*)
- White-topped aster (*Seriocarpus rigidus*)
- White rock larkspur (*Delphinium leucophaeum*)
- Peacock larkspur (*Delphinium pavonaceum*)
- Howellia (*Howellia aquatilis*)

Although most of the watershed within the greater Portland-Vancouver region is privately owned, some important blocks of habitat and wildlife connectivity areas have been preserved. Milo McIver Park includes 951 acres of lawns, public amenities, and substantial wooded areas on natural terraces above the Clackamas River. BLM and Forest Service lands, including a small portion of the Mt. Hood National Forest, are scattered throughout the subbasin. Metro acquired significant contiguous parcels along Clear and Richardson creeks and on either side of Clackamas County-owned Barton Park; both of these parcels are along key biodiversity corridors. Mt. Talbert Nature Park is currently under restoration for oak habitats. North Clackamas Parks and Recreation District (NCPRD) owns or manages 800 acres of parks, open spaces, and natural areas that contributing significant habitat and connectivity in or near urban areas.

Several entities are working to protect natural areas on the forested "East Buttes" that provide important habitat for elk, birds, and other wildlife. These buttes loop up from the Clackamas River to some Johnson Creek headwaters and then back down to the river, providing critical wildlife connectivity between watersheds and to the mainstem. Deep, Eagle and Tickle creeks connect to large habitat areas to the south and west, including the Sandy River subbasin; connections to the latter are in need of improvement. The Clackamas River provides an east-west corridor. Rock Creek is the key movement corridor running north-south from the Clackamas River to the East Buttes. The creek lies between developed areas to the west and new urban areas slated for development, and it is in need of restoration in some areas.

Despite the relatively undeveloped condition of much of the Clackamas subbasin, invasive species constitute a serious threat to fish and wildlife habitat. It will be important to continue ongoing efforts to control and eradicate invasive weeds such as Japanese knotweed, spurge laurel, garlic mustard, Himalayan blackberry, false brome, Scot's broom, and purple loosestrife. There are opportunities to address this problem through outreach, education, and targeted weed eradication in collaboration with the Bureau of Land Management, the Four County Cooperative Weed Management Area (CCWMA), Metro, Oregon Department of Agriculture, Clackamas Soil and Water Conservation District, and U.S. Forest Service.

In addition, the Clackamas River is plagued by water quality issues common throughout the Willamette Basin, such as excess mercury and bacteria and elevated water temperatures. There are high levels of nitrate and phosphorous in some of the Clackamas's lower tributaries, including Cow, Sieben, Rock, Deep, and Clear creeks. Pesticides are an issue and targeted education is needed for lower Clackamas River landowners, with an emphasis on natural landscaping, wider riparian areas, and reduced use of chemicals.

The highest priority areas for restoring aquatic and riparian functions are the mainstem of the Clackamas River below and above River Mill Dam. Large sections of the river, particularly below the dam, are disconnected from the floodplain and have reduced floodplain and riparian vegetation composition and extent. There is limited large wood in the river system and extensive loss of historical backwater habitats, including side channels and alcoves, which are important to salmon. Key lower subbasin watersheds for anadromous and resident trout production (particularly cutthroat trout) are Clear, Foster, and Eagle creeks. Restoring channel complexity is a priority in the lower and middle Clackamas River; Clear, Foster, Deep/Goose, Eagle and Wade creeks; Oak Grove Fork; and the Collawash River.

Many of the subwatersheds in the lower basin have been developed, and the loss of wetlands and increased amount of impervious surfaces have changed hydrologic processes. Restoring river- and stream-associated wetlands that contribute to aquatic habitat and floodplain connectivity, particularly in the Lower Clackamas River, Rock and Richardson creeks, Lower Clear Creek, Foster Creek, Deep and Goose creeks, and Wade Creek is a high priority. Important actions include managing stormwater in developed areas and restoring river- and stream-associated wetlands that contribute to aquatic habitat and floodplain connectivity. There are opportunities to restore degraded riparian/floodplain habitats between high-quality areas, which would create corridors across watersheds.

Current Salmonid and Water Quality Improvement Initiatives

- Water quality monitoring and protection—Clackamas River Water Providers, Oregon Department of Environmental Quality, Oregon Department of Agriculture, Clackamas Soil and Water Conservation District, Clackamas County Service District #1
- Voluntary Pesticide Reduction Campaign www.deq.state.or.us/wq/pubs/factsheets/community/pesticide.pdf

[2] *Willamette Subbasin Plan*, Northwest Power and Conservation Council, May 2004, http://www.nwcouncil.org/fw/subbasinplanning/willamette/plan/Intro.pdf
[3] See http://www.dfw.state.or.us/fish/CRP/.

- Shade Our Streams http://clackamasriver.org/resources-for-landowners/shade-our-streams
- Bull trout reintroduction http://www.fws.gov/oregonfwo/species/Data/BullTrout/ReintroductionProject.asp
- Clackamas County Water Education Team
- PGE shade program. As part of its relicensing agreement, PGE and the Clackamas River Basin Council will partner to plant riparian vegetation along Clear Creek and other tributaries that are important to healthy salmon populations.

Watershed Assessments and Plans — Clackamas Subbasin

- Clackamas County Soil and Water Conservation District WeedWise Program. www.conservationdistrict.org/
- Clackamas County Water Environment Services / Service District #1 Rock Creek Watershed Action Plan. 2009. www.riverhealth.org/rock-creek-watershed-documents
- Clackamas River Basin Action Plan. 2005. http://clackamasriver.org/watershed-assessments/action-plan
- National Oceanic and Atmospheric Administration. 2001. Endangered and Threatened Species: Designation of Critical Habitat for Threatened Lower Columbia River Coho Salmon and Puget Sound Steelhead. www.federalregister.gov/articles/2011/01/10/2011-283/endangered-and-threatened-species-designation-of-critical-habitat-for-threatened-lower-columbia
- Oregon Department of Fish and Wildlife Conservation Strategy. 2006. www.dfw.state.or.us/conservationstrategy/
- U.S. Fish and Wildlife Service prairie species recovery plan. 2010. www.fws.gov/oregonfwo/Species/PrairieSpecies/default.asp
- U.S. Forest Service Roads Analysis and Action with support for the Legacy Roads Act. 1999. www.fs.fed.us/eng/road_mgt/01titlemain.pdf
- Willamette Basin Restoration Priorities Watershed Summaries. 2005. Prepared for the Oregon Watershed Enhancement Board. www.oregon.gov/OWEB/docs/pubs/Rest_Priorities/Willamette_Watershed_Council_Summaries_Dec05.pdf
- Willamette Synthesis Project. 2009. The Nature Conservancy, Oregon Field Office. Portland, OR 97214

Organizations and Partners — Clackamas Subbasin

- City of Damascus, OR — www.ci.damascus.or.us/, 503-658-8545
- Clackamas River Basin Council — www.clackamasriver.org, 503-558-0550
- Clackamas County — www.co.clackamas.or.us/, 503-742-4500 Including: Board of County Commissioners, Water Environment Services, Department of Transportation and Development
- Clackamas River Water Providers — www.clackamasproviders.org/, 503-723-3510
- Clackamas River Technical Working Group – A partnership for water quality protection (Clackamas River Water Providers, Clackamas River Basin Council, Oregon Department of Agriculture, Oregon Department of Environmental Quality, Clackamas Soil and Water Conservation District, municipalities, U.S. Geological Survey). Contact Clackamas River Basin Council.
- Clackamas County Soil & Water Conservation District – www.conservationdistrict.org/, 503-221-6001

2. Lewis River Subbasin

Lori Hennings, Metro and Jeff Azerad, Washington Department of Fish and Wildlife

Includes these named USGS HUC watersheds:
East Fork Lewis River
Lower Lewis River

Within the greater Portland-Vancouver region, the Lewis River subbasin consists of two subbasins, the East Fork (EF) and Lower (North) Fork (NF) and contains portions of Clark, Cowlitz and Skamania counties. A third subbasin, the Middle Fork Lewis River, lies outside the region. The two subbasins drain 164 and 182 square miles, respectively, within the region. The North Fork's headwaters originate on the southern flanks of Mt. Adams and Mt. St. Helens, and the river flows southwesterly through three impoundments: Swift Reservoir (at RM 48), Yale Reservoir (at RM 34), and Merwin Lake (at RM 20). The East Fork is considered a tributary to the North Fork. Its headwaters lie in the Gifford Pinchot National Forest, and the river drains primarily through Clark County westward into the North Fork near Woodland, Washington. The high point of the subbasin is at an elevation of almost 12,000 feet, and the low point is near sea level. Extensive meandering, braiding, and channel shifting occur in the lower subbasin, with some tidal effects from the Columbia River.

Major land ownership includes Washington Department of Natural Resources, federal lands, Clark County, and private individuals. The North Fork is primarily privately owned (84 percent private, 16 percent state), while the East Fork includes more state and federal lands (63 percent private, 36 percent state and federal). Most of the upper two-thirds of the subbasin is forested and typical of the western hemlock vegetation zone; timber harvest is the predominant land use, with about three-fourths of the subbasin within the region in tree cover or regenerating forests. A 30-square mile area was denuded by the 1980 eruption of Mt. St. Helens, and forestry and fire result in patchy disturbances over time. Much of the lower subbasin is pasture and grassland, with rural and urban development. Urban development is primarily concentrated in Amboy and Woodland in the North Fork, and around Battle Ground, La Center, Ridgefield, Yacolt, and the I-5 corridor in the East Fork. The urban population in the subbasin is expected to increase significantly in coming decades.

Historically, the Lewis River subbasin was covered almost entirely by coniferous forest (54 percent) and burned forest (40 percent), with only 2 percent prairie and 1 percent oak. It was the second most heavily forested basin in the greater Portland-Vancouver region and remains so today. Almost all prairie and oak and about 20,000 acres of conifer forest and burned forest were converted to agriculture, which covers about 13 percent of the subbasin. Only 2 percent of the subbasin is in urban cover (La Center and part of Woodland). An increase of more than 3,900 acres of water in the subbasin is attributable to the

Lewis Subbasin (partial) 220,839 acres	
Land cover	**% of Watershed**
Agriculture	13%
Regen. forest	12%
Developed	3%
Low Veg	5%
Tree Cover	64%
Water	3%
Forest Patches*	71%
Jurisdictions	
Battle Ground	<1%
LaCenter	<1%
Ridgefield	1%
Woodland	<1%
Yacolt	<1%
Rural	99%

*Tree/regen. forest patches >30 acres.

construction of Lake Merwin in 1931, at the expense of coniferous and mixed forest.

The Lewis River is the second-largest watershed in the greater Portland-Vancouver region, making up 12 percent of the entire region.

Key facts about the Lewis River subbasin within the greater Portland-Vancouver region:

- Has 64 percent tree cover, the highest proportion of all the region's watersheds.
- Has forest patches (i.e., patches of trees and regenerating forest that together are 30 acres or larger) that cover 71 percent of the subbasin within the region. This attests to the high proportion of private and public lands managed for timber.
- Is 22 percent publicly owned. This represents about 20 percent of all privately owned lands in the region.
- Includes more than 12,000 acres that are within FEMA 100-year floodplains and 10,700 acres of mapped wetlands.

Land use practices throughout the subbasin, in particular dams, residential development, gravel mining, and agricultural activities, have negatively affected habitat conditions in the lower subbasin. Nonetheless, the Lewis River subbasin is home to diverse fish and wildlife populations. People appreciate the kayaking, camping, wildlife watching, hiking, and fishing opportunities offered by the subbasin's riparian and upland habitat.

North Fork Characteristics. The North Fork subbasin's watersheds include Fly Creek, Lower Canyon Creek, Marble Creek, Cedar Creek, and the Lewis River. Stream conditions in the lower North Fork subbasin are generally better than in the East Fork subbasin because the human population is less and more of the subbasin is forested. Water temperatures at Amboy and at the mouth of Cedar Creek are elevated and potential affecting steelhead juveniles. High temperatures have been attributed to agriculture, grazing, water withdrawals, surface water runoff, residential development, forestry operations, and the construction of illegal dams and diversions. Water quality information is lacking for other lower Lewis tributaries.

The upper and middle portions are generally forested. Stand-replacement fires burned large portions in the subbasin during the first three decades of the 1900s, including the large Yacolt Burn. The resulting impacts to vegetation and soil stability likely exacerbated major floods in 1931 and 1934. The lower subbasin lies in a broad alluvial valley characterized by agriculture and residential uses, which are largely protected from flooding by dikes. This section is extensively channelized and tidally influenced in some areas. The valley begins to narrow for the next 8 miles, eventually forming a canyon from the confluence of Cedar Creek to Merwin Dam, which blocks passage to 80 percent of the historical anadromous salmon habitat.

Historically, the upstream area was a major production area coho salmon, spring and fall Chinook salmon, and winter and summer steelhead. These species have declined drastically in number, and they are listed under the federal Endangered Species Act; mitigation programs have attempted to reestablish historical salmon runs, with limited success. However, the North Fork mainstem from RM 15 to Merwin Dam provides a highly productive spawning area for fall Chinook salmon. All three reservoirs (Merwin, Yale, and Swift) support populations of bull trout and Dolly Varden. In the upper river, three streams provide rearing and spawning habitat for bull trout: Pine and Rush creeks, which flow into Swift Reservoir, and Cougar Creek, which flows into Yale Reservoir. The North Fork subbasin also supports cutthroat trout and Pacific lamprey. Cedar Creek and its tributaries, including Pup, Bitter, Beaver, and Chelatchie creeks, currently provide most of the productive tributary habitat for anadromous salmon.

East Fork Characteristics. The East Fork Lewis River has its source near Green Lookout Mountain in the Gifford Pinchot National Forest, elevation 4,442 feet. The subbasin's watersheds within the greater Portland-Vancouver region include the Coyote, Basket, Rock and Lockwood Creek watersheds. The East Fork's headwaters are characterized by steep slopes and narrow valleys that are dominated by bedrock and boulder substrates. Copper Creek and upper Rock Creek are the two largest tributaries in the upper subbasin.

Stream conditions are generally fair to good in the upper watershed and poor to fair in the middle and lower watershed. The mid-lower watershed is affected by low summer flows, high stream temperatures, and coliform bacteria, and the mainstem and tributaries are listed on the 303(d) list of impaired water bodies. Water bodies placed on the 303(d) list require the preparation of a total maximum daily load (TMDL) to identify and quantify sources of the impairments and to recommend implementation strategies for reducing point and nonpoint source pollutant loads. The Washington Department of Ecology is analyzing temperature and bacteria data and is expected to begin holding Advisory Committee meetings to determine the control measures that will be incorporated into the TMDL water cleanup plan.

The East Fork subbasin still retains significant populations of salmonids, including chum, fall Chinook, and coho salmon and winter and summer steelhead, all of which are listed as threatened under the federal Endangered Species Act. The East Fork mainstem is completely free flowing, with no manmade obstructions or dams. Lucia Falls is a natural barrier, above which only steelhead routinely pass. Some tributary streams have fish-blocking road culverts. Upstream migration for steelhead was essentially blocked at Sunset Falls (RM 33) until 1982, when the falls were notched. Below Lucia Falls the river flows through a narrow valley that forms a canyon in places, until it opens up around RM 14 into a broad alluvial valley.

Wildlife, Habitat, and Connectivity. The subbasin's wildlife habitat varies and includes extensive near-stream wetlands, bottomland forest and floodplains, scattered intact headwater wetlands, and some interesting linear wetland sequences formed by the Missoula floods at the end of the last ice age. Native prairie and oak remnants are scattered through the western lowlands. Substantial intact forested areas support diverse wildlife communities. Agricultural lands, though disturbed, provide important habitat to grassland birds, small mammals, and other wildlife, as well as providing some connectivity between natural habitat areas. Invasive species such as knotweed are a problem in some riparian areas, and Scot's broom and other invasive species have invaded some upland areas. Efforts to control invasive species are ongoing.

The Washington Department of Fish and Wildlife's Comprehensive Wildlife Conservation Strategy identifies specific areas and actions to help sensitive habitats and wildlife species. The WDFW's Priority Habitats and Species program identifies the mainstem, associated floodplains, and major low-lying tributaries as important habitat areas for breeding and over-wintering bald eagles and waterfowl, including concentrations of geese, ducks, and wintering populations of tundra swans. The Woodland bottomlands support large concentrations of wintering waterfowl, including dusky and cackling Canada geese, resident geese, tundra swans, and migrating sandhill cranes. Bea-

ver ponds along Cedar Creek and ponds along I-5 near Woodland provide important cavity-nesting duck habitat. Winter concentrations of bald eagle use portions of the East Fork and North Fork mainstems for perching and foraging.

The Lewis River subbasin provides extensive upland habitat as well. A series of Oregon white oak patches near the Rock Creek/mainstem confluence provides key habitat for oak-associated species, and Martin's Bluff, north of the Woodland bottomlands, includes about 100 acres of mixed forest with an oak component. An unusual grassy bald is situated near the headwaters of Cedar Creek. Grouse Creek, a tributary to Rock Creek, provides important winter deer habitat as well as a snag-rich area important to many wildlife species. Deer, elk, and associated large predators such as cougar are present in many areas of this watershed. Washington Department of Fish and Wildlife's Washington State Elk Herd Plan calls for maintaining the current level of elk winter range along the Lewis River, where the northern area provides important winter range for the Mt. St. Helens and Mt. Rainier herds of Rocky Mountain and Roosevelt elk. Increasing elk herds are causing some agricultural damage in portions of the Yale Valley. WDFW owns the Cedar Creek Wildlife Area, an active band-tailed pigeon mineral spring site. Some remnant prairie areas remain, particularly in the eastern watershed, including Spilyeh and Chlatchie prairies in the northeastern area of the subbasin.

This watershed provides habitat for a diverse group of amphibians and reptiles, including the Cope's giant, Pacific giant, Cascade torrent, Larch mountain, and other salamanders; tailed and red-legged frogs and western toad; the ring-necked snake, racer, rubber boa and three species of garter snakes; and the northern alligator lizard.

The Lewis River subbasin still provides a great deal of connectivity for fish and wildlife, and several important habitat and movement corridor areas have been protected. The North Fork and East Fork mainstems are key corridors. Cedar Creek connects the North Fork and East Fork subbasins. Clark County owns substantial riparian habitat throughout much of the lower East Fork in large parcels of designated park land. The Woodland bottomlands, La Center Bottoms Wildlife Area, and East Fork Lewis River Greenway form a long, wide swath of wetland/bottomland habitat that provides key wildlife connectivity and offers many recreational opportunities. The greenway connects to the Gifford Pinchot National Forest and other important habitat areas and is recognized as important by city, county, and state governments. Several north-south tributaries connect the mainstems with large habitat areas. Mason Creek is among one of the most important lower East Fork natal salmon tributaries and constitutes a primary corridor for fish and wildlife. Lockwood Creek plays an important role connecting Missoula Flood wetlands. Some areas along these corridors would benefit from restoration and protection via acquisitions or conservation easements. Other parks also preserve habitat and provide access to nature, including Lake Merwin, Lucia Falls, Lewisville, Daybreak and Paradise Point parks. The northern portion of Battleground State Park connects to Salmon Creek, the watershed to the south. Washington Department of Natural Resources owns thousands of forested acres in the northern and eastern subbasin.

Restoration and Salmon Recovery. Because of remaining salmon populations and tributary habitat, the Lewis River subbasin is expected to play a key role in recovery efforts for Lower Columbia River salmon and steelhead, as detailed in the Lower Columbia Fish Recovery Board's 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. Specific reaches and subwatersheds in the Lewis subbasin have been prioritized based on the plan's biological objectives, fish distribution, critical life history stages, current habitat conditions, and potential fish population performance. North Fork Lewis populations of Chinook and chum salmon will need to be restored to a high level of viability to meet regional recovery objectives. Spring Chinook recovery will occur in the upper North Fork Lewis, while chum recovery and fall Chinook enhancement will occur in the lower North Fork. Maintaining stable populations in the East Fork subbasin is important to recovery efforts. The subbasin's stream reaches have been placed into Tiers (1 through 4), with Tier 1 reaches representing the areas where recovery measures would yield the greatest benefits toward accomplishing the biological objectives. The plan's 6--year habitat work schedule identifies salmon-related habitat restoration needs. The Lower Columbia Fish Recovery Board is working together with key stakeholders to develop a community-based habitat restoration strategy. Restoration projects, partner information and selected watershed plans are available at www.lowercolumbiasalmonrecovery.org.

Active habitat restoration and preservation efforts have been under way for some time now by several nonprofit groups, including Fish First, Friends of the East Fork, Columbia Land Trust, the Lower Columbia Fish Recovery Board, and Clark County. The relatively new East Fork Lewis mitigation bank will re-establish approximately 100 acres of wetland habitat to offset impacts to critical areas in the rapidly growing portions of Clark County and the cities of Battle Ground, Ridgefield and La Center.

The 2010 Clark County Stream Health Report recommends the following priority general action categories for the Lewis River watershed:

- Improve wetlands and riparian forest in the lower watershed.
- Conserve agricultural and forestlands and promote healthy practices.
- Plant trees to increase the amount of forest cover.
- Minimize the impact of surface and groundwater withdrawals in tributary streams.
- Restore stream channels and side channels.
- Work with rural property owners to eliminate pollution sources.

Organizations and Partners — Lewis River Subbasin

City of Vancouver
360-487-8600
www.cityofvancouver.us

Clark County ESA Program
Contact: Bobbi Trusty
360-397-2121 ext. 5268
bobbitrusty@clark.wa.gov
www.co.clark.wa.us/esa/index.html

Clark Public Utilities' StreamTeam
360-992-8585
StreamTeam@clarkpud.com
http://www.clarkpublicutilities.com/index.cfm/our-environment/stream-team/

Clark-Skamania Flyfishers
Contact: Richard Kennon
360-686-3626
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Cowlitz Indian Tribe
360-577-8140
www.cowlitz.org/

Columbia Land Trust
360-696-0131
www.columbialandtrust.org/

Gifford Pinchot Task Force
Contact: David Jennings
360-866-7551
www.gptaskforce.org

Lower Columbia Fish Enhancement Group
Contact: Tony Meyer
360-882-6671
tony@lcfeg.org, www.lcfeg.org

Lower Columbia Salmon Recovery and Watershed Management
(includes partner organization contacts)
Contact: Bernadette Graham Hudson
360-425-1552
www.lowercolumbiasalmonrecovery.org

Northwest Power and Conservation Council
503-222-5161 or 800-452-5161
www.nwcouncil.org/

PacifiCorp
503-813-6666
www.pacificorp.com/index.html

Vancouver Watersheds Council
Contact: Gary Bock
360-852-9189
info@vancouverwatersheds.org
www.vancouverwatersheds.org

Washington Department of Ecology
360-407-6000
www.ecy.wa.gov/ecyhome.html

Washington Department of Fish and Wildlife
360 902-2200
www.wdfw.wa.gov

Washington Department of Natural Resources
360-902-1000
www.dnr.wa.gov/Pages/default.aspx

Washington State University
Clark County Extension – http://clark.wsu.edu/

Watershed Plans, Assessments, and Reports — Lewis River Subbasin

- Clark County Stream Health Report www.co.clark.wa.us/water-resources/stream.html
- East Fork Lewis River Community-Based Habitat Restoration Plan www.lcfrb.gen.wa.us/east_fork_lewis_river_community.htm
- Friends of East Fork Lewis River – Restoration projects in planning or under way: www.eastforklewisriver.org/river-restoration.html
- Gee Creek Watershed Restoration Background Report – includes extensive reference list: http://clark.wsu.edu/natural/geeCreek.html#state
- Landscape Planning for Washington's Wildlife: Managing for Biodiversity in Developing Areas www.wdfw.wa.gov/publications/pub.php?id=00023
- Lewis, Salmon-Washougal Watershed Plan (WRIA 27/28) www.ecy.wa.gov/programs/eap/wrias/Planning/27-28.html
- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Volume

3. Lower Columbia – Clatskanie Subbasin

Jeff Azerrad, Washington Department of Fish and Wildlife, and Lori Hennings, Metro

Includes these named USGS HUC watersheds:
Beaver Creek – Frontal Columbia River
Cathlamet Channel-Columbia River
Kalama River-Frontal Columbia River

The Lower Columbia-Clatskanie subbasin is discussed in two sections below, based on local expertise within watersheds:
3a: Cathlamet Channel – Columbia River watershed
3b: Kalama River – Frontal Columbia River watershed

KEY FACTS: The Lower Columbia-Clatskanie subbasin within the greater Portland-Vancouver region:

- Has a relatively high proportion of agriculture (37 percent, compared to 22 percent in the region)

Lower Columbia–Clatskanie Subbasin (partial) 21,976 acres	
Land cover	**% of Watershed**
Agriculture	37%
Regen. forest	2%
Developed	10%
Low Veg	5%
Tree Cover	29%
Water	18%
Forest Patches*	23%
Jurisdictions	
St. Helens/ Columbia City	6%
Rural	94%

*Tree/regen. forest patches >30 acres.

- Includes 10 percent developed land.
- Has 18 percent water coverage (second only to the Hayden Island-Columbia River watershed), primarily because of its mainstem rivers.
- Has lower than average (29 percent) tree cover, virtually none which is in public ownership.
- Has correspondingly low percentages of forest patches (23 percent) and interior forest habitat (14 percent).
- Has nearly 9,000 acres within the FEMA 100-year floodplain and about 2,900 acres of mapped wetlands.

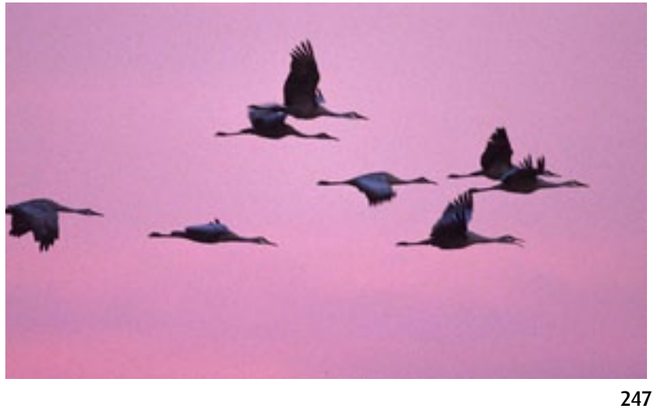
3a. Cathlamet Channel – Columbia River

The Cathlamet Channel-Columbia River subbasin includes the mainstem Columbia River and a number of islands within the river. The land bordering the mainstem and islands generally lies in adjacent subbasins. Its northern (i.e., downstream) extent is near Skamokawa, Washington, north of Cathlamette Island. The watershed's southern (i.e., upstream) boundary is just north of Sauvie Island Wildlife Area and adjacent to the city of St. Helens on the Oregon side, and just north of the Lewis River/Columbia River confluence on the Washington side. Only a small portion of the watershed—just over 7 square miles—lies within the boundary of the greater Portland-Vancouver region.

The river and its floodplain constitute an ecological unit of singular importance because of its size, the diversity of high-quality habitat it provides, and its extremely high value for waterfowl and shorebirds for breeding, feeding, and migration. The area also provides critical connectivity for salmon and wildlife. About one-quarter of the area is terrestrial habitat, made up mostly of cottonwood riparian forest, shrublands, mudflats, and some of the region's most abundant sand bars in a setting of islands, side channels, sloughs, and shoreline. Invertebrate density and diversity are particularly high in such areas, and associated shallow- and deep-water habitats are important to salmon life cycles.

The complex of habitats provides a rich environment for shorebirds, waterfowl, and other wildlife. Waterfowl form large concentrations in the watershed during the winter, including dusky Canada geese, tundra swans, wigeon, mallards, pintails, and cavity-nesting ducks. Osprey nest on artificial platforms and wood pilings. The area also supports migrating sandhill cranes and resident and breeding Canada geese. The riparian and floodplain forested habitat along all the islands host a fair number of breeding songbirds such as song sparrow, Swainson's thrush, common yellowthroat, and other warblers.

Historically, this basin was composed of about 23 percent water (primarily the Columbia River and its large floodplain lakes), 25 percent prairie



and savanna, and about 15 percent each coniferous forest and burned forest. By 2010, about a third of the basin had been converted to agriculture and 7 percent to urban uses (portions of Saint Helens and Woodland). Agriculture consumed about 5,000 acres of prairie and savanna and smaller amounts of conifer and burned forest, and urban cover was derived mostly from converted conifer forest. About 25 percent of the water features have been filled or drained, and 40 percent of the riparian forest has been converted. Almost all prairie and oak habitats have been converted to agriculture.

About 5 miles downstream at the northern edge of the greater Portland-Vancouver region are the two largest islands in the area, Burke and Martin islands, which are separated by Martin Slough. The islands are adjacent to the Woodland bottomlands in the Kalama River-Frontal Columbia River subbasin; together they make up a very large habitat patch. Burke and Martin islands have been largely grazed and converted to croplands. Nonetheless they support significant wildlife populations and are priority habitats under Washington State's Priority Habitats and Species program. Several pairs of bald eagles nest in cottonwoods on Martin Island, with a few additional nests on smaller islands to the south. A colony of less than 20 nesting pairs of great blue heron also have been reported in a cottonwood stand on Martin Island. Although this portion of the watershed does not currently support the federally endangered Columbian white-tailed deer, the area is within the species' historical range and a reintroduction recently occurred on nearby Cottonwood Island.

On the Oregon side of the Columbia River, directly across from Martin and Burke islands, are Deer and Goat islands. Deer Island encompasses more than 3,000 acres and is largely undeveloped. The island contains sloughs and lakes interspersed with grassy marshes and pasture; it is heavily used by wintering waterfowl, bald eagles, purple martins, and a variety of other wildlife. Goat Island is a narrow, forested island 1.5 miles long between Deer Island and the small town of Deer Island, Oregon.

Further south near St. Helens, Sand Island was created in the late 1920s from dredge spoils. Now largely forested, this island provides recreational opportunities but also high-quality bottomland hardwood forest and sand bars that are important to invertebrates fish and shorebirds. Sand Island Marine Park is owned by the State of Oregon and City of St. Helens. The island is accessible only by boat and offers docks, picnic tables, nature trails, and a beach for sunbathing and swimming.

Water quality issues are well documented in the Columbia River (see the watershed assessments listed at the end of this section), and new strategic frameworks are in place to address persistent toxics. The U.S. Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (DEQ), and Washington Department of Ecology all are working to address Columbia River pollutants. EPA released a 2010 toxics reduction action plan in collaboration with Washington and 15 other organizations, and Oregon and DEQ developed plans and legislation to reduce persistent toxics statewide. Major contaminants include DDT, polychlorinated biphenyls (PCB), mercury, flame retardants (such as polybrominated diphenyl ethers, or PBDEs), and other toxics that are causing concerns about ecosystem health, human health, and salmon recovery in the Columbia Basin.

According to the Lower Columbia Fish Recovery Board's 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, all Columbia River salmon and steelhead stocks must, at a minimum, pass through a portion of the Columbia River subbasins twice during the successful completion of their life cycle. However, many Columbia River salmon and steelhead use the lower Columbia River mainstem and estuary extensively, either for juvenile rearing and emigration or adult migration and holding. Thus, lower mainstem and estuary conditions affect all Columbia River salmon and steelhead to some degree. Numerous salmon and steelhead evolutionarily significant units (ESUs) of salmon and steelhead have been listed as threatened or endangered under the Endangered Species Act, and others are proposed for listing. Altered habitat conditions have increased salmon predation, and competition and interbreeding with domesticated or nonlocal hatchery fish have reduced productivity. Fish are harvested in fresh and saltwater fisheries.

The Lower Columbia Fish Recovery Board's 2010 plan documents habitat conditions in the estuary and lower mainstem as a function of the prevailing long-term hydrological conditions, including both ocean and river processes. These hydrological conditions affect all aspects of habitat formation, including sediment movement and turbidity levels, salinity and nutrient concentrations and movement, woody debris recruitment and movement, and production and cycling of organic matter. Water management and channel manipulations, including mainstem hydropower operation, navigation, and flood control dikes, jetty construction and maintenance, and channel dredging, have altered the historical flow and flooding regimes and disrupted habitat-forming processes. Restoration of the historical hydrology, and the habitat-forming processes it controls, will be vital to the restoration of estuary and lower mainstem habitat function and recovery of salmon and steelhead from throughout the Columbia Basin.

The Lower Columbia Fish Recovery Board's 2010 plan proposes the following specific goals, among others:

- Restore subbasin valley floodplain function and stream habitat diversity. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain will restore normal habitat-forming processes and reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing.

- Manage forests to restore watershed processes. The mainstem and estuary are affected by actions in adjacent and upriver subbasins.

- Help address immediate risks with short-term solutions, such as by building spawning channels, constructing side channels or engineered log jams, or remediating contaminants.

- Regulate land use to protect existing and restored watershed processes and habitat conditions. Projections in all areas of the subbasin are for continued growth in the next 20 years.

The Lower Columbia River Estuary Partnership (www.lcrep.org) is a two-state public-private initiative that is one of 28 programs in the National Estuary Program. Using a watershed approach, the Estuary Partnership integrates 28 cities, nine counties, and the states of Oregon and Washington over an area that stretches 146 miles from Bonneville Dam to the Pacific Ocean. The Estuary Partnership's primary responsibility is to implement the voluntary Comprehensive Conservation and Management Plan for the Lower Columbia River. The Estuary Partnership's website includes a mapping tool for enhancement and monitoring projects, including projects on Deer Island, Active habitat restoration efforts by the Lower Columbia Salmon Recovery Board, the Estuary Partnership, and others are under way. Focal projects include riparian restoration, instream projects such as off-channel habitat and log-jams, and attempts to restore flow to a more natural regime.

Organizations and Partners — Cathlamet Channel–Columbia River Subbasin

Columbia Soil & Water Conservation District
503-397-4555
info@columbiaswcd.com

Lower Columbia Fish Enhancement Group
360-882-6671
www.lcfeg.org

Lower Columbia River Estuary Partnership
503-226-1565
www.lcrep.org

Lower Columbia Salmon Recovery and Watershed Management
Bernadette Graham Hudson
360 425-1552
www.lowercolumbiasalmonrecovery.org

Oregon Department of Environmental Quality
503-229-5696
www.oregon.gov/DEQ/

Oregon Department of Fish and Wildlife
503-947-6000
www.dfw.state.or.us/

Washington Department of Ecology
360-407-6000
www.ecy.wa.gov/ecyhome.html

Washington Department of Fish and Wildlife
360 902-2200
www.wdfw.wa.gov

Watershed Plans, Assessments, and Reports — Cathlamet Channel–Columbia River Subbasin

- Campbell, B.H. 2004. Restoring Rare Native Habitats in the Willamette Valley. A Landowner's Guide for Restoring Oak Habitats, Wetlands, Prairies, and Bottomland Hardwood and Riparian Forests. Defenders of Wildlife, West Linn, OR.
- Lower Columbia River Estuary Partnership's online mapping tool (restoration, monitoring, other projects) http://maps.lcrep.org/
- Columbia River Toxics Reduction Plan (2010) www.epa.gov/region10/pdf/columbia/toxics-action-plan_sept2010.pdf
- Comprehensive Conservation and Management Plan for the Lower Columbia River (1999) www.lcrep.org/complete-plan
- EPA's Columbia River Basin website http://www.epa.gov/columbiariver/
- Landscape Planning for Washington's Wildlife: Managing for Biodiversity in Developing Areas (A Priority Habitats and Species Guidance Document) www.wdfw.wa.gov/publications/pub.php?id=00023
- Lower Columbia River and Columbia River Estuary Subbasin Summary (2002) www.cbfwa.org/FWProgram/ReviewCycle/fy2003ce/workplan/020517LowerColEstuary.pdf
- Lower Columbia River Bi-State Water Quality Studies – compilation of studies available online www.lcrep.org/lower-columbia-river-bi-state-water-quality-studies
- Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead (Oregon Lower Columbia Plan; the final bi-state recovery plan is under development and is expected to be adopted in 2013) www.dfw.state.or.us/fish/CRP/lower_columbia_plan.asp
- Lower Columbia River Restoration Prioritization framework (2006) http://www.lcrep.org/habitat-restoration-prioritization-framework
- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (Washington, 2010) www.lcfrb.gen.wa.us
- Oregon Conservation Strategy www.dfw.state.or.us/conservationstrategy/
- Oregon Department of Environmental Quality's priority persistent pollutants website www.deq.state.or.us/wq/SB737/index.htm
- Oregon Department of Fish and Wildlife's Native Fish Conservation Policy (2003) http://dfw.state.or.us/fish/CRP/nfcp.asp
- Protocols for Monitoring Habitat Restoration Projects in the Lower Columbia River and Estuary (2009) www.lcrep.org/sites/default/files/pdfs/
- The Columbia River Basin State of the River Report for Toxics (2009) http://www.epa.gov/columbiariver/
- U.S. Fish and Wildlife Services' Bald Eagle web site www.fws.gov/oregonfwo/Species/Data/BaldEagle/default.asp
- USGS water quality monitoring information http://wa.water.usgs.gov/cgi/realtime.data.cgi
- Washington Comprehensive Wildlife Conservation Strategy www.wdfw.wa.gov/conservation/cwcs

3b. Kalama River–Frontal Columbia River

The Kalama River-Frontal Columbia River subbasin drains only 15 square miles within the boundary of the greater Portland-Vancouver region. The Kalama River originates in the low foothills of the southwest Washington Cascades and flows into Lake River, which drains northward from Vancouver Lake into the Columbia River. Lake River also receiving water from Flume and Whipple creeks. Tributary streams are primarily low-gradient meandering systems within Clark County. Vancouver Lake and Lake River are within the historical Columbia River floodplain and are tidally influenced. Burnt Bridge Creek flows into Vancouver Lake and is centered in the city of Vancouver. The watershed includes the Upper Salmon, Lower Salmon, Lake River-Frontal Columbia River, Burnt Bridge Creek, and Gee Creek subwatersheds.

The watershed includes the majority of the urban land areas in the Washington portion of the greater Portland-Vancouver region, including Vancouver, Battle Ground, Hazel Dell, and Orchards. Land use is predominantly privately owned timber and agriculture in the upper and middle portions of the watershed and rural and urban development in the lower portion of the watershed. Much of the historical wetland and floodplain habitat has been converted to urban uses, although some large areas are preserved. The human population in the watershed is expected to double by 2020, primarily in Vancouver and Battle Ground; this will increase pressure to convert forest and rural lands to high-density suburban and urban uses.

The Salmon Creek watershed lies along the Pacific Flyway and is critical to migrating and breeding birds. Meriwether Lewis and William Clark camped near the mouth of Salmon Creek on November 4, 1805. Clark purportedly did not sleep well because of the noise made by swans, geese, ducks, and other birds nearby.

The watershed's stream health and fish and wildlife habitat have been affected by urban and rural development, agricultural practices, transportation corridors, and timber harvest. Salmon Creek currently exceeds state and federal standards for water temperature, turbidity, and coliform bacteria, and tributaries also have problems with dissolved oxygen and pH. Floodplain connectivity has been lost and streams channelized. High peak flows and low summer flows are key urban issues, so development practices and stormwater management are important tools in managing future urban growth. Clark Public Utilities, Clark County, and the Washington Department of Ecology have entered a joint agreement to develop and maintain an effective management strategy for the watershed's groundwater resources, which supply most of the water to residents and businesses.

Habitat loss, fragmentation and invasive species are of particular concern in the Salmon Creek watershed. Native oak habitats and prairies are threatened by Scot's broom. Purple loosestrife and knotweeds affect wetlands and riparian habitats. Despite these difficulties, substantial habitat remains and much has been protected. The Ridgefield lowlands extend north-south through most of the western portion of the watershed and

continue northward to the Lewis and Kalama River-Columbia Frontal River subbasins. The area contains a mosaic of seasonal and permanent wetlands, grasslands, upland forest, riparian corridors, and cropland. The watershed also includes remnant stands of Oregon white oak. The Washington Department of Natural Resources identifies Mankas Prairie, a remnant prairie and oak savanna habitat area in the northeastern portion of the watershed, as a heritage site, and the upper reaches of Weaver Creek include an important mature mixed forest-wetland complex.

Washington's Priority Habitats and Species program identifies the Ridgefield lowlands, Salmon Creek, and major low-lying tributaries as high-quality habitat for breeding and overwintering bald eagles and waterfowl, including winter concentrations of dusky Canada, Canada, and white-fronted geese, and lesser sandhill cranes, and wintering and breeding ducks. Agricultural lands in the lowlands contribute to habitat value for these species. The area also supports a diverse array of amphibians, reptiles, and mammals. The sloughs, wetlands, and riparian areas in the bottomlands around the city of Woodland support cavity-nesting ducks, and this area also is used by migrating sandhill cranes. The riparian and floodplain forested habitat hosts a variety of breeding passerines, including song sparrow, Swainson's thrush, and common yellowthroat. The forested portion of the watershed northeast of Woodland forms the edge of the Mt. Saint Helens elk herd's wintering range. Although this portion of the Kalama watershed does not currently support the federally endangered Columbian white-tailed deer, the area is within the species' historical range and a reintroduction recently occurred on nearby Cottonwood Island.

The U.S. Fish and Wildlife Service established the Ridgefield National Wildlife Refuge Complex in 1965, with a total of 5,217 acres set aside for wildlife and habitat. Washington Department of Fish and Wildlife owns another 2,730 acres immediately to the south, in the Shillapoo Wildlife Area. The Port of Vancouver also owns some important preservation and mitigation areas. Numerous other habitat areas are protected through a variety of ownerships, including holdings along Whipple Creek, Salmon Creek Greenway, and Burnt Bridge Greenway.

Several key wildlife movement corridors connect to the Columbia River and adjacent watersheds. The lowlands connect in all directions: west to the Columbia River, north and south to other watersheds, and to important wildlife areas such as Burnt Bridge, Cougar Canyon, Whipple, and Flume creeks. Upper Salmon Creek provides a corridor through urban and agricultural areas to forest in the upper basin.

The Lower Columbia Fish Recovery Board's 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan provides a detailed salmon-oriented characterization of Salmon Creek subbasin. Historically, the Salmon Creek subbasin supported thousands of fall Chinook, winter steelhead, chum, and coho. Salmon and steelhead numbers have declined to only a fraction of historical levels. Extinction risks are significant for all of these species, but the populations in the Salmon Creek subbasin are not considered primary for population recovery under the Lower Columbia Fish Recovery Board's plan; however, meeting regional recovery goals will require that the Salmon Creek populations be maintained at their current level of viability. Although no single threat is responsible for the declines in salmon and steelhead viability, loss of tributary habitat quality and quantity accounts for the largest relative impact. Key habitats have been isolated or eliminated as a result of dredging, channel modifications, diking, filling, and draining of floodplains and wetlands. Hydropower operation on the Columbia River mainstem has altered flows, habitat, and migration conditions. Altered habitat and competition and interbreeding with hatchery fish have reduced productivity.

The Lower Columbia Fish Recovery Board's 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan identifies growth management, forest, floodplain, and riparian restoration and preservation and restoration of watershed processes and habitat conditions as immediate priorities for salmon recovery and identifies reach-specific restoration activities to improve fish habitat. The Clark County 2010 Stream Health Report recommends the following priority general action categories for this watershed: increase infiltration and retention of stormwater runoff, restore stream and side channels in the middle and upper watershed, implement development regulations to minimize impacts, minimize the impact of surface and groundwater withdrawals, promote good septic system maintenance practices, and work with property owners to eliminate pollution sources.

Washington's Comprehensive Wildlife Conservation Strategy identifies specific areas and actions to help sensitive habitats and wildlife species. A recovery plan is in place in this watershed for several threatened or endangered prairie species, including Fender's blue butterfly, Icaricia icarioides fenderi (endangered); Willamette daisy, Erigeron decumbens var. decumbens (endangered); Bradshaw's lomatium, Lomatium bradshawii (endangered); Kincaid's lupine, Lupinus sulphureus, ssp. kincaidii (threatened); and Nelson's checkermallow, Sidalcea nelsoniana (threatened).

Active habitat restoration and preservation efforts have been under way for some time now by several nonprofit groups, including the City of Vancouver, Clark County, Clark Public Utilities, the Port of Vancouver, and Lower Columbia Fish Recovery Board. The Salmon Creek Watershed Council provides a forum for citizens and organizations residing in Clark County to participate and partner for "on-the-ground" restoration, water quality, and advocacy. Clark County's StreamTeam organizes restoration projects in the Salmon Creek Greenway, and the Vancouver Watershed Council is similarly engaged in plantings, cleanups, and community education. Salmon Creek runs through the Washington State University campus, and students, professors and partners are engaged in restoration and watershed education.

Organizations and Partners — Kalama River-Frontal Columbia River Watershed

City of Vancouver
360-487-8600
www.cityofvancouver.us

Clark Conservation District
Denise Smee
360-883-1987
dsmee@clarkcd.org
www.clarkcd.org/index.html

Clark County ESA Program
Contact: Bobbi Trusty
360-397-2121 ext. 5268
bobbitrusty@clark.wa.gov
www.co.clark.wa.us/esa/index.html

Clark County Parks & Recreation
360-487-8311
parksrec@ci.vancouver.wa.us

Clark Public Utilities' StreamTeam
Lisa Beranek
360-992-8585

StreamTeam@clarkpud.com
http://www.clarkpublicutilities.com/index.cfm/our-environment/stream-team/

Lower Columbia Fish Enhancement Group
Tony Meyer
360-882-6671
tony@lcfeg.org
www.lcfeg.org

Lower Columbia Salmon Recovery and Watershed Management
Bernadette Graham Hudson
360-425-1552
www.lowercolumbiasalmonrecovery.org

Salmon Creek Watershed Council
Bianca Streif
360-721-3816
Bianca.streif@salmoncreekwatershed.org
www.salmoncreekwatershed.org

Vancouver Lake Watershed Partnership
Loretta Callahan
360-759-4479
loretta.callahan@ci.vancouver.wa.us
www.ci.vancouver.wa.us/PublicWorks/vancouverlake/index.htm

Vancouver Watersheds Council
Gary Bock
360-852-9189
info@vancouverwatersheds.org
www.vancouverwatersheds.org/

Washington Department of Ecology
360-407-6000
http://www.ecy.wa.gov/ecyhome.html

Washington Department of Fish and Wildlife
360-902-2200
www.wdfw.wa.gov

Clark County Extension (WSU)
Jennifer Naas
360-397-6060
jenifer.naas@clark.wa.gov
http://clark.wsu.edu/

Watershed Plans, Assessments, and Reports — Kalama River-Frontal Columbia River Watershed

- Clark County Water Quality Division. 1995. Burnt Bridge Creek Watershed Plan: Clark County watershed protection program. Vancouver, WA: the Division.
- Clark County Water Resources Division. 1997. Lakeshore & Salmon Creek Watershed Areas Plan Clark County watershed protection program. Vancouver, WA: the Division.
- Clark County Stream Health Plan www.co.clark.wa.us/water-resources/stream.html
- Clark County stream monitoring information http://www.co.clark.wa.us/water-resources/monitoring/streammonitor.html
- Gee Creek Watershed Restoration Background Report http://clark.wsu.edu/natural/geeCreek.html#state
- Habitat Conservation Plan information for Washington state-owned and managed wildlife areas www.wdfw.wa.gov/lands/wildlife_areas/hcp/
- Lewis, Salmon-Washougal Watershed Plan (WRIA 27/28) www.ecy.wa.gov/programs/eap/wrias/Planning/27-28.html
- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (2010) www.lcfrb.gen.wa.us
- Overview of the Lewis and Salmon-Washougal Water Resources Management Program Rules www.ecy.wa.gov/biblio/0811006.html
- Shillapoo Wildlife Area management plan www.wdfw.wa.gov/lands/wildlife_areas/management_plans/
- U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf

4. Lower Columbia – Sandy Subbasin

Includes these named USGS HUC watersheds:
Middle Sandy River
Washougal River
Lower Sandy River
City of Washougal-Columbia River

The Lower Columbia-Sandy subbasin is discussed in three sections below, based on local expertise within watersheds:
4a: Sandy River watershed
4b: Washougal River watershed
4c: City of Washougal-Columbia River watershed

The Lower Columbia-Sandy subbasin is the region's third largest watershed and makes up 12 percent of the greater Portland-Vancouver region.

KEY FACTS: The Lower Columbia-Sandy subbasin within the greater Portland-Vancouver region:

- Ties with the Lewis subbasin for the highest proportion of tree cover in a watershed: 64 percent.
- Has forest patches that cover 63 percent of the subbasin, suggesting a low degree of forest fragmentation.
- Is 26 percent publicly owned. This is higher than any other watershed in the region and represents nearly one-quarter (23 percent) of all publicly owned lands throughout the region.
- Has nearly 20,000 acres within FEMA 100-year floodplains and 9,100 acres of mapped wetlands.
- Is about one-quarter publicly owned.

4a. Sandy River

Steve Wise, Sandy River Basin Watershed Council

The 315,000-acre (500-square-mile) Sandy River basin is a dynamic and diverse glacial river system that spans 6,000 feet in elevation. It supports habitat types from Columbia River floodplains through subalpine forest. The Sandy and its major subwatersheds—the Salmon, Zigzag, and Bull Run rivers—are a regionally significant refuge for federally listed wild salmon and steelhead in the Lower Columbia. Relatively intact landscapes serve as habitat for diverse species of plants and animals while also supporting intensive human use and drinking water for much of the Portland area. Restoration of free-flowing conditions via removal of Marmot Dam in 2007 set the stage for a basin-scale, collaborative effort to protect and restore the Sandy for salmon habitat and ecological values.

Lower Columbia-Sandy Subbasin (partial) 217,161 acres	
Land cover	**% of Watershed**
Agriculture	12%
Regen. forest	5%
Developed	6%
Low Veg	7%
Tree Cover	64%
Water	5%
Forest Patches*	63%
Jurisdictions	
Camas	2%
Metro UGB**	2%
Sandy	<1%
Vancouver	2%
Washougal	2%
Rural	92%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB.

Geography and Landform

The Sandy River flows 56 miles from glaciers higher than 6,000 feet on the southwest side of Mt. Hood to the river's confluence with the Columbia near Troutdale, Oregon, giving the watershed a total stream network of 680 stream miles. The river runs through unconsolidated lahars (i.e., volcanic debris flows) that allow significant channel migration during frequent high-water events. The Lower Sandy subwatershed, which is entirely within the greater Portland-Vancouver region is 72 square miles, and the Middle Sandy subwatershed, which is partially within the region, is 54 square miles. Together they drain almost half the river's length, from River Mile 30 to the river's mouth.

Below RM 30, which is the former site of Marmot Dam, the Sandy River Gorge envelops long, steep rapids. Below Revenue Bridge (at RM 24), the Sandy bends between high bluffs rising more than 200 feet. The Bull Run River, which is located outside the greater Portland-Vancouver region

but serves as Portland's water supply, joins the Sandy at Dodge Park (RM 18). Between Dodge and Oxbow parks (at RM 13), another gorge limits road access. The Sandy slows and meanders through Oxbow Regional Park and Dabney State Park (RM 6) and collects the significant tributaries Gordon, Trout, and Beaver creeks. North of Interstate 84, the Sandy River Delta, which is owned and managed by the U.S. Forest Service, totals 1,500 acres at the river's confluence with the Columbia.

Streamflow in the Sandy River ranges from hundreds to tens of thousands of cubic feet per second within a single reach. Intense rain-on-snow events cause dramatic flows, movement of glacial and large woody debris, bank erosion, and channel migration, particularly in late winter.

Native American Use

Native Americans used the Sandy River for hunting and fishing, and the river formed part of a trail system between the Columbia and areas to the east. Lewis and Clark recorded a Clackamas Indian village near the current site of Portland International Airport. Portions of the upper basin are currently co-managed with the Confederated Tribes of Warm Springs for harvest of traditional foods.

Modern Settlement

The Sandy was a key link in modern settlement transportation routes. Wagon trains first crossed the area in 1840, and the Barlow Road officially opened in 1846. By the early 1900s railroad service made the Sandy a production zone for timber and gravel. The Mt. Hood Loop Highway's completion in the 1920s created additional access, and in 1952 the highway became part of U.S. Highway 26. The Historic Columbia River Highway follows the Sandy's lower reaches. Since its construction in the 1950s, Interstate 84 has crossed the Sandy at Troutdale.

Timber harvest began in the lower Sandy in the 1850s and had intensified by the early 20th century. Forest Service roads expanded beginning in the 1950s, eventually totaling more than 550 miles. Logging in floodplain and riparian areas converted mixed fir, hemlock, and cedar conifer forests to higher concentrations of alder. This reduced shade and recruitment of natural large wood and increased sediment loads into streams.

Sandy River fish have been harvested since the mid-1800s. By the 1870s, harvesting and habitat modification had caused declines in salmon and steelhead populations. Spring Chinook harvest peaked on the Columbia at 43 million pounds in 1873. By the 1940s, the harvest of all Columbia River salmon species was substantially depressed.

Historical and Current Vegetation

Historically, the Sandy River subbasin was covered almost entirely by coniferous forest (82 percent) and burned forest (16 percent), making it the most heavily forested basin in the greater Portland-Vancouver region. Virtually no prairie or oak was recorded in the General Land Office surveys. Increases in prairie and oak in the ecological system life form (ESLF) data created for the U.S. Geological Survey's (USGS) Gap Analysis Program probably are due to misclassification. About 20 percent of the basin was converted to agriculture and 10 percent to urban uses (portions of Gresham, Sandy, and Troutdale), mostly within the greater Portland-Vancouver region.

Much of the Sandy Basin remains forested. Although the lower Sandy is dominated by young, privately owned forest, more than half the basin's forest is more than 150 years old, particularly on federal lands in the Bull Run, Salmon, and upper basin wilderness. Approximately 74 percent of the basin, including nearly the entire upper basin, is managed by the U.S. Forest Service-Mt. Hood National Forest (approximately 70 percent) and the Bureau of Land Management (BLM). The Salmon River is a tier-one watershed under the Northwest Forest Plan and is managed for wild salmon and steelhead, bull trout, and resident fish. About 3 percent of the watershed is owned by the Portland Water Bureau and other local, state, and regional governmental entities.

In contrast with the upper watershed, the portion of the Sandy River watershed that is within the greater Portland-Vancouver region (approximately 23 percent of the watershed) is primarily privately owned and includes the cities of Troutdale, Gresham, and Sandy. Private conservation ownership totals about 2,000 acres, which are concentrated along the mainstem Sandy. Other private ownership is a mixture of agriculture (especially nurseries), small lot forest, and residential land. Most streambanks along the middle and lower Sandy are privately owned, with residential subdivisions dotting sections along the upper and middle river. Developed neighborhoods, manufactured home parks, and several private summer camps are located within the lower basin. Agriculture is the designated land use for about 15,000 acres (5 percent of the watershed), with rural residential and other zoning designations at 13,545 acres (4 percent). Less than 10% are classified as urban.

Less than 5 percent of the Sandy Basin lies within the urban growth boundary. However, the human population in most areas of the Sandy Basin has increased substantially in recent decades, although it still totals less than 100,000. From 1980 to 2000 alone, the combined populations of Troutdale, Sandy, and Gresham grew 162 percent.

Recreation is a major human use and important economic driver within the basin. Significant portions of the upper basin are managed for recreation, and the Sandy provides opportunities for angling, hiking, swimming, boating, kayaking, biking, skiing, and nature study. Salmon and steelhead in the Sandy support popular sport fisheries that account for a large percentage of regional angling opportunities.

Regional Significance

Despite significant changes in land use and other human alterations, the Sandy Basin supports numerous sensitive species. Evaluations by state and federal agencies and The Nature Conservancy has identified as many as 90 species of concern that are or potentially are present in the Sandy.

The Sandy's vegetative cover falls into 12 cover type categories, as defined by the Oregon Natural Heritage Program's Oregon Gap Project. The Sandy Delta alone has seven habitat types, including forest, savanna, upland and wetland forest scrub-shrub, and upland and wetland meadow.

The Sandy River and its tributaries support a diverse assemblage of 22 native and 19 introduced fish species, including Lower Columbia River spring and fall Chinook salmon and coho salmon and winter steelhead. Other native fish species of ecological or cultural significance that may be found in the basin include coastal cutthroat trout, Pacific lamprey, mountain whitefish, smelt, and resident rainbow trout, bull trout, and white sturgeon. The majority of the introduced species in the basin are found in the lower river near the Sandy Delta's slower, warmer flows. Pacific smelt, which once were a popular game fish, were listed as threatened in 2010.

The Sandy and its tributaries represent anchor habitat for federally listed Chinook and coho salmon and steelhead. The lower mainstem reaches of Sandy River are particularly important for recovery of late-run fall Chinook, while upper basin reaches are critical for coho recovery. The Sandy River also provides key habitat for native spring Chinook and winter steelhead. The Sandy's location downstream of the federal dams on

the mainstem Columbia River gives the basin's populations added significance. The Lewis River in Washington (which also is within the greater Portland-Vancouver region) is the only other stream that supports a self-sustaining native fall Chinook population from the Lower Columbia River ESU, and the Clackamas River is the only other home to a self-sustaining population of native Lower Columbia River coho. The Sandy River populations of these threatened native fish play a critical role to successful recovery in the lower Columbia Basin.

Historical runs of as many as 15,000 coho, 20,000 winter steelhead, 10,000 fall Chinook, and 10,000 spring Chinook have fallen to below 10 percent of their historical levels. Wild steelhead returns above Marmot Dam averaged less than 1,000 between 1981 and 2006, with only around 600 wild winter steelhead returning in 2005 and 2006. An average of 1,900 wild Chinook returned between 1999 and 2007. Chum salmon are considered extirpated in the Sandy.

The Sandy hosts several rare, threatened, or endangered birds, including the iconic northern spotted owl, predators such as the bald eagle and northern goshawk, and greater sandhill crane. Great blue herons, eagles, and osprey nest in the lower Sandy, and the river provides migratory habitat for neotropical songbirds and waterfowl. Oregon spotted salamanders and Cascades and northern red-legged frogs are among eight amphibians in the basin. The Sandy Delta hosts numerous rare, threatened, or endangered species, including eight bird species, two amphibian species, and at least two plant species (and possibly 19 more).

Mammal species that live in the basin include Roosevelt elk, black-tailed deer, black bear, coyote, cougar, bobcat, otter, raccoon, beaver, mink, and wolverine. The habitats adjacent to the rivers and tributaries provide important travel corridors for wildlife movement and dispersal.

Remaining wetlands total slightly less than 6,500 acres, equal to 2 percent of the basin. Wetlands are most prevalent in the lower and middle Sandy River watersheds, which have 1,534 and 1,185 acres of wetlands, respectively.

Undammed: Reversing Historical Impacts

As recently as 2008, passage for migrating fish was blocked in three areas for water supply, hydropower generation, and hatchery production. Recent actions have begun to restore connectivity and function in historically interrupted segments of the Sandy.

The City of Portland has managed the Bull Run watershed (28 percent of the Sandy Basin's area) for water supply since 1892. The headworks dam, built in 1922, effectively blocked all fish passage to the upper Bull Run and raised temperatures in the lower river. In 2008, the Portland Water Bureau's adoption of a Habitat Conservation Plan committed the City of Portland to investing $93 million in habitat restoration and protection actions over 50 years to compensate for habitat blocked by drinking water dams.

Portland General Electric's Bull Run Hydropower Project built passage-blocking dams at Marmot on the middle Sandy River in 1906, and on the Little Sandy River, a Bull Run River tributary, to divert water for power production. PGE is voluntarily decommissioning the Bull Run project and removed the Marmot and Little Sandy dams in 2007 and 2008, respectively. These efforts largely restored the Sandy to a free-flowing condition, from the headwaters to the river's confluence with the Columbia River.

Until 2010, when a program began to pass wild fish, a state fish hatchery blocked passage for wild fish to the upper 10 miles of on Cedar Creek. On the Sandy Delta, a small dam constructed in 1932 separates about 1 mile of the historical main channel to the northeast from the current main channel. This dam is scheduled for removal in coming years.

What Are the Important Protected Areas?

The Sandy Basin incorporates portions of the Columbia Gorge Scenic Area (at the Sandy Delta), state and federal wild and scenic waterways, federal wilderness, and numerous county, city, and Metro parks. More than 58 miles of streams within the basin are designated wild, scenic, or recreational under the federal Wild and Scenic Rivers Act; together, these designations protect 18,626 acres of land within these corridors. The lower Sandy River Gorge is one of the great conserved areas near a major metropolitan region.

Protection of the lower Sandy began in 1970 when the Diack family donated 156 acres to The Nature Conservancy. A 12.5-mile segment of the Sandy from Dodge Park downstream to Dabney State Recreation Area was designated a federal Wild and Scenic River and a State Scenic Waterway in 1972, and 58.4 stream miles in the basin were designated wild, scenic, or recreational in 1988 under the Wild and Scenic Rivers Act. Since 1995, Metro has acquired 1,300 acres of natural areas in the lower Sandy, adding to nearly 500 acres owned by The Nature Conservancy and about 14,000 acres owned by the BLM. Metro also manages the 1,200-acre Oxbow regional park, which is used for fishing, camping, and hiking, and education. Other state, municipal, and county parks are spread throughout the Sandy Basin, from Lewis and Clark State Park near the mouth to the upper tributaries.

Land transfers associated with the decommissioning of Marmot Dam in the middle Sandy added 1,500 acres to BLM's landholdings that will be managed as a BLM Area of Critical Environmental Concern.

Important Threats

HATCHERY FISH

Marmot Dam allowed separation of wild and hatchery fish. Since its removal, the percentage of hatchery-origin spawners has increased dramatically. In 2010, 70 percent of surveyed spawners on average were hatchery fish, and in some streams the number was 100 percent in some streams; this far exceeds the Oregon Department of Fish and Wildlife's target of 10 percent.

STREAM TEMPERATURE

Stream shading is generally good in the middle and upper reaches of the Sandy River. Agricultural and residential development activities have altered or disturbed riparian habitat areas. The effects of those alterations are particularly marked in the lower river: TMDLs are in place for temperature on the lower Sandy mainstem, Gordon Creek, and Beaver Creek (which also has a TMDL for bacteria).

INVASIVE SPECIES

Noxious weeds occur throughout much of the Sandy Basin. Japanese and giant knotweed, English and Irish ivy, Scot's broom, Himalayan blackberry, garlic mustard, and butterfly bush all colonize riparian areas disturbed by logging or development and are widespread in the basin.

DEGRADED STREAM REACHES

Following a large flood in 1964, the U.S. Army Corps of Engineers and local communities joined efforts to channelize parts of the Salmon, Zigzag, and Sandy rivers and Still Creek. The work affected the timing, variability, and duration of floodplain and wetland inundation in the area and led to loss of spawning gravel from some reaches. The now degraded reaches were especially important for winter-rearing juvenile steelhead and Chinook salmon.

Alteration of stream channels also altered native vegetation in riparian areas. On the Sandy Delta and elsewhere, wetlands were drained and filled and forests cleared for agricultural production. Alteration of Columbia River flows for hydropower production also largely eliminated

seasonal floods on the delta, to which cottonwood gallery forests and associated vegetation were adapted.

Current Conservation Efforts

In 1999, a coalition of governmental and non-governmental organizations formed the Sandy River Basin Partners to restore ESA-listed salmon and steelhead through a collaborative, science-based approach. The partnership includes more than a dozen organizations representing non-governmental organizations, including conservation and fishing groups, and government agencies. The Sandy River Basin Partners have developed numerous studies and reports that document existing conditions, address limiting factors for species, and provide a framework for restoring habitat for ESA-listed fish species in the Sandy Basin.

The Sandy River Basin Partner's Anchor Habitat Assessment and Long-Term Restoration Strategy specifically identified the Sandy River mainstem corridor as a key area for habitat restoration. The area is of very high ecological value given the full life history needs of the fish species and serves as an important rearing and migratory corridor for juvenile and adult salmon and steelhead.

The Oregon Department of Wildlife's Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead identifies the Sandy as key to recovery of the Lower Columbia River salmon and steelhead ESUs. The recovery plan cites impaired physical habitat quality and habitat access for the Sandy populations of coho, spring and fall Chinook, and winter steelhead, with key threats being related to stream cleaning, straightening and channelization, diking, wetland filling, and lack of large wood. Recommended actions include restoring off-channel habitat and access to such habitat, particularly side channels, wetlands, and floodplains.

The Sandy Basin Vegetation Restoration Coalition, led by the Nature Conservancy, has organized a concerted effort to target priority areas for restoring large, contiguous areas of riparian and upland vegetation. A basin-wide early detection and rapid response program is under way, and participating organizations and volunteers continue plantings on both public and private lands.

Through 2010, the USDA Forest Service had removed almost half the miles of forest road in the watershed.

Watershed Plans, Assessments, and Reports — Sandy River Basin

The Sandy River Basin Partners Characterization Report, Anchor Habitat Assessment, Short-term and Long-Term Aquatic Habitat Restoration Strategies, and other reports are available on line at:
http://www.sandyriverpartners.org/background.html
The following plans prioritize actions in the lower Sandy River:

- Oregon Department of Fish and Wildlife (ODFW). 2010. Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead http://www.dfw.state.or.us/fish/CRP/lower_columbia_plan.asp
- Bull Run Water Supply Habitat Conservation Plan http://www.portlandonline.com/water/index.cfm?c=46157
- Oregon Department of Environmental Quality Sandy River TMDL Analysis http://www.deq.state.or.us/wq/tmdls/sandy.htm
- BLM Sandy River Basin Integrated Management Plan http://www.blm.gov/or/districts/salem/plans/files/SRBIMP_Chapters34.pdf
- Salmon and Steelhead Runs and Related Events on the Sandy River Basin: A Historical Perspective http://www.portlandgeneral.com/community_environment/initiatives/protecting_fish/sandy_river/river_history.aspx
- Sandy River Water Trail http://www.ci.sandy.or.us/index.asp?Type=B_LIST&SEC={A61B8AFD-E527-4B75-AB89-C3DF2CA15D57}
- Sandy Basin Vegetation Restoration Coalition Plan (SBVRC). The Nature Conservancy, Portland, OR

Organizations and Partners — Sandy River Basin

General inquiries about the Sandy River Basin Partners can be directed to Chair Janet Senior at Portland Water Bureau: 503-823-4287. Other SRBP contacts are:

- Clackamas County — www.co.clackamas.or.us Steve Hanschka
- Columbia Land Trust — www.columbialandtrust.org Dan Roix
- Freshwater Trust — www.thefreshwatertrust.org/ Mark McCollister
- Metro — www.oregonmetro.gov Brian Vaughn
- Mt. Hood National Forest, USDA Forest Service — www.fs.fed.us/r6/mthood Lisa Norris
- Multnomah County — www.co.multnomah.or.us Roy Iwai
- National Marine Fisheries Service — www.nmfs.noaa.gov Ben Meyer
- Nature Conservancy — nature.org/wherewework/northamerica/states/oregon Dan Bell
- Northwest Steelheaders — www.sandysteelheaders.org Mike Myrick
- Oregon Department of Fish and Wildlife — www.dfw.state.or.us Todd Alsbury
- Portland Water Bureau — www.portlandonline.com/water Steve Kucas
- Sandy River Basin Watershed Council — www.sandyriver.org Steve Wise
- USDI Bureau of Land Management — www.blm.gov/nhp Bruce Zoellick
- Western Rivers Conservancy — www.westernrivers.org Josh Kling

Other groups working in the Sandy include:

U.S. Forest Service Columbia Gorge National Scenic Area
902 Wasco Street, Suite 200, Hood River, OR 97031 (541) 308-1700

SOLV (Steve Kennett)
5193 NE Elam Young Pkwy, Suite B, Hillsboro, Oregon 97124
www.solv.org; 503-844-9571 ext. 318

Ecotrust Whole Watershed Restoration Initiative (Kate Carone)
721 NW Ninth Ave., Ste. 200 Portland, OR 97209
www.ecotrust.org/wwri; 503.467.0814

Friends of Mt. Hood
http://www.friendsofmounthood.org/fmh.htm

Friends of Beaver Creek
FriendsofBeaverCreek@gmail.com
http://sites.google.com/site/friendsofbeavercreek/

Friends of Sandy River Delta
http://groups.yahoo.com/group/SRD_MUD/

4b. Washougal River

Lori Hennings, Metro and Jeff Azerrad, Washington Department of Fish and Wildlife

The Washougal River subbasin drains 160 square miles within the region. The majority of the watershed lies within Skamania County; the Washougal River enters Clark County and drains to the Columbia River near the city of Camas. The headwaters are in Gifford Pinchot National Forest. The upper mainstem Washougal flows through a narrow, deep canyon until it reaches Salmon Falls, about 15 miles upstream from the Columbia, where the river valley begins to widen. The lower 2 miles of the Washougal River are within the Columbia River floodplain. The highest point in the watershed is approximately 3,200 feet. Smaller watersheds within the subbasin include Lacamas Creek and the lower, middle, and west forks of the Washougal River. Other tributaries include the Little Washougal River and Shanghai, Cougar, Vogel, Hagen and Canyon creeks.

The majority of the watershed is privately owned forest that is steeply sloped and managed for timber harvest. Commercial, industrial, urban, and agricultural land uses are generally limited to the lower watershed, which includes the cities of Washougal and Camas. The Lacamas Creek drainage includes a substantial amount of rural residential and agricultural land uses, as well as the two cities. The westernmost portion of the Washougal subbasin lies within the expanding Vancouver metropolitan area. Urbanization is expected to increase in the subbasin, primarily through eastward expansion of the Vancouver urban region. In 2000 the human population was 36,600, but the population is expected to increase to 92,800 by 2020.

Historically, the Washougal Basin was composed of 87 percent conifer forest and burned forest, making it the third most heavily forested basin in the region. Oak and prairie or savanna covered about 4 percent and 5 percent, respectively. Today, the basin remains forested, with 15 percent in agriculture and some urban areas (i.e., portions of Camas, Vancouver, and Washougal). Agriculture and urban cover consumed roughly equal portions of conifer forest, burned forest, and oak. Although oak and prairie never were abundant historically, overall losses have been 95 percent and 99 percent, respectively.

Past natural and human disturbances have had significant impacts on fish and wildlife habitat conditions within the subbasin. The Yacolt Burn, forestry practices, dams, roads, mining, residential and industrial development, water withdrawals, and industrial pollution from paper mills have all altered habitat conditions. Floodplain connections have been lost along portions of the mainstem Washougal and its major tributaries, and aquatic and upland habitat in the lower watershed is fragmented. Nonetheless, the middle and upper portions of the watershed are well-forested and provide water and fish and wildlife habitat.

Water quality issues are concentrated primarily in the Lacamas watershed, with various streams 303(d) listed for temperature, pH, dissolved oxygen, and, to a lesser degree, fecal coliform. Lack of riparian vegetation is a key contributor to high water temperatures. Total maximum daily loads for these pollutants have not yet been established.

Lacamas Creek below Round Lake has low dissolved oxygen and high water temperature. In the 1970s, Lacamas Lake had excessive phosphorous loading. The Lacamas Lake Restoration Project assisted many landowners in adopting agricultural best management practices in order to correct this problem. Even though specific areas of the subbasin have excess nutrients, overall nutrient levels are believed to be limited because of the lack of salmon carcasses. In the 1960s a paper mill discharged sulfite-laden wastewater into the Camas Slough, but that water is now treated at Lady's Island facilities; sediments, though, may still be polluted. Two salmon hatcheries, Skamania and Washougal, may release potentially harmful effluent containing antibiotics and pathogens. Elevated turbidity may be a problem in Little Washougal, Jones, and Dougan creeks.

As with other watersheds, the Washougal subbasin has salmon issues. Historically, passage for most anadromous fish (except steelhead) was blocked at Salmon Falls until the 1950s, when a fish ladder was built there. Anadromous fish currently can access a few miles upstream of Salmon Falls but are blocked at Dougan Falls, although summer steelhead can negotiate the falls. Historically, the Washougal subbasin supported thousands of fall Chinook, chum, coho, and summer and winter steelhead. Those numbers have been drastically reduced, and today all of these species are listed under the federal Endangered Species Act. A recovery plan was developed in 2010, the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. The plan is the result of a collaborative planning initiative coordinated by the Lower Columbia Fish Recovery Board, with a number of planning partners.

Washington's Comprehensive *Wildlife Conservation Strategy* identifies areas and actions to help sensitive habitats and wildlife species, and the Department of Natural Resources identifies several important natural areas in the Washougal subbasin. The Green Mountain Biodiversity Area includes approximately 300 acres of mature forest that serves as a stronghold for black-tailed deer and an important remnant habitat located within rapidly expanding development. Lacamas Lake Bottoms provides key habitat for cavity-nesting ducks and other waterfowl. The Camas Biodiversity Area includes mature timber that supports high numbers of Vaux's swifts surrounding Dead Lake. The headwater of North Fork Lacamas Creek has abundant large snags more than 36 inches in diameter. A large federally owned area—Camp Bonneville Military Reserve—lies along the Lacamas Creek mainstem and the east and north forks. The area is primarily natural forest, although the mainstem Lacamas has a relatively narrow riparian area. Lacamas Prairie has a rare population of *Lomatium bradshawii* and is one of the region's few remaining large wet prairies.

The Washougal River riparian corridor supports high levels of biodiversity and is an important wildlife movement corridor. Other corridors include major streams throughout the subbasin and a BPA powerline corridor that extends horizontally across the southern subbasin. Boyles Creek connects to the upper Washougal River winter deer range to the east, just outside the boundary of the region.

Spotted owls, bald eagles, and Larch Mountain salamanders are all species of concern. Elk, deer, and goose populations in the watershed are doing well, maintaining themselves via natural production, and not imperiled at this time in the Washougal River watershed. The Washougal subbasin supports a diverse group of amphibians and reptiles that includes the northwestern, long-toed, Cope's, Pacific giant, and Cascade torrent salamanders; tailed and Pacific tree frogs and western toad; northern alligator lizard; and rubber boa, ring-necked snake, and three species of garter snakes.

Clark County and the *Lower Columbia Fish Recovery Board's Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan* set general and specific priorities for the Washougal subbasin. The recovery plan lists the most immediate

priorities in this subbasin as protecting intact forests in headwater basins, managing forest lands to protect and restore watershed processes, managing growth and development to protect watershed processes and habitat conditions, restoring passage at culverts and other barriers, and restoring lowland floodplain function, riparian function, and stream habitat diversity. Restoration projects, partner information, and selected watershed plans are available at www.lowercolumbiasalmonrecovery.org. Clark County suggests the following stream health strategies in the western part of the Washougal subbasin: conserve agricultural and forest lands and promote healthy practices; implement development regulations to minimize impacts, particularly from clearing and grading; protect and restore stream channels and riparian forest in tributary streams; and minimize the impact of surface and groundwater withdrawals in tributary streams.

Numerous agencies and organizations are actively involved in restoring the Washougal subbasin, including counties; water quality programs, such as those of the Washington Department of Ecology; and fish and wildlife habitat programs, such as those of the Washington Department of Fish and Wildlife, Clark Conservation District, Lower Columbia Fish Enhancement Group (LCFEG), tribes, landowners, Northwest Power Planning Council. The LCFEG partnership has

worked on priority salmon restoration projects for several years; projects include upper Washougal bedrock channel restoration, Little Washougal River riparian restoration, Hamilton Creek engineered logjams, Grays River large woody debris additions, and numerous nutrient enhancement and Washougal mainstem restoration projects. The Lower Columbia Fish Recovery Board's plan includes a detailed map and 6-year work program to address key priorities in the Washougal subbasin.

Organizations and Partners — Washougal River Watershed

City of Camas
Parks and Recreation
360-834-5307
www.ci.camas.wa.us/

City of Washougal
Public Works Department
360-835-8501
www.cityofwashougal.us/

Clark Conservation District
360-883-1987
www.clarkcd.org/index.html

Clark County ESA Program
Contact: Bobbi Trusty
360-397-2121 ext. 5268
bobbitrusty@clark.wa.gov
www.co.clark.wa.us/esa/index.html

www.co.clark.wa.us/esa/index.html

Clark County Extension (WSU)
360-397-6060
http://clark.wsu.edu/

Clark Public Utilities' StreamTeam
360-992-8585
www.clarkpublicutilities.com

Lower Columbia Fish Enhancement Group
360-882-6671
www.lcfeg.org

Lower Columbia Salmon Recovery and Watershed Management
360 425-1552
www.lowercolumbiasalmonrecovery.org

Vancouver-Clark Parks & Recreation
360-487-8311
parksrec@ci.vancouver.wa.us

Vancouver Watersheds Council
Gary Bock
360-852-9189
info@vancouverwatersheds.org
www.vancouverwatersheds.org/

Washington Department of Ecology
360-407-6000
www.ecy.wa.gov/ecyhome.html

Washington Department of Fish and Wildlife
360 902-2200
www.wdfw.wa.gov

Watershed Plans, Assessments, and Reports— Washougal River Watershed

- Clark County Stream Health Plan, 2010 www.co.clark.wa.us/water-resources/stream.html
- Clark County stream monitoring information www.co.clark.wa.us/water-resources/monitoring/streammonitor.html
- Draft Washougal River Subbasin Summary, 2003 www.cbfwa.org/FWProgram/ReviewCycle/fy2003lc/workplan/020517Washougal.pdf
- Habitat Conservation Plan information for Washington state-owned and managed wildlife areas www.wdfw.wa.gov/lands/wildlife_areas/hcp/
- Lewis, Salmon-Washougal Watershed Plan (WRIA 27/28) 2006 www.ecy.wa.gov/programs/eap/wrias/Planning/27-28.html
- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, 2010 www.lcfrb.gen.wa.us
- Overview of the Lewis and Salmon-Washougal Water Resources Management Program Rules www.ecy.wa.gov/biblio/0811006.html
- R2 Resource Consultants. 2004. Kalama, Washougal and Lewis River habitat assessments. Chapter 6: the Washougal River basin.
- U.S. Fish and Wildlife Service. 2010. Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington www.fws.gov/oregonfwo/Species/PrairieSpecies/Documents/PrairieSpeciesFinalRecoveryPlan.pdf
- USGS water quality monitoring information http://wa.water.usgs.gov/cgi/realtime.data.cgi
- Washington Comprehensive Wildlife Conservation Strategy www.wdfw.wa.gov/conservation/cwcs
- Washington Department of Ecology–TMDL, water quality data and projects, surface-groundwater interactions along the mainstem, livestock report and other information www.ecy.wa.gov/programs/wq/tmdl/TMDLsbyWria/tmdl-wria28.html

4c. The City of Washougal – Columbia River

Rick Till, Friends of the Columbia Gorge and Lori Hennings, Metro

The City of Washougal-Columbia River subbasin straddles the Columbia River and includes the Columbia River Gorge. The Washougal River originates in the Gifford-Pinchot National Forest in Skamania County and runs parallel to the Columbia River Gorge until passing through the city of Washougal and into the Columbia River near Camas, Washington. Approximately 76 square miles of the subbasin lie within the greater Portland-Vancouver region, just east of Multnomah Falls. Major tributaries in the Washington portion of the region include Gibbons and Watson creeks plus numerous smaller tributaries to the east. On the Oregon side, Latourell, Young, Bridal Veil, and Multnomah creeks are the major tributaries.

The subbasin includes locally and regionally significant natural and recreational resources and provides habitat for several threatened and endangered anadromous fish species and valuable forested upland habitats. Recreational resources include excellent boating, swimming, and fishing opportunities. The city of Washougal lies along the Columbia River at the eastern end of the greater Vancouver urban area and serves as Washington's gateway to the Columbia River Gorge.

Historically, this subbasin consisted of 47 percent conifer forest, 16 percent burned forest, 8 percent prairie and savanna, and 3 percent oak. By 2010, combined conifer and mixed forest covered about half of the basin, while 14 percent was agriculture and 4 percent urban (i.e., Washougal). Agriculture and urban cover has consumed roughly equal portions of conifer forest, burned forest, and oak. The amount of oak has reduced by about 64 percent, and prairie and savanna have disappeared almost completely. Present-day lands are generally woodlands, open space, agriculture, and residential.

The Columbia River Gorge is a remarkable natural, scenic, cultural, and recreational resource. The Gorge is an 85-mile-long canyon cutting a sea-level passage through the Cascade Mountains. Much of the Gorge was designated for protection in 1986 with the adoption of the Columbia River Gorge National Scenic Area Act. The National Scenic Area encompasses roughly 292,000 acres and includes portions of six counties (Multnomah, Hood River, and Wasco in Oregon and Clark, Skamania, and Klickitat in Washington). The area within the greater Portland-Vancouver region encompasses portions of the National Scenic Area in eastern Clark County and western Skamania County.

The National Scenic Area is divided into two general land use designations: Special Management Areas and General Management Areas. The greater Portland-Vancouver region includes General Management Area lands and portions of "Gates of the Columbia River Gorge" Special Management Area. The Columbia River Gorge Commission is responsible for adopting land use regulations that govern land uses in General Management Areas, while the USDA Forest Service is responsible for adopting land use regulations in Special Management Areas. Land use guidelines require protection for scenic, natural, recreational, and cultural resources.

The National Scenic Area Act required that the natural resources of the Columbia River Gorge be inventoried and that the inventory data be used as the basis for land use designations and regulations. The Columbia River Gorge Commission has undertaken the Vital Signs Indicators Project to study the condition of scenic, natural, recreational, and cultural resources in the National Scenic Area. (See http://gorgevitalsigns.org/.)

Washington State Route 14 leaving Washougal is designated a State Scenic Byway and is also the travel route for the Lewis and Clark National Historic Trail. State Route 14 is a primary travel route into the Columbia River Gorge and provides outstanding scenic views, access to recreational and natural resource areas, and opportunities for historical interpretation.

The Columbia River, its tributaries, and adjacent wetlands provide habitat for all anadromous fish migrating upstream and downstream through the greater Portland-Vancouver region. Most of the tributary streams are high gradient, with spawning habitat limited to the lowest reaches. Focal salmonid species in lower Columbia River Gorge tributaries include winter steelhead, chum, coho, and fall Chinook. Coastal cutthroat trout and Pacific lamprey also are present. Salmon and steelhead numbers have declined to a fraction of historical levels, and extinction risks are significant for all but chum; this watershed is a high priority for salmonid recovery.

Unlike the Columbia River itself, many of this subbasin's tributaries have relatively intact hydrology because of the area's steep slopes, forest cover, and large amounts of protected lands. Small tributaries provide salmon spawning habitat, cold-water refugia, protection from predators, and rearing habit. Some tributaries are altered as a result of Bonneville Dam, water diversions (e.g., Gibbons Creek), and small impoundments for recreation or other purposes.

Water quality in the mainstem Columbia River is impaired by warm temperature, toxics, and other issues; TMDL parameters include dioxin and total dissolved gas. TMDLs are still under development for some areas. Gibbons Creek has a TMDL in place for fecal coliform.

The portions of the greater Portland-Vancouver region that are within the Columbia River Gorge include numerous Washington Department of Fish and Wildlife priority habitats, including talus slopes, cliffs, old-growth and mature forests, herbaceous balds, Oregon white oak habitats, and riparian areas. Oregon white oak is particularly prevalent in parts of the Columbia River Gorge. The area also includes habitat used by numerous species listed as sensitive, threatened, or endangered by the states or the federal government. These species include anadromous fish, the Larch Mountain salamander, and peregrine falcons. Many of these priority habitats and sensitive species are located on publicly owned lands such as natural area parks and trails that also provide public recreation opportunities. For example, portions of the Cape Horn Trail recently were transferred from private into public ownership, providing recreational opportunities while preserving habitat.

Immediately east of the City of Washougal is Steigerwald Lake National Wildlife Refuge. This 1,049-acre refuge has historical riverine floodplain habitat, semi-permanent wetlands, cottonwood-dominated riparian corridors, pastures, and remnant stands of Oregon white oak. Adjacent to Steigerwald Lake National Wildlife Refuge is the Washington Department of Natural Resources' Washougal Oaks Natural Area Preserve. This 223-acre site represents native oak habitats that once were common in the Puget Sound and Willamette Valley area but are now rare.

The eastern end of the study area includes substantial lands owned and managed by the Washington Department of Natural Resources (DNR). Some of these lands are managed as State School Trust lands to provide perpetual funds for state schools. Other DNR lands are managed under the DNR's Natural Areas Program (see Chapter 6 of the *Regional Conservation Strategy*). For example, the Columbia Falls Natural Area Preserve is managed exclusively for the preservation of highly sensitive natural resources.

Captain William Clark Park is managed by the City of Washougal and provides river access and hiking opportunities. Reed Island State Park is a 510-acre park located in the Columbia River near Washougal. The island offers bird watching, boating, beach walking, camping and picnicking. The St. Cloud Day Use Site provides river access, has ADA facilities, and is possibly the largest remaining natural wetland in the Columbia River Gorge, providing habitat for an extensive variety of wildlife.

Aside from hatchery and harvest issues, key priorities for the City of Washougal–Columbia River subbasin include:

- Reduce out-of-subbasin impacts on salmon and steelhead so that the benefits of in-basin actions can be realized.
- Address immediate salmonids risks with short-term habitat fixes such as building chum salmon spawning channels and constructing coho overwintering habitat (e.g., alcoves, side channels, and log jams).
- Restore riparian function and stream habitat diversity.
- Manage growth and development to protect watershed processes and habitat conditions.
- Manage forest lands to protect and restore watershed processes.

Active habitat restoration and preservation efforts have been under way for some time now by several government and nonprofit groups, including the Washington Department of Natural Resources, the USDA Forest Service, the U.S. Fish and Wildlife Service, Clark County, Skamania County, the Skamania County Noxious Weed Control Board, Friends of the Columbia Gorge, Columbia Land Trust, Columbia Gorge Refuge Stewards, and the Lower Columbia Salmon Recovery Board.

Organizations and Partnerships — City of Washougal and Columbia River

- City of Washougal — www.cityofwashougal.us
- Washington Department of Ecology — www.ecy.wa.gov/ecyhome.html
- Washington Department of Fish and Wildlife — www.wdfw.wa.gov
- Washington Department of Natural Resources — www.dnr.wa.gov/Pages/default.aspx
- Washington State University Clark County Extension — http://clark.wsu.edu/
- USDA National Forest Service, Gifford-Pinchot National Forest and the Columbia River Gorge National Scenic Area Office — www.fs.fed.us/
- U.S. Fish and Wildlife Service (Steigerwald Lake, Franz Lake, and Pierce National Wildlife Refuges) — www.fws.gov/ridgefieldrefuges/complex/index.html
- Clark County — www.co.clark.wa.us
- Skamania County — www.skamaniacounty.org/
- Skamania County Noxious Weed Control Board – http://www.skamaniacounty.org/noxious-weeds/
- The Columbia River Gorge Commission — www.gorgecommission.org/
- Friends of the Columbia Gorge — www.gorgefriends.org/

- The Lower Columbia River Fish Enhancement Group — www.lcfeg.org/
- Columbia Gorge Refuge Stewards — http://www.refugestewards.org/
- Lower Columbia River Estuary Partnership — http://www.lcrep.org/
- Columbia Land Trust — www.columbialandtrust.org/

Active restoration and enhancement partners in the City of Washougal and the Columbia River include:

Clark County ESA Program
Contact: Joel Rupley
P.O. Box 9810, Vancouver WA 98666-9810
360-397-2022
joel.rupley@clark.wa.gov
www.co.clark.wa.us/esa/index.html

Gifford Pinchot Task Force
Contact: David Jennings
P.O. Box 87542, Vancouver, WA 98687
360-866-7551
www.gptaskforce.org

Lower Columbia Fish Enhancement Group
Contact: Tony Meyer
12404 SE Evergreen Highway
Vancouver, WA 98668-5471
360-882-6671
tony@lcfeg.org, www.lcfeg.org

Lower Columbia Salmon Recovery and Watershed Management
(includes partner organization contacts)
Contact: Bernadette Graham Hudson
2127 8th Ave., Longview, WA 98632
360-425-1552
www.lowercolumbiasalmonrecovery.org

Friends of the Columbia Gorge
Contact: Rick Till
522 SW 5th, Suite 720
Portland, OR 97206
503-241-3762 ext. 107
rick@gorgefriends.org
www.gorgefriends.org

U.S. Fish and Wildlife Service
Ridgefield National Wildlife Refuge Complex
P.O. Box 457, Ridgefield, WA, 98642
28908 NW Main Avenue
Ridgefield, WA, 98642
Phone: (360) 887-4106
Fax: (360) 887-4109

Washington Department of Natural Resources
Contact: Carlo Abbruzzese
PO Box 280
Castle Rock, WA 98611
(360) 575-5056
CARLO.ABBRUZZESE@dnr.wa.gov

Watershed Plans, Assessments, and Reports — City of Washougal and Columbia River

- Columbia River Gorge National Scenic Area Vital Signs Indicators Project http://gorgevitalsigns.org/
- Lewis, Salmon-Washougal Watershed Plan [includes some planning for lower Gorge tributaries] (WRIA 27/28) www.ecy.wa.gov/programs/eap/wrias/Planning/27-28.html
- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, Volume II: Washougal River, Lower Gorge Tributaries (2010) http://www.lcfrb.gen.wa.us
- Management Plan for the Columbia River Gorge National Scenic Area http://www.gorgecommission.org/managementplan.cfm
- Northwest Power Planning Council. 2004. http://www.nwcouncil.org/
- U.S. Environmental Protection Agency, Region 10. 2009. Columbia River Basin: State of the River report for toxins http://www.epa.gov/columbiariver/
- Washington Department of Ecology – Washougal River and Gibbons Creek, TMDL, water quality data and projects, surface-groundwater interactions along the mainstem, livestock report and other information http://www.ecy.wa.gov/programs/wq/tmdl/TMDLsbyWria/tmdl-wria28.html
- Washington DNR Columbia Falls Natural Area Preserve www.dnr.wa.gov/ABOUTDNR/MANAGEDLANDS/Pages/amp_na_columbia_falls.aspx
- Washington State Department of Fish and Wildlife 2011-2017 Strategic Plan www.wdfw.wa.gov/publications/00971/wdfw00971.pdf

OVERVIEW

Understanding the Willamette River Watershed

Travis Williams, Willamette Riverkeeper

This section provides an overview of the Willamette River watershed, to provide context for discussion of the watersheds that fall within it in the greater Portland-Vancouver region: Hayden Island-Columbia River, Johnson Creek, Salmon Creek-Frontal Columbia River, Scappoose Creek-Frontal Columbia River, Willamette River-Frontal Columbia River, Abernethy Creek-Willamette River,

The Willamette River is a defining natural feature of the Portland metropolitan portion of the greater Portland-Vancouver region. As the final receiver of water from the surrounding landscape, the Willamette reflects what is happening around it. Over the decades the Willamette has been subject to a variety of impacts, especially conversion of the landscape to housing, industry, and agriculture. Today, efforts to reverse some of the negative effects on the river focus on improving water quality and enhancing natural habitat for a range of native species.

The Willamette River drains the Willamette Basin, which comprises 11,460 square miles between the Coast Range and the Cascades. This area encompasses the cities of Eugene, Springfield, Corvallis, Albany, Salem, and Portland and is home to nearly 70 percent of Oregon's population. The mainstem Willamette is formed by the confluence of the Coast Fork Willamette and Middle Fork Willamette tributaries east of Eugene and flows 187 miles to its confluence with the Columbia River in Portland, incorporating 12 major tributaries along the way. The Willamette's lower 36 miles, from its confluence with the Molalla River downstream to the Columbia, are within the greater Portland-Vancouver region.

From its southern extent near Eugene, the river flows south to north through farmland, parks, floodplain forest, wetlands, oak habitats, and native prairie. The river also flows past multiple cities that have used and affected the river in a variety of ways since their founding. As the river weaves its way north, the gradient decreases, as does the extent of its historical floodplain. Where it meets the Molalla River in the Newberg Pool area, the Willamette has a very low gradient and slow flow. Just upstream of Oregon City the river enters the Willamette Narrows, where it is constrained by basalt bluffs. The only dam on the mainstem is in Oregon City at RM 26.5; it is operated by Portland General Electric. Farther north, the river flows through miles of suburban and urban areas with extensive hardened banks (to protect homes and businesses) until it reaches its confluence with the Columbia River in North Portland.

Flows on the mainstem Willamette are significantly controlled by tributary dams constructed for flood control and water supply. The dams substantially dampen flow dynamics by reducing high flows and raising low flows. Dams also act as barriers that block native fish migration. Although the mainstem channel may appear natural in the southern portion of the basin, the floodplain of the river has been dramatically reduced and the river is typically confined to one main channel. This "channelization" of the Willamette goes back many decades and is the result of efforts by farmers and cities to

IMPACTS ON RIVER HEALTH

Human influences have affected the Willamette River throughout its extent, from high in the basin to the metropolitan Portland. Key impacts are as follows:

- **Impaired downstream and upstream passage of fish on major tributaries, because of multiple dams. Passage impairments have reduced the natural reproductive ability of fish populations.**
- **Loss and alteration of habitat. Reduced riparian vegetation and floodplain forest, loss of side channels and refugia, competition from non-native plants and animals, and separation of the river from its historical floodplain all have affected fish, mammal, and bird species.**
- **Contamination. Contaminated sites in and along the river are in need of cleanup.**
- **Poor water quality in some areas.**

protect their lands from flooding. Changes in the Willamette's flow have reduced habitat complexity and the amount of temperature and habitat refugia for many kinds of fish and wildlife.

The Willamette Basin is home to spring Chinook salmon (*Oncorhynchus tshawytscha*) and winter steelhead (*Onchorhynchus mykiss*), and many other focal species identified in federal recovery plans and Oregon's Conservation Strategy. Salmon and steelhead from through the basin must pass through the Portland area twice during their lifecycle—as juveniles on their way downstream to the ocean and as adults moving upstream to spawn. These anadromous fish have been staples of subsistence fishing historically, and more recently for sport fishing. The numbers of naturally reproducing spring Chinook salmon and winter steelhead have dropped greatly, and both species are listed as threatened under the Federal Endangered Species Act. Today native populations are supplemented by hatchery-raised fish that compete with native fish for resources and contaminate natural genetics.

The Pacific lamprey (*Lampetra tridentata*) is an additional species of interest in the lower Willamette. These long, eel-like fish have been harvested by native peoples for many generations at Willamette Falls and have been present in the Willamette River system from Portland Harbor to well upstream. In recent years the population of Pacific lamprey has declined, likely because of habitat and water quality issues. Today Pacific Lamprey are being actively studied to determine the best way to pathway to recovery.

The portion of the Willamette Basin that is within the greater Portland-Vancouver region was home to the Kalapuyan, Chinook, and Clackamas people, who populated the Willamette Valley and surrounding highlands, with distinct bands in different areas. Willamette Falls was an important gathering and trading area.

Impacts on River Health

Habitat alteration occurs in both urban and rural areas along the river. In the Portland area, habitat alteration along the Willamette can be seen in the form of hardened sea walls and riprap placed on the riverside to confine the river and prevent banks from eroding. Poor water quality has been a very significant issue on both the Willamette mainstem and its tributaries, and today there is a TMDL for temperature in the Willamette system—especially high summer water temperatures. The TMDL triggered a plan to help restore cooler temperatures in key areas. Other chronic or episodic water quality violations involve household and industrial chemicals, pesticides and sewer overflows.

Invasive species are abundant in the lower portion of the Willamette River, and this can affect the health of a range of native species. Invasive species such as smallmouth bass, carp, Asian clams, nutria, and purple loosestrife occupy habitat and compete for food resources. These can thwart efforts to restore native species populations.

The Willamette's primary tributaries in the greater Portland-Vancouver region include the Molalla River to the south, the Tualatin River just above Willamette Falls and the Clackamas River just below the falls, the more urban Tryon and Johnson creeks, and Columbia Slough, which flows into the Willamette near its confluence with the Columbia. Confluences often have rich assemblages of fish and wildlife. Each tributary reflects upstream land cover, channeling runoff to the Willamette that may include a variety of pollutants and excess sediments. The lower Willamette itself has been subjected to intensive industrial use that has led to significantly contamination in the river. Numerous effluent discharges contribute treated effluent to the river from industrial and municipal sources. In total, the portion of the Willamette River that is within the greater Portland-Vancouver region is much more polluted than areas upstream.

Contamination and Cleanup

Polluted sediments can be found in the Willamette River within the center of Portland, and there are a few isolated hotspots of pollution between Ross Island and the Fremont Bridge where polychlorinated biphenyls (PCBs) are the primary contaminants. As the river approaches Swan Island, it enters the heart of the Portland Harbor Superfund site, which consists of several miles of contaminated sediments and upland riverside areas that extend roughly to Multnomah Channel. (Cleanup activities at Superfund sites are overseen by the U.S. Environmental Protection Agency.) The host of contaminants and a severely altered river make this area the most degraded portion of the entire Willamette. The pollution in the degraded portion of the Willamette is due to over 140 years of industrial development that included such activities as ship building and demolition, chemical manufacturing, chemical treatment of wood.

In the coming years, the Superfund cleanup of Portland Harbor will require those who polluted the harbor, known as the Potentially Responsible Parties, to clean up their contribution to the mess. It will also require habitat to be restored as part of the Natural Resource Damages process.

Restoration Priorities

Priorities for restoration along the Willamette include the following:[4]

- Restoring riparian areas
- Restoring floodplain and near-shore habitat in both urban and rural areas
- Increasing the extent of floodplain forest
- Restoring fish passage and related natural flows to tributaries of the Willamette
- Protecting and restoring cold-water refugia to assist migrating fish and meet TMDL requirements

Some of these priorities are being implemented at Oaks Bottom, the City of Portland and others are working to increase the connection of the wetland area and pool at Oaks Bottom with the mainstem Willamette River. The approach includes improving a culvert to increase water flow and native fish access to the off-channel refugia. This project exemplifies how habitat enhancement in a large urban area, on a developed portion of the Willamette, can greatly benefit wildlife and native habitat.

Local Assessments and Plans

- Willamette Subbasin Plan, Northwest Power and Conservation Council, May 2004 http://www.nwcouncil.org/fw/subbasinplanning/willamette/plan/Intro.pdf
- Willamette River Basin Planning Atlas (Northwest Ecosystem Research Consortium, Stan Gregory and David Hulse, OSU Press, 2002)

http://www.fsl.orst.edu/pnwerc/wrb/Atlas_web_compressed/PDFtoc.html

Key Organizations and Partnerships

Organizations working on the Willamette River mainstem in the Portland area include Willamette Riverkeeper, Audubon Society of Portland, the Urban Greenspaces Institute, Metro, Oregon State Parks, The Nature Conservancy, the City of Portland's Office of Healthy Working Rivers, Portland Parks and Recreation, and the City of Portland's Bureau of Environmental Services.

Those organizations working at the confluence areas include the Tryon Creek Watershed Council, Clackamas Basin Council, Johnson Creek Watershed Council, and Columbia Slough Watershed Council.

At this point, all of the organizations above work together in different ways on various projects from habitat restoration, enforcing the Clean Water Act, ecological monitoring, invasive species management, and more.

PROTECTED AREAS

The following are some of the key natural areas along the Willamette River within the greater Portland-Vancouver region that are currently protected:

Molalla River State Park

Willamette Narrows

Elk Rock Island

Oaks Bottom Wildlife Refuge

Ross Island's 44 publicly owned acres

[4] See also the "Willamette River–Frontal Columbia" section.

5. Johnson Creek Watershed

Matt Clark, Johnson Creek Watershed Council

The Johnson Creek Watershed is 54 square miles (34,000 acres) and includes parts of five cities—Damascus, Gresham, Happy Valley, Milwaukie, and Portland—and two counties: Multnomah and Clackamas. Johnson Creek originates in the foothills of Mount Hood near Boring, flows generally westward for approximately 24 miles, and enters the Willamette River just south of the City of Portland border, 18.5 river miles above the Willamette's confluence with the Columbia River.

The upper watershed is predominantly rural residential and agricultural (largely tree nurseries), with less than 10 percent impervious surface. The lower watershed is heavily urbanized and is dominated by residential, commercial, and industrial areas, with generally more than 25 percent impervious surface. Developed land represents about 40 percent of the watershed. As of 2006 the watershed had an estimated 175,000 residents, making it one of the most densely populated watersheds in Oregon. More than 90 percent of the Johnson Creek watershed is within the current Metro Urban Growth Boundary, with 6,000 acres added to the UGB in the last decade. Additional areas near Highway 26 in both Clackamas and Multnomah counties were designated as urban reserves in 2010.

The Johnson Creek watershed represents 3 percent of the greater Portland-Vancouver region. Within the region, 91 percent of the Johnson Creek watershed falls within the Metro Urban Growth Boundary.

KEY FACTS: The Johnson Creek watershed within the greater Portland-Vancouver region:

- Includes about 3,200 acres that are within the FEMA 100-year floodplain and just over 500 acres of mapped wetlands.

- Has 39 percent developed land, second only to the Willamette River-Frontal Columbia River watershed. This level of development is a strong contributor to flooding in the watershed.

Johnson Creek Watershed 60,113 acres	
Land cover	**% of Watershed**
Agriculture	6%
Regen. forest	<1%
Developed	39%
Low Veg	13%
Tree Cover	41%
Water	2%
Forest Patches*	16%
Jurisdictions	
Metro UGB	91%
Rural	9%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB.

- Has significant tree cover (41 percent), particularly considering the relatively high level of development. The tree cover helps offset flood problems that otherwise would be worse.

- Has a relatively high proportion (13 percent cover) of low vegetation. This includes substantial amounts of backyard and landscaping habitat.

The northern side of the watershed west of Gresham and the southern side west of I-205 are relatively flat, with deep, permeable, sedimentary soils. This contrasts with the steeper slopes and low-permeability silt soils of the volcanic buttes (the East Buttes) in the southeastern portion of the watershed, which explains why most of Johnson Creek's major tributaries come from the south. The exception is ground-water fed Crystal Springs Creek, the lowest major tributary, which enters from the north. Other major tributaries include Veterans, Kelley, Butler, Sunshine, and Badger creeks, with Kelley and Crystal Springs creeks contributing most of the stream volume. The summer base flow of Johnson Creek frequently falls below minimum standards established by the Oregon Department of Fish and Wildlife for salmonids, and winter floods are common. (A total of 39 flood events have been recorded since 1941.) Flooding causes erosion and bank scouring within the basin, as well as property damage.

Historically, the Johnson Creek subbasin was 70 percent coniferous forest, 11 percent oak, 15 percent burned forest, and less than 1 percent prairie. By 2010, this basin had become the most heavily urbanized basin in the region, with 69 percent of the basin converted to urban uses (i.e., portions or all of Clackamas, Gresham, Lake Oswego, Milwaukie, Oak Grove, Portland, and Tualatin). Another 10 percent of the basin has been converted to agriculture. Together, the transition to urban and agricultural uses has consumed 67 percent of the oak habitat and 100 percent of the prairie. Combined coniferous and mixed forest decreased about 55 percent. Agriculture consumed about 5,000 acres of conifer forest, and urban consumed 25,000 acres of conifer forest and about 5,000 acres of oak.

Early farmers (circa 1850) initially increased the meandering of the creek to expand the floodplain and increase nutrient deposition. By the 1930s, the watershed had substantially urbanized and flooding came to be viewed as a problem—a view that continues to this day. To address flooding concerns, the Works Progress Administration widened and straightened much of the lower 15 miles of Johnson Creek, lining the channel with rocks. Today it is recognized that historical flood prevention efforts were largely counter-productive, and significant public and private investment has been made to reconnect Johnson Creek to its historical floodplain. In addition to mitigating nuisance flooding, reconnecting the historical floodplain provides critical off-channel rearing and refuge habitat for native fish, including salmon and steelhead. Historically Johnson Creek had large salmon populations, which declined dramatically with urbanization and the WPA channelization mentioned above.

Today, most of the forest is on the volcanic East Buttes. Upland forests on the East Buttes generally range from 40- to 100-year-old second growth that typically is a mixed conifer-deciduous forest in mid-successional stage. Invasive weed species are a problem throughout the watershed, particularly in the herbaceous and shrub layers. (Invasive weeds are discussed in more detail below.)

Native fish—particularly those tolerant of warm water—represented 99.7 percent of the species sampled in the watershed by the Oregon Department of Fish and Wildlife between April 2008 and February 2009. Despite precipitous declines, cold-water species such as ESA-listed Chinook and coho salmon and steelhead and cutthroat trout are still present. Steelhead and cutthroat trout are found along most of Johnson Creek, while coho and Chinook salmon have been found primarily in the lower mainstem and in Crystal Springs Creek. Western brook lamprey and Pacific lamprey also are present in lower Johnson Creek and its tributaries.

Little data are available about fish distribution in the upper mainstem of Johnson Creek. However, in December 2010, four wild coho salmon (three spawned-out carcasses and one live fish) were sighted on mainstem Johnson Creek at River Mile 15, near the eastern border of Gresham, much farther upstream than they have been recently documented.

In 2010, several populations of western pearlshell freshwater mussels were found in upper Johnson Creek. Although still relatively

widespread in western Oregon, western pearlshells are considered a vulnerable species and their conservation is closely linked to that of salmon.

Other sensitive species present include long-toed, northwestern, and Columbia salamanders, red-legged frogs, and painted turtles. The East Buttes and forested tributary headwaters provide upland and streamside habitat for resident and migratory birds, including Pacific-slope and willow flycatchers; western wood-pewees; golden-crowned kinglets; Bewick's and winter wrens; orange-crowned, Wilson's, and Townsend's warblers; and Swainson thrushes. The Johnson Creek mainstem and its many tributaries act as travel corridors and connect habitat for birds, black-tailed deer, coyote, river otter, and beaver. The East Buttes provide important habitat and connectivity for elk, and the Johnson Creek mainstem is probably the most important east-west biodiversity corridor in the southern portion of the Portland metropolitan region.

There currently are about 4,600 acres of parks and open space in the watershed. including nearly 900 acres acquired since 1995. Inside the City of Portland boundary, more than 1,000 acres are designated as special habitat areas, meaning that they provide especially important fish and wildlife habitat values and functions. Important habitat types still present in the watershed include bottomland hardwood forest, wetland complexes (one of the largest being 19-acre Beggars Tick marsh), and upland prairie and grasslands. There is protected forested upland habitat on Powell Butte, Clatsop Butte, Gabbert Hill, and various other volcanic buttes.

Some of the most extensive streamside forest on Johnson Creek is in the middle watershed. For example, Reach 16, upstream of Regner Road in Gresham, has an intact riparian forest canopy, as does the riparian corridor between Powell Butte and Leach Botanical Garden. The headwater streams flowing through rural and agricultural lands in the upper watershed have very little riparian vegetation. Some of the tributary headwaters remain well forested (e.g., Upper Kelley Creek and Upper Mitchell Creek). The lower watershed generally suffers from a lack of riparian vegetation. Notable exceptions include Johnson Creek's confluence with the Willamette River and Tideman Johnson Natural Area.

Based on Ecosystem Diagnosis and Treatment (EDT) modeling for coho salmon, priorities for core instream and riparian habitat protection include Reach 16 of Johnson Creek, lower Hogan Creek, upper and lower Kelley Creek, and upper Mitchell Creek. Priority areas for restoration are Reaches 4 and 5 of Johnson Creek (i.e., Tideman-Johnson), Reach 15 of Johnson Creek, Upper Crystal Springs, Errol Creek, middle Kelley Creek, lower Mitchell and Sunshine creeks, and Badger Creek. The next step for salmon habitat recovery is to connect core habitat areas, which include Reaches 1, 2, 6, 7, 8, 9, 10, and 17 of Johnson Creek.

Conservation and restoration efforts should focus on areas that increase riparian connectivity and provide wildlife travel corridors. One of the challenges will be to maintain ecological and hydrological function as areas in the middle and upper watershed (notably the Pleasant Valley and Springwater planning areas and the City of Damascus) develop in the coming years.

As noted above, much of Johnson Creek has been channelized and disconnected from its historical floodplain. Off-channel habitat remains rare on Johnson Creek, in spite of recent projects that have reconnected the creek to its floodplain (notably at Tideman-Johnson Natural Area, the confluence of Errol Creek and Johnson Creek, the Johnson Creek mainstem south of Powell Butte, and Kelley Creek's confluence with Johnson Creek). In addition, large woody debris is severely lacking throughout Johnson Creek.

The Oregon Department of Environmental Quality rated water quality in Johnson Creek as poor. Water quality issues include bacteria, high temperatures, and toxic legacy pesticides such as DDT, primarily originating in the agricultural upper watershed and brought into the creek by eroding soils.

There are several known invasive weed species in the watershed, including Japanese knotweed (more than 90 percent controlled as of 2010), false-brome, garlic mustard, and regionally ubiquitous invasive species such as reed canarygrass, English and Irish ivy, and Himalayan blackberry.

The following are high-priority conservation or restoration actions in this watershed:

- Non-point source pollution reduction
- Low-impact development in middle and upper watershed
- Stormwater retrofitting in existing development
- Private lands restoration and conservation
- Continued streamside forest restoration

Current Major Initiatives — Johnson Creek Watershed

- Watershed-wide riparian invasive weed removal and native species revegetation (ongoing)
- Removal of eight partial fish passage barriers on Crystal Springs Creek
- Floodplain reconnection /off-channel rearing and refuge habitat (several large projects have been completed; several more programmed)
- Instream and floodplain large wood installation at Johnson Creek/Willamette River confluence

Organizations and Partners — Johnson Creek Watershed

- Johnson Creek Watershed Council – Matt Clark
- City of Damascus – Dan O'Dell
- City of Milwaukie – JoAnn Herrigel
- City of Portland – Maggie Skenderian (Bureau of Environmental Services), Lynn Barlow (Portland Parks and Recreation)
- City of Gresham – Steve Fancher
- Clackamas Water Environment Services – John Nagy
- North Clackamas Parks and Recreation – Tonia Burns
- Multnomah County – Roy Iwai
- East Multnomah Soil and Water Conservation District – Jean Fike
- Clackamas County Soil and Water Conservation District – Tom Salzer
- Johnson Creek Conservation Partnership (a group of nonprofits and jurisdictions focused on acquisition of conservation land)
- Backyard Habitat Certification Program /Johnson Creek pilot (Johnson Creek Watershed Council, Portland Audubon, Columbia Land Trust)
- Crystal Springs Community Collaborative – Rowan Steele, City of Portland
- SOLV – Sara Ryan
- Friends of Trees – Logan Lauvray
- Reed College – Zac Perry
- Johnson Creek Interjurisdictional Committee (focus on watershed monitoring)
- Xerces Society /Johnson Creek Watershed Council – Freshwater mussel sampling

Watershed Plans, Assessments, and Reports — Johnson Creek Watershed

- Johnson Creek Restoration Project Census (in development by the Johnson Creek Watershed Council and partners) http://jcwc.conservationregistry.org/
- Johnson Creek Watershed Action Plan, 2003 http://jcwc.org/
- Johnson Creek Restoration Plan (City of Portland, 2001) http://www.portlandonline.com/bes/index.cfm?a=214367&c=33212
- Willamette Basin Restoration Priorities Watershed Summaries (Oregon Watershed Enhancement Board, 2005) http://www.oregon.gov/OWEB/docs/pubs/Rest_Priorities/Willamette_Watershed_Council_Summaries_Dec05.pdf?ga=t
- Aquatic Inventories Project, Physical Habitat Surveys, Johnson Creek (Oregon Department of Fish and Wildlife, 1999)
- Johnson Creek Stormwater Master Plan (City of Gresham, 2005)
- Johnson Creek Watershed Land Acquisition Plan (in development by Johnson Creek Conservation Partnership)

6. Salmon Creek – Frontal Columbia River

Lori Hennings, Metro

The Salmon Creek – Frontal Columbia River subbasin (referred to as the Salmon Creek watershed) drains 205 square miles within the greater Portland-Vancouver region. Salmon Creek originates in the low foothills of the southwest Washington Cascades and flows into Lake River, which drains northward from Vancouver Lake into the Columbia River, along the way receiving water from Flume and Whipple creeks. Tributary streams are primarily low-gradient meandering systems within Clark County. Vancouver Lake and Lake River are within the historical Columbia River floodplain and are tidally influenced. Burnt Bridge Creek is mostly within the city of Vancouver and flows into Vancouver Lake. The Salmon Creek watershed includes several subwatersheds: the upper Salmon, lower Salmon, Lake River-Frontal Columbia River, Burnt Bridge Creek, and Gee Creek.

Salmon Creek-Frontal Columbia Watershed 131,398 acres	
Land cover	**% of Watershed**
Agriculture	21%
Regen. forest	1%
Developed	24%
Low Veg	20%
Tree Cover	31%
Water	3%
Forest Patches*	19%
Jurisdictions	
Battle Ground	4%
Camas	3%
Ridgefield	2%
Vancouver	44%
Rural	47%

*Tree/regen. forest patches >30 acres.

Most of the urban lands in the Washington portion of the greater Portland-Vancouver region are within the Salmon Creek watershed, about one-quarter of which is urbanized. For example, the Washington cities of Vancouver, Battle Ground, Hazel Dell ,and Orchards are within the Salmon Creek watershed. Land use is predominantly privately owned timber and agriculture in the upper and middle portions of the watershed and rural and urban development in the lower portion of the watershed. Much of the historical wetland and floodplain habitat has been converted to urban uses, although some large areas have been preserved. The human population in the watershed is expected to double between 2000 and 2020, primarily in Vancouver and Battle Ground; this growth in the human population will increase pressures for conversion of forest and rural lands to high-density suburban and urban uses.

A total of 53 percent of the watershed lies within urban growth boundaries, and the watershed represents 7 percent of the total area of the greater Portland-Vancouver region.

KEY FACTS: The Salmon Creek – Frontal Columbia River watershed within the greater Portland-Vancouver region:

- Consists of 24 percent developed land cover (much of which is within the City of Vancouver's urban growth area) and 21 percent agriculture.
- Includes 31 percent tree cover. Forest patch cover represents 19 percent of the watershed, reflecting the fragmentation of habitat that is common in urban areas.
- Has 20 percent low vegetation. The combination of tree cover and low vegetation (collectively more than 50 percent) suggests that the watershed is relatively green, despite its urbanization.
- Is 11 percent publicly owned.
- Has about 22,000 acres within the FEMA 100-year floodplain.
- Includes more than 16,000 acres of mapped wetlands—the most of any watershed in the region.

The Salmon Creek watershed lies along the Pacific Flyway and is critical to migrating and breeding birds. Meriwether Lewis and William Clark camped near the mouth of Salmon Creek on November 4, 1805. Clark purportedly did not sleep well because of the noise made by swans, geese, ducks, and other birds nearby.

Stream health and fish and wildlife habitat within the watershed have been affected by urban and rural development, agricultural practices, transportation corridors, and timber harvest. Salmon Creek currently exceeds state and federal standards for water temperature, turbidity, and coliform bacteria, and tributaries also have problems with dissolved oxygen and pH. Floodplain connectivity has been lost and streams channel-

ized. High peak flows and low summer flows are key urban issues, so development practices and stormwater management will be important tools in managing future urban growth. Clark Public Utilities, Clark County, and the Washington Department of Ecology have entered into a joint agreement to develop and maintain an effective management strategy for the watershed's groundwater resources, which supply most of the water needs of residents and businesses.

Historically, the Salmon Creek subbasin was 53 percent coniferous forest, 18 percent burned forest, 9 percent prairie and savanna, and 3 percent oak. By 2010, 32 percent of the watershed had been converted to urban uses (i.e., the cities of Battle Ground, Ridgefield, and Vancouver, and part of the city of Camas), making this basin the third most heavily urbanized in the region. Conversion to urban cover consumed about 56 percent (approximately 30,000 acres) of combined coniferous and mixed forest and about 5,000 acres of prairie. Agriculture covered a quarter of the basin and consumed about 20,000 acres of conifer and mixed forest and 3,000 acres of prairie. Riparian forest and water features—primarily on the floodplain of the Columbia River—each were reduced about 21 percent by filling or drainage.

Habitat loss, fragmentation, and invasive species are of particular concern in the Salmon Creek watershed. Native oak habitats and prairies are threatened by Scot's broom. Purple loosestrife and knotweeds affect wetland and riparian

habitats. Despite these difficulties, substantial habitat remains, and much has been protected. The Ridgefield lowlands extend north-south through most of the western portion of the watershed and continue northward to the Lewis and Kalama River-Columbia Frontal River subbasins. The area has a mosaic of seasonal and permanent wetlands, grasslands, upland forest, riparian corridors, oak habitats, and cropland. The Washington Department of Natural Resources identifies Mankas Prairie—a remnant prairie and oak savanna habitat area in the northeastern portion of the watershed—as a heritage site, and the upper reaches of Weaver Creek have an important mature mixed forest-wetland complex. The state's Priority Habitats and Species program identifies the Ridgefield lowlands, Salmon Creek, and major low-lying tributaries as high-quality habitat for breeding and overwintering bald eagles and waterfowl, including winter concentrations of dusky Canada geese, Canada geese, and white-fronted geese, lesser sandhill cranes, and wintering and breeding ducks. The area also supports a diverse array of amphibians, reptiles, and mammals.

The Salmon Creek subbasin provides habitat for numerous amphibian and reptile species, including the northwestern, long-toed, Cope's, Pacific giant, and Cascade salamanders; tailed and red-legged frogs and the western toad; the ring-necked snake, rubber boa, and three species of garter snakes; and the painted turtle and northern alligator lizard.

The U.S. Fish and Wildlife Service established the Ridgefield National Wildlife Refuge Complex in 1965, with a total of 5,217 acres set aside for wildlife and habitat. The Washington Department of Fish and Wildlife owns another 2,730 acres immediately to the south, in the Shillapoo Wildlife Area. The Port of Vancouver also owns some important preservation and mitigation areas. Numerous other habitat areas are protected through a variety of ownerships, including holdings along Whipple Creek, Salmon Creek Greenway, and Burnt Bridge Greenway.

Several key wildlife movement corridors connect to the Columbia River and adjacent watersheds. The lowlands connect in all directions: west to the Columbia River and north and south to other watersheds, as well as to important wildlife areas such as Burnt Bridge, Cougar Canyon, Whipple and Flume creeks. Upper Salmon Creek provides a corridor through urban and agricultural areas to forest in the upper basin.

The Lower Columbia Fish Recovery Board's 2010 Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan provides a detailed salmon-oriented characterization of the Salmon Creek subbasin. Historically the basin supported thousands of fall Chinook salmon, winter steelhead, and chum and coho salmon. Salmon and steelhead numbers have declined to only a fraction of their historical levels. Extinction risks are significant for all of these species, but none of the Salmon Creek populations are considered primary for recovery under the Lower Columbia Fish Recovery Board's plan; however, the plan calls for management action to sustain these populations at their current level of viability, to meet regional recovery objectives. Although no single threat is responsible for the declines in Salmon Creek's fish and wildlife populations, a loss of tributary habitat quality and quantity accounts for the largest relative impact. Key habitats have been isolated or eliminated as a result of dredging, channel modifications, diking, filling, the draining of floodplains and wetlands, and hydropower operation on the mainstem. These activities have altered flows, habitat, and migration conditions. Altered habitat and competition and interbreeding with hatchery fish have reduced productivity.

The Lower Columbia Fish Recovery Board's 2010 recovery plan identifies growth management, restoration of forest, floodplain, and riparian habitat, and preservation and restoration of watershed processes and habitat conditions as immediate salmon priorities and identifies reach-specific restoration activities to improve fish habitat. The Clark County 2010 Stream Health Report recommends the following priority general action categories for this watershed: increase infiltration and retention of stormwater runoff, restore stream and side channels in the middle and upper watershed, implement development regulations to minimize impacts, minimize the impact of surface and groundwater withdrawals, promote good septic system maintenance practices, and work with property owners to eliminate pollution sources.

Washington's Comprehensive Wildlife Conservation Strategy identifies specific areas and actions to help sensitive habitats and wildlife species. A recovery plan is in place in this watershed for several threatened or endangered prairie species, including Fender's blue butterfly (Icaricia icarioides fenderi), which is endangered; Willamette daisy (Erigeron decumbens var. decumbens), which is endangered; Bradshaw's lomatium (Lomatium bradshawii), which is endangered; Kincaid's lupine (Lupinus sulphureus ssp. kincaidii), which is threatened; and Nelson's checkermallow (Sidalcea nelsoniana), which is threatened.

Active habitat restoration and preservation efforts have been under way for some time now by the City of Vancouver, Clark County, Clark Public Utilities, the Port of Vancouver, the Lower Columbia Fish Recovery Board, and others. The Salmon Creek Watershed Council provides a forum for citizens and organizations residing in Clark County to participate in and partner on on-the-ground restoration, water quality, and advocacy. Clark County's StreamTeam organizes restoration projects in the Salmon Creek Greenway. The Vancouver Watersheds Council is similarly engaged in plantings, cleanups and community education. Salmon Creek runs through the Washington State University campus, and students, professors and partners are engaged in restoration and watershed education.

Organizations and Partners — Salmon Creek Watershed

City of Vancouver
360-487-8600
www.cityofvancouver.us

Clark Conservation District
Denise Smee
360-883-1987
dsmee@clarkcd.org
www.clarkcd.org/index.html

Clark County ESA Program
Joel Rupley
360-397-2022
joel.rupley@clark.wa.gov
www.co.clark.wa.us/esa/index.html

Clark County Parks & Recreation
360-487-8311
parksrec@ci.vancouver.wa.us

Clark Public Utilities' StreamTeam
Lisa Beranek
360-992-8585
StreamTeam@clarkpud.com
http://www.clarkpublicutilities.com/index.cfm/our-environment/stream-team/

Lower Columbia Fish Enhancement Group
Tony Meyer
360-882-6671
tony@lcfeg.org
www.lcfeg.org

Lower Columbia Salmon Recovery and Watershed Management |
Bernadette Graham Hudson
360 425-1552
www.lowercolumbiasalmonrecovery.org

Salmon Creek Watershed Council
Bianca Streif
360-721-3816
Bianca.streif@salmoncreekwatershed.org
www.salmoncreekwatershed.org

Vancouver Lake Watershed Partnership
Loretta Callahan
360-759-4479
loretta.callahan@ci.vancouver.wa.us
www.ci.vancouver.wa.us/PublicWorks/vancouverlake/index.htm

Vancouver Watersheds Council
Gary Bock
360-852-9189
info@vancouverwatersheds.org
www.vancouverwatersheds.org/

Washington Department of Ecology
360-407-6000
www.ecy.wa.gov/ecyhome.html

Washington Department of Fish and Wildlife
360 902-2200
www.wdfw.wa.gov

Clark County Extension (WSU)
Jennifer Naas
360-397-6060
jenifer.naas@clark.wa.gov
http://clark.wsu.edu/

Watershed Plans, Assessments, and Reports — Salmon Creek Watershed

- Clark County Water Quality Division. 1995. Burnt Bridge Creek Watershed Plan: Clark County watershed protection program. Vancouver, WA: The Division.

- Clark County Water Resources Division. 1997. Lakeshore & Salmon Creek Watershed Areas Plan. Clark County watershed protection program. Vancouver, WA: The Division.

- Clark County Stream Health Plan www.co.clark.wa.us/water-resources/stream.html

- Clark County stream monitoring information http://www.co.clark.wa.us/water-resources/monitoring/streammonitor.html

- Gee Creek Watershed Restoration Background Report http://clark.wsu.edu/natural/geeCreek.html

- Habitat Conservation Plan information for Washington state-owned and managed wildlife areas www.wdfw.wa.gov/lands/wildlife_areas/hcp/

- Lewis, Salmon-Washougal Watershed Plan (WRIA 27/28) www.ecy.wa.gov/programs/eap/wrias/Planning/27-28.html

- Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (2010) www.lcfrb.gen.wa.us

- Overview of the Lewis and Salmon-Washougal Water Resources Management Program Rules www.ecy.wa.gov/biblio/0811006.html

- Shillapoo Wildlife Area management plan www.wdfw.wa.gov/lands/wildlife_areas/management_plans/

- USGS water quality monitoring information http://wa.water.usgs.gov/cgi/realtime.data.cgi

- Washington Department of Ecology – TMDL, water quality data and projects, surface-groundwater interactions along the mainstem, livestock report and other information www.ecy.wa.gov/programs/wq/tmdl/TMDLsbyWria/tmdl-wria28.html

7. Scappoose Creek – Frontal Columbia River Watershed

Janelle St. Pierre, Scappoose Bay Watershed Council

The Scappoose Bay watershed is located along the eastern flanks of the Tualatin Mountains, near the confluence of Multnomah Channel and the Columbia River. The watershed contains a broad diversity of habitats, ranging from small, steep mountain streams to low-gradient stream valleys that transition into the lowland floodplain of the Columbia River estuary. The watershed includes the mainstem and tributaries of North and South Scappoose creeks, Milton Creek, Honeyman Creek, and McNulty Creek, as well as several other smaller streams. Scappoose Bay and its connected bottomlands—a unique freshwater tidal estuary—is the focal point of this complex system, which provides clean water to its human residents and supports diverse wildlife habitat.

Most of the watershed is privately owned industrial forest with a small percentage of federal and state land (managed by the Bureau of Land Management and Oregon Parks and Recreation Department) and a scattering of small woodland properties. Rural residential properties take up most of the valleys, transitioning into (1) the urban areas of Scappoose and St. Helens/Columbia City, and (2) a small amount of agriculture in the lower portion of the watershed, primarily in the dikelands around Scappoose.

Scappoose Creek-Frontal Columbia River Watershed 123,105 acres	
Land cover	**% of Watershed**
Agriculture	22%
Regen. forest	4%
Developed	6%
Low Veg	5%
Tree Cover	57%
Water	5%
Forest Patches*	55%
Jurisdictions	
Metro UGB**	1%
Scappoose	2%
St. Helens/ Columbia City	3%
Rural	94%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB

Despite recent growth in the human population and the watershed's proximity to a major metropolitan area, the Scappoose Bay watershed still has 57 percent tree cover, which includes substantial conifer forests with remnant oak forests and savanna scattered at lower elevations. Wetlands rich in wildlife still grace the lowlands, filtering the basin's runoff.

Within the greater Portland-Vancouver region, the Scappoose Creek – Frontal Columbia River contributes about 7 percent of total lands.

KEY FACTS: The Scappoose Creek-Frontal Columbia River watershed within the greater Portland-Vancouver region:

- Is 16 percent publicly owned.

- Is 94 percent rural, with just 6 percent of the watershed falling within urban growth boundaries (primarily Scappoose and St. Helens/Columbia City).

- Has higher than average tree cover: 57 percent.

- Has a forest patch coverage rate of 55 percent. Of this, 14 percent is publicly owned and a substantial portion is working forest that is managed for timber extraction.

- Has 21,600 acres that are within the FEMA 100-year floodplain.

- Includes about 9,000 acres of mapped wetlands.

Historically, five species of salmonids were present in the Scappoose Bay watershed: fall Chinook, coho, and chum salmon and winter steelhead and cutthroat trout. Viable though imperiled wild populations of coho, cutthroat, and steelhead remain. Chum is considered extirpated, and the status of the fall Chinook population is uncertain. Historically, the Milton Creek and North and South Scappoose Creek subwatersheds had the highest diversity and largest populations of salmonids. Numerous smaller independent tributaries to Scappoose Bay and Multnomah Channel also provided salmonid habitat, but these did not have the species diversity or habitat availability of Milton Creek and North and South Scappoose creeks.

The Scappoose Bay watershed has a history of mining, logging, farming, diking, and other activities that degrade habitat. Loss of potential productivity of fish habitat was highest for all species and life stages in the valley floodplain stream type, which occurs mainly in the agricultural/rural residential areas of the mainstems of South Scappoose and Milton creeks. Despite severe population declines, creeks such as South Scappoose Creek—the most productive salmon-bearing creek within the Scappoose Bay watershed—still serve as an essential connection between Scappoose Bay and high-quality salmon habitat in the upper watershed. Remaining challenges include determining how best to restore the critical creek corridors and making strategic efforts to restore salmonid populations.

The Scappoose bottomlands are a rare freshwater tidal estuary near the confluence of the Columbia River and Multnomah Channel. This

area has habitat value both for resident species of fish, wildlife, and plants and for the salmon and bird species that migrate through the Columbia and Willamette basins and along the Pacific Flyway. Located next to Sauvie Island Wildlife Refuge and across from Ridgefield National Wildlife Refuge Complex, the Scappoose bottomlands are part of one of the last high-quality freshwater estuary systems left on the Columbia. The area's ash gallery forests, oak habitats, and tidal wetland plant communities host numerous migratory birds, including waterfowl, Neotropicals, and large birds of prey. The bottomlands also provide important habitat to Chinook, coho, and steelhead, which use the area for foraging and refugia.

Historical and current grazing and hydropower/flood control activities have degraded the quality of the bottomlands by altering the historical vegetation communities and hydrology. Hydrologic alteration has significantly reduced the connection between Multnomah Channel and Scappoose Bay. The historical sloughs that once linked the two water bodies have been cut off, and the bay and remaining channels face increased sedimentation because of a lack flushing flows (which occurred historically). Importantly, this has reduced food sources and vital off-channel habitats for salmon and steelhead.

Historical Conditions

The modern Columbia River valley was formed by conventional river processes and glacial outburst floods (i.e., the Missoula floods). The floodplain is wider than the active floodway—as much as 15 miles across near the confluence with the Willamette River. Locally, the floodplain narrows to just 1.5 miles wide, and the constriction has backed up floodwaters upstream that have caused the storage of considerable amounts of sediment in the vicinity of the Scappoose bottomlands.

Historically, the Scappoose Basin was 54 percent coniferous forest, 12 percent burned forest, 12 percent prairie and savanna, and 3 percent oak. By 2020, 20 percent had been converted to agriculture (consuming about 10,000 acres each of conifer forest and prairie) and 6 percent to urban uses (i.e., the cities of Scappoose and part of St. Helens, which consumed about 5,000 acres of conifer forest). Water features, primarily on the floodplain of the Columbia River, were reduced about 30 percent by filling or drainage.

Local and Regional Conservation and Restoration Priorities

The highest priority habitat identified in the Scappoose Bay watershed is the large area of estuarine channels and wetlands around Scappoose Bay (i.e., Scappoose bottomlands). The area is identified in the Oregon Conservation Strategy and Willamette Synthesis Project and represents one of the few remaining large tracts of lower Columbia River floodplain habitat that has not been drained, diked, and converted to farmland. However, both plans fail to acknowledge the connection between the bottomlands and the rest of the watershed, thus creating an incomplete picture of the area.

The area contains the mainstem of Scappoose Creek, numerous tidal sloughs and ponds, extensive beds of wapato, and ash and cottonwood forests that provide habitat for fish and wildlife, including long-legged wading birds, migratory waterfowl, and salmonids, who rear in the area. Most of the bottomlands are privately held, although there are a few large tracts that are state owned or in conservation easements. Past industrial use around the bay has left a toxic legacy of contaminated or potentially contaminated sites. The Oregon Department of Wildlife is in the process of working with potentially responsible parties to develop plans to address concerns.

The Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead identifies the Scappoose area (including portions of Sauvie Island and the lower Columbia River watershed) as an important area for recovery of coho and fall Chinook salmon and the potential reintroduction of Columbia River chum. This area is seen as a lynchpin for the recovery of salmonid populations in the lower portion of the Columbia (on the Oregon side) because of the already existing populations of wild fish and the potential for significant restoration and/or enhancement of refugia habitat.

Priorities and Plans for Future Conservation and Restoration

The Scappoose Bay Watershed Council is planning to conduct a limiting factors analysis (LFA) in order to direct future investments in restoration and conservation, build on existing efforts to improve salmonid habitat in the watershed, and tie in with salmon conservation and recovery planning. The LFA will analyze previously collected data to define areas of rich habitat and provide site-specific prescriptions to protect and enhance spawning and rearing habitat for salmonids in high-priority areas of North and South Scappoose creeks, Milton Creek, and significant tributaries. The analysis will quantify and map spawning gravel, summer-rearing habitat, floodplain connectivity, riparian function, sources of recruitment of large wood and gravel and other aspects of habitat quality and identify remaining impediments to passage.

The watershed council also is planning on creating a State of the Watershed Report for 2012. The report will identify the current state of the watershed, based on extensive data collection and the results of 10 years of restoration efforts, and will prioritize watershed management needs and identify habitat and water quality improvements projects and project partners and funding opportunities. With the addition of creek data collected in 2011, the watershed council will be able to provide a very detailed analysis of the health and function of salmon habitat in the watershed.

Major Initiatives

A comprehensive barrier assessment demonstrated that barriers have a significant cumulative impact on fish habitat on most streams in the watershed and prioritized barrier correction for all subwatersheds and the watershed as a whole. The Scappoose Bay Watershed Council has treated the majority of significant barriers along salmon-bearing creeks and tributaries in the watershed, working with partners to remove or replace 42 barriers, opening up more than 56 miles of creek for fish access. Additional barriers are targeted.

A 2000 watershed assessment and restoration plan identified South Scappoose Creek as the primary corridor between Scappoose Bay and high-quality salmonid habitat upstream and identified multiple factors that limit the creek's ability to support salmon. These factors include the filling of historical floodplains and secondary channels, channel straightening and realignment, loss of riparian vegetation, and floodplain constriction at road crossings. The Scappoose Bay Watershed

Council currently is implementing floodplain enhancement projects on two properties and plans for additional work in the near future.

Watershed Plans, Assessments and Reports

The following are available through the Scappoose Bay Watershed Council
http://www.scappoosebay-wc.org/

- Lower Columbia River Basin Aquatic Inventories Project (Oregon Department of Fish and Wildlife, 1998)
- Scappoose Bay Watershed Assessment (David Evans and Associates, 2000)
- A Comprehensive Assessment of Fish Passage Barriers in the Scappoose Bay Watershed (David Evans and Associates, 2001)
- The Scappoose Bay Bottomlands Conservation and Restoration Plan (The Wetland Conservancy, 2004)
- Scappoose River Basin Aquatic Inventories Project - Stream Habitat Surveys (Oregon Department of Fish and Wildlife, 2007 and 2009)
- Scappoose Bay Watershed Rapid Bio-Assessment (Bio Surveys, 2008)
- South Scappoose Creek Restoration Plan (Swanson Hydrology + Geomorphology, 2009)
- Hydrogeomorphic and Alternatives Assessment Report: Scappoose Bay, Oregon (Herrera Environmental Consultants, Inc., 2010)

Organizations and Partners

Scappoose Bay Watershed Council
57420-2 Old Portland Rd.
Warren, OR 97053
503-397-7904
http://www.scappoosebay-wc.org

Columbia Soil and Water Conservation District and the Natural Resources Conservation Service
2414 Sykes Road
St. Helens, OR 97051
503-397-4555
http://columbiaswcd.com

OSU Extension Service: Columbia County
505 N. Columbia River Hwy
St. Helens, OR 97051
503-397-3462
http://extension.oregonstate.edu/columbia

Lower Columbia River Estuary Partnership
811 SW Naito Parkway Suite 410
Portland, OR 97204
503-226-1565
http://www.lcrep.org

U S Fish and Wildlife Service
Habitat Restoration Program|
1211 SE Cardinal Court, Suite 100
Vancouver, WA 98683
360-604-2500
http:// www.fws.gov/columbiariver

Oregon Department of Fish and Wildlife
17330 SE Evelyn St,
Clackamas, OR 97015
971-673-6000

Oregon Watershed Enhancement Board
775 Summer St. NE, Suite 360
Salem OR 97301-1290
503-986-0178
http://www.oregon.gov/OWEB

8. Willamette River – Frontal Columbia River Subbasin and Hayden Island-Columbia River Watershed

Kaitlin Lovell, City of Portland

These two watersheds are combined for this watershed description, although watershed statistics are presented separately to illustrate the nature of the river island portion. Collectively, the two watersheds cover 98,000 acres, contributing 5 percent of all acres within the greater Portland-Vancouver region.

Within the region, the Willamette River – Frontal Columbia River subbasin's current land cover includes (Tables 1-1 and 1-2 and first inset box):

Willamette River-Frontal Columbia River Watershed 78,662 acres	
Land cover	**% of Watershed**
Agriculture	1%
Regen. forest	<1%
Developed	53%
Low Veg	12%
Tree Cover	28%
Water	6%
Forest Patches*	10%
Jurisdictions	
Metro UGB**	98%
Rural	2%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB

KEY FACTS: The Willamette River – Frontal Columbia River Subbasin within the greater Portland-Vancouver region:

- Is 54 percent developed, with only 2 percent of the watershed outside of the Metro Urban Growth Boundary. This watershed is the most urbanized watershed in region and makes up 4 percent of the region's total area.
- Is 40 percent vegetated (28 percent tree cover plus 12 percent low vegetation)—a level that reflects the relatively high level of development.
- Consists of 6 percent water. Bodies of water include Oaks Bottom and Smith and Bybee Wetlands Natural Area.
- Has 10,400 acres within the FEMA 100-year floodplain.
- Includes about 1,500 acres of mapped wetlands.

Hayden Island-Columbia River Watershed 15,558 acres	
Land cover	**% of Watershed**
Agriculture	<1%
Regen. forest	6%
Developed	10%
Low Veg	<1%
Tree Cover	75%
Water	<1%
Forest Patches*	6%
Jurisdictions	
Camas	9%
Metro UGB**	12%
Vancouver	14%
Rural	65%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB

KEY FACTS: The Hayden Island-Columbia River watershed within the greater Portland-Vancouver region:

- Is the region's smallest watershed, making up only 1 percent of the region.
- Is 75 percent water, reflecting the fact that the watershed consists of river islands and part of the mainstem Willamette River.
- Is mostly within the FEMA 100-year floodplain (more than 17,500 acres); this includes the river itself.
- Includes nearly 1,000 acres of mapped wetlands.
- Is 7 percent developed (primarily on Hayden and Government islands).
- Has 10 percent low vegetation and some significant sand bars. This reflects the watershed's placement in the Willamette and corresponding flood disturbance regime.

The habitats and biological communities of the Lower Willamette River are strongly influenced by the landscape in which they occur and the

170 years of changes that have shaped current conditions. The river channel and floodplain, wetlands, lakes, shoreline and sand bars, islands, and bluffs and ridges at the confluence of the Willamette have undergone substantial change. These features result in a biologically diverse albeit greatly simplified community in this now heavily urbanized area.[5]

Historical Condition of the Willamette River

The 187-mile-long Willamette River is the 19th largest river in the U.S. by volume and drains north into the Columbia River, the fourth largest river, at Columbia River Mile 105.[6] As with any watershed reach, the lower Willamette River reflects the cumulative impacts of conditions throughout the drainage area above it, including flood control dams on important tributaries, urbanization, and agriculture. However, the lower Willamette River is also strongly influenced by geologic conditions quite different from those in the upper basin. As the river flows over Willamette Falls, it transitions from a wide river to a deep, naturally constrained river. The floodplain in this reach is very narrow, and some of the river's deepest waters (100 feet or more) are found here. As the river passes Elk Rock Island, the channel re-opens. Historically this area was a dynamic delta full of braided channels, ephemeral streams, sloughs, lakes, and wetlands consistent with a large, active floodplain.[7] As it entered the Columbia, the Willamette River was nearly one-half mile wide, with a large shoal on the east river bank near Linnton.

In 1850, this basin was composed of 31 percent coniferous forest, 24 percent burned forest, 13 percent prairie and savanna, 3 percent oak, and substantial floodplain and riparian forest. Today, the basin is more than half urban, containing the city of Portland and part of Gresham, and 12 percent agriculture. Less than 1 percent of the basin is oak or prairie/savanna. Urban development consumed about 40,000 acres of coniferous and burned forest and about 6,000 acres of prairie, while agriculture consumed about 5,000 acres each of prairie and riparian forest. Water features, primarily on the floodplain of the Columbia and Willamette rivers, have been substantially reduced by filling or draining.

The Willamette and Columbia rivers flowed naturally until the 1930s, with high winter flows and peaks occurring in the late spring. Winter and spring floods were both frequent and important drivers of ecosystem function. They recharged wetlands, activated side-channels, moved sediments and wood, delivered nutrients, and shaped the channel. The Columbia River frequently backed up into the Willamette and flowed through many sloughs and gulches, including Sullivan's Gulch (now Interstate 84), the Columbia Slough, and Hawthorne Slough. Even this far inland from the ocean, the Willamette River experiences daily tides as far up as Willamette Falls. This part of the river was dominated by beaches and wetlands with most water depths at 20 feet or less. The Columbia Slough and Sauvie Island floodplain wetland system spanned more than 55,000 acres and connected to both the Willamette and Columbia rivers.

Current Condition of the Willamette River

The Willamette River – Frontal Columbia subbasin is the most urbanized watershed with the greater Portland-Vancouver region, with 98 percent of the region falling within the Metro Urban Growth Boundary. More than half of the land cover is mapped as developed. Portland (Oregon's largest city) sits on the lowest 19 miles of the Willamette's riverbank and 17.8 miles of the Columbia's. Portland is a major city at the confluence of two large rivers, where river-dependant industry thrived for decades; the city still provides significant jobs and benefits to the local economy. Flooding and significant flow variation historically made it difficult for businesses and urban centers to operate at the river's edge. Construction of upstream dams on both the Willamette and Columbia rivers radically altered the hydrology of the lower Willamette River, reducing winter and spring discharge and increasing summer flow. The ecologically valuable annual flood pulses of the past are largely gone.

These altered patterns enabled the development and urbanization of the area as we know it today. To further facilitate development, sea walls, levees, and riprap structures reinforced the riverfront. The river was dredged and cleared of snags and debris to accommodate larger ships. Bridges for cars and railroads crisscrossed the river. As a result, 89 percent of the historical off-channel habitat and floodplain was destroyed and 79 percent of the shallow water habitat (approximately 780 acres) was lost through deepening. A series of levees managed by drainage districts has completely disconnected the Columbia River from the floodplain between the Willamette and Sandy rivers.

The Willamette River's water quality declined significantly but has recently improved somewhat through expensive but effective efforts. The lower 6 miles of the Willamette River are a designated federal Superfund site on the National Priorities List.

Lakes and Wetlands

Several lakes occupied the west side of the river, including Caruthers, Couch, Guilds, and Doane. On the east side were Oaks Bottom, Hawthorne Slough, Rivergate, Ramsey, and Smith and Bybee Lakes. These lakes were frequently connected to the Willamette through braided channels or high flows and provided important migration, nesting, rearing, and refugia habitat to migrating fish and waterfowl, as well as permanent residence to numerous birds, amphibians, fish, and mammals. During high flows these lakes were important sources of nutrients, sediment, wood deposition, and flow attenuation for the Willamette and Columbia rivers.

Today, most of the lakes have been filled or greatly reduced. The former Caruthers Lake now supports the South Waterfront and Johns Landing communities. Couch, Guilds, Doane, Ramsey ,and Rivergate were filled to support industrial development. Only a remnant of Doane Lake exists today, completely isolated from the Willamette River. The remaining lakes and wetlands at Oaks Bottom and Smith and Bybee Lakes show evidence of historical landfill encroachment. All are actively managed to maintain water levels for wildlife and invasive vegetation control. However, these bodies of water still support numerous species of mammals and waterfowl, including osprey, blue herons, ducks, beavers, otters, coyote, and native fish.

Between the lakes were extensive wetlands, side channels, and riparian forests. The massive Missoula (i.e., Bretz) Floods between 10,000 and 20,000 years ago left scours and deposits along the banks, resulting in ridges and terraces that were covered in firs, oaks, and grasslands, with the Tualatin Hills to the west dominated by firs.

[5] Most of the information in this chapter was derived from Draft River Channel Characterization – Habitat and Biological Communities (City of Portland Bureau of Environmental Services, 2003). More detailed evaluations are in the Willamette Watershed Subbasin Status reports at http://www.portlandonline.com/bes/index.cfm?c=30938&

[6] USGS, http://pubs.usgs.gov/of/1987/ofr87-242/

[7] 1852 Government Survey Maps, available at: http://www.glorecords.blm.gov/

River Islands

When Lewis and Clark traveled down the Columbia they initially missed the Willamette River because the confluence area was hidden behind numerous islands. With the extensive shallow water, ephemeral shoaling, dynamic delta, and Missoula Flood deposits, there were many ephemeral islands in addition to large, permanent islands. Today we know those islands as Government Island, Hayden Island, Sauvie Island, Swan Island, Ross Island, and Elk Rock Island. The islands provided safe nesting and rearing sites for birds, migratory stopover habitat, flood attenuation, sources of gravel for mainstem spawning fish, wood for complexity, and other benefits to the river.

Elk Rock Island currently represents the most intact example of the riverine islands. Its habitat is a mix of oak and madrone forest with some firs, with emergent wetland vegetation near the fringes. Swan Island is completely altered, filled to connect with the mainland and provide additional development property. In the early 1900s Swan Island was the location for Portland Airport, before the area was developed for industrial use. Undeveloped areas of Sauvie and Hayden islands likely represent the type of habitat lost on Swan Island: prairie grasslands and riparian forest with mixed ash and cottonwood and some oak trees. The bluffs (discussed below) still contain some of this remnant habitat.

Upland Habitats and Connectivity

The Missoula Floods are primarily responsible for the topography of the area that remains today. On the east are buttes, terraces, and ridges, surrounded by flatter lands consistent with an alluvial floodplain. Before 1850 these areas were a mix of wetland, prairie, oak, and mixed conifer-deciduous and riparian forest. These areas were drained by numerous permanent and ephemeral tributaries. As the habitat transitioned toward the river, it became a riparian forest with cedar, cottonwood, willow, ash, and native shrubs. There are two distinctive bluffs on the east side of the river—one near Swan Island and one near Oaks Bottom—that continue to provide oak habitats. These bluffs also provide unique habitat for hawks and falcons. Currently, Portland's total canopy coverage is 27 percent.

The west side of the river is dominated by the Tualatin Hills formation known as the West Hills, which stretches from Tryon Creek to Sauvie Island and includes Forest Park. In upland areas, oak occupied shallow soils and drier microclimates and mixed conifer-deciduous forest was the dominant landcover types. The river floodplain was a complex mix of wetland, riparian, and floodplain types.

Large-scale vegetation removal occurred throughout this area but most predominantly on the east side because of urbanization and development. Remnant habitat patches remain, but they tend to be altered and often isolated. The westside uplands and hills remain the most intact but are impaired by large areas of invasive species such as ivy and blackberry.

The transition from the uplands to the river has been heavily altered. Many of the creeks that drain the west side have been piped underground, combined with sewer sent to the treatment plant, or eliminated altogether. The low-lying areas have been heavily developed. Riverview/Powers Marine, Harborton forest and wetlands, and Kelley Point Park provide the few remaining areas where there is some connectivity. As a result, the tributary processes such as wood and sediment transport, off-channel habitat, riverine habitat, nutrient delivery, and cooling benefits have been significantly constrained. Lowland habitat that differed in vegetation from the upland forest has been significantly altered and replaced with impervious surfaces.

Fish and Wildlife Species

Lewis and Clark famously noted the abundant wildlife in the area: "I [s]lept but verry little last night for the noise Kept [up] during the whole of the night by the Swans, Geese, white and Grey Brant Ducks &c…they were emensely numerous, and their noise horrid" (The Journals of Lewis and Clark, p.277). It is difficult to know how many species of fish were present historically. Today, 61 fish species are present in the lower Willamette, approximately half of them native.

There are 16 salmon and steelhead species or evolutionarily significant units (ESUs) that are protected under the federal Endangered Species Act. Lamprey—a culturally and ecologically significant native fish—are declining but still found in the lower Willamette and are harvested by tribal members at Willamette Falls. White and green sturgeon species are believed to be declining in this area but research is ongoing.

Bottomland forests and wetlands provide habitat for waterfowl, shorebirds and Neotropical migratory birds, including songbirds, kingfishers, cormorants, great blue herons, and ducks. Mammal species such as river otter, mink, weasel, deer, coyote, fox, and beaver still use the area. Reptiles and amphibians, including red-legged frogs, western painted turtles, and salamanders, are found in the sloughs and wetlands.

The bluffs and higher forests provide habitat for raptors such as hawks, eagles, osprey, and peregrine falcons; Neotropical migrants, including warblers, flycatchers, swallows, and tanagers; resident or short-distance migrant birds such as robins, chickadees, wrens, thrushes, sparrows, towhee, and kinglets; and bats. Remnant oak habitats are also used by several oak specialist species, including slender-billed (white-breasted) nuthatch, western gray squirrel (in some larger connected patches), and several moth and invertebrate species.

Although this represents robust biodiversity in an urban area, it is a small fraction of the historical populations. Many of the remaining species are tracked as ESA candidate species or state species of concern.

Conservation Priorities

Conservation priorities and efforts for this watershed are detailed in numerous local, state, and federal documents. Generally, the documents prioritize protecting and restoring key habitats and reintroducing lost habitat types and species. This is being partly addressed through acquisition, restoration, invasive species removal programs. and land use planning. Water quality protection is also a key priority. Efforts include the largest infrastructure project in the history of Portland to reduce the number of sewer overflows directly into the Willamette and advancements in innovative stormwater treatment such as green streets, rain gardens, and ecoroofs. Finally, contaminated sediment remediation continues to be an ongoing focus, especially with the cleanup of the Portland Harbor Superfund site and the ongoing remediation of the Columbia Slough sediments. Some of the key programs that are occurring and ongoing in the area include Portland Harbor, the City of Portland's Watershed Management Plan and River Plan, Metro's Bond Measure Acquisition Program, and a multi-jurisdictional sustainable

stormwater effort.

Into the future, climate change will have a profound effect on the river and its habitats, resulting in changes to the diverse biological communities. Some of the region's governments are beginning to work on climate change adaptation plans, but these efforts and the implementation will need to accelerate in the future to maintain, protect, and restore the existing and changing biodiversity of the region.

Organizations and Partners — Willamette River

- City of Portland – www.portlandonline.com/
- Metro Regional Government – www.metro-region.org
- Port of Portland – www.portofportland.com/SiteMap.aspx
- Columbia Slough Watershed Council – www.columbiaslough.org/
- Oregon Department of Fish and Wildlife – www.dfw.state.or.us/
- U.S. Fish and Wildlife Service - http://www.fws.gov/
- National Marine Fisheries Service of NOAA – www.nmfs.noaa.gov/
- Lower Columbia River Estuary Partnership (LCREP) – www.lcrep.org/
- U.S. Army Corps of Engineers – www.nwp.usace.army.mil/
- Multnomah County Drainage District – www.mcdd.org/ABOUTUS.html
- Portland State University – www.pdx.edu
- Nonprofits such as Willamette Riverkeeper, Audubon Society of Portland, Urban Greenspaces Institute, Columbia Land Trust

Resources — Willamette River

- NOAA Fisheries Estuary Module www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Estuary-Module.cfm
- Lower Columbia Salmon Conservation and Recovery Plan www.dfw.state.or.us/fish/CRP/lower_columbia_plan.asp
- City of Portland Willamette Watershed Subbasin Plan www.portlandonline.com/bes/index.cfm?c=30938&
- Oregon Conservation Strategy www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

9. Abernethy Creek-Willamette River Watershed (Greater Oregon City)

Rita Baker, Greater Oregon City Watershed Council

The Greater Oregon City watershed is within the Willamette Basin in western Oregon. The watershed encompasses three primary subwatersheds: Abernethy Creek, Beaver Creek, and the Willamette River.

Abernethy Creek enters the Willamette River at River Mile 25 and is tidally influenced at its confluence with the river. Lower Columbia River anadromous runs of coho salmon and steelhead are present in the Abernethy Creek subwatershed.

Beaver Creek, of which Parrott Creek is a large tributary, enters the river above Willamette Falls at RM 31. This system is not tidally influenced. Because Beaver Creek is above the falls, and historically blocked some fish runs, this stream is part of the middle Willamette River system. The Beaver Creek subwatershed contains resident cutthroat trout and lamprey and may now be accessible to Upper Willamette River steelhead.

The Willamette River subwatershed consists of small tributaries that begin within Oregon City and flow over steep-sided bluffs directly into the river. These small streams have very high gradients and do not contain salmonids, with the exception of lower channel habitats within the Willamette River floodplain. Fish occupy the lower floodplain portions of the small streams during high-flow periods.

Abernethy Creek-Willamette River Watershed 87,102 acres	
Land cover	**% of Watershed**
Agriculture	30%
Regen. forest	<1%
Developed	15%
Water	2%
Low Veg	10%
Tree Cover	43%
Forest Patches*	31%
Jurisdictions	
Canby	3%
Donald	<1%
Metro UGB**	19%
Rural	79%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB

The Greater Oregon City watershed contains four hydrogeologic units: unconsolidated sedimentary aquifer, Troutdale gravel aquifer, Troutdale sandstone aquifer, and older rocks.

The rich history of the Oregon City area has been influenced by its strategic location near Willamette Falls. Originally called Green Point, the area served as a gathering spot for Native Americans who fished at Willamette Falls for more than 3,000 years. George Abernethy arrived in 1840 as part of a mission and homesteaded 640 acres just north of present-day Oregon City. Oregon Trail emigrants started arriving on rafts from Fort Vancouver in 1843, often wintering at Abernethy's house, to scout out land in the Willamette Valley, file their claim at the Government Land Office, and resupply at Oregon City stores.

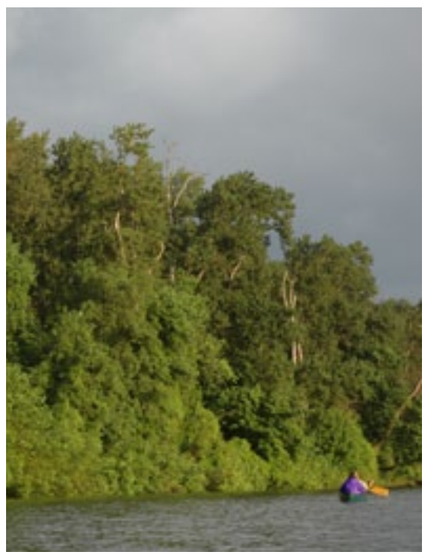
Currently most land is privately owned. The major land cover types and land uses are agricultural and rural residential land uses. Nine percent of the watershed is covered by impervious surfaces.

The Abernethy Creek-Willamette River watershed makes up 5 percent of the total area within the greater Portland-Vancouver region.

KEY FACTS: The Abernethy Creek-Willamette River watershed within the greater Portland-Vancouver region:

- Has a high proportion of agriculture (30 percent).
- Consists of 79 percent rural lands, with another 19 percent in the Metro Urban Growth Boundary. Developed cover is 15 percent.
- Is 96 percent privately owned.
- Is more than half covered by trees (43 percent) and low vegetation (10 percent).
- Has more than 3,900 acres within the FEMA 100-year floodplain.
- Includes more than 1,000 acres of mapped wetlands.

The Abernethy Creek, Beaver Creek, and Willamette River subwatersheds have been dramatically altered over the years as a result of urbanization, agriculture, and other land uses. Historically, old-growth and younger coniferous forest covered about 52 percent of this subbasin, prairie and savanna covered about 25 percent, and oak about 11 percent. By 2010, more than 70 percent had been converted to agriculture and urban uses (i.e., the cities of Canby, Oregon City, West Linn, and Wilsonville). All of the historical prairie and savanna, about 60 percent of the oak, and about 30,000 acres of conifer forest were split equally between agriculture and urban uses.



Historically the areas along the streams were occupied by a mix of deciduous-coniferous forests and wetlands. Riparian-area vegetation included red alder, big-leaf maple, western red cedar, and Douglas

fir, with an understory of fern, snowberry, and salmonberry. The area along the Willamette River between Abernethy and Beaver creeks consists of upland bluffs and steep cliffs. Many of the area's unique and culturally significant plant species, including the state endangered pale rock larkspur (*Delphinium leucophaeum*) and camas (*Camassia* sp.), are found in this area, as they were historically. Historically, the upland bluffs contained substantial oak and prairie habitats.

A 2010 watershed assessment evaluated current conditions for riparian and wetland areas, using LiDAR-based imagery to assess vegetation within 100 feet on each side of the stream channel. Approximately half of the Abernethy and Beaver Creek riparian areas are forested.

Four salmonid species and a variety on native non-salmonid fish species inhabit the streams for at least a portion of their life cycle. Non-salmonid fish species include Pacific and brook lamprey, cutthroat trout, sculpins, dace, and shiners. Coho salmon, fall Chinook salmon, and winter steelhead were historically abundant in the lower Willamette River and its tributaries. Anadromous fish in the watershed have experienced significant declines. The cutthroat trout has the widest distribution of any fish the Greater Oregon City watershed. Although lamprey have been declining in abundance, the Willamette Basin still is probably the most important production area for Pacific lamprey within the Columbia River system.

Despite its developed nature the watershed provides feeding, breeding, and movement habitat for a variety of songbirds, raptors, deer, small mammals, amphibians, and other wildlife. Native Oregon white oak remnants harbor slender-billed (white-breasted) nuthatches and other oak-associated species. Stream corridors, including Newell Creek, provide key habitat and the best remaining wildlife connectivity from the river to other habitat areas; for this reason, riparian enhancement would significantly benefit wildlife.

The Greater Oregon City watershed provides several large habitat blocks, including 300 acres in Newell Creek Canyon in the Abernethy Creek subwatershed, 107 acres in the upper Abernethy Creek headwaters, and 112 acres in the Willamette Narrows and Canemah Bluff in the Willamette River subwatershed.

The April 2010 Greater Oregon City Watershed Council (GOCW) assessment identified work needed on riparian habitat in 4 percent of both the Abernethy Creek and Beaver Creek areas. Although the area covered by riparian vegetation is relatively small, it is disproportionately important because it fulfills several critical functions that promote healthy streams and fish populations: stream shade, food sources, and large wood in the stream channel that creates pools, cover, and other high-quality fish habitat elements. Although the Abernethy Creek and Beaver Creek watersheds include substantial forest, they contain very few large trees, so there are few opportunities for large trees to fall and provide the amount of large wood to stream channels necessary for high-quality fish habitat.

A comprehensive field inventory of invasive plants has not been completed for the subbasin, but there are scattered observations. All five of the most common invasive plant species (English and Irish ivy, Himalayan blackberry, Scot's broom, reed canarygrass, and Japanese knotweed) were present in an inventory of the Newell Creek canyon, particularly along forest edge areas and highway corridors.

Protecting high-quality habitats for salmonids and other species "anchor" the subbasin's restoration efforts and provide core areas that can be enhanced and reconnected to the entire watershed through restoration actions. The Greater Oregon City Watershed Council has identified the Newell Creek, Holcomb Creek, and Potter Creek systems in the lower portions of the Abernethy Creek subwatershed as priority areas for restoration activities. Collaboration with Metro on a portion of its 300 acres near OR-213 and Beavercreek Road is being explored at this time. A secondary priority is enhancing habitat in the Beaver Creek-Parrott Creek confluence where a dam that had been historically present in one form or another since the 1800s washed out in 2009. Discussions have taken place and are ongoing with landowners about potential alternatives for conservation and restoration opportunities.

A dam near the confluence of Beaver and Parrott creeks created an impoundment, Sevick Pond, which backed up water in the area upstream and blocked fish access. This dam remained in place until the January 2009 flood, which eroded the northern portion of the dam, creating a channel that may be passable to fish. Outreach to the landowners and intervention by wildlife agencies on attempted repairs to the dam have netted a recent contact with the landowner's consultant to begin a dialog that may result in habitat restoration in the future.

The Greater Oregon City Watershed Council is also working on a complementary project with Clackamas Community College to plan for a green infrastructure stormwater project on campus. The Clackamas Community College campus is located on the headwaters of Newell Creek.

Watershed Plans, Assessments, and Reports — Abernethy Creek-Willamette River Watershed

- Newell Creek Watershed Restoration and Conservation Strategy (Clearwater BioStudies Inc. Prepared for PACE Engineering, Oregon City, OR, and the John Inskeep Environmental Learning Center.)
- Greater Oregon City Watershed Assessment and Action Plan, 2010 www.GOCWC.org.
- Biological Assessment for Endangered Species Action Section 7 and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Clackamas County Bank Stabilization Project, Lower Abernethy Creek, Clackamas County, Oregon. (C.W. Huntington, 2007.)
- Abernethy and Newell Creeks Goals and Objectives (Metro, 2009) www.oregonmetro.gov/index.cfm/go/by.web/id=26790
- Effects of Urbanization on Stream Ecosystems in the Willamette River Basin (I.R. Waite, S. Sobieszczyk, K.D. Carpenter, A.G. Arnsberg, H.M. Johnson, C.A. Hughes, M.J. Sarantou, and F.A. Rinella, 2008)

Organizations and Partners — Abernethy Creek-Willamette River Watershed

- City of Oregon City/Public Works – Eric Hand, P.O. Box 3040, Oregon City, OR 97045 - 503-657-8241
- Clackamas Community College – Alison Heimowitz, 19600 S. Molalla Avenue, Oregon City, OR 97045 – 503 -594-3696
- Clackamas County – Mark Mouser, 2051 Kaen Rd, Oregon City, OR 97045 – 503-742-4400
- Clackamas County Soil and Water Conservation District — Jenne Reische, 221 Molalla Avenue, Suite 102, Oregon City, OR 97045 – 503 -210-6011
- Metro – Brian Vaughn, 600 NE Grand Avenue, Portland, OR 97232 – 503 -797-1919
- SOLV – Steve Kennett, 5193 NE Elam Young Pkway, Suite B, Hillsboro, OR 97124 – 503-844-9571 x318
- Oregon Department of Fish and Wildlife Northwest Region Office – www.dfw.state.or.us/agency/directory/local_offices.asp, 971-673-6000
- Oregon Watershed Enhancement Board – www.oregon.gov/OWEB/, 503-986-0061
- Oregon Wildlife Heritage Foundation – www.owhf.org/, 503-255-6059

10. Chehalem Creek – Willamette River Watershed

Patricia Farrell, Yamhill Watershed Stewardship Fund

The Chehalem Creek - Willamette subwatershed totals 78,245 acres, including 43,563 acres north of the Willamette (Chehalem Creek) and 34,618 acres south of it (Willamette watershed). The 68-square-mile (43,400-acre) Chehalem Creek Watershed is located at the northeast end of Yamhill County. Elevations range from about 60 feet above sea level, at the Willamette River, to more than 1,400 feet along the mountain ridge on the east and northern fringe. The Chehalem and Parrett Mountains form the northern and eastern edge of the watershed, at elevations or 1,414 and 1,247 feet, respectively. The Red Hills of Dundee, at elevation 1,067 feet, occupy the southwest corner of the watershed.

Unique in Yamhill County, the Chehalem Creek watershed drains directly to the Willamette River, rather than the Yamhill River. The watershed includes the urban areas of Newberg and Dundee. The 50-square-mile southern portion of the watershed, known as French Prairie, is in northern Marion County, is primarily flat, and divided by Mission, Champoeg and Case creeks.

Chehalem Creek originates from springs, wetlands, and headwater streams 6 miles southeast of Gaston and discharge into the Willamette River between Newberg and Dundee. Other named streams within the watershed include Springbrook, Hess, Harvey, Dopp, and Bryan creeks. Chehalem Valley soils are a complex mix of volcanic and sedimentary types. The creeks flow generally north through deep alluvial soil.

Historically, the Chehalem subbasin was covered almost entirely by oak (60 percent) and prairie (29 percent), the most extensive occurrences of these cover types in the greater Portland-Vancouver region. Almost all of this oak and prairie—approximately 30,000 acres of oak and nearly 20,000 acres of prairie—were converted to agriculture and urban uses (i.e., approximately 8,000 acres of oak in Dundee and Newberg).

Chehalem Creek-Willamette River Watershed 87,102 acres	
Land cover	**% of Watershed**
Agriculture	54%
Regen. forest	<1%
Developed	10%
Low Veg	6%
Tree Cover	29%
Water	1%
Forest Patches*	21%
Jurisdictions	
Dundee	1%
Newberg	5%
St. Paul	<1%
Rural	93%

*Tree/regen. forest patches >30 acres.

Combined conifer and mixed forest showed a net gain of 10 percent cover, probably at the expense of oak in the absence of fire. The indigenous Che-ahm-ill people of the "Yam Hills" area (a subgroup of the Kalapuya nation) occupied the valley at the time of Euro-American contact until they were moved, primarily to the Grand Ronde reservation in the Coast Range.

The watershed covers about 4 percent of the total area in the greater Portland-Vancouver region.

KEY FACTS: The Chehalem Creek – Willamette River watershed within the greater Portland-Vancouver region:

- Has the highest proportion of agriculture (54 percent) of any watershed in the region.
- Consists of 10 percent developed land, much of which is in Newberg. A total of 7 percent of the watershed lies within an urban growth boundary.
- Has relatively little tree cover (29 percent), which reflects the watershed's agricultural nature.
- Has 6 percent low-structure vegetation cover, some of which likely is in vineyards.
- Has about 7,600 acres within the FEMA 100-year floodplain.
- Includes more than 1,200 acres of mapped wetlands.

Currently, the Chehalem Creek watershed has extensive vineyards and numerous wineries, as well as nurseries, grass seed, and specialty crops. Previous watershed assessments indicate that forestry represents about 36 percent of the land use, urban uses are approximately 7 percent, and 2 percent is in quarries. The City of Newberg has an urban reserve area and is proposing an expansion of its urban growth boundary to the south for industrial lands. Highway 99 is the major transportation corridor and source of traffic through the county. A traffic bottleneck through Dundee has lead to efforts to construct a Newberg/Dundee bypass, and an environmental impact study has been undertaken. Except for small urban areas, the creek drainages, and Champoeg State Park, the Willamette portion is dominated by agriculture, especially grass seed and row crops.

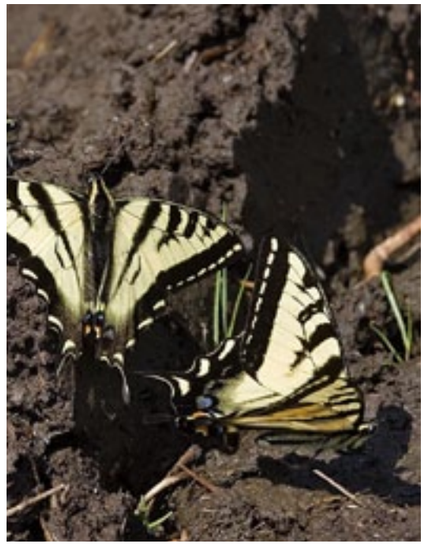
In the Chehalem Creek watershed, large floodplain wetlands continue to persist in the upper valley, forming a nearly continuous landform with the Wapato Lake complex to the north; however, many of the watershed's streams and wetlands have been altered, ditched, and drained for agriculture and development. Oak savanna has been mostly lost to Douglas fir forestry and vineyard development. Riparian cover has been greatly reduced. At least seven small dams have been constructed for agricultural purposes. Other fish barriers include culverts on most streams. Streamflow has been altered by groundwater wells for domestic and agricultural purposes, and the Oregon Water Resources Department has designated a groundwater-limited zone in the Chehalem Mountain area.

The Chehalem Creek watershed includes the interesting landscape formations of the Chehalem Mountains, the Willamette River, the Red Hills of Dundee, and the upper Chehalem Valley wetlands. The Chehalem Valley forms a link between the Wapato Lake/Tualatin watershed and the Willamette River.

The watershed is home to sensitive plant and wildlife species, including western gray squirrel, flying squirrel, bobcat, western pond turtle, red-legged frog, pileated woodpecker, acorn woodpecker, western bluebird, northern goshawk, bald eagle, white-breasted nuthatch, Kincaid's lupine, Fender's blue butterfly, Nelson's and meadow checkermallow, and numerous species of bats.

Chehalem Creek has mapped critical habitat for winter steelhead; however, passage is restricted at a culvert at Highway 240. Floodplain and riparian areas along the Willamette River and Ash Island benefit instream habitat for spring Chinook salmon and winter steelhead trout. Native cutthroat trout are also known to persist in the watershed.

Oregon State Parks owns Bald Peak State Park on Chehalem Mountain, Willamette Greenway State Park at the eastern edge of the county, and Champoeg State Park along the Willamette. Chehalem Parks and Recreation District operates exclusively within the Chehalem Creek watershed, with properties along Chehalem Creek, Springbrook Creek, and the Willamette River, as well as many other more urban or developed parks and the Chehalem Glen Golf Course.



Preliminary analysis is under way for an expanded trail system linking the various parks and open spaces and connecting regional trails. There are no county parks in the watershed.

The Chehalem Creek–Willamette watershed has several of the priority habitats listed in the *Oregon Conservation Strategy*, including oak habitats, riparian bottomland forest, freshwater aquatic habitats, and wetlands. Both the Oregon Department of Fish and Wildlife and The Nature Conservancy have been mapped Conservation Opportunity Areas in the watershed. These priority habitats include Tier 1 wetlands, oak, mid-elevation forest, floodplain forest, and riparian forest.

The U.S. Fish and Wildlife Service has mapped all of Yamhill County under its recovery plan for prairie species in western Oregon and southwestern Washington. Both the U.S. Fish and Wildlife Service and the Yamhill Soil and Water Conservation District are working with landowners to preserve and enhance habitat for listed species, including Kincaid's lupine, Fender's blue butterfly, and Nelson's checkermallow.

The watershed has ample opportunities for restoration and enhancement. The upper Chehalem valley has extensive farmed or grazed wetlands that present restoration and conservation opportunities. The mid-valley supports large tracts of intact riparian floodplain forest along Highway 240 that could be conserved and enhanced. The confluences of the local creeks and the Willamette River create opportunities for both conservation and restoration of riparian and off-channel habitats. Springbrook Creek also has potential for restoration as part of a planned subdivision. In addition, wet and upland prairie habitats could be restored in the watershed and landowner interest in conservation easements exceeds the capacity of agencies to respond to requests. Acquisition of land on Ash Island represents a mainstem Willamette conservation opportunity. Priorities include:

- Inventory, restoration, and preservation of oak habitats
- Upper Chehalem Valley wetland restoration
- Prairie species restoration and conservation
- Riparian enhancement for temperature reduction and soil stability
- Restoration of floodplain and off-channel habitats along Willamette River and Chehalem Creek
- Pond turtle habitat conservation
- Improved agricultural practices to improve water quality

Several Wetlands Reserve Program and oak savanna projects are already under way. Both the City of Dundee and the Chehalem Parks and Recreation District are eager to invest in the opportunities for recreation along the Willamette River and its greenway and throughout the Chehalem watershed. The U.S. Fish and Wildlife Service has begun to acquire land for its Wapato Lake Wildlife Refuge, which is part of the Tualatin Refuge system. Although this new refuge is just over the county line, it is on the flyway of migratory waterfowl and songbirds and thus provides the watershed's residents with nearby opportunities for bird watching and passive recreation. Oregon State Parks is restoring oak and prairie habitat at Champoeg State Park.

Organizations and Partners — Chehalem Creek Watershed

- Greater Yamhill Watershed Council – Bernadette Hansen gywc_administrator@co.yamhill.or.us
- City of Newberg, http://www.newbergoregon.gov/
- City of Dundee, http://www.dundeecity.org/
- Yamhill County, http://www.co.yamhill.or.us/
- Marion County, http://www.co.marion.or.us/
- Chehalem Parks and Recreation – Don Clemens, clemend@cprdnewberg.org
- Yamhill Soil and Water Conservation District – Tim Stieber, Tim.Stieber@or.nacdnet.net
- George Fox College – Clyde Thomas cthomas@georgefox.edu
- Yamhill Watershed Stewardship Fund – Patricia Farrell, ywsf08@yahoo.com
- Yamhill Partners for Land and Water – Patricia Farrell, ywsf08@yahoo.com;Will Neuhauser, co-chair@yamhillpartners.org
- Friends of Yamhill County – Ilsa Perse
- U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program – Chris Seal, chris_seal@fws.gov
- Natural Resource Conservation Service – Kim Hudnall, District Conservationist, 503-472-1474 X 101

Watershed Plans, Assessments, and Reports — Chehalem Creek Watershed

- Chehalem Watershed Assessment (Yamhill Basin Council, 2001) https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?pn=viewrecord&XMLname=120.xml
- Yamhill Basin Council 2005 Action Plan for the Yamhill River and Chehalem Creek Watersheds
- Yamhill Soil and Water Conservation District Strategic Plan http://www.yamhillswcd.org/about_us/StrategicPlan07.pdf
- The Nature Conservancy – Conservation Action Plan for Yamhill County (in progress)
- Natural Resources Conservation Service Strategic Plan (draft, not available on web)
- Chehalem Heritage Trail (Parks and Recreation District) http://www.cprdnewberg.org/ChehalemHeritageTrails/index.shtml
- Willamette River Water Trail http://www.willamettewatertrail.org/

11. Molalla-Pudding Subbasin

Michael Moody, Molalla River Alliance
Lori Hennings, Metro

Includes these named USGS HUC watersheds:
Lower Molalla River
Rock Creek
Senecal Creek – Pudding River

The Molalla-Pudding subbasin is located in the northeastern portion of the middle Willamette Basin and covers approximately 561,000 acres, including 181,000 acres within the greater Portland-Vancouver region. The headwaters of the 53-mile-long Molalla River are located near the Table Rock Wilderness within the Cascade Range. This dam-free river flows through basalt rock canyons and conifer forests before reaching agricultural land, flowing through the cities of Molalla and Canby and then into the Willamette River between River Miles 35 and 36 near Canby. The Pudding River is 62 miles long and originates in the low-elevation Waldo Hills east of Salem.

Within the greater Portland-Vancouver region, the subbasin encompasses three major watersheds: Senecal Creek–Pudding River (53 square miles), Rock Creek (86 square miles), and Lower Molalla River (144 square miles). The middle and upper portions of the subbasin lie outside the greater Portland-Vancouver region and are a mix of private agriculture and forest lands. The Bureau of Land Management owns 67 square miles in the upper Molalla watershed, known as the Molalla River Recreation Corridor.

Within the greater Portland-Vancouver region, the Molalla - Pudding subbasin contributes 10 percent of the area.

Molalla-Pudding Subbasin (partial) 180,960 acres	
Land cover	**% of Watershed**
Agriculture	43%
Regen. forest	3%
Developed	8%
Low Veg	4%
Tree Cover	42%
Water	<1%
Forest Patches*	37%
Jurisdictions	
Aurora	<1%
Barlow	<1%
Canby	1%
Donald	<1%
Hubbard	<1%
Molalla	1%
Woodburn	2%
Rural	96%

*Tree/regen. forest patches >30 acres.

KEY FACTS: The Molalla-Pudding subbasin within the greater Portland-Vancouver region:

- Is 97 percent privately owned.
- Lies mostly (96 percent) outside urban growth boundaries.
- Is 8 percent developed.
- Has nearly equal amounts of tree cover (42 percent) and agriculture (43 percent).
- Has nearly 11,000 acres within the FEMA 100-year floodplain.
- Includes about 3,800 acres of mapped wetlands.

The subbasin's soils, geology and habitat were influenced by glaciers and sediment deposition, including the Missoula Floods about 10,000 years ago. These events created a variety of ancient bogs, marshes, and swamps that influence soils, wetlands, and topography in the subbasin today.

The Senecal Creek-Pudding River watershed lies primarily in Marion County, with the northeastern portion in Clackamas County. Mill, Senecal, and Deer creeks merge and enter the Pudding River near Aurora. The Pudding enters the Molalla River at the northernmost portion of the watershed, about 1 mile from the Molalla-Willamette confluence. Agriculture is the primary land use, but the subbasin also includes the small city of Aurora and the larger city of Woodburn. Both cities are considered to be part of the Salem metropolitan statistical area.

The Rock Creek watershed is in Clackamas County. The upper (southern) area includes substantial privately owned forest in the foothills of the Cascades, with the remainder dominated by agriculture. Major tributaries include Cedar, Bear, Kaiser, Teasel, Comer, and Marquam creeks.

The Lower Molalla River watershed, which also is in Clackamas County, has more than 40 percent tree cover, including substantial amount of forestlands in the eastern two-thirds of the drainage. The remainder of the Lower Molalla River watershed is in agriculture (43 percent) and several relatively small urban areas. Beavercreek and Mulino are hamlets, a model of governance in Clackamas County representing a type of rural subdivision. The Molalla River runs south to northeast through this watershed, entering the Willamette River east of Wilsonville. Major tributaries include Beaver, Buckner, Cedar, Little Cedar, and Milk creeks.

The Molalla-Pudding subbasin provides the region with important natural resources, including high-quality agricultural soils and timber production lands. The Molalla River is the primary source of drinking water for more than 20,000 citizens of Canby and Molalla and offers recreational opportunities and many acres of native fish and wildlife habitat, including cold-water spawning streams for fish.

Historical Land Use and Vegetation

The Molalla River and the adjacent Table Rock Wilderness provided important trade routes across the Cascades between indigenous peoples of the northern Willamette Valley and eastern Oregon. The Molalas were the primary native inhabitants. They relied heavily on deer, elk, salmon, and seasonal resources such as roots, seeds, nuts, and berries. Camas growing in wet prairie was common and regularly harvested.

Modern settlers arrived around the 1840s and initiated agriculture almost immediately. The Molalla River and its tributaries were heavily logged from the late 1940s though 1970; during this period logging practices included the use of splash dams, which are temporary structures that block the flow of the river. The lack of forest practice rules allowed logging to the river edge. Local residents reported that the slightest rains during this time caused the river to run bright red because of the large amounts of exposed soils and sediment.

Historically, 72 percent of the Molalla Basin was split evenly between coniferous forest and prairie or savanna, with another 11 percent in oak. By 2010, 50 percent of the basin had been converted to agriculture, which consumed about 50,000 acres of prairie and savanna and 10,000 acres of oak. An additional 10,000 acres of oak were converted to urban use (i.e., the cities of Aurora, Hubbard, Molalla, and Woodburn, and part of Canby). The extent of combined coniferous and mixed forest has remained about the same.

Current streamside vegetation is highly variable, but often streamside vegetation is scarce or dominated by invasive species. Potential streamside vegetation includes black cottonwood, Oregon ash, western Hawthorne, bigleaf maple, and shrubs such as willow, dogwood, hazelnut, and snowberry. Current upland vegetation is highly mixed and includes crop and pasture land, coniferous and deciduous forest, and orchards. Small remnants of oak and prairie are largely unmapped.

Species, Habitats, Threats, and Conservation and Restoration Opportunities

The river and its surrounding lands are at risk from impacts of agriculture, timber harvesting, urbanization, and climate change.

WATER QUALITY

Agriculture and forest practices exert the most pressure on the subbasin's water quality, quantity, and hydrologic patterns. These alterations can lead to changes in peak and low flows, as well as surface and groundwater yield within a watershed. Agricultural activities such as clean-tilling of the soil, disruption and removal of riparian vegetation, and stream channelization affect water quality (pesticides and excess nutrients) and hydrology. Stream channelization on agricultural lands has occurred throughout the lower subbasin. Forest practices, such as road building, the use of splash dams, and the removal and disturbance of timber and other vegetation, also influence the quantities and rates of runoff, evapotranspiration, and infiltration.

Section 303(d) of the federal Clean Water Act requires states to list rivers and other water bodies that do not meet water quality standards. According to the total maximum daily load for the Molalla-Pudding subbasin (issued by the Oregon Department of Environmental Quality in December 2008) 14 reaches in the subbasin are water-quality impaired, including the entire Molalla River mainstem. As with streams in many other watersheds in the greater Portland-Vancouver region, elevated water temperature is identified as as a key problem.

Temperature affects rearing and spawning habitat for salmonids. The reasons for increased water temperatures are many, including removal of riparian vegetation, logging, land use changes, and road building. Warming temperatures that are projected to occur over the next several decades will exacerbate water temperature problems, hydrology will change, and the amount of thermally suitable habitats will shrink. Small cold-water tributaries will be vital in ensuring that the Molalla-Pudding system is as resilient as possible to these expected changes, and that

it remains healthy and productive for native fish and as a drinking water source. To achieve this, such tributaries need to be protected from excess nutrients, sediments, and debris from logging and agriculture. Stream side shade needs to be retained to keep streams cool.

Other water quality issues in various areas of the subbasin include nitrates, dissolved oxygen, fecal bacteria, metals (iron, manganese and arsenic; the latter two may occur naturally), and legacy pesticides—primarily DDT and dieldrin.

FISH

The headwaters of the Molalla River provide vital spawning, rearing, and migration areas for two ESA-listed fish: wild winter steelhead and spring Chinook salmon. The river also has resident rainbow and cutthroat throat and a reintroduced population of coho salmon. Butte Creek, which becomes the Pudding River south of the Senecal Creek–Pudding River watershed, has some of the best remaining and potential salmon habitat and is identified as an important priority in fish recover.

Chinook Salmon

The Molalla River historically supported relatively abundant Chinook populations, but these dwindled through the 20th century because of habitat conditions caused by agricultural and forest practices, urbanization, out-of-basin stockings, and poaching in summer holding areas. The Molalla spring Chinook salmon run is part of the Upper Willamette evolutionary significant unit (ESU), which was federally listed as threatened under the Endangered Species Act in 1999. Recovery planning efforts have identified the need to recover all historical populations of Chinook in the Upper Willamette ESU, including in the Molalla-Pudding subbasin. Abundance and productivity information indicate that the subbasin's Chinook population is likely close to extirpation and has been assigned an extinction risk category of very high (see the Oregon Department of Fish and Wildlife's Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead).

Steelhead

The Molalla wild winter steelhead run is part of the Upper Willamette ESU, which was federally listed as threatened under the Endangered Species Act in 1999. The Molalla River population is now considered a stronghold population. For decades before 1997, the Molalla River was stocked with out-of-basin summer steelhead, winter steelhead and coho salmon. These stockings, combined with heavy timber harvest in the mid-century, led to the sharp decline of this population. Stocking stopped with the listing of native winter steelhead and spring Chinook salmon. Only a decade ago, Molalla River wild winter steelhead were estimated to number fewer than 200 fish, but in 2007 and 2008 the estimate grew to more than 1,500 fish, according to Oregon Department of Fish and Wildlife and Native Fish Society reports.

Trout, Lamprey, and Coho Salmon

The upper Molalla River has a healthy population of native cutthroat and resident rainbow trout. A remnant population of Pacific lamprey also remains in the river. In addition, Native Fish Society observations and Willamette Falls fish counts indicate that a run of reintroduced coho salmon from a stocking program that was discontinued in 1998 has had a steady and significant linear increase.

WILDLIFE AND KEY HABITAT AREAS

Within the greater Portland-Vancouver region, the Molalla-Pudding subbasin supports deer, elk, native squirrels, beaver, mountain beaver (aplodontia), raccoons, fox, coyotes, cougar, and bear. Wet areas support rough-skinned newt, Pacific tree frog, Pacific giant salamander, and the common garter snake. Many song birds breed, forage, and migrate through the area, as do geese, wood ducks, grouse, pileated woodpeckers, American dippers, great blue heron, osprey, and common and hooded mergansers.

Low-lying and foothill areas in the subbasin include native Oregon white oak and prairie remnants, although thorough mapping has yet to be done. These habitats support numerous sensitive, threatened, or endangered plants and animals, such as western gray squirrel and white-breasted nuthatch.

Molalla River State Park protects the confluence of the Pudding, Molalla, and Willamette rivers. The floodplains of these rivers provide important habitat for waterfowl, wading birds, deer, small mammals, reptiles, and amphibians. A blue heron rookery, one of the largest in the Willamette Valley, is located in Molalla River State Park.

WATERSHED PRIORITIES

The Oregon Department of Fish and Wildlife's Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead lists water quality (including water temperature), habitat access, and physical habitat quality as some of the factors limiting the viability of fish populations in the upper Willamette River and its tributaries. The plan recommends several strategic actions, such as restoring fish passage, improving water quality (especially temperature), improving habitat access through river restoration, protecting habitat quality by reducing forestry impacts, and successfully designating the Molalla a Wild and Scenic River. The key priority for groups working on the Molalla River is to preserve or improve the water quality of the river and sustain the people, wildlife, fish and plants that inhabit its watershed.

INITIATIVES CURRENTLY UNDER WAY

The Molalla River Alliance initiated and leads efforts to secure federal Wild and Scenic River designation for approximately 22 miles of the upper river. The designation would protect approximately 7,000 acres of riparian land along the river.

Several local organizations, including Molalla RiverWatch and many volunteers, are working with federal, state and local agencies as well as local landowners to protect the Molalla River, restore its fish and wildlife, and encourage tourism. A fish barrier on Russell Creek was replaced to open up passage for winter steelhead, coho salmon, and resident rainbow and cutthroat trout. Local organizations are actively seeking funding to open more streams to fish passage and improve spawning and rearing habitat. Each year the Native Fish Society guides volunteers in conducting surveys and placing hatchery salmon carcasses for nutrient enrichment in the upper watershed.

The Molalla River Alliance, Molalla RiverWatch, and the Native Fish Society created the Molalla River Resource Center in downtown Molalla so that the community has a central location for information on the Molalla River and its recreational opportunities. The Molalla River Alliance is also engaged in environmental education through schools and guided field trips, trash pick-up parties, trail improvement, and removal of invasives.

Organizations and Partnerships

Molalla RiverWatch
Contact: Bruce Taylor, riverwatch@molalla.net, 503-824-2195

Molalla RiverWatch is a nonprofit organization created in 1992 by local citizens to protect, preserve, and restore the flora, fauna, and water quality of the Molalla River and its tributaries. The Oregon Watershed Enhancement Board recognizes Molalla RiverWatch as the Molalla River Watershed Council. The council is committed to promoting respect and understanding of the Molalla River watershed through education and conservation for current and future generations.

The Molalla River Alliance
Contact: Michael Moody, Molalla River Alliance, moody@teleport.com, 503- 699-8704

The Molalla River Alliance is a nonprofit coalition of more than 45 civic and conservation organizations; local, state, and federal agencies; user groups; and property owners. Founded in 2008, the alliance's key conservation priorities are to preserve water quality; sustain the watershed's wildlife, fish and plants; and promote a safe and healthy environment that encourages diverse recreational and tourism opportunities.

Some of the alliance's members and partners include:
American Rivers
American Whitewater
Back Country Horsemen
Back Country Hunters and Anglers
BARK
Bureau of Land Management
City of Molalla
Clackamas County Parks & Recreation
Clackamas County Sheriff
Ecotrust
Freshwater Trust
Hamlet of Mulino
Molalla RiverWatch
Molalla Pioneer
Molalla Police Department
Native Fish Society
NOAA Fisheries
North America Salmon Stronghold
Northwest Steelheaders
Oregon Department of Fish & Wildlife
Oregon Department of Forestry
Oregon Dept. of Environmental Quality
Oregon Equestrian Trails
Oregon Wild
Sierra Club Oregon
Wild Salmon Center
Willamette Riverkeeper

Watershed Plans, Assessments, and Reports

■ Lower Molalla River and Milk Creek Watershed Assessment (ABR Inc., 2004, prepared for Molalla Riverwatch)

■ Molalla River Watershed Analysis (Bureau of Land Management and U.S. Forest Service, 1999, BLM Salem District Office, Salem, OR. 242 pp.)

■ Molalla River-Table Rock Recreation Area Management Plan (Bureau of Land Management, August 2011) www.blm.gov/or/districts/salem/plans/molalla/documents.php

■ Molalla-Pudding-French Prairie-North Santiam Subbasins Agricultural Water Quality Management Area Plan. Developed by The Molalla-Pudding-French Prairie-North Santiam Subbasins Local Advisory Committee with assistance from the Oregon Department of Agriculture and Marion Soil and Water Conservation District, March 2004.

■ The ecological and recreational benefits of the Molalla River, Oregon (Kavita Heyn, American Rivers and Russell Bassett, Native Fish Society, June 2009)

■ Oregon Conservation Strategy http://www.dfw.state.or.us/conservationstrategy/

■ Willamette Total Maximum Daily Load (TMDL) (Oregon Department of Environmental Quality, 2006) www.deq.state.or.us.

■ Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (Oregon Department of Fish and Wildlife, August 2011) www.dfw.state.or.us/fish/CRP/upper_willamette_river_plan.asp

■ Oregon State University Institute for Water and Watersheds. The IWW is the state water resources research institute for Oregon and contains a library of watershed publications. Oregon State University, Corvallis, OR. http://water.oregonstate.edu/

■ Willamette Valley Planning Atlas: Trajectories of Environmental and Ecological Change (Pacific Northwest Research Consortium, 2002, Oregon State University Press, Corvallis, OR)

■ Pudding River Watershed Assessment (Pudding River Watershed Council, Adolfson Associates, Alsea Geospatial, 2006)

■ Molalla-Pudding Watershed Profile (U.S. Environmental Protection Agency, 2007) www.epa.gov.

12. Tualatin Subbasin

Rich Hunter, Clean Water Services
Monica Smiley, Tualatin Riverkeepers
April Olbrich, Tualatin River Watershed Council
Brian Wegener, Tualatin Riverkeepers

Includes these named USGS HUC watersheds:
Gales Creek
Scoggins Creek-Tualatin River
Dairy Creek
Rock Creek-Tualatin River
Fanno Creek-Tualatin River

Tualatin Subbasin 453,180 acres	
Land cover	**% of Watershed**
Agriculture	22%
Regen. forest	8%
Developed	13%
Low Veg	7%
Tree Cover	49%
Water	1%
Forest Patches*	47%
Jurisdictions	
Banks	<1%
Gaston	<1%
Metro UGB**	19%
North Plains	<1%
Rural	81%

*Tree/regen. forest patches >30 acres.
**Cities in Portland area UGB.

The Tualatin River watershed is 712 square miles, more than twice the size of any other watershed in the greater Portland-Vancouver region. The watershed includes all of Washington County and small portions of Multnomah, Clackamas, Yamhill, Tillamook, and Columbia counties. Washington County is Oregon's second most populous county, with 529,710 residents (2010 estimate) and includes the cities of Banks, Beaverton, Cornelius, Durham, Forest Grove, Gaston, Hillsboro, King City, North Plains, Sherwood, Tigard and Tualatin.

The Tualatin River watershed is a low-elevation, low-gradient watershed whose headwaters originate mostly in the Coast Range (more than 3,000 feet in elevation), although tributaries flow from a rim along the north, east, and south that includes the Tualatin, Chehalem, and Parrett Mountains, at 1,000, 1,630, and 1,240 feet maxi-

mum elevations, respectively. Annually, more than 1.1 million acre-feet of water flow out of the watershed into the Willamette River; this includes water imported from the Trask River and Bull Run water supply. Nearly 85 percent of this flow is discharged between November and March, with less than 3 percent typically discharged during June through October. Contributing to this flow are eight major tributaries: Gales, Scoggins, Wapato, Dairy, Rock, McFee, Chicken, and Fanno creeks.

The Tualatin River drops about 2,700 feet over its first 14 miles, then slowly meanders generally eastward for the rest of its 83-mile length. It enters the Willamette River just upstream of Willamette Falls (at River Mile 28.5) through a steep, walled canyon, falling about 50 feet over its last 3 miles. Other low notches in the mountain rim are found at Wapato Lake, Oswego Notch, and Tonquin. Through these low spots, the prehistoric Bretz (or Missoula) Floods of 13,000 to 15,000 years ago filled the Tualatin Basin with approximately 500 feet of water. The floods deposited deep layers of sediment and left a landscape of swamps, marshes. and prairies. Scabland channels from these floods can still be seen at Tonquin.

Approximately 10,000 years ago, a group of Kalapuya (the Twality or Atfalati) settled the Tualatin. When European immigrants arrived less than 200 years ago, the Twuality numbered in the thousands. The Twality lived mainly on big game and traded with people in neighboring watersheds. They burned some lowlands and open meadowlands for hunting. After Fort Vancouver was built in the 1820s, farming began in the Tualatin River watershed, which at that time was about 80 percent forest. By 1855, the last year of the Donation Lands Claim Act, about 350 farms had been claimed in the watershed, occupying land as far west as River Mile 67, current location of the city of Cherry Grove, near Gaston.

Historically, the Tualatin Basin was approximately 51 percent coniferous forest, 20 percent oak, and 12 percent each burned forest and prairie or savanna. By 2010, about one-quarter of the basin had been converted to agriculture and about 20 percent to urban uses (i.e., the cities of Aloha, Banks, Beaverton, Forest Grove, Gaston, Hillsboro, North Plains, Sherwood, Tigard, Tualatin). Because the Tualatin Basin is the largest in the region, acreage associated with land conversion appears inordinately large when compared to that in other basins. Agriculture consumed about 40,000 acres each of conifer forest, oak, and prairie or savanna. Urban uses consumed about the same amount of forest cover, about 30,000 acres of oak, and 15,000 acres of prairie and savanna. Combined coniferous and mixed forest experienced an overall decline of about 10 percent.

The Tualatin Basin is the region's largest watershed and makes up about one-quarter of the entire region.

KEY FACTS: The Tualatin subbasin within the greater Portland-Vancouver region:

- Consists of 81 percent rural lands (i.e., not within an urban boundary), but also has as a significant portion within the Metro Urban Growth Boundary, such as the cities of Beaverton, Hillsboro, Tualatin, and Sherwood.
- Is 12 percent publicly owned and contributes 23 percent of the region's total public lands.
- Contributes 26 percent each of the region's forest patches and interior forest habitat.
- Has nearly 41,400 acres within the FEMA 100-year floodplain.
- Includes about 8,700 acres of mapped wetlands.

Given the Tualatin Basin's historically extensive marshes, swamps, and large woody debris jams, which obstructed channels up to 1 mile in some locations, flooding was a continual concern of the settlers. One of the first businesses was the manufacturing of tiles to drain wetlands. Farmers drained much of the lowlands to plant crops and develop pasture for cattle. Settlers built canals, ditches, dikes, and dams, harvested timber, and modified the river and its tributaries to get logs to the mills. Perhaps one of the biggest impacts to the river between 1850 and 1890 was the clearing of woody debris jams to allow steamboat passage. An estimated 60 percent of the original wetlands were lost as a cumulative result of these practices.

Railroad construction began in 1887, and the river was judged unworthy for steamboat travel in 1895. By the 1910s, railroads had brought extensive investment from eastern timber companies and expanded the pace of logging. Around 1900, several dams were built in the watershed to generate electricity but have since been removed or failed. Drainage of lowlands for agriculture continued, affecting Wapato Lake (which is now partially included in the Tualatin River National Wildlife Refuge) and Lake Lousignot. By the 1940s, crops consumed more water as a result of electric irrigation pumps. The combined effects of logging, drainage, and pumping for irrigation led to heavy winter flows and almost no late summer flows in the river. Irrigation demands rose with the growth of nursery and berry crops. In the 1950s, near the city of Tualatin, water would sometimes flow upstream in the river. Low summer flows resulted in high levels of phytoplankton growth and low dissolved oxygen concentrations, especially in the lower river, which in some spots a person could straddle. These conditions led to development of water resources in the watershed.

Beginning in 1938, drinking water was imported from Portland's Bull Run water supply. Barney Reservoir was built in the late 1960s to supply water to Hillsboro from the neighboring Trask River watershed; in 1998, Barney Reservoir was enlarged from 4,000 to 20,000 acre-feet. Increases in the human population and agricultural water demand led to construction in 1978 of Scoggins Dam, which has a storage capacity of 56,000 acre-feet. In the 1960s, wastewater had also become a serious water quality problem and led to a development moratorium. Over the years, wastewater released to the river had come from municipal sewage, canneries, meatpacking, tanneries, paperboard plants, and food products. The Unified Sewerage Agency (or USA, which is now called Clean Water Services) was established in 1970 to improve water quality with expanded regional wastewater treatment capacity for municipal and industrial sources.

In 1986, the Northwest Environmental Defense Center, concerned about low dissolved oxygen levels and high phosphorus and algal levels in the Tualatin River, filed the first successful lawsuit to require enforcement of the total maximum daily load (TMDL) section of the Clean Water Act. The Oregon Department of Environmental Quality adopted and apportioned TMDLs for ammonia, nitrogen (to improve dissolved oxygen levels), and phosphorus (to reduce algal levels) in 1988. In the 1990s, DEQ added temperature, bacteria, and dissolved oxygen to the list of water quality impairments. In 2001, DEQ issued TMDLs for those pollutants and updated the earlier phosphorus and ammonia TMDLs. The entire Tualatin Basin is included under the Willamette TMDL, which addresses temperature, bacteria, and mercury. Both water quality management practices and flow augmentation have been undertaken to improve water quality during the low-flow period. Clean Water Services (known as USA at the time) expanded its tertiary treatment at two of its treatment plants in the early 1990s to comply with the discharge limits. During the summer, Tualatin River flow is increased by as much as one-third of its natural

flow from Henry Hagg Lake, Barney Reservoir, and wastewater treatment plant effluent. Stored water is now managed to maintain minimum monthly mean flow of 120 cubic feet per second (cfs) from June to August and 150 cfs for September to November at RM 33.3. The river is now intensively managed, but its water quality is vastly improved.

The watershed's land uses today are approximately 50 percent forest, 30 percent agriculture, and 20 percent urban. Most of the working forestlands are found in the Coast Range, in the upper portion of the watershed, while the rest of the rim contains urban, rural residential, and agricultural areas. The lower watershed's broad alluvial valley encompasses both the residential, commercial, and industrial urban core and diverse, productive agricultural lands.

Since the nineteenth century, humans have vastly altered ecosystems in the Tualatin River watershed. More than half its area has been converted from the original forest and floodplain habitat to urban or agricultural use, and the remaining forest is now intensively managed. Water retention on the landscape has been reduced while water use exceeds the basin's supply from May into November in an average year. The abundance and diversity of fish and wildlife populations have been threatened by shrinking habitat and human impacts on aquatic and terrestrial communities. Without action, these trends are likely to worsen because Washington County is expected to gain nearly one-half million people over the next few decades.[8] Within the urban growth boundary of the Tualatin Basin there are approximately 20,000 acres of impervious cover connected to a separate storm sewer system. Twelve urban streams in the basin are listed by DEQ as water-quality impaired for biological criteria. Temperature, toxics, nutrients, bacteria, and impaired flow regime are all contributing factors to this biological impairment.

Because of its varied geography and size, the Tualatin Basin has a wide diversity of natural communities and species across a spectrum of mountain forests, valley woodlands, grasslands, and floodplains, and these present excellent conservation opportunities. Despite many threats, the basin still harbors many significant populations of special-status and sensitive species in aquatic, wetland, and upland habitats. One of the most significant features of the basin is the river's 58-mile-long floodplain, which is consistently noted as a regionally significant biodiversity resource. (For example, in the Oregon Conservation Strategy, it is included as Willamette Valley Conservation Opportunity Area 5.) The floodplain and associated valley wetlands contain vitally important waterfowl habitats in the Pacific Flyway. Moving west from Wapato Lake, Patton Valley and the area upstream to Cherry Grove have been noted as an important conservation opportunity.

Migrating birds routinely number in the thousands at several key sites. Species include tundra swans; cackling, Canada, and dusky Canada geese; northern pintail; canvasbacks; blue-winged and green-winged teal; and buffleheads. Shorebirds also are plentiful in the valley's wetlands, where there are healthy populations of American bittern and greater yellowlegs. Several large heron rookeries in the basin host high numbers of great blue herons and also the black-crowned night heron. Remnant forests and prairie also support Neotropical migratory birds.

Despite well-chronicled declines, native coldwater fish species such as cutthroat trout and the ESA-listed threatened winter steelhead are still present in the Tualatin River and its tributaries. Although not historically present in the Tualatin, coho salmon totaled record numbers in recent surveys, and the basin's abundance of slow-water habitat appears to provide ample opportunity for a population stronghold in the future. Western brook lamprey and Pacific lamprey are also present in the Tualatin River and tributaries, but very little is known about their distribution or population status. Several large populations of sensitive amphibians and reptiles are known, including northern red-legged frogs, western painted turtles, and western pond turtle. In the absence of trapping during the last decade, beaver have made rapid gains and recolonized many of the basin's creeks, to the benefit of many species. Although old-growth forests are scarce, the basin is host to several sensitive late-successional forest wildlife species, including northern spotted owl, Townsends big-eared bat, marbled murrelet, and northern flying squirrel. The basin also supports numerous elk, deer, muskrat, otter, cougar, and bobcat, along with a variety of other wildlife.

Approximately 55,000 acres (12 percent) of the Tualatin Basin is held by public entities for natural resource, open space, and park purposes, but only a small fraction of these properties is managed primarily for biodiversity conservation. More than three-quarters of the basin's natural resource land is located outside urban areas, with the largest owners being the Oregon Department of Forestry (approximately 25,000 acres in Tillamook State Forest) and Bureau of Land Management (approximately 10,000 acres). Local governments, including cities and the Tualatin Hills Park and Recreation District, collectively own a large component of park and natural resource lands—about 10,000 acres. These local government lands are typically near creeks and floodplains, but their distribution is fragmented and many of the habitat tracts are isolated.

There are several noteworthy tracts of publicly owned conservation lands across the Tualatin Basin. Recent acquisitions by the U.S. Fish and Wildlife Service have enlarged the Tualatin River National Wildlife Refuge to about 3,000 acres of mainstem floodplain, wetlands, and related uplands.

Metro has added more than 3,500 acres of natural areas since 1995, representing a variety of habitat types across the basin. The Metro natural areas have some large landscapes, such as 1,200 acres of mixed forest on Chehalem Ridge, as well as some unique sites with rare habitats, such as the peat bogs of Killin Wetlands. Clean Water Services and the cities of Hillsboro and Forest Grove cooperatively manage more than 1,500 acres of Tualatin River floodplain and wetlands at Jackson Bottom and Fern Hill wetlands.

The Coast Range portion of the basin also has some large public holdings in addition to Tillamook State Forest and the BLM parcels. There are patches of high-quality mixed coniferous forest at Stub Stewart State Park (approximately 1,700 acres) and in City of Forest Grove watershed lands (approximately 3,800 acres). Washington County manages about 2,500 acres of U.S. Bureau of Reclamation lands at Henry Hagg Reservoir. Although a majority of Hagg Lake Park is inundated by Scoggins Dam, the surrounding uplands contain a diverse assemblage of forest types, including oak habitats and prairies that have several rare species, including the federally endangered Fender's blue butterfly and federally threatened Kincaid's lupine.

There are only a few private land holdings dedicated to conservation purposes in the Tualatin Basin, but several significant urban wetlands are owned and managed by The Wetlands Conservancy; these include Cedar Mill Wetlands and Hedges Creek. A variety of easements and management agreements exist for riparian, floodplain, and water resource protection throughout both urban and rural portions of the basin. Homeowners' associations own more than 2,500 acres of dedicated open spaces in the urban area but often lack funds for management.

[8] http://www.oregon.gov/DAS/OEA/Pages/demographic.aspx

Current Major Initiatives

- Stream enhancement
- Clean Water Services Surface Water Management Program
- Culvert retrofits/fish barriers — Washington County Land Use & Transportation http://www.co.washington.or.us/LUT/Divisions/Operations/Programs/culvert-replacement.cfm
- Tualatin River Watershed Council http://www.trwc.org/basin_projects/
- Riparian reforestation
- Clean Water Services Temperature Management Plan http://www.cleanwaterservices.org/AboutUs/Departments/WatershedManagement/
- Enhanced Conservation Reserve Enhancement Program (eCREP) — Tualatin & West Multnomah Soil and Water Conservation Districts
- Community Tree-for-All Stream Planting Challenge (2 million native plants in 20 years) http://www.cleanwaterservices.org/Residents/JoinTheCycle/InYourCommunity/TreeforAll/default.aspx
- Invasive plant control: targeted early detection/rapid response for garlic mustard, knotweed, giant hogweed and yellow flag iris
- Cooperative Weed Management Area http://4countycwma.org/
- Tualatin River National Wildlife Refuge Comprehensive Conservation Plan http://www.fws.gov/tualatinriver/refugeplanning.htm
- Metro Natural Areas Science and Stewardship Program — Restoration of native ecosystems http://www.oregonmetro.gov/index.cfm/go/by.web/id=37086

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Watershed Plans, Assessments, and Reports — Tualatin Subbasin

From Tualatin River Watershed Council (http://www.trwc.org/tualatin_info.html):

- Watershed Action Plan and Technical Supplement
- Watershed Analyses, J.T. Hawksworth, Washington County SWCD
- Upper Tualatin - Scoggins, 2000
- Dairy - McKay, 1999
- Middle Tualatin - Rock Creek, 2001
- Lower Tualatin, 2001
- Gales Creek Watershed Assessment, 1998
- Lower Gales Creek Habitat Enhancement Plan, 2004
- Geomorphic Assessment, 2005
- The Water Project, and interactive guide to the Tualatin River Watershed, produced by Pacific University, Oregon http://www.trwc.org/water/index.html

From Clean Water Services:

- Clean Water Services Healthy Streams Plan (2005) http://www.cleanwaterservices.org/Content/Documents/Healthy%20Streams%20Plan/Healthy%20Streams%20Plan.pdf

From the Oregon Department of Forestry:

- Oregon Department of Forestry Northwest Forest Management Plan http://www.oregon.gov/ODF/STATE_FORESTS/nwfmp.shtml

Assessments of aquatic biota available at Clean Water Services website (http://www.cleanwaterservices.org/OurWatershed/MapsAndData/):

- Distribution of Fish and Crayfish and Measurement of Available Habitat (1999-2001)
- Assessment of Macroinvertebrate Communities (USA by ABR, 2000)
- Assessment of Macroinvertebrate Communities in Relation to Land Use, Physical Habitat and Water Quality (Clean Water Services by ABR, 2002)
- Assessment of Fish and Macroinvertebrate Communities of the Tualatin River Basin (Clean Water Services by ABR, 2005-06)