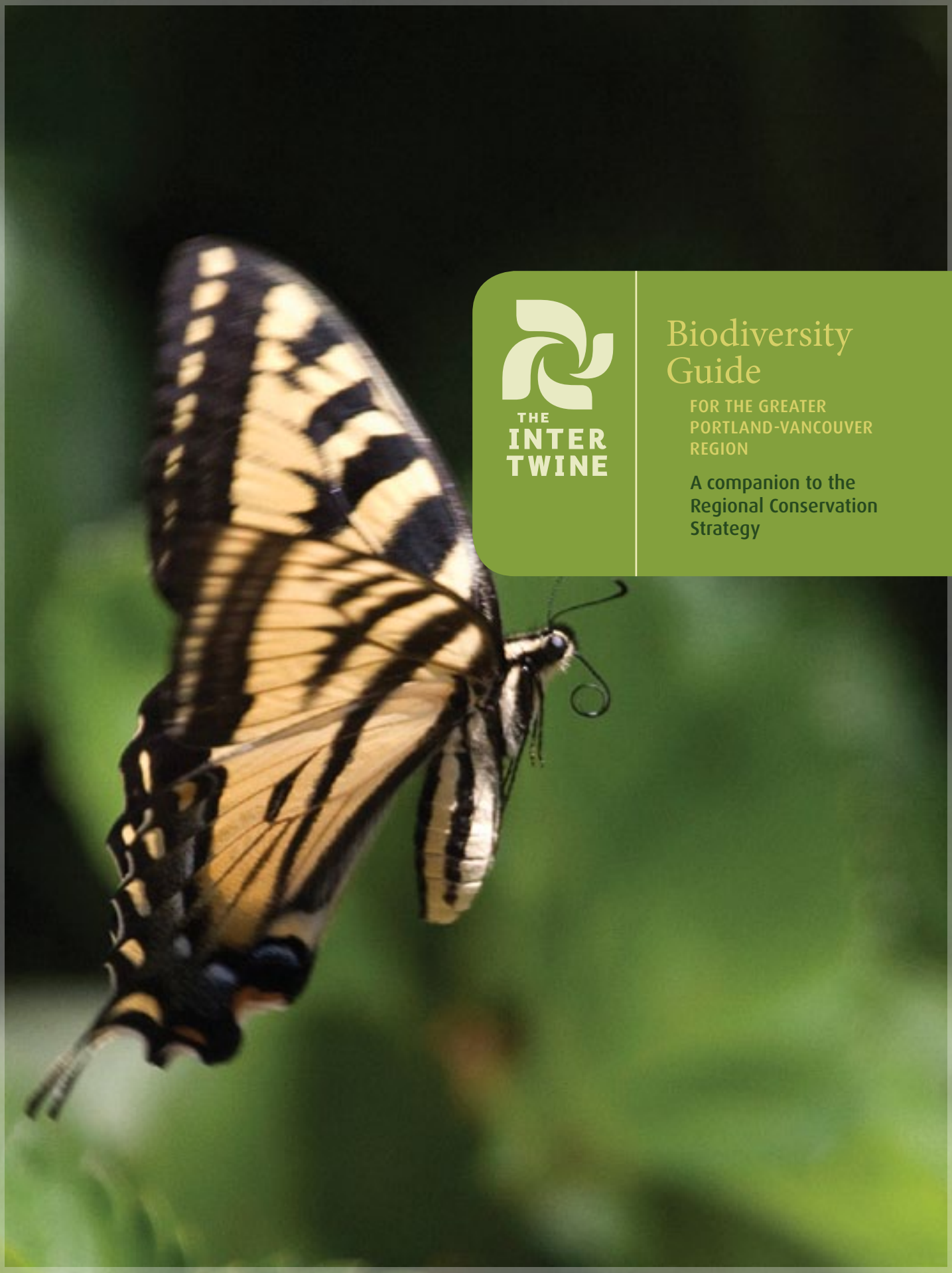

THE INTER TWINE

Biodiversity Guide

FOR THE GREATER PORTLAND-VANCOUVER REGION

A companion to the Regional Conservation Strategy

The Intertwine Alliance. 2012. *Biodiversity Guide for the Greater Portland-Vancouver Region*. A. Sihler, editor. The Intertwine Alliance, Portland, OR. www.theintertwine.org

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Preface

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The prospect of developing a single document that captures basic but comprehensive information about the greater Portland-Vancouver region's biodiversity—while also proposing a transparent, data-driven approach to setting conservation priorities—was simultaneously compelling and daunting. At the start of this effort, the data to adequately map much of the region's biota at significant detail or accuracy was lacking, as was funding to compile such information. At the same time, conservation practitioners and policy makers have a great need for state-of-the art ecological and mapping information, at multiple geographic scales, to assist them in setting conservation priorities.

This *Biodiversity Guide for the Greater Portland-Vancouver Region* is an effort to provide a scientific baseline and framework to fill that need. Using a combination of new and previously developed data, published research, maps, and expert opinion, this document begins to describe the current status of our region's biota, changes that have occurred since 1850, and potential future changes and losses if conservation and restoration actions do not take place. The *Biodiversity Guide* also addresses non-biological issues of importance, such as fire, floodplains, and climate change. It takes a high-level look at threats to the region's ecological health and strategic opportunities to protect and enhance the region's biodiversity. Finally, the *Biodiversity Guide* identifies regional conservation priority areas; these opportunities to strategically invest in meaningful biodiversity conservation in the region were identified through a combination of computer modeling and expert opinion.

Although the *Biodiversity Guide* is useful as a stand-alone reference document, it was prepared as a companion to The Intertwine Alliance's *Regional Conservation Strategy for the Greater Portland-Vancouver Region*; as such, the *Biodiversity Guide* provides the biological framework for the *Regional Conservation Strategy's* discussions of issues, current conservation work, and future strategic opportunities. Given that there is some overlap between the two documents, in this *Biodiversity Guide* we refer the reader to the *Regional Conservation Strategy* in cases where that document treats a particular topic in greater depth.

This *Biodiversity Guide* and *Regional Conservation Strategy* are not meant to replace current assessments by state, federal, or local jurisdictions, agencies, or nonprofit organizations, such as watershed councils. Instead, the two documents place ecological data in a larger framework, geographical scale, and context. We hope that new data generated by this project will be useful for conservation efforts based on previous studies and plans. Conservation priorities depend on scale; what is important at one scale may not be important at another. This does not mean that one is more valid than another, but instead that geographic scale influences goal setting and the questions one asks. This project is no different. For this effort, we wanted to ensure that areas and resources that may have been overlooked or undervalued in larger biodiversity and

ecological assessments are identified and valued within their own geographic context.

This effort both builds on and fill gaps left by Oregon and Washington's statewide conservation strategies,[1] as well as other regional or local assessment efforts. (For a more thorough discussion of this subject, see Chapter 3 of the *Regional Conservation Strategy.*) The *Biodiversity Guide for the Greater Portland-Vancouver Region* illustrates how the region's urban, suburban, and rural areas serve as a link between large areas of predominantly publicly owned lands in the Cascade Range to the east and the Coast Range to the west, and between the Willamette Valley proper and the southern Puget Trough, to the south and north, respectively. The assumption is that analysis and mapping done at this scale can support successful decision making regarding adaptation to climate change, the impacts of future urban growth, transportation planning, and—most importantly—conservation investment at a different geographic scale than previous efforts, larger and smaller.

We chose to use subwatersheds (HUC 4 and HUC 5; see Chapter 1) as boundaries to define the greater Portland-Vancouver region. Specific boundaries were selected to keep the extent of the area reasonably small, to exclude most federally owned land, and to moderate data processing costs. Still, the region encompasses 14 subwatersheds totaling 1.83 million acres in parts or all of 10 counties in two states.

Ultimately, boundaries are human constructs. Some have real biological meaning, but many are somewhat arbitrary delineations along a continuum of change. Whether a given area is just inside or just outside our assessment area says more about the vagaries of available data, our budget, and our group's judgment than any hard and fast conservation biology axiom. Finally, the delineation of the greater Portland-Vancouver region for the purposes of this Biodiversity Guide is not meant to imply any form of prioritization or eligibility for any future support by The Intertwine Alliance.

[1] The Oregon Conservation Strategy (Oregon Department of Fish and Wildlife 2006) and Washington Comprehensive Wildlife Conservation Strategy (Washington Department of Fish and Wildlife 2006).

Current Conditions

CHAPTER 1

This chapter provides an overview of the current land cover and land ownership within the greater Portland-Vancouver region, which, for the purposes of this document and its companion *Regional Conservation Strategy*, is defined as the geographical area shown in Figure 1-1. In general, the region consists of 1,829,575 acres (2,859 square miles, or 7,404 square kilometers) primarily within the northern Willamette Valley and southern Puget Trough ecoregions, along with portions of the the Coast Range and the Cascade Mt. foothills. The region spans parts of two states, parts or all of 10 counties, and parts or all of eight HUC-4 watersheds and 22 HUC-5 watersheds. (HUC stands for hydrologic unit code; see sidebar on page 3.) Figure A-2 in Appendix A and Table 1-1 show the watersheds—at several different HUC levels—that were delineated and explored for this *Biodiversity Guide.*[1]

Elevation, habitat, and development patterns within the region are diverse. Elevation varies from just above sea level along the Willamette and Columbia rivers to more than 4,000 feet in the foothills of the Cascades (see Figure A-3). Most of the region (75 percent) lies below 2,000 feet in elevation, and 8 percent is below 50 feet.

Land cover classes and land ownership also are diverse, and the process of classifying and estimating them within the region was intricate and involved (see Appendix A for a description). For ease in understanding, this chapter describes the region's land cover in terms of seven generalized groupings of land cover classes—agriculture, regenerating forest, developed land, low vegetation, sand bars, tree cover, and water—and two derivatives of land cover: forest patches and forest patch interior. All of these classifications have specific definitions for the purposes of this chapter (see Appendix A), as do categories such as rural and urban areas and public and private lands. For more information on land cover classes, exactly what they indicate, and how they were derived, see Appendix A and the tables in this chapter.

[1] In a few cases, small portions of watersheds near the edge of the region were added to other watersheds in order to cover the entire Willamette Valley ecoregion.

TABLE 1-1

Land Cover by Watershed in the Greater Portland-Vancouver Region

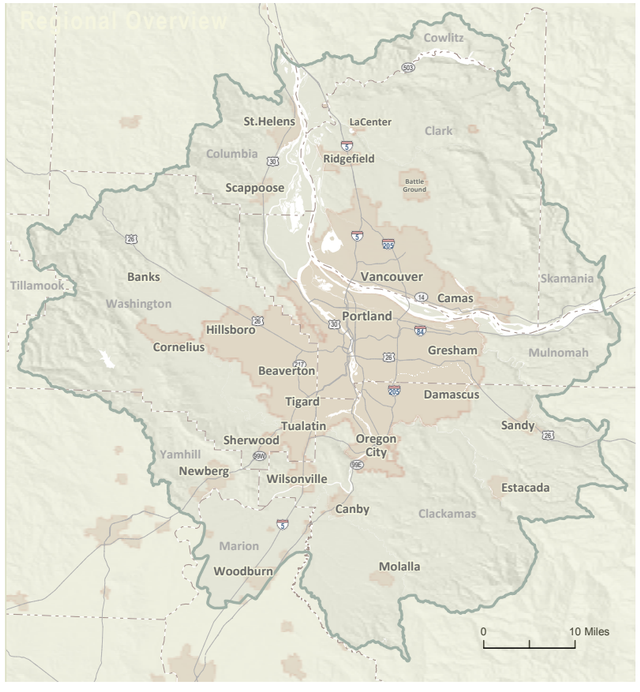
Watershed (WS) or Subbasin (SB)	Watershed Acres	% of the Region	Agriculture	Regen. Forest	Developed	Low Vegetation	Sand Bars	Tree Cover	Water
Abernethy Cr-Willamette R	87,000	5%	30%	<1%	15%	10%	<1%	43%	2%
Chehalem Creek-Willamette R	78,000	4%	54%	<1%	10%	6%	<1%	29%	1%
Clackamas SB (partial)	158,000	8%	22%	3%	8%	7%	<1%	59%	<1%
Hayden Island-Columbia R	19,000	1%	<1%	<1%	6%	10%	<1%	9%	75%
Johnson Creek	60,000	3%	6%	<1%	39%	13%	<1%	41%	2%
Lewis SB (partial)	221,000	12%	13%	12%	3%	5%	<1%	64%	3%
Lower Columbia-Sandy SB (partial)	217,000	12%	12%	5%	7%	7%	<1%	64%	5%
Lower Columbia-Clatskanie SB (partial)	22,000	1%	37%	2%	10%	5%	<1%	29%	18%
Molalla-Pudding SB (partial)	181,000	10%	43%	3%	8%	4%	<1%	42%	<1%
Salmon Creek-Frontal Columbia R	131,000	7%	21%	1%	24%	20%	<1%	31%	3%
Scappoose Creek-Frontal Columbia R	123,000	7%	22%	4%	6%	6%	<1%	57%	5%
Tualatin SB	453,000	25%	22%	8%	13%	7%	<1%	49%	<1%
Willamette R-Frontal Columbia R	79,000	4%	1%	<1%	54%	12%	<1%	28%	6%
TOTAL	1,830,000	100%	22%	5%	13%	8%	<1%	49%	3%

It is important to point out that a land cover map is never considered a perfect representation of the landscape. Improvements to land cover maps can, and should, be made as additional "ground truth" information about actual land cover components and spatial patterns is acquired through time. These improvements should be based on independent assessments of the map's quality.

— D. STOMS
A Handbook for Gap Analysis, 1994

FIGURE 1-1

The Region



Data Sources and Limitations

It is difficult to obtain high-quality, consistent data over a large geography such as the greater Portland-Vancouver region when multiple layers of information are needed. Yet consistency enables comparison between watersheds. As a result, there are some precise and accurate data sets for portions of the region that we could not use. At a 5-meter resolution, the land cover data in this *Biodiversity Guide* are more detailed than anything else that covers this geography but are not as detailed (i.e., not as fine scaled) as some of the local inventories conducted by individual municipalities.

For instance, a tree canopy layer created in 2008 for the Metro urban growth boundary at a 1-meter resolution reported 31 percent tree cover, whereas this *Biodiversity Guide* reports 34 percent for the same area at a 5-meter resolution. The former may be more accurate, but the latter covers the entire region; the 3 percent difference may be within the margin of error for both data sets. On the other hand, in 2008 ReGAP [2] mapped 27 percent of the region (30-meter resolution) as agriculture, while this *Biodiversity Guide* reports 22 percent. Differences may be due to differences in precision, differing definitions of "agriculture," or error in one or both data sets. Thus, the data are representative at a large scale but not necessarily good for finer-scale analyses.

Mapping land cover accurately over a large geographic area is always challenging but especially in highly developed and fragmented areas. This is so because of the small patch size (i.e., the area occupied by one type of land cover), the difficulty of differentiating between some specific land cover types with remote sensing, and the high cost of ground-based verification. Small patch size in particular has typically prevented regional or statewide projects from accurately identifying or mapping habitat in the more urbanized portions of the greater Portland-Vancouver region. Furthermore, current remote sensing techniques are unable to determine the difference between certain land uses, such as natural versus agricultural land cover where heights or spectral signatures (i.e., reflected colors) are similar. There are always some errors in remote sensing, but techniques have improved substantially over time.

Our land use and land cover estimates are derived primarily from two sources, both of which drew from of a variety of data sources and analytic techniques. The Intertwine Alliance contracted with the Institute for Natural Resources in 2012 to develop a fine-scale land cover map (Figure 1-4) (Appendix A) using a combination of high-resolution color aerial photography, light detection and ranging (LiDAR), satellite imagery, and hand digitizing that covers 88 percent of the greater Portland-Vancouver region. Within the 88% of the region covered by LiDAR imagery, the resulting data layer has high precision, including 5-meter pixels in urban areas, but uses relatively few cover types such as plant associations or detailed habitat types. The remaining 12 percent was mapped at 30-meter resolution and resampled to 5 meters.

Limitations in the land cover layer for this *Biodiversity Guide* include a lack of distinction between agricultural trees (such as orchards or

ABOUT THE HYDROLOGIC UNIT CODE (HUC) SYSTEM

The hydrologic unit system is a standardized watershed classification system developed by the U.S. Geological Survey in the mid-1970s. Hydrologic units (HUCs) are geographical areas representing all or part of a watershed. Organized in a nested hierarchy by size, hydrologic units range in size from regions, such as the Willamette Basin (a 3rd-field HUC) to smaller watersheds such as the Clackamas, Sandy, Molalla, Tualatin, and Lewis River watersheds (4th-field HUCs), to local watersheds such as Beaver Creek or Salmon Creek (5th-field HUCs).

THE REGION'S MAPPED LAND COVER CONSISTS OF:

49% Trees

22% Agriculture

13% Developed land

8% Low vegetation

5% Regenerating forest

3% Open water

<1% Sand bars

[2] ReGAP is a national effort to map land cover and identify cover types that are underrepresented in terms of protection status. See *Final Report on Land Cover Mapping Methods, Map Zones 2 and 7, PNW ReGAP,* by E.B. Grossmann and others, published by the Institute for Natural Resources at Oregon State University.

HOW MUCH OF OUR NATURAL LAND COVER IS PROTECTED?

The truth is, no one knows exactly, in part because the meaning of the word "protected" is not consistently defined. Does it include forestry lands or regulated areas? Some properties are managed for multiple uses. The best we can do right now is to estimate how much of the natural landscape is publicly owned, but that does not guarantee protection, and it leaves out protection by nonprofits such as land trusts, conservancies, and privately owned conservation easements.

Christmas tree farms) and young natural forest, or between natural prairie from lawns and especially commercial grass fields or pasture. Patches of field agriculture 4 acres or larger are reasonably well mapped outside of urban areas, although some low-stature natural vegetation may be mapped as agriculture and vice versa.

Public lands and protected habitat also were difficult to identify and categorize. At the time of publication there was no database or geographical information system (GIS) layer that clearly distinguished between public land and protected habitat. Public land is land owned by some form of government and can consist of natural habitat, public parks, schools, golf courses, or developed land. In some cases future development is not legally prohibited on public land. In contrast, protected land may be in public or private ownership and refers to lands whose current and future management is constrained to—at the very least—prevent outright development.

The mapping team for this *Biodiversity Guide* chose to use a draft version of Metro's Recreation, Conservation, and Public Lands layer to estimate protected habitat. Although this data set is still being refined, it was determined that the benefit of having a tax lot based-layer, which differentiated between federal, state, special district, regional, local, and nonprofit lands, was more useful for the *Biodiversity Guide* than a more coarsely scaled data set of Pacific Northwest protected lands from the ReGAP project.

As with any large-scale mapping effort, the resulting representation of the land cover of our region is certain to have errors in some or even many specific locations, yet it still provides a reliable representation of the overall patterns of most cover types in the region. An accuracy assessment (see Appendix A) revealed a relatively high degree of accuracy, as long as land cover types were somewhat generalized, as described below. Future mapping priorities may include differentiating habitats and cover types not adequately addressed here such as prairie, oak types, tree farms, natural shrub cover, and small farms, and differentiating between high-structure and low-structure agriculture. Improved land cover data allowed us to improve habitat priority modeling for the region as well (Appendix B). The land cover data and modeled results allow for a scalable, science-based approach to regional priority setting. The modeling effort is described more fully in Appendix A.

Land Cover in the Greater Portland-Vancouver Region

The information below describes land cover in the greater Portland-Vancouver region and explores some differences between urban and rural areas. The information is watershed-based to illustrate the linkages among urban areas, rural areas, predominantly publicly owned lands, and other habitat areas within the Willamette Valley, Puget Trough, and Coast Range and Cascades.

Urban and Developed Areas

With the presence of two major and 48 smaller cities, urban areas occupy one-fifth of the greater Portland-Vancouver region and are a key focus of the conservation efforts described in the *Regional Conservation Strategy* (Figure A-1). Urban areas are defined as urban growth boundaries in Oregon and urban growth areas in Washington. About one-third of urban areas in the region have mapped tree cover, which includes forests as well as many single trees and small clusters of trees. Although "urban" is defined as lands that lie within official jurisdictional boundaries regardless of land cover, "developed" is a specific land cover category created using remote sensing information. Developed areas include buildings, paved roads, and parking lots.

KEY FACTS: "Urban" Areas

- 20 percent of the greater Portland-Vancouver region is classified as urban area, meaning that it is within an urban growth boundary or urban growth area.
- 31 percent of the urban area is classified as trees.
- 9 percent of the urban areas is publicly owned.
- Public landowners that own more than 1,000 acres within urban areas include the cities of Portland and Gresham, Vancouver-Clark Parks & Recreation, and Metro.

The developed land cover category includes roads, parking lots, and buildings anywhere within the region, but not the lawns associated with those buildings.

KEY FACTS: "Developed" Land

- The developed land cover classification covers 13 percent of the region.
- Within urban areas, 44 percent of the land cover is classified as developed.
- Within rural areas (i.e., specifically not urban), 5 percent of the land cover is classified as developed.

Low vegetation is a mix of natural and non-natural cover types and includes an unknown but likely significant amount of landscaped and agricultural types, along with natural cover types. Low vegetation covers about 8 percent of the entire region and 17 percent of the land classified as urban.

Open Water and Wetlands

The open water land cover category includes rivers, large streams, lakes, ponds, wetlands, and water bodies where GIS-based land cover classification detected a water signal. The open water land cover category generally excludes small streams and some seasonal or heavily vegetated wetlands. (For a more detailed description of open water and wetlands see Chapter 3.)

Because water flows downhill and measures of water quality (i.e., temperature and chemical contamination) in rivers and streams generally reflect conditions throughout a watershed, the condition of open-water habitats gives strong clues as to the ecological condition of the surrounding region. Although the region's river systems have been altered over the past 150 years, its water bodies continue to provide habitat, ecosystem services, biodiversity conservation benefits, and biodiversity linkages that greatly exceed their collectively low percentage of total land cover. The open water cover class includes large rivers, such as the Willamette and Columbia; major tributaries, such as the Clackamas, Lewis, Molalla, Sandy, Tualatin and Washougal rivers; and important lakes, such as Vancouver Lake, Sturgeon Lake, Lake Oswego, and Hagg Lake.

KEY FACTS: "Open Water"

- 3 percent of the region is classified as open water.
- 10 percent of the region is within the Federal Emergency Management Agency's 100-year floodplain.
- More than 5,500 miles of streams and rivers have been mapped within the region.

The region's water quality issues are primarily a result of land use changes. Aside from dams, the greatest impacts are typically from urban and agricultural land uses, with forestry practices also impairing water quality. Most water bodies in the region are greatly affected by dams, irrigation withdrawal, or changes in hydrology and water quality that have resulted from increases in the amount of impermeable surfaces and other human influences in the watersheds. Key effects of these changes include flashier streams, increased flooding and property losses, damaged streams, and pollution. These changes are reflected in the existence of a total maximum daily load (TMDL) for the entire Willamette River and also a specific TMDL for the Tualatin Basin to limit further inputs of pollutants, including tempera-

ture, fecal bacteria, and mercury. [3] (Chapter 7, "Threats and Challenges," describes water quality issues in the region in more detail.)

Major rivers in the region whose hydrology is altered by dams include the Willamette, Columbia, Clackamas, Tualatin, Molalla, Washougal, and Lewis. The Sandy River is the largest river without any dams. Most of the smaller rivers and streams have weirs, ponds, or other structures to facilitate water withdrawal for fish hatcheries, irrigation, or other agricultural use. In the most extreme examples, some streams in urban areas have been rerouted into pipes; this is the case in inner east and downtown Portland.

Wetlands are typically—but not always—found in floodplains. Throughout much of the region, wetlands have been drained, filled, or disconnected from their water source by dikes in order to facilitate commercial, residential, or agricultural development. Some wetlands are included in the open water land cover category but not specifically identified. Therefore, we made an effort to collect more detailed information on these special habitats.

KEY FACTS: "Wetlands"[4]

- About 4 percent of the region consists of wetlands.
- The percent cover of wetlands in urban areas does not differ substantially from that in rural areas.
- About one-quarter of known wetlands are publicly owned.

Although the current extent of wetlands has certainly declined over time, surveys from 1850 vastly underrepresented wetlands; for this reason it is not possible to estimate the degree of loss.

Tree Cover and Forest Patches

Forests in our region's natural areas span a range of forest types and conditions, including floodplain forests dominated by hardwoods, remnant mixed oak-conifer forests, and riparian and upland forests that range from 100 percent deciduous to 100 percent coniferous (the percentage depending largely on the forest's management and disturbance history).

OVERALL TREE COVER

Forested areas occur throughout the region. Trees, including street trees and all agricultural trees, cover 49 percent of the region (see Table 1-1 and Figure A-4). Forests are patches of trees, and the size of a habitat patch generally correlates with its biological diversity (see Chapter 7, "Biodiversity Corridors," in the *Regional Conservation Strategy*). In addition to size, the shape of a habitat patch is important to wildlife because interior habitat, which is away from the edges of the habitat patch, is generally more valuable for sensitive species and contains fewer invasive plant and animal species than does edge habitat.

Our land cover classification had the greatest success in classifying trees within the region. LiDAR imagery was available for the majority of the region, allowing identification not just of tree cover but of tree heights as well. Because the LiDAR data ranged in quality and source year, this chapter only reports on the presence of trees, with no attempt to specify height or tree type (i.e., conifer or deciduous).

KEY FACTS: "Tree Cover"

- Trees of any kind cover about 49 percent of the region, which is equivalent to about 900,000 acres.
- 54 percent of the region is classified as trees or regenerating forest (i.e., regenerating clear cuts). This totals nearly 1 million acres.
- 83 percent of the land cover that is classified as trees or regenerating forest occurs in patches that are more than 30 acres in size.

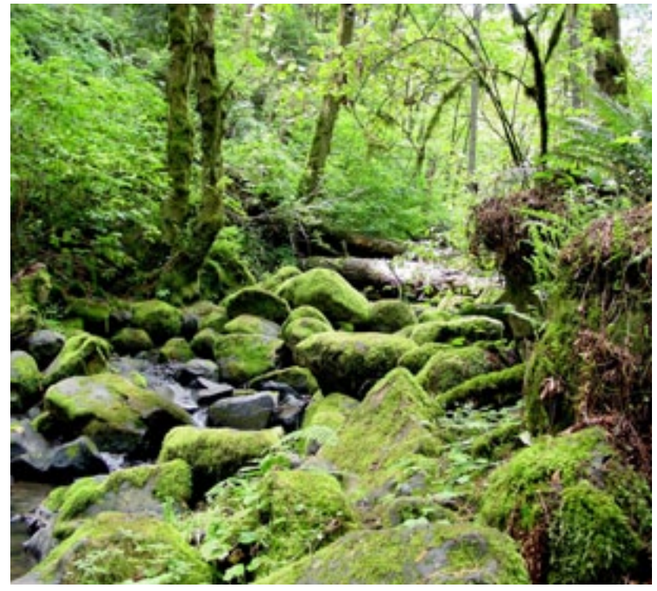
[3] The Federal Clean Water Act is implemented at the state level under the TMDL process. In Oregon this is done by the Department of Environmental Quality and in Washington by the Department of Ecology. For more information see www.deq.state.or.us/wq/tmdls/tmdls.htm or http://www.ecy.wa.gov/programs/wq/tmdl/index.html. Key facts about wetlands are based on a hybrid of mapping efforts, using the best available local data.

[4] Key facts about wetlands are based on a hybrid of mapping efforts, using the best available local data.

The total amount of tree cover is clearly important, but the size and shape of forest patches also influence the region's fish and wildlife, particularly the more sensitive or declining species. We analyzed rough size and shape estimates through forest patches and interior tree patches respectively, below.

FOREST PATCHES

We differentiate between the tree land cover classification and forest patches, with the latter being patches of trees plus areas of regenerating forest. For this analysis, a forest patch is defined as a cluster of trees and/or regenerating forest (i.e., clear cut) that is at least 30 acres in size. Land cover mapping for this Biodiversity Atlas does not distinguish between 30 acres of 20-year-old trees mixed with weeds and 30 acres of old-growth forest with native understory that includes rare plants. Many of the region's largest forest patches are managed for timber harvest. These are working lands. In terms of mapping, regenerating forests are successional because under current forest practices they are continually replanted. In addition, clear cuts and natural clearings within a forest are important to species such as elk. Research indicates that 30 acres is a reasonable low end for what constitutes a large forest patch.



KEY FACTS: "Forest Patches"

- Forest patches (larger than 30 acres) cover 45 percent of the region (see Figure A-5).
- Forest patches cover about 10 percent of urban areas, compared to 54 percent of rural areas.

Forests are not equally distributed throughout the region. The watersheds that have the highest number of acres of forest are the Tualatin, Lewis, Lower Columbia-Sandy, and Clackamas; collectively these watersheds total 57 percent of the region and contribute nearly one-third of the region's forest. Similarly, some urban areas have more tree cover than others, particularly where there are many streams or large protected natural areas, such as nature parks.

The largest contiguous areas of forestlands are in the eastern, northeastern, northern, and western fringes of the region, in the foothills of the Coast Range and Cascades. However, three major Coast Range spurs—Chehalem Ridge, Parrett Mountain, and the Tualatin Mountains, including Forest Park and Tryon Creek State Park—support substantial forested areas, as do the East Buttes area of Clackamas County and the Sandy River Gorge (Figures A-4 and A-5). In Washington, significant forested habitat is found near Lacamas Lake, Camp Bonneville, Whipple Creek Park, and Ridgefield National Wildlife Complex. Large forested areas also are found near outlying cities such as Battleground and in areas near the Cascade foothills.

The age of trees and the condition of the understory help in determining the species mix and structure of a forest. Most actively managed, commercial, and private industrial forests in the greater Portland-Vancouver region are composed mostly of Douglas fir trees (or occasionally ponderosa pine) that are between 1 and 60 years old. These stands typically have few snags, limited native shrubs, and scant large wood on the forest floor. As a result they are unlikely to support

species that depend on old-growth (i.e., mature) forest or species that require native shrub communities. This likely also is the case in state-owned forests managed by the Washington Department of Natural Resources and Oregon Department of Forestry to produce income for state school trust programs and, to a lesser extent, in so-called matrix lands owned and managed by the federal government (especially the U.S. Bureau of Land Management and U.S. Forest Service), where a focus on commercial thinning rather than clear cutting may enhance shrub communities and create some larger trees. Exceptions are likely to occur along streams protected by Oregon and Washington state forest protection acts, where species diversity and average age may be higher. Family-owned forests may also have greater age and species diversity, depending on management approach.

In urban areas and, increasingly, in rural areas, forests are suffering from high levels of invasive plant species such as English or Irish ivy (*Hedera* sp.), garlic mustard (*Alliaria petiolata*), invasive blackberry (*Rubus* sp.), Scotch broom (*Cytisus scoparius*), false brome (*Brachypodium sylvaticum*), and traveler's joy (*Clematis vitalba*), among others. This is especially the case along unmanaged roadside and in riparian areas. (For more on this issue, see Chapter 7, "Threats and Challenges.")

OLD-GROWTH/MATURE FOREST

Old-growth and mature forest has largely disappeared within the greater Portland-Vancouver region. No comprehensive layer of old-growth forest exists for the region, and conversations with land managers suggest that only a tiny fraction of old-growth, mature, or previously unharvested forest remains. However, there are a few small patches of old-growth forest within the region. Notable examples on the Oregon side include two patches totaling less than 200 acres on public land on the Sandy River, a small patch along the Clackamas River near Eagle Fern Park, and small amounts in or near Forest Park. In Washington, nearly 2,000 acres of patches that include mature or old-growth forest have been mapped; these are scattered throughout lands owned by PacifiCorp, mostly along the Lewis River.

The effort invested in mapping relatively small areas of old-growth forest showcase the rare and valuable nature of the region's remaining old-growth forest.

PRAIRIE AND NATIVE OAK

In 1850, prairie, oak savanna, and oak woodland habitats occupied about 25 percent of the greater Portland-Vancouver region. Evidence for this can still be seen today in the small patches and individual mature oak trees scattered throughout residential, commercial, and agricultural lands and mixed within the region's less intensively managed forestland at elevations below about 2,000 feet. Although these habitats are scattered throughout much of the region, they are most abundant in the southern end of the region, at the western edge of the Willamette Valley in Oregon, along the Willamette River, and in the eastern edge of the region in the Columbia River Gorge, especially in Washington.

TABLE 1-2

Regional Examples of Significant Prarie and Oak Habitats

Area	Owner/Manager
Sauvie Island	Oregon Department of Fish and Wildlife
Willamette Narrows	Metro, Oregon Parks and Recreation and The Nature Conservancy, among others
Cooper Mt. Nature Park	Metro, Tualatin Hills Parks and Recreation District
Ridgefield National Wildlife Refuge Complex	U.S. Fish and Wildlife Service
Washougal Oaks Preserve	Washington Department of Natural Resources
Lacamas Park and Lacamas Prairie	City of Camas, Washington Natural Heritage Program and multiple private owners
Lands in the Lake River/Columbia River lowlands between the Shillapoo Wildlife Area and the Ridgefield National Wildlife Refuge Complex	Private

The mapping effort for this *Biodiversity Guide* did not attempt to map oak and prairie habitats. Although these habitat types do fall within tree cover or other land use classes, there are no comprehensive and accurate maps of oak and prairie habitats available for most of the region from other sources. However, various Oregon entities have partial oak maps, and the Washington Department of Fish and Wildlife has mapped thousands of acres of oak and prairie habitats as part of it Priority Habitats and Species program.

The ReGAP project estimates that 3 percent (49,000 acres) of the greater Portland-Vancouver region supports oak woodland. However, that small number, which represents a 90 percent loss since 1850, is still likely to be an overestimate. This is so because, even though potentially suitable habitat for oak woodland is widespread, few large examples of oak woodlands are known to exist, and present-day oak is often mixed in with other types of trees. Data on oak savanna and prairie are similarly unreliable, although ReGAP estimates that less than 1 percent of the region (1,500 acres) is currently prairie. Reliable figures for the percent of oak woodland, savanna, and prairie in public ownership do not exist, but a high percentage is thought to be in private ownership. Table 1-2 lists some significant areas of prairie and oak within the region.

Agriculture

There are no accurate statewide or, in most cases, even county-level map layers for agriculture. The mapping effort for this *Biodiversity Guide* used a combination of a modeling approach and hand digitizing from aerial photographs to separate agriculture from other short-stature land cover types. The mapping and acreage estimates in this *Biodiversity Guide* lack precision around Christmas trees farms, nut and fruit orchards, and vineyards (all of which are likely included in other land cover categories) and probably underestimate even row crops and grass fields because the hand-digitizing process excluded small areas. The hand digitizing substantially improved the quality of this land cover category.

KEY FACTS: "Agriculture"

- 22 percent of the region's land cover —just over 400,000 acres—is mapped as agriculture.
- 82 percent of the classified Agriculture land falls within four counties:
- Clackamas County: 31 percent (approximately 125,000 acres)
- Washington County: 23 percent (approximately 93,000 acres)
- Clark County: 17 percent (approximately 68,000 acres)
- Marion County: 11 percent (approximately 45,000 acres)

Most of the region's largest agricultural areas lie in the interface between urban areas and the outer large forested areas, where lands are relatively flat, soils are good, and water is accessible. Depending on management and type of crop, agricultural lands can provide important habitat for birds and other wildlife, such as grassland birds and wintering waterfowl. However, loss of habitat and management activities such as mowing during nesting season can reduce wildlife populations.

Derivatives of the Land Cover

Natural Lands and Natural Patches

Natural lands were defined by removing developed and agricultural lands from the land cover and adding wetlands and small water bodies. Natural land cover types with a cumulative contiguous area larger than 1 acre were grouped as "natural patches." This was integral to the subsequent habitat modeling process (see Appendix B) where we wanted to value small natural urban patches in relationship to their surroundings. In the habitat model, this kept the urban patches from being eclipsed by the larger, mostly publicly-owned patches in the foothills of the region.

KEY FACTS: "Natural Lands and Natural Patches"

- 60 percent of the landscape was classified as natural patches larger than 1 acre.
- 53 percent of all the natural patches acres (or roughly 30 percent of the total region) are in patches larger than 30 acres.
- 25 percent of the urban area is classified as natural patches that are larger than 30 acres.[5]

Interior Forest Habitat [6]

Table 1-3 provides information on the habitat differences between urban and rural areas as illustrated by the tree cover and forest patch size statistics described above, as well as by the amount of interior forest habitat.

KEY FACTS: "Forest Habitat"

- 53 percent of the region's tree cover occurs in areas classified as interior forest habitat (i.e., at least 50 meters inside a forest patch).
- 97 percent of all interior forest habitat lies outside areas classified as urban.
- About 14,000 acres of interior forest habitat are located within areas classified as urban.

[5] See Chapter 6, "Issues and Concepts," for information on patch size and the relative importance of interior versus edge habitat.

[6] For the purposes of this *Biodiversity Guide*, interior habitat is defined as that which is 50 meters or more to the inside (away from the edge) of the patch of forest. Research suggests that in the greater Portland-Vancouver region, that is the approximate distance at which adverse edge effects, such as non-native species proliferation and simplified forest structure, are substantially reduced.

TABLE 1-3

Publicly and Privately-Owned Lands, Forest Patches (FP) and Interior Forest Habitat (IF) in the Region, by Watershed (WS)

Watershed or Subbasin	Ownership (Total Area in Watershed)		Forest Patches > 30 Acres (FP)			Interior Forest Habitat (IF)		
Name	% Pub.	% Priv.	% Cover in WS	%FP That is Public	WS's Contrib. to all Regional FP	% Cover in WS	%IF That is Pubic	WS's Contrib. to all Regional IF
Abernethy Cr-Willamette R	4%	96%	31%	7%	3%	13%	10%	2%
Chehalem Creek-Willamette R	1%	99%	21%	2%	2%	8%	1%	1%
Clackamas Subbasin (Partial)	9%	91%	55%	15%	11%	35%	18%	11%
Hayden Island-Columbia R	13%	87%	6%	53%	<1%	2%	55%	0%
Johnson Creek	11%	89%	16%	37%	1%	6%	57%	1%
Lewis Subbasin (Partial)	22%	78%	71%	28%	19%	48%	34%	20%
Lower Columbia-Sandy Subbasin (Partial)	26%	74%	63%	36%	17%	43%	43%	18%
Lower Columbia-Clatskanie Subbasin (Partial)	0%	100%	23%	0%	1%	14%	0%	1%
Molalla-Pudding Subbasin (Partial)	3%	97%	37%	8%	8%	23%	10%	8%
Salmon Creek-Frontal Columbia	11%	89%	19%	17%	3%	8%	25%	2%
Scappoose Creek-Frontal Columbia	16%	84%	55%	14%	8%	39%	15%	9%
Tualatin Subbasin	12%	88%	47%	20%	26%	31%	25%	26%
Willamette R-Frontal Columbia	15%	85%	10%	65%	1%	6%	77%	1%
TOTAL	13%	87%	45%	22%	100%	29%	27%	100%

Note: Publicly owned is defined as federal, state, local jurisdiction, and special district ownership.

Land Management and Public Lands

Although land ownership data are available, land protection data are imperfect. Most public land is not specifically designated according to management focus, such as natural area, recreational area, or playground. This limited our ability to make definitive statements about the amount of conserved or protected land. Clearly, not all publicly owned land is protected from future development or managed for conservation purposes. Some parcels, such as parks, golf courses, and some school properties, have mixed uses and values, while also providing important wildlife habitat within urban areas. Other areas, such as some publicly owned forests and agricultural areas, are managed primarily for economic production rather than biodiversity values.
Our definition of "publicly owned" is a broad category that includes publicly owned golf courses; public parks; federal, state, county, and city-owned lands; schools; and special districts (Figure A-6). There is a higher proportion of forest in public lands than in private lands.

continued on page 14

FIGURE 1-1

Regional Conservation Modeled Output

High-Value Lands in the Region

This graphic shows ecologically high-value lands in the greater Portland-Vancouver region, based on The Intertwine Alliance's conservation priority model. High-value areas on the regional map ranked in the top one-third of all areas because of the type, location, and size of their habitat. In short, these areas represent regional priority lands within our nearly 3,000-square-mile region.

Our scientifically based prioritization model divided the region into 5 meter pixels (5 x 5 meter squares) and analyzed them for a number of features, including: existing vegetation, wetlands, habitat patch size and shape, and the presence of roads. To account for habitats in both urban and rural settings, pixels were scored independently and patch size was assessed in relative and absolute terms. This approach generated information that can help prioritize conservation strategies at a variety of geographic scales – from the entire region to the local neighborhood; and allows us to prioritize urbanized habitats as part of a collective effort to preserve the region's biodiversity.

In general, the results are consistent with, but more detailed and geographically comprehensive than, previous efforts to prioritize wildlife habitat within the region. Because the region has both highly developed urban areas and relatively undisturbed landscapes, much of the highest value habitats fall outside the region's urban growth boundaries. However, more than 19,400 acres of regional high-priority lands occur within and around the region's cities.

Reliable, region-wide information for some important habitats such as oak woodlands, prairie, rare species and high-quality forests, was not available. For now, their inclusion in planning efforts will continue to require expert knowledge. It's also important to note that the model addressed biodiversity, not culturally or visually significant landscapes. Future efforts of The Intertwine Alliance will address these important issues.

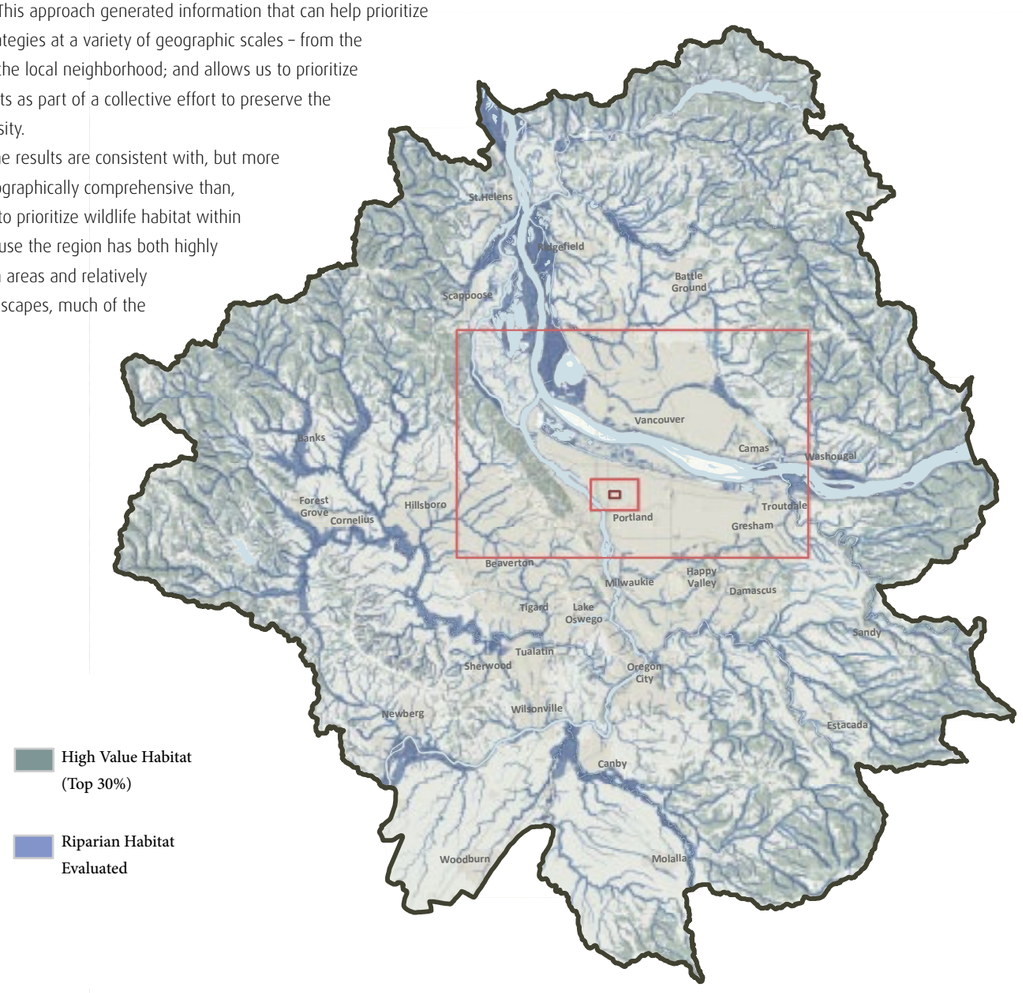
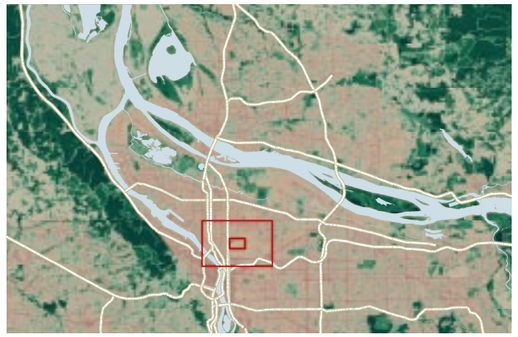


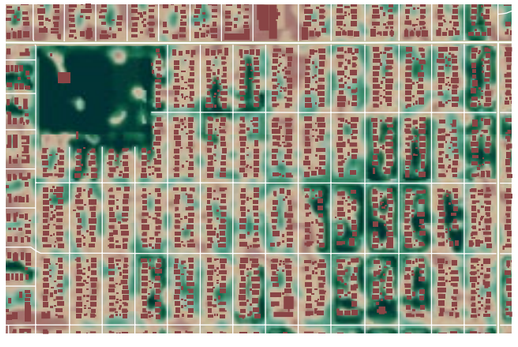
FIGURE 1-2

Understanding Conditions at Multiple Scales



Regional 1"=6.3 MILES, OR 33,333 FEET

Local 1"=0.85 MILES, OR 4,500 FEET



Neighborhood 1"=0.19 MILES, OR 1,000 FEET

Highest Value
High Value
Medium-High Value
Medium-Low Value
Low Value
Least Value

An important benefit of our approach is the flexibility to analyze data at any scale, from the 3,000-square-mile region to the local neighborhood. The following examples represent patterns of land cover and relative conservation value as one zooms in from the regional to the neighborhood scale.

Regional

At the regional geographic scale, most small, local habitats are not apparent. Only the most prominent features stand out, such as rivers and large forest blocks. The highest scoring areas reflect habitats that have significant conservation value within the 3,000-square-mile region. Most highly fragmented urban habitats are not represented at this scale even though these areas are critical to regional biodiversity.

Local

At this intermediate scale, finer habitat patterns are more apparent while regional elements are still prominent. In this example, blocks of habitat barely visible at the regional scale become more dominant. For example, patterns of street tree density within east Portland become recognizable as a potential regional planning element. Opportunities to create ecological connections between regional sites are suggested. Only the highest scoring areas at this scale are likely to have regional significance.

Neighborhood

At the local scale, the neighborhood, features that appear less significant at the regional scale are apparent. Habitats barely or not recognizable at larger scales, such as local parks, creeks, vegetated hillsides, or tree patches can be woven into a meaningful framework and incorporated into local habitat conservation planning, neighborhood by neighborhood.

KEY FACTS: "Publicly Owned Land"

- 13 percent of the region's land base is in public ownership.
- 22 percent of the land classified as forest patches is publicly owned.
- 27 percent of the land classified as interior forest habitat is publicly owned.
- 28 percent of the land classified as natural land cover is publicly owned.

Of the 28 percent of the region's natural land cover in public ownership, significant acreage is owned and managed by the states of Oregon and Washington, U.S. Bureau of Land Management, U.S. Forest Service, and U.S. Fish and Wildlife Service. Key owners of natural land within urban areas include Vancouver-Clark Parks, Metro, and the cities of Portland, Gresham and Hillsboro. Many other jurisdictions and several nonprofit organizations also own and manage natural habitats (Appendix C). These lands are managed for a variety of purposes, including commercial forest production, nature based recreation, and species and habitat conservation.

The level of natural area protection is not the same across watersheds. Although protection equality at the watershed scale is not an important goal, it is important that land protection priorities be considered at multiple scales, and that the most important lands at each scale be identified and protected. This *Biodiversity Guide* can provide important information for such prioritizations.

Appendix C describes the portfolios of the region's major public land managers and their management approaches (see also Figure A-6).

FOR MORE INFORMATION

Final Report on Land Cover Mapping Methods, Map Zones 2 and 7, PNW ReGAP
E.B. Grossmann, J.S. Kagan, J.A. Ohmann, H. May, M.J. Gregory, C. Tobalske. 2008. Institute for Natural Resources, Oregon State University, Corvallis, OR.

"Actual Vegetation Layer"
D.M. Stoms. 1994. *A Handbook for Gap Analysis.*

"Assessing Land Cover Map Accuracy for Gap Analysis"
D. Stoms, F. Davis, C. Cogan, and K. Cassidy. 1994. *A Handbook for Gap Analysis.*

How Can My Watershed Address Help Me Find USGS Data? (And What Is a HUC?)
http://nwis.waterdata.usgs.gov/tutorial/huc_def.html

Biogeography of the Greater Portland-Vancouver Region

CHAPTER 2

Oaks Bottom Wildlife Refuge, less than three miles from downtown Portland, highlights the region's complexity of landscape.

Focal Area

Jonathan Soll, Metro and Esther Lev, The Wetlands Conservancy

The geographic area that is the focus of this *Biodiversity Guide for the Greater Portland-Vancouver Region* includes 1,829,575 acres (2,859 square miles), all or parts of seven Oregon and three Washington counties (see Figure A-1), and 14 subbasins (HUC 4 and HUC 5) (see Figure A-2 and Table 2-1). Nestled between the Cascade Mountains and Columbia River Gorge to the east and the Coast Range to the west, the region lies at the northern tip of the Willamette Valley and the southern end of Puget Trough. It encompasses both the confluence of the Willamette and Columbia rivers and the upstream end of the Columbia's tidal freshwater zone. Within the region are major cities (including Oregon's largest metropolitan area), world-class farm and forest land, two major ports, and two interstate highways that connect the area to Mexico, Canada, and the east.

Although most of the region lies between 100 and 1,000 feet in elevation, elevation ranges from near sea level along the Willamette and Columbia rivers to highs of more than 4,000 feet at the region's eastern edge (see Figure A-3). Although climate varies with altitude, it is generally mild, with cool, wet winters and warm, dry summers that are conducive to plant growth. Precipitation is generally lowest in the rain shadow of the Coast Range at the low end of the Coast Range foothills, near the southwestern fringe of the region, and gradually increases in all directions from there. The upper elevation portion of the region in the foothills of the Cascades gets the most annual precipitation and is the only area with significant winter snowfall.

The current typical natural upland vegetation type is mixed coniferous/deciduous forest less than 60 years old, generally dominated by Douglas fir (*Pseudotsuga menziesii*) and bigleaf maple (*Acer macrophyllum*). However, oak habitats, prairie, riparian and floodplain forest, and wetlands also are key elements in supporting the region's beauty and biodiversity. Forest is widespread at the edges of the region but in urbanized areas is limited largely to riparian corridors, patches of less than 30 acres, and street trees. These diverse habitats support more than

TABLE 2-1
Subbasins Used for Analysis of Vegetation Change

Number	Basin	Acres
1	Abernethy Creek-Willamette River	87,105
2	Cathlamet Channel-Columbia River	21,944
3	Chehalem Creek-Willamette River	78,157
4	Clackamas River	158,238
5	Johnson Creek	60,110
6	Lewis River	220,736
7	Molalla River	180,866
8	Salmon Creek-Frontal Columbia River	137,341
9	Sandy River	67,123
10	Scappoose Creek-Frontal Columbia River	125,287
11	Tualatin River	452,981
12	Washougal (City)-Columbia River	47,696
13	Washougal River	102,128
14	Willamette River-Frontal Columbia River	89,032
Total		1,828,745

409 species of native wildlife, including at least 47 fish species, 18 amphibians, 14 reptiles, 219 birds, 66 mammals, and 59 types of butterflies. These numbers exclude thousands of other invertebrate species (see Appendices E, G and H).

The region is blessed with several major rivers—the Clackamas, Columbia, Lewis, Molalla, Salmon, Sandy, Tualatin, Washougal, and Willamette—and many smaller rivers, creeks, and sloughs. Lakes are few and mostly have been altered for water supply and flood control; they include Sturgeon, Smith, Bybee, Vancouver, Lacamas and Hagg lakes; Lake Oswego; and Kellogg, Merwin and Scroggins reservoirs. These water bodies support at least two dozen native fish species, including iconic runs of salmon and steelhead.

The Willamette and Columbia rivers divide the region roughly into thirds (see Figure A-1). The Columbia runs west, dividing Oregon and Washington before heading north as it passes through Portland and Vancouver. The Willamette runs roughly east through the southern portion of the region and then turns north after passing Wilsonville, before joining the Columbia north of Portland. The foothills of the Cascade Range define the eastern portion of the region, while the Coast Range foothills define the northwest. The Tualatin Mountains form a forested spine through the city of Portland, running southeast-northwest from Lake Oswego to the Coast Range above Scappoose. The Chehalem Mountains extend west and then northwest from Sherwood to Forest Grove. A series of geologically recent volcanic cones collectively named the East Buttes dot southeast Portland and the lower Clackamas watershed.

Near the end of the last ice age (approximately 12,000 years ago), the Missoula Floods carved out the Columbia River Gorge, flooded what is now the Portland-Vancouver area, altered river courses, and deposited rocks and rich sediments onto the valley floor.

The greater metropolitan areas of Vancouver, Washington, and Portland, Oregon, are home to the lion's share of the region's residents: 2.1 million, as of 2010, with approximately 1 million more residents expected over the next 25 years. Although urban areas extend throughout the region, development is densest near its center, roughly at the confluence of the Willamette and Columbia rivers. The population generally becomes sparser toward the perimeter. Oregon cities include Beaverton, Canby, Estacada, Forest Grove, Gresham, Hillsboro, Lake Oswego, Milwaukie, Newberg, Portland, Scappoose, St. Helens, Sherwood, Troutdale, Wilsonville, and Woodburn. Washington cities include Battle Ground, Camas, La Center, Ridgefield, Vancouver, Washougal, and Woodland.

As in much of the Willamette Valley, but in contrast to much of the rest of Oregon and Washington, the region's land base has little federal land ownership. However, 239,352 acres (13.1 percent of the region) are in public ownership, with significant areas owned by Metro, the states of Oregon and Washington, and local jurisdictions (see Figure A-5). Federal ownership is restricted mostly to three wildlife refuges and some areas on the fringe of the region, such as the western end of the Columbia River Gorge Scenic Area. Some important natural areas are listed in Table 2-2. In addition, the states of Oregon and Washington manage substantial forested areas—in the Coast Range foothills and Cascade foothills, respectively—for income for school trusts and other public benefits.

The south/southwest portion of the region is part of the Willamette Valley proper. Like most of the valley, this former prairie and savanna area is dominated by agriculture, with significant acreage in grass seed. The lower, flatter, undeveloped areas of the Tualatin Basin also are predominantly agricultural, as are the Columbia River lowlands (excluding Vancouver and other urban areas) and much of Sauvie Island. Vineyards have extended the reach of agriculture to steeper slopes in warmer microclimates, especially in the rain shadow of the Coast Range at the western edge of the Willamette Valley. Nurseries occupy significant areas in the mid-elevation portions of rural Multnomah, Clackamas, and Clark counties and elsewhere. Forests and forestry dominate undeveloped landscapes elsewhere, particularly above the 1,000-foot level.

With this unique geographic and cultural setting, the region understandably has unique and diverse flora and fauna, and correspondingly unique conservation challenges and opportunities.

Habitat Change in the Region, 1850-2010

John A. Christy, Oregon Biodiversity Information Center, Portland State University[1]

Analysis of changing land cover in the greater Portland-Vancouver region since 1850 indicates which habitats have sustained the greatest impacts from settlement, and by proxy, which

TABLE 2-2
Important Natural Areas in the Greater Portland-Vancouver Region

Area	Owner/Manager
Tualatin, Ridgefield, Steigerwald Lake, Franz Lake, and Pierce Lake National Wildlife Refuges	U.S. Fish and Wildlife Service
Sauvie Island, Multnomah Channel, and Palensky State Wildlife Areas (Palensky Wildlife Area is within Burlington Bottoms)	Oregon Department of Fish and Wildlife, Metro, and Bonneville Power Administration
Forest Park	City of Portland
Molalla River State Park, the Lower Sandy River Gorge, the Lower Clackamas River	Multiple owners
Willamette Narrows	Metro and Oregon Parks and Recreation Department
Shillapoo Wildlife Area	Washington Department of Fish and Wildlife

[1] This section is abstracted from the report *Changing Habitats in the Portland-Vancouver Metro Area, 1850-2010*, produced by John A. Christy of the Oregon Biodiversity Information Center for the *Regional Conservation Strategy* and *Biodiversity Guide* project. Details on analytic methods are found in the full report, which is available on request from Metro's Natural Areas Program).

TABLE 2-3
Acreage, Percent of Total Area, and Percent Change for 11 Land Cover Types in the Region

Pre-settlement mapping efforts did not map or grossly under-represented habitats that existed as smaller patches (non-matrix types). As a result, data for emergent wetalnd, riparian forest, shrub swamp and shrubland likely grossly underestimate the degree of loss since 1850.

	1850		2010		
Land Cover Type	**Acreage**	**% of Total**	**Acreage**	**% of Total**	**% Change**
Agriculture	0	0.00	500,174	27.35	n/a
Emergent wetland	7,164	0.39	21,457	1.17	199.50
Mixed forest	1,205,245	65.90	778,118	42.55	-35.44
Oak	198,995	10.88	49,244	2.69	-75.25
Prairie and savanna	266,296	14.56	1,494	0.08	-99.44
Riparian and wet forest	80,016	4.38	83,046	4.54	3.79
Shrub swamp	7,721	0.42	6,562	0.36	-15.02
Shrubland	428	0.02	3,265	0.18	662.94
Unvegetated	669	0.04	1,573	0.09	135.14
Urban	0	0.00	328,838	17.98	n/a
Water	62,205	3.40	54,976	3.01	-11.62
TOTAL	1,828,740	100	1,828,745	100	

species assemblages are most at risk. In order to provide information at both the regional and subwatershed scales, data were analyzed for the region as a whole and for 14 separate subbasins (HUC 4 and HUC 5 and Table 2-1). The main sources of data were General Land Office land survey data from the 1850s, U.S. Forest Service maps of forest type from the 1930s, and— for 2010 vegetation—ecological system life form data created for the U.S. Geological Survey's gap analysis program. Eleven land cover types (Table 2-3) were used to analyze changes in habitat. (For methods, see "Data Sources and Methods," below.)

Results indicate that agriculture and urban development have caused the greatest changes in land cover in the region, and oak, prairie, and savanna habitats have sustained the greatest losses. Changes at the subbasin level vary widely, depending mostly on the location of subbasin relative to urban development and farmland. Extensive areas of commercial forest at the edges of the region keep overall forest cover high; although more urbanized subbasins have lost substantial forest cover.

Limitations of the Data

Source data are generally accurate for large-scale features but commonly misclassify or underestimate those types occurring in small areas. Consequently, less emphasis should be placed on figures for small-patch cover types, including emergent wetland, riparian forest, shrub swamp, shrubland, and unvegetated land. The use of small-patch cover types here is limited to analysis of what historical types were converted to agriculture and urban cover.

Vegetation Change over the Region

Historically, about 50 percent of the region was covered by conifer/mixed forest and 16 percent was burned forest, with most of the remaining area covered in prairie or savanna (14.6 percent), and oak (10.9 percent). By 2010, nearly half of the region had been converted to either agriculture (27.4 percent) or urban and suburban development (18 percent). Prairie, savanna, and burned forest had essentially disappeared, and oak was reduced to 2.7 percent. Combined non-oak forest cover declined about 35 percent. Changes in the six small-patch cover types (Table 2-3) in the study area are difficult to explain and to a large degree represent differences in classification in the underlying data sets.

More detailed vegetation change by subbasin is presented in each subbasin description (see Appendix I).

Vegetation Change by Subbasin

The 14 subbasins vary greatly in size, historical and current species composition, and relative amounts of agricultural and urban development (see Table 2-3). Changes in the subbasins largely reflect differences in the history of settlement and development. Basin-by-basin changes in the four cover types of greatest conservation concern are shown in Figure 2-2. Prairie/savanna and oak showed consistent losses across all subbasins except the Sandy River (this exception probably is attributable to misclassification in the data set), averaging 85 percent and 63 percent, respectively. Mixed forest declined an average of 35 percent in all subbasins except for the Chehalem, where it showed an 81 percent gain, presumably because—in the absence of fire—Douglas fir and other upland forest trees invaded prairie/savanna and oak habitats. Water showed declines in the Cathlamet, Salmon, Scappoose, and Willamette subbasins but increases in the Clackamas and Molalla subbasins. Losses in the former presumably are due to drainage and diking for agriculture, while the gains in the Clackamas and Molalla subbasins may be attributable to the creation of gravel pits. The large increase in water in the Lewis River subbasin is attributable to the construction of flood control reservoirs after 1931. Agriculture and urban forest were excluded from Figure 2-1 because they were not present in 1850.

Historically, the following basins consisted of more than 20 percent prairie or savanna habitat: Molalla River (37 percent), Chehalem Creek (29 percent), Clackamas River (27 percent), Abernethy Creek (26 percent), and Cathlamet Channel (25 percent). With the exception of the Cathlamet Channel subbasin, prairies in Washington were small and scattered but relatively numerous. Very few are left today in the region, and prairies are of great conservation concern. Oak habitat covered more than 20 percent of two subbasins—Chehalem Creek (60 percent) and Tualatin River (20 percent)—but never was extensive in the Washington portion of the region.

Today, urbanized land represents more than 20 percent of the following subbasins: Johnson Creek (69 percent), Willamette (62 percent), Salmon Creek (32 percent), Abernethy Creek (26 percent), and Tualatin River (21 percent). In nine basins, agriculture represents more than 20 percent of the land; these basins are Chehalem Creek (67 percent), Molalla River (51 percent),

FIGURE 2-1
Relative Percent Change of Major Land Covers, 1850-2010, for the Region
Excludes Emergent Wetland and Shrubland Because of Differences in Data Sets

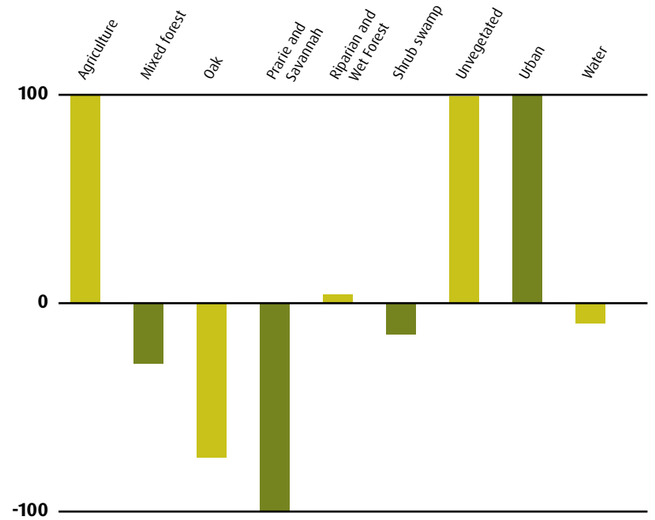
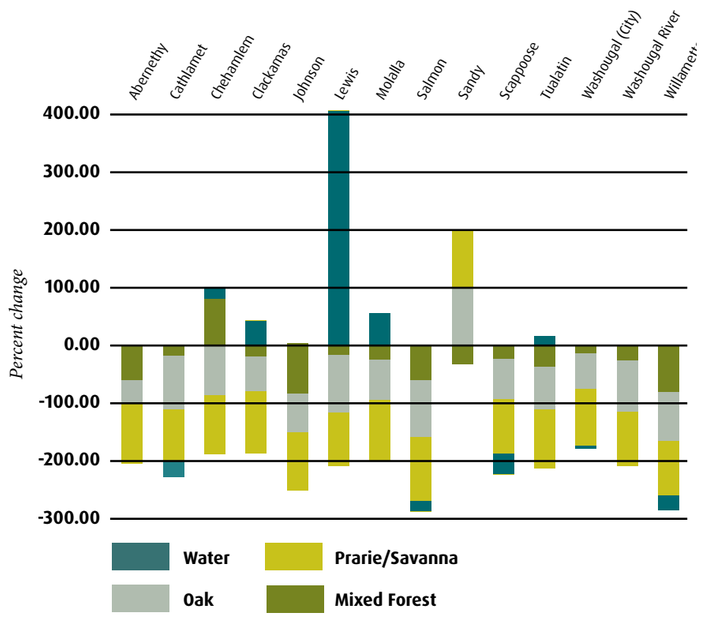


FIGURE 2-2
Percent Change of Major Land Covers by Subbasin, 1850-2010*



*Total habitat loss for an area cannot exceed 100%. However, the stacked bar format used here shows percentage loss for each individual habitat in an additive fashion in order to show the relative change for each type.

Abernethy Creek (39 percent), Cathlamet Channel (34 percent), Clackamas River (28 percent), Tualatin River (28 percent), Salmon Creek (27 percent), Scappoose Creek (20 percent), and Sandy River (20 percent). In general, the amount of relic habitat of conservation concern is inversely proportional to the extent of urban and agricultural land cover.

Data Sources and Methods

Assessments of 1850 vegetation for the region were derived from 1850s General Land Office (GLO) land survey data, which were augmented with 1930s maps of forest type developed by the U.S. Forest Service. Assessments of 2010 vegetation were derived from the ecological system life form (ESLF) data created for the U.S. Geological Survey's (USGS) Gap Analysis Program. Vegetation attributes in the General Land Office layer were reduced to 13 types and translated to the ESLF layer (see Table 2-3).

The 13 land cover types were reduced to 11 in the final comparison of historical and current vegetation. Key points are as follows:

- Two historical cover types—burned forest and woodland—disappeared completely because of fire suppression and were divided between coniferous/mixed forest and oak, depending on dominant species, in order to better assess overall change in forest cover.
- Most forest in the General Land Office layer was classified as coniferous because it was dominated by conifers, although most stands contained hardwoods. The ESLF cover classified most forest as mixed. As a result, coniferous and mixed forest stands were combined for analyses.
- Agriculture and urban cover did not exist in 1850 but are of major importance in 2010.
- Because of technical challenges, it is likely that oak is overestimated in the modern layer.
- Although the General Land Office layer delineated large stands of historical riparian-floodplain forest, it did not include small stands, particularly in the interiors of sections. In contrast, most large floodplain forests are now gone, but the ESLF cover included the extensive network of forest along smaller streams. As a result, the data indicate an increase in riparian forest, when logic suggests that it has actually declined.
- Together, emergent wetland, scrub-shrub wetland, shrubland, and unvegetated land made up only 0.87 percent of the landscape in 1850 and 1.80 percent in 2010; these figures are suspect because of differences in scale and classification in the underlying datasets.

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How the *Biodiversity Guide* Relates to Other Regional Planning Efforts

Over the past 20 years, several regional, state, and local conservation priority-setting efforts have been completed that overlap, are adjacent to, or are fully within the boundary of the greater Portland-Vancouver region (see Table 2-4). The larger regional analyses generally share an overall project goal with the *Biodiversity Guide* and *Regional Conservation Strategy*—i.e., identifying where best to direct conservation actions so as to preserve overall biodiversity at the regional scale. Previous conservation planning efforts focused on the Willamette Valley (e.g., the Oregon Department of Fish and Wildlife's Oregon Conservation Strategy in 2006 and the Nature Conservancy-led Willamette Synthesis project in 2009), the Willamette Basin (the Pacific Northwest Ecosystem Research Consortium's Willamette River Basin Planning Atlas), or even multi-state ecoregions like the Cascade Mountains or Coast Range (The Nature Conservancy and its partners' ecoregional assessments in 2006 and 2007). In contrast, more local efforts, such as those conducted by Metro, counties, cities, soil and water conservation districts, watershed councils, and other nonprofit organizations, tend to address individual areas or single watersheds within the region and do not evaluate the areas within the context of the larger regional landscape. Finally, projects like U.S. Fish and Wildlife Service recovery plans focus on particular species or habitats. The resulting lack of consistent data sets, methods, and project objectives make it difficult to align and adequately integrate larger and smaller scale priorities into the specific geography of the greater Portland-Vancouver region.

One of the principal weaknesses of the previous regional efforts was their lack of attention to urban and near-urban areas. Historically, the value of urban areas in supporting regional conservation efforts has been underrated; analyses have been skewed by the available data sets, the large scale of analysis, and the lack of appreciation of the role that urban natural areas can play in connecting sites and watersheds, both within the region itself and in linking the region to the larger ecological landscape.

This *Biodiversity Guide* aims to build on the previous regional and local-scale analyses and prioritizations by filling in the gaps between plans done with a larger landscape context and local plans. The final product will allow for conservation priorities to be set at a geographic scale that matches the region but that can also integrate smaller, watershed-based plans and nest within larger bioregional analyses.

TABLE 2-4

Regional Biodiversity Assessments Conducted since 1990

Plan or Project	Geography and Purpose	Project Leader and Key Participants	Comments
Clark County Legacy Lands Project, 1992 and onward	Greater Vancouver metropolitan region Identify and implement actions to protect, conserve, and restore the system of natural areas, trails, and open spaces	Clark County and a coalition of public agencies, nonprofit conservation organizations, private landowners, and the community	Expert opinion-based effort; for information about projects and data contact patrick.lee@clark.wa.gov or see http://www.co.clark.wa.us/legacylands/index.html
Oregon Biodiversity Project, 1993-1999	Oregon statewide High-priority conservation areas in Oregon	Defenders of Wildlife and many stakeholders	Identified about 18% of the state. The value of urban areas largely is overlooked at that scale.
Willamette Basin Alternative Futures: Conservation and Restoration Option, 2002	Willamette Basin Presented an achievable vision of conservation and restoration opportunity areas that would still allow for anticipated growth	Pacific Northwest Ecosystem Research Consortium, led by the University of Oregon and Oregon State University, with many partners and many stakeholders providing feedback	Does not include Washington portions of the greater Portland-Vancouver region
Metro Title 13 Regionally Significant Fish and Wildlife Habitat Inventory, 2005	Extends to one mile outside the urban growth boundary Used to provide scientific context for meeting Oregon's land use Goal 5 requirements	Metro staff, jurisdictions, Department of Land Conservation and Development, and stakeholder steering committee	Focused on a smaller watershed-specific scale. Oregon portion of the region only.
Actions for Watershed Health: Portland Watershed Management Plan, 2005	City of Portland Guides City decisions and projects by providing a comprehensive approach to restoring watershed health.	City of Portland Bureau of Environmental Services	City of Portland boundary.
Framework for Integrated Management of Watershed Health, 2006	City of Portland Science to guide City decisions that affect watershed health; ensures cross-bureau consistency; establishes goals, objectives, indicators of success.	City of Portland Bureau of Environmental Services	City of Portland boundary. Includes annual reports
Oregon Conservation Strategy, 2006	Oregon statewide Identified priority species and habitats and conservation opportunity areas	Oregon Department of Fish and Wildlife and many stakeholders	Limited information on urban areas. The scale is very coarse. The strategy will be updated in the next few years. Conservation opportunity areas in the greater Portland-Vancouver area will be based on work of the Willamette Synthesis project.
Washington Conservation Strategy, 2006	Washington state Identified priority species and habitats; conservation opportunity areas as in Oregon's strategy were not mapped	Oregon Department of Fish and Washington Department of Fish and Wildlife and many stakeholders	No specific conservation opportunity areas are identified. Scale is too large to provide the level of detail needed in the greater Portland-Vancouver region.
Nature Conservancy Pacific Northwest Coast Ecoregional Assessment, 2006	Oregon and Washington Coast Range Identified focal area for biodiversity conservation	The Nature Conservancy with stakeholders and expert review by many agencies and organizations	The *Biodiversity Guide* links to these assessments, for the most part not overlapping with them.
Natural Features Project, 2006	Addressed much of the greater Portland-Vancouver region (excluding Washington)	Coalition of government agency and nonprofit organizations under the auspices of Metro Greenspaces Policy Advisory Committee	Expert opinion-based effort, polygons are not delineated, and there are no attributes.
Nature Conservancy East and West Cascade Mts. Ecoregional Assessment, 2007	Oregon, Washington, and Northern California Identified focal areas for biodiversity conservation	The Nature Conservancy with stakeholders and expert review by many agencies and organizations	The *Biodiversity Guide* links to these assessments, for the most part not overlapping with them.
Willamette Synthesis Project, 2009	Willamette Basin Integrated previous assessments and updated state of Oregon conservation opportunity areas with better data	The Nature Conservancy with stakeholders and review by many agencies and organizations	Provides a good starting point; however, as with the state conservation strategies, the scale is too large to provide the level of detail needed in our region.
Oregon and Washington Recovery Plans for Lower Columbia River Salmon and Steelhead, 2010	Lower Columbia watersheds of Oregon and Washington Set programmatic and geographic priorities for salmon and steelhead recovery	ODFW in Oregon and Lower Columbia Fish Recovery Board in Washington, with participation by many stakeholders	Information from this plan is used in the *Biodiversity Guide*.
U.S. Fish and Wildlife Service, Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington, 2010	Willamette Valley and southern Puget Trough Identified actions and goals for prairie and savanna conservation to benefit listed species	Institute for Applied Ecology for U.S. Fish and Wildlife Service; many partners provided input	Information from the recovery plan is used in the *Biodiversity Guide*.
Watershed-based Assessments and Plans (various).	Plans and assessments typically tied to watershed or subwatershed boundaries	Developed by watershed councils and similar groups or agencies	Factored into the *Biodiversity Guide*.

Major Habitat Types of the Region

CHAPTER 3

Rivers, Streams, and Open Waters

Jane Hartline, West Multnomah Soil and Water Conservation District, and Ted Labbe, Kingfisher Ecological Services

The aquatic habitats discussed in this section are flowing and standing bodies of water, meaning rivers, streams, lakes, bays, ponds, and sloughs. Hundreds of interconnected lakes, ponds, and streams thread their way across the region, connecting large rivers and bays with headwater wetland and upland environments. As open, linear systems, streams reflect the health of the entire watershed. Food webs in open water depend on organic matter that originates from forests along the water's edge and from upstream contributing areas. Thus it is difficult to separate the ecological health of these water bodies from the health of their watersheds and associated shoreline, mudflat, and floodplain ecosystems. (For descriptions of these other habitats, see the "Riparian and Bottomland Hardwood Forests," "Wetlands," and "Shorelines and Mudflats" sections of this *Biodiversity Guide*).

Organisms, water, energy, sediment, and organic matter move laterally (across the land/water boundary), longitudinally (upstream/downstream), and vertically (between open water, groundwater, and flood-prone lands), continually reshaping and restructuring aquatic ecosystems and thus creating and maintaining habitat. Fallen leaves, woody debris, terrestrial insects, and other organic matter is swept downstream and forms the foundation of open-water food webs, sustaining aquatic insects, small fish, and amphibians and ultimately their predators, which include salmon, birds, bats, and mammals.

Rivers, streams, and open waters perform important though often underappreciated ecological services. These water bodies attenuate and reduce flood flows, recharge groundwater, store sediment, transform and ameliorate harmful nutrients, deliver clean water, cool urban areas during summer heat spells, and provide numerous recreational opportunities. In the Pacific Northwest, open-water riparian areas support some of the highest levels of biodiversity and represent important movement corridors for both aquatic and terrestrial species.

The character of rivers, streams, and open waters is determined by such factors as watershed geology, topography, land use/land cover, and riparian vegetation. The most immedi-

Rivers, streams and open waters provide many important benefits, including recreational opportunity.

ate influences include water depth, flow, temperature, substrate materials such as sand and gravel, bank conditions, and the presence or absence of floating and submerged logs and debris. Seasonal fluctuations of water level, temperature, and flow are important in all of the region's waters but have been significantly modified in many areas by surface and groundwater withdrawals, dams, dikes, and other water control structures. In rivers and sloughs, upstream flow regulation has reduced the impact of spring freshets and winter floods and severed or undermined connections between open-water habitats and surrounding ecosystems. Other human-caused disturbances include impacts associated with stormwater runoff, fill and channelization, toxic and nutrient pollution, erosion and sedimentation, removal of riparian vegetation, alteration of banks and shorelines, and the creation of barriers to fish and wildlife movement. Natural processes that influence the development of streams, rivers, and open-water habitats include flooding, drought, accretion, siltation, and tidal influence.

Historical and Current Occurrence

The amount of open-water habitat in the greater Portland-Vancouver region has declined by more than 49 percent since 1806. Several lakes in the region were drained or filled decades ago for development and agriculture, and most remaining open-water habitat has been significantly altered. Dams have altered stream and river flow patterns, reducing peak flows and moderating seasonal fluctuations. Levees, dikes, and pumps have disconnected streams and rivers from their associated floodplains and wetlands. The proliferation of roads, buildings, and other impervious surfaces has radically transformed stream hydrology, increasing pollution and the frequency and severity of winter scouring flows.

Many streams, particularly in the urban area, have been put into underground pipes. Roads that crisscross drainage networks create numerous culvert barriers to fish and wildlife movement, and they alter the delivery of large wood and sediment to receiving waters downstream. Removal of riparian vegetation has resulted in higher water temperatures and reduced inputs of large woody debris and organic matter—materials that are critical for stream health. Revetments for flood protection along shorelines have eliminated refugia for young fish, amphibians, and turtles and diminished habitat values for many other species. Salmon, lamprey, and sturgeon species are among the casualties of the degradation of the region's rivers, streams, and open waters.

River, stream, and open-water habitats in the region include the following:

- The Columbia, Willamette, Clackamas, Tualatin, Lewis, Washougal, Sandy, and Molalla rivers, as well as many smaller tributary rivers, streams and sloughs
- Lakes and permanent large wetlands, including Sturgeon Lake and other lakes on Sauvie Island, Smith and Bybee Wetlands Natural Area, Blue Lake, Fairview Lake, Vancouver Lake, Hagg Lake, Oswego Lake, and Force Lake
- Crystal Springs and several other permanent spring-fed streams, ponds, and wetlands
- Scappoose Bay
- Numerous ponds, including natural and small farm ponds, stormwater ponds, impoundments behind weirs and dams, and golf course water hazards
- Sloughs, including Multnomah Channel and Columbia Slough

River, Stream, and Open-water Species

The Pacific Northwest's salmon and steelhead are the iconic residents of the region's water bodies, along with sturgeon, lamprey, and various smaller native fish, mollusks, turtles, amphibians, and garter snakes. However, a majority of the region's wildlife species spend at least part of their lives in or near rivers, streams, or open water, and purple martins, swallows, and other birds and bats feed on insects above these habitats. Many birds, such as gulls, cormorants, osprey, bald eagles, kingfishers, and white pelicans, feed on fish and aquatic invertebrates in the region's streams, rivers and open waters.

Because the greater Portland-Vancouver region is part of the Pacific Flyway, legions of geese, ducks, loons, grebes, and swans winter on local waters, while other birds stop over as they migrate through. Eagles migrate and winter in the region, and more eagles are staying through the summer to nest. Wood ducks and mergansers also nest in the region, using both the waters and the snags and cavities in adjacent riparian habitat.

River otters, mink, muskrats, and beavers live their lives in and near water bodies. Beavers actually create ponds and other habitats characterized by slow-moving water. Two species of native turtles, several species of frogs, freshwater mussels, and pond-breeding newts and salamanders use quiet open waters. Other amphibians, such as torrent salamanders and tailed frogs, rely more on the region's clear, cold-water streams.

Plants are less abundant in streams and large open rivers than in shallower bodies of water, but wapato, plantago, duckweed, polygonums, and other floating plants are present in quiet waters.

Threats Specific to Rivers, Streams, and Open Waters

Humans have profoundly influenced the region's bodies of water. Some threats to this habitat are residual from a more cavalier era when people did not understand the consequences of their actions and land use regulations were less protective of aquatic resources, but many threats are ongoing.

Approximately 80 percent of stream miles in the lower Willamette subbasin are severely disturbed, primarily from urban and agricultural land uses. Streams that originate in forestlands show significantly less instream and riparian habitat degradation than streams whose headwaters are not within forestland. Stream temperature and disturbance of streamside vegetation are the most prevalent stressors, affecting 75 to 90 percent of all stream miles. Other important stream health stressors include fine sediment, streambed stability, nutrient impairment, and low dissolved oxygen, which the Oregon Department of Environmental Quality estimates affect 30 to 60 percent of stream miles in certain watersheds.

The following actions degrade, diminish, or eliminate the region's aquatic habitats:

- Draining and filling lakes and ponds
- Alteration of natural flow and water level fluctuations through dam operation and stormwater runoff
- Surface and groundwater withdrawal, which lowers water tables and diminishes stream flows
- Channelization, hardening, and other alterations of banks and shorelines
- Small "check-dams" and artificial farm ponds, which impede fish passage and diminish water quality
- Erosion of banks from removal of vegetation
- Dredging
- Construction of water crossings, which impede fish and wildlife movements and disrupt delivery of sediment and large wood, which are essential for healthy habitat

- Introduction of pollutants via stormwater runoff from residential, commercial/industrial, and agricultural areas
- Removal of riparian vegetation (This increases water temperatures.)
- Introduction of invasive plants and animals, such as carp, nutria, and reed canarygrass
- Development and agriculture along shorelines

Likely Effects of Climate Change

The full effects of climate change on regional aquatic habitats are unknown. However, climate change models point to probable declines in winter and spring mountain snowpacks, which will alter the hydrology of large rivers like the Columbia, Willamette, Clackamas, Lewis, and Sandy. It is likely that for these rivers and their associated wetlands downstream, spring snowmelt flows will be lower and rainfall-driven high flows in the fall, winter, and spring will be flashier.

Warmer, drier summers may induce higher rates of water extraction to irrigate crops and supply urban populations. It is likely that the growing demands on groundwater and surface water withdrawals will reduce stream flows and available open-water habitat. Lower water levels, in turn, may contribute to higher summer water temperatures, further stressing the region's native cold-water species (such as trout and salmon) and favoring introduced warm-water species, such as bass and carp.

It also is likely that sea-level changes will alter the extent of Columbia-Willamette bottomlands that are under tidal influence.

Conservation Strategies and Opportunities

Because hydrologic alterations are the primary cause of declines in aquatic habitats, strategies to restore natural hydrology are key solutions, along with improving water quality. The Endangered Species Act listing of numerous runs of salmon and steelhead and regulations related to the Clean Water Act have brought an influx of funds for open-water projects. However, additional work is needed. Selected strategies include the following:

- Avoid development in floodplains and along shorelines, and remove existing structures in these areas where possible.
- Remove dams, dikes, and levees where feasible to reconnect low-lying ponds, lakes, and wetlands to their neighboring streams and rivers and to attenuate flooding downstream.
- Remove or repair stream crossing structures such as culverts that block passage of fish and wildlife and interfere with the transport of key habitat-forming materials, such as sediment and large wood.
- Ensure that river dredge spoils are disposed of properly, outside of flood-prone areas.
- Remove pilings along the river if they are potential sources of contamination (because of creosote) or if they serve as habitat for introduced warm-water fish species; provide alternate bird nesting structures to replace the removed pilings.
- Modify water releases from dams and stormwater management facilities to better resemble natural fluctuations in water levels.
- Reduce the impacts of ship and boat wakes in high-impact areas by reducing maximum speed and designating travel routes as far from shore as possible.
- Improve transient flood storage in low-lying environments by protecting and restoring floodplains, requiring balanced cut and fill, removing historical fill (as is happening in the Johnson Creek floodplain), and creating or restoring wetlands.
- Protect and restore vegetation throughout the watershed, especially in floodplains and along rivers, streams, and wetlands.
- Restore natural stream channel and shoreline morphology where feasible by re-meandering and daylighting streams, stabilizing streambanks by planting native vegetation, and adding large wood to streams.
- Reduce impervious surfaces near streams, in the floodplain, and throughout the watershed.
- Increase onsite and near-site stormwater detention in developed areas by installing and maintaining bioswales, detention facilities, rain gardens, and downspout disconnections.
- Continue work to improve water quality through voluntary approaches (e.g., river cleanup days, providing dog waste bags in parks) and regulatory approaches (e.g., addressing Superfund and brownfield sites, effectively implementing the Clean Water Act).
- Aggressively control aquatic invasive plant and animal species such as Asian carp and zebra and quagga mussels. Prevent new inadvertent introductions by supporting monitoring and enforcement of ballast water discharge, aquarium trade, and boat transfer regulations.

FOR MORE INFORMATION

Clark County Stream Monitoring Reports
http://www.co.clark.wa.us/water-resources/documents-monitoring.html#strmac

Willamette Basin Rivers and Streams Assessment Report
Oregon Department of Environmental Quality
http://www.deq.state.or.us/lab/wqm/assessment.htm

Columbia River Investigation Reports on Urban Streams
Oregon Department of Fish and Wildlife http://www.dfw.state.or.us/fish/oscrp/CRI/publications.asp#Urban

Effects of Urbanization on Stream Ecosystems in the Willamette River Basin and Surrounding Area, Oregon and Washington
I.R. Waite, Steven Sobieszczyk, K.D. Carpenter, A.J. Arnsberg, H.M. Johnson, C.A. Hughes, M.J. Sarantou, and F.A. Rinella. 2008. U.S. Geological Survey Scientific Investigations Report 2006-5101-D, 62 p.
http://pubs.usgs.gov/sir/2006/5101-D/

PSU Center for Lakes and Reservoirs
http://www.clr.pdx.edu/

River Plan-North Reach
http://www.portlandonline.com/bps/index.cfm?c=42540Documents

Oregon Willamette Valley watershed councils
http://oregonwatersheds.org/oregoncouncils/willamette-map

Lower Columbia Salmon Recovery Funding Board
http://www.lcfrb.gen.wa.us/default1.htm

Lower Columbia River Estuary Partnership
http://www.lcrep.org/

City of Portland Watershed Management Plan
http://www.portlandonline.com/bes/index.cfm?c=38965

Shorelines and Mudflats

Lori Hennings, Metro

Mudflats, sandbars, beaches, and other sparsely vegetated habitats are found bordering river islands, deltas, and river shores and around wetlands and lakes. Shorelines and mudflats are rich with invertebrates and provide unique and important foraging and migration stopover habitats for shorebirds, waterfowl, terns, gulls, and other wildlife.

Shorelines and mudflats are a product of hydrology and sediment transport/deposition. Slower moving water deposits sediments in low-lying areas, along stream and river bends, and in wetlands and floodplain pools. As the level, volume, and velocity of the water change, the easily eroded sediments may be moved around; this results in a shifting inventory of typically small and sometimes linear habitats where land and water meet. River deltas sometimes form

larger sandbar, mudflat, and rocky areas because they are highly depositional, and they can also be tidally influenced. Logs and other debris sometimes are deposited on shorelines and mudflats. The sparse vegetation condition is maintained by regular inundation and, in some cases (such as pure sand or rocky beaches) by low nutrient levels. Human activities also create or maintain these habitats, which include river dredge spoil deposits and—during the rainy season—plowed farm fields.

Historical and Current Occurrence

The floodplain downriver from Portland to Deer Island historically was where most of the region's mudflats and sandbars were located and is where most of the remaining sandbars and mudflats are found today. This floodplain includes the Vancouver lowlands, Sauvie Island and other islands in the Willamette and Columbia rivers, the Sandy River Delta, and the Ridgefield, Scappoose, and Woodland areas. Within the floodplain, undeveloped mainstem and island areas with shallow water provide important ecological functions and are critical for young salmonids.

Mudflats and sandbars have been substantially reduced from historical levels because of human activities that alter hydrology. Dams alter the natural ebb and flow of water levels, often eliminating important seasonal flooding and low flows. Dams also trap sediments upstream. Sudden water releases may wash away beaches. Dredging deepens channels and can pull sediments back into the river. Ships and boats create large wakes that can damage shorelines and properties and wash away sandbars and mudflats. Development, dikes, and other changes in major floodplain areas have greatly reduced the circumstances under which these habitats form. Sandy and rocky beaches are particularly vulnerable to weedy species that thrive in disturbed conditions.

Wildlife Use

Mudflats are nutrient-rich and thus densely populated with surface and subsurface invertebrates; this makes mudflats particularly important for shorebirds. The lower Columbia River is one of the most important areas in the Pacific Flyway for migrating shorebirds, with peak counts in the Columbia River estuary of almost 150,000 birds and substantial numbers using other areas along the Columbia River up to Sauvie Island and in the Willamette Valley (Pacific Coast Joint Venture 1994). Reductions in the amount of mudflats and shorelines in the region have had the effect of fragmenting habitat needed by shorebirds, which travel along the major rivers of the Pacific Flyway during migration. Shorebirds are aptly named, and are known to partition these resources through foraging strategy and bill type. For example, birds with relatively long bills can forage next to short-billed species without targeting the same invertebrates. Gulls and terns target surface prey on shorelines and mudflats and also rely on these habitats for resting, as do geese and some other waterfowl. Streaked horned larks are known to use such shorelines and mudflats, including dredge spoils.

Coyotes, mink, and weasel take advantage of the resulting abundance of larger prey species, and river otter have a particular taste for the freshwater clams and mussels that live along river and streambanks. A variety of small shorebirds, such as western sandpipers and greater yellowlegs, are closely associated with this habitat. Additionally, bald eagles are known to key in on sandbars and mudflats for hunting, possibly because these features indicate shallow-water habitat with readily available fish and waterfowl. Inland marine mammals such as the California sea lion may come ashore on sandbars and mudflats to loaf.

Conservation Strategies and Opportunities

Several regulatory, nonregulatory, and planning approaches have been implemented to protect the quantity and quality of shoreline, sandbar, and mudflat habitat:

- Federal rules, such as the Clean Water Act, River and Harbor Act, National Environmental Policy Act, and Coastal Zone Management Act. (See the Washington Department of Ecology's summary at http://www.ecy.wa.gov/programs/sea/pubs/90031/index.html#RTFToC22.)
- Washington's Shoreline Management Act. This act regulates alteration of wetlands associated with the shoreline of lakes 20 acres or larger; streams with flows greater than 20 cubic feet per second; and all lands within 200 feet of shorelines of the state (measured from the ordinary high water mark), plus associated marshes, bogs, and swamps.
- Washington's Growth Management Act of 1990. This act requires cities and counties with populations of more than 50,000 or that are rapidly growing (see http://www. commerce.wa.gov/site/395/default.aspx) to develop plans that designate and protect "critical areas," including wetlands.
- Oregon's statewide land use planning program and city and county land use plans. These address wetlands under a number of state policies, including Goals 5 (Open Spaces, Scenic and Historic Areas, and Natural Resources) and 16 (Estuarine Resources).
- No-wake, low-speed boating rules. These boating rules have been implemented along several reaches of the Columbia and Willamette rivers to reduce adverse shoreline effects.

A potential future strategy to improve the quantity and quality of shoreline and mudflat habitats is to strategically manage dams to provide hydrologic conditions that are more similar to the pre-dam conditions (i.e., implement so-called sustainable flows projects); this would involve releasing higher high flows and lower low flows than are currently allowed. A partnership led by The Nature Conservancy and the U.S. Army Corps of Engineers is currently exploring such management of some Willamette River dams.

The Pacific Joint Coast Venture's Lower Columbia River plan documents the importance of mudflats and sandbars to wildlife. The U.S. Shorebird Conservation Plan recommends the Columbia River estuary as a site of international shorebird significance and recognizes the Willamette Valley as regionally important. Planning for connectivity between these habitats by strategically addressing hydrology in specific areas may help migrating and foraging birds. Avoiding new development and diking and, where possible, removing existing structures can conserve and re-create shoreline and mudflat habitat.

FOR MORE INFORMATION

"Foraging Ecology of Bald Eagles in a Freshwater Tidal System"
C.M. Thompson, P.E. Nye, G.A. Schmidt, and D.K. Garcelon. 2005. Journal of Wildlife Management 69:609-617.

"Foraging Shorebird Response to Trail Use around San Francisco Bay"
L.A. Trulio and J. Sokale J. 2008. *Journal of Wildlife Management* 72:1775-1780.

Joint Venture Implementation Plans: Lower Columbia River
Pacific Joint Coast Venture/Oregon Wetlands Joint Venture. 1994. West Linn, OR. http://www.ohjv.org/pdfs/lower_columbia_river.pdf

U.S. Shorebird Conservation Plan: Northern Pacific Coast Regional Shorebird Management Plan
M.S. Drut and J.B. Buchanan. 2000.

Riparian and Bottomland Hardwood Forests

Elaine Stewart, Metro

As transitional areas between aquatic and terrestrial environments, riparian forests are exceptional in their diversity and habitat value. More than 90 percent of the region's wildlife species regularly use water-associated habitats, and nearly 50 percent are closely associated with them. These dynamic areas experience frequent and patchy disturbance events such as floods, windstorms, and disease outbreaks that over time create a mosaic of habitats with varying stand ages and compositions. In the greater Portland-Vancouver region, riparian forests include cottonwood gallery forests, Douglas fir, western red cedar, Oregon ash/Pacific willow swamps, and various mixes of Oregon ash, red alder, big leaf maple, Oregon white oak, and black cottonwood. Bottomland hardwood forests (BLH) are wetlands, with associated hydric soils and regular flooding; they are dominated by Oregon ash and sometimes cottonwood.

Historical and Current Occurrence

Historically, the region's broad floodplains included a diverse mix of riparian forests, both upland and wetland. Before major settlement began in the mid-nineteenth century, floodplain forests along the Willamette River (especially south of Albany) were as much as 3.2 kilometers wide; near major confluences, floodplain forests were up to 10.5 kilometers wide. These forests provided organic matter in the form of leaf litter and downed wood. They stored carbon, recharged aquifers, and shaped streams. The vast floodplains flooded frequently, trapping sediment and nutrients from floodwaters. Stream channels typically were braided and frequently changed course as trees fell and shifted on the floodplain. Sections of the Willamette River had more than 500 snags per kilometer; snagging records indicate that many snags were more than 50 meters long and up to 2 meters in diameter. Although the floodplains in the greater Portland-Vancouver region are smaller than those along the upper Willamette, they probably had similar structures and processes.

Throughout the greater Portland-Vancouver region, riparian zones have been significantly altered by harvest, development, clearing for agriculture, construction of dams, irrigation, and removal of wood in streams to facilitate navigation. Loss of BLH wetland is estimated to be more than 70 percent in the Willamette Valley. Remaining riparian areas often are reduced to thin strands, with frequent gaps and lack of connectivity to upland habitat. Loss of riparian and BLH forests and development within floodplains disrupted the wood cycle, resulting in decreased the structural complexity of rivers, streams and riparian habitats and reduction of the region's rivers to a single channel; this has decreased habitat complexity and the amount of active floodplain and shoreline in the region.

Some of the best remaining examples of BLH wetlands are along Multnomah Channel, on the north end of Sauvie Island, at Smith and Bybee Wetlands Natural Area, and in the Columbia floodplain areas in Washington, including Ridgefield National Wildlife Refuge Complex and the state-owned Shillapoo Wildlife Area. Relatively intact riparian habitat can be found in areas of the Clackamas and lower Molalla and Pudding rivers, the lower Tryon Creek watershed and one of its tributaries, Arnold Creek, as well as at the headwaters of Kelley Creek, which is a tributary of Johnson Creek in Multnomah County. Other notable areas include West Hayden Island, Government Island, and Meldrum Bar Park in Gladstone.

Important Processes and Species

Riparian and BLH forests provide many ecosystem services, including stream shading and associated temperature regulation and provision of large wood to streams. These vegetated zones filter sediments and other pollutants in stormwater and stabilize streambanks, thus preventing erosion. Trees and shrubs store carbon and help moderate air temperatures. Forest leaves intercept rainfall, while root systems help soils hold water and release it more slowly to streams, thus reducing the flashiness of urban streams.

The beaver is a keystone species of riparian and BLH habitats. Its tree-felling and dam-building activities create openings and ponds that provide fish habitat, trap sediments, provide refugia for aquatic species during droughts, and kill trees that then become snags for wildlife. Other keystone species include Chinook and coho salmon and steelhead trout, whose spawning migrations return nutrients to tributaries and headwaters. Black cottonwood trees provide food and habitat for migrating and nesting songbirds, nest sites for bald eagles and great blue heron, and downed wood for terrestrial and aquatic species.

Myriad species use the region's riparian habitats. Neotropical migratory birds travel through riparian zones, and species such as the Swainson's thrush, Wilson's warbler, and western wood-pewee nest there. Resident birds such as brown creeper and black-capped chickadee may use riparian forests year-round, while others (e.g., Steller's jay and ruby-crowned kinglet) spend winters there and return to higher elevations for breeding. Mammals in the region's riparian zones range from black-tailed deer and river otter to Pacific shrew. Native amphibians spend much time foraging in riparian areas, and many amphibians and reptiles use riparian habitats for overwintering.

The Oregon and Washington state conservation strategies list a number of species that rely on healthy riparian and BLH habitats. The willow flycatcher and yellow-breasted chat require shrub habitats near streams and wetlands. The western pond turtle needs basking logs in streams and wetlands, open areas in the riparian zone for nesting, and a suitable duff layer for hibernation and summer dormancy. The Oregon spotted frog depends on riparian habitats and spends most of its life in riparian areas. Aquatic species that are identified in the state conservation strategies as benefitting from high-quality riparian and BLH habitat include the Willamette floater (a freshwater mussel); brook and Pacific lamprey; Chinook and coho salmon; and steelhead and cutthroat trout. BLH wetlands provide refugia and rearing habitat for juvenile salmon.

Threats and Challenges

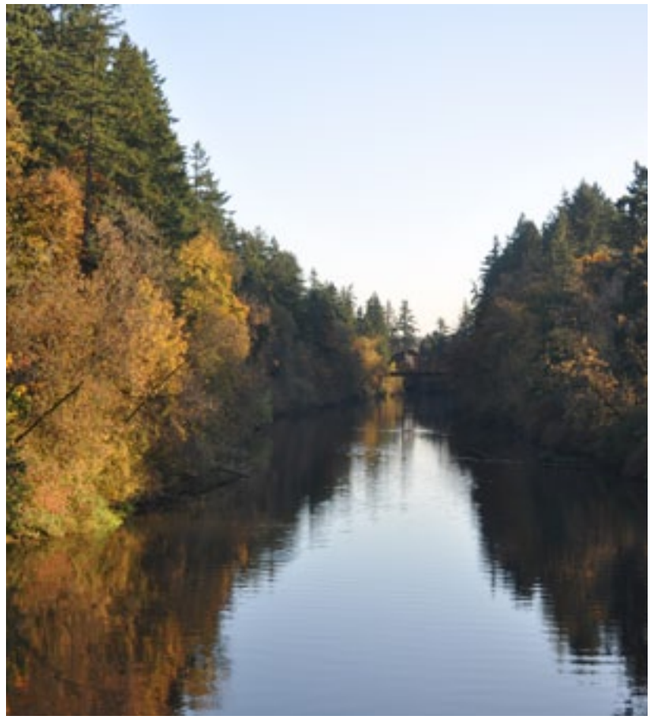
Wetland and riparian protection programs are slowing and reducing the loss of remaining riparian and BLH forests, and a number of initiatives and grant programs are rehabilitating degraded riparian zones and previously converted floodplains throughout the region. However, many changes on the landscape are irreversible, and many threats remain. Dam operations on major rivers have reduced the historical disturbance regime (i.e., flooding) to a fraction of its former extent and amplitude. The region's iconic cottonwood forests depend on this disturbance; with reduced flooding, new forests are no longer being created. Development in floodplains has permanently disconnected many of them from their rivers.

Threats in remaining riparian and BLH forests include invasive species such as reed canarygrass and English and Irish ivy that (1) prevent native plants from becoming established, or (2) in the case of ivy, can topple trees from the weight of large vines. The invasion of the emerald ash

borer—a non-native insect—is imminent; if not controlled, the emerald ash borer could decimate remaining BLH forests. Increases in the amount of impervious surface from development increase the flashiness of streams, causing down cutting; the associated lowering of the water table stresses riparian vegetation.

Likely Effects of Climate Change

Climate change may affect riparian and BLH forest habitats both directly and indirectly. In tidally influenced areas of the lower Columbia system, sea-level rise could stress BLH forests by preventing the seasonal drying that they require. If summers become hotter and drier, as expected, increased demand for water for irrigation, municipal use, and power generation may exacerbate drought stress by drawing down groundwater. This may be offset if increased flood frequency and magnitude in winter and spring expand floodplains, store water longer, and increase groundwater recharge.



Conservation Strategies and Opportunities

Conservation of riparian and bottomland hardwood forest must focus on reconnecting floodplains to their rivers, so as to reestablish ecological processes such as recruitment of large wood to streams. Strategies are as follows:

- Reconnect broken strands of riparian zones and increase the patch size of riparian and BLH forest complexes. This will supply intact corridors, improve riparian habitat function, and make interior habitat available for area-sensitive species.

- Reconnect and restore large floodplain areas to increase flood storage capacity, which could become increasingly important if climate change brings more severe and frequent winter storms and reduces storage capacity in snowpack, as many models predict.

- Implement revegetation projects to reestablish habitat and the historical recruitment of wood to streams.

- Increase riparian plantings in agricultural areas through easements and farm bill programs.

However, perhaps the greatest opportunity for riparian habitat conservation is prevention of further decline, because the greatest threat to these areas is urban and agricultural development. Prevention of further decline can be accomplished through the following:

- Protect remnant BLH and riparian forests, which are the last reserves of these habitat types. BLH forests that are not protected should be a high priority for conservation.

- Restore some marginal agricultural lands in floodplains as BLH and riparian areas and reconnect them to their rivers.

- Where riparian zones are narrow, use adjacent upland forests and shrublands as buffers against the effects of development and to help preserve riparian functions.

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Shrub Habitat

Lori Hennings, Metro

Shrubs are woody-stemmed plants that reach relatively low heights (1 to 20 feet) at maturity. Biologists consider shrub habitat either in terms of its structural condition—meaning the height of its woody vegetation, including young trees—or its species composition. Johnson and O'Neil (2001) consider shrubby areas with less than 10 percent tree cover to be shrubland, subdivided by percent cover and height classes.

Shrubs add complexity to other habitats, greatly increasing the amount of area available for cover and nesting. Numerous studies in the Pacific Northwest document the importance of shrubs to a wide variety of arthropods, amphibians, small mammals, and birds. The fruit and flowers of shrubs—particularly deciduous ones—host abundant pollinator and prey species. The diets of deer and elk consist largely of shrub browse. Shrubs also provide important habitat connectivity and may effectively widen a forested biodiversity corridor.

In the greater Portland-Vancouver region, shrub habitats occur most often in riparian areas or as an early successional stage following disturbance such as clear-cuts, insect kill, or fire. Shrubs also are key components of many habitat types, including deciduous and coniferous forests, bottomland hardwood forests, and Oregon white oak habitats—the latter particularly where fire has been suppressed. Shrubby wetlands are discussed under "Wetlands" in this section of the *Biodiversity Guide*.

Historical and Current Occurrence

Unlike eastern Oregon and Washington, the greater Portland-Vancouver region has no explicitly described climax shrub habitat types; therefore, it is difficult to estimate the degree of loss or change in shrub habitat from the 1850s to today. However, it is likely that the decrease in fire frequency and increased density and active management of forests—particularly industrial or commercial forest types—has produced less

shrub habitat than was present in 1850. That said, alterations in structure (i.e., loss of vertical diversity) and composition (fewer species and many invasives) are likely as significant as changes in the overall amount of shrub habitat from historical conditions. Human activities are the major ecological drivers for these changes.

High-quality natural shrub habitat can still be found in preserved natural areas such as Metro's Cooper Mountain, Chehalem Ridge, and Clear Creek Natural Areas. Oxbow Regional Park, the East Buttes area, and Ridgefield National Wildlife Refuge Complex provide good examples of healthy native shrub communities embedded within forests.

Important Processes and Disturbances

In urban areas, where natural habitat loss is obvious and extensive, landscaping strongly influences the cover, composition, and spatial arrangement of shrub habitat. Urban shrub habitats often consist of non-native and invasive species. Vacant lots, rights-of-way, and unmanaged areas frequently are dominated by non-native blackberries, knotweed, clematis, and other species. In such areas, biological diversity is greatly reduced. However, in some cases backyard habitat may draw surprisingly high numbers of native birds, invertebrates, and other wildlife species because of the large variety of shrub structure and species. These benefits are increased through the use of native plants.

In forested landscapes, logging creates short-term shifts to earlier successional stages (i.e., grasses, shrubs, and small trees) in a patchy and constantly changing distribution. Historically, wind, fire, insects, and disease played a similar role in creating shrub habitat. However, in contrast to the long establishment period for natural forests following fire (as much as 50 to 100 years), typical modern reforestation techniques generally rely on high-density tree planting and herbicides to reduce competition; this tends to reduce and exclude shrubs, essentially bypassing the shrub-dominated stage associated with naturally regenerating forests.

Agricultural lands replace shrub habitats and prevent their re-growth through intensive crop management, typically narrow riparian areas, and encroachment of invasive species along edges. The trend toward larger monoculture farm fields has reduced the amount of shrubby field margins and fencerows, thus eliminating habitat and connectivity for small mammals and birds.

Shrub Species and Wildlife Use

Typical shrub species in the greater Portland-Vancouver region include Oregon grape (*Mahonia* species), wild rose (*Rosa* species), salal (*Gaultheria shallon*), ocean spray (*Holodiscus discolor*), snowberry (*Symphoricarpos albus*), Indian plum (*Osmoronia [Oemleria] cerasiformis*), huckleberry (*Vaccinium* species), currant (*Ribes* species), salmonberry (*Rubus spectabilis*), and some small tree species such as willow (*Salix* species), vine maple (*Acer circinatum*), red-osier dogwood (*Cornus stolonifera*) and hazelnut (*Corylus cornuta*).

Shrublands and shrub components embedded within other habitats are closely associated with the majority of the region's amphibians, reptiles, birds, and mammals and therefore also with many of the region's declining wildlife species. Some indicator species or guilds that rely heavily on shrub habitat include garter snakes; orange-crowned warbler and other Neotropical migratory songbirds; little willow flycatcher, common yellowthroat, and yellow-breasted chat (riparian); and deer mouse or small mammal communities. The little willow flycatcher and yellow-breasted chat are species of concern in the Oregon or Washington statewide conservation strategies. Untold numbers of insects, including many pollinators, also rely on shrub habitat.

Threats and Challenges

The encroachment of invasive species constitutes a major threat for shrub habitat and may worsen with climate change. In addition, climate change may increase the amount of shrub cover, at least temporarily, as habitat is converted from forests to newly regenerating areas. Continued management of area forests in a way that reduces shrub cover is on ongoing threat.

Conservation Strategies and Opportunities

There are numerous opportunities to improve shrub cover and habitat quality:

- Manage some forests for older forest and more open canopies to increase shrub cover, complexity, and age in ways that benefit wildlife. Mature and older shrub communities are particularly important to wildlife.

- Implement forestry approaches that delay crown closure and allow some shrub competition in young forests support shrub-associated wildlife.

- Encourage landowners interested in increasing riparian shrub habitat to make use of federal funding. In agricultural areas, federal programs to enhance habitat include the Conservation Reserve Enhancement Program (CREP), Environmental Quality Incentives Program (EQIP), and Wildlife Habitat Incentives Program (WHIP). The federal Clean Water Act and Endangered Species Act also encourage and sometimes require riparian restoration in strategic areas to cool stream water and improve salmon habitat, and restoration funds are frequently available for such areas. In Oregon, the Oregon Watershed Enhancement Board funds projects to enhance habitat.

- Restrict tree canopy development in selected areas, to restore and maintain upland shrub habitat, which are vital to wildlife.

- Increase shrub cover in urban areas by encouraging the use of native plants, such as through the efforts of various local jurisdictions and the Audubon Society of Portland and Columbia Land Trust partnership that supports the Backyard Habitat Certification program.

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COLUMBIA SEDGE MEADOWS

Columbia sedge meadows are considered a critically imperiled habitat type in Oregon. Historically abundant, most sedge meadows have been lost as a result of filling, draining, agricultural and grazing practices, and fire suppression. Remaining Columbia sedge meadows are most threatened by invasive plant species. Remnants occur at Metro's Smith and Bybee Wetlands Natural Area in north Portland.

Wetlands

Esther Lev

Wetlands are swamps, marshes, bogs, and other transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water; wetlands can also exist in a slope or depressional setting that is not associated with another water body. Typically, wetland soils are saturated with moisture, either permanently or seasonally, but each wetland is different. This is because of variations in soil, landscape, climate, water regime and chemistry, vegetation, and human disturbance. Wetlands may be covered partially or completely by shallow pools of water that is salty, brackish, or fresh.

Wetlands are among the most important ecosystems on earth. These complex habitats store, clean, and filter water, prevent soil erosion, and control flooding. They provide habitat for thousands of species of birds, fish, and mammals. They are also, in effect, natural libraries that contain information on climate, history, adaptation, and evolution embedded in peat, muck, clay, and silt. Yet historically people did not recognize the value of wetlands, regarding them as "wastelands," barriers to development, and breeding grounds for mosquitoes, insects, and disease. Consequently, many of the nation's wetlands have been drained, filled, and paved over for other uses.

The greater Portland-Vancouver region has retained a variety of different types of wetlands, from freshwater marshes to wet prairies. The descriptions below include examples of where each major wetland type can still be found in the region. Such areas can serve as reference sites for wetland enhancement and restoration projects.

Major Wetland Types in the Greater Portland-Vancouver Region

AQUATIC BEDS

Aquatic beds are composed mostly of submerged vegetation, the upper portions of which may float at the surface. Aquatic beds occur in near-shore areas along the coast, in estuaries, and in rivers, ponds, lakes, and sloughs on most topographic surfaces throughout the state. Plants may be rooted, suspended in the water column, or free-floating. They provide critical food and cover for fish, amphibians, and invertebrates and are usually directly linked to riverine and emergent wetlands by hydrology, chemistry, and food webs. A large variety of invertebrates and vertebrates use both aquatic beds and emergent wetlands during part of their life cycles. Since 1850, much aquatic bed habitat has been lost to river channelization, siltation, and filling for agriculture or urban development. Examples of aquatic bed habitat can be found at Sturgeon Lake, Smith and Bybee Wetlands Natural Area, and the Vancouver lowlands.

FENS

Most wetlands in Oregon that have been called bogs are actually fens, because they are hydrated by mineral-rich surface water or groundwater, lack a domed peat profile, and have a pH generally higher than 5.5. However, many fens contain localized hummocks or lawns of Sphagnum with a pH as low as 4, and these are classified as "poor fens." Oregon's fens occur in depressions on various landforms, particularly in troughs between dunes and in headwall basins and floodplains. Fens can also occur around the edges or over the surface of mid-slope slump or sag ponds in landslide areas. Fens are usually perennially saturated, but local areas of surface drying are not uncommon. Fens may include patches of shrub swamp and forested wetland occurring on peat soils. Drainage, filling, peat mining, conversion to commercial cranberry or blueberry production, and plant succession have destroyed many fens, and losses continue to occur despite wetland regulations that were designed to protect them. The only known fen left in the Willamette Valley was recently protected by Metro.

FORESTED WETLANDS

Sometimes called swamps, forested wetlands occur on seasonally or perennially wet flats, depressions, or stream terraces. Hydration occurs via precipitation, groundwater discharge, or inflowing streams. Forested wetlands sometimes are located within riparian zones but differ from riparian wetlands in their higher water tables and longer duration of surface water. Forested wetlands typically are flooded for several weeks during the growing season (seasonal flooding), and are differentiated from riparian stands that may have surface water for only a few days during a temporary flood. Examples of forested wetlands can be found at the Vancouver Lake lowlands, on Sauvie Island, and along the Columbia River.

FRESHWATER MARSHES

Freshwater marshes occur in depressions and around the edges of lakes, ponds, rivers, and streams where surface water is present for all or most of the growing season and the soil is perennially wet. (Freshwater tidal marshes are treated separately in the following section.) They are characterized by emergent herbaceous vegetation such as spikerush (*Eleocharis spp.*), sedges (*Carex* spp.), bulrushes (*scirpus spp.*), bur-reed (*Sparganium* spp.), cattails (*Typha* spp.), and various grasses. Broadleaved herbs and shrubs may also be present. Freshwater marshes are particularly well known as breeding or foraging sites for birds. Freshwater marshes are found throughout the state, but many thousands of acres have been diked, drained, and farmed. Ridgefield Wildlife Refuge Complex, Tualatin Wildlife Refuge, Fernhill Marsh, Wapato Lake, Jackson Bottom, and Shillapoo Lake offer examples of freshwater marshes.

RIPARIAN WETLANDS

Riparian wetlands occur along rivers and streams throughout the state and are often intermixed with upland portions of floodplains in a jumble of units that are difficult or impossible to map separately. Riparian wetlands usually are associated with seasonal flooding of adjacent streams and rivers, but they also can be hydrated by perennial or seasonal seepage, tributary streams, or flooding caused by tidal cycles. Vegetation in riparian wetlands can be forested, scrub-shrub, or herbaceous but is usually a mixture of alternating patches of all three different types. Historically, most riparian areas were grazed intensively by livestock and severely degraded as a result of soil compaction, denudation, down cutting of streams, and subsequent invasion by upland or non-native invasive species. These impacts also degraded streams and have impaired fish and other aquatic species. Over the last 20 years, extensive areas of riparian vegetation and hydrology have been restored by improved management practices. Examples of riparian wetlands can be found along Multnomah Channel, Shillapoo Lake, and the Sandy, Clackamas, Columbia, and Lewis rivers).

SCRUB-SHRUB WETLANDS

Scrub-shrub wetlands include areas dominated by woody vegetation less than 6 meters (20 feet) tall. Characteristic species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included. Willow, spirea, and red twig dogwood are common dominant shrub species found in scrub-shrub wetlands in the region. Examples of scrub-shrub wetlands can be found at Killin Wetland, Beggars Tick Marsh, Oaks Bottom Wildlife Refuge,

Minthorn Springs, Hearthwood Preserve, and Shillapoo Lake.

DEAD SCRUB-SHRUB WETLANDS

Dominated by dead woody plants less than 6 meters tall, dead scrub-shrub wetlands usually are produced as a result of a prolonged rise in the water table caused by impoundment of water by landslides, people, or beavers. Such wetlands may also result from various other factors such as fire, insect infestation, air pollution, and herbicides. Smith and Bybee Wetlands Natural Area and Killin Wetlands have examples of dead scrub-shrub wetlands.

WET PRAIRIES

Wet prairies are one of the region's rarest wetland types. Most occur at relatively low elevations on bedrock or clay soils that have a seasonally perched water table. These sites usually dry out by late spring, but depressions may retain water well into the summer. Wet prairie in the Willamette and Umpqua valleys and Vancouver lowlands provide habitat for several rare species of plants and may support grassland birds such as western meadowlark. Although best known for tufted hairgrass (*Deschampsia caespitosa*), wet prairies contain many other species of grasses, sedges, and herbaceous plants such as western buttercup and large-leaf avens. A number of prairie plants that occur in the greater Portland-Vancouver region are now threatened or endangered because of habitat destruction. Before the era of flood control, wet prairies on the Columbia River bottoms were flooded 1 or 2 months every year during the annual spring freshet, which was fueled by snowmelt in the Columbia Basin. Most wet prairies have been drained, farmed, or overrun by exotic reed canarygrass (*Phalaris arundinacea*). Examples of wet prairie can be seen at the Camassia Natural Area, Knez Preserve, Gotter Prairie, Lovejoy Preserve, and Lacamas Prairie.

Historical and Current Occurrence

In just over two centuries, development has obliterated many wetlands. Statewide, Oregon has about 1.4 million acres of wetlands and Washington has about 938,000 acres of wetlands; in both states wetlands represent approximately 2 percent of the state's total land surface. The Willamette Valley has lost approximately 57 percent of its original wetlands area. A total of 80 percent of once-abundant riparian bottomland forest has been converted to agricultural and urban land uses. Today, wet prairie is one of Oregon and Washington's rarest native plant communities, reduced by an estimated 99 percent since 1850. In the last 100 years, wetland habitat within the lower Columbia River corridor has decreased by as much as 75 percent from historical levels. The amount of marshes and forested wetlands also has decreased, while the proportion of developed land and open water has increased. Dike and levee construction, development, hydrosystem operations, and other activities all contribute to the loss of wetland habitat.

Such high levels of habitat loss and modification have had serious impacts. Several species of fish and wildlife that depend on lower Columbia River habitat have been listed as threatened and endangered, and aesthetic, recreational, and other human uses of wetlands been compromised. Degraded and converted wetland habitats are less able to absorb flooding and filter out and take up pollutants. Shorebirds, waterfowl, fish, and other wildlife depend on wetlands for survival. As wetland habitat is destroyed, the number of species threatened with extinction increases and migrating birds may be forced to change traditional migration routes when a wetland is destroyed. Similarly, other species must adapt to the loss of critical habitat or die.

Wetland Plant and Wildlife Species

Aquatic-associated wildlife species that are commonly found in the region's wetlands include the great blue heron, osprey, belted kingfisher, mallard, wood duck, green-winged teal, hooded merganser, and common merganser. Canada geese are common year-round residents. Wetlands also provide critical habitat for many species of amphibians and reptiles, especially turtles. Most amphibians lay gelatinous eggs under water, while some, like some salamanders, lay their eggs on moist land. Wetlands serve as breeding sites, as a habitat for larval development, and as a primary food source for adults.

Floodplain wetlands can serve as important rearing habitat for juvenile salmonids, providing opportunities to feed and take refuge from predators and high flows. Beaver ponds and off-channel habitats, which are formed when runoff is channeled through swales as the mainstem migrates, can provide important habitat to juvenile coho salmon (*Oncorhynchus kisutch*). These channels and associated ponds also are productive habitat for overwintering fish and maintain a hydrologic connection to the river during the winter.

Five species of rare plants are known to occur in remnant stands of native wet prairie, the presettlement vegetative community that has suffered the greatest loss regionally since 1850. Of this group, Bradshaw's lomatium (*Lomatium bradshawii*) and Willamette daisy (*Erigeron decumbens* ssp. *decumbens*) are federally listed endangered species and Nelson's checkermallow (*Sidalcea nelsoniana*) is a federally listed threatened species. All three species are endemic to the Willamette Valley, and two are found in southwestern Washington. Two species that occur in both the Willamette Valley and the Puget Trough of Washington and British Columbia are also at risk: *Montia howellii* is a candidate species in Oregon and *Sericocarpus rigidus* (white-topped aster) is a federal species of concern.

Most rare wetland-associated animals in the greater Portland-Vancouver region occur in emergent wetlands or open-water habitats. One of these is the Oregon chub (*Oregonichthys crameri*), which is a federally listed endangered species. Although the Oregon chub once occupied most reaches of the Willamette River and its tributaries, the species now occurs in only a few isolated localities. Most of its habitat has disappeared since flood control dams altered channel morphology along the Willamette River. Four federal species of concern that are found in greater Portland-Vancouver region—the western pond turtle (*Actinemys marmorata*), western painted turtle (*Chrysemys picta bellii*), northern red-legged frog (*Rana aurora*), and Oregon spotted frog (*Rana pretiosa*)—have been decimated by loss of habitat and by predation by the introduced bullfrog and largemouth bass, both of which are now ubiquitous in the region's wetlands and ponds. The willow flycatcher (*Empidonax traillii brewsteri*) is still present in riparian habitats in the region but may be in decline.

The Aleutian Canada goose (*Branta canadensis leucopareia*) and greater sandhill crane (*Grus canadensis tabida*) once were common in the wetlands of the greater Portland-Vancouver region but now occur most often in agricultural fields that replaced the prairie. (The Aleutian Canada goose formerly was listed as threatened species under the federal Endangered Species Act but has been delisted.) Wet to moist habitats in Douglas fir forests host the rare Oregon slender salamander (*Batrachoseps wrighti*), which has been affected by forest management practices.

Threats to Wetlands

Many historical wetlands have been eliminated altogether through drainage, fill, or submergence. In recent decades the rate of wetland loss has slowed, in part because of Oregon and Washington's removal-fill permitting process. However, ongoing development and land uses continue to threaten and degrade these important habitats, causing them to be filled, dredged, or drained. Urban growth, for example, can result in wetlands degradation by increasing the volume and rate

of runoff and the amount of pollutants that the runoff carries. Diversion of surface water and groundwater withdrawal are other major causes of wetlands degradation in urban areas. Invasive plant and animal species are a threat to wetlands, which also can be damaged by agriculture, forestry practices, and the clearing of vegetation. Obviously, the degradation of a wetland diminishes or eliminates some or all of its ecological functions.

The projected impacts of climate change will impose additional stresses, the effects of which are still unknown. With the region's wetlands already under threat, even a small change in climate could be devastating.

Conservation Strategies and Opportunities

Protection, enhancement, and restoration of the remaining wetlands in the greater Portland-Vancouver region would play a huge role in conserving the important functions of wetlands and maintaining connectivity among functioning habitat in the region. Strategies include the following:

- Conserve remaining wetlands.

- Consider the lands that buffer wetlands during conservation and restoration planning because they are an interconnected part of the system. Habitat adjacent to wetlands perform the initial filtering of sediments and other pollutants from runoff, they slow and direct runoff, and are important to wetland hydrology. In addition, adjacent areas serve as habitats and "habitat connectors," providing a protective pathway through which wildlife species can move from a wetland to upland habitats. They are also crucial for the many species that need to access upland areas near wetlands to complete their life cycles.

- Learn about the different types of wetlands within the greater Portland-Vancouver region—where they occur, their specific needs, potential threats, and how to assess missing or degraded functions.

- Identify and prioritize sites and strategies for protection, restoration or rehabilitation.

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Upland Forests

Jonathan Soll, Metro

Coniferous and mixed conifer/deciduous upland forests are the dominant natural habitat of the greater Portland-Vancouver region. Two important characteristics make these forests unique from others in the mesic temperate forest zone. First, low-elevation Pacific Northwest old-growth forests typically are dominated by the conifers Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*), with Willamette Valley ponderosa pine (*Pinus ponderosa*), silver fir (*Abies amabilis*), and other species also occurring but less commonly or near the edge of the area. The second outstanding feature of these forests is the potential longevity and size of their forest trees and the quantity of biomass those trees generate. Under natural conditions, trees of many of the dominant species live to be 350 to 750 years old or older and frequently have diameters of 8 feet or more.

Old-growth Forests and Changes since 1850

Before 1850, upland fir forests occupied approximately 65 percent of the greater Portland-Vancouver region. At the time of the 1850 surveys, about one-quarter of that forestland had recently burned. At that time many stands were old growth or late successional (referred to as old growth from here on), with typical ages of between 400 and 500 years. Today these forest types cover approximately 40 percent of the region and the vast majority are less than 50 years old.

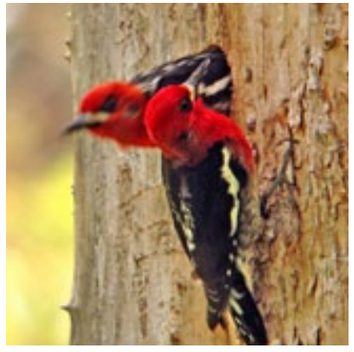
Old-growth conifer forests differ significantly from young forests in species composition, function (i.e., the rate and paths of energy flow and nutrient and water cycling), and structure. Most differences are related to four structural components of old growth: large live trees, large snags (i.e., standing dead trees), large logs on land, and large logs in streams. Old-growth forests have a complex, multi-layered canopy and numerous canopy gaps dominated by deciduous species,

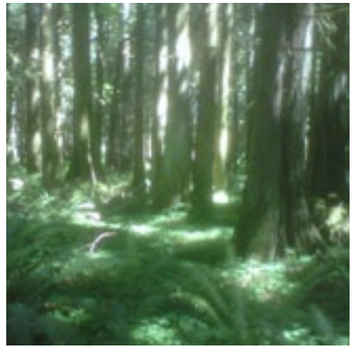
including many shrubs and forbs (i.e., small flowering plants).

The differences in composition between old-growth and middle-aged natural stands stem from ecological changes occurring over time that alter the structure and array of plant and animal species and their relative abundance. Over time, young forests consisting almost exclusively of Douglas fir, transition to more diverse mixtures as dominant trees die allowing western hemlock, western red cedar, and many shrub and deciduous species to occupy canopy gaps. Regardless of species composition, only large, old trees can have large cavities and large, complex branches, and create large wood on the ground.

The least diverse stage, in both plant and animal species, is a dense, rapidly growing young conifer forest in which understory vegetation has been suppressed. The differences between young and old forests are especially profound in commercial stands, where non-tree species are actively controlled to facilitate quick crown closure and maximize the amount of the stand's energy that goes into wood production.

Before 1850, stand establishment was likely to be slow following disturbance such as fire, allowing ample time for development of a rich shrub layer and a forest of multiple species. Although mixed deciduous-coniferous forests were typical, deciduous species did not usually dominate the forest canopy, except in floodplains, riparian areas





and oak and madrone dominated areas. Deciduous trees filled an important role as early occupiers after disturbance, occupying openings (i.e., gaps) or constituting the understory in established forest (especially red alder [*Alnus rubra*] and big leaf maple [*Acer macrophyllum*] but also many others). Stands of Douglas fir or ponderosa pine mixed with Oregon white oak (*Quercus garryana*) and Pacific madrone (*Arbutus menziesii*) occupied the drier and more fire-prone areas of the region, with the oak also being a typical component of some riparian areas.

Historically, fire and wind (and to a lesser extent disease) were the disturbance types responsible for initiating new forests or shaping established ones. Fires, including those purposefully set by Native Americans, covering many thousands of acres initiated or altered stand development in much of the Pacific Northwest. Full canopy closure often developed over many decades, frequently after stands were re-burned. Many features were retained from the burned forest, including large standing living and dead trees and large fallen trees. Long establishment periods allowed for a diverse, mature shrub component in developing forests. Wind generally produces smaller, localized disturbances. The resulting openings create habitat for sun-dependent forb and shrub species that support many insect and bird species.

Current Conditions

Currently, old-growth forest occupies a tiny fraction of the greater Portland-Vancouver region. Most upland forests in the region have been harvested multiple times or have recently occupied areas of former prairie or oak habitat. Forests managed for timber production (i.e., much of the foothills of the Coast Range and Cascades) typically are less than 60 years old, are densely planted with Douglas fir, and generally lack a significant shrub and tree layer beneath the canopy. Although clear-cut harvest creates open conditions favorable for many species, it does not typically leave important elements of biological legacies from the previous stand. Large dead wood in most commercial stands is limited to the few remaining old stumps of the original forest. Forests in conservation areas that have developed following harvest and abandonment (e.g., Sandy River, Gresham Buttes) or fire (Forest Park) vary greatly in species composition, depending on harvest method, fire intensity, and conditions immediately after harvest. Such stands range from almost pure conifers (this is uncommon without active stand management) through mixed conifer and broadleaf stands to almost pure deciduous stands dominated by big leaf maple, alder, and diverse shrubs.

Biodiversity

Plant and animal use of forests follows the changes in forests over time and environmental conditions that influence forest composition and stand structure. At each stage of development, forests provide different conditions that, in turn, provide habitat for different types of living things. Very young natural stands with open conditions support a high diversity and productivity of shrubs and forbs and the wildlife species that depend on them (see Appendix D). As the forest canopy closes, biodiversity drops dramatically. When a forest reaches the old-growth stage and has more open canopy and extensive gaps, it begins to once again provide habitat for many light-dependent plant species while also providing habitat for species that depend on large trees, snags, cavities, and large wood on the forest floor. Species that depend on older forests tend to be habitat specialists. For example, the northern flying squirrel (*Glaucomus sabrinus*) depends on the decayed logs, dense canopy, and understory cover that occur in old-growth forests. The endangered spotted owl (*Strix caurina*) relies on the northern flying squirrel as a primary food source and also uses old-growth forest as primary nesting areas. Significant population reductions in habitat-specialist species associated with old-growth forest, such as northern spotted owl, flying squirrel, pileated woodpecker, and many cavity- nesting species, reflect modern changes in overall forest structure across the region.

Landscape Issues

The size, shape, and distribution of forest habitat patches affect their value in terms of biodiversity (see Chapter 6 of this document and Chapter 7 of the *Regional Conservation Strategy* for a more detailed discussion of this issue). Patches of 30 acres begin providing habitat for species that require interior habitat, but true interior conditions and population viability probably requires patches of 300 acres or more. Before 1850, forests in the greater Portland-Vancouver region were well connected, with patches of thousands or even hundreds of thousands of acres. Although large areas of contiguous forest still exist around the edges of the region (mostly in commercial forestry and related riparian areas), there has been a profound trend toward smaller patch size and increased isolation in more developed areas of the region.

Threats and Challenges

The major threats to biodiversity in established forest include lack of important habitat features, invasive species, fire suppression that can lead to catastrophic wildfire, and habitat loss or fragmentation as a result of development and conversion to agricultural lands.

INVASIVE NON-NATIVE SPECIES

Non-native plants and animals represent a substantial threat to forest health and are the primary threat to protected forests, especially in the near-urban area. Climbing species such as English and Irish ivy and old man's beard can kill or topple mature trees. Shade-tolerant weeds such as English and Irish ivy, garlic mustard, and spurge laurel can smother and eliminate native plants on the forest floor. These species and more light-loving ones such as Himalayan blackberry can prevent establishment of young trees in gaps created by dying canopy-dominant trees. Non-native mammals such as squirrels and Virginia opossum compete for habitat resources and prey directly on native species, including cavity-nesting birds. Non-native insects such as the Asian gypsy moth threaten entire stands of trees. Although no non-native diseases currently threaten our primary forest species, non-native diseases have been responsible for the loss of dominant species such as American chestnut and American elm in other parts of the country. Forests managed for single species are particularly vulnerable to the impacts of non-native species.

HABITAT LOSS AND ISOLATION

Poorly planned conversion of remaining forest lands to residential areas, agriculture, or roads could compromise the existence of (1) forest patches of a size sufficient to maintain biodiversity, and (2) the remaining biodiversity corridors that connect upland forests and other habitats. The issue is more severe in the near-urban area, but care should be taken to build and maintain connections between patches of forest managed for biodiversity values throughout the region.

LACK OF IMPORTANT HABITAT FEATURES

Although commercial forests provide many benefits, they have limited value for many plant and wildlife species because they are dominated by small Douglas fir, lack the range of age classes typical of natural forests, have a poorly developed

shrub layer, and lack snags and large wood on the forest floor. The emphasis on creating old-growth conditions in public forests and the short rotations and rapid reforestation—often using herbicides—in private forests have created a regional shortage of forests with abundant mature shrubs.

LIKELY EFFECTS OF CLIMATE CHANGE

The region's dominant tree species are expected to be largely tolerant of near-term climate changes. However, climate change is expected to cause hotter, drier summers that may lead to increases in catastrophic wildfire or increased vulnerability to native or non-native diseases or insects; these changes could result in substantial damage to forest and stream systems. In addition, resources might be diverted toward fighting forest fires and away from conservation management.

Conservation Strategies and Opportunities

IMPROVING THE HABITAT QUALITY OF OUR FORESTS: CREATING "OLD-GROWTH LIKE" CONDITIONS

It is possible to mimic some aspects of old-growth forest ecosystems by actively managing to create its key structural and compositional components. Wider initial spacing or aggressive thinning of young forests with interplanting of native forbs and shrubs can (1) facilitate faster production of large trees, (2) maintain or encourage the development of a deep, complex canopy, with a diverse understory and canopy gaps; and (3) in some cases, help defray the costs of management through timber receipts. Girdling or topping live trees can produce snags for wildlife. Felled hazard trees can be left in large pieces onsite. Small trees harvested for thinning purposes can be piled to mimic the effects of larger single trees on the forest floor.

LAND CONSERVATION

Strategic protection or restoration of large patches of forest and functional connectivity corridors will not only help protect forest-dependent biodiversity but will also provide a substantial return on investment in terms of air and water quality protection and provision of other ecosystem services. Such protection and restoration can be accomplished through acquisition, easements, payments for ecosystem services, or other incentives to private landowners, along with carefully conceived regulation.

INVASIVE SPECIES CONTROL PROGRAMS

Adequately funded and regionally coordinated invasive species control programs that include early detection and rapid response programs are essential in protecting the health of the region's forests. The framework for coordination is well established with the 4-County Cooperative Weed Management Area, which covers Multnomah, Clackamas, Washington, and Clark counties. However, funding has not been adequate to address the issue even within natural areas, let alone within the unmanaged and privately owned undeveloped areas of the region.

ADAPTATION TO CLIMATE CHANGE IMPACTS

A system of healthy, well-connected forests is thought to offer the best chance of resilience and adaptation to climate change, whether that resilience is expressed through response to fire and disease or species migrations. A successful strategy will include cooperation on fire management through community wildfire protection plans and fuel load management, as well as plans for early detection of and rapid response to new diseases or insects.

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Oak Woodland and Savanna

Mary Bushman, City of Portland; Dan Bell, The Nature Conservancy; Mark Wilson, City of Portland; Jonathan Soll, Metro; Ed Alverson, The Nature Conservancy

Oregon white oak (*Quercus garryana*) is the only oak species native to the greater Portland-Vancouver region. Mature white oak habitat (i.e., savanna, woodland, and forest) provides important wildlife habitat, and its abundant acorns are a key element of the food chain.

Oak woodlands are characterized by an open canopy (i.e., 30 to 70 percent coverage) dominated by Oregon white oak; depending on conditions, oak woodlands may also have ponderosa pine, Douglas fir, Oregon ash, or big leaf maple components. The understory generally is composed of grasses, forbs, and scattered low shrubs. As tree cover increases toward oak or mixed oak-conifer forest, shrubs replace grasses in the understory.

Oak savanna is essentially prairie with a few trees per acre. Like prairie, savanna ground cover is characterized by wildflowers (forbs) and grass-like plants (grasses, sedges, and rushes) but also includes tree cover of up to 25 percent and scattered clusters of shrubs. Archetypical savanna in our region has a few widely spaced large Oregon white oaks, typically with a mushroom-shaped canopy and well-developed limbs. However, pre-1850 vegetation data show that the Willamette Valley's savanna was more structurally diverse and also supported Douglas fir, ponderosa pine, and Oregon ash.

White oak savanna and woodland are among the most endangered ecological communities in the Pacific Northwest. Both are identified as focal habitats in the Oregon and Washington state conservation strategies. Mapping of these important habitats is incomplete within the greater Portland-Vancouver region, and few large examples are known.

Several factors influence the location of Oregon white oak habitat and explain its current scarcity:

- Large Oregon white oaks are fire resistant. In locations where low-intensity fire occurs frequently, large white oak trees are able to thrive for centuries, with small trees generally re-sprouting after fire. Douglas fir and big leaf maple, which favor similar soils and site conditions, tolerate fire less well.

- Oak trees are drought and fire tolerant but do not tolerate shade and decline or die with competition from taller but more fire-sensitive species, such as Douglas fir, or more shade-tolerant species, such as big leaf maple.

- Oregon white oak can occur on a wide range of topographic types, including floodplains, bluffs ands terraces, rocky outcrops, and gentle slopes.

- Oregon white oak grows on a wide range of soils, from seasonally flooded clay soils to xeric sites—conditions to which its competitors are poorly adapted. Historically, Oregon white oak grew primarily in areas that today are dominated by residences or agriculture and on south-facing slopes within riparian areas.

Importance of Oak Habitat to Wildlife

Large oak trees provide many of the structural features desired by 140 wildlife species associated with oak habitat; these features include the potential for cavities, high acorn production, and large, horizontal, moss-covered branches. The following species are common to oak woodlands and savanna:

- Western red-backed salamander *(Plethodon vehiculum)*
- Pacific tree frog *(Pseudacris regilla)*
- Rubber boa *(Charina bottae)*
- Northern alligator lizard *(Elgaria coerulea)*
- Common garter snake *(Thamnophis sirtalis)*
- Western wood-pewee *(Contopus sordidulus)*
- Northern pygmy-owl *(Glaucidium californicum)*
- Lazuli bunting *(Passerina amoena)*
- Red breasted nuthatch *(Sitta canadensis)*
- Cassin's vireo *(Vireo cassinii)*
- Common bushtit *(Psaltriparus minimus)*
- Purple finch *(Carpodacus purpures)*
- California quail *(Callipepla californica)*
- Bullock's oriole *(Icterus bullockii)*
- Black-tailed deer *(Odocoileus hemionus)*
- Roosevelt elk *(Cervus canadensis roosevelti)*
- Coyote *(Canis latrans)*

At least 12 bird species are at risk and would suffer further declines if oak habitats were lost or degraded (see Appendix E). Species at risk include the following insects, birds, and mammals, all of which are oak habitat-dependent species of concern in the Oregon and Washington state conservation strategies:

- Fender's blue butterfly *(Icaricia icarioides fenderi)*
- Taylor's checkerspot butterfly *(Euphydryas editha taylori)*
- American kestrel *(Falco sparverius)*
- Western kingbird *(Tyrannus verticalis)*
- Savanna sparrow *(Passerculus sandwichensis)*
- Oregon vesper sparrow *(Pooecetes gramineus affinis)*
- Chipping sparrow *(Spizella passerine)*
- Lewis's woodpecker *(Melanerpes lewis)*
- Western pond turtle *(Clemmys marmorata)*
- Band-tailed pigeon *(Patagioenas fasciata)*
- "Slender-billed" white-breasted nuthatch (*Sitta carolinensis*)
- Acorn woodpecker *(Melanerpes formicivorus)*
- Western bluebird *(Sialia mexicana)*
- Western meadowlark *(Sturnella neglecta, only in very open oak systems)*
- Western gray squirrel *(Sciurus griseus)*

TABLE 3-1

Conservation Land with Known Oak Habitat

Area	Owner/Manager
Elk Rock Island	City of Portland
Mt Talbert, Canemah, and Willamette Narrows	Metro and Clackamas County
Cooper Mountain	Metro and Tualatin Hills Parks and Recreation District
Camassia Natural Area	The Nature Conservancy
Champoeg State Park	Oregon State Parks
Sauvie Island Wildlife Area	Oregon Department of Fish and Wildlife
Ridgefield and Tualatin National Wildlife Refuges	U.S. Fish and Wildlife Service
Washougal Natural Area	Washington State Department of Natural Resources
Lacamas Park	City of Camas
Fanno Creek Greenway	Tualatin Hills Parks and Recreation District

Flora of Oregon White Oak Habitats

Notable common species among the approximately 375 species of native plants known to rely on savanna and prairie habitats include most of the typical prairie species (see "Upland Prairie, Wet Prairie, and Rocky Balds," below), as well as notable savanna or woodlands species, including the following:

- Blue wildrye *(Elymus glaucus)*
- Fawn lily *(Erythronium oregonum)*
- Oregon sunshine *(Eriophyllum lanatum)*
- Celery leaf lovage *(Ligusticum apiifolium)*
- Oregon grape *(Berberis aquifolium)*
- Hound's tongue *(Cynoglossum grande)*
- Wood fern *(Dryopteris arguta)*
- California fescue *(Festuca californica)*
- White-topped aster *(Sericocarpus oregonensis)*
- Birch-leaf spirea *(Spirea betulifolia)*
- Trillium *(Trillium parviflorum)*
- Ponderosa pine *(Pinus ponderosa)*
- Cascara *(Rhamnus purshiana)*
- Snowberry *(Symphorocarpus albus)*
- Poison oak *(Toxicodendron diversilobum)*
- Sword fern *(Polystichum munitum)*
- Bracken fern *(Pteridium aquilinum)*
- Pacific madrone *(Arbutus menziesii)*
- Western serviceberry *(Amelanchier alnifolia)*

Appendix F presents a more extensive list.

At least three plant species that are listed as priority species in Oregon or Washington are known to occupy oak habitats (see Appendix F): Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii*), white-topped aster (*Sericocarpus rigidus*), and white rock larkspur (*Delphinium leucophaeum*). The entire range of the larkspur is within the greater Portland-Vancouver region. Given the generally inadequate mapping of the habitat and the limited plant inventory for oak habitat, there are many species whose status is poorly understood, and many may be sharply declining within the region. More discussion of savanna understory vegetation can be found in "Upland Prairie, Wet Prairie, and Rocky Balds," following).

Importance to Native Americans

The history of oak habitat in the region includes the indigenous people that managed this area for thousands of years before approximately 1840. The Cowlitz and Upper Chehalis Indians of the Puget lowlands and the Kalapuya tribes of the Willamette Valley regularly set fires to favor plants on which they depended for food and medicine. Beyond oak, important savanna plants were camas (*Camassia* sp.), wild onion (*Allium* sp.), and tarweed (*Madia* sp.). Some woodlands were deliberately left unburned to provide areas where deer, elk, grouse, and other game would concentrate. The imprint left by that history continues today.

Historical and Current Occurrence

Explorers and settlers arriving in the Willamette Valley in the 1800s found vast areas of prairie and oak habitat. In 1841, explorer Charles Wilkes described the landscape as being "destitute of trees, except oaks." Oak woodland and savanna once covered about 400,000 acres in the Willamette Valley; this was in addition to 1 million acres of prairie. Today less than 7 percent of the original habitat remains in the Willamette Valley. Approximately 460,000 acres of oak and prairie were present in the greater Portland-Vancouver region in 1850. Lack of accurate current habitat mapping makes accurate estimates of the degree of loss for the region impossible to determine, but the situation is likely worse within the Portland-Vancouver region than in the more rural upper Willamette Valley—especially within the Oregon portion of the region, where urban and agricultural development has replaced nearly all the former oak areas. Few large known examples of the habitat remain.

Distribution of Oak Habitats in the Region

Because oak habitat has not been well mapped, its distribution is not known with precision. Remnant habitats within the more urbanized portion of the greater Portland-Vancouver region provide connectivity to areas with more extensive habitat. Patchy but mostly contiguous—although degraded—areas of oak stretch along the Willamette River, east and south through Milwaukie, Oregon City, and Wilsonville to the Willamette Valley. Oak habitats also are found as remnants of the historical floodplain forests of the Columbia River. These habitats extend upslope to rocky outcrops in the Coast Range foothills and into the Columbia River Gorge National Scenic Area to the east. The farmlands of the Tualatin Valley and in Clackamas, Clark, Marion, and Yamhill counties are populated by the remnants of oak habitats. Large single oaks and patches of oak often are located on the hillsides and along streams and wetlands in the rolling hills of the greater Portland-Vancouver region, perhaps because of the difficulties in developing or planting field crops in these areas.

Large, often isolated oaks found along roads in urban or rural areas, in rural residential settings, and in agricultural fields are clues to the former regional extent of oak habitat. These ecologically valuable reminders of our region's natural history are decreasing as they decline with age, are harvested, or are cut down for development. Even on good soils where Oregon white oak grows at a relatively fast rate, the replacement of large-diameter oak trees that are favored by wildlife can take more than a century.

Condition of Existing Oak Habitats

The structure and composition of remaining oak habitats often are degraded by lack of fire, habitat conversion, and invasive species. These factors have led to the decline or loss of many species of native plants and wildlife populations that depend on large, open-grown oak trees or native bunchgrass prairie such as western bluebirds, white-breasted nuthatches, acorn woodpeckers, and western gray squirrel.

Lack of fire over the past 150 years has allowed conifers and big-leaf maple to overtop and shade out oaks. Evidence for this can be seen in the narrow canopies or skeletons of formerly large oaks (and madrones) in existing Douglas fir and maple stands. In some areas, oaks have increased in density, with dense stands of narrow-crowned oak trees replacing the open-grown oak so valuable to wildlife. Small, shaded, or crowded oak trees produce fewer acorns, make fewer and smaller cavities, are more vulnerable to fire and may eventually succumb to other forest types. Fire suppression may also be a cause for reduced oak reproduction in the region.

Conversion of oak habitats to farms, production forest, or residential areas has led to smaller patch size and increased isolation. This not only limits the use of oak habitats to species with small home ranges, but decreases the viability of plant and wildlife populations within the patch, leading to loss of local biodiversity.

The understory of many remaining oak habitats is degraded by non-native invasive species such as English and Irish ivy (*Hedera* sp), non-native blackberries (*Rubus armeniacus* and *laciniatus*), Scot's broom (*Cytisis scoparius*), and various non-native grasses. As a result, most stands have low diversity and cover of native grasses and forbs (i.e., wildflowers) and the animals that depend on them.

Examples within the Region

Much of the remaining oak habitat in the region is in private ownership. Oak is found throughout most of the region at elevations below 2,000 feet, but especially in the southernmost and westernmost areas of our region. Table 3-1 lists known examples of oak habitat within the region.

Entities Working on the Issue

Restoration of oak habitats is under way by nonprofit institutions such as The Nature Conservancy, Tualatin Riverkeepers, Columbia Land Trust, and the University of Portland, and by government agencies such as Clean Water Services, the Natural Resources Conservation Service, Metro, the City of Portland, Tualatin Hills Parks and Recreation District, and the U.S. Fish and Wildlife Service. The Oregon Oak Communities Working Group meets occasionally to share information and projects.

Threats and Challenges

Meaningful conservation of oak habitats is difficult for several reasons. The habitat is poorly mapped, and protected areas generally are small and isolated. Much of the original oak landscape in its various forms has been developed, and what remains generally is degraded. Finally, oak and prairie habitat need ongoing active management that requires some degree of staff expertise and resources (although several useful guides do exist). The following are issues specific to the management of oak habitats:

- Valley woodlands once dominated by widely spaced oaks are becoming forests crowded with conifers and shade-tolerant trees. White oaks survive only a few decades in such conditions.

- Those legacy oaks that persist in residential areas or on pastures and woodlots are being cut down as agricultural practices intensify, or they are aging and not being replaced.

- Vineyard development on land once unsuitable for farming threatens some remaining oak habitat.

- The lack of a strong market for oak creates little economic motivation to maintain oak stands and favors conversion to conifers.

- Invasive, non-native plants such as Scot's broom, Himalayan blackberry, and non-native grasses reduce the survival and growth rate of oak seedlings and compete against wildflowers

and native grasses that are associated with oak habitats, thus reducing native biodiversity.

- Park managers and homeowners seldom plant white oak for landscaping because of its reputation for slow growth.

- Low availability and the high price of appropriate native seed limits the effectiveness of restoration.

Likely Effects of Climate Change

Most climate models predict warmer, wetter winters and more prolonged drought during summer, leading to more frequent and intense forest fires in the Pacific Northwest. If such a scenario proves true, it may favor fire-adapted species and habitats such as oak woodlands, savanna, and prairie. Unfortunately, rapidly changing climate is likely to have the greatest negative impact on species that occupy small, isolated habitat patches because they may not be able to migrate and disperse.

Important Management Strategies

Oak woodlands and savanna are a high priority for protection and restoration for two primary reasons:

- The oak habitats in the region provide connectivity between the Willamette Valley to the south and Puget Trough to the north; both provide oak habitats critical for the survival of declining species.

- Conservation of the Oregon white oak ecosystem is necessary to protect associated species and culturally important historical sites, including many plant and animal species at risk of local or global extinction.

Management strategies to ensure the survival of oaks and related species should include the following:

- Protect remaining oak habitats—even single trees in important connectivity areas.

- Manage competing woody vegetation, especially by removing competing trees and overgrown shrubs, to protect oaks and open habitat and reduce fire intensity.

- Implement prescribed fire or actions such as grazing, haying, and mowing that mimic its effects.

- Reduce invasive species using mechanical, biological, or chemical approaches.

- Enhance existing and restored habitat by collecting, cultivating, and planting oak-associated species.

- Identify areas that may increase the range of oak habitats as climate change alters conditions within the species' current range.

Conservation Strategies and Opportunities

Because much of the remaining oak and prairie is in private ownership, conservation strategies need to include actions that can be successful on both public and private lands. Those actions that can increase the extent and connectivity of oak habitats should receive high priority.

- Map oak habitat and prioritize patches and connections.

- Restore and maintain remaining examples on public land in strategic locations.

- Conserve and restore the best remaining privately owned sites through acquisition and easements and by encouraging landowners to participate in incentive programs.

- Complete an inventory of remaining oak sites to determine the status of oak-dependent plants.

- Especially in urban or urbanizing areas, small stands (i.e., stands of less than 1 acre, or 0.4 hectare) or single oak trees may be considered priorities for conservation. Important examples include areas near other oak or prairie sites (because they provide connectivity) or oaks that contain cavities, have a large diameter and canopy, or are known to be used by priority species.

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Upland Prairie, Wet Prairie, and Rocky Balds

Mary Bushman, City of Portland; Dan Bell, The Nature Conservancy; Jonathan Soll, Metro; Mark Wilson, City of Portland; Ed Alverson, The Nature Conservancy

Prairies are natural or uncultivated areas composed of bunchgrasses (grasses that grow in clumps), grass-like plants (sedges and rushes), herbaceous plants (forbs, commonly referred to as wildflowers), mosses, and lichens. Trees and shrubs occasionally are present. Before 1850, prairies were the most extensive vegetation type in the Willamette Valley and, together with oak savanna, occupied 15 percent (270,000 acres) of the greater Portland-Vancouver region. The native prairies of western Oregon and southwestern Washington are now among the most endangered ecosystems in the United States and are identified as focal habitats in the Oregon and Washington state conservation strategies.

TABLE 3-2
Sites with Ongoing Prairie Restoration

Site	Owner/Manager
Cooper Mountain	Metro
Graham Oaks	
Gotter and Lovejoy Prairie	
St Johns' Landfill	
Durham Prairie	Clean Water Services
Baltimore Woods	City of Portland

Prairies include a range of habitats:

Wet prairies. Wet prairies typically occur on poorly drained clay soils or floodplains. Wet prairie plants tolerate soils that are saturated or occasionally flooded during winter or at times of high water in floodplains.

Upland prairies. Upland prairie soils typically are well drained, although sometimes rocky. Historically, upland prairie often was near or integrated with oak savanna, a habitat type distinguished from prairie largely by chance survival of scattered or small patches of trees.

Rocky balds. Rocky balds are found in areas with thin soils that are wet in the winter and dry in the summer. In the greater Portland-Vancouver region, many rocky bald sites were formed when glacial floods scoured soil from rock outcrops along area rivers. Balds also typically form on exposed ridge tops with thin soil. They are found along the Columbia, Willamette, Tualatin, Clackamas, and Sandy rivers and along Lacamas Creek in Washington.

Historical and Current Occurrence

Before 1850, approximately 1 million acres of wet and upland prairie existed in the Willamette Valley, with additional acres scattered through the Washington portion of the greater Portland-Vancouver region. In all but the shallowest rocky soils, prairies historically were maintained via periodic fire, which effectively kills or suppresses most trees and shrubs. Native perennial grasses and forbs have a relatively high tolerance for drought and late-season fire, so historically they could persist on well-drained soils or the shallow soils of rocky balds.

Because prairie habitats are typically in locations that are also convenient for agriculture and residential development, most prairie was lost over the last 160 years through farming, grazing, and urban and suburban development. Fire suppression has contributed to habitat loss, with unburned prairie eventually converting to forest or woodland. Estimates suggest that less than 2 percent of the original 1 million acres of prairie present at the time of the 1851 Government Land Office surveys still remain in the Willamette Valley. Prairies with a substantial component of native vegetation are even rarer.

Currently, prairie habitats within the near-urban portions of the greater Portland-Vancouver region generally are rare, small, and heavily degraded. Examples can be found along the Willamette, Columbia, Clackamas, and Tualatin rivers; these mostly are rocky balds. The remaining larger areas of remnant prairie are present within oak savanna and at restoration sites in rural Washington, Clackamas, and Clark counties or intermixed with agriculture fields. Because remote sensing technology cannot effectively distinguish prairie from pasture or commercial grassland, there may be unknown examples of prairies on private lands in the more rural areas of the region.

Examples of oak-prairie habitats within the greater Portland-Vancouver region include Elk Rock Island (City of Portland), Clear Creek Natural Area (Metro), Cooper Mountain (Metro and Tualatin Hills and Park and Recreation District), the Camassia Natural Area (The Nature Conservancy), and privately owned rocky bluffs above St. Helens. Additional areas of importance are known among various private ownerships along the Tualatin and Willamette rivers.

Condition of Existing Prairies

Remnant prairies in the near-urban environment typically are small, with few native species and high cover of non-native species. Typically, native bunchgrasses, rushes, and sedges have been replaced by non-native grasses such as the perennials velvetgrass *(Holcus* sp.*)*, bentgrass *(Agrostis* sp*)*, tall fescue *(Schedonorus phoenix)*, and meadow foxtail *(Alepocurus pratensis)* and annuals such as dog-tail *(Cynosurus echniatus)* and cheatgrass *(Bromus* sp*)*. Invasive shrubs such as Himalayan blackberry and Scot's broom often dominate unmanaged grassland areas.

Remnant plants of prairie habitats, including rare species, sometimes are found between roads and fences on public or private property where they are threatened by roadside maintenance activities. Remaining larger, unplowed areas that once were prairie generally have been managed as pasture for domestic animals or as hay fields. Although commercial grassland or pasture may provide some habitat benefits for prairie wildlife, many grassland- and prairie-dependent species, such as western meadowlark (*Sturnella neglecta*), streaked horned lark (*Eremophila alpestris strigata*), Fender's blue butterfly (*Icaricia icarioides fenderi*), and Taylor's checkerspot butterfly (*Euphydryas editha taylori)*, have declined—often dramatically—in response to habitat loss and degradation.

Important Flora and Fauna

FLORA

Native Willamette Valley prairies have extraordinarily diverse plant life. Approximately 375 native grass and forb species are highly or moderately dependent on prairie or savanna habitat in the greater Portland-Vancouver region. The following are some common native grasses found in prairies:

- Roemer's fescue *(Festuca roemeri)*
- California oatgrass *(Danthonia californica)*
- Prairie junegrass *(Koeleria macrantha)*
- Blue wildrye *(Elymus glaucus)*
- Lemmon's needlegrass *(Achnatherum lemmonii)*
- Tufted hairgrass (*Deschampsia cespitosa*)
- Meadow barley (*Hordeum brachyantherum*)

Dense sedge (*Carex densa*) also is common. Native forbs that are commonly intermixed with the grasses include the following:

- Fragrant popcorn flower *(Plagioborthrys figuratus)*
- Camas *(Camassia quamash ssp. maxima and C. leichtlinii ssp. suksdorfii)*
- Oregon sunshine *(Eriophyllum lanatum)*
- Slender cinquefoil *(Potentilla gracilis)*
- Meadow checkermallow *(Sidalcea campestris)*
- Heal-all *(Prunella vulgaris)*
- White pussy ears *(Calochortus tolmiei)*
- Oregon Iris *(Iris tenax)*

The U.S. Fish and Wildlife Service has listed five prairie and savanna plant species that occur in the region as threatened or endangered, and six other species that either are being considered for listing or are species of concern (see Appendix F); these include Kincaid's lupine *(Lupinus sulphureus* ssp. *kincaidii),* shaggy horkelia *(Horkelia congesta* ssp. *congesta)*, Willamette daisy *(Erigeron decumbens* var. *decumbens)*, white-topped aster *(Sericocarpus rigidus)*, golden paintbrush *(Castilleja levisecta)*, and white rock larkspur *(Delphinium leucophaeum)*.

Fauna

Birds that depend on prairies include the streaked horned lark, western meadowlark, Northern harrier hawk, American peregrine falcon, yellow-breasted chat, western bluebird, purple martin, and nighthawk. Mammals include deer and elk, the little brown myotis bat, and the big brown bat. Appendix E provides a more complete list.

At least 13 fauna species associated with prairies in the greater Portland-Vancouver area are listed by the states or federal agencies as threatened or declining (see Appendixes E and G):

- Western meadowlark *(Sturnella neglecta)*
- Streaked horned lark *(Eremophila alpestris strigata)*
- Fender's blue butterfly *(Icaricia icarioides fenderi)*
- Taylor's checkerspot butterfly *(Euphydryas editha taylori)*
- American kestrel *(Falco sparverius)*
- Western bluebird *(Sialia mexicana)*
- Western kingbird *(Tyrannus verticalis)*
- Savanna sparrow *(Passerculus sandwichensis)*
- Oregon vesper sparrow *(Pooecetes gramineus affinis)*
- Chipping sparrow *(Spizella passerine)*
- "Slender-billed" white breasted nuthatch *(Sitta carolinenses aculeate)*
- Lewis's woodpecker *(Melanerpes lewis)*
- Western pond turtle *(Clemmys marmorata)*

Entities Working on the Issue

Restoration of prairie habitats is under way by nonprofit groups such as The Nature Conservancy and Tualatin Riverkeepers and by governmental agencies such as Metro, the City of Portland, the U.S. Fish and Wildlife Service, and Tualatin Hills Park and Recreation District. Table 3-2 lists sites that have examples of ongoing prairie restoration. In addition, the Port of Portland is considering prairie restoration on Government Island.

Threats and Challenges

DEVELOPMENT AND AGRICULTURE

Prairie and undeveloped former prairie are at high risk for development because the typical sites are easy places to build homes, graze livestock, and plant vineyards. Wet prairies are more difficult to develop because of permitting requirements but they may be vulnerable to hydrologic alteration.

INVASIVE SPECIES

Encroachment of invasive species is found in every known prairie throughout the region. Pressure from these new plants may be even greater in the urban areas, where agriculture, industry, and horticultural influences have greatly influenced the natural habitats for many decades.

Plants that invade the prairie when there is a lack of management include native woody species such as Douglas fir (Pseudotsuga menziesii), Oregon ash (Fraxinus latifolia), and Nootka rose (Rosa nutkana) and non-natives such as one-seed (Douglas') hawthorn (Crataegus monogyna), Scot's broom (Cytisus scoparius), Himalayan blackberry (Rubus armeniacus), reed canarygrass (Phalaris arundinacea), and St. John's wort (Hypericum perforatum). Non-native, perennial sod-forming grasses that are fire tolerant and difficult to control are perhaps the worst weed threat.

FIRE SUPPRESSION

The exclusion of fire as a natural disturbance factor that promotes prairie conditions is a key threat to grassland and prairie. Fire suppression affects prairie habitats in several ways:

- Thatch buildup (i.e., roots and dead organic material at the soil surface) alters soil conditions and reduces the availability of the mineral soils on which many prairie species depend for germination.
- The absence of disturbance (i.e., fire and grazing) favors long-lived perennial and woody species over short-lived species, especially annuals.
- Except in the shallowest soils, fire suppression leads to encroachment of trees and shrubs and eventual conversion to forest.

LACK OF UNDERSTANDING, NEED FOR EDUCATION AND INFORMATION

Understanding the importance of prairie plants and wildlife and their management requirements has grown, as evidenced by the inclusion of prairies in both Oregon and Washington's state's conservation strategies as a conservation target. Volunteer stewardship and public support for long-term funding are two keys to the future success of prairie habitat restoration.

Likely Effects of Climate Change

Oak and prairie habitats are relics from warmer, drier periods that were present in the region 7,000 to 10,000 years ago. As the climate warmed and became wetter, indigenous people maintained oak and prairie habitats through burning. Many climate models predict warmer, wetter fall and spring seasons followed by drier and warmer summers. This combination may produce conditions in the region that will bring more frequent fire. Change closer to the historical pattern is likely to favor upland prairie, but changing seasonal patterns may also disrupt relationships between pollinators and plants and the food webs they support.

Conservation Strategies and Opportunities

- Conserve and restore existing prairie, especially any remaining large examples, and increase the connection between sites. This should be a primary strategy.
- Implement conservation approaches that can be applied on both public and private lands. Actions to increase the range and connectivity of prairie habitats should receive high priority.
- Map prairie habitats and prioritize patches and connections, beginning with the areas described above.
- Restore and maintain remaining examples on public land in strategic locations.
- Encourage landowners to participate in existing and new incentive programs through soil and water conservation districts, the Oregon Department of Fish and Wildlife, Oregon Department of Forestry, Natural Resources Conservation Service, and others to restore habitat in private ownership.
- Increase the availability of genetically appropriate plant materials through cooperative collection and production of prairie and savanna species.

- Actively manage existing and restored prairies:
  - Manage woody vegetation to protect open habitat and reduce fire intensity.
  - Implement prescribed fire or actions such as grazing, haying, and mowing that mimic fire's effects.
  - Control invasive species using mechanical, biological, or chemical approaches.
  - Protect and enhance existing habitat by collecting, cultivating, and reintroducing prairie-associated species.
  - As climate models become more predictable, look for suitable areas in which to expand prairie habitats under new climate conditions.
  - Reinstate appropriate hydrology for wet prairies.
- Study key at-risk species and conduct research on the following subjects to fill data gaps and inform prairie restoration:
  - The potential role of small-scale prairie patches or gardens (i.e., backyard habitat) as pollinator habitat. Important examples of small-scale prairies are found in urban and urbanizing areas and near other oak or larger prairie sites. These small sites provide connectivity to larger restoration sites and serve as buffers between larger sites and urban or near-urban lands.
  - The importance of partial restoration with mixed native/non-native grasses and native forbs.
  - The key attributes of urban/near-urban prairie restoration sites.
  - Effective methods for mimicking fire.
  - Techniques for restoration at difficult sites—i.e., sites with disturbed soils, weed seed banks, altered hydrology, soil compaction, and rodent impacts.

Because of landownership patterns, the degree of habitat loss, and the expense of managing prairies, successful prairie conservation will necessarily involve careful prioritization, substantial work with private landowners, and good partnerships. Prairie habitats should be defined based on the key functions they provide for prairie fauna.

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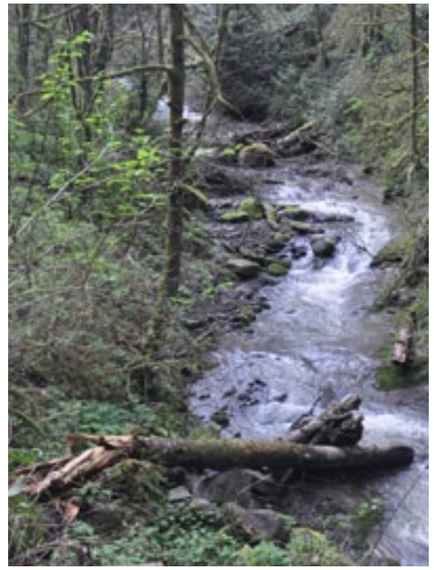
Special Habitat Features

Susan Barnes, Oregon Department of Fish and Wildlife

Some natural communities and landscape features are not adequately represented through the "coarse filter" of major habitat or land cover types. So-called special habitat features often occur at the local scale, have a patchy distribution, and may host rare or endemic species. The historical occurrence of some special habitat features is not well known, and, because special habitat features can be difficult to map, they are poorly represented in regional data sets. Historically, special habitat features were created through the effects of volcanic activity, seasonal floods, and wildfire, but many special habitat features have been lost as a result of altered hydrology and fire regimes, urbanization, conversion to farming or forestry, and mining. Today, remnant special habitat features are threatened by factors such as encroaching urbanization, recreational pressures, and invasive species. Regional conservation partners are endeavoring to protect and preserve special habitat features, which include the features below.

Snags and Downed Wood

Standing dead or dying trees are called snags. Once on the ground or in streams, snags are referred to as downed wood or large woody debris. The loss of snags and downed wood is one of the main limiting factors for fish and wildlife in the greater Portland-Vancouver region, particularly in the region's urban areas. Snags and downed wood have been widely removed because they are not seen as having any value, they are perceived as "unsightly," or they are deemed hazardous. Snags and downed wood host a variety of plant and animal life, such as salamanders and woodpeckers, and they provide nesting cavities for many wildlife species including wood ducks. Without these natural cavities, many wildlife species cannot thrive, or they attempt to find shelter in human structures. Historically, streams in the greater Portland-Vancouver region were full of large wood that helped create and maintain pools, riffles, and other elements of structural diversity that are crucial to maintaining healthy streams that could support species such as salmonids. (Snags and downed wood are also discussed in "Upland Forests," above.)



Forest Openings

Disturbances such as wildfire, disease, and insect outbreaks result in openings (i.e., gaps) in forests with high forb and shrub diversity and structure, such as large snags and logs on the ground. Such openings provide essential structural complexity and plant diversity. They provide foraging and nesting habitat for deer, elk, black bear, ruffed grouse, olive-sided flycatcher, willow flycatchers, MacGillivray's warblers, white-crowned sparrows, and common nighthawk. Open areas with snags are important for purple martins and western bluebirds. Terrestrial salamanders such as the clouded salamander live in large logs and stumps in forest openings. With management emphasis on older forest successional stages on public forestlands and more intensive management of private forestlands, the number of forest openings has declined, resulting in a declining food base for a variety of wildlife and the loss of nesting and foraging habitat. (Forest openings are also discussed in "Upland Forests," above.)

Rock Habitats

Rock habitats include geologic features such as cliffs, rim rock, rock outcrops, and talus slopes. These habitats are important for a variety of flora and fauna, including terrestrial salamanders, peregrine falcons, cliff swallows, bats, snakes, and rare invertebrates and plants. Some rock habitats are susceptible to human disturbances such as

mining and recreational uses (e.g., rock climbing). One such site is Madrone Wall, formerly known as the Hardscrabble Quarry, located in Clackamas County southeast of Carver. Nesting peregrine falcons were discovered on the Madrone Park site in 2010. A large unprotected example of rock habitats is situated above St. Helens, Oregon.

Bretz Flood Features

The Tonquin Geologic Area comprises approximately 17 square miles of land in Washington and Clackamas counties, extending from the communities of Tualatin and Sherwood south to Wilsonville. The area supports extensive evidence of the Bretz (or Missoula) Floods that scoured the Columbia River Gorge and extended into the Willamette Valley multiple times between approximately 13,000 and 15,000 years ago. These floods left behind geologic formations such as kolk ponds and channels, basalt hummocks, and knolls, which are widely present in the area today and which support considerable and diverse plant, fish, and wildlife habitat.

Springs and Seeps

Springs and seeps are places where groundwater emerges, sometimes under pressure, with variable temperature and chemistry. Water from springs and seeps usually flows into a local wetland or forms the headwaters of streams and rivers. Springs and seeps provide cold water to wetlands and streams, making them particularly important to native fish and invertebrates that need cool water to thrive. Several rare and declining amphibian species, such as torrent salamanders and the coastal tailed frog, are closely associated with springs, seeps, and headwater habitats. Some springs are important sources of minerals that are needed by wildlife, including band-tailed pigeons. Many springs have been tapped for domestic water supplies or farm and ranch uses. At such sites, water typically has been piped or diverted and sometimes is polluted. The wetlands created by springs and seeps may be altered or degraded.

Vernal Pools

Vernal pools are one of Oregon's rarest wetland types. They form on impervious basalt bedrock or on soils cemented by a calcareous or siliceous hardpan that impedes drainage. Pools can range in size from 1 acre (0.4 hectare) or more to patches as small as 10 to 225 square feet (1 to 5 square meters) and can occur singly or in groups covering many acres. Vernal pools usually fill with water in the fall or winter and dry up in spring or early summer, but seasonal precipitation can be highly variable, so pools may fill for only brief periods or not at all. They are home to a large variety of plants and animals adapted to these harsh conditions, including some globally rare species. Vernal pools are threatened primarily by urbanization on the typically flat and easily accessible landforms in which they occur. Vernal pools are important habitats for amphibians, rare plants, and fairy shrimp and other invertebrates. (For more on vernal pools, see "Wetlands," above.)

Fens

Fens are a unique type of wetland that includes a shallow lake with a floating peat mat. Fens are habitat for unique and rare plants as well as a variety of declining wildlife species, such as amphibians and turtles. It takes up to 10,000 years for a fen to form naturally. The only known fen left in the Willamette Valley was recently protected by Metro. (For more on fens, see "Wetlands," above.)

Off-Channel Habitats

Off-channel habitat features such as beaver ponds, oxbows, stable backwater sloughs, and side channels are important ecological components of river systems, especially large systems such as the Columbia and Willamette rivers and their major tributaries. Many species and age classes of native fish select off-channel habitat instead of the main channel to feed, avoid predation by other fish, escape fast water, or seek out cool water in the summer. Native turtles and amphibians, birds, freshwater mussels, and dragonflies are attracted to alcoves, oxbows, and side channels because of unique physical and water quality characteristics. In the last 150 years, off-channel habitats have disappeared because of channelization, revetments, diking, drainage of wetlands, removal of large wood, agricultural practices, and changes in seasonal flows that have resulted from the construction of dams throughout the Willamette and Columbia basins. Off-channel habitats now are uncommon in the region, especially in the lower reaches of the Willamette River. (For more on the importance of these habitats to fish, see Chapter 5.)

Conservation Strategies and Opportunities

A priority strategy for managing and restoring special habitat features is to protect and maintain those features that remain on the landscape. Because not all remnant SHF are known and mapped, land use policies should be in place to protect them once their locations are known. In some cases, special habitat features should be buffered from activities on adjacent lands because the features themselves typically are vulnerable to degradation; buffering also is needed because the many species of flora and fauna associated with special habitat features tend to be sensitive to human-caused disturbances.

The following conservation strategies also are recommended:

- Control invasive species.
- Restore natural flow regimes and re-create off-channel habitats.
- Manage beaver populations to provide for beaver-created off-channel habitats.
- Provide buffers for springs and seeps.
- Enforce seasonal closures to protect sensitive wildlife (e.g., birds nesting on cliffs).
- Site recreational trails away from special habitat features.
- Employ forest management practices to create and maintain forest openings.

- When addressing hazard trees, leave a section standing (high-stump method) to provide some wildlife benefit; leave wood onsite in large pieces as much as possible.
- Retain existing snags and downed wood where they occur; manage for future snags and downed wood by girdling or topping trees.
- Evaluate methods to imitate natural vernal pool function in old ditches and depressions in agricultural fields.
- Improve mapping of all special habitat features.

FOR MORE INFORMATION

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Flora of the Region

CHAPTER 4

Angie Kimpo, City of Portland, and George Kral, Ash Creek Forest Management

Situated as it is at the west end of the Columbia River Gorge and within Columbia River freshwater tidal zone, at the convergence of several larger ecoregions (i.e., the Willamette Valley and Puget Trough, and the Cascade and Coast ranges), the greater Portland-Vancouver region is home to unique and diverse native flora. Known native plant species in the region number roughly 650; of these, approximately 250 either have been extirpated since modern settlement began or have not been detected during the last 20 years. Plant species being rare, in decline, or regionally extirpated is strongly associated with loss and degradation of habitat. It is likely that some of the 250 "missing" species always have been infrequent in the region and thus were lost quickly as a result of habitat destruction or disruption of critical processes. Others succumbed to wholesale habitat loss. For example, diking, settlement, and development of the vast floodplain wetlands along the Columbia and Willamette rivers resulted in the loss and decline of emergent wetland and ruderal (i.e., disturbance-loving) species that flourished on those systems' sandy soils. The nearly complete loss of oak and prairie habitats has had similar impacts. Species associated with old-growth or late seral forests have declined with conversion to production forestry. Increasingly, our remaining native flora is threatened by non-native invasive plant and animal species, introduced pests and pathogens, continued habitat loss, and lack of knowledge. Action is needed to protect and conserve the species that remain.

How Do Plants Provide Habitat?

Vegetation is the foundation for nearly all habitats because it creates food and structure. Along the Columbia River, species such as Columbia River willow *(Salix fluviatilis)*, Columbia sedge *(Carex aperta)*, and other wetland emergents have evolved with the late spring freshets of the Columbia River system and tolerate extremely high water levels in the early summer. These species provide important habitat for a number of rare or declining wildlife species, including neotropical migratory songbirds, native amphibians, and juvenile salmonids.

Flowering plants provide habitat for pollinators such as butterflies and native bees, along with other insects. Higher plant diversity generally means higher insect diversity. And because of the

TABLE 4-1
Primary Threats to Rare Plants in the Portland-Vancouver Region, by Type

Habitat Type	Primary Threats to Plant Diversity and Rare Plant Populations
Upland Forest (Primarily Old-Growth)	Habitat loss from logging and development
Oak Woodland, Savanna, and Prairie	Habitat loss resulting from conversion to residences, farming, or forest; alteration of habitat as a result of lack of natural disturbance (e.g., fire), invasion of exotic species and natural succession to woody plant communities
Riparian, Bottomland Hardwood, and Shorelines and Mudflats	Alteration of habitat as a result of diking or bank hardening, flow alterations related to dam operations, stormwater inputs, or invasive species; loss of habitat as a result of development and conversion to agricultural uses
Wetlands	Alteration of habitat as a result of changes in flow patterns (hydrologic modification) or exotic species invasion; loss of habitat as a result of residential or agricultural development
Shrublands	Loss of habitat as a result of development and intensive forest management.
Aquatic/Open Water	Alteration of habitat as a result of hydrologic modifications, contamination, or invasive species

tight relationship between some plants and some insects, the loss of a plant species can mean a loss of one or more insect species as well. Insects are the basis of the food web for birds associated with rare habitats, and they also pollinate agricultural crops in the region. Oak trees provide important habitat for the western grey squirrel and acorn woodpecker, both of which require mature oaks with bountiful acorn production as a food source.

Rare Species in the Region

In the greater Portland-Vancouver region approximately 100 plant species have federal or state legal status or may be of concern locally (see Appendix F). In addition, hundreds more are tied to declining habitats such as oak and prairie and are at risk because of isolation and habitat degradation. In general, rare species declines in our region can be attributed to three variables: loss of habitat, habitat degradation, or, for species occurring near the edge of their range, fluctuations in microclimate. Table 4-1 describes the primary threat to rare plants, by habitat.

Threats and Challenges

Natural areas in the greater Portland-Vancouver region continue to support rare plant populations. However, these populations are threatened by habitat loss and fragmentation, invasive species, loss of genetic diversity, lack of knowledge regarding species status, and lack of availability of plant materials.

HABITAT LOSS AND FRAGMENTATION

Plants move only by dispersal of seeds or vegetative propagules (such as root fragments). The continuing loss of land to development reduces potential habitat for uncommon and rare species. Beyond the effect of outright habitat loss is the effect of road building and other development on the size of and connectivity of habitat patches. Smaller, more isolated individual patches result in smaller, less genetically diverse populations that are more vulnerable to local extinction.

INVASIVE SPECIES

Non-native plants that are introduced unintentionally, as horticultural species, or for agricultural purposes pose a fundamental threat to native and sometimes rare plant populations. Species

such as reed canarygrass *(Phalaris arundinacea)*, invasive knotweeds *(Polygonum* spp.*)*, and false indigo *(Amorpha fruiticosa)* readily out-compete natives in riparian and floodplain areas along the Willamette and Columbia rivers. In oak habitats and rock outcrop areas, false brome *(Brachypodium sylvaticum)* and shining-leaf geranium *(Geranium lucidum)* wreak havoc on rare plant communities that are generally dominated by annual or short-lived perennial species that depend on fire.

POPULATION GENETICS

Genetic diversity gives populations the ability to adapt to changing conditions. When populations drop to a very small size, they can lose important elements of diversity and adaptability through a bottleneck effect (i.e., inbreeding depression) that is irreversible even if the population size later recovers. Historically, plant populations maintained genetic diversity through migration and mixing of populations and the adaptation of connected groups of small populations (meta-populations) to localized conditions. Over the past 150 years, development of the region has resulted in the loss of genetic diversity and inbreeding in some species.

Hybridization between introduced and native species increasingly is recognized as a problem in the conservation of native plant populations. In the greater Portland-Vancouver region, hybrids have been well documented for natives such as *Prunus emarginata* (wild cherry), *Malus fusca* (crabapple), and *Crataegus suksdorfii* (hawthorn). Hybrids threaten species viability through loss of genetic diversity and local adaptation. Eventually, natives can be reduced or replaced by hybrids.

A primary but often overlooked element of genetic conservation is the coordination and prioritization of restoration across the landscape. In general, funding is site-based rather than species based, and restoration projects may not address genetic issues such as inbreeding that threaten populations. This problem is exacerbated by the focus of much regional restoration funding on "starting fresh" rather than preserving or conserving existing sites, which is generally viewed as maintenance or operations rather than restoration.

LACK OF KNOWLEDGE

The lack of comprehensive site inventories by capable botanists results in a lack of knowledge about the status of many plant species and hampers our ability to make informed decisions. Although there are records of many taxa collected or observed, there has been no thorough floristic study of the Portland metropolitan area beyond the information gathered in *Urbanizing Flora of Portland* (Christy et. al 2009). Analysis of historical and modern herbarium collections, cross-referenced to regional plant lists, revealed an overall lack of information about the status of many rare plant populations. Out of 581 species defined as "native, rare" that occurred in the region historically, approximately 320 are documented to still

occur. More than 254 are extirpated or have not been observed in the last several decades.

LACK OF PLANT MATERIAL AVAILABILITY

Although many more growers produce native plant materials now than even just 10 years ago, most species remain unavailable. This lack of availability of plant materials thwarts all but the most determined and well-funded restoration efforts.

Likely Effects of Climate Change

Current climate change models predict changes in temperature and precipitation patterns, rises in sea level, and an increase in forest fires and pests. These changes could affect efforts to conserve rare plant species in several ways:

- A number of species documented in our region occur primarily east of the Cascades or in the eastern Columbia River Gorge. Many have not been documented recently and may have occurred in the greater Portland-Vancouver region during prolonged dry or warm periods. Species whose westernmost range is at the edge of the region may expand once again into the region and proliferate. Conversely, species for whom the region is at the southern edge of their range may struggle to persist.
- On tidally influenced sites on the Willamette and Columbia rivers, rises in sea level could affect remnant populations of rare species associated with those systems.
- Increased potential for forest fire may pose a high risk to both coniferous forests and oak woodlands, where fuels have accumulated naturally and through fire suppression; on the other hand, it is possible that an increase in natural fires could benefit oak and prairie habitats.

Priority Conservation and Restoration Strategies

SURVEY THE REGION'S (RARE) PLANTS

A comprehensive inventory of the region's flora is needed, with sampling of as many examples of each habitat type in the region as possible. Voucher specimens including standard locality data should be collected. Specimens should go to Portland State University, Oregon State University, and specialists in the taxa being collected. A comprehensive inventory is likely to reveal that most remaining taxa are represented on lands in public ownership. Public lands may hold the only remaining populations of some species in the area. Likely hotspots include Cooper Mountain, the Willamette Narrows, the Clackamas Bluffs, Lacamas Creek/Meadow, remnant peat swamps, oak-pine-ash forest communities such as at Tualatin Hills Nature Park and Camille Park, and the floodplain of the Columbia River, including Ridgefield National Wildlife Refuge Complex. It is likely that more common assemblages, such as upland conifer and mixed conifer-hardwood forest, are well represented at Forest Park, Powell Butte, and other forested parcels in both public and private ownership. Because the largest and least-disturbed areas of these common habitats are in public ownership, it is possible that some less common woodland species may also be confined to these tracts of land.

CONDUCT SITE-LEVEL SURVEYS BEFORE SITE-DISTURBING ACTIVITIES

Aside from regulations affecting federal or state-listed species, there is no policy regarding conservation and management of rare plants and rare plant communities within the region. The Endangered Species Act does not protect listed plants from "take" in the same way listed animals are protected, although it is illegal to collect or maliciously harm listed plants on federal land and protection from commercial trade and the effects of federal actions do apply for plants. Increased recognition and guidance are needed. As a starting point, natural area managers should perform rare plant surveys before any soil- or vegetation-disturbing activities, especially on sites likely to support rare plants. Survey results should be shared with the Oregon Biodiversity Information Center and Washington Department of Natural Resources Natural Heritage Program. Managers are encouraged to actively protect and enhance known rare plant populations, or at the very least avoid disturbing them.

MANAGE KNOWN RARE PLANT POPULATIONS

Effective management of rare plant populations requires documentation, protection, and maintenance or restoration of habitat quality. Where populations are small or isolated, managers should consider increasing genetic diversity by bringing in seeds from other local populations.

COLLECT AND CULTIVATE PLANTS

The region's land managers and private growers should partner to collect and cultivate more of the region's native plants for use in restoration efforts. There is a critical need to conserve genetic diversity and expand populations, especially of rare plants. Focusing efforts on observing and collecting seeds, spores, and cuttings of rare species may result in some of the most vulnerable populations being rescued.

Habitat Needs and Opportunities for Conservation Strategy Species

State conservation strategies in Oregon and Washington approach statewide conservation on two levels. The "coarse filter" approach seeks to address conservation at the habitat level, while the "fine filter" approach addresses the status of rare and declining species by identifying those species that require special attention. Table 4-2 lists selected rare plants in the greater Portland-Vancouver region that are focal species of the states' plans and describes appropriate conservation strategies. Appendix F provides a more complete list of rare flora in the region.

Key Groups Working on Plant Conservation

NATURAL RESOURCES CONSERVATION SERVICE, CORVALLIS PLANT MATERIALS CENTER (ORPMC)

The ORPMC develops new technology in plant propagation and establishment, seed production, revegetation, restoration, and erosion control; it also develops new plant sources, which includes developing seed sources and plant materials for rare plant conservation.

INSTITUTE FOR APPLIED ECOLOGY

The Institute for Applied Ecology is proposing the formation of a Willamette Valley-wide plant materials cooperative to coordinate production of native plant materials. Proposed partners for this project include federal, state, and local agencies; private growers; and nongovernmental organizations and nonprofit groups.

TABLE 4-2

Conservation Strategies for Rare Plants in the Region That are Focal Species of State Conservation Plans

Species	Status and Habitat	Strategies
Bradshaw's lomatium *(Lomatium bradshawii)*	Endangered—Federal, Oregon, Washington Prairie and savanna	Survey potential habitat for populations, maintain or restore occupied habitat, maintain and augment populations, reintroduce new populations, collect and store seeds.
Columbia cress *(Rorippa columbiae)*	Endangered—Washington Columbia River riparian zone	Survey potential habitat for populations, maintain or restore occupied habitat, maintain and augment populations, reintroduce new populations, collect and store seeds.
Golden paintbrush *(Castilleja levisecta)*	Threatened—Federal Endangered—Oregon and Washington Prairie and savanna	Survey potential habitat for populations, continue experimental reintroduction.
Water howellia *(Howellia aquatilis)*	Threatened—Federal, Oregon,* and Washington Wetlands, seasonal ponds ("ponds in the woods")	Maintain or restore seasonal wetland habitats, control invasive plants at priority sites, survey for additional populations.
Kellogg's dwarf rush *(Juncus kelloggii)*	Endangered—Washington Wet meadow	Survey potential habitat, maintain or restore existing habitat. Augment populations, reintroduce new populations, collect and store seeds.
Kincaid's lupine *(Lupinus sulphureus ssp. kincaidii)*	Threatened— Federal and Oregon Endangered—Washington Savanna and prairie	Maintain or restore habitat, survey for new populations, introduce and augment populations.
Nelson's Sidalcea (checkermallow) *(Sidalcea nelsoniana)*	Threatened—Federal and Oregon Endangered—Washington Wet prairie	Maintain or restore habitat, maintain and augment populations, continue experimental reintroduction.
Oregon sullivantia *(Sullivantia oregano)*	Endangered—Washington Moist cliffs near waterfalls	Survey potential habitat for populations, especially in the Columbia River Gorge. Research on threats (e.g., rock climbers, hydrology?) is needed.
Peacock larkspur *(Delphinium pavonaceum)*	Endangered—Oregon Wet prairie, forested wetland edges, oak woodlands, along roadsides and fence rows	Maintain or restore habitat, maintain and augment populations, reintroduce new populations, collect and store seeds.
Smooth goldfields *(Lasthenia glaberrima)*	Endangered—Washington Wet stream banks and vernal pools	Maintain and restore habitat, survey for new populations, reintroduce populations to suitable habitat. Research on threats is needed.
Thin-leaved peavine *(Lathyrus holochlorus)*	Endangered—Washington Oak, grasslands or shrubland	Survey prairie and oak habitat remnants for populations. Maintain or restore habitats, augment populations.
White-rock (Pale) larkspur *(Delphinium leucophaeum)*	Endangered—Oregon and Washington Rocky balds, prairie, savanna, open oak woodland	Maintain and restore habitat, survey for new populations, reintroduce populations to suitable habitat.
White-topped aster *(Sericocarpus rigidus)*	Threatened—Oregon Rocky balds, prairie, savanna	Maintain or restore prairie, maintain populations, collect and store seeds, develop stock for outplanting to suitable habitats.
Willamette daisy *(Erigeron decumbens var. decumbens)*	Endangered—Federal and Oregon Wet and dry prairies	Survey potential habitat for populations, develop plant stock for outplanting, reintroduce populations to suitable habitats and protect and manage occupied sites.

** Species has been listed federally, but Oregon Administrative Rules (OAR 603-073) have not yet been updated. All federally listed plant species occurring in Oregon are administratively protected by the State of Oregon*

METRO REGIONAL GOVERNMENT, NATIVE PLANT CENTER

Metro's plant materials center produces commercially unavailable plant materials for use in restoration efforts by Metro and its partners. In recent years, the Metro Native Plant Center has taken the lead on collection and seed increase of locally rare species in the Portland metropolitan area.

FOR MORE INFORMATION: REGIONAL ASSESSMENTS AND PLANS

Rare, Threatened and Endangered Species of Oregon
Oregon Biodiversity Information Center. 2010.
http://orbic.pdx.edu/rte-species.html

The Oregon Biodiversity Information Center is responsible for listing rare, threatened, and endangered species in Oregon. Using a database of species occurrences throughout the state and by consulting with agencies, specialists, academics, and citizen scientists, ORBIC reviews and publishes this list every two to three years. The latest revision of the list was updated in 2010. Species ranks are used to prioritize natural resource management, restoration, and conservation efforts and to highlight species that need more research or protection.

Washington Natural Heritage Plan
Washington Natural Heritage Program. 2011.
http://www1.dnr.wa.gov/nhp/refdesk/plan/VascularPlantList.pdf

Inventory of Natural, Scenic and Open Space Resources for Multnomah County Unincorporated Urban Areas, Final Report
City of Portland, Bureau of Planning and Adolfson Associates. Prepared for Multnomah County Department of Environmental Services, Jan. 2002.

In 2002, Multnomah County and the City of Portland provided the County Board of Commissioners with a compliance report and set of recommendations designed to meet the requirements of the Urban Growth Management Functional Plan, especially Statewide Planning Goal 5, which requires all Oregon cities and counties "to conserve open space and protect natural and scenic resources." Within this plan, locally rare species were identified at sites within the unincorporated areas of Multnomah County.

Oregon Flora Project
http://www.oregonflora.org

Oregon Flora Project Rare Plant Guide
http://www.oregonflora.org/rareplants.php

The Oregon Rare Plant Guide provides information on some of Oregon's rare, threatened, and endangered vascular plants. The information for each taxon is organized into a fact sheet that is designed to aid in the identification of rare plants in the field. Search features allow users to select a subset of taxa that share features such as geographical region, habitat, survey time, or status of rarity. Fact sheets contain additional information, photographs, illustrations, and maps.

Urbanizing Flora of Portland, Oregon, 1806-2008
J.A. Christy, A. Kimpo, V. Marttala, P.K. Gaddis, and N.L. Christy. 2009. NPSO Occasional Paper 3.319 pages.

This compilation of the vascular plants of the Portland-Vancouver area analyzes changes in the region's vegetation since 1806 based on herbarium specimens, publications, and unpublished manuscripts. A total of 1,556 taxa in 125 families are represented. The paper includes a history of botany in Portland, a gazetteer of historical and modern place names, botanical miscellanea, and lists of rare species for use by local planners and land managers.

Natural Resource Inventory Update
City of Portland, Bureau of Planning and Sustainability. 2009.
http://www.portlandoregon.gov/bps/40540

Updated in 2009, the inventory includes a number of items that categorize natural resources within the city of Portland. Inventory products include the following:

Updated natural resource feature information, geographic information system (GIS) data, and maps

Updated special-status animal and plant species

Lists and maps of Special Habitat Areas (SHAs)

Criteria and models to evaluate the relative function and quality of the resources using

GIS technology

Relative ranking maps for riparian areas, wildlife habitat, and combined resources

Documentation of the project approach

Field Guide to the Rare Plants of Washington
P. Camp and J. Gamon, eds. 2011. University of Washington Press. 392 pages.

Field Guide to the Rare Plants of Washington provides information on Washington's endangered, threatened, and sensitive vascular plants. The guide includes descriptions and information on identification, distribution, and habitat for all plant species with conservation status in Washington.

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington
U.S. Fish and Wildlife Service. 2010.
http://www.fws.gov/oregonfwo/Species/Prairie-Species/default.asp

Fish and Wildlife of the Region

CHAPTER 5

Invertebrates

Scott Hoffman Black and Matthew Shepherd, Xerces Society for Invertebrate Conservation; James R. LaBonte, Oregon Department of Agriculture; Dana Ross, Lepidopterist Consultant; Aaron Borisenko, Oregon Department of Environmental Quality

Invertebrates eclipse all other forms of life on Earth, not only in sheer numbers, diversity, and biomass, but also in their importance to functioning ecosystems. Invertebrates are found in every habitat type and perform vital services such as pollination, seed dispersal, and nutrient recycling.

Detailed surveys are lacking, but it is likely that many thousands of invertebrate species can be found in the greater Portland-Vancouver region. These organisms can be divided into to basic groups: terrestrial and aquatic. The terrestrial group includes the insect orders Hymenoptera (bee, wasps and ants), Lepidoptera (butterflies and moths), and Hemiptera (true bugs), as well as non-insect taxa such as Arachnida (spiders, mites, and their relatives), Diplopoda (millipedes), and Chilopoda (centipedes). The aquatic group includes Plecoptera (stoneflies), Ephemeroptera (mayflies) and Trichoptera (caddisflies), as well as freshwater mussels (in the class Bivalvia). Some species inhabit both terrestrial and aquatic environments; examples include Coleoptera (beetles), Diptera (flies), Odonata (dragonflies and damselflies), and Gastropoda (snails and slugs). Table 5-1 lists examples of native terrestrial invertebrates in the greater Portland-Vancouver region (see also Appendix G for a list of the region's butterflies).

There is a growing consensus that invertebrates are underrepresented when it comes to conservation attention and research. This lack of knowledge may limit conservation funding and prevent the funds that are available from conserving the majority of at-risk species. Anecdotal evidence suggests severe decline for some species. For instance, the western bumble bee (Bombus occidentalis) was once commonly found in the Portland-Vancouver region but is now thought to be extirpated. Freshwater mussels are in decline throughout the West, but species such as the western pearlshell (*Margaritifera falcata*) recently have been found in Portland-area creeks. Fender's blue butterfly (*Icaricia icarioides fenderi*), a federally endangered butterfly, was thought to be extirpated from the greater Portland-Vancouver region, but a small population was recently discovered at Hagg Lake. The zerene fritillary

(*Speyeria zerene*) and field crescent (*Phyciodes tharos*) butterflies may also be extirpated from the region.

Invertebrates are found in every habitat type in the greater Portland-Vancouver region, from the soil to the tops of trees, and in every body of water, including streams, rivers and wetlands. The sheer number and mass of invertebrates reflect their enormous ecological influence. Although some invertebrates have a negative impact on humans (either directly as disease agents or by attacking food crops), the adverse effects pale in comparison to invertebrates' essential beneficial actions. Invertebrates are a critical part of nearly every food chain; they serve both as food for other animals and or as agents in the endless recycling of nutrients in the soil. Food webs often depend on critical species performing essential services such as pollination or seed dispersal (see "Pollinators and Pollinator Conservation" in Chapter 6).

Conservation Issues and Threats

Insects are threatened by the same destructive forces that affect many other animals. According to the International Union for Conservation of Nature, the leading causes of decline are habitat destruction, displacement by introduced plant and animal species, alteration of habitat by chemical pollutants (such as pesticides), hybridization with other species, and overharvesting.

CONSERVATION ISSUES AND THREATS IN TERRESTRIAL HABITATS

Habitat Loss, Degradation, and Fragmentation

Habitat loss and fragmentation are often cited as the most significant factors in decline of invertebrate species. Factors causing habitat loss and fragmentation include increasing urbanization, expansion of intensive agriculture, invasive plants, and climate change.

Introduced Plant and Animal Species

There are few studies of the direct effects of non-native plants on native insects. Introduced, non-native plants compete with native plants for resources, alter habitat composition, and cause significant reductions in the abundance and diversity of pollinators and other herbivorous insects (see Table 5-2). There is also evidence that native pollinator insects prefer native plants, even though many native insects will feed on non-native plants when few natives are available.

The Oregon Department of Agriculture estimates that there are about 1,000 species of exotic terrestrial invertebrates in Oregon. Because Port of Portland facilities have been the primary point of entry for exotic terrestrial invertebrates in Oregon, most of these 1,000 exotic species are found in the greater Portland-Vancouver region. Unlike with habitat alteration or loss, once an exotic animal or plant species is established its presence is usually permanent unless aggressive efforts are made to eradicate it. These efforts may harm native invertebrates and cost a lot of time and money.

TABLE 5-1

Examples of Native Terrestrial Macroinvertebrates of the Greater Portland-Vancouver Region

Species or Group	Population Status	Causes or Comments
Native Slugs and Snails	Declining	Habitat loss or alteration, competition with exotic slugs and snails, exotic predators and parasites
Native Earthworms (e.g., Oregon giant earthworm, *Driloleirus macelfreshi*)	Declining or extinct	Habitat loss or alteration, competition with exotic earthworms, exotic earthworms, exotic predators and parasites
Clown Millipede, *Harpaphe haydeniana*	Uncertain or declining	Habitat loss or alteration; possible keystone species of detritus nutrient cycling
Pacific Black-legged Tick, *Ixodes pacificus*	Increasing	Increased urban/forest interface, more deer; vector of Lyme disease
Wahkeena Falls Flightless Stonefly, *Zapada wahkeena*	Unknown	Known only from Wahkeena Falls, western Columbia River Gorge
Grasshoppers (several species)	Increasing	Disturbance specialists; conversion of woodlands to pasture or agriculture
Giant Silkmoths (e.g., Polyphemus moth, *Antheraea polyphemus*)		Unknown, some species may be declining Habitat/host destruction, invasive plants, non-target biocontrol agent effects, exotic bird predators
Some Predatory Carabid Beetles (e.g., *Pterostichus algidus, Scaphintous marginatus*)	Increasing	Habitat generalists
Carabid Beetle, *Promecognathus crassus*	Unknown	Specialist predator of clown millipede
Carabid Beetle, *Acupalpus punctulatus*	Unknown or declining	Wetland specialist; until recently only known from Forest Grove in 1941
Carabid Beetles, *Pterostichus johnsoni* and *P. smetani*	Unknown	Waterfall plunge pool splash zones in western Columbia River Gorge; P. smetani known only from that area
Trout Stream Beetles *(e.g., Amphizoa striata)*	Unknown or declining	Require fast, clear, clean water; specialist predators of stonefly larvae
Ectoparasitic Mammal Beetles (e.g., *Leptinullus aplodontiae* and *Platypsyllus castoris*)	Unknown	L. aplodontiae on mountain beaver; P. castoris on true beaver; abundance depends on host abundance
Metallic Wood-boring Beetle, *Buprestis gibbsii*	Declining?	Specialist on large, fallen oak branches or trunks
Native Ladybird Beetles	Some declining	Competition and predation by exotic ladybird beetles (e.g., Coccinella septempunctata and Harmonia axyridis)
Mountain Beaver Flea, *Dolichopsylla stylosus*	Unknown	Only host is mountain beaver; abundance depends on host abundance; world's largest flea
Native Ants (e.g., species of *Formica*)	Increasing	Disturbance specialists; anthropogenic habitats favor many ant species
Native Bumblebees (e.g., *Bombus occidentalis*)	Declining	Habitat alteration or loss, exotic pathogens and parasites, competition with exotic bumblebees
Native Butterflies (e.g., *Icaricia icarioides fenderi ; Erynnis propertius; Pyrgus communis; Atalopedes campestris; Parnassius clodius*)	Declining	Habitat loss and alteration

TABLE 5-2

Examples of Exotic Terrestrial Macroinvertebrates of the Greater Portland-Vancouver Region

Species or Group	Effects
Exotic Crop Pests	Economic loss; increased pesticide use; introduction of exotic, generalist biocontrol agents
Terrestrial Flatworm, *Bipalium* sp.; Predator slug, *Testacella haliotidea*	Predators of native and exotic slugs, snails, and earthworms
Exotic Slugs and Snails	Crop and ornamental damage, increased pesticide use, competitors of native slugs and snails, vetors of novel pathogens and parasites (affecting vertebrates and humans as well)
Exotic Earthworms	Change soil structure favoring exotic weeds and detrimental to native earthworms; competitors of native earthworms; vectors of novel pathogens and parasites of native earthworms; support high populations of exotic and native predators that also eat native earthworms
Chinese Mantid, *Tenodera aridifolia sinensis*	Generalist predator of native insects, including beneficials and pollinators
Bedbug, *Cimex lectularius*	Major nuisance, increased pesticide use
Brown Marmorated Stink Bug, *Halyomorpha halys*	Major nuisance pest, is becoming a major crop and ornamental plant pest, increased pesticide use
Seed Bugs (e.g., *Metapoplax ditomoides* and *Raglius alboacuminatus*)	Significant nuisance pests, increased pesticide use
European Gazelle Beetle, *Nebria brevicollis*	Competitor of native carabid beetles, possible novel predator of non-adult stages of threatened and endangered butterflies
Bark and Ambrosia Beetles (e.g., *Anisandrus dispar*, *Scolytus multistriatus*, & *Scolytus rugulosus*)	Damage, stress, or kill crop, ornamental, and forest shrubs and trees; increased pesticide use
Cabbage White Butterfly, *Pieris rapae*	Pest of cabbage, lettuce, etc.; increased pesticide use
Cherry Bark Tortrix, *Enarmonia formosana*	Kills orchard and ornamental cherries, plums, etc.; increased pesticide use; costs associated with biocontrol implementation
European Crane Flies (*Tipula oleracea & T. paludosa*)	Crop, ornamental, and turf damage; increased pesticide use
Mosquito, *Ochlerotatus japonicus*	Disease vector, nuisance, increased pesticide use
Housefly, *Musca domestica*	Disease vector, nuisance, increased pesticide use
Spotted Wing Drosophila, *Drosophila suzukii*	Crop pest increased pesticide use
Exotic Ants (e.g., Odorous House Ant, *Tapinoma sessile*, and Pavement Ant, *Tetramorium caespitum*)	Nuisance, crop damage by protecting sap-sucking insects from predators and parasites, competitors of native ants, predators of native soil terrestrial invertebrates, increased pesticide use

Pesticides

Pesticides, which include insecticides and herbicides, harm invertebrates. Insecticides not only kill insects outright, but sublethal doses can affect their foraging and nesting behaviors. Pesticides intended for a specific target often harm a host of other species.

Herbicides can kill plants on which insects depend, thus reducing the amount of foraging or egg-laying resources. The broadcast application of a non-selective herbicide can indiscriminately reduce flowers, caterpillar host plants, or nesting habitat, causing a decline in pollinators and other invertebrates.

Insecticides are widely used in urban areas throughout the United States to control both native and non-native species. These chemicals are designed to kill insects and their allies, and there is little doubt that they have led to significant decline of both terrestrial and aquatic insects. Their use should be avoided wherever possible.

CONSERVATION ISSUES AND THREATS IN AQUATIC HABITATS

Portland's urban drainages are characterized by storm-driven runoff patterns, soil erosion and sedimentation, chemical pollutants from lawn fertilizers and pesticides, channelization, and, in some areas, steep eroding banks and general channel instability. These influences harm invertebrates through toxicity, reduced oxygen in the water, habitat loss, habitat simplification, and habitat alteration. (For more information, see Chapter 7, "Threats and Challenges").

Channelization

The process of channelization destroys pools and riffles, cuts off meanders, reduces stream length, deepens channels, and destroys riparian vegetation. Loss of pools and riffles reduces habitat diversity for aquatic organisms. Loss of riparian vegetation can increase water temperature, destabilize banks (thus causing erosion), and affect aquatic invertebrate food resources.

Dewatering

Dewatering activities influence rivers and streams by altering the channel, flow, water temperature, and water chemistry, all of which in turn affect aquatic organisms. Freshwater mussels, which can live for decades, have been documented in several urban streams. Dewatering can eliminate entire populations of this long-lived invertebrate, even if the dewatering is for a short period of time for restoration purposes.

Siltation

Development reduces water quality for invertebrates in two primary ways: by increasing sedimentation loads during construction and by increasing flow after storms. Sedimentation can affect aquatic insect respiration, rendering the habitat unsuitable for many organisms.

Fertilizers and Pesticides

The application of fertilizers and pesticides and their subsequent runoff in the greater Portland-Vancouver region is highly destructive to invertebrate life. Chemically polluted streams are generally characterized by high densities of midges and worms and a lack of sensitive species such as stoneflies, mayflies, and caddisflies. In many cases the volume of pesticides and fertilizers used per acre on urban lawns and gardens is greater than that used on agricultural crops.

Conservation Strategies: Habitat Needs of Invertebrates

Although the status of most of the region's invertebrates is unknown, residents can still take action to maintain and increase the diversity of invertebrates in both terrestrial and aquatic environments. A variety of native habitats will meet the needs of many species. Planting native plants in yards and parks and along streams, leaving areas "unmanaged," and limiting the use of pesticides all can have a positive impact. Managing for healthy invertebrate populations can be done by anyone—homeowners with only a small yard, business and industry, roadside managers, and people who care for parks and natural areas.

RECOGNIZE HABITAT

Invertebrate habitat can be found anywhere, and even small patches can contribute to supporting regionwide invertebrate populations. For example, warm, sunny habitat areas attract a good variety of invertebrates. Conserving the following features will benefit many invertebrates:

- **Natural or semi-natural grassland.** Grassland can support a diverse native flora.
- **Hedgerows or small patches of shrub.** These can provide both habitat and connectivity to larger habitat areas.

- **Roadsides.** Carefully managed roadsides can provide good herbaceous and shrub habitat for invertebrates.
- **Urban gardens and parks.** These areas provide important habitat in a fragmented landscape. If managed properly, they can serve as biodiversity reservoirs.
- **Stream, ditches, wetlands, and ponds.** All of these can be important in harboring invertebrates. Freshwater mussels inhabit many urban waterways. Although they are hard to see, they are important in helping to keep these waterways clean.

PROTECT EXISTING HABITAT

Protecting existing habitat and managing natural areas with invertebrates in mind are primary conservation activities. The *Regional Conservation Strategy* will help identify some key biodiversity habitats, but there is more information about woody habitats than grassland and prairie, which are critical to a large group of invertebrates. It will be important to identify, conserve and restore grassland and prairie in future conservation work to protect butterflies and other species.

Aquatic systems are vitally important to invertebrates. Maintaining all existing wetlands and ephemeral, intermittent, and permanent streams and streamside areas is vital to the maintenance of a healthy aquatic invertebrate community. Enforcement of newer construction requirements designed to protect waterways from harmful sedimentation, maintain more natural hydrology, and protect riparian habitat can help prevent further harm.

RESTORE HABITAT

Restoration in urban areas should include establishing native flowering herbaceous plants, providing nesting materials for bees, and reducing pesticide use, to encourage bees and other insects to colonize parks, gardens, and other urban areas. Pavement, buildings, and turf eliminate habitat for ground-nesting insects and reduce the area available for plants. If gardens and other potential habitat are too fragmented and widely spaced, they may not be able to support species whose flight range is limited. The Backyard Habitat Certification program (a partnership between Columbia Land Trust and the Audubon Society of Portland) encourages homeowners to help biodiversity; identifying gaps in connectivity for invertebrates and other animals can help focus programs such as these where they will be most effective. The following are some restoration principles to consider for invertebrate conservation:

- Control and remove invasive weeds.
- Use native forbs and grasses to enhance the diversity of grasslands.
- Use flowering native shrubs to create hedgerows, and lengthen the flowering period by using a variety of species.
- In urban parks and gardens, create flower borders, ecolawns, and ornamental plantings that feature native plants.
- Consider a green roof (i.e., an ecoroof) roof on buildings and structures.
- Relocate mussels found during aquatic restoration using a standard relocation protocol (http://www.xerces.org/wp-content/uploads/2009/10/mussel-relocation-position-statement.pdf).

MANAGE HABITAT

The following techniques for managing habitats are of particular relevance to urban areas:

- Reduce pesticide use, consider less toxic alternatives, and implement an integrated pest management (IPM) plan.
- Pesticides that are not allowed on blooming crops to protect beneficial insects may still be allowed on roadsides, gardens, and parks. Targeted education can reduce these uses.
- A chemical sampling protocol can be designed for urban streams to determine what types and amounts of chemicals are entering the system. Once these chemical inputs have been determined, steps can be taken to limit them in the system. This approach can be expensive but can help in developing targeted strategies.

Mowing is a common practice in urban areas, usually to maintain the height of grasses in parks and lawns. Mowing should be avoided in areas that offer insect habitat, such as those where bees are actively foraging or nesting. Alternately, mowing can be conducted in the evening, when insects are less active. Other mowing techniques that help avoid harm to insect populations include mowing only one part of the area per year, leaving unmanaged areas for pollinators, avoiding mowing during major bloom periods, and allowing habitat to grow back between mowings.

Questions, Unresolved Issues, and Data Gaps

More systematic surveys of the greater Portland-Vancouver region are needed to better understand the region's fauna. One very useful exercise would be to pull all of the information that is already available into one place. Metro has implemented butterfly surveys at several of its natural areas. Surveys of the snail fauna of Forest Park have been implemented. The Xerces Society and local watershed groups are conducting mussel surveys across the Portland-Vancouver region. Unfortunately this information is not in any one place and is hard to access. A clearinghouse where all of this type of data can be house and easily accessed would be ideal.

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www.xerces.org/wp-content/uploads/2009/06/pnw_mussel_guide_2nd_edition.pdf

Western Freshwater Mussels
www.xerces.org/western-freshwater-mussels/

Information on aquatic macroinvertebrate and water quality monitoring in streams and wetlands
www.xerces.org/aquatic-invertebrates/
www.deq.state.or.us/lab/techrpts/docs/DEQ03LAB0036SOP.pdf
www.oweb.state.or.us/OWEB/docs/pubs/wq_mon_guide.pdf

Pollinator conservation and other invertebrate information
http://www.xerces.org

Fish

Todd Alsbury and James Byrne, Oregon Department of Wildlife, and Jeff Azerrad, Washington Department of Wildlife

At least 72 species of fish spend some or all of their life history within the greater Portland-Vancouver region (see Appendix E). Of these, 47 are native species and 24 are non-native. One native species, the Oregon chub, is extirpated in the region. Many of the region's fish species spend their entire life within a specific home range that can vary in size from feet to several miles. The region also hosts anadromous species such as salmon, steelhead, sturgeon, Pacific eulachon (smelt) and Pacific lamprey that spend a portion of their life history within the region, as rearing juveniles and spawning adults, but live the bulk of their lives in the ocean.[1] All native fish species in the region are highly dependent on habitat and water quality conditions at every stage of life in order to maintain viability or prevent declines or potential extirpation. Connectivity and access within and among various habitat types within the region is critical in maintaining viable populations. Development and the associated stream barriers and road crossings create challenges for many fish species in the region.

Conservation Issues and Key Threats to Fish

Fish occupy the following major habitat types within the region:

- Estuary (i.e., the Lower Willamette and Columbia River tidally influenced lowlands)
- Rivers and streams (e.g., the Willamette, Columbia, Clackamas, Lewis, and Washougal rivers; Tryon, Johnson, Butte, and Boardman creeks in Oregon; and Mason, Salmon, Gee, and Lacamas creeks in Washington)
- Lake/wetland (e.g., Smith and Bybee, Beaver, Blue, Fairview, Steigerwald, Vancouver and Columbia River Gorge lakes and wetlands)
- Pond (e.g. Salish and Laurelhurst in Oregon; King's Pond in Washington)
- Off-channel/wetland (e.g. Oaks Bottom, the Ridgefield and Tualatin National Wildlife Refuges, and Sauvie Island Wildlife Area)

Fish occupying every habitat type in the region face challenges related to management of land and water. More than 160 years of development, particularly in the Portland-Vancouver metropolitan area, has altered once-important habitat areas in the Lower Willamette River, Columbia River estuary, and tributaries that supported fish species native to the region.

The Columbia River estuary (including the Lower Willamette below Willamette Falls) provides essential habitat for all native fish species, including juvenile salmon, steelhead, and other anadromous fish as they grow to a size and condition that increases their survival during their ocean migration. Historically, the estuary contained substantial amounts of shallow-water habitat that provided excellent conditions for growth and survival of native fish species. Human land and water management activities have modified these estuarine habitat conditions, resulting in a loss of habitat complexity and access to off-channel habitats. Combined with the effects of the hydropower/flood control system, the primary activities that have determined current estuary habitat conditions include riparian habitat loss, channel confinement (primarily via diking and seawall construction), channel manipulation (e.g., dredging and bank stabilization), floodplain development, and water withdrawal for urbanization and agriculture. With the exception of high summer water temperatures, water quality has generally improved in the lower Willamette River over past decades as a result of pollutant reductions. Yet high pollutant and thermal loads that still occur in some areas, during certain time periods, may be lethal to fish that spend even a limited amount of time in the area.

Tributary stream habitat conditions are also moderately to severely degraded within much of the region. Widespread development and land use activity affect habitat quality and complexity, water quality, and watershed processes in lower Willamette and Columbia tributaries. Stream habitat degradation is primarily due to past and current land-use practices that have affected properly functioning stream channels, riparian areas, and floodplains, as well as watershed processes. The following land management activities create threats and lead to conditions that limit survival of native fish species within the region:

- **Timber harvest and development within riparian areas.** This has reduced stream shade and the input of large woody debris, increased water temperature, and destabilized streambanks, which has led to increased input of fine sediment. Active removal of large wood contributed significantly to reductions in the amount of complex instream habitat. Removal of wood in an attempt to reduce risk and damage from floods continues to this day but is not as extensive as past efforts to completely remove all wood from the region's stream systems.

- **Agricultural development throughout the lowlands in the region.** Agricultural development has directly affected riparian areas and floodplains. Historical floodplain habitats were lost through the filling of wetlands, channelization, and construction of levees and seawalls. Runoff and erosion from agricultural lands where pesticides, herbicides, and fertilizers are applied reduce water quality, to the detriment of native fish and other aquatic species.

- **Construction of dams, culverts, and other barriers.** These structures limit access to spawning, rearing, and foraging habitats for native fish. Dams alter overall flow, reduce high and low flows, and change temperature patterns and hydrologic and geomorphic processes in ways

[1] "Anadromous" refers to fish that spend most of their adult lives at sea but return to fresh water to spawn.

that can result in erosion and reduced natural scour and coarse sediment movement in rivers where dams are located. A number of fish species—in particular several populations of anadromous salmonids—have altered their normal life history patterns to reflect changes in flow and/or temperature patterns that result from the operation of dams in the Columbia and Willamette rivers.

- **Urban and rural development throughout the region**. Development has led to the degradation of riparian and floodplain conditions and an increase in stormwater runoff from roads, ditches, and impervious surfaces. The result is dramatically altered hydrology and a decrease in water quality (because of pollutants associated with development) that can severely limit the productivity and survival of native fish species.

Many species of fish in the region—particularly the anadromous salmonids—also are affected by management activities associated with the production of hatchery fish to support sport and commercial fisheries. According to NOAA Fisheries, recent studies and scientific works have identified the following potential adverse effects of artificial propagation:

- Behavioral differences that result in diminished fitness and survival of hatchery fish compared to naturally spawned fish.

- Genetic effects that result from poor broodstock and rearing practices; these effects include inbreeding, outbreeding, and domestication selection.

- Incidence of disease.

- Increased rates of competition with and predation on naturally spawned populations.

In recent years, some hatchery programs have been designed to conserve or recover natural populations of salmon.

Habitat Needs, Threats, and Opportunities

The resident and anadromous salmonid species found within the region (i.e., Chinook, coho, and chum salmon, steelhead/rainbow trout, bull trout, and resident and coastal cutthroat trout) occupy multiple habitat types during their varied life histories. Unfortunately, because of population declines, local populations of salmon, steelhead and bull trout are listed as threatened under the federal Endangered Species Act and coastal cutthroat trout are identified as a state species of concern. Salmonids within the region require connectivity within and among various habitat types, water quality that meets current standards, and riparian areas that provide shade and the potential for woody debris to maintain habitat and viable populations.

Salmonids are found in most of the region's water bodies, with the exception of blocked and impaired stream reaches and small, isolated wetlands that do not connect to flowing water. Various trout species are found in a number of isolated, often constructed, ponds in the region; these ponds either currently are or historically have been stocked by fish and wildlife agencies or private landowners for recreational purposes but are not supported by natural production of native trout species. Anadromous salmonid species that return to the region after growing and maturing in the ocean spawn in major tributaries of the lower Willamette and Columbia rivers, such as the Clackamas, Sandy, and Lewis rivers; in numerous minor tributaries on the Oregon side of the Columbia River, including Abernethy, Tryon, Kellogg/Mt. Scott creeks and Johnson Creek/Crystal Springs; and in many tributaries in every subbasin on the Washington side.

A host of state and federal funding, research, educational, and regulatory programs are in place to support the region's native fish populations, including salmonids.

COHO SALMON

Coho salmon (*Oncorhynchus kisutch*) in the Columbia Basin have been in decline for the last 50 years. The number of wild coho returning to the Columbia River historically was at least 600,000 fish; at a recent low point in 1996, the total return of wild fish may have been as few as 400. Coinciding with this decline in total abundance has been a reduction in the number of self-sustaining wild populations. All Columbia Basin coho populations upstream of Hood River have been extirpated. Of the 24 historical populations that made up the Lower Columbia River coho evolutionary significant unit (ESU), only in the Clackamas and Sandy subbasins is there direct evidence of persistence during the adverse environmental conditions of the 1990s. Since 2000, the numbers of wild coho have increased in both the Clackamas and Sandy subbasins. During this same period, naturally reproducing coho populations have become re-established in the Scappoose and Clatskanie subbasins. In Washington, the East Fork Lewis and Lower Gorge coho populations are targeted as primary populations to be restored in order to increase the long-term viability of coho.

CHINOOK SALMON

In general, the numbers of Chinook salmon (*Oncorhynchus tshawytscha*) in the lower Columbia Basin are thought to be substantially lower than they were historically. Coinciding with this decline in total abundance has been a reduction in the number of functioning wild populations, particularly in the case of fall Chinook in Oregon. (At the ESU level, spring Chinook populations also have declined.) In addition, the significant presence of stray hatchery fish is thought to be common throughout most of the range of Lower Columbia River fall Chinook. Up to 90 percent of the naturally spawning fall Chinook in Oregon's portion of the Lower Columbia River Chinook ESU are believed to be stray hatchery fish. Of the 12 historical naturally reproducing Chinook populations in Oregon's portion of the Lower Columbia River ESU, only four can be confirmed as present: the early fall Chinook population in the Clatskanie, the late fall population in the Sandy, and the spring Chinook populations in the Sandy and Clackamas. Washington has substantial runs of fall Chinook in the Lewis, Kalama, Washougal and Wind River systems, but many of these are hatchery-origin fish, which pose a risk to naturally produced fish through interbreeding. In Washington, the Kalama, North Fork Lewis, East Fork Lewis, and Washougal populations are targeted for intensive recovery actions to increase the likelihood of long-term persistence, whereas the Lower Gorge population can potentially contribute to Chinook recovery.

STEELHEAD

Although wild steelhead (*Oncorhynchus mykiss*) in Oregon's portion of the Lower Columbia River steelhead distinct population segment (DPS) are depressed relative to historical levels, no known population extirpations have occurred. However, current extinction risk estimates for these populations are large enough that they all are classified as being at at least moderate risk of extinction; this is considered a non-viable status. Key Washington populations targeted for restoration efforts to ensure steelhead survival include the Kalama, East Fork Lewis, Washougal (for summer steelhead), and Lower Gorge (for winter steelhead).

CHUM SALMON

Chum salmon (*Oncorhynchus keta*) have been sporadically observed in several Oregon tributaries, most notably Big Creek; however, there are no data that lend themselves to a quantitative status assessment as performed for Lower Columbia River coho, Chinook, and steelhead species. Chum salmon have not been routinely observed in recent years during spawning surveys conducted for coho and Chinook in lower Columbia tributaries. This lack of chum spawners indicates that the fish are no longer present. As a result, Oregon's Columbia River chum salmon populations are considered either extremely depressed or functionally extirpated. In Washington, the East Fork Lewis, Washougal, and Lower Gorge populations are key populations targeted for recovery efforts. Chum are routinely found spawning in Washington's Grays River, in the area

upstream of the I-205 Bridge (at Woods Landing and Riverside), and in an area below Bonneville Dam (at Ives Island and Duncan, Hamilton, Horsetail, Multnomah, and Hardy creeks). The hatchery program for these populations uses local brood stock to augment the wild populations with the same genetic stock.

OTHER FISH SPECIES

The greater Portland-Vancouver region also includes important habitats for other culturally important, sensitive, and declining species such as federally listed bull trout (*Salvelinus confluentus*), Pacific lamprey (*Lampetra tridentata*), coastal cutthroat trout (*Oncorhynchus clarki clarki*), Pacific eulachon (*Thaleichthys pacificus*), North American green sturgeon (*Acipenser medirostris*), and white sturgeon (*Acipenser transmontanus*). These species have been affected by many of the same factors that have resulted in declines in salmon and steelhead, such as habitat loss and degradation, alterations in flows and sediments, declines in water quality, and loss of access to important areas. Many of the conservation and restoration actions that are being implemented for salmon and steelhead are helping to improve conditions for these and numerous other native species, although there are times when opportunities to benefit other species can be missed if they are not considered explicitly. Fortunately, efforts are under way to try to fill the gaps in our knowledge and practices for some of the less understood at-risk species in the region.

Bull Trout

Bull trout are native throughout western North America (Oregon, Washington, Idaho, Nevada, Montana, and British Columbia) and were historically found throughout the Columbia and Willamette rivers and in their tributaries. Given bull trout's long incubation time and need for very cold water, the species is more sensitive to increased water temperatures, poor water quality, and degraded stream habitat than many other salmonids. Bull trout are now rarely found in the greater Portland-Vancouver region. The U.S. Fish and Wildlife Service listed bull trout as threatened in 1998 and designated critical habitat for the species in 2005; these criteria were revised in 2010. Critical habitat in the region includes the mainstem Columbia River and portions of the Lewis River. The U.S. Fish and Wildlife Service is in the process of updating its draft bull trout recovery plan (scheduled for publication in 2012), although recovery actions are already under way. For example, in 2011, in cooperation with the Oregon Department of Fish and Wildlife and other partners, an experimental population of bull trout was reintroduced into the upper Clackamas River basin.

Eulachon (Smelt)

In 2010 NOAA Fisheries listed the Pacific eulachon (commonly called smelt, candlefish, or hooligan) as threatened in the greater Portland-Vancouver region, as part of the southern DPS. Eulachon typically spend 3 to 5 years in salt water before returning to fresh water to spawn in their natal streams. Within the Columbia Basin, the major and most consistent eulachon spawning runs occur in the mainstem of the Columbia River as far upstream as Bonneville Dam, and in the Cowlitz River. Critical habitat designated in 2011 includes the lower Columbia River up to Bonneville Dam and the lower portions of the Sandy and Lewis rivers, which provide important spawning grounds, with sandy and course gravel substrates. Most eulachon adults die after spawning. Larvae are carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Recovery planning for the species is expected to occur now that the listing process has been completed. Threats to the species include habitat loss and degradation, hydroelectric dams (which block access to historical eulachon spawning grounds and affect the quality of spawning substrates via flow management), altered delivery of coarse sediments, and siltation. Other concerns include dredging activities (which can entrain and kill fish or otherwise result in decreased spawning success), chemical pollutants, and the potential impacts of climate change, such as ocean warming trends that may alter prey, spawning, and rearing success.

Pacific Lamprey

Although the Pacific lamprey has not been listed under the Endangered Species Act, recent data indicate that the abundance and distribution of this species have been reduced in many river drainages. Historically, Pacific lampreys were thought to be distributed wherever salmon and steelhead occurred. The U.S. Fish and Wildlife Service considers Pacific lamprey to be a species of concern and has been leading a Pacific lamprey conservation initiative to improve the status of the species in collaboration with Native American tribes and other federal, state, and local agencies. In 2010 the agency released the document, Best Management Practices to Minimize Adverse Effects to Pacific Lamprey. In 2011, the U.S. Fish and Wildlife Service finalized its Pacific Lamprey Assessment and Template for Conservation Measures, which contains an overall description of the status of the species, threats affecting them, and the relative risk of population groupings within specific geographical regions throughout the range of the species in the United States. The document also describes conservation actions and research, monitoring, and evaluation efforts that are occurring and needed within each region. Lower Columbia and Willamette river Pacific lamprey populations were found to be at lower risk than populations in other parts of the Columbia Basin. Needed actions identified within this area include passage improvements, lamprey-specific surveys and identification workshops, water quality improvements, stream and floodplain restoration, and outreach and education. The next phase of the initiative will involve development of regional implementation plans. Efforts are being made to address the specific needs of lamprey in fish passage and habitat restoration projects, and to protect lamprey during and after construction projects when ammocoetes (i.e., lamprey larvae) are living in stream substrates.

Coastal Cutthroat Trout

The U.S. Fish and Wildlife Service is leading development of a similar conservation plan for coastal cutthroat trout under the multi-agency Coastal Cutthroat Trout Conservation Initiative. Although the coastal cutthroat trout has been proposed for listing under the federal Endangered Species Act in the past, as recently in 2010 the U.S. Fish and Wildlife Service has found that listing of this subspecies was not warranted. However, coastal cutthroat trout are considered to be a sensitive species because of many ongoing threats. Under the species initiative, partnering agencies and organizations will develop a range-wide coastal cutthroat trout conservation plan that will assess coastal cutthroat trout populations, identify threats and conservation needs, and be used to help coordinate conservation efforts. This initiative, with the development of the conservation plan and other tools, will result in the implementation and evaluation of important conservation measures for coastal cutthroat trout.

White Sturgeon

White sturgeon are not currently listed under the Endangered Species Act, but the species has received special conservation attention. The Lower Columbia River downstream from Bonneville Dam is the most productive in the species' range. The Oregon Department of Fish and

Wildlife released its Lower Columbia River and Oregon Coast White Sturgeon Conservation Plan in 2011 to address requirements under Oregon's Native Fish Conservation Policy. The plan covers the white sturgeon population segment within the mainstem lower Columbia River downstream of Bonneville Dam and gives consideration to fish inhabiting the lower Willamette River and Oregon's coastal rivers, bays and estuaries. The aim of the plan is "to ensure a healthy, viable and productive white sturgeon population in the lower Columbia River downstream of Bonneville Dam for use and enjoyment of present and future generations." In 2011, the Oregon and Washington departments of fish and wildlife issued the 2011 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead and White Sturgeon, which describes catch limits for white sturgeon in specific watershed areas; these catch limits vary in number and size depending on various watershed zones. Numbers are being watched carefully to ensure appropriate management of this species over time.

Green Sturgeon

The southern Distinct Population Segment for North American green sturgeon, which includes fish in the Columbia River from the estuary up to Bonneville Dam, was listed as threatened by NOAA Fisheries in 2006; the agency is working to conserve green sturgeon. The species is primarily associated with oceanic waters, bays, and estuaries. Critical habitat designated in 2009 includes the Columbia River estuary from the mouth up to River Mile 74 but not the area from River Mile 74 to Bonneville Dam (which is at River Mile 146). In addition to Endangered Species Act protections, Oregon and Washington fisheries regulations that protect this species are currently in effect in the Columbia River.

Climate Change

It is likely that all of the region's fish species, both native and non-native, will be affected by the potential increase in water temperature and hydrologic changes associated with global climate change. Many non-native fish species may actually expand their range as increasing water temperature allows them to successfully forage and reproduce in rivers and streams flowing throughout the region. Most isolated lakes and ponds and the entire Columbia River estuary, which includes the Lower Willamette River, provide habitat conditions suitable for non-native, warm-water fish species to thrive. Introduced, non-native fish species often compete with native fish for food and space; many non-native fish feed on other fish species and have the potential to feed on native fish species if they co-occur in the lower Willamette and Columbia rivers and lower reaches of larger tributary streams. Conversely, it is likely that the range of cold-water fish, including salmonids and lamprey, will be reduced because of climate change-related increases in stream temperature, alterations in hydrology, and competition with non-native species.

Priority Conservation and Restoration Strategies

Coordinated recovery efforts for Oregon and Washington currently are being implemented. In Oregon, the Oregon Department of Fish and Wildlife completed the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead in 2010 and adopted the Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead in 2011. In Washington, the Lower Columbia River Fish Board completed the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan in 2004 and updated it in 2010. These documents outline threats and limiting factors for the survival and recovery of ESA-listed fish populations that spend part of their life cycle within the greater Portland-Vancouver region. The Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan identifies watersheds of importance to threatened and endangered salmonids in the lower Columbia River (Table 5-3). In both states' recovery plans, limiting factors and threats are divided into specific groups related to habitat, hydropower/irrigation/flood control, hatcheries, and harvest. Actions are identified

TABLE 5-3

Roles of the Region's Salmon and Steelhead Populations in the Recovery of Lower Columbia River Evolutionarily Significant Units: Summary of Designations for Each Population, According to the Preferred Recovery Scenario

P = primary = targeted for restoration to high persistence probability
C = contributing = low to medium improvements needed to reach moderate persistence probability
S = stabilizing = to be maintained at current levels (generally low persistence probability)

Watershed	Fall Chinook (Tule)	Fall Chinook (Bright)	Spring Chinook	Chum	Winter steelhead	Summer steelhead	Coho
Scappoose	**P**	--	--	**P**	**n/a**[1]	--	P
Kalama	**C**	--	**C**	**C**	**P**	**P**	**C**
NF Lewis	**X**	**P***	**P**	**X**	**C**	**S**	**C**
EF Lewis	**P**	--	--	**P**	**P**	**P**	**P**
Salmon	**S**	--	--	**S**	**S**	--	**S**
Washougal	**P**	--	--	**P**	**C**	**P**	**C**
Sandy	**C**	**P***	**P**	**P**	**P***	--	**P**
Clackamas	**C**	--	--	**C**	**P**	--	**P***
Lower Gorge	**C**	--	--	**P***	**P**	--	**P**

[1] Not listed under U.S. Endangered Species Act.
Source: Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan, 2010.
X refers to subset of larger population.
Primary populations designated for a very high level of viability are denoted with *.
Dashes indicate that the species is not present.

TABLE 5-4
Strategies to Recover Lower Columbia River Salmon and Steelhead Populations and Their Relevance to General Threats Affecting Those Populations

STRATEGY	GENERAL THREAT CATEGORY ADDRESSED				
	Fish Harvest	Hatchery Mgmt.	Hydro/Flood Control	Land Use	Invasive Species
Protect and conserve natural ecological processes that support the viability of wild salmon and steelhead populations and their life history strategies throughout their life cycle.	■	■	■	■	■
Restore floodplain connectivity and function and maintain unimpaired floodplain connectivity and function.			■	■	
Restore riparian condition and LWD recruitment, and maintain unimpaired conditions.			■	■	
Restore passage and connectivity to habitats blocked or impaired by artificial barriers, and maintain unimpaired passage and connectivity.		■	■	■	
Restore and maintain hydrologic regimes that support the ecological needs of wild salmon and steelhead populations.			■	■	
Restore channel structure and complexity, and maintain unimpaired structure and complexity.			■	■	
Restore impaired food web dynamics and function, and maintain unimpaired dynamics and function (both impacts of competition for food resources and altered ecosystem function).	■	■	■	■	■
Restore degraded water quality and maintain unimpaired water quality.			■	■	
Restore degraded upland processes to minimize unnatural rates of erosion and runoff, and maintain natural upland processes.				■	
Reduce the impact of non-native plants and animals on wild salmon and steelhead populations and prevent the introduction of new non-native plants and animals					■
Reduce predation on wild salmon and steelhead that has been exacerbated by anthropogenic changes to the ecosystem.		■	■	■	■
Manage fisheries so that harvest impacts do not compromise the recovery of wild salmon and steelhead populations.	■				
Manage hatchery origin fish in ways that support the recovery of wild salmon and steelhead populations		■			
Reduce or eliminate other source anthropogenic sources of mortality (e.g. beach stranding of juveniles due to ship wakes in the estuary) and prevent them from becoming a problem in areas where they currently do not occur.	■	■	■	■	■

Source: : Lower Columbia Salmon Recover and Fish & Wildlife Subbasin Plan 2010 and ODFW 2010.

for each threat category and are prioritized based on what is determined to be the most effective measure for achieving viability and subsequent delisting of salmon and steelhead populations in the lower Columbia and Willamette rivers (Table 5-4). In general, several strategies can be implemented throughout the greater Portland-Vancouver region to improve conditions for all salmonids:

- Protect intact headwaters and existing native vegetation.
- Protect and increase riparian corridor width and shade to reduce temperatures, increase the availability of wood, and provide cover and invertebrate prey.
- Increase the amount of off-channel habitat for migrating salmonids and provide additional refugia and rearing areas for juvenile salmonids.
- Improve connectivity with floodplains.
- Restore fish passage at culverts, dams, and other barriers.
- Manage forests and urban and rural growth and development to protect and restore watershed processes.
- Reduce the amount of impervious surfaces and retrofit sites to improve stormwater management and add green infrastructure in urban areas.
- Increase channel complexity and the amount of large wood in streams.
- Monitor action effectiveness to ensure that measures produce the intended effect.

Questions, Unresolved Issues, and Data Gaps

Research, monitoring, and evaluation are needed to assess the status and trends of fish species and their habitats, track progress toward achieving recovery goals (for ESA-listed species), and provide the information needed to refine strategies and actions to recover depressed populations through the process of adaptive management. The status of most non-salmonid native fish species is largely unknown because of an inability to effectively monitor smaller populations of fish that occupy varied habitats. Populations that do not receive sufficient monitoring to track abundance and productive capability may be at increased risk of extirpation because of reduced diversity within the population and an inability to survive unsuitable habitat conditions over time.

FOR MORE INFORMATION

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U.S. Fish and Wildlife Service bull trout website
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U.S. Fish and Wildlife Service Coastal Cutthroat Trout Conservation Initiative
http://www.fws.gov/columbiariver/cctinitiative.html

U.S. Fish and Wildlife Service Pacific lamprey website http://www.fws.gov/pacific/Fisheries/sphabcon/Lamprey/index.cfm
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Amphibians

Char Corkran, herpetologist and consultant, and Laura Guderyahn, City of Gresham

Of the 36 amphibian species known to occur in Oregon and Washington (34 of which are native), 18 native amphibians and one non-native live in the greater Portland-Vancouver region (see Appendixes E and G). We are now beginning to understand the important roles of frogs, toads, newts, and salamanders in energy and nutrient cycling. Their potential as indicators of environmental health is a function of both their life history and the permeability of their skin to toxins. Most amphibian species have an aquatic larval stage before they metamorphose into a terrestrial adult form, so they are closely tied to both water and land habitats. Streams surrounded by conifer forests, ponds next to upland woods or prairies, and side channels of rivers lined with riparian hardwoods are examples of adjacent habitat pairs that are important to amphibians in the region.

Conservation Issues and Key Threats to Amphibians

Amphibians are facing unprecedented threats at local, regional, and global levels. Worldwide, 200 amphibian species may now be extinct, and one-third of the remaining amphibian species are threatened. Of the 19 species found in the greater Portland-Vancouver region, 12 are considered federal species of concern and/or are state listed as sensitive species in Oregon or Washington (see Appendix E); it is likely that the Oregon spotted frog has already been extirpated from the greater Portland-Vancouver region.

Research is linking global amphibian losses to habitat destruction and fragmentation, diseases, non-native species, global climate change, pesticides and other pollutants, and poaching for the pet trade. Amphibians in the greater Portland-Vancouver region are affected by most of these factors, but the most significant conservation issue is loss and degradation of habitat. Among amphibian habitats in the region, wetlands have suffered the most drastic losses in acreage and quality.

The filling or draining of wetlands for residential or industrial development and agriculture has been a major issue for most amphibian species, but especially for western toads and Oregon spotted frogs. The introduction of non-native plants and animals into wetlands and open water also is implicated in the decline of amphibians. For example, introduced bass, other warm-water fish, and American bullfrogs all prey on native amphibian species. In addition, American bullfrogs are carriers of a fungal disease that has caused amphibian declines and extinctions throughout the world. In urban areas, stormwater runoff has the seasonal pattern of water levels in many of the remaining natural; this has been a primary driver of native plant communities and associated biota being replaced by invasive species.

In stream systems, increased water temperatures can be lethal to Cascade torrent salamanders, while siltation can prevent all stream-breeding amphibians from using sites for cover and egg laying. In some streams, introduced crayfish may threaten rare native amphibian species. In forested habitats, short harvest rotations prevent the recruitment of large logs that otherwise would provide habitat for terrestrial salamanders and winter refugia for some frogs.

Predicted climate changes include warming temperatures, erratic weather patterns, and earlier summer drying of ponds and streams. These impacts are likely to disrupt breeding cycles for many amphibians. Stream-breeding amphibians and the Cascades frog, which is limited to high-elevation wetlands, may be the most sensitive, although the temperature requirements of northern red-legged frog eggs make this species vulnerable, too. The limited mobility of amphibians also is a challenge because it makes it difficult for them to shift their range in the face of climate change.

Conservation Strategy Species: Habitat Needs, Threats, and Opportunities

The Oregon Conservation Strategy identified 17 amphibian species in Oregon that need attention, and Washington's Comprehensive Wildlife Conservation Strategy identified five amphibian species needing attention in that state. Of these, 14 salamander species and five frog species now live in at least the edges of the greater Portland-Vancouver region; one other frog species, the Oregon spotted frog, apparently has been extirpated from the area.

The 12 extant amphibian conservation strategy species in the region share habitat needs, face similar threats, and may have the same opportunities for conservation and restoration (see Appendix E). Most of the 12 species, including pond-breeding northern red-legged frogs and terrestrially breeding clouded salamanders, need mature upland forest with abundant logs and debris for at least some of their life. Four of the species, including the coastal tailed frog and the Cascade torrent salamander, require cold, silt-free streams in forests, and four other species occur at least seasonally along such streams. The Larch Mountain salamander and three other species need talus or forests with rocky soil. The specialized habitat needs of these species and the isolation of appropriate habitat patches make localized extirpations likely.

Several amphibian species occur in the region only in its northeast corner; these include the stream species, the Cascades frog, and the Larch Mountain salamander. Other important sections of the region for amphibians designated in the Oregon and Washington conservation strategies are Forest Park and the forested buttes that are adjacent to wetlands, such as Powell, Jenne, and Grant buttes. Finally, forested stream corridors with adjacent floodplains, pocket wetlands, and stormwater ponds, such as Johnson Creek, the Tualatin River, Multnomah Channel, La Center Bottoms, Ridgefield National Wildlife Refuge Complex, Green Lake Wetlands, and Burnt Bridge Creek, are important hiding and overwintering places for amphibians in urban areas.

Priority Conservation and Restoration Strategies

- Incorporate knowledge of amphibians' needs into planning efforts in the region. The presence, habitats, movements, and seasonal activity patterns of amphibians can be addressed in planning

for trails, transportation and development projects, invasive species control, and habitat restoration on publicly owned lands and encouraged on private properties. As an example, management for amphibians in the Oregon portions of the region currently includes wetland restoration and creation efforts, with a focus on northern red-legged frogs, western painted turtles, and western pond turtles.

- Continue current management efforts to provide large woody debris and develop new stands of forest for future recruitment of large logs.

- Expand current protection of fish-bearing waters from siltation and pollutants to include headwater streams and ephemeral ponds.

Current Activities and Programs

Conservation assessments and strategies have been developed by federal and state agencies for several rare or declining amphibian species to summarize their status, biology, threats, and management (see "For More Information"). Paired with efforts on behalf of declining amphibian species in the Oregon Conservation Strategy is the goal of keeping currently common species from becoming rare.

In 1999 the Oregon Spotted Frog Recovery Team was formed as a partnership by Pacific Northwest zoos, aquariums, governmental jurisdictions, and conservation organizations throughout Oregon, Washington, and British Columbia. In 2007, the Oregon Zoo began a captive rearing program to reintroduce Oregon spotted frogs to a site in Washington. To date, there are no efforts to reintroduce the species in the greater Portland-Vancouver region.

Several citizen science programs engage volunteers in monitoring pond-breeding amphibians in the region. The cities of Portland, Gresham, and Hillsboro, Metro, the Vancouver Water Resources Education Center, and Clark, Cowlitz, and Wahkiakum counties recruit and train hundreds of volunteers each year to identify and record the numbers of egg masses and larvae of northern red-legged frog and more common species. The goal of these programs is to create a regional database that will allow assessment of regional population trends.

Questions, Unresolved Issues, and Data Gaps

The design of amphibian protection measures can be improved by filling knowledge gaps such as their range extents, habitat needs, dispersal capabilities, and movement dynamics. For example, understanding the dispersal abilities of Cope's giant salamanders and which populations are more apt to metamorphose would allow stream barriers to be prioritized for removal. Determining the extent and role of fungal and viral diseases could help protect vulnerable amphibian populations from extirpation. Basic reproductive history and habitat needs for some of the terrestrial salamanders still are not fully known. Assessing the distribution of amphibians such as the Oregon slender salamander in urban areas could guide the provision of healthy and connected habitats. More could also be done to assess water quality thresholds that may be important for sustaining viable populations of amphibians that use stormwater facilities.

FOR MORE INFORMATION

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K.A. Cushman and C.A. Pearl. March 2007. USDA Forest Service Region 6, USDI Bureau of Land Management, Oregon and Washington. Available at http://fresc.usgs.gov/products/papers/1578_Pearl.pdf

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Kelly R. McAllister and William P. Leonard. July 1997. 47 pp. A publication of the Washington Department of Fish and Wildlife. Available at http://wdfw.wa.gov/publications/pub.php?id=00382

Clark County Community Based Amphibian Monitoring. Summary of 2008 and 2009 Field Data
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Oregon Spotted Frog Pilot Reintroduction Project: 2007-2012
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Conservation Assessment for the California Slender Salamander in Oregon (Batrachoseps attenuatus)
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Citizen Science programs: See Chapter 10, "Species-specific Initiatives," of the *Regional Conservation Strategy for the Greater Portland-Vancouver Region.*
Special Status Amphibians and Reptiles (see Appendix H)

Metro's bird, mammal, and amphibian/reptile wildlife checklists for the Portland area http://www.oregonmetro.gov/index.cfm/go/by.web/id=15421

Washington Herp Atlas: http://www.dnr.wa.gov/nhp/refdesk/herp

Reptiles

Char Corkran, herpetologist and consultant, and Laura Guderyahn, City of Gresham

Of the 31 species of reptiles in Oregon and Washington (28 of which are native), 16 species occur in the greater Portland-Vancouver region (see Appendix E): two native and two non-native turtle species, four lizards, and eight snakes. Although most of these reptiles are characteristic of the drier habitats of the region—i.e., oak habitats, grasslands, and shrublands, which regionally are limited in extent—a few species occur in upland conifer forests. However, the turtles (including the introduced species) and two of the garter snakes are closely tied to open water and to adjacent upland habitats such as oak savanna, grassland, and riparian forest—a combination that occurs in several portions of the region.

Conservation Issues and Key Threats to Reptiles

On a global scale, the status of the vast majority of reptile species is unknown. Within the greater Portland-Vancouver region, 11 of the 14 native reptile species are considered secure in both Oregon and Washington. However, the western pond turtle is listed by the state of Washington as endangered and is considered Sensitive–Critical by the state of Oregon. The western painted turtle has the same Sensitive–Critical status in Oregon but is not considered rare in Washington because of large populations east of the Cascades. The sharptail snake is a federal species of concern and is considered Sensitive-Critical in Washington; it may not be present on the Oregon side. The racer and the gopher snake, which still are common elsewhere in the two states, may have been extirpated from the Puget Lowlands.

Worldwide threats to reptiles include habitat loss and fragmentation, excessive collection for food and the pet trade, non-native species, predation, vehicles, climate change, diseases, pollution, and mining. Habitat loss or degradation, including loss of connectivity, is the most serious issue in the greater Portland-Vancouver region, with wetland and pond habitats being the

most severely affected. The decreasing acreage of oak habitats, grasslands, and shrublands raises concern for local populations of northern alligator lizard, southern alligator lizard, racer, and ring-necked snake.

Furthermore, all of the region's reptile species are affected by collection for pets, road mortality, predation by non-native species, and disturbance that interferes with basking and nesting. Garter snakes and alligator lizards are particularly susceptible to predation by house cats, as they often live in wood piles or house foundations. Vehicles cause mortality, particularly when reptiles move between basking, breeding, and overwintering sites. Gopher snakes are mistaken for rattlesnakes and killed. Disturbance by hikers, unleashed dogs, bikers, and rock climbers can limit critically important basking time for many reptiles. The secretive behavior of the ring-necked snake and rubber boa makes it difficult to understand factors that could threaten their populations. Climate change models forecast earlier runoff of rivers, drying of ponds, and warming temperatures. Although many snake and lizard species may not be affected by these changes, the more aquatic species would be. The native turtles would lose productive summer habitat, including shallows with aquatic vegetation that are critical for hatchlings and small juveniles. If ponds dry early and strand frog tadpoles, both habitat and a major food resource for common garter snakes and western terrestrial garter snakes would be lost. Warmer temperatures may skew sex ratios in turtle populations because gender is determined by nest temperature during early stages of egg development.

Conservation Strategy Species: Habitat Needs, Threats, and Opportunities

The *Oregon Conservation Strategy* and Washington's *Comprehensive Wildlife Conservation Strategy* designate four reptiles as species of concern: western pond turtle (in both states), western painted turtle (in Oregon), and the racer and the gopher snake (in Washington, Puget Trough only) (see Appendix E). Both turtle species live in ponds, lakes, and slow-moving stream channels. Within aquatic habitats, these species need logs and other sites for basking, which is critical to thermoregulation for effective foraging and the production of eggs. However, these turtles also require nearby, sparsely vegetated upland areas for nesting, such as grasslands, oak savanna, or openings in riparian forests. In addition, the western pond turtle winters in oak or riparian woodlands. Both of the snake species occur in grassland habitats and require communal winter den sites.

Both turtle species have suffered from the filling and draining of wetlands for agriculture and development. Remaining aquatic habitats are degraded by pesticides and pollutants. Invasive reed canarygrass has choked many open-water sites, while exotic blackberry species shade nesting sites and hamper movement on land. Non-native turtles compete with native species and infect them with diseases and parasites. Non-native fish and American bullfrogs prey on turtle hatchlings and small juveniles, and unleashed dogs kill and disturb adults. Raccoons and coyotes, albeit native species, are at relatively high densities in urban areas; these animals prey on turtles and dig up nests to eat their eggs. At many western pond turtles sites there is little or no successful nesting or recruitment of juveniles into the population, so the population consists mostly of adults. When female turtles are nesting or moving to and from nesting habitats, they are particularly vulnerable to predation, disturbance, vehicle mortality, and illegal capture for pets.

Both the racer and the gopher snake have lost grassland habitats in the Portland-Vancouver region and are vulnerable to road mortality and agricultural and landscaping practices. In addition, gopher snakes and occasionally juvenile racers are killed because of their resemblance to poisonous rattlesnakes.

Priority Conservation and Restoration Strategies

- Continue to restore aquatic and upland habitats (includes enhancing water quality), especially at important areas for native turtle, i.e., Sauvie Island, the Columbia Slough, and other natural areas along all rivers in the region. High-quality, appropriate connecting corridors and wildlife crossings are important for reptiles and amphibians because these animals generally do not move very fast or very far.

- Provide key habitat features for reptiles, such as large logs for turtle basking (both now and in the future), various sizes of woody debris (i.e., logs and smaller debris), and rocky outcrops.

- Control invasive species.

- Educate the public about area closures to protect turtle nesting, controlling dogs, the need to restrict raccoon and coyote access to pet food and garbage, and the importance of leaving native turtles in the wild and pets in captivity; this latter point may need to be backed up with regulations and enforcement.

Current Activities and Programs

Conservation assessments and strategies for reptiles in the region have focused on native turtle species (see "For More Information"). Conservation assessments for the western painted turtle and western pond turtle in Oregon were completed in 2009, and the Washington Department of Fish and Wildlife wrote a state recovery plan for the western pond turtle in 1999. Seattle's Woodland Park Zoo, the Washington Department of Fish and Wildlife, the U.S. Forest Service, and the Oregon Zoo developed a program for wild-caught hatchling pond turtles to be raised in captivity and released when large enough to avoid most predation. Since 1990, more than 1,500 pond turtles have been reared in zoos and released into the wild.

The Lower Willamette Valley Turtle Working Group and the Western Pond Turtle Recovery Project are partnerships among local, county, and state jurisdictions and nonprofit groups. They have shared goals of implementing conservation assessments and recovery plans and sponsoring research into limiting factors.

Besides efforts for reptiles designated as conservation strategy species in the Oregon Conservation Strategy and Washington's Comprehensive Wildlife Conservation Strategy, a primary objective is to keep currently common species from becoming rare. Educational efforts should focus on protecting known nesting and overwintering sites, re-creating such habitats, reducing invasive species, providing rocks and logs for basking and cover, and controlling domestic cats and dogs. Another key is educating the public to leave native turtles, snakes, and lizards in the wild and refrain from releasing non-native reptiles to the wild.

Questions, Unresolved Issues, and Data Gaps

Appendix H includes a list of current research needs by species. In addition to general habitat and range information, data on the impacts of diseases spread or introduced by invasive species, impacts of predators, and population genetics for the region's native turtles and lesser known snakes and lizards would greatly increase our ability to manage local reptile populations. To accurately gauge current threats to native reptile populations, an overall focus is needed on increasing the body of knowledge of basic life history, range extents, and habitat.

FOR MORE INFORMATION

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Oregon Zoo Headstart Program for the Western Pond Turtle http://www.oregonzoo.org/Conservation/westernpondturtle.htm

Conservation Assessment for the Western Painted Turtle in Oregon (Chrysemys picta bellii)
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Native Turtle Working Group, Native Turtles of Oregon
http://www.oregonturtles.com/

Special Status Amphibians and Reptiles (see Appendix H)
Metro's bird, mammal, and amphibian/reptile wildlife checklists for the Portland area
http://www.oregonmetro.gov/index.cfm/go/by.web/id=15421

Washington Herp Atlas:
http://www1.dnr.wa.gov/nhp/refdesk/herp/index.html

Birds

Katy Weil and Lori Hennings, Metro

Birds make up the majority of the greater Portland-Vancouver region's vertebrate species. At least 219 native bird species use habitat in the region, as do eight non-native species. Two species are likely extirpated. The sheer diversity in bird species and ranges in the region creates complex management needs.

Birds provide valuable ecosystem services such as insect predation, pollination, seed dispersal, and scavenging. They also create tree cavities used by many other species and exert strong controls on invertebrate populations. For example, more than 90 percent of birds rely on an insect population to successfully raise juveniles, thereby reducing damage to plants (including trees) from insects such as tent caterpillars and bark beetles. Birds control termites and carpenter ants, thus protecting human structures. Birds also can be reliable indicators of a healthy ecosystem—the proverbial canary in the coal mine. When native birds decline in an ecosystem, it is likely that the health of that system is deteriorating.

Birds are highly mobile and use every natural habitat type and many man-made structures in the greater Portland-Vancouver region, with habitat defined as the areas that birds need for feeding, nesting, roosting, resting, protection from predators, dispersal, and migration. Because of their flight capability, birds can respond to and use non-contiguous resources and habitats. For some species, gaps in the forest serve as important habitat, so the number, size, and condition of forest gaps can influence bird populations.

Bird species can be highly specialized. Examples include the acorn woodpecker and slender-billed (white-breasted) nuthatch, which rely on stands of Oregon white oak, and the streaked horned lark, which requires sparse vegetation with little structure. Other species use a variety of forested, agricultural, shoreline or other habitats. Some species, such as pileated woodpeckers and Swainson's thrushes, require large forested areas.

Urban centers and their surrounding lands can provide important avian habitat, including migratory stopover areas, for birds and other wildlife. The Oregon Department of Fish and Wildlife and the U.S. Fish and Wildlife Service consider urban areas critical for migrating birds. In fact, because the greater Portland-Vancouver region is located along the Pacific Flyway, large concentrations of birds migrating along the flyway use key habitats within the region—including habitats in urban areas. The City of Portland signed an Urban Conservation Treaty for Migratory Birds with the U.S. Fish and Wildlife Service in 2003 to demonstrate the City's long-term commitment to the protection and conservation of migratory birds and the contributions that urban areas can make toward bird conservation.

The North American Bird Conservation Initiative's 2011 State of the Birds report notes that public lands also provide essential habitat for the survival of hundreds of bird species. Approximately 40 percent of the bird species that inhabit the United States have at least 50 percent of their distribution on public lands and waters.

Conservation Issues and Key Threats to Birds

Given the mobility and complex life history of some bird species, the threats they face are many and varied. The following threats to birds are increasingly common at the global, regional, and local scales:

- Degradation, loss, and fragmentation of habitat
- Disturbances such as roads, noise, and artificial lights
- Building strikes (particularly during migration)
- Invasive species (both avian and plant)
- Urbanization
- Predation by domestic cats and disturbance and predation by domestic dogs
- Land management and restoration practices that conflict with nest success
- Reduction in insect populations, which are important food resources

These particular threats are described in more detail in Chapters 6 and 8 of this *Biodiversity Guide* (see "Patch Size and Anchor Habitats" and "Biodiversity Corridors and Connectivity" in Chapter 6 and "Conservation in Developed Areas" in Chapter 8), along with Chapter 6 of the *Regional Conservation Strategy*

SPECIAL-STATUS SPECIES

In 2001, a presidential executive order mandated that federal agencies protect migratory birds. This order emphasized the importance of protecting "species of concern" that have been identified under the Endangered Species Act and in regional lists provided by the North American Bird Conservation Initiative and Partners in Flight, a Neotropical migratory bird conservation initiative. Within the greater Portland-Vancouver region, one species that may occur in the outskirts of the region is currently listed as federally threatened: the northern spotted owl. The bald eagle was originally federally listed as endangered in 1967, but it was downlisted to threatened in 1995 and has now recovered to the point that it was removed from the list (i.e., officially delisted) in 2007. The peregrine falcon has gone through a similar process. The California condor, a feder-



ally listed endangered species, is extirpated from the region (although the Oregon Zoo's breeding program is augmenting the world's small remaining condor population). The yellow-billed cuckoo also is likely extirpated from the region; it and the streaked horned lark are candidates for listing.

Twenty-nine bird species found in the greater Portland-Vancouver region are listed as either sensitive or priority species of concern in Oregon or Washington; this includes four species listed as threatened or endangered in Oregon and/or Washington: the northern spotted owl (Oregon), American white pelican (Washington), sandhill crane (Washington), and bald eagle (Oregon). The City of Portland has a more extensive list of 58 special-status bird species that are supported primarily by riparian and riverine habitats, grassland, oak woodland or savanna, or mature coniferous forest.

MANAGEMENT OF CONIFEROUS FORESTS

Coniferous forests in the Pacific Northwest support some of the highest densities of breeding land birds in North America, including many Neotropical migrants. A 2004 report by Environment Canada[2] indicated that songbirds respond positively not only to larger habitat patches, but to the total amount of tree cover in a given region. It is likely that part of this response is due to increased connectivity in areas with more trees. A Seattle area study suggested 42 hectares (104 acres) as a patch size at which most native forest species were present (see also "Patch Size" in Chapter 6). The unique habitats and avian diversity of Pacific Northwest forests require a detailed regional conservation effort aimed at reducing the potentially deleterious effects of multiple land-use management activities on ecosystem function and on important land bird breeding habitat.

In the greater Portland-Vancouver region thousands of publicly and privately owned acres are managed for timber harvest. These are very large forested areas with scattered clear-cuts and earlier successional shrub and forestlands. Forest age is a significant habitat limitation for birds within the region because timber rotation on most commercial forests occurs about every 40 years and the forests do not achieve mature or old-growth conditions. In addition, reforesting for timber harvest tends toward Douglas fir monoculture without tree species diversity or mature, berry-producing shrubs in the understory. However, current practices typically result in smaller clear-cuts than in the past, and timber harvesters have worked to reduce impacts on streams, leave a few trees and snags, and generally create a more heterogeneous landscape in place.

LOSS AND DEGRADATION OF OAK HABITAT

Among important avian habitats in the greater Portland-Vancouver region, aside from prairie, oak habitats have shown the most significant reduction in acreage and quality. Focal species such as the white-breasted (slender-billed) nuthatch and acorn woodpecker depend on this habitat for the majority of their life cycle. Previously it was thought that only large, contiguous sections of oak habitat were enough to sustain these species, so small patches of oak within the region were considered inconsequential. However, recent research has begun to demonstrate that even small patches of uncommon habitats may be important for regional conservation.

A shift from open to more dense or closed-canopy oak habitat (because of fire suppression) has altered wildlife communities. For example, more open oak habitat such as savanna can support higher numbers of grass-nesting birds, as well as species that use large, open-grown trees. Larger trees tend to have more nesting cavities and produce more lichens, which are a seasonally important food resource for deer and elk, and acorns, which are important to many animals. The shift from savanna to woodland has also substantially reduced associated prairie habitat. The double jeopardy of habitat loss and higher tree density in remaining oak habitats has resulted in substantial declines of oak-associated wildlife species.

LOSS OF RIPARIAN HABITATS

Riparian-associated birds, including birds that use small stream corridors, wetlands, floodplains, and bottomland hardwood forests, are declining because of habitat loss and other factors. Nearly all of the region's wildlife uses water-related habitats at some point in their lives. Only five bird species—two of them non-native—are not associated with any water-related habitat. Of the 227 bird species known to occur annually in the Portland-Vancouver region (see Appendix E), 92 of them (40 percent) rely on or are strongly associated with riparian areas and wetlands. Although the yellow-billed cuckoo has been considered extirpated in the region, a single yellow-billed cuckoo was observed in 2009 in the Sandy River Delta. This sighting is a hopeful sign and a good reason to continue restoring contiguous bottomland hardwood habitat. The yellow-billed cuckoo does an excellent job controlling tent caterpillar infestations and, unlike European cuckoos, does not rely on other species to raise its young (i.e., it is not a nest parasite).

Riparian forests are highly productive, providing leaves, dead wood, and abundant invertebrates to the nearby ground and water. A healthy riparian forest has complex vegetation structure with lots of native shrubs. Birds and other wildlife use these resources for food, cover, breeding, and—importantly—movement. The fairly linear, contiguous nature of streamside vegetation, coupled with these resources and the availability of water, make riparian forests excellent movement corridors for birds and other wildlife. In fact, riparian forests provide the majority of remaining connectivity in urban and agricultural areas. Disruptions in these corridors come in the form of roads, bridges, and development and farming practices that fail to maintain sufficient riparian vegetation.

REMOVAL OF DEAD AND DYING TREES

Approximately 30 percent of bird species use standing dead and dying trees (i.e., snags). Private and some public landowners tend to remove dead and dying trees because of perceived hazards and aesthetics. Sometimes this is justified, but cutting down dead and dying trees also removes key elements from ecosystems, thus diminishing their functional value for birds and other wildlife.

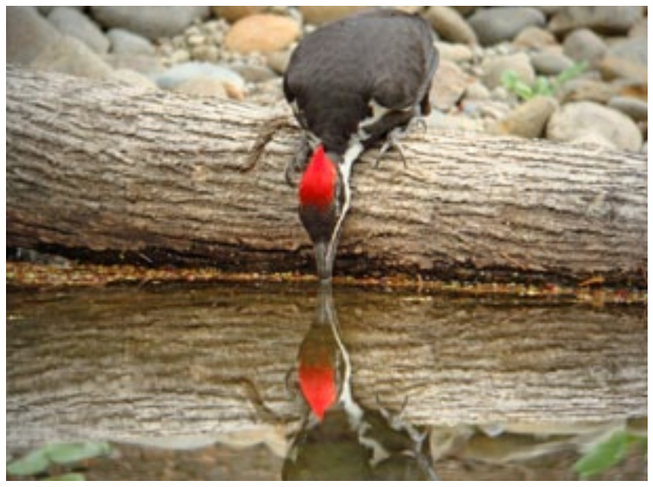
Nearly 100 wildlife species use snags in western Oregon and Washington forests, and more than half of these species depend on cavities created by birds. Primary cavity users are those that actually create cavities, such as woodpeckers. Secondary cavity users cannot create cavities; instead, they use cavities created naturally or by other species. For cavity-dependent species, absence of snags can be a primary limiting factor, and long-term breeding bird survey data document declines in many cavity-dependent birds. Local examples of cavity-dependent species include woodpeckers, western bluebirds, American kestrels, small owls, some bats, house and Bewick's wrens, nuthatches, chickadees and northern flying squirrel. Many other reptile, amphibian and small mammal species use cavities for roosting and thermal protection. Hawks, eagles, and olive-sided flycatchers use snags for perches, and snags frequently serve as nesting sites for eagles and osprey.

[2] *How Much Habitat Is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern.*

Because different species require different snag sizes and decay classes, retaining a variety of snag types will benefit more species. In general, snags that are at least15 inches diameter are most useful to wildlife, and conifer snags last longer than most hardwoods. Large live trees with dead or broken tops sometimes serve similar functions to snags.

AGRICULTURAL PRACTICES

Threats related to agricultural lands and practices include conversion from native habitats, loss of connectivity, and poor timing of mowing and other management activities. The habitat value of croplands diminishes as field size increases and there are fewer fencerows, hedges, and grassy field margins, which provided some habitat value for perching, nesting and movement. However, some grassland species such as the streaked horned lark need larger fields without woody structure. Areas of unplowed pasture represent much of the remaining prairie or prairie-like habitat in the region. Pastures and grain and grass seed fields attract wildlife and provide some value to prairie or grassland-associated birds, as well as moles, voles, and gophers. However, these habitats differ from native grasslands and prairies and are subject to management practices that harm wildlife, such as mowing or harvesting during nesting season.



CLIMATE CHANGE AND INVASIVE PLANT SPECIES

In North America, monitoring already has documented the earlier arrival of migratory birds into breeding territories because of warmer temperatures farther south. In addition, winter ranges are shifting northward; data from the National Audubon Society's nationwide annual Christmas bird count reveal a northward shift averaging 35 miles for all species over the last 40 years. Rates of bird range shifts are correlated with rates of temperature change; urban and suburban birds shifted the most, and forest birds shifted the second most. Grassland birds were the only group that shifted to the south more than to the north. This provides clues about how to focus conservation actions on the species likely to be most affected.

Climate change may also increase invasive species problems as new plants and animals move into the region without their corresponding population controls (disease, natural predators, etc.). Avian populations may decline as the vegetation with which they are associated is out-competed by new invaders. In addition, invasive species may simplify the habitat structure and reduce the plant species diversity that is critical to so many wildlife species.

OTHER ISSUES

In urban areas within the greater Portland-Vancouver region, where cats, dogs, and other small predators abound, surveys of breeding birds indicate that birds that nest close to the ground are declining compared to birds with other nesting habits. Neotropical migratory birds that breed here but overwinter south of the U.S.-Mexico border have been shown in Portland and other U.S. urban areas to be declining disproportionately compared to other species. Migratory songbirds seem to be sensitive to habitat fragmentation. They are associated with native shrub cover, require stopover habitat over long distances, and may be sensitive to human disturbance.

Current State and Local Priority Conservation and Restoration Strategies

The many programs, projects, and efforts that are currently in place to conserve birds have

developed out of an urgent need to (1) monitor populations where decline has been suspected, (2) communicate that information to land managers and others, and (3) develop recommended management guidelines where necessary and possible. Within the greater Portland-Vancouver region, bird conservation efforts include the following:

- Oregon Habitat Joint Venture, which promotes protection, restoration, and enhancement of important habitats for birds and the systems on which they depend.

- Important Bird Areas program, administered by the National Audubon Society and Birdlife International.

- Monitoring Avian Productivity and Survivorship (MAPS) Program, which assesses and monitors the vital rates and population dynamics of land birds to provide critical conservation and management information. The Institute for Bird Populations established the MAPS Program in 1989. Within the greater Portland-Vancouver area, MAPS stations are located at Ridgefield National Wildlife Refuge Complex in Washington and at Oak Island (on Sauvie Island) in Oregon. Bird lists and more information are available online at http://www.birdpop.org/.

- North American Bird Conservation Initiative (NABCI), which is a coalition of 22 government agencies, private organizations, and bird initiatives in the United States. NABCI's mission is to ensure the long-term health of North America's native bird populations based on sound science and cost-effective management.

- Partners in Flight, an international cooperative effort that involves partnerships among federal, state, and local government agencies, foundations, professional organizations, conservation groups, industry, the academic community, and private individuals. Partners in Flight develops bird conservation plans that address characteristic habitats and focal species. Examples in the greater Portland-Vancouver area are shown in Table 5-5.

TABLE 5-5
Sample of Regional Habitats and Species Covered by Partner in Flight Conservation Plans

General Habitat Type	Number of Focal Species	Species
Coniferous Forest	20	Pileated woodpecker Pacific (winter) wren Red crossbill Band-tailed pigeon Orange-crowned warbler
Westside Lowlands and Valleys (includes bottomland hardwood, oak savanna, and at least four other distinct habitats)	Nearly 30	Common nighthawk House wren Purple martin Western meadowlark Swainson's thrush

At the state level, the Oregon Conservation Strategy identifies urban priorities related to new urban area planning, using multiple tools to meet conservation goals. The document incorporates habitat considerations into other conservation efforts (such as water quality/quantity), along with urban solutions such as green roofs and naturescaping; it also encourages cooperation across jurisdictional boundaries.

The U.S. Fish and Wildlife Service created the Urban Conservation Treaty for Migratory Birds program in 1999 to help municipal governments conserve birds that live, nest, overwinter, or migrate through their cities. Portland joined the program in 2003 as one of the nine participating cities committing to conserve migratory birds through education, habitat improvement, and bird conservation actions. In a February 14, 2011, letter to the U.S. Fish and Wildlife Service, the City of Portland renewed that commitment. In support of that effort, the City has developed a bird agenda. Next steps in the bird agenda have been identified, and the City is currently in the process of determining how the following major categories of action will be implemented:

- Habitat protection and improvement
- Hazard reduction
- Invasive species management
- Education and outreach

Priority Conservation and Restoration Strategies

Strategies to ensure the persistence of key bird species must begin by incorporating knowledge of the species' habitat needs into planning efforts within the greater Portland-Vancouver region. Avian habitat use, movements, and seasonal activity patterns can be addressed in planning for trails, invasive species control, and habitat restoration on publicly owned lands and encouraged on private properties.

Management actions taken within the greater Portland-Vancouver region can be effectively monitored by tracking bird use, thus adding valuable knowledge as to the efficacy of certain management practices. The following are some useful management practices for maintaining or improving bird habitat in the region:

- Selective forest thinning /oak release (i.e., removing Douglas fir that overtops and shades oak trees).

- Maintaining a variety of seral stages, including native shrub habitat, in forested landscapes.

- Creating and retaining snags and dead wood on the ground.

- Focused management of forest gap size and condition.

- For particularly sensitive or rare habitats, or small populations, use of rotational vegetation management to avoid changing a large area all at once

- Identifying and improving biodiversity corridors. Although some birds may not rely on fully connected habitat, others likely do. Connectivity for birds can be particularly important in urban areas, where habitat patches can be few and far between. Because narrow corridors can attract predators, increasing the width of movement corridors and the number of "entries and exits" of a habitat patch can help species find and safely use the corridor.

- Planning habitat thoughtfully into future urban area design.

- Identifying important conservation areas in the working landscape.

- Siting trails and other recreational facilities carefully to avoid affecting high-quality bird habitats.

Best management practices are available for various habitats within the region, including coniferous forest and lowlands and valleys. For example, see *A Landowner's Guide for Restoring and Managing Oregon White Oak Habitats* (Vesely and G. Tucker, 2004) and B. Altman's two conservation strategies for landbirds in western Oregon and Washington in "For More Information," below. Urban landscapes can be made more inviting to birds by increasing tree and native shrub cover, preserving special habitat areas such as oak savanna and native prairie, creating and improving habitat on private lands through education and outreach (such as the Audubon Society of Portland and Columbia Land Trust's Backyard Habitat Certification program), and focusing on conserving and connecting large, intact habitat areas. A helpful resource is the Audubon Society of Portland's recently released Bird Friendly Building Guidelines.

Opportunities to improve bird conservation on agricultural lands include Farm Bill funded-programs such as the Conservation Reserve Enhancement Program CREP, which is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. Such programs enhance habitat and food resources and provide surrogate habitat for some species, including grassland birds.

Many owners of small woodlands and lots adjacent to public greenspaces and streams in the greater Portland-Vancouver region want to improve the condition and habitat value of their forests. Continuing to implement favorable management practices on public lands and supporting private timberland owners can provide more valuable wildlife habitat within current land use patterns (see "Upland Forests" in Chapter 3 for more on changes in forest landscapes).

The City of Portland's Bureau of Environmental Services is developing guidelines for how to use "wildlife trees," downed wood, and brush piles to benefit wildlife. This may encourage landowners not to remove dead and dying trees that help maintain ecosystem functions. The City also has adopted guidelines for protecting nesting birds and developed other resources and projects as described in Portland, Oregon's Bird Agenda.

Questions, Unresolved Issues, and Data Gaps

There are knowledge gaps about the needs of bird species that use the greater Portland-Vancouver region. Examples include whether certain plant species (e.g., ocean spray) are particularly good hosts for invertebrates that serve as prey for birds, and whether certain bird species in the region have a fall moult (i.e., feather drop and replacement) that represents a distinct life history, with different habitat requirements. If so, which species are these, and what are their habitat needs? Regarding climate change, there is a need to identify bird species whose activities are tied to the timing of plant flowering or seeding, plant species or communities whose populations are likely to increase or decrease as a result of climate change, and the potential implications of these changes for birds. Another pressing question is how habitat for Neotropical migratory songbirds can be better managed in urban areas.

In some cases, existing data, such as that from the breeding bird survey and Christmas bird count, can be used to guide management recommendations, such as by identifying bird species whose ranges are shifting. In other cases, additional research, monitoring, and evaluation efforts are needed. Nest success studies are one example, particularly relating to habitat patch size (singing males do not always indicate nesting).

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Mammals

Susan Barnes and Liz Ruther, Oregon Department of Fish and Wildlife, and Jeff Azerrad, Washington Department of Wildlife

Oregon has at least 122 mammal species and Washington has 111, not including marine mammals. At least 76 mammal species, including eight non-natives, occur within the greater Portland-Vancouver region. Mammals are extremely diverse and are present at every level of the food web as herbivores, granivores, insectivores, omnivores, and carnivores. Habitat quality and quantity are the main predictors of mammal species diversity. Mammals typically are divided into seven subgroups:

- Rodents
- Rabbits, hares, and pikas
- Bats
- Shrews and moles
- Ungulates (i.e., hoofed mammals)
- Omnivores
- Carnivores

Small and medium-sized mammals, especially those that eat grain, are the most abundant mammals in urban and suburban environments. Suburban residential areas often make excellent habitat for medium-sized omnivores, such as raccoons and skunks. In general, urban environments support fewer species of mammals than do surrounding rural and undeveloped areas. The species that occur in urbanized environments tend to be habitat generalists rather than specialists. Urbanized areas can support high populations of non-native mammal species such as the house mouse, Norway rat, Virginia opossum, and eastern fox squirrel. In less urbanized areas where larger patches of intact habitat remain, a greater variety of species is likely to be encountered.

Mammals play a variety of ecosystem roles. Predatory mammals regulate herbivores (i.e., plant-eating animals) populations; this in turn affects grazing patterns and influences the development and quality of vegetation and thus wildlife habitat. For example, cougar limit deer and elk populations, thereby reducing habitat overgrazing. Another example of mammals as regulators is the relationship between bat and insect populations. Bats in Oregon and Washington consume only insects, with an adult bat eating about 1,000 insects per hour. Bats also are a source of natural fertilizer (guano) that is important to ecosystem health. Mammals such as squirrels and chipmunks play an important role in habitat regeneration by dispersing seeds. Mammals provide stability to entire food webs and life cycles, although these functions often are disrupted by human actions.

Some mammals are considered keystone species, meaning that their role in the ecosystem has a ripple effect on every species below them, as well as on the ecosystem within which they live. Pocket gophers are an example of a keystone species. Pocket gophers live in grasslands and create extensive tunnel systems, thus aerating the soil (which promotes plant health), creating burrows for other species, and creating areas of bare earth that are used by other species, including birds, insects, and reptiles. Another keystone species is the American beaver, which often is referred to as an "ecosystem engineer" because it creates extensive wetland complexes through its dam-building activities. Beaver-created wetland habitats provide a mosaic of water/land interfaces, resulting in greater plant and animal diversity than would otherwise be present. There is increasing evidence that beavers play a critical role in overall ecosystem health and influence water quality and quantity, plant regeneration, and fish and wildlife production.

Mammals such as raccoons, coyotes, and eastern fox squirrels are habitat generalists, while others, such as the gray fox, western gray squirrel, and Douglas squirrel, are habitat specialists. Generalists are more adaptable to fragmented habitats, while specialists typically require larger, more intact habitats or specific habitat types and are less tolerant of urbanization and human presence.

Conservation Issues and Key Threats to Mammals

Conservation of mammal species diversity is a concern locally, regionally, and globally. All mammals face a variety of threats, although some threats are more obvious than others. Rare species whose distribution naturally is limited are most susceptible to environmental degradation and at greatest risk of extinction or local or regional extirpation. Small mammals are just as likely to become extinct as larger species, but ungulates (i.e., hoofed mammals) and large carnivores receive disproportionate attention with respect to conservation activity and research. Many of these smaller mammal species are classified as nongame wildlife. Nongame species generally receive less conservation attention, primarily because federal and state fish and wildlife management agencies traditionally have been structured and funded based on fish and game species.

The majority of mammal species in the greater Portland-Vancouver region receive some level of protection by federal and/or state wildlife management agencies. In Oregon, some fall into the category of non-protected nongame wildlife (OAR 635-044-0132) and therefore are not protected from take (i.e., being killed or removed from the wild). In Washington, nongame species

classified as protected may not be hunted, killed, possessed, or controlled (WAC 232-12-011). It is also illegal in Washington to use body-gripping traps to capture any mammal for recreational or commercial purposes (WAC 232-12-142). Washington's Growth Management Act requires that all cities and counties designate areas that are critical to fish and wildlife (primarily nongame species). Under the Growth Management Act, local policies and regulations must be enacted (WAC 365-196-830) to conserve and protect these areas.

Land ownership and how a mammal species interacts with its human-influenced environment can dictate species management. Oregon Department of Agriculture statutes and rules classify certain mammals as predators on private lands when they are "causing damage, are a public nuisance, or are posing a public health risk" (ORS 498.012) on those lands. This allows private landowners to take (i.e., kill) animals such as mice, voles, American beaver, mountain beaver (apolodontia), various squirrels, chipmunks, muskrat, rabbits, and coyote.

Habitat loss and fragmentation are the most significant threats to overall mammal diversity and population viability. These threats and the associated loss of special habitat elements such as large dead and dying trees and large downed wood have caused localized losses and declines of some mammals, particularly those associated with interior forest habitats (e.g., American marten). Habitat degradation from invasive plant and animal species also poses a threat to native mammals. Some mammals, such as bats, face persecution that is rooted in fear or ignorance. Large carnivorous mammals such as cougar also often face persecution, or people are simply unwilling to tolerate their presence. Even native mammals that people often view as "cute" and harmless, such as deer and tree squirrels, sometimes become nuisance wildlife and then are harassed.

Physical barriers such as roads and culverts pose a significant threat to a variety of mammal species and affect daily, seasonal, and dispersal movement patterns. Other key threats to mammals are poaching and over-harvest, pollution and chemical contaminants (including impacts on non-targeted species), disease, invasive species, predation by off-leash dogs and free-roaming cats, encroachment by humans, injury or mortality resulting from collisions with moving vehicles, artificial feeding, and other sources of injury or mortality, such as entanglement in fences, monofilament fishing line, and sticky glue strips and traps.

Lack of survey and breeding information poses another challenge to mammal species management and conservation, especially in the face of expanding urbanization and decreasing budgets at public agencies. Some mammal species are inherently difficult to study or monitor; these include species that naturally occur at low population levels, underground species such as moles and shrews, arboreal species such as the red-tree vole, secretive species, and those—such as the fisher—that have large home ranges and require large patches of remote and intact habitats.

Special-status Species: Habitat Needs

Of the 68 native mammal species found in the greater Portland-Vancouver region, 16 are either classified by Oregon or Washington as a sensitive species or have a more critical designation, and 21 are identified as state strategy species in one or both state conservation strategies. The gray wolf is listed as endangered in both Oregon and Washington, and the Columbian white-tailed deer is listed as endangered in Washington. At least 15 of the 25 mammal species that the Oregon Department of Fish and Wildlife classifies as protected nongame wildlife occur within the region. In Oregon, these species may not be hunted, trapped, pursued, killed, caught, angled for, or possessed, whether dead or alive, whole or in part (OAR 635-044-0130) (see Appendix E).

Several special-status species (e.g., American marten, fisher, red tree vole) need large patches of intact, late successional mixed conifer habitats with multi-layered canopies. These species need a high density of snags and logs for den sites and foraging and typically have low survival rates in fragmented forests. The red tree vole, which occurs only in western Oregon and northern California, has a small home range but requires tree-top connectivity for post-breeding dispersal; this species. A recent U.S. Fish and Wildlife Service decision listed the North Oregon Coast red tree vole population, whose range includes the western portion of the greater Portland-Vancouver region, as a distinct population segment; this population is a candidate for federal Endangered Species Act listing.

The Columbian white-tailed deer is a federally listed species that historically occurred throughout Columbia River bottomland hardwood forests. Now only remnant populations occur in riparian habitats on remaining islands along the lower Columbia River.

Many of the region's special-status species are bats. Although many bat species are known to use human structures such as crevices in bridges for roost sites, bats within the greater Portland-Vancouver region typically are associated with mature forests and will use large snags, hollow trees, and downed wood for roost sites.

Data Gaps

There are knowledge gaps for many of the mammal species that occur within the greater Portland-Vancouver region, particularly for nongame and special-status species. Additional information on basic species distribution, population densities and trends, dispersal patterns, seasonal movements, overwintering locations and the level of human-caused mortality would improve conservation efforts for mammals within the region and across species' ranges.

Conservation Strategies

- Prevent additional habitat fragmentation within the region, both in developed areas and toward the outer fringes of the region.
- Improve habitat connectivity within the region and with key habitat areas outside the region.
- Incorporate the needs of wildlife when implementing culvert replacement and fish passage projects, to allow animal movement.
- Develop and use measurable indicators of high-quality habitats.
- Evaluate the effectiveness of providing passage around barriers to mammal movement, to enhance species migration and habitat connectivity.
- For species that depend on habitats that already have a high degree of fragmentation or isolation, determine the patch sizes and configuration needed to maintain viable populations.
- Complete conservation assessments for special-status species that summarize status, life history, threats, and conservations strategies.
- Fill species data gaps, focusing on the highest priority special-status species first.
- Determine the impacts of introduced mammal species (i.e., nutria, eastern fox squirrel, eastern gray squirrel, eastern cottontail rabbit, Virginia opossum) on native wildlife.
- Control invasive plant species to address habitat degradation.
- Develop new cost-effective and efficient techniques for studying species that are elusive or difficult to study.
- Enact harsher penalties (e.g., fines) for wildlife crimes.

- Amend state Department of Wildlife administrative rules to eliminate the non-protected nongame wildlife category, in recognition of the inherent value of all native species of wildlife and the ecosystem services they provide.

- Amend state Department of Agriculture statutes to redefine predatory animals and the process for addressing wildlife damage.

- Implement educational and informational campaigns and policy related to the effects of dogs (on and off-leash) and free-roaming cats on wildlife.

- Enact local and/or state laws that prohibit the artificial feeding of wild mammals (with certain exceptions, such as when necessary for wildlife scientific or research purposes, or when approved by the state fish and wildlife department).

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Important Issues and Concepts

CHAPTER 6

Protecting wildlife habitats and vegetation communities is key in establishing and maintaining an ecologically robust and healthy interconnected system of natural areas and, in turn, protecting regional biodiversity, air and water quality, and other ecosystem services. Although plant communities and wildlife habitat are visible and tangible units, they are in turn affected by a variety of external processes and functions. When prioritizing conservation actions and identifying desired future conditions, it is important to consider the role that climate, fire, hydrology, pollination, anchor habitats, and habitat connectivity play in achieving conservation goals for ecosystems, watersheds, and the entire greater Portland-Vancouver region.

Climate Change[1]

Mike Houck, Urban Greenspaces Institute and Kaitlin Lovell, City of Portland

Climate change will affect all aspects of conservation within the greater Portland-Vancouver region. That climate change already is occurring has been well documented. Over the last century, the Pacific Northwest has seen an increase in average temperature (by 1.5 degrees Fahrenheit), the loss of snowpack in the Cascades, and shifts in the timing and volume of stream flows. Projected changes to aquatic systems include changes in hydrology, water supply, and stream flows; reduced water quality; degradation of wetland ecosystems; and an increase in breeding grounds for waterborne diseases. The region can expect to have reduced air quality, along with higher average annual air temperatures and more frequent extreme heat events.

Current models predict that the region's terrestrial resources also will experience negative effects from climate change; these effects include increased incidents of short-term drought, increases in the frequency and intensity of wildfires, and more frequent landslides. There are likely to be shifts in the quantity and quality of fish and wildlife habitat and refugia for sensitive species. Generally, specialist species and species that require specific habitats or ecosystem processes may be more adversely affected by climate change than generalist species. It is likely that certain species' ranges will be further constricted, or

[1] This discussion is excerpted from a more in-depth piece written for the *Regional Conservation Strategy* (Chapter 5).

they will become locally extirpated; this is likely to be the case for species that rely on spatially limited habitats such as wetland, prairie, or oak savanna and species that depend on cold water, are not mobile, are capable of only limited mobility, have already been isolated, or already are at the edge of their range. The loss of these species will reduce the region's biodiversity. Conversely, generalist species, common species and habitats, and highly mobile species could benefit from climate change. Species that can migrate and are already in a hospitable environment are likely to expand their ranges.

There are also likely to be changes in interspecies interactions and life history timing, such as predator-prey relations, pollinator-pollen dependence, other food web dynamics, and, potentially, the timing of species' life cycles. Other impacts on the region's native fish and wildlife species may include loss of genetic diversity, shifts in species' gender balance, shifts in migration patterns and habitat range, an increase in invasive species, and increased fragmentation of biodiversity corridors and habitats.

Strategies for Maintaining the Resilience of Natural Systems

The cumulative and synergistic effects of climate change on both natural and built systems may be dramatic. According to the state of Oregon's framework on adaptation for fish and wildlife, immediate action is needed to proactively adapt to the predicted consequences of climate change. Potential impacts to climate change, both negative and positive, must be evaluated through the lenses of uncertainty; cumulative, synergistic effects; and scale, both temporal and geographic. The greater Portland-Vancouver region needs to produce a suite of solutions that are applied systematically to a range of problems. Above all, our responses should be based on the precautionary principle, which advises that, in the face of uncertainty, when an action could result in harm to human health or the environment, precautionary measures should be taken even if some effects have not been fully established scientifically. With these factors in mind, the following should be incorporated into all of the region's climate adaptation strategies:

- Protect the best and restore the rest. We should protect the region's best functioning natural systems and strategically restore degraded systems.

- Manage natural resources to allow for dynamics in the landscape—i.e., ensure that floodplains are allowed to expand in order to absorb the expected more frequent high flow events, fire regimes are allowed to function, and other changes in the landscape are allowed that accommodate the needs of natural systems.

- Protect and restore the natural diversity of habitat types and species. Apply ecosystem-based approaches to establish an effective network of terrestrial and aquatic habitats.

- Mimic natural systems and integrate their components into the built environment where possible and practicable.

- Integrate regional growth management strategies with local land use and water planning to proactively mitigate for and adapt to climate change.

- Develop and use the best available science.

- Incorporate back-up strategies and redundancy. Redundancy is a positive attribute of ecosystem management because it confers resilience. Multiple approaches should be pursued to ensure success. Fortunately, there are multiple ways to restore stream flows, reduce water temperature, and protect habitat.

- Use adaptive management. Incorporating monitoring and research into ecosystem management, continuously evaluate performance, and adjust responses accordingly.

- Seek solutions that yield multiple benefits. Adopt integrated approaches to maximize benefits.

- Share results and success stories. Strengthen communication within and between the environmental management and research communities through the Urban Ecosystem Research Consortium and Portland State University's expanding urban ecosystem research initiatives and improve communication with the general public through The Intertwine Alliance.

- Link the climate change adaptation strategies in this document and the *Regional Conservation Strategy* to the *Oregon Conservation Strategy,* Washington's Comprehensive Wildlife Conservation Strategy, and recommendations outlined in Oregon's guidance for adapting to climate change for the state's fish and wildlife.

- Build strong partnerships and coordinate across political and jurisdictional boundaries. This can be accomplished in part by increasing the diversity and number of partners in The Intertwine Alliance.

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Washington Department of Fish and Wildlife:
http://wdfw.wa.gov/conservation/climate_change

Fire

Jonathan Soll, Metro

Fire has played a pivotal role in shaping the vegetation of the western United States—nowhere more so than in the Willamette Valley and southern Puget Trough. Frequent fires (purposefully) set by people were responsible for the vast extents of prairie and savanna in the Willamette Valley and southern Puget Trough observed in the early and mid-19th century, and natural and anthropogenic fire was central in shaping the forest landscape. The end of widespread anthropogenic fire, the implementation of active fire suppression, and the replacement of fire by timber harvest as the primary method of regenerating forest has had profound impacts on the condition and distribution of fire-dependent habitats and the composition and structure of forests throughout the greater Portland-Vancouver region.

Effects of Fire on Prairie, Savanna, and Oak Woodland

Low-intensity fire helps maintain the structure of prairie, savanna, and oak woodland habitats by killing or suppressing small trees and shrubs, but it has little effect on large oaks, pines, and firs, which generally are able to withstand even moderate-intensity fire. Thus, historically, fire in what is now the greater Portland-Vancouver region

resulted in a mosaic of prairie, savanna, and open woodland; these habitats occupied significant portions of the region when it was first surveyed and mapped around 1850. By exposing mineral soil, fire can create a favorable environment for the establishment of annual and perennial forbs among perennial grasses. However, the presence of non-native grasses in modern habitats complicates the use of fire in restoration; this is so because perennials such as velvet grass (*Holcus* sp), reed canarygrass (*Phalaris arundinaceae*), and bentgrass (*Agrostis* sp) and annuals such as cheatgrass (*Bromus* sp) and dog-tail (*Cynosurus* sp) can capitalize on the additional nutrients and growing space to increase their cover following fire, unless supplemental treatments are part of the restoration plan.

Although data are scarce, observations of the response of prairies and savanna to the cessation of fire suggests that frequent fire (i.e., every 1 to 10 years) must have played an important role in maintaining these habitats. Mid-nineteenth century residents of the region reported rapid development of shrubs and oaks in prairie and savanna. Evidence of the role of fire in maintaining prairies and savanna also exists in the many examples of formerly open-grown oak or fir trees that now are surrounded by younger, dense forests. These changes, together with the wholesale conversion of prairie and oak habitats to agriculture, Douglas fir forestry, and residential development, have resulted in the loss of more than 98 percent of former prairie and 85 percent of all oak habitat types in the Willamette Valley. Most of the remaining oak habitat in the Willamette Valley remains threatened with conversion to Douglas fir. The situation is most severe in the greater Portland-Vancouver region.

Effects of Fire on Upland Forests

Before 1850, conifer-dominated forests also were shaped by fire. At that time fires covering many thousands of acres initiated and modified stand development in both the Coast and Cascade ranges and foothills. Vegetation data collected in the 1850s show that 16 percent of the region's forests had recently been burned. It is likely however, that even high-intensity, stand-replacing-type fires burned erratically, leaving unburned trees and patches of different ages in a mosaic across large landscapes. Full canopy closure following fire appears to have developed over several decades (creating valuable shrub habitat), and many biological legacies were retained from the burned forest, including large standing living, damaged, and dead trees and large fallen trees that served as habitat for a variety of species, from bacteria and insects to salamanders and woodpeckers. In drier forest types, especially those adjacent to prairie and savanna, it is likely that low-intensity fires kept stands relatively open, favored large individuals of fire-resistant species such as Douglas fir and Ponderosa pine, and helped maintain a diverse shrub community.

Implications of the Modern-day Lack of Fire

The lack of fire in the modern landscape threatens the region's biodiversity and creates challenges for regional resource managers, in part because fire also represents a risk to valuable infrastructure, human lives, and livelihoods. However, without fire or management approaches that effectively mimic its impact, we will be unable to maintain a rich diversity of prairie, savanna, and open oak woodland habitats. In all habitats, the buildup of fuel loads in areas with a history of burning or a high chance of ignition creates a risk of higher intensity, so-called catastrophic wildfire, with the possibility of substantial losses of mature forest from the region's conservation portfolio and damage or destruction of valuable property.

Strategies to Address the Need for Fire in the Landscape

- **Strategic use of prescribed fire.** In places where the risks associated with prescribed fire are reasonable (i.e. in larger, more isolated locations and where fire control infrastructure is good), resource managers should partner with local fire districts, federal agencies, and professional fire crews to execute safe, effective prescribed fires.

- **Community wildfire protection plans.** Cooperation between agencies and the public to develop and implement plans that address fire from many perspectives are an important element of capacity building and public outreach and education efforts.

- **Improved landscaping practices.** Creating fire-resistant landscapes around natural areas can reduce the chances of fires spreading into or from natural areas and increase the safety and effectiveness of fire control measures when fires occur.

- **Forest management with fire in mind.** Plans such as those developed by the City of Portland for Forest Park that integrate fire resistance and resilience into resource management plans will increase the likelihood that entire natural areas will not be lost to fire, and that, when fire does occur, it will provide benefits rather than be destructive.

- **Research fire alternatives.** Resource managers and academics should continue to develop, test, and report on alternatives to prescribed fire.

Likely Effects of Climate Change

Although the future climate remains uncertain, models currently forecast wetter winters and drier warmer summers. Such a scenario would increase fire risk and heightens the need for the strategic measures identified above.

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Floodplains and Hydrology

Lori Hennings, Metro, and Leslie Bach, The Nature Conservancy

Floodplains are low-lying lands adjacent to streams or rivers that become inundated during periods of increased streamflow caused by heavy rainfall and rapid snowmelt. Floodplains sometimes extend a significant distance from the main channel to outlying areas along the stream, depending on topography. The degree to which a given floodplain is active depends on season, climate, precipitation, soil characteristics, and local topography. Legally, floodplains are defined by the Federal Emergency Management Agency based on the expected extent of water in flood that reaches a particular elevation, typically that of a 100-year or 500-year flood event.

In practical terms, floodplains store floodwater, thus reducing the intensity of flooding downstream and increasing the quantity of water available late in the season. By passing water through the ground, floodplains contribute to water quality protection and cooling.

The hydrologic cycle (or the hydrology of an area) is synonymous with the water cycle and describes the occurrence, pattern, timing, distribution, movement, and properties of water and its relationship with the environment. When hydrologic patterns are altered, so too are water bodies and floodplains.

In general, small streams high in a watershed lack floodplains and have limited riparian areas. Further downstream, where the topography is generally less steep, small floodplains may form and riparian areas widen. Stream channels are formed, sustained, and changed by the interaction of the underlying geology and landform with the water, sediment, and organic material they carry. During the dry season, water tables near the surface sustain stream flow. When streams join to form larger rivers and these rivers reach low elevations with relatively flat topography, large floodplains may form that are subject to periodic water inundation. Annual flooding plays a major role in the productivity of and biological interactions in river-floodplain systems.

The diverse plant and animal communities that live in or depend on floodplains are adapted to and may depend upon unique hydrologic conditions. Floods disturb vegetation, deposit sediments, and store surface and groundwater to create changing but more or less stable conditions, because the disturbance is regular. The dynamic equilibrium of floodplain inundation and draining may be disrupted by human activities, causing a loss of important functions.

Altered Hydrology

Under pre-settlement conditions, lowlands in the greater Portland-Vancouver region were subject to high water and frequent, widespread flooding in winter and early spring, with flows tapering through fall. Many areas of the region had extensive active floodplains, especially the lower elevation portions of the Tualatin, Molalla-Pudding, and lower Columbia rivers, the confluence of the Columbia and Willamette rivers, and the mainstem Willamette near the southern edge of the region.

More recently, urbanization, agriculture, and timber harvest have altered historical floodplains and stream channel morphology, primarily through the loss of vegetation and soil permeability but also because dams, floodwalls, and levees have disconnected historical floodplains from the river. Dams are designed to store and release water in a controlled way, which can result in significantly altered flow and temperature patterns, reduced fish survival, and fish passage problems. Perhaps less appreciated are the changes to the low-water end of the hydrological spectrum. Dams operations can result in higher flows and changing temperature gradients during the spring and summer, which also affect fish behavior and riparian and floodplain vegetation. One consequence of failing to achieve adequately low flows is the failure to successfully establish cottonwood gallery forests.

Vegetation in floodplains slows and stores rainwater and upstream runoff, thus reducing the delivery of water downstream and allowing water to seep into the soil and recharge groundwater. Significant loss of vegetation loss allows water to run off quickly, causing erosion that widens and deepens stream channels as they accommodate high flows. This effect is exacerbated by the presence of impervious surfaces such as roads, parking lots, and buildings. The result sometimes is "flashier" streams, in which high water moves through the system quickly, causing localized flooding, while in the dry season the stream has low flow or dries out completely. The impacts of vegetation loss and impervious surfaces can alter stream structure and composition, increase pollutant loads, simplify habitat, and disrupt the river's connection to its floodplains. Such changes are cumulative within watersheds. In fact, studies have shown that increasing the amount of impervious (i.e., hardened) surface in a watershed reduces the number of aquatic macroinvertebrates in stream systems.

Ongoing Threats

Altered hydrology, which can be caused by man-made barriers and development in floodplains and elsewhere in the watershed, can render a stream incapable of dispersing water, soil, and nutrients to the floodplain. Such changes do more than reduce the ability of floodplains to provide valuable water quality protection; they also can lead to greater flood damage to property and infrastructure. Solutions to the problem of altered hydrology are not easy, particularly in light of expected increases in the human population of the region. The impacts of altered hydrology are nearly ubiquitous, and most land use changes will not allow a return to natural hydrologic processes and conditions. This underscores the need to avoid further floodplain development wherever possible.

Strategies to Improve Hydrology and Floodplain Function

- Continue thoughtful land use planning in and near urban areas. Plan new urban areas to minimize hydrologic alterations. Use zoning, stream corridor protection, and site design to protect streams, floodplains, wetlands, and wildlife habitat.
- Plan at watershed scales to protect and restore ecological processes and functions.
- Avoid development in floodplains (present and future). If such development is unavoidable, reduce impacts by limiting development to the higher elevations of the floodplain, reducing impervious footprint, and creating onsite stormwater storage.

- Prioritize and reconnect isolated habitats by acquiring strategic properties and removing buildings, impervious surfaces, berms, levees, and floodwalls.

- Retrofit developed areas for stormwater detention; develop and implement strategies to reduce the area of effective impervious surfaces and increase vegetation cover.

- Increase riparian corridors and stream channel complexity through plantings, maintenance of native vegetation on stream and riverbanks, and the addition of large woody debris.

- Engage in projects that help mimic natural flow conditions—e.g., "sustainable flow" dam management, water conservation, and purchase of floodplain easements and water rights for instream use.

- In upper and middle watershed areas, use forest practices that leave riparian areas intact, reduce habitat fragmentation, and reduce sediment and chemical loads.

- In mid-elevations, implement strategic land use planning and work with rural landowners, ranchers, and farmers to implement best management practices to increase vegetation and the width of riparian corridors, and to reduce the effects of agriculture on streams, rivers, and floodplains.

Stream and floodplain restoration can be complicated in human-influenced landscapes. Taking these approaches can add up over time to help stabilize hydrology and improve stream and floodplain conditions.

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Pollinators and Pollinator Conservation

Mace Vaughan, Xerces Society

Pollination is the transfer of pollen within or between flowers, resulting in the production of seeds. In most cases pollen transfer is accomplished either by the wind or by an animal. More than 75 percent of plant species require insects to successfully move pollen between plants. The non-native European honey bee (Apis mellifera) is the most well-known insect pollinator, yet North America is home to more than 4,000 species of native bees, along with countless other pollinators such as butterflies, various beetles, flies, solitary wasps, hummingbirds, and other animals. Of these species, bees are considered among the most important to temperate North American terrestrial ecosystems.

Importance of Protecting Pollinators

Pollinators are essential to our environment and economy. The ecological service that pollinators provide is necessary for the reproduction of nearly 75 percent of the world's flowering plants. Fruits and seeds that are derived from insect pollination are a major part of the diet of approximately 25 percent of birds and mammals, from red-backed voles to bears. In addition, insect pollinators are direct food for other wildlife species; for example, more than 90 percent of bird species require insects as a primary food source during at least one stage of their life. The conservation of biological diversity benefits from a framework that guides conservationists to work at multiple levels of the food chain. Pollinator conservation provides such a framework by focusing on the foundational elements of all terrestrial food webs—i.e., native plants and invertebrate communities.

Pollinators also play a key role in agriculture, enabling production of more than two-thirds of the world's crop species, whose fruits and seeds together provide more than 30 percent of our foods and beverages. The United States alone grows more than 100 crops that either require or benefit from pollinators. The economic value of insect-pollinated crops in the United States was estimated to be $20 billion in 2000. Oregon and Washington are among the world's largest producers of insect-pollinated crops, such as berries, tree fruit, alfalfa seed, and vegetable seed.

In many places, the essential service of pollination is at risk. Pesticide use and the loss, alteration, and fragmentation of habitat contribute to pollinator declines, especially in landscapes with high levels of urban or agricultural development. On October 18, 2006, the National Academy of Sciences released the report Status of Pollinators

in North America, which called attention to the decline of pollinators and urged nonprofit organizations to collaborate with land managers to promote and sustain these important species.

Native Pollinators in the Region

Located at the north end of the Willamette Valley and the south end of Puget Trough, the greater Portland-Vancouver region is home to at least 250 native bee species. Declines of a few of these species are well documented. The western bumble bee (Bombus occidentalis)—formerly one of the most common bumble bee species in Oregon—has declined dramatically in recent years and now is at immediate risk of extirpation throughout the western United States. Although an exotic disease has been implicated in the decline of the western bumble bee, pollinator biologists also recognize other factors, such as pesticide use and the loss, fragmentation, and degradation of natural habitat.

Beyond bees, the greater Portland-Vancouver region is home to other imperiled pollinators, such as the Fender's blue butterfly (Icaricia icarioides fenderi), whose dependence on the threatened Kincaid's lupine (Lupinus sulphureus subsp kincaidii) makes it critically vulnerable to extinction. (The lupine's range has become restricted to a handful of locations in western Oregon and

Washington.) In addition, several hummingbird species in the greater Portland-Vancouver region have experienced ongoing declines. Studies suggest that hummingbirds may require contiguous corridors for movement, even if the corridor is narrow.

The greater Portland-Vancouver region is home to a wide variety of pollinators. Bee species in the region include the mining, long-horned, bumble, sunflower, mason, leafcutter, sweat, carder, carpenter, and cuckoo bees. Butterfly species in the region include the swallowtail, painted lady, admiral, skipper, blue, ochre ringlet, duskywing, copper, hairstreak, and fritillary butterflies. Although the region's urban areas do not host the same diversity of pollinators as rural landscapes do, they are still places where beneficial insects can be abundant and conserved, and urban habitats play a role in pollinator habitat connectivity.

Pollinator Conservation

Pollinator conservation is the protection, enhancement, and creation of high-quality habitat that supports important pollinators. Such habitat includes (1) diverse and abundant native shrubs and wildflowers that provide nectar and pollen for pollinators, (2) nesting habitat, such as areas of bare or semi-bare ground for ground-nesting bees, hollow pithy stems and beetle-riddled snags for tunnel-nesting bees, and snags, brush piles, rock piles, and abandoned rodent nests for bumble bees, and (3) larval host plants for butterflies and moths.

The time is right for pollinator conservation in the Portland-Vancouver region. Over the past 3 years, the widespread declines in honey bee colonies from colony collapse disorder have been covered extensively in the media. The decline of both honey bees and native bee and other insect pollinator species makes it imperative that natural resource agencies work with diverse public and private partners to actively incorporate the needs of wild native pollinators into land management efforts and goals.

It is likely that the region's open habitats such as meadows, prairies, oak savanna, and forest understories have been proportionately most affected by changes since 1850. Both wet and dry prairies have been nearly eliminated from the region, and the amount of early successional forest dominated by shrubs and flowering plants also has been reduced, as a result of changes in forest management and the dominance of invasive species in many unmanaged semi-natural areas. This has likely led to a commensurate decline in pollinator species that depend on the diverse flora of these once common habitats.

Implementing pollinator conservation measures means creating landscapes that support a greater diversity and abundance of bees, butterflies, hummingbirds, and other pollinators. A robust system of natural areas in the region can serve as pollinator refuges and source habitats for adjacent landowners, gardeners, and farmers. The end result should be a landscape with an abundance of native plants known to provide pollen and nectar for bees; nectar for butterflies, flies, wasps, and hummingbirds; host plants for butterflies; and ultimately, a landscape with greater biodiversity.

Strategies for Pollinator Conservation

- Manage natural areas for the greatest diversity and abundance of pollinator-friendly plants, nest sites, and butterfly larval host plants. Land managers need to continue efforts to remove invasive species that eliminate diverse flowering plant communities. Although some invasive species (e.g., Himalayan blackberry) provide limited resources for pollinators, they do so at the expense of diverse native plant communities that can supply nectar and pollen for a greater variety of animals over a longer period of time.

- Develop incentive programs and partnerships that help the region's landowners to create pollinator-friendly, flower-rich habitats in natural and working landscapes.

- Educate urban and rural landowners on how to eliminate, minimize, and/or mitigate the impacts of insecticide use on pollinators.

- Emphasize the role of backyard habitat, green roofs, bioswales and other dispersed vegetation in pollinator connectivity.

- Educate urban landowners about the diversity of bees and other pollinators in the region.

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Patch Size and Anchor Habitats

Lori Hennings, Metro

Habitat area, or patch size, is one factor that determines the conservation value and wildlife use of a given area. Although patch size requirements vary from one species to the next, there is wide agreement among conservation biologists that conserving relatively large areas that meet the needs of many species is an important part of a successful regional conservation approach. In fact, relatively large patches are sometimes referred to as "anchor habitats" because they not

only sustain populations of many species over long time periods, but, if connected to smaller areas, can help repopulate areas where species have become locally depleted.

Large habitat patches tend to have fewer edge effects[1], support more wildlife species per unit of area, and can accommodate area-sensitive species that require relatively large home ranges. What constitutes a "large" habitat patch depends on factors such as the species in question, habitat type, setting (e.g., urban, agriculture, or rural), and geographic region.

The value of a habitat patch to a given species depends not just on size, but also on its shape and relationship to surrounding habitats. For example, the streaked horned lark—a grassland species that has declined precipitously in the region—uses a relatively small breeding territory, but it selects territories within much larger areas that lack tall structures such as trees or buildings. Some area-sensitive species may be able to use habitat patches that are individually too small by composing a home range made up of multiple habitat fragments. Pileated woodpeckers, particularly in the non-breeding season, may be one species in the region that does this.

The typical patch size of every natural habitat type in the region has, on average, been reduced compared to historical conditions. Vegetation maps generated from data collected during land survey work done by the General Land Office between 1851 and 1895 show large blocks of forest, wetland, prairie, and riparian areas. Forested habitats have lost extensive acreage, but wetlands, oak woodlands, and prairies have proportionately lost much more (see "Habitat Change in the Region, 1850-2010" in Chapter 2). The result has been widespread fragmentation of habitat and smaller, more isolated habitat areas.

Research suggests that the size of habitat patches may even influence human health. A Portland, Oregon, study found that Hantavirus, which is spread by rodents and can be deadly to humans, was less prevalent in habitat patches with higher small mammal diversity, and that larger patches had higher diversity. A study of Lyme disease in the eastern United States showed similar results.

According to local field research conducted by Portland State University and Metro, in this region 30 acres (12 hectares) seems to be the minimum size at which habitat patches provide some of the wildlife species typically associated with "large" patches. In general, patches of this size are where area-sensitive small mammal and bird species and improved habitat conditions begin to appear. Studies elsewhere suggest a lower, 25-to 30-acre threshold for some species; this is the case in studies of birds in eastern England, understory insectivorous birds in the Amazon, birds across multiple seasons in Georgia, and headwater-associated amphibians in northwestern California. Some species require much larger habitat patches, and anchor habitats that benefit a wide range of native species typically are much larger than 30 acres. For example, true interior old-growth forest habitat begins only at the center of a 100-acre circle.

Studies suggest that the following species in the region may be sensitive to habitat patch size during the breeding season:

- **Forested habitats:** Black-capped chickadee, black-headed grosbeak, brown creeper, Cassin's vireo, downy woodpecker, golden-crowned kinglet, hairy woodpecker, Swainson's thrush, hermit thrush, varied thrush, Pacific-slope flycatcher, pileated woodpecker, red-breasted nuthatch, red-eyed vireo, ruby-crowned kinglet, Steller's jay, Pacific wren, yellow-breasted chat, and several small mammal species, including the short-tail weasel, Oregon vole, northern flying squirrel, shrew-mole, white-footed mouse, Trowbridge's shrew, vagrant shrew, Douglas squirrel, western gray squirrel, and Townsend chipmunk.

- **Grassland/ savanna/oak habitats:** Northern harrier, short-eared owl, western meadowlark, streaked horned lark, and white-breasted nuthatch (also need large oaks).

[1] Edge effects also depend on shape; see Chapter 7, "Biodiversity Corridors," in the *Regional Conservation Strategy* for a more thorough discussion.

Large or anchor habitat patches benefit many of the region's most sensitive species and are vitally important to retaining the region's biological diversity. They are also likely than smaller habitats to be more resilient to the negative impacts of climate change. However, the value of even relatively large patches is enhanced by increasing overall landscape permeability: the more vegetation in urban areas, the more permeable the landscape. Anchor habitats in a more vegetated setting are likely to hold more species and more animals than large patches embedded within an entirely urban matrix. Smaller habitat patches, backyard trees and shrubs, street trees, rights-of-way, and green roofs all can provide valuable opportunities to increase landscape permeability, thus enhancing the value of anchor habitats.

Strategies for Maximizing the Effectiveness of Large or Scarce Habitats

- Protect or expand existing patches.

- Limit the area of edge habitat through strategic restoration (e.g., strive for more round or rectangular shapes).

- Connect habitat patches with well designed and strategically located corridors.

- Enhance areas surrounding habitat patches by adding vegetation, especially shrubs and trees.

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Biodiversity Corridors and Connectivity[1]

Nathan Poage, Clackamas Stewardship Council; Shannah Anderson, City of Portland; and Lori Hennings, Metro

Biodiversity corridors are key landscape elements that provide and increase connectivity between habitat patches, thus allowing species to disperse from natal areas, escape predation, locate better habitat, find a mate, or access habitat they need at various times. Biodiversity corridors are not necessarily continuous and are best defined by functionality. Corridors often follow streams but may also consist of greenways, hedgerows, or other features that add more natural character to developed or agricultural landscapes.

Over time, the loss of habitat, forest structural diversity, and downed wood reduces connectivity, thus altering wildlife populations and contributing to local species extirpations. These losses are common in urban areas. Longer isolation means fewer species. Corridors help maintain genetic diversity, allow locally extirpated species to recolonize, and increase the likelihood of species persistence. Without explicit yet broad-scale planning, connectivity tends to be haphazard, accidental or absent.

Characteristics of Effective Corridors

Corridor function is affected by length relative to target species movement abilities, the number of gaps or barriers and habitat quality, including corridor width. Surrounding matrix features (e.g., urban or rural) also influence corridor value. Several corridors are more effective than a single option.

Wide corridors can increase animals' movement rates between patches and accommodate larger animals and more species. The key is to provide connectivity between populations and prevent reproductive isolation. Selecting focal species for each habitat area and planning for the species with the most rigorous corridor requirements can accommodate the needs of a variety of species. More specific corridor needs for different classes of animals are described below.

CORRIDOR NEEDS OF FISH

The greater Portland-Vancouver area provides habitat for dozens species of native fish, including at least seven anadromous salmonid species. Salmonids depend on stream corridors with cool water, dissolved oxygen, invertebrate prey, and instream features such as pools, riffles, gravel beds, and off-channel habitat. Large wood is an important aspect of habitat; its documented loss in urban streams degrades fish habitat quality.

It is important to provide cold-water refugia for fish in the region's major rivers, which both the Oregon Department of Environmental Quality (DEQ) and Washington Department of Ecology have identified as having water temperature problems. (In 2006, DEQ issued a total maximum daily load [TDML] for temperature, mercury, and fecal bacteria for the Willamette River). Remedies include creating off-channel cold water fish habitat, planting vegetation, reducing pollutants, improving fish passage, and reducing erosion and sediment inputs to streams. Fish passage projects offer excellent and sometimes inexpensive ways to improve wildlife connectivity. For example, a shelf or boulders in a culvert can allow small animals to pass during high water

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CORRIDOR NEEDS OF TERRESTRIAL WILDLIFE SPECIES

Connectivity research varies widely by geographic area and species, but it is clear that narrow corridors, hedgerows, field margins, fencerows, and street trees can improve connectivity for some animals, such as songbirds, pollinating insects, and small mammals. However, it is likely that many of the region's species require wider movement corridors. In general, birds are most mobile and can travel along many types of corridors, mammals have a diverse range of corridor needs, and reptiles and amphibians have the most difficulty finding connectivity between habitats.

For many species, corridors link different habitat types (such as aquatic and terrestrial) that are important to the species' life history requirements. For species that are highly susceptible to human disturbance, corridors should be wider, limit or exclude trails, and be placed away from busy roadways. Some species such as butterflies and bluebirds depend on open habitat and may be best accommodated by early successional corridors embedded within a forested matrix.

Research suggests that large habitat patches, connectivity, native shrub cover, and downed wood significantly improve habitat conditions for many wildlife species. Mobile species with large home ranges may not use available habitat if they are behaviorally sensitive to human activity or built features. For homeowners, leaving the property somewhat "messy," with leaves, woody debris, and snags, can improve onsite wildlife habitat. Within identified corridors or where road kill is a known issue, removing barriers and installing appropriate wildlife crossings can help maintain wildlife diversity in the region.

Amphibians

Of all the classes of animals, amphibians may be the most vulnerable to extinction because of habitat isolation and climate change. Amphibians have small home ranges and cannot travel as freely as other animals. Corridor habitat quality is particularly important for this group. Most amphibians require aquatic habitat, terrestrial habitat near water, and ample woody debris. It may be difficult or impossible for these species to navigate an urban matrix without functional corridors. Stormwater detention facilities are emerging as a key factor in wetland connectivity and provide regular feeding and breeding habitat for a variety of native amphibians. Passage between habitats can be enhanced with appropriate wildlife under-crossings and by augmenting cover. However, it will be necessary to continue to assess the quality and value of these facilities as amphibian habitats.

Reptiles

Reptiles are a diverse group that may require upland habitat, riparian habitat, or both, depending on species. Woody debris and rocks provide important habitat and connectivity for many species. Western pond turtles and painted turtles are susceptible to isolation because of their low reproductive rates and their need for both slow-moving water and uplands. Because females travel upland for nesting and move slowly, roads present a major barrier and mortality issue. Conserving, restoring, and creating wetlands and important nearby upland habitat will benefit turtles and many other species. Careful placement of woody debris, rocky substrate, and native plants can significantly enhance connectivity for reptile species.

Birds

Birds travel extensively along riparian corridors but can also use stepping stones such as backyards, hedgerows, field margins, and street trees. Species that prefer large areas sometimes require wider movement corridors, while habitat specialists sometimes require specific vegetation structure or composition to move well between

[1] This discussion is excerpted from a more in-depth piece written for the *Regional Conservation Strategy* (Chapter 5).

patches. Some birds seem reluctant to cross vegetation gaps wider than 50 meters. Increasing the amount of habitat distributed throughout the landscape and strategically addressing gaps within corridors and the matrix can help these species' movement.

Mammals

Many mammal species require complex habitat structure, good connectivity, access to water, and—particularly for small mammals—woody debris and a duff layer. Larger species tend to have larger home ranges and require wide corridors. Bats need snags and crevices and tend to move and forage along riparian corridors, including intermittent streams; they often roost in artificial structures. Bat-friendly habitats can be provided in new and existing bridges and other structures at little or no extra cost.

Threats and Challenges

Sound planning that includes consideration for maintaining habitat connectivity is a critical challenge for protecting regional biodiversity, especially in the face of looming climate change.

Corridor efficacy is reduced by trails, roads and bridges, and invasive vegetation. Trails often run along the same narrow riparian areas as biodiversity corridors, roads and bridges can increase mortality and prevent wildlife passage, and invasive vegetation reduces habitat quality and requires expensive intervention and management. Narrow corridors may present issues such as predation, poor habitat conditions, invasive species, competition with generalist species, and human disturbance. However, research suggests that in many instances, a narrow corridor may be better than none. Many potential disadvantages of corridors can be avoided or mitigated through the use of wider corridors.

Strategies for Improving Connectivity

Tools to improve connectivity include conservation/protection, restoration, and invasive species control. These are described in more detail in Chapter 7 ("Major Categories of Strategies") of this *Biodiversity Guide* and in Chapter 7, "Biodiversity Corridors," of the *Regional Conservation Strategy* for the Greater Portland-Vancouver Region. Other strategies to improve connectivity include the following:

- Protect large habitat areas and connections between them.
- Create wide rather than narrow biodiversity corridors.
- Identify and remove barriers to the movement of fish and wildlife.
- Increase the natural component of urban and other developed landscapes through native landscaping, green streets and other approaches.
- Combine biodiversity corridor protection or creation with other, non-ecological objectives (i.e., remove or avoid creating barriers to wildlife movement during road construction).

FOR MORE INFORMATION

The following two citations both have comprehensive bibliographies.

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Metro Sustainability Center, Portland, OR.

Wildlife Crossings: Providing Safe Passage for Urban Wildlife
Metro Regional Government. 2009. Portland, OR.

Additional resources can be found through the Washington Wildlife Habitat Connectivity Working Group: http://waconnected.org/

Threats and Challenges

CHAPTER 7

Currently in the greater Portland-Vancouver region we face the challenge of providing for growing human populations and needs while simultaneously addressing the needs of native fish, wildlife, and plants and protecting important ecosystem services such as water quality and plant pollination. Unfortunately, maintaining the status quo is not good enough. Many native species already are at risk, from habitat loss and degradation, the presence of contaminants from urban and agricultural sources, diseases both familiar and new, and hazards associated with human activity. If the predicted influx of people to the region becomes a reality, many more native species are likely to decline across the region unless we become better at conserving and enhancing their habitat.

The information in this *Biodiversity Guide* and the *Regional Conservation Strategy* can help us consider the needs of native species as we identify how our activities can be modified to improve fish and wildlife habitats. For each threat there are strategies we can choose to implement to reduce both current and future impacts to native species. The chapter describes each threat, its impact, and provides possible strategies for conserving the region's biodiversity. This chapter does not prioritize among the threats. Instead, the descriptions of threats and challenges are meant to provide a reasonably comprehensive framework to guide individuals and organizations in making sound decisions about how they invest their time and resources, given their unique priorities and interests.

Habitat Loss

Habitat can be defined as an area that provides the food, cover, water, and space that living things need to survive and reproduce. Species diversity and population numbers can be attributed to the quality, extent, distribution, and size of particular types of habitat. When a watershed or individual natural area is changed by human activities—such as agriculture, commercial or residential development, logging, road construction, or water diversion—the area may no longer be able to provide the necessary food, water, cover, and space to enable adult survival and successful reproduction. Obviously people need places to live and work, yet our patterns of settlement typically reduce the availability, quality, and function of habitat for

native fish and wildlife. What is the scale of such habitat loss? Worldwide, approximately half the Earth's land area already has been transformed for human use: 11 percent each for farming and forestry, 26 percent for livestock pasture, and 2 to 3 percent for development (housing, industry, infrastructure, services, and transportation). In the greater Portland-Vancouver region, 22 percent of the land is identified as agriculture, 13 percent as developed, and an unknown but large number of acres is managed for forestry (see Table 1-1). Loss and degradation of habitat has resulted in the regional decline and extirpation of many plant, fish, and wildlife species, including the spotted frog, Lewis' woodpecker, western rattlesnake, black bear, and many plants and Neotropical migratory birds The most common types of habitat loss are habitat conversion, habitat fragmentation, and habitat degradation:

- **Habitat conversion.** Habitat conversion refers to the outright loss of habitat and includes construction of roadways, conversion to farms, and industrial, commercial, and residential development. The activities typically involve filling in wetlands, dredging rivers, mowing fields, and cutting down trees.

- **Habitat fragmentation.** Habitat fragmentation refers to conversion that results in larger, connected habitat patches being split into smaller, more isolated ones. Development and roadways—especially those without adequate wildlife crossings—have been the major cause of habitat fragmentation in the greater Portland-Vancouver region. For aquatic species, habitat also has been fragmented by dams, improper culverts, and water diversions. The loss and fragmentation of habitat make it difficult for migratory species to find places to rest and feed along their migration routes and reduces the viability of local resident populations.

- **Habitat degradation.** Habitat degradation refers to actions that, although they do not eliminate habitat, reduce the value of a given habitat patch for supporting biodiversity. Pollution, invasive species, structural simplification (such as removing standing dead trees), and disruption of ecosystem processes such as natural hydrological fluctuations and fire are some of the ways that habitats can become so degraded they no longer support native wildlife.

Of all land uses, development is considered the most lasting form of habitat loss, because the presence of pavement and buildings practically precludes a return to natural conditions.

Not all human modifications of the landscape are harmful to fish and wildlife. In some cases, human manipulation of land can improve habitat quality for some species. For example, agricultural areas and flooded fields have created habitat for some bird species, and structures such as tall buildings, cell phone towers, power line supports, and bridges have proven valuable for nesting raptors. Warm water created by dams and other impoundments are excellent habitat for warm-water fish such as perch and bass (although most warm-water species are non-native).

Barriers and Declining Landscape Permeability

Curt Zonick, Metro

Most biological communities remain stable only when they exist as a network of many smaller, functionally connected subpopulations. Together, the linked subpopulations form a regional metapopulation that is able to withstand occasional local extirpations by reoccupying empty habitat patches that have remained in spite of the extirpations. In addition, a biological community generally is healthier if it has abundant suitable habitat in large patches. As habitat patches become smaller in size and the number of suitable patches declines, chances increase that the subpopulations occupying those patches will disappear. This is basic island biogeography theory. However, just as important as the number or size of patches is how well they are connected. A patch of suitable habitat isolated from other patches may not serve a true functional role for native species or regional biodiversity.

Given the dynamics of metapopulations and habitat patches, preserving and improving ecological connectivity is a fundamental aspect of maintaining or restoring regional biodiversity. Thus, identifying and removing barriers that reduce ecological connectivity must be a high conservation priority. In some cases, federal transportation funding sources will increase project dollars for projects that retain or improve wildlife connectivity.

Natural Versus Artificial Barriers

Anything that prevents or reduces the free movement of native organisms among appropriate habitat patches is a barrier. Barriers reduce landscape permeability, which refers to ecological connectivity and an organism's ability to move freely within the landscape to meet its basic life needs.

Natural barriers, such as mountain ranges, large bodies of water, and areas of unsuitable habitat between suitable habitat patches, are a normal aspect of landscape-level biology and contribute to the evolution of species and the creation of a diversity of habitats. Natural barriers generally exist at the landscape scale and can take hundreds or even hundreds of thousands of years to divide a large population into two smaller but still quite large subpopulations. In contrast, human-made barriers such as roads, subdivisions, cities, and farms can carve a population into hundreds of very small subpopulations in just a few years or decades.

The isolation of small, remnant subpopulations can reduce the landscape's ability to support native fish and wildlife as much as habitat loss from development can. However, if habitat fragments remain functionally connected, native plant and animal species that might otherwise be extirpated will instead have a chance of persisting, despite declines that result from habitat loss and associated factors, such as edge effects.

Connectivity creates options, while barriers remove them. When organisms are able to move freely among remaining fragments, they have a greater chance of responding to stress and locally harsh conditions. Restricting or eliminating movement among habitat patches reduces the ability of subpopulations of plants and animals to find refuge in neighboring habitat patches when the one they are occupying becomes unsuitable because of reductions in food and nutrient resources, shelter, breeding conditions, or other factors. Isolation also reduces breeding interaction among subpopulations, thus fostering inbreeding, which over time reduces the genetic diversity, vigor, and adaptability of the regional metapopulation.

Types and Impacts of Artificial Barriers

Urbanization and land use changes in the greater Portland-Vancouver region have created a highly fragmented landscape with many human-made barriers and declining ecological permeability. The two most common types of human-made barriers stem from structural development, such as housing, and transportation infrastructure, such as roadways, railroads, and trails. Other types of artificial barriers that effectively disconnect habitat patches include large agricultural fields without brushy margins and hedgerows. For species that depend on old growth, large blocks of commercial forest can act as barriers to movement because they represent large areas of unsuitable habitat.

The effects of development are relatively obvious. A row of houses or commercial buildings replaces habitat with a mosaic of pavement, structures, and fencing that, collectively, can form an impassible barrier for most native terrestrial life forms.

Roads may seem more innocuous (especially smaller ones), but they can create barriers that are impermeable to some wildlife species. Wildlife impacts associated with road barriers include direct mortality from vehicular impacts, habitat loss and fragmentation, noise, light, and reduced air and water quality in adjacent habitats. Many wildlife species avoid roads altogether; this behavior protects them from vehicular impacts but also fragments their populations. Railroads and even poorly planned pedestrian trails can have many of the same barrier effects.

Incidental features associated with human-made barriers, such as artificial noise and light, can greatly amplify their harmful effects. Excessive noise can disrupt the normal habitat use and activity patterns of many wildlife species, increasing stress, drowning out breeding calls and other forms of communication, increasing predation risk, and reducing reproductive success. Artificial light can serve as a barrier by repelling or disorienting some species. Many bird and insect species have shown aberrant behavior near artificial lighting. Human disturbance also can serve as a virtual barrier for some species. For example, foot or bicycle traffic along trails can repel some birds or other animals or cause them to flush or abandon nests.

A significant effect of most human-made features is an increase in harmful, non-native species that tolerate people and developed habitats and even exploit the nooks, crannies, crusts, and crumbs of human infrastructure. Norway rats, skunks, raccoons, crows, starlings, and other generalist species can have devastating influences on native populations and form a sort of biotic barrier to native populations that are unable to compete with these opportunistic species for food, shelter, and breeding niches.

Roads and trails function most effectively for humans when they are connected to other roads and trails, and residential developments function better when they are located near commercial development and schools. In this way, regional planning that drives human transportation and development toward efficiency and higher human connectivity may drive native species toward a system of disconnected habitat fragments, reduced landscape permeability, and low biodiversity.

Effects of Barriers on Different Types of Biota

As described under "Biodiversity Corridors and Connectivity" in Chapter 6, a feature's influence on different guilds of plants and animals varies depending on the organism's size and its mode of travel or dispersal. A small road or swath of English ivy may be merely a nuisance to a deer or coyote but an insurmountable barrier to an amphibian. Flying animals can overcome barriers that block dispersal of some terrestrial animals. Culverts may allow adequate dispersal of fish, amphibians, and even some small mammals, provided that the culverts are partially or periodically dry; however, some terrestrial animals avoid small culverts, instead either crossing the road or turning back, thus aborting dispersal. Increasing the size of the culvert in a road often can promote passage by more species, but many animals that have the capability to cross a barrier still choose not to do so because of factors discussed above, such as light (often too little, but excessive artificial light can also be a barrier), artificial noise, moisture, or vegetation characteristics (too much or too little).

Additionally, indirect effects associated with culverts, such as their influence on water velocity when used to convey a stream beneath a road, can act as a functional barrier to fish and other guilds of wildlife that otherwise would be expected to pass through the barrier.

Plants that disperse by wind generally are able to traverse barriers better than those with heavy seed or that require animal vectors. Similarly, plants that require animal pollinators are more easily isolated than species that do not.

How New Barriers Are Assessed

The ecological impacts of artificial barriers often are assessed solely by their direct impacts. For example, the acreage of habitat directly lost when a building or a road is built often defines the amount of habitat restoration required (if any) to mitigate environmental damage from the project. This strategy is grossly insufficient, especially when the artificial barrier has a protracted linear dimension; examples include roads, canals, or trails. In fact, the impact of direct habitat loss resulting from a poorly designed road or trail project often is dwarfed by the damage done to local wildlife by separating previously connected habitat areas and wildlife populations. Although roads are carefully designed to allow water to pass beneath them (to preserve the integrity of the road), roads usually have only the most cursory wildlife crossing features, if they have any at all. Because of the Endangered Species Act, many road projects in the greater Portland-Vancouver region incorporate features designed to allow salmonids and other native fish to pass beneath them but they ignore the needs of terrestrial wildlife.

Strategies to Improve Regional Connectivity

Protecting and improving regional landscape permeability for native biota must be a high priority if the region's biodiversity and ecosystem services are to be protected and restored. It certainly is possible to build roads and human developments that pass through habitats without isolating the wildlife on either side. The solution requires that road projects be designed and budgeted to incorporate wildlife crossing features—and that such features be considered just as essential as water passage features or features to prevent subsidence when the project inevitably threatens to exceed the planned budget. Housing developers can set aside greenbelts that are sufficiently wide and thoughtfully designed to be not just token features, but functional corridors that preserve true landscape permeability and connect wildlife populations and their habitat patches.

Improving regional connectivity can probably best be accomplished through implementation of the following strategies:

- Work creatively, collaboratively, and proactively to design new road and development projects to ensure that they are truly ecologically permeable.
- Assess current roads and other transportation systems to identify, characterize, and prioritize barriers that can be modified to increase functional permeability.
- Use resources such as Metro's Green Trails and Wildlife Crossings guidebooks to reduce the impacts of barriers and human disturbance.
- Identify and prioritize the region's potential corridors and barriers within them.
- Conserve and restore key parcels in priority corridors through acquisition or incentive programs in partnership with private landowners.

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Water Quality

Lori Hennings, Metro

Historically, forest was the predominant land cover in the greater Portland-Vancouver region. Clearing for agriculture, followed by increasing urbanization and rural residential development, has markedly influenced overall water quality. Scientific research shows that water quality responds predictably to changes in land cover, typically declining as tree cover is removed and the amount of hard surfaces increases. Comparisons of land cover to overall stream health suggest that streams in the region have followed this general pattern.

Clark County – Clark County DES Perspective

The 2010 Clark County Stream Health Report (Clark County Department of Environmental Services, 2010) indicates that many Clark County streams are moderately to severely degraded. The report analyzes aquatic health in 10 county-defined watershed areas using water quality, biological, and stream flow indicators. The analysis is based on a significant amount of data collected since 2004, including nearly 900 water quality samples, 125 samples of aquatic invertebrates, and 19 continuous stream flow gages.

Forest cover and riparian vegetation condition strongly influence stream health issues in Clark County. Stream temperature issues are ubiquitous and typically stem from lack of shade and low summer stream flows. Channel erosion and habitat loss caused by altered stream hydrology is compounded by insufficient streamside vegetation and loss of instream woody debris. Inadequate riparian areas contribute to increased turbidity and fecal coliform bacteria pollution. The report recommends protection and rehabilitation of forest and riparian zones as critical components in improving stream health.

Overall stream health at the county watershed scale is summarized in Table 7-1. For detailed results at a scale covering 78 county subwatersheds, the complete 2010 Clark County Stream Health Report is available at http://www.clark.wa.gov/water-resources/watersheds.html.

CONDITION OF INDIVIDUAL WATERSHEDS IN CLARK COUNTY

A summary of conditions and conservation issues in each watershed in the RCS area is provided in Appendix I.

West Slope Watershed

Subwatersheds in the West Slope range from 18 to 38 percent forest and 11 to 25 percent hard surface. Significant additional urbanization is expected in the future. Water quality, biological health, and flow all are rated as poor. Water quality studies indicate widespread issues, including fecal coliform bacteria and elevated turbidity.

Salmon Creek Watershed

Subwatersheds in Salmon Creek range from 7 to 68 percent forest and 10 to 51 percent hard surface. This watershed contains some of the most urbanized and least urbanized areas in the

county, with significant additional urbanization expected. Salmon Creek also contains some of the least healthy and most healthy subwatersheds countywide. Water quality and flow are rated as fair, with biological health rated as poor. The watershed has temperature, fecal coliform, and turbidity issues.

East Fork Lewis River Watershed

Subwatersheds in the East Fork Lewis River range from 20 to 90 percent forest and 4 to 20 percent hard surface. The upper watershed is primarily forested, while the middle and lower watershed has mostly been cleared for agriculture and development. Water quality and biological health are rated as fair, and stream flow is rated as good. Water quality studies indicate issues with fecal coliform bacteria, particularly in the lower watershed.

North Fork Lewis River Watershed

Subwatersheds in the North Fork Lewis River range from 39 to 75 percent forest and 3 to 14 percent hard surface. Timber management continues to be the primary land use, and very little future urbanization is expected. Water quality is rated as good and biological health as fair. No stream flow data are available. Cedar Creek has stream temperature issues.

Lacamas Creek Watershed
Subwatersheds in Lacamas Creek range from 12 to 83 percent forest and 6 to 40 percent hard surface. Significant continued urbanization is expected in the already cleared areas in the western and southern watershed. The heavily forested upper watershed is protected within the Camp Bonneville military reservation. Water quality and biological health are rated as fair, and stream flow is rated as good. Lacamas Lake is a regional resource in this watershed; studies indicate that the lake is eutrophic and significantly altered from its natural historical condition. General lake health is fair.

Washougal River Watershed
Subwatersheds in the Washougal River range from 18 to 91 percent forest and 5 to 28 percent hard surface. Urbanization is concentrated in the lower watershed, with limited additional growth expected. Water quality and stream flow are rated as good, and biological health is fair. The watershed has the highest overall health rating in the county, but stream temperatures are an issue.

Gibbons Creek Watershed
Subwatersheds in Gibbons Creek range from 13 to 54 percent forest and 8 to 15 percent hard surface. Urbanization is confined to the Campen Creek area in the western watershed. Limited future development is expected; much of the watershed is protected as part of the Columbia River Gorge Scenic Area. Biological health is rated as fair; data on water quality or stream flow are insufficient to determine a rating. Studies indicate issues with fecal coliform and, to a lesser degree, turbidity.

Vancouver Lake/Lake River Watershed
Much of this watershed is within the historical Columbia River floodplain, so forest cover in the area is naturally limited. Urbanization is concentrated in the eastern and southern portions of the watershed, within the city of Vancouver. Limited additional urbanization is expected, except for expansion at the Port of Vancouver. Data are available only for the heavily urbanized Lakeshore area, where water quality and biological health are rated as poor; stream flow data are unavailable. Vancouver Lake is a significant regional resource in this watershed but is in poor health. Studies indicate that the lake is hypereutrophic and significantly altered from its natural historical condition.

Burnt Bridge Creek Watershed
Subwatersheds in Burnt Bridge Creek range from 4 to 10 percent forest and 50 to 58 percent hard surface. This is the most heavily urbanized watershed in Clark County. A limited dataset was analyzed for the report, which rated water quality as poor. Studies indicate widespread issues with fecal coliform bacteria and stream temperature. Historical datasets suggest that Burnt Bridge Creek is the least healthy stream in Clark County.

Columbia Slope Watershed
Subwatersheds in the Columbia Slope range from 5 to 15 percent forest and 28 to 54 percent hard surface. This area is heavily urbanized, and surface water consists primarily of hillslope seeps that drain to the Columbia River. No water quality, biological, or stream flow data are available.

TRENDS IN STREAM HEALTH FOR CLARK COUNTY WATERSHEDS

Trend information is somewhat limited for Clark County streams. Samples collected at 15 locations indicate that water quality is improving at four locations, degrading at five, stable at four, and variable at two. Overall, improving trends are in areas with poor current water quality that have long been degraded; declining and mixed trends are in areas with increased urbanization and rural residential development.

Data sets of aquatic invertebrates in Clark County are insufficient for statistical trend calculations. General patterns based on samples from 10 locations suggest that locations with declining biological health or consistently low scores are in heavily developed or rapidly urbanizing areas. Improving or consistently high scores are in relatively undeveloped areas with higher amounts of intact forest. Figure 7-1 shows the general health of Clark County watersheds.

STRATEGIES FOR CLARK COUNTY WATERSHEDS

The report suggests that protection and rehabilitation of forest and riparian zones are critical components in improving stream health in many Clark County watersheds, along with effective stormwater management, appropriate development regulations, and wetland enhancement. The following strategies are recommended for forest and riparian zones in many Clark County watersheds:

- Control invasive species.
- Reforest previously cleared forest lands.
- Restore streambanks, floodplains, and riparian vegetation.
- Support healthy riparian management practices in residential areas.
- Conserve intact forested areas.

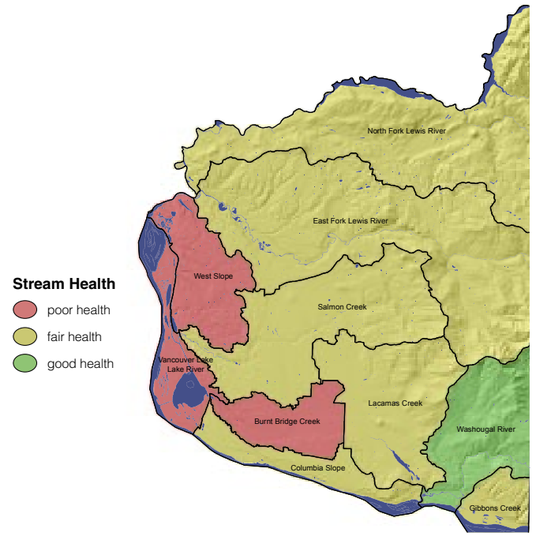
Oregon Department of Environmental Quality (DEQ) Perspective

A 2009 study by the Oregon Department of Environmental Quality (DEQ) used aquatic chemical, habitat, and biological indicators to measure the health of the 12 subbasins in the Willamette Basin. Land use and land cover were the critical factors associated with aquatic and streamside conditions. Substantial data demonstrated that fish, amphibians, aquatic insects, and water quality strongly depend on the trees, shrubs, and groundcover along streams. Agriculture, urbanization, and forest practices throughout the basin diminish the health of the Willamette Basin's rivers and streams by causing habitat loss and altering hydrology.

The most significant problem is stream temperatures that are too warm for salmon and other aquatic species, in part because of loss of streamside vegetation. The report finds that restoring and maintaining native streamside vegetation may be the best and most practical solution to several problems.

Specific water quality issues in the Clackamas, Lower Willamette, Molalla-Pudding, Tualatin, and Yamhill subbasins that make up much of the greater Portland-Vancouver region are summarized below, with a focus on the ecologically important indicators of macroinvertebrates, vertebrates, fine sediment, riparian vegetation, stream temperature, and total nitrogen (Table 7-2). The complete report is available online at www.deq.state.or.us/lab/wqm/docs/WillametteBasinAssessment2009.pdf.

FIGURE 7-1
Clark County Stream Health by Watershed



CONDITION OF INDIVIDUAL SUBBASINS IN OREGON

Clackamas Subbasin

The Clackamas subbasin is 89 percent forested, with the remaining 11 percent being a combination of urban and agriculture land uses. Of the five Oregon subbasins in the greater Portland-Vancouver region, the Clackamas has the fewest impaired stream miles: 15 percent of the stream miles are in poor condition for macroinvertebrates and 26 percent are in poor condition for fish and amphibians.

The extent of poor habitat structure conditions is fairly low for the stressors that were evaluated. Riparian vegetation and fine sediment are extensive stressors in the Clackamas subbasin. The overall chemical water quality is generally good. The extent of streams with excessive nitrogen is among the lowest of the five Oregon subbasins in the greater Portland-Vancouver region, but elevated water temperatures are fairly extensive (i.e., 50 percent of the stream length).

Lower Willamette Subbasin

Most of the Portland metropolitan area is within the Lower Willamette subbasin, which is located at the downstream end of the Willamette Basin and is the basin's most extensively urbanized subbasin. A total of 51 percent of the Lower Willamette subbasin is in urban land use, 21 percent is agricultural, and 28 percent is forested. Of the five Oregon subbasins in the greater Portland-Vancouver region, the Lower Willamette has the highest proportion of stream miles that are in poor condition for aquatic macroinvertebrates and aquatic vertebrates (77 percent and 41 percent of stream miles, respectively).

High fine sediment loads and poor riparian vegetation are key habitat impairments, and water quality is the lowest among all subbasins within the Willamette Basin. Temperature is the key water quality impairment, with 82 percent of stream miles exceeding the temperature standard. Excess nitrogen is a major stressor.

Molalla-Pudding Subbasin

Land uses in the Molalla-Pudding subbasin are primarily forestry and agriculture (49 percent and 45 percent of the subbasin, respectively). Of the five Oregon subbasins in the greater Portland-Vancouver region, only the Yamhill has a higher percentage of agricultural land use. The Molalla-Pudding subbasin ranks second lowest in the percentage of stream miles in poor condition for aquatic vertebrates and aquatic macroinvertebrates (30 percent and 38 percent, respectively).

The most extensive water quality stressors in the Molalla-Pudding subbasin are high water temperature (87 percent of stream miles rated as poor) and excess nitrogen (71 percent of stream miles rated as poor). The extent of poor riparian habitat conditions is fairly high (i.e., 45 percent of stream extent). Approximately 30 percent of the streams had high levels of fine sediment. Many impaired stream sites are in the agriculturally dominated Pudding River subbasin.

Tualatin Subbasin

The Tualatin subbasin is the second most urbanized subbasin in the Willamette Basin, with nearly 27 percent of the subbasin in urban land use. The watershed includes all or part of the cities of Beaverton, Hillsboro, Forest Grove, Tigard, Tualatin, and Lake Oswego. Of the five Oregon subbasins in the greater Portland-Vancouver region, the Tualatin has the second highest number of stream miles in disturbed biological condition for both aquatic vertebrates and aquatic macroinvertebrates (37 percent and 71 percent, respectively).

TABLE 7-1

Land Use and Water Quality, Biological, and Stream Flow Indicators in Clark County, Washington

Watershed	Land Use (range of % in subwatersheds		Water Quality Indicator	Biological Indicator	Stream Flow Indicator
	Forest	Hard surface	Oregon Water Quality Index	Benthic Index of Biological Integrity	TQmean
West Slope	18-38	11-25	Poor	Poor	Poor
Salmon Creek	7-68	10-51	Fair	Poor	Fair
East Fork Lewis R	20-90	4-20	Fair	Fair	Good
North Fork Lewis R	39-75	3-14	Good	Fair	NA
Lacamas Creek	12-83	6-40	Fair	Fair	Good
Washougal River	18-91	5-28	Good	Fair	Good
Gibbons Creek	13-54	8-15	NA	Fair	NA
Vancouver Lake/Lake River	8	17-47	Poor	Poor	NA
Burnt Bridge Creek	4-10	50-58	Poor	NA	NA
Columbia Slope	5-15	28-54	NA	NA	NA

Many of the streams in the Tualatin subbasin are in an undesirable condition to support aquatic life, with high levels of excess fine sediment (81 percent of stream miles) and poor riparian vegetation (50 percent of stream miles). The Tualatin subbasin has more stream miles disturbed by excess fine sediment than any of the five Oregon subbasins in the greater Portland-Vancouver region and ranks second in terms of the extent of poor riparian vegetation. It is estimated that 100 percent of streams in the Tualatin subbasin violate the temperature standard and 35 percent of them are in poor condition for nitrogen.

Yamhill Subbasin

The Yamhill subbasin has the most agriculture land use (48 percent) of the five Oregon subbasins in the greater Portland-Vancouver region and is similar to the Molalla-Pudding subbasin in terms of the amount of urban and forested area (8 percent and 44 percent, respectively. The Yamhill subbasin has a moderate (and variable) level of impaired biological condition for aquatic vertebrates (17 percent of stream miles are rated as poor) and aquatic macroinvertebrates (63 percent of stream miles are in the most disturbed condition).

DEQ's survey indicated a moderately high level of habitat impairment. Of the five Oregon subbasins in the greater Portland-Vancouver region, the Yamhill subbasin ranked highest in the number of stream miles impaired by sparse riparian vegetation (53 percent) and third in the number that are impaired by excess fine sediment (43 percent). High water temperature is the leading stressor, impairing 37 percent of the stream miles in the subbasin, but the basin is second best (after the Clackamas) for total nitrogen impairment (only 6 percent of stream miles).

CONCLUSIONS REGARDING OREGON SUBBASINS

Warm water is the single most extensive impairment in subbasins in the Oregon portion of the greater Portland-Vancouver region. The proportion of stream miles (by subbasin) that violate the temperature criteria range from 37 percent to 100 percent. Protection for sensitive cold-water fish such as salmon and trout is lacking. Depending on subbasin, between 11 percent and 53 percent

TABLE 7-2

Land Use and Biological, Habitat, and Water Quality Indicators in Selected Willamette Basin Subbasins

Subbasin	Land Use (% of watershed)			Biological Indicators % of stream miles in poor condition		Habitat Indicators % of stream miles in poor condition		Water Quality Indicators % of stream miles in poor condition	
	Urban	Ag	Forest	Macros	Fish & Amphibians	Riparian Vegetation	Fine Sediment	Temp.	Total Nitrogen
Clackamas	7	5	89	15	26	11	20	50	0
Lower Willamette	51	21	28	77	41	27	51	82	22
Molalla-Pudding	6	45	49	38	30	45	32	87	71
Tualatin	27	35	38	71	37	50	81	100	35
Yamhill	8	48	44	64	17	53	43	37	6

of stream miles lack riparian vegetation to provide canopy cover. Elevated fine sediment is also an important stressor in these subbasins, impairing from between 20 percent and 81 percent of stream miles (with the amount varying by subbasin). The Clackamas subbasin is not impaired by total nitrogen, but in other subbasins, the proportion of stream miles that are nutrient impaired ranges from 6 to 70 percent.

STRATEGIES FOR OREGON SUBBASINS

The single most important strategy that should be adopted for Oregon subbasins within the greater Portland-Vancouver region is riparian protection and restoration measures. Improving riparian conditions will reduce stream temperatures, sediment, and pollutant inputs and increase large wood delivery and overall fish and wildlife habitat.

FOR MORE INFORMATION

Clark County Stream Health Report (2010)

http://www.clark.wa.gov/water-resources/watersheds.html

Willamette Basin Rivers and Streams Assessment Oregon Department of Environmental Quality. 2009. http://www.deq.state.or.us/lab/wqm/docs/WillametteBasinAssessment2009.pdf

Invasive Species

Dominic Maze, City of Portland; Tania Siemens, Oregon State University Extension Service; and Mary Logalbo, West Multnomah Soil and Water Conservation District

There are several commonly used definitions of invasive species. Perhaps the most robust and succinct defines invasive species as "non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." A key element to all definitions is that invasive species can actively displace other (i.e., native) species and have long-lasting or even permanent detrimental effects on various habitats and the organisms that depend on them.

Next to outright conversion of land, invasive species and climate change are generally considered the most important threats to biodiversity. Invasive species play a significant role in altering the landscape and fundamental ecosystem processes, decreasing biodiversity, and damaging infrastructure. In an urbanized and fragmented area, invasive species pose a particularly acute threat to remaining habitats.

Invasive species such as non-native rats, insect pests, human and animal diseases, and many plants that now are considered weeds were first introduced to the greater Portland-Vancouver region by European trappers, explorers, and early settlers. The subsequent agricultural development and urbanization of the region over the last 150 years has resulted in a landscape that bears scant resemblance to its pre-developed state, with altered habitats for native plants and wildlife. This remaining, fragmented habitat is degraded by invasive species that already have become established and is under threat from new invaders that are continually and increasingly being introduced. The influx of invasive species is particularly pronounced in the greater Portland-Vancouver region, which not only supports two major ports, but also has interstate highways, powerline and gasline corridors, and commercial and recreational shipping/boating that serve as pathways for new introductions of invasive species.

Importance

When invasive species become dominant or even merely common, populations of native species typically decline as a result of outright competition or secondary effects, such as changes in stream bank stability or the frequency and intensity of fire. New invaders often out-compete native species for food, light, and space. Examples include the English and Irish ivies (*Hedera helix* and *H. hibernica*) that dominate many mixed conifer, riparian and floodplain forests, or English starlings that compete with western bluebirds and birds in narrow riparian corridors for nest cavities. Competition may be direct, as in the case of bullfrogs that actively prey on native amphibians, but less direct effects also are important. For example, the grey garden slug (*Deroceras reticulatum*) prefers to eat native, annual forb seedlings, thus creating opportunities for non-native plants to flourish. When non-native grasses, such as slender false brome (*Brachypodium sylvaticum*), dominate the forest understory, it provides cover from predators, allowing rodents to eat native seedlings. Invasive garlic mustard can grow in interior forests, where its fungicidal properties may impair native plant establishment and health. Finally, the loss of one native species may result in the loss of other native species that rely on the first for essential resources, as in the dependence of Fender's blue butterfly (*Icaricia icarioides fenderi*) on Kincaid's lupine (*Lupinus sulphureus var. kincaidii*).

Although invasive species initially increase diversity by adding new species to an area, the temporary increase in the total number of species in a community is followed by an eventual decrease in regional-scale diversity as the region's (and world's) biota is homogenized toward fewer, dominant invasive species.

Invasive species can pose threats to both native species and human well-being. Invasive species affect watershed health by increasing erosion rates and sedimentation levels of waterways, and by eventually reducing canopy cover, which can increase water temperature. The dense growth of English and Irish ivies and old man's beard weighs down trees, increases fuel loads, and alters fire dynamics, resulting in increased fire severity and risk. Invasive plants alter and homogenize vegetation cover types; this can result in dramatically reduced stormwater interception as habitats are converted to an invasive monoculture. Aquatic animal invasives such as the New Zealand mudsnail (*Potamopyrgus antipodarum*) and quagga mussel (*Dreissena bugensis*), both of which have become established east of the greater Portland-Vancouver region, impose large and sometimes restrictive maintenance costs on fish hatcheries and hydroelectric power plants. Finally, invasive animals such as nutria (*Myocastor coypus*) and non-native mosquitoes can carry diseases such as Salmonella spp. and West Nile virus to which humans are susceptible.

TABLE 7-3
Typical Invasive Species by Major Habitat Type

Habitat Type	Examples of Invasive Species	Effects
Upland Conifer and Mixed Conifer Broadleaf Forest	English and Irish ivy *(Hedera helix and H. hibernica)* Garlic mustard *(Alliaria petiolata)* English holly *(Ilex aquifolium)* Himalayan blackberry *(Rubus armeniacus or Rubus discolor)* Scots' broom *(Cytisus scoparius)* Old man's beard *(traveler's joy, Clematis vitalba)* Spurge laurel *(Daphne laureola)* Gypsy moths *(Lymantria dispar)*	Vines climb and topple trees. Brooms prevent reestablishment of trees following harvest or blow-down. All species can dominate understory. Some species poisonous to animals and can cause dermatitis in humans. Insects can cause severe defoliation of hardwoods and conifers.
Riparian Forest	Knotweeds *(Polygonum spp.)* Himalayan blackberry Green alder sawfly *(Monsoma pulveratum)*	Alterations in streambank erosion dynamics and the large wood cycle; decreased structure variability. The sawfly defoliates and weakens alders *(Alnus spp.)*
Floodplain Forest	Old man's beard Black stem borer *(Xylosandrus germanus)*	Increases in fire severity and return interval Shading of understory Plants attack numerous tree species, spreading symbiotic fungal disease *(Fusarium sp.)* Possible extirpation of Oregon ash *(Fraxinus latifolia)* populations
Wet and Upland Prairie	Non-native grasses, thistles, blackberry, Scots broom Non-native slugs *(Arion ater complex, Deroceras reticulatum)*	Grasses form dense, rhizomatous (root) mats that prevent growth of natives and decrease habitat for ground-nesting birds. Slugs preferentially consume native annual forbs.
Oak Woodland and Savanna	One-seed hawthorn *(Crataegus monogyna)* Scot's broom Himalayan blackberry Pasture grasses Eastern gray squirrel	Displacement of native forbs/grasses Restricted Oregon white oak *(Quercus garryana)* recruitment Eastern gray squirrel out-competes western gray squirrel for resources
Wetlands	Reed canarygrass Common reed *(Phragmites australis ssp. australis)* Nutria	Displacement of native vegetation and avian nesting habitat Erosion Nutria out-competes native muskrat.
Freshwater and Upper Estuarine	Brazilian elodea *(Egeria densa)* Water primrose *(Ludwigia spp.)* New Zealand mudsnail *(Potamopyrgus antipodarum)* Siberian prawn *(Exopalaemon modestus)*	Dense monocultures that increase sedimentation and reduce water quality, navigational ability and recreational opportunities Dramatic alterations in trophic interactions and nutrient cycling, resulting in decreased growth rates for native animal species

Habitats Affected

The greater Portland-Vancouver region supports many habitat types, including pure and mixed coniferous forest, floodplain forest, wet and upland prairie, oak savanna and woodland, wetlands, and riparian and open-water ecosystems. (See Chapter 3 for descriptions of these and other habitat types.) These habitats all support diverse and unique assemblages of native species. Although invasive species have heavily affected many of these habitats (see Table 7-3), the extent of the effect differs. There is evidence that prairies, oak savanna, and wetlands have been the most altered by invasive species. This alteration of the vegetation leaves little habitat or resources for many at-risk species (see Chapter 3 for details).

Aquarium turtles that have been released to the wild, such as red-eared sliders, out-compete native turtle species in wetlands and can spread disease to native animals. The spread of exotic grass species, such as reed canarygrass (*Phalaris arundinacea*), in wet and seasonally wet habitats results in dense monocultures that can create an ecological desert where virtually all the biomass of the habitat is one species and is of little use to most native wildlife species.

Economic Impact

Invasive species result in lost resource potential and are being managed at the regional, state, and federal level. By the end of the 1990s, invasive plants alone cost the U.S. economy $13 billion dollars annually. These costs are primarily due to losses in crop and livestock production, control efforts, damage to property values, and reduced export potential and are being passed on to consumers through higher costs in the agricultural products consumers buy in the marketplace. The Oregon Department of Agriculture estimates that 21 invasive plant species in Oregon have reduced personal income in the state by $83 million per year.

In a study of 12 different invasive species, the median cost of early detection, control, and eradication was $1 dollar for every $17 dollars of future potential damage that would have been caused by that species. In 2008, Oregon spent an estimated $26 million on invasive species-related activities. This figure does not include resources expended by private entities such as homeowners and timber companies.

Estimates of the economic impact of invasive species do not account for future impacts such as the collapse of native pollinator services or the introduction of diseases that affect humans and domestic animals. Less tangible impacts include the loss of native bird and amphibian species that are essential components of a healthy ecosystem and that, for many people, increase the aesthetic value of the landscape.

Himalayan blackberry eradication has taken on new importance with the introduction of the spotted wing drosophila (Drosophila suzukii). This new pest of berry and tree fruit uses the invasive blackberry as a host and can build up huge populations to infest nearby crop land.

Strategies to Combat Invasive Species

Strategies to combat invasive species include prevention, early detection and rapid response control programs, research, monitoring, implementation of best management practices, effective policy, and education. Coordination at the appropriate geographic level is essential to successful invasive species management because invasive species can travel quickly over the landscape across multiple land ownerships and jurisdictions. Example of species that require national coordination include zebra and quagga mussels and the Emerald ash borer. To achieve success in the implementation of these strategies, additional

capacity should be built on a local, regional, statewide, and national scale.

PREVENTION AND EDUCATION

Regional efforts must focus on preventing the introduction and establishment of invasive organisms. Education in all sectors, including natural resource agencies, the nursery/pet industries, and the general public, is an integral part of any prevention plan. Prevention efforts should be institutionalized in all levels of operation, ranging from day-to-day protocols (such as cleaning footwear, tires, and equipment) to the thoughtful sale and purchase of non-invasive organisms.

EARLY DETECTION AND RAPID RESPONSE

Early detection and rapid response (EDRR) programs are considered the most cost-effective strategy for preventing the spread of invasive species at the county or multi-county scale. EDRR is analogous to preventive medicine: we minimize cost and damage to our natural resources by finding and controlling high-priority new invaders early, when their populations are still manageable. This strategy increases the likelihood that invasions will be addressed effectively while populations are small enough to be contained and eradicated.

Although the concept of EDRR is intuitive and appealing to many land managers, actually achieving effective EDRR requires strong coordination and shared responsibility across federal, state, and local agencies and organizations, as well as with private landowners, hobby groups, and concerned citizens. A successful EDRR program integrates a target invasive species list, informed surveyors, reporting and mapping protocols, pre-determined local management responses, and thorough survey and follow-up protocols. Policies that provide resources and require the rapid treatment of the highest priority EDRR species would greatly enhance this strategy's functionality because often the main obstacles in EDRR programs are a lack of permission to treat lands and lack of funding.

RESEARCH AND MONITORING

Extensive research and monitoring in the realm of detection, vector control, integrated pest management, and existing control efforts are crucial to ensure effectiveness and allow for adaptive management. Timely research on controlling newly arriving species is critical. Additional intensive and proactive agency and academic efforts are needed to complete risk assessment studies and identify candidates for such studies. Information exchange and multiagency efforts should be coordinated through targeted networks, such as cooperative weed management areas (see sidebar) and shared databases to maximize regional success and to pinpoint program strategy areas and species.

RESTORATION/CONTROL PROGRAMS

Even if efforts to slow or stop the arrival and spread of new invaders are successful, there is a substantial need for and an enormous potential benefit to effective and efficient treatment of existing invasive species problems in the region's natural areas, parks, and unmanaged landscapes. Given the limited financial and personnel resources, prioritization of the removal and control of existing invasive organisms in key natural areas and working lands and waters should be done thoughtfully. Candidates for control should be determined by considering the invaders' ability to disrupt key ecological and economic services. Control efforts should be targeted in crucial habitat areas, biodiversity corridors, and working lands. Realistic long-term management plans for areas where invaders are treated are vital to success.

4-COUNTY COOPERATIVE WEED MANAGEMENT AREA

The Clackamas, Clark, Multnomah, and Washington County Cooperative Weed Management Area is a partnership of about 25 organizations in the four counties dedicated to combating invasive weeds for the benefit of native habitat and people. The 4-County CWMA is part of the Northwest Weed Management Partnership. Because weed issues typically extend across multiple ownerships, the CWMA emphasizes and supports collaborative weed management among land managers. The partnership actively engages in weed education and outreach and serves as a coordinating body for weed inventory and prevention and on-the-ground weed control activities, with a focus on members' early detection and rapid response lists. The CWMA meets monthly and maintains a master weed list as well as information on the status of invasive species in the region. For more information, go to www.4countycwma.org and http://www.westerninvasivesnetwork.org/pages/nwmp.html

Climate Change and Invasive Species

Climate change may complicate invasive species control efforts and further exacerbate already stressed ecosystems. Possible outcomes of concern include a higher likelihood of new species dispersing into the region and a loosening of the environmental constraints that, until now, have kept populations of certain exotic species present in the region from becoming invasive. Identifying and mitigating any of these effects will require many of the same strategies identified above, including monitoring, coordination at multiple scales, and careful use of available resources.

Successes

Although the impacts and sheer number of invasive species present and poised to establish themselves in the greater Portland-Vancouver region seem insurmountable, battles are being won. As of the beginning of 2010, the Washington Department of Fish and Wildlife had intercepted and decontaminated 17 boats with quagga and zebra (Dreissena polymorpha) mussels. Early detection of species such as the Gypsy moth, which could devastate Oregon and Washington's economies and landscapes, have resulted in prompt and coordinated eradication. Laws prohibiting the possession or release of certain plant and animal species within each state are being strengthened and modified to address new threats and risks. The Oregon and Washington Invasive Species Councils are national models in conducting a coordinated, comprehensive effort by multiple local, state and federal partners to keep invasive species out of the Pacific Northwest. Successful classical biological control of several of the most damaging plant and invertebrate pests has resulted from intensive research and coordination between partners such as Oregon State University, the Oregon and Washington State Departments of Agriculture, and the U.S. Department of Agriculture. Coordination of multiple entities through the 4-County Cooperative Weed Management Area has resulted in successful early detection and rapid response campaigns in the region and production of many outreach and education materials. Cities such as Portland lead the nation in progressive, multi-tiered approaches to mitigating and managing the effects of invasive species and leveraging resources available through partnerships at the state and federal level to advance collaborative efforts with NGOs, city bureaus, counties, regional governments such as Metro, and neighborhood groups.

For species that seem certain to arrive because of their dispersal abilities and difficulty to detect, such as the New Zealand mudsnail, any amount of time they are kept out of the region should be considered a cost-saving victory. For species that already are present, such as slender false brome, management, containment, and education will continue to mitigate future costs and damage to the environment.

Continuing the efforts to combat invasive species is essential to the region's economy, native habitats, and quality of life. World commerce and ease of travel continue to increase, providing ample opportunity for species to arrive in

new locales. Perhaps the greatest future threat with regard to invasive species is apathy: as the public becomes more aware of the risks, costs, and damage inflicted by these species, a sense of futility may emerge. However, it is essential to the integrity of the region's ecology and inhabitants that these efforts continue.

FOR MORE INFORMATION

Online Resources

Four County Cooperative Weed Management Area
http://www.4countycwma.org

Weed Watchers EDRR (Early Detection and Rapid Response) ID Guide for Multnomah County & Sandy River Basin
http://www.wmswcd.org/public/file/EDRR%20Booklet/book_intro%20proof.pdf

Oregon Invasives Hotline
http://oregoninvasiveshotline.org/

Oregon Invasive Species Council
http://www.oregon.gov/OISC

http://www.oregon.gov/ODA/PLANT/index.shtml

City of Portland, Invasive Plant Management
http://www.portlandonline.com/bes/index.cfm?c=45696

iMapInvasives
http://www.imapinvasives.org/

Northwest Weed Management Partnership
http://www.westerninvasivesnetwork.org/index.php

Species Identification Guides

Urbanizing Flora of Portland, Oregon 1806-2008
John A Christy, Angela Kimpo, Vernon Marttala, Philip Gaddis, Nancy L Christy. 2009.

Weeds of the West
Western U.S. Cooperative Extension Services
Tom Whitson, Editor. 2001.

Northwest Weeds
Ronald J. Taylor. 2003.

Field Guide to Weeds of the Willamette Valley
Institute for Applied Ecology. 2008.

Human Activity

Bruce Barbarasch, Tualatin Hills Parks and Recreation District

For as long as humans have lived in the Pacific Northwest they have modified the environment to suit their needs. As post-1850 settlement progressed, roads, homes, businesses, and industrial areas were built across the region. These changes directly affected habitat and indirectly affected the behavior of wildlife in transition or edge areas. Although some wildlife benefit from human changes to the environment, most are negatively affected. For example, roads create edges between developed and natural areas or fragment natural areas. There are nearly 4 million miles of roads in the United States. Urban areas with high road densities can be deterrents, permanent barriers, or sources of mortality for wildlife when they attempt to cross these roads. Although some species of plants and animals thrive in edge environments created by roads, many others find roads problematic. In addition, roadways can be corridors for invasive and non-native weeds A review of wildlife studies found that the negative effects of roads on wildlife outnumbered positive effects by a factor of five.

Noise from roads primarily affects wildlife negatively, although in a few circumstances certain species may benefit. Road noise and related traffic can cause flight behavior in large mammals, increase stress response, and disrupt reproduction. Many native bird species—particularly neotropical migrants—are less attracted to areas with busy or many roads or avoid them altogether. A number of studies show that birds and frogs alter the pitch of their songs in the presence of road noise, possibly to be heard over the noise in order to attract mates or defend territories.

Artificial light from streetlamps, homes, and businesses often finds its way into natural areas. Lights allow for extended foraging time for certain reptile and bird species and enhanced foraging for bats that follow insects attracted by the lights. Some nocturnal animals are disoriented by light or experience navigation issues or temporary blinding, which can lead to an increase in predation. Migrating birds are known to be confused by tall buildings lit up at night, sometimes striking a building and falling to their deaths. Lights can also form barriers to large predators who avoid well-lit areas. In some cases, artificial lighting causes birds or frogs to sing at night or earlier in the morning than they naturally would, and waste valuable energy.

Although trails allow people access to nature and give them a sense of connection, trails also have a subtle but direct impact on wildlife. Physically, trails create edge habitat, cause soil compaction and erosion, serve as corridors for invasive plant species, and fragment habitat at a small scale. Trails can attract nest predators such as crows and jays. In addition, human use of trails in natural areas alters wildlife behavior; for example, nearly all birds will flee if approached too closely, although larger species and those that nest close to the ground may more tolerant of disturbances. Some wildlife appear to acclimate to human activities, while others become less abundant in areas with trails. Wildlife seem to be less affected by slower moving walkers than by joggers or bicyclists and are the least affected by people in slow-moving or stopped vehicles.

Dogs on or near trails have negative impacts beyond those of people alone. In one study, deer and small mammals stayed twice as far away from trails with dog activity than they did from trails with human use only; another researcher observed a 35 percent reductions of birds and small mammals near trails used by dogs compared to trails used just by people. Domestic cats may be abundant in urban natural areas and are prolific hunters who kill birds, snakes, lizards, and small mammals.

Strategies for Reducing the Impact of Human Activity

Although human activity can significantly alter wildlife habitat and behavior, there are many opportunities to foster nature in the city through the use of best management practices and behavior changes:

- Draw on the increasing body of knowledge about wildlife's response to roads—including manuals on wildlife crossings—to help provide for wildlife movement in new projects or to improve movement when retrofitting existing roads.

- Lessen unnecessary artificial lights through local building codes and other measures. Groups such as the International Dark-Sky Association already are working on this issue.

- Design and redesign trails to both provide access to nature and allow wildlife to pursue their normal activities.

- Engage in public education, create and enforce appropriate park rules, and actively manage sites to reduce the numbers of domestic animals in wildlife areas.

FOR MORE INFORMATION

Lights Out Portland
Audubon Society of Portland. Online information about bird kill studies and efforts to reduce light pollution. www.audubonportland.org/issues/metro/bsafe/lo

"Effects of Artificial Night Lighting on Terrestrial Mammals"
P. Beier. 2006. P. 19-42 in C. Rich, and T. Longcore [eds.], *Ecological Consequences of Artificial Night Lighting.* Island Press, District of Columbia, U.S.

"Quantifying the Road-effect Zone: Threshold Effects of a Motorway on Anuran Populations in Ontario, Canada"
Eigenbrod, F., S. J. Hecnar, and L. Fahrig. 2009. *Ecology and Society* [online] 4:Article 24.

"Human-caused Disturbance Stimuli as a Form of Predation Risk"
A. Frid and L. Dill. 2002. Conservation Ecology [online] 6:Article 11.

International Dark Sky Association. International nonprofit. Online resource available at http://www.darksky.org/.

Ecological Impacts of Recreational Use of Trails: A Literature Review
M. Jordan. 2000. The Nature Conservancy, Cold Spring Harbor, NY. Available online at www.parks.ca.gov/pages/1324/files/ecological%20impacts%20of%20recreational%20users.pdf

"Ecological Light Pollution"

T. Longcore and C. Rich. 2004. *Frontiers in Ecology* 2:191-198.

"Wildlife Responses to Pedestrians and Dogs"

S.G. Miller, R.L. Knight, and C.K. Miller. 2001. *Wildlife Society Bulletin* 29:124-132.
Noise Pollution Clearinghouse. National nonprofit. Online resource available at http://www.nonoise.org/index.htm.

"Disturbance by Traffic of Breeding Birds: Evaluation of the Effect and Considerations in Planning and Managing Road Corridor"
R. Reijnen, R.R. Foppen, and G. Veenbaas. *Biodiversity and Conservation* 6(4), 567-581. 1997.

Green Trails: Guidelines for Environmentally Friendly Trails
Metro Regional Government. 2004. Portland, OR.

Wildlife Crossings: Providing Safe Passage for Urban Wildlife
Metro Regional Government. 2009. Portland, OR.

Chemical Pollutants

Lori Hennings, Metro

Chemical pollutants affect water quality, fish and wildlife, and potentially human health. Sources of chemical pollutants include households, industry, agriculture, soil erosion, roads, and wastewater discharge; in the case of air pollution, sources can be local or global. Persistent pollutants are toxics that persist in the environment or bioaccumulate in the tissues of humans, fish, wildlife, or plants. Some persistent pollutants are known carcinogens, disrupt endocrine (i.e., hormone) functions, or are harmful via other mechanisms. Legacy persistent pollutants are those that have been banned or restricted for several years but remain detectable in sediment and tissue samples; the breakdown products of DDT are one example. Table 7-4 lists some of the persistent pollutants found in the greater Portland-Vancouver region.

Local, state, and federal concern over persistent pollutants has grown in recent years because scientists are more aware of harmful effects, more pollutants are being manufactured and used, and detection methods have improved. Recent studies in Oregon and Washington attest to these concerns. U.S. Geological Service studies in the Willamette Basin and U.S. Environmental Protection Agency studies of the Columbia River have shown significant levels of pesticides and other toxic pollutants, such as polychlorinated biphenyls (PCBs) and mercury, in water and some species of fish. These findings resulted in fish consumption advisories and restrictions in some areas.

Strategies

Both Oregon and Washington have statewide plans in place to reduce persistent chemical pollutants. The plans generally focus on prevention strategies, but some sites are being cleaned up under federal Superfund designations (see sidebar). The Washington Department of Ecology

TABLE 7-4
Selected Persistent Pollutants in the Greater Portland-Vancouver Region

Pollutant	Uses/Examples/Potential Effects
Polycyclic Aromatic Hydrocarbons (PAHs)	Combustion byproducts. Many of these have been identified as carcinogenic.
Halogenated/Polybrominated Flame Retardants	Flame retardants such as PBDEs or PBEs (polybrominated diphenyl ethers); are used ubiquitously. Many have been banned in Europe since 2003. Some are regularly found in breast milk or throughout the body. Long-term effects on humans can include liver damage, reproductive problems, severe skin irritation, and damage to the nervous system.
Pesticides and Herbicides	Used for agricultural, groundskeeping, and urban pest and weed control. Legacy pesticides often enter streams through eroded soils. Includes chlordane, DDT, dieldrin, endrin, heptachlor, and mirex. Some are carcinogenic, bioaccumulative, or endocrine disrupters. The breakdown products of DDT were responsible for several birds being listed under the Endangered Species Act listings because eggshell thinning caused reproductive failure.
Pharmaceuticals and Personal Care Product Ingredients	Includes synthetic hormones, antipsychotics, antidepressants, sedatives, caffeine, food additives, and disinfectants. Some of these are suspected of disrupting endocrine functions. Increasingly are found at low but detectable levels in local rivers.
Perfluorinated Surfactants	Anti-stain coatings.
Metals	Arsenic, tributyltin, cadmium, copper, lead, mercury, selenium. Some of these have been identified as carcinogenic. Mercury, copper, and lead at some locations in the greater Portland-Vancouver region were found at levels of concern for fish and/or human health. Mercury and lead are especially hazardous to children.
Stabilizers for Polymers and Plasticizers	Includes bisphenol A (BPA), which is used to make polycarbonate plastic and epoxy resins. Polycarbonate plastic is used to make products such as compact disks, eyeglass lenses, water bottles, and baby bottles. Many food and drink cans are lined with epoxy resins that contain BPA. Possible endocrine disrupter.
Polychlorinated Biphenyls (PCBs)	Used for cooling and insulating fluid in closed electrical systems (e.g., transformers). Frequently carcinogenic, tend to bioaccumulate, and may have endocrine or neurologic effects.
Polychlorinated Naphthalenes (PCNs)	Used in insulating coatings for electrical wires, in wood preservatives, and as rubber and plastic additives. In very limited production since 1976.
Dioxins and Furans	Dioxins are petroleum-derived and used to bleach paper and manufacture certain pesticides; furans are a byproduct of chemical manufacturing and metal refining. Likely carcinogens that tend to bioaccumulate. High levels found locally near industrial sites.

PORTLAND HARBOR SUPERFUND SITE CLEANUP

Portland Harbor is a heavily industrialized stretch of the Willamette River north of downtown Portland that was designated as a Superfund site in 2000. River sediments are contaminated with various toxics, including metals, PAHs, PCBs, chlorinated pesticides, and dioxin. River pollutant levels are highest near contaminated sites that sit adjacent to the river on the shore. The U.S. Environmental Protection Agency and Oregon DEQ, along with many other agencies, tribal governments, community groups, and companies, are working to investigate and clean up contamination in Portland Harbor. The EPA is the lead agency responsible for investigating and cleaning up contaminated sediments in the river itself, and the DEQ is the lead agency for investigating and cleaning up contamination on upland sites, working with individual property owners.

ALCOA SUPERFUND SITE CLEANUP

The Alcoa aluminum smelter site is located 3 miles northwest of Vancouver, on the north bank of the Columbia River. The smelter was closed in 2007, when cleanup began. Industrial and solid wastes from construction and operation of the smelter were stored in waste piles and consolidated in onsite landfills. Hazardous contaminants include hydrocarbons, PCBs, cyanide, fluoride, trichloroethylene (TCE), low-level organic chemicals, and metals. In December 2008, Alcoa and the Washington Department of Ecology agreed on a Cleanup Action Plan and Consent Decree for the upland cleanup and remediation of PCB-contaminated sediments in the Columbia River; groundwater cleanup beneath the landfill was not included in the decree. Alcoa finished dredging PCB-contaminated sediments from the Columbia River in early 2009. Smelter demolition and final removal of contaminated soils from the site were completed in March 2010. The Port of Vancouver purchased the site from Evergreen Aluminum and Alcoa, Inc., in 2009 and is redeveloping the area into a bulk storage and transport terminal.

recommends the following prevention strategies (www.ecy.wa.gov/toxics/):

- Prevent toxic chemicals from being used in the first place. Averting toxic exposures and avoiding future costs is the smartest, cheapest, and healthiest approach.
- Assist business in reducing or managing the amount of toxic chemicals that enter the environment.
- Clean up after toxics have polluted the air, land, or water. Cleanups are necessary but costly solutions to avoidable contamination.

Both Oregon and Washington toxics websites offer detailed information about toxics and what citizens can do to keep toxics out of the land, water, and air, as well as homes and food. DEQ and Metro offer support for recycling and disposing of hazardous household waste. DEQ's toxics website links to resources for electronics recycling, lawn, garden and household toxics alternatives and disposal venues, and other toxics advice: www.deq.state.or.us/wq/SB737/#work.

FOR MORE INFORMATION

Reducing Persistent Pollutants in Oregon's Waters: SB 737 Legislative Report
Oregon Department of Environmental Quality. 2010. Portland, OR. http://www.deq.state.or.us/wq/SB737/

USGS Toxic Substances Hydrology Program, 2010
H.T. Buxton. U.S. Geological Survey Fact Sheet 2010-3011.

http://pubs.usgs.gov/fs/2010/3011.

Columbia River Basin Toxics Reduction Plan
U.S. Environmental Protection Agency, Region 10, and the Columbia River Toxics Reduction Working Group. 2010.
http://www.epa.gov/region10/pdf/columbia/toxics-action-plan_sept2010.pdf.

Disease

Susan Barnes, Julia Burro and Colin Gillin, Oregon Department of Fish and Wildlife

Like people, fish and wildlife and their habitats can get sick. Diseases caused by viruses, bacteria, fungi, and protozoans are a natural part of the web of life, but they can cause illness or death. Some diseases affect individual animals, some affect large numbers of animals, and some affect local or regional populations. Disease spreads more quickly when wildlife are concentrated. People can do their part to prevent disease outbreaks by not feeding wildlife, by vaccinating pets, and by managing habitat for wildlife.
Many diseases that affect the region's fish and wildlife are endemic (i.e., they are naturally occurring in the region). Examples include adenoviral hemorrhagic disease of deer and canine distemper in mammals, low pathogenic avian influenza in birds, and infectious hematopoietic necrosis virus and viral hemorrhagic septicemia virus in fish, plus many bacterial pathogens and parasites like trichinosis and a variety roundworms and tapeworms. However, some of the greatest disease concerns center on non-native pathogens that are introduced by non-native flora and fauna. Non-native diseases can have devastating effects on native organisms, human health, recreational opportunities, and local economies. The following are some introduced diseases that could affect biodiversity:

- Chronic wasting disease—affects deer and elk. Is endemic to the United States but not Oregon.
- Highly pathogenic avian influenza strains. Could be introduced or endemic.
- Whirling disease—affects juvenile fish, including salmonids.
- White-nosed syndrome—affects bats. Could be introduced (from Europe) or endemic.
- Sudden oak death.

Some of these diseases have not yet been detected in the greater Portland-Vancouver region. Infectious diseases in wildlife (particularly introduced species) are emerging at unusually high rates around the world. There is significant concern that disease may pose a substantial threat to biodiversity. Infectious diseases have the potential to play a significant role in regulating the composition, diversity, and richness of species found within communities, adding to natural mortality. This may occur because diseases can facilitate declines in local populations, cause contraction in the geographic ranges of populations, and evolve to infect numerous hosts. At the global scale, infectious disease has not been considered as significant a driver of species extinction as forces such as habitat loss and overexploitation, but the role of disease in global biodiversity loss may change with accelerated changes in global climatic conditions.

Although disease is well recognized as a threat to biodiversity, there is new evidence that the loss of biodiversity results in increased emergence, transmission, and spread of infectious disease. The connection between two developing crises—emerging novel diseases and unprecedented declines in biodiversity—has long been suspected, is difficult to quantify, and is not completely understood. Recent scientific analyses indicate that biodiversity seems to protect organisms, including humans, from transmission of infectious diseases. For example, research indicates that high microbial diversity on the skin of frogs can prevent infection with a lethal fungus that is devastating many amphibian populations around the world. In addition, there is a strong correlation between low bird diversity and increased risk of disease transmission (West Nile virus) to humans in the United States. In addition, a local

study has shown that increased diversity of small mammals is tied to decreases in occurrence of hanta virus. Finally, communities with low avian diversity tend to be dominated by species that amplify the virus—thus increasing the prevalence of infection in mosquitoes and people—while communities with high avian diversity have many species that are less competent hosts. On the other hand, for novel diseases, greater diversity may provide a larger potential pool of hosts. Hotspots for novel disease emergence sometimes occur in areas where growing human populations come in contact with many wild animal species. Theoretically, the more host species present, the more pathogen species they will harbor and the greater the opportunity for transmission to people. In other words, naturally high biodiversity should increase the potential pool of sources for new pathogens. Recent studies indicate that although biodiversity could be a source of new diseases, once a disease emerges, greater biodiversity appears to protect against the spread of the new disease.

Despite the unanswered questions, connections between biodiversity and disease are sufficiently clear to support increased efforts to preserve natural ecosystems and the biodiversity they contain. Conservation of biodiversity, to the greatest extent possible, may be our best strategy to guard against harmful infectious disease. Other actions needed to address disease concerns are related to surveillance, hygiene protocols, management of wildlife-human interactions, and control of non-native species. Public education is a key component of any effort.

Recommended Priority Strategies to Address Threats Linked to Disease

- Preserve large intact areas of natural habitat where it exists.
- Restore habitats to endemic plant communities to protect and increase biological diversity (both plant and animal).
- Enforce existing regulations and develop new regulations, policies, and protocols to prevent or minimize the spread of disease and minimize human contact with wildlife (e.g., ban feeding of wildlife, conduct disease surveillance, and restrict unregulated animal translocation).
- Strengthen regulations and policies related to (1) handling, moving, and relocating native fish and wildlife, and (2) importing, possessing, and releasing non-native species, to prevent the introduction and spread of non-endemic disease.
- Improve systems at multiple scales (city, county, state, and regional) for the surveillance, detection, and control of emerging diseases.
- Increase public awareness of the issues surrounding disease through interagency and multi-organization communication efforts.
- Support and continue research on emerging infectious diseases that adopts a multidisciplinary approach to identifying their underlying causes and controlling their spread.

Applicable Regulations

The Lacey Act of 1900

The Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990

Oregon Revised Statute 498.052 (Release of domestically raised or imported wildlife without permit from ODFW prohibited)

Oregon Administrative Rule 635-056 (regulates importation, possession, confinement, transportation and sale of non-native fish and wildlife)

OAR 635-007-0960 thru 0995 Fish Health Management Policy

OAR 635-044-0200 Wildlife Rehabilitation rules

OAR 635-049- 0065, 0067 Diseases and Captive Cervids rules

Various Oregon Department of Agriculture ORSs and OARs that are designed to prohibit disease like CVI and that require animal import permitting.

FOR MORE INFORMATION

"Emerging Infectious Diseases of Wildlife: Threats to Biodiversity and Human Health"
P. Daszak, A.A. Cunningham, and A.D. Hyatt. 2000. 21 January 2000 Vol 287 *Science* www.sciencemag.org Pages 443–449.
http://irceb.asu.edu/amphibians/pdf/science.pdf

"Wildlife Diseases Threaten Biodiversity and Human Health"
Global Biosecurity Media Release. Dec. 9, 2009.

"Impacts of Biodiversity on the Emergence and Transmission of Infectious Diseases"
Keesing, F., L.K. Belden, P. Daszak, A. Dobson, C.D. Harvell, R.D. Holt, P. Hudson, A. Jolles, K.E. Jones, C.E. Mitchell, S.S. Myers, T. Bogich, and R.S. Ostfeld. 2010. Nature, Vol. 468, Pages 647–652.
http://www.nature.com/nature/journal/v468/n7324/full/nature09575.html

http://oregonstate.edu/ua/ncs/archives/2010/dec/nature-study-loss-biodiversity-can-increase-disease-transmission

http://www.nature.com/news/2010/101201/full/news.2010.644.html

"Local Scale Effects of Disease on Biodiversity"
K.F. Smith, M. Smith, D. Behrens, and D. F. Sax. 2009. *EcoHealth* 6, 287–295.

"Naturally Occurring Fish and Wildlife Diseases"
Oregon Department of Fish and Wildlife. 2006. Pages 372-375 in *Oregon Conservation Strategy.*
http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

ODFW's Wildlife Health Program
http://www.dfw.state.or.us/wildlife/health_program/

An Overview of Contemporary Biological Diversity Conservation in Oregon: A White Paper for the Oregon Board of Forestry
A. Yost (editor). 2011. Feb. 1, 2011
http://www.oregon.gov/ODF/BOARD/docs/2011_March/BOFATTCH_20110309_03_01.pdf?ga=t

Anthropogenic Hazards

Susan Barnes, Oregon Department of Wildlife

Urbanization and, to a lesser extent, development for agriculture are characterized by built structures such as buildings, roads, electrical lines, fences, lights, and communications towers that, together with associated human activities, can displace, injure, or kill fish and wildlife or otherwise alter wildlife behavior. Although some human activities involve intentional killing of wildlife—for commercial purposes, as food, or out of fear—many anthropogenic injuries and mortalities occur purely by accident, such as when motor vehicles collide with animals on the roadway.

The degree of impact of anthropogenic injuries and mortalities depends not simply on the number of incidents but also on the kinds of wildlife killed (male vs. female, adult vs. juvenile, reproductive vs. non-reproductive) and the timing of mortality (e.g., before or after the reproductive season). It is difficult to quantify the impact of anthropogenic activities on a given species, and estimates by individual cause of injury or mortality often vary by an order of magnitude. However, cumulative mortality from anthropogenic hazards is believed to be significant—for example, up to 1 billion birds a year in the United States.

Anthropogenic Hazards to Fish and Wildlife in the Region

COLLISION HAZARDS

Automobiles, Trains, and Boats

All types of wildlife are at risk from collisions with motor vehicles, trains, boats, and even bicycles. Each year some of Oregon's native turtles (western pond and western painted) are found injured or killed on roadway and railroad tracks. Many of these are pregnant females migrating to nesting sites.

Airplanes

Birds are especially susceptible to injury and mortality resulting from collisions with airplanes, either on runways or in the air. Portland International Airport staff actively haze wildlife from the airfield to minimize wildlife-related air strikes.

Buildings and Windows

Conservative estimates are that windows kill one billion birds annually in the United States. Windows are basically invisible to birds, and casualties occur from head trauma after a bird leaves a perch from as little as 1 meter away in an attempt to reach habitat seen through—or reflected in—clear and tinted panes. There is no window size, building structure, time of day, season of year, or weather conditions that allows birds to elude the lethal hazards of glass in urban, suburban, and rural environments.

Communication Towers, Aviation Lights, and Guy Wires

Communication towers and the aviation lighting and high-tension lines or guy wires that are sometimes associated with them pose a hazard to birds in flight, especially night-migrating birds. Communication towers kill an estimated 4 to 5 million birds in the United States each year.

Wind Turbines

Wind energy facilities can adversely affect wildlife, especially birds and bats, with the greatest hazard during spring and fall bird and bat migration. Mortality occurs from direct impact with turbines or by changes in air pressure near the rotating blades. In the Oregon portion of the Columbia Plateau ecoregion, it has been estimated that the existing wind energy facilities result in a mean of 2.5 bird fatalities per megawatt per year and a mean of 1.2 bat fatalities per megawatt per year.

Electrical Power Lines

Utility poles and electrical lines can benefit raptors and other birds by providing perching or nesting structures where there are few natural perching or nesting options. However, utility poles and electrical lines also pose electrocution and collision threats, most typically with larger birds such as raptors and great blue herons, although smaller birds also are at risk. Nationwide mortality estimates from electrocution are not available.

Hazards from Materials

Monofilament Fishing Line, Hooks, and Nets

Improperly discarded fishing gear—especially barbed hooks and nets—are a hazard to a variety of wildlife, from herons and seabirds to turtles and otters.

Baling Twine, Plastics, and Styrofoam

Birds and other wildlife are injured or die from becoming entangled in these materials. Baling twine is the cause of death for many adult osprey and their chicks. It has been estimated that, in some areas, baling twine alone kills about 10 percent of osprey chicks.

Glue Strips and Traps

Sometimes used by people to catch and kill "pests" such as house mice, rats, and flying insects, sticky glue traps and strips can be hazardous to native small mammals, such as bats. Licensed wildlife rehabilitation facilities regularly receive bats that have been trapped by sticky glue fly strips. In most cases these bats do not recover.

HAZARDS FROM HUMAN BEHAVIOR

Artificial Feeding of Wildlife

Whether deliberate or accidental, artificial feeding is hazardous to all wildlife for a variety of reasons. Introduced food is often unhealthy. Artificial feeding unnaturally concentrates animals, thus increasing the spread of disease, changing wildlife behavior and migratory patterns, and making animals more susceptible to anthropogenic causes of injury, death, and predation.

Persecution

Some species have historically been subject to systematic mistreatment by humans, out of fear, hostility, or competition for resources. Individual species usually are targeted. Coyotes, snakes, and bats often are persecuted because they are viewed as dangerous, gross, and carriers of disease. Even more "popular" wildlife species such as deer, squirrels, and woodpeckers are subject to persecution if they are viewed as pests. Although not all causes of persecution can be addressed, attitudes can be changed over time through education and the provision of alternative solutions to common nuisance wildlife situations.

Illegal Take (Poaching)

Despite laws that regulate hunting and fishing, many species are threatened by poaching, which affects species viability at local and regional scales. A recent ODFW research study of deer estimated that poachers are killing almost the same number of animals as legal hunters are. Although the poaching of game fish and wildlife species is most often highlighted, no species is exempt from poaching. In addition, ODFW has confirmed the illegal collection of native turtles for the pet trade industry and local and overseas food markets.

OTHER HAZARDS

Rodenticides and Other Poisons

All wildlife are at risk from poisonous substances dispersed into the environment deliberately or by accident. Poison meant for Norway rats or house mice may be consumed by native rodents and other small mammals such as squirrels and chipmunks. Localized die-offs occur in wintering goose populations that have foraged on agricultural fields treated with rodenticide (e.g., zinc phosphide). Other wildlife that are frequently exposed include carnivores such as mountain lions, bobcats, hawks and owls; omnivores such as coyotes, foxes, skunks, and raccoons; and granivores and herbivores such as squirrels and deer.

Fences

Although fences can help reduce wildlife-human conflicts, such as motor vehicle collisions with wildlife, they also can be hazardous to a variety of wildlife species. Fences can restrict or alter animal movement patterns, thus disrupting daily, seasonal, and dispersal movements and potentially reducing the probability of survival of some wildlife populations.

Introduced Predators

As the most common introduced predators, cats and dogs pose a real hazard to biodiversity, causing nearly 100 million bird deaths in the United States annually. Birds that spend the bulk of their life cycle in the low- to mid-canopy vegetation layer are particularly susceptible to cat predation. Cats and dogs also prey on small mammals, reptiles, and amphibians. Even when on leash, dogs are hazardous to most wildlife. Dogs directly injure or kill wildlife, and their presence can alter normal feeding, mating, and parental behaviors. When chased by dogs (even if the chase is unsuccessful), the potential prey wastes significant energy, subjecting them to higher rates

of mortality. Cats and dogs also can transmit pathogens, including parvovirus, muscle cysts, leptospirosis, and external parasites such as ticks, keds, tapeworms, and fleas. Free-roaming dogs also degrade habitat by trampling vegetation and adding nitrogen to the soil (via feces); both of these impacts encourage the growth of non-native plants at the expense of natives. Dogs also cause mortality of salmonid or amphibian eggs or juvenile salmon by direct disturbance or by causing eggs to be covered with sediment.

Lack of Knowledge

An often overlooked but very real hazard to all fish and wildlife and their habitats is the lack of knowledge or awareness by the public about biodiversity issues and values, conservation practices, and applicable regulation that is intended to protect and enhance biodiversity. Sometimes because of ignorance, even well-intentioned individuals can harm and create hazards that threaten and challenge the health of fish and wildlife and their habitats.

Strategies to Minimize Hazards to Fish and Wildlife

- Reduce collisions by doing the following:
  - Work with partners to inventory, prioritize, and remove wildlife movement barriers, leveraging current work done by state wildlife management agencies and their partners.
  - Maintain and restore habitat to ensure habitat connectivity, especially in urban centers.
  - When planning transportation projects, consider the movement needs of fish and wildlife; incorporate safe passage features into transportation designs. Work with public transportation departments and railroad companies to identify and address wildlife mortality. Where significant wildlife mortality is known to occur, install wildlife underpasses or overpasses and direct wildlife to safe crossing areas.
  - Implement efforts similar to the Audubon Society of Portland's BirdsSafe Program to promote education, monitoring, and proper response to bird injuries and mortalities caused by buildings and windows. Educate boaters on how to report and safely respond to injured wildlife.
  - Continue wildlife management efforts at airfields aimed at preventing and reducing wildlife-related airplane strikes. Employ hazing techniques, modify habitat, and install physical barriers.
  - Implement existing and future guidance on the siting and design of communication towers, wind energy facilities, and electrical power lines and supporting structures. The Edison Electric Institute's Avian Power Line Interaction Committee (APLIC) and U.S. Fish and Wildlife Service have developed guidelines on electrical power lines, and the U.S. Fish and Wildlife Service has guidance regarding communication towers.
- Compile information on the effects on fish, wildlife, and habitat of hazards from dogs, fences, and materials (i.e., monofilament fishing line, hooks, nets, baling twine, plastics, Styrofoam, and glue strips and traps). Compile information on the effects of rodenticides and other poisons on non-target animals and habitat.
- Enact stronger laws and regulations to ban the feeding of certain wildlife species (state and local regulations), stop persecution of wildlife (federal, state, and local regulations), reduce illegal take of wildlife (federal and state regulations), and regulate the use and application of various chemicals that are known to affect non-target fish and wildlife species (federal and state laws).
- Support and expand existing programs to provide seasonally appropriate informa¬tion on preventing and resolving conflicts with wildlife. Based on ODFW's, WDFW's and Portland Audubon's existing Living With Wildlife series, initiate a broad-scale campaign to educate the general public regarding common "nuisance" wildlife situations and provide alternative legal and biologically appropriate solutions. Continue to promote naturescaping as the wildlife-friendly and more economical alternative to artificial feeding.
- Because human-wildlife conflict issues often are biologically and socially complex, create multi-stakeholder/interagency task forces to ad¬dress major issues.
- Reduce impacts from domestic cats and dogs. Work with the Feral Cat Coalition, the Humane Society, county animal control departments, state fish and wildlife agencies, and others to reduce hazards posed by outdoor cats, especially feral cats, and work with dog organizations and others to promote observance of leash laws, particularly in areas designated as natural or wildlife areas. Initiate a local pilot project to better understand the effects of dogs on wildlife and wildlife habitats.
- Initiate a campaign to educate the general public about the issues, values, and ecosystem services related to biodiversity; hazards that threaten and challenge biodiversity; and recommended actions to address hazards.
- Improve coordination and communication between conservation partners to maximize benefits from various educational efforts.

Applicable Regulations

Federal Migratory Bird Treaty Act (16 U.S.C. 703-712)http://migratorybirds.fws.gov/intrnltr/mbta/mbtintro.html

The Federal Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

Federal Endangered Species Act (16 U.S.C. 1531-1544)

ORS 498.002 Wildlife as state property; taking, angling, hunting or trapping in violation of wildlife law or rules prohibited

ORS 498.046 Making toxic substances accessible to wildlife prohibited

ORS 498.022 Purchase, sale or exchange of wildlife prohibited

ORS 498.006 Chasing or harassing of wildlife prohibited.

ORS 498.102 Use of dogs to hunt or tack game mammals or birds. Regulates dogs hunting, running or tracking any game mammals or game bird.

FOR MORE INFORMATION

"A Place for People and Wildlife: Conservation in Urban Areas"
Oregon Department of Fish and Wildlife. 2006. Oregon Conservation Strategy.
http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

Every year, window strikes kill millions of birds like this mourning dove.

Additional Resources

TOPIC	RESOURCES
Collisions with Autos, Trains and Boats	A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. W.P. Erickson, G.D. Johnson, and D.P. Young Jr. 2005. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. http://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_1029-1042_erickson.pdf http://www.fhwa.dot.gov/publications/research/safety/08034/08.cfm
Collisions with Airplanes	http://www.portofportland.com/PDX_WldLife_Mngmnt.aspx
Collision with Buildings and Windows	http://audubonportland.org/issues/metro/bsafe http://training.fws.gov/EC/Resources/mig_birds/handouts/avian_mortality_at_windows.pdf
Collisions with Communication Towers	http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm http://www.fws.gov/habitatconservation/com_tow_guidelines.pdf http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf
Collisions with Wind Turbines	http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf http://wdfw.wa.gov/publications/pub.php?id=00294
Electrical Power Lines	http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/APP/AVIAN%20PROTECTION%20PLAN%20FINAL%204%2019%2005.pdf http://www.aplic.org/uploads/files/2643/SuggestedPractices2006(LR-2).pdf http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf
Baling Twine, Plastic, Styrofoam	http://www.dfw.state.or.us/wildlife/living_with/docs/osprey.pdf
Human Dimensions	http://www.nature.nps.gov/socialscience/docs/archive/SSRR_6.pdf
Illegal Take (Poaching)	http://www.democratherald.com/news/local/article_7a25ad0a-a9e8-5a11-a409-9aa808393c96.html
Introduced Predators	http://audubonportland.org/backyardwildlife/brochures/cats/?searchterm=cats http://www.abcbirds.org/abcprograms/policy/cats/materials/predation.pdf
Rodenticides and Other Poisons	http://www.sfromp.org/rodenticides_mitigation_decision.pdf

Major Categories of Strategies

CHAPTER 8

The complex mix of land uses, habitat types, and lifestyles in the greater Portland-Vancouver region requires an equally broad array of approaches to conserving and enhancing the region's biodiversity and related ecosystem services. As with the strategies in the *Regional Conservation Strategy*, the set of strategies presented in this chapter is neither prescriptive nor prioritized. Instead the strategies are meant to provide a reasonably comprehensive framework of important ways that individuals and organizations can make sound, strategic investments of their time and resources, based on their own priorities and interests. It is hoped that, within these strategies, each stakeholder group, jurisdiction, agency, and individual in the region can find a way to positively engage in protecting our region's most crucial natural assets or to better frame their efforts in light of regional priorities.

Naturally, the content of this chapter overlaps substantially with that of the *Regional Conservation Strategy for the Greater Portland-Vancouver Region.* In fact, four of the six topics addressed here (biodiversity corridors, conservation in developed areas, conservation in working lands, and conservation education) are explored in more depth in the *Regional Conservation Strategy* and are presented here in shortened form. Two other sections (preservation/conservation and habitat restoration and enhancement) are treated most comprehensively here.

Preservation and Conservation

Esther Lev, The Wetlands Conservancy, and Jonathan Soll, Metro

Governments, nonprofit organizations and private landowners have a variety of tools to choose from to protect or conserve natural areas and to connect or restore habitat. Many approaches offer private landowners ways to realize financial benefits, including direct income, estate tax reductions and, in some cases, income and property tax reductions. Approaches can be roughly divided into protection/acquisition and conservation.

Protection/Acquisition

Protection/acquisition generally implies taking land out of the economic system. Permanent protection is most appropriate for areas that are very highly sensitive to use, rare or irreplaceable, or essential to the protection of landscape processes, habitat, or species. Permanent protection prevents these critical lands from being lost or degraded.

Education and outreach are vital in promoting the use of appropriate conservation tools.

Generally, there are two ways to achieve permanent protection of land:

- Permanent, full-fee, title ownership through acquisition of all property rights. This can be accomplished through sale or donation of the land.
- Partial ownership of the development or use rights to the land through a conservation easement.

SALE OPTIONS (TITLE TRANSFER WITH COMPENSATION)

Landowners can choose from four sale options, each of which has advantages:

- **Fair market value:** The landowner sells the property for its fair market value. This allows the landowner to receive full value for the property.
- **Bargain sale:** The landowner sells the property to a land trust, conservation organization, or agency at a price below the fair market value, with the difference between the sale price and the fair market value being considered a donation. The seller may qualify for a tax deduction and a reduction in capital gains taxes.
- **Installment sale:** The landowner sells the property to a land trust, conservation organization, or agency and defers all or part of the consideration, which is paid in successive years. In installment sales, payment of the capital gains tax can be deferred until the seller has the cash in hand with which to pay the tax.
- **Right of first refusal:** The landowner gives a land trust, conservation organization, or agency the option to match a purchase offer and acquire the land if another buyer approaches the landowner. Right of first refusal can give land trusts and other conservation organizations time to acquire the funds needed to purchase the land.

The disadvantage of all types of property sales is that, if the land value has appreciated since it was purchased; the seller becomes liable for the income tax on the capital gain.

DONATION OPTIONS (TITLE TRANSFER WITHOUT COMPENSATION)

Landowners can choose from three types of donations: outright donation, donation at the time of death, and donation with a reserved life estate. Each of these has advantages and drawbacks.

Outright donation grants full title and ownership to the conservation organization, community, or government agency that receives the donated property. Outright donation has several advantages: money is not needed to protect the property, so the donation frees resources for other sites; it is a simple, clean, and efficient transfer of responsibilities and rights, and it offers the maximum tax benefit for donor. However, the property owner loses all value, and some property owners may not be able to take full advantage of the tax benefit.

Donation at the time of death transfers property through a will and allows the property owner to use the property until death. Like outright donation, donation at the time of death does not require money to protect the property, so it frees resources for other sites, plus it is a simple, clean, and efficient transfer of responsibilities and rights. Its disadvantages are that heirs may contest the will, tax benefits for the donor may be less, and society does not begin reaping the benefits of donation until the donor's death.

Donation with a reserved life estate permits the landowner to use the donated property during his or her lifetime and the lifetimes of designated family members. This eliminates the risk of heirs contesting the will and allows the property owner to use the property until death. In addition, well-written life estates begin providing public benefit immediately. However, donations with a reserved life estate can create a complex relationship between the donor and the land manager. Other disadvantages are that tax benefits for the donor are less than those with outright donation and society does not reap the full benefits until the donor's rights expire.

CONSERVATION EASEMENTS

Landowners can restrict how land may be used through written agreements, called easements. These become part of the property deed and stay with the land, binding subsequent property owners to the terms of the agreement. With a conservation easement, the landowner retains title to the property but transfers certain property rights to a land trust, government agency, or nonprofit conservation organization. Through the easement, the landowner can restrict the type and amount of development on a piece of property in order to protect significant natural features, including wildlife or habitat. Each conservation easement is tailored to the particular piece of property and the wishes of the landowner. The parties involved can renegotiate the easement if circumstances change (although there may be tax implications).

Advantages of Conservation Easements

- Easements provide income tax, estate tax, and gift tax benefits if the easement is donated or sold at less than market value.
- The property owner retains ownership of the property while potentially receiving income tax, estate tax, and property tax reductions.
- The easement holder generally pays less than for full fee ownership.

Disadvantages of Conservation Easements

- Easements can involve giving up some property usage rights.
- The landowner may need to maintain the land and be responsible for expenses, including taxes.
- Because easements run with the deed, the holder has a relationship with unknown future landowners.
- Management responsibility can be complicated.

Conservation

Conservation allows for the active use of the land while habitat values and ecosystem services are maintained over time. Conservation can apply to areas used for resource production. For example, owners of land used for agriculture and forestry are encouraged to apply best management practices such as no-till seed drilling, riparian and wetland buffers, or longer harvest rotations.

Conservation also applies to urbanizing areas where changes in land use might adversely affect a resource. Conservation of natural areas is a concern in urbanizing settings where adjacent use by humans affects wetlands, streams, riparian areas, meadows, and forest lands. Improved management practices on the part of homeowner associations, private landowners, land developers, watershed councils, schools, and volunteer groups can help to reduce impacts. Education and outreach are vital in promoting the use of appropriate conservation tools.

Enhancing Biodiversity Corridors and Regional Connectivity

Lori Hennings, Metro

Preservation, conservation, restoration, and invasive species control are some of the tools available and necessary to improve regional connectivity among the priority conservation areas and potential biodiversity connectivity areas shown on maps that accompany this *Biodiversity Guide*. The maps depict potential biodiversity corridors based on aerial photo interpretation, modeling, and local knowledge, but they also suffer from significant data and research gaps. Additional work is needed to assess the functionality of these biodiversity corridors and determine what is necessary to make them fully functional. The following strategies outline steps

to address these gaps, improve corridor function, and better prioritize restoration and enhancement activities:

1. Gather available information on barriers, existing wildlife crossing structures, and solutions. For example, various agencies have identified priorities for removing culverts that block fish passage.

2. Establish a wildlife connectivity communication venue and/or working group consisting of partners and stakeholders identified through the *Biodiversity Guide*'s biodiversity corridors mapping process and other interested parties.

3. Collaborate closely with organizations and individuals that work in or near corridors or that own land there (e.g., transportation and trails organizations, industry, homeowners' associations, parks providers, and large-lot landowners or groups of landowners where action or education is needed). Talk with them about why the corridor is important and provide maps and information. Ask them to help identify potential conflicts and opportunities, and how we might partner with them; they may know more than we do.

4. Conduct research to assess the condition and actual function of mapped corridors in order to improve corridor function and regional priority setting:

- Assess which wildlife species actually use or are likely to use mapped corridors and which species could or should be using them. A logical early step in this process is to assign focal species to each corridor based on the habitat areas it connects.
- Assess current habitat conditions and identify and characterize existing partial or full barriers, including gaps in vegetation.
- Use the information from the previous steps to prioritize restoration and enhancement actions.
- Correct barriers and gaps strategically but opportunistically. For example, major road work may occur infrequently in a given area but can provide key construction and funding opportunities to address barriers. Major trail work may provide similar opportunities.
- Conduct pre- and post-monitoring on wildlife crossings for several years. Sometimes it takes a few years for target species to use a crossing, and small adjustments can make all the difference.

5. Periodically refine the maps and priorities as data and analytical tools improve.

Habitat Restoration and Enhancement

Esther Lev, The Wetlands Conservancy, and Jonathan Soll, Metro

Most natural areas and the surrounding landscapes in the greater Portland-Vancouver region have been significantly altered. Impacts include direct changes such as ditching, drain tile installation, stream channelization, sedimentation, removal of vegetation, grazing, logging, loss of habitat structure, and planting or invasion of non-native species. Even when direct human impacts on a site have been slight, their effects may be significant because of changes in the natural environment and the processes that historically maintained the region's biological communities. Natural area managers must deal with the impacts of such threats as invasive non-native species, fire exclusion, altered streams and water systems, and landscape fragmentation as a result of roads, pipelines, and development in order to maintain or improve the biodiversity of the region and its natural areas. Fortunately, in most cases even natural areas that are severely out of balance in composition, structure, and function and have been highly altered from their original condition or isolated from other similar habitat can be move toward a healthier and ecologically productive condition through carefully designed and implemented restoration or enhancement projects.

Restoration Projects

Generally speaking, restoration projects seek to reestablish conditions similar to the original condition of an area that has been highly altered by human activity. Successful restoration usually is based on re-establishing an area's original hydrology, topography, and natural processes, such as flooding, and commonly includes re-establishing the original native plant cover.

EXAMPLES OF RESTORATION PROJECTS

Many urban streams have been filled, covered, or straightened. A restoration project might involve daylighting a stream (i.e., re-routing it out of an underground pipe and back onto the surface), re-meandering a channelized stream (i.e., making it curvy), or installing fish- and wildlife-friendly culverts. As other examples, agricultural fields can be restored to wetland or upland prairie habitat, or an even-age single-species forest can be managed toward a diverse forest with old-growth characteristics.

Enhancement Projects

Although there is no hard and fast distinction between restoration and enhancement, enhancement projects generally are less extreme and strive to maintain or increase a particular set of functions of an existing natural area. Enhancement compensates for natural processes that no longer exist or mitigates the effects of historical impacts, thereby helping to move moderately or even severely degraded natural areas to a higher quality condition. Generally, enhancement projects target improved wildlife habitat and native vegetation diversity. Specific enhancements might include prescribed burns, invasive species control, native plantings, or adding nest boxes or large wood for wildlife.

Enhancement can also change the physical characteristics of a largely functioning natural system, such as by impounding water behind a dike or dam, or by dredging a pond in a relatively undisturbed wetland. Enhancement techniques should be evaluated carefully because one-time enhancement projects can cause unintended problems for future projects on the same site.

EXAMPLES OF ENHANCEMENT PROJECTS

Many natural areas are severely degraded by invasive plants. Invasive species removal projects aim to increase overall plant and animal diversity via active management of the undesirable species. An example of a management/enhancement plan for a degraded oak woodland would be to reduce fuels by removing competing woody vegetation, initiate a prescribed burn, eliminate the invasive plant species, and plant native species to encourage wildlife habitat and nesting areas. Other examples of simple enhancement actions are planting cedar trees underneath the canopy of a maple-dominated forest, planting shrubs in a grass-dominated wetland, and removing competing conifers from an oak woodland.

Overview of the Practice of Natural Area Restoration and Enhancement

Restoration or enhancement of natural systems and communities is an adaptive process that typically plays out over many years. A successful project requires a good understanding of the critical elements of a site, its ecological dynamics, and the functions it plays in the greater landscape and in maintaining watershed health. It also is important to have a clear goal and well-defined statement of the desired future conditions. for the site. Ideally the goal of every project would be return to historical conditions, but not all sites can be returned to their historical state. For example, the manager may control only part of the original site, or some ditches might need to

be retained so that adjoining properties do not flood. Onsite or watershed hydrology might have been altered. Neighbors may not cooperate, or some elements that are inconsistent with historical conditions may need to retained for social or economic reasons. Despite these sorts of limitations, in most cases meaningful enhancement and restoration can still occur if they are carefully planned and executed.

Forces of nature, climate change, and unknown elements of a site can alter even the best-planned design. Climate modeling suggests that, in this region, temperatures and the amount of winter precipitation will increase, while summer precipitation will decrease. Some natural areas may prove to be sensitive to changing climate because they depend on precipitation as their primary hydrologic input (although the timing of the predominant rainfall is predicted to remain somewhat consistent, mostly falling from November through March). As a result, monitoring, adaptive management, and long-term maintenance are as important as the initial planning of successful projects.

A typical restoration project involves the following:

1. Site visits and research. In the early stages of brainstorming, take a trip around the watershed and subbasin. Look for potential reference sites that model the desired future conditions for the restoration project and identify similar types of projects within the subbasin and region. Learn what worked, what changes were necessary, and what might be done differently if the project were being done today.

2. Planning. Once there is a general concept for the project, define specific measures of success. Design a very detailed plan to achieve those measures of success and develop a task list, timeline, and budget. Expect to experience unexpected results and delays and be prepared to adapt your plan accordingly.

3. Long-term view. Restoration is a long-term commitment. Developing the desired future condition is likely to take years or decades, or possibly even centuries. Make sure that your organization has the long-term staffing or volunteers and the funding needed to stay involved for the long term and ensure a truly successful project.

Although sometimes expensive and usually challenging, restoration and enhancement of habitat can be essential in building and maintaining a healthy ecosystem in the greater Portland-Vancouver region. Restoration and enhancement can directly improve habitat quality, return and restore missing ecological functions and processes, remove and mitigate for existing stressors, connect isolated habitats, and improve regional connectivity, thereby improving our region's biodiversity, water quality, wildlife habitat, and resilience to climate change.

Conservation in Developed Areas

In the greater Portland-Vancouver region, developed lands are all lands except natural areas, waterways, wetlands, biodiversity corridors, working agricultural lands, and working forests. The developed landscape includes industrial, commercial, and residential properties, developed parks, schoolyards, golf courses, cemeteries, airports, and the streetscape. The intensity of development ranges from skyscrapers in downtown Portland to suburban and rural neighborhoods in surrounding communities.

Nearly 22 percent of the land within the greater Portland-Vancouver region is covered by residential, commercial, and industrial development and roadways. Developed areas include active open spaces such as ball fields, school yards, and cemeteries, which can provide some of the ecological functions that natural areas do. With more ecological foresight we might have carefully nested our developed areas among an interconnected system of natural features in a way that prioritizes the function of natural systems. However, today's developed lands are situated such that remnant natural areas are highly fragmented, the tree canopy is only a fraction of historical levels, and historical streams, wetlands, and floodplains have been degraded, filled in, or covered over. In addition, our urban landscapes are replete with an array of wildlife hazards that includes buildings, powerlines, roadways, free-roaming domestic animals, and toxins. Despite these challenges, a huge diversity of wild animals, both migrant and resident populations—including some highly imperiled species—make use of our developed landscapes for some or all of their lifecycle. In addition, nearly 80 percent of the U.S. population now resides in cities, creating a culture of conservation that will depend on engaging people in wildlife stewardship where they live, work and play.

Developed are have a vital role to play in preserving regional biodiversity and protecting environmental health. When effectively managed, developed lands increase the urban landscape's overall permeability for wildlife, enhance the functionality of natural areas and biodiversity corridors, and engage the public in wildlife stewardship. When we choose to integrate nature into all aspects of the built environment, developed lands have the potential to do the following:

- Increase the permeability of the overall urban landscape for migrating wildlife populations
- Reduce direct and indirect impacts on natural areas
- Reduce hazards to wildlife
- Protect critical resident wildlife populations
- Support equity and community health
- Foster stewardship and community engagement in conservation

The desired future condition for developed areas is one in which nature is incorporated into the built environment at all spatial scales—from the small urban home lot to towering skyscrapers and expansive industrial parks. We envision a developed landscape where each development and redevelopment project incorporates elements that provide habitat and reduce wildlife hazards, where green infrastructure meets habitat and biodiversity objectives (among others), and where the public is actively engaged and supported in stewardship of native plants and wildlife in their yards, neighborhoods, business districts, and communities.

This vision of the future condition of developed lands acknowledges that there is no clear dividing line between the built environment and the natural environment. Native plants and wild animals do not recognize our arbitrary boundaries, and the impacts of our developed landscapes extend far beyond their actual footprint. In short, we all have a role to play in the protection, restoration, and management of our native plant communities and local wildlife populations.

STRATEGIC ACTIONS

The *Regional Conservation Strategy* identifies the following strategies to ensure that the full biodiversity potential of the built landscape is realized and that detrimental impacts on wildlife are minimized. These include the following:

- **Increase the permeability of the developed landscape for wildlife populations by integrating the built and natural environments.** The integration of green infrastructure at all scales of development activity can dramatically increase the ability of wildlife to traverse the urban landscape and meet their needs at different phases of their lifecycle. Examples include habitat-focused ecoroofs, street trees, backyard naturescaping, wildlife crossings on roadways, and bank restoration at river industrial sites.

- **Identify and manage at-risk species that have critical populations residing on the built landscape.** A number of at-risk species use the built landscape for some portion of their lifecycle. Examples include (1) the tens of thousands of migrat-

ing Vaux's swifts that use Chapman School's chimney for roosting during their fall migration, and (2) peregrine falcons, for whom Portland-Vancouver area bridges provide significant nesting habitat (i.e., more than 5 percent of their known nesting sites).

- **Identify and reduce wildlife hazards in the built environment.** Tremendous numbers of wild animals die each year as a result of collisions with manmade structures, predation by free-roaming domestic animals, and exposure to toxins. Identifying and addressing the most significant hazards is critical in ensuring that both the built and natural environments meet their full potential. Examples of proven effective strategies include reducing nighttime non-essential lighting on tall buildings during bird migration and adopting bird-friendly building guidelines to reduce collisions.

- **Engage the general public in wildlife stewardship.** With 80 percent of the U.S. population residing in cities, raising awareness and promoting stewardship in the built environment is essential in reconnecting people to the landscape and promoting a culture of conservation in future generations. Programs that promote residential rain gardens, backyard naturescaping, and schoolyard restoration can engage new and diverse audiences in biodiversity conservation and send an important message that each of us has a role to play in restoring wildlife populations.

Surprisingly, the greater Portland-Vancouver region's most popular wildlife viewing spot is not found in one of the region's natural areas or wildlife refuges. Rather, it is in a schoolyard in Northwest Portland, where each evening in the fall hundreds and sometimes thousands of people gather to watch tens of thousands of Vaux's swifts descending into the Chapman School chimney, which serves as a substitute for increasingly rare hollowed-out old-growth trees that the swifts historically roosted in on their annual southward migration. As the Vaux's swifts demonstrate, the greater Portland-Vancouver region will remain critical habitat for myriad wildlife populations, both resident and migratory. By increasing permeability, reducing hazards, targeting critical local wildlife populations for special management, and promoting wildlife stewardship among urban residents, we can help ensure that the built landscape enhances rather than undermines regional biodiversity.

Conservation in developed areas is discussed more thoroughly in Chapter 6 of the Regional Conservation Strateg.y

Conservation in Working Landscapes

Working lands are farms and forests that support the production of natural resource-based commodities that sustain rural lifestyles and contribute to the regional economy. The physical and chemical characteristics of working lands allow them to support the production of plants and animals for sale in the marketplace, contribute some habitat and ecological functions, and provide some ecosystem services such as air and water purification, sequestration of carbon, and flood attenuation. Unlike developed and natural lands, working lands are actively managed with intent to yield an economic return through harvest and management activities.

Working lands are an integral part of the economy, identity, and culture of the greater Portland-Vancouver region. Working lands also are vital to regional conservation. Lands used for agriculture and timber production serve as critical connectors between the region's urban areas (located at river confluences), and state and federally managed land at the headwaters of the region's many watersheds.

When properly cared for, working lands are part of the matrix of lands that capture, retain, and filter water. In some areas, streams and rivers overflow onto working lands during the winter, serving to protect downstream areas from floods. Standing timber and agricultural plants sequester carbon, while soil holds carbon underground. Working lands serve as buffers for natural areas and can help support connectivity between natural areas within the region.

Working lands can be successfully managed both for production and for their conservation values, with mutually beneficial results. A strong economic return enables land managers to continue natural resource protection on their land while increasing their ability to produce food and fiber. This results in a sustainable farm and forestland base to be managed by future generations. Working lands that are economically viable are more likely to stay in production and retain those qualities that serve conservation purposes. In the long run, working lands will be as important to the region's sustainable future as housing and other forms of development, and they will be critical in addressing our future needs for local food, clean water, healthful air, and other ecosystem services.

The desired future condition for working lands is preservation and enhancement of their integrity and function as critical components of both regional conservation and a sustainable local food and fiber economy. We envision a future in which funding opportunities exist for a new generation of farmers to purchase or lease land, and landowners who lease out property do so in a manner that encourages long-term conservation investments. We envision streams and riparian areas on working lands functioning at a level that mirrors pre-settlement conditions to the extent possible, and farms and forestland that help to maintain the resilience of natural systems in the face of climate change. We envision individuals of all economic backgrounds being able to obtain a majority of their food needs locally, agriculture being incorporated into new developments through community gardens, and viable farms and forest lands being protected from development caused by an expanding human population.

THREATS AND CHALLENGES

- Urban development
- Conversion to "hobby" farms
- Declining revenues for food and fiber production
- Lack of recognition of the importance of protecting working lands
- Challenges of transferring land to the next generation
- Short-term farm leases
- Limited funding for conservation

STRATEGIC ACTIONS

- Increase financial support for conservation activities on working lands.
- Improve management of working lands for habitat value and water quality.
- Explore better integration of farming and forestry into natural area management, including on publicly owned lands.
- Increase farm and forestland easements to prevent conversion to other uses and support the long-term economic viability of local farm and forestland.
- Provide funding and support for new farmers to purchase or lease farms, so that they are not developed.

Conservation Education

Conservation education is education that explores people's place in and connection with the natural world. Whether structured or non-formal, conservation education increases people's environmental literacy by showing how their actions affect the natural world around them, both positively and negatively[1]. Content and modes of instruction vary, but most conservation education programs focus on individuals' decisions as part of the learning process and strive to connect students of all ages to the local environment; thus, students are encouraged to "act locally" even as they learn to "think globally" about the connections between human behavior and natural processes and conditions.

The conservation, sustainability, and environmental education programs of the region strive to improve participants' understanding and appreciation of the natural world. An intended long-term outcome of these efforts is creation of

[1] The Oregon Environmental Literacy Plan, prepared by the Oregon Environmental Literacy Task Force in 2010, defines environmental literacy as an individual's understanding, skills, and motivation to make responsible decisions that take into consideration his or her relationships to natural systems, communities, and future generations.

an environmentally literate and engaged populace, meaning a citizenry that can make informed conservation-related decisions, is motivated to take appropriate actions, and promotes those behaviors to others. A goal that already has been achieved is the establishment of the Intertwine Conservation Education Council (i.e., Con Ed Council) to represent all conservation, sustainability, and environmental education providers in the region. The Con Ed Council currently is working to strengthen providers' roles in the region's conservation education efforts. Identified concerns stem from a central belief that decreased recognition of people's place in and connection with the natural world can negatively affect the environment. Consequently, the Con Ed Council envisions the greater Portland-Vancouver region as a place where everyone shares a connectedness with nature.

A variety of educational services and activities already are taking place within the region and among Intertwine Alliance partners. These activities blend service learning, personal and group development, conservation and environmental education, and direct conservation efforts. Intertwine Alliance partners are a diverse group, with varied constituencies. Some partners are geographically limited and concerned with a specific resource or site; examples include "friends" groups and watershed councils. Other partners address larger portions of the region but single out specific animals or natural features to focus on. Public agencies such as city governments, soil and water conservation districts, and service districts play a role in conservation education. Schools and school districts also are valuable partners, generating and using service learning and conservation resources for students and teachers. Notably, schools are an institutional support for environmental literacy as called for in the 2010 Oregon Environmental Literacy Plan.

Much conservation education in the region occurs outside the formal education institutions. Non-formal conservation education may meet clearly defined objectives through organized educational activities such as field trips, group restoration work and other work crews, camp programs, scouting, afterschool programs, or community classes. Some conservation education is self-directed, taking place during visits to parks, natural areas, refuges, and demonstration gardens.

The Intertwine's current network of parks, trails, and natural areas is the result in part of earlier investments in conservation education. In the same way, the effectiveness of future community engagement and decision making on conservation issues will depend on continued—and possibly improved—environmental literacy. One critical issues in which conservation education is likely to influence policy outcomes is management of human population growth in the region. In addition, conservation education is key to non-regulatory controls, such as prevention of illegal dumping and invasive species control. Nationally, formal education increasingly incorporates volunteerism, service learning, and other strategies to address science, engineering, technology, and mathematics learning and student achievement. And many current conservation efforts in the region, such as development and protection of backyard habitat, watershed restoration, tree canopy protection, and wildlife monitoring, rely on adequate levels of volunteer knowledge and engagement. Moreover, key regional conservation documents, such as Building Climate Resiliency in the Lower Willamette Region of Western Oregon,[2] recommend environmental literacy as part of implementation. Clearly, environmental literacy has the potential to affect everything from daily lifestyle choices to community and political engagement.

[2] Building Climate Resiliency in the Lower Willamette Region of Western Oregon: A Report on Stakeholder Findings and Recommendations (Climate Leadership Initiative, 2011).

A. Land Cover Mapping

This appendix briefly describes the process of creating the land cover map for the *Biodiversity Guide for the Greater Portland-Vancouver Region*. Land cover statistics are presented in Chapter 1, "Current Conditions," of the *Biodiversity Guide*.

Understanding land cover or vegetation patterns and their distribution on the landscape is an important part of identifying and prioritizing conservation opportunities. Having such information in a standardized, digital format allows for sophisticated modeling approaches that support data-driven decision making. The geographic scale at which the land cover mapping occurs determines the finest scale at which subsequent analyses of conservation value can occur. Put more simply, coarse-scale mapping efforts fail to capture habitat that exists at a finer scale, and unmapped habitat cannot be prioritized.

There is a direct tradeoff between data scale and the size of subsequent data sets. As landscapes are analyzed at a fine scale, data sets grow larger. Thirty-six 5-meter pixels fit into a single 30-meter pixel. As data sets get larger, more computing power and time are necessary, making some forms of analysis challenging or even impossible. For large geographic areas analyzed at a fine scale, the issue of database size becomes increasingly limiting. As a result, despite the existence of aerial imagery with 0.5-meter resolution or better, most regional mapping efforts have worked at a pixel size of 30 meters or larger, consistent with the resolution of Landsat Thematic Mapper (TM) satellite imagery. A 30-meter-resolution map is appropriate to address conservation efforts at a whole ecoregion or statewide scale. However, higher resolution is required to address the more localized conservation objectives in an urban environment that occur at a relatively fine scale.

In order to capture the finer scale land cover patterns of the greater Portland-Vancouver region, the *Regional Conservation Strategy* working group contracted with Portland State University's Institute for Natural Resources (INR) in 2011 to produce a land cover map of the greater Portland-Vancouver region at 5-meter pixel resolution (i.e., 25 square meters).

Land Cover

INR generated the initial land cover grids using a combination of 1-meter resolution LiDAR imagery (a laser based remote imaging technology that accurately measures the elevation and the height of objects), 1-meter 2009 National Agricultural Imagery Program (NAIP) imagery, and 30-meter Landsat TM satellite imagery. For areas of the region in which LiDAR was available (approximately 88 percent of the region), INR generated a 22-class land cover data set at a 4-meter resolution. Where LiDAR data were unavailable—mostly on the region's fringes, where land cover patterns occur in larger patterns—INR used Landsat TM satellite imagery and aerial photographs to create a 30-m, 10-class land cover grid. The first draft of the land cover map was created by combining these two data sets into a 5-meter land cover data set with 25 classes.

The resulting data were then augmented by the project team using a combination of modeling and hand digitizing from color and color infrared aerial photography. These steps allowed us to more fully distinguish land covers and land uses that computer-based approaches were unable to adequately distinguish among, such as bare ground, agriculture, and sand/cobble bars.

■ **Agriculture.** In order to successfully model conservation priority areas, we needed to be able to separate agricultural lands from other low-height vegetation classes (i.e., vegetation less than 13 feet tall), a task that the initial land cover did not attempt. The first draft of the land cover had 585,000 acres (32 percent of the region) combined into these low-vegetation classes. We analyzed various 30-meter land cover/vegetation data sets to see how we could accurately identify agricultural lands without writing over our more detailed land cover data (for example, the 30-meter data may not capture a narrow tree corridor that appears in the 5-meter data). We established rules based on elevation, patch size, and whether or not the patch occurred inside or outside urban growth boundaries/areas. Both modeled and manual techniques were used to create the agriculture class. Patches of low vegetation outside urban areas, below 600 feet, and greater than 2 acres in size were reclassified as agriculture. Within urban areas, patches larger than 4 acres were manually examined and reclassified where appropriate. Above 600 feet, polygons larger than 4 acres were manually classified. Through these processes we were able to reclassify 75 percent (440,000 acres) of low vegetation classes as either agriculture or clear cuts.

■ **Bare ground.** Approximately 55,000 acres originally classified as bare ground (developed) included several land cover categories. We created polygons of these areas and examined them on high-resolution aerial photographs. Roughly 51,000 acres were reclassified as low vegetation, agriculture or clear cuts; with the remaining 3,500 acres added to the bare ground (developed) category.

■ **Sand/cobble bars.** The initial modeled results brought to our attention that sand/cobble areas next to rivers were classified as pavement (i.e., developed) and consequently received a low habitat value. In order to more accurately capture this important habitat, we buffered major rivers by 50 feet and reclassified any developed land cover in that area (approximately 1,500 acres) into its own class.

After reaching the limit of our resources to improve the accuracy of several priority land cover classes, we created three levels of detail at which one can view data or calculate statistics: Land Cover Levels 2, 1, and 0.

LAND COVER LEVEL 2 (33 CLASSES)

The most complex of the three outputs, Level 2 retains the interim values that we used to refine and improve the initial land cover data set. Low-structure vegetation classes are differentiated by whether or not they fall within urban areas. Agriculture areas within urban areas are separated out, as are agricultural areas higher than 600 feet in elevation. Clear cuts have separate classes based on whether they were defined from within the LiDAR extent or by Landsat data.

LAND COVER LEVEL 1 (15 CLASSES)

For a simpler though still very rich land cover, we combined a number of Level 2 categories to create a data set with 15 classes for which we had high confidence.

LAND COVER LEVEL 0 (SIX CLASSES)

For regional statistics, modeling, and cartographic purposes, Level 0 may be the most useful of the three. Here we group land cover types into six classes: trees, agriculture, developed land, low vegetation, water, and sand bars.

Accuracy Assessment of Land Cover Data

The project team completed a formal accuracy assessment by photo interpreting seven categories of the Level 2 mapped land cover to 2009 NAIP aerial photographs using 891 geographically stratified, random points. Overall accuracy was determined to be 94.3 percent.

Limitations of the Data Set

Despite our best efforts, funding and technological limitations prevented us from accurately mapping the following cover types of interest:

■ Lawns, ball fields, golf courses and other grass-dominated fields typically associated with development were not mapped as a unique type but were included within other cover types of similar height.

■ Agricultural trees such as orchards or Christmas tree farms and street trees were merged with tree cover types of similar height.

■ Oak trees were not specifically identified.

■ Vineyards were not specifically identified and are likely included in natural vegetation of similar height.

■ Native prairie was not identified as a unique type and was merged with the lowest stature vegetation classes.

■ Old-growth forest is not specifically mapped, although tree heights are available for the 88 percent of the region (i.e., the area with LiDAR coverage).

FIGURE A-1

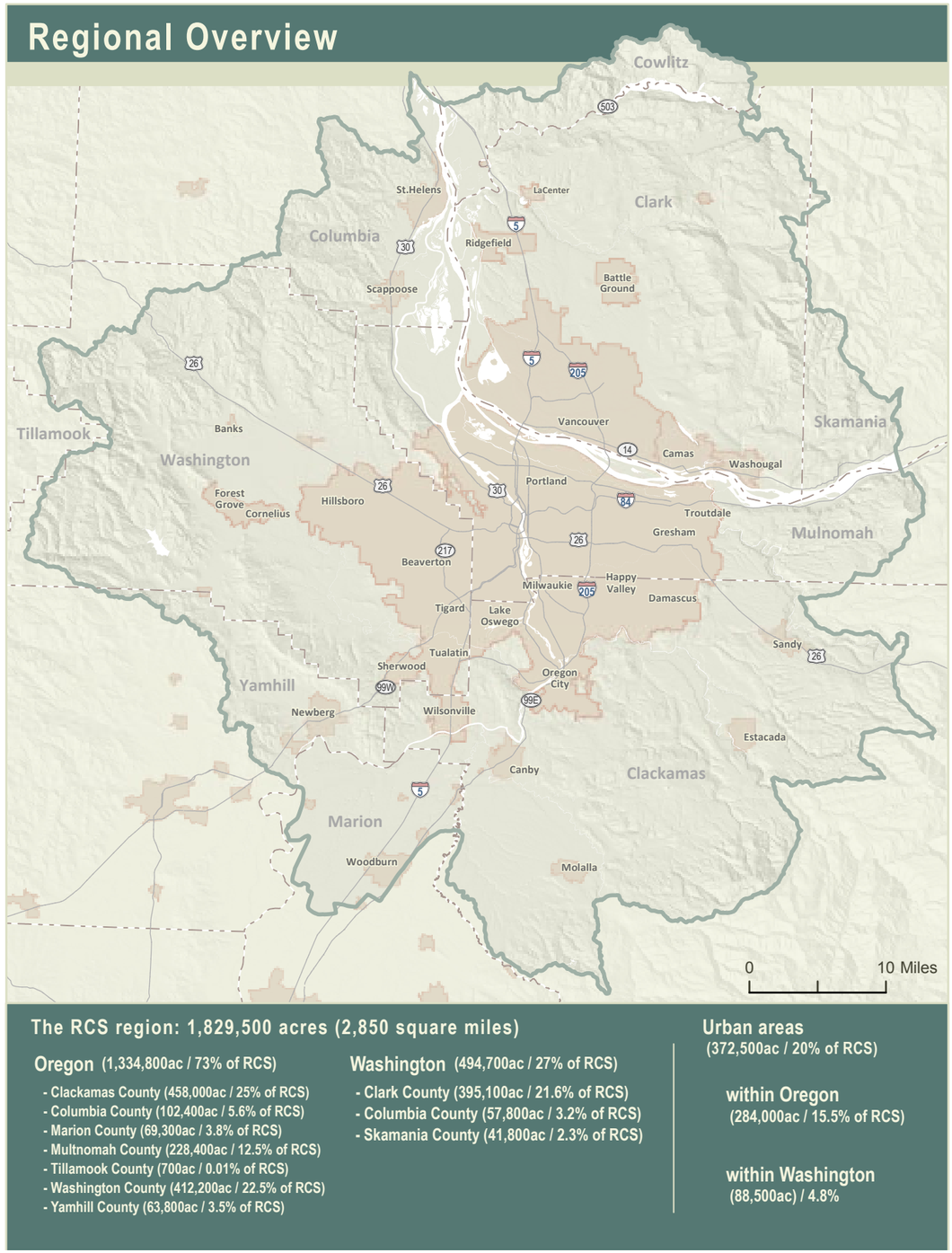
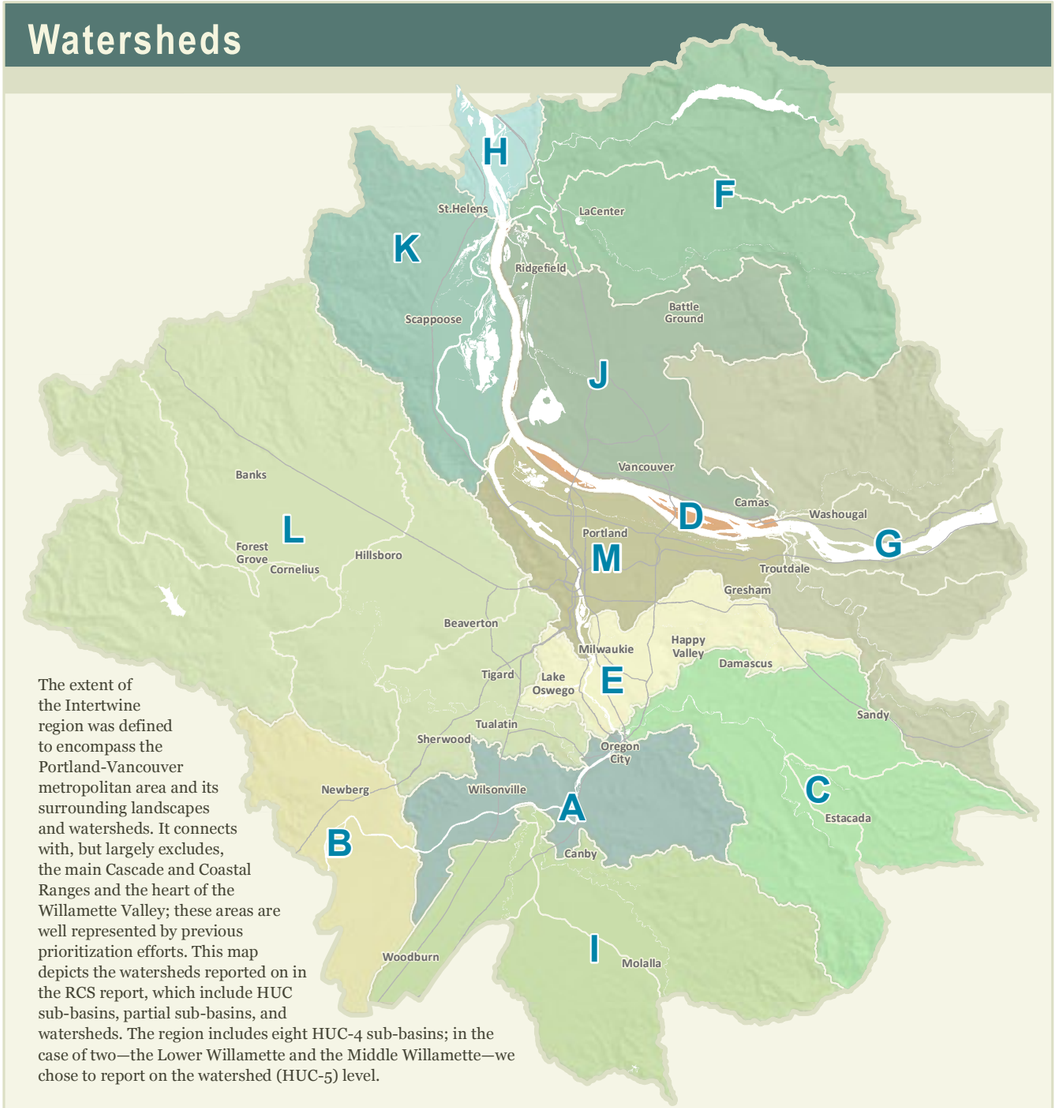


FIGURE A-2

Watersheds



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.

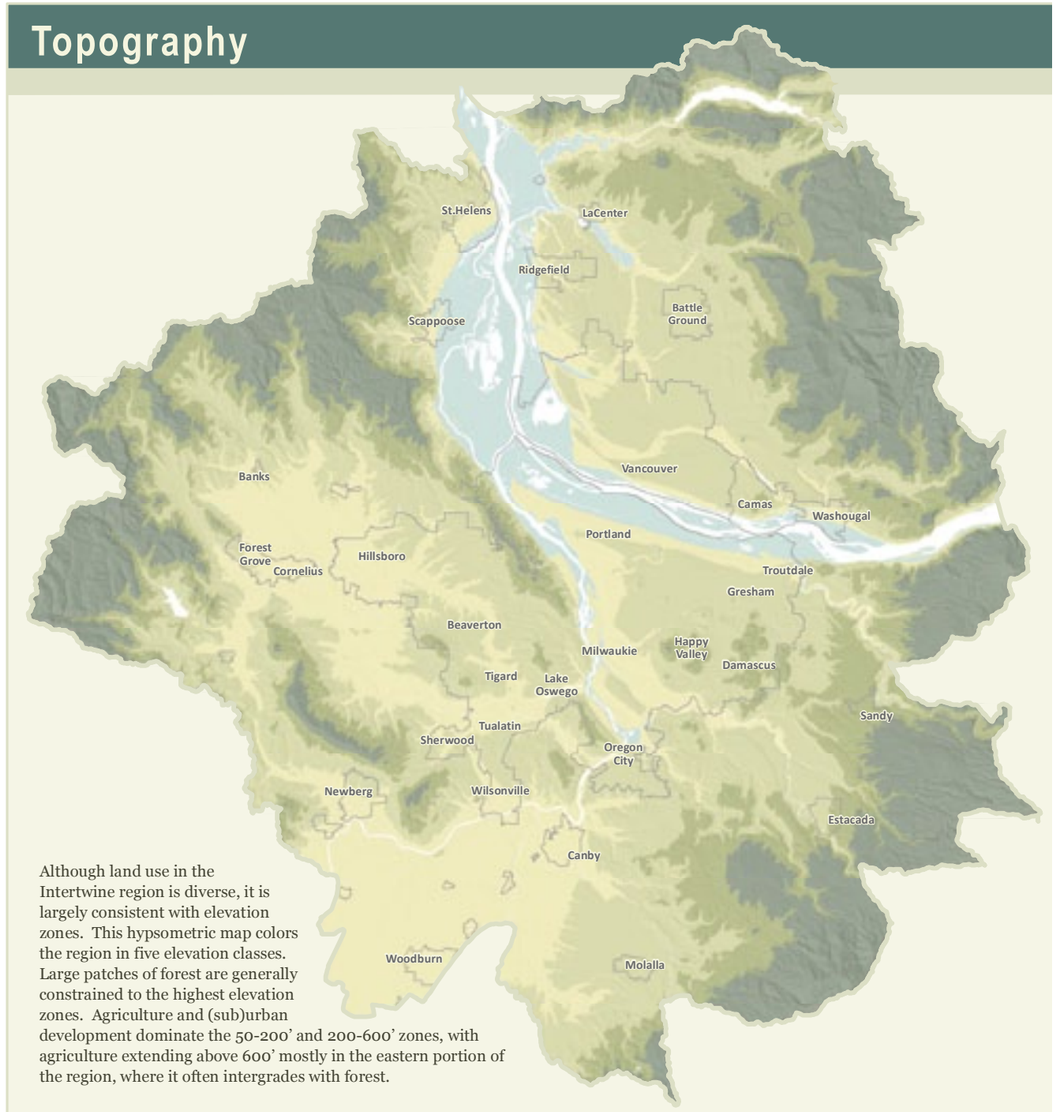
RCS Defined Watersheds

HUC 5 watersheds are lightly outlined * Represents a partial sub basin

- A - Abernethy Creek-Willamette River Watershed (87,000 ac)
- B - Chehalem Creek-Willamette River Watershed (78,000 ac)
- C- Clackamas Sub Basin * (158,500 ac)
- D - Hayden Island-Columbia River Watershed (18,500 ac)
- E - Johnson Creek Watershed (60,000 ac)
- F - Lewis Sub Basin* (221,000ac)
- G - Lower Columbia-Sandy Sub Basin* (217,500ac)
- H - Lower Columbia-Slatskanie Sub Basin* (22,000ac)
- I - Molalla-Pudding Sub Basin* (181.000ac)
- J - Salmon Creek-Frontal Columbia River Watershed (131,500ac)
- K - Scappoose Creek-Frontal Columbia River Watershed (181,000ac)
- L - Tualatin Sub Basin (453,500ac)
- M - Willamette River-Frontal Columbia River Watershed (78,000ac)

FIGURE A-3

Topography



Although land use in the Intertwine region is diverse, it is largely consistent with elevation zones. This hypsometric map colors the region in five elevation classes. Large patches of forest are generally constrained to the highest elevation zones. Agriculture and (sub)urban development dominate the 50-200' and 200-600' zones, with agriculture extending above 600' mostly in the eastern portion of the region, where it often intergrades with forest.

Elevation range 0 - 50 feet
8.2% of the Region (150.000 acres)
ColumbiaRiver and lower portions of the Willamette River

Elevation range 50 - 200 feet
19.3% of the Region (354.000 acres)
Mostly Floodplain, Urban and Agriculture areas

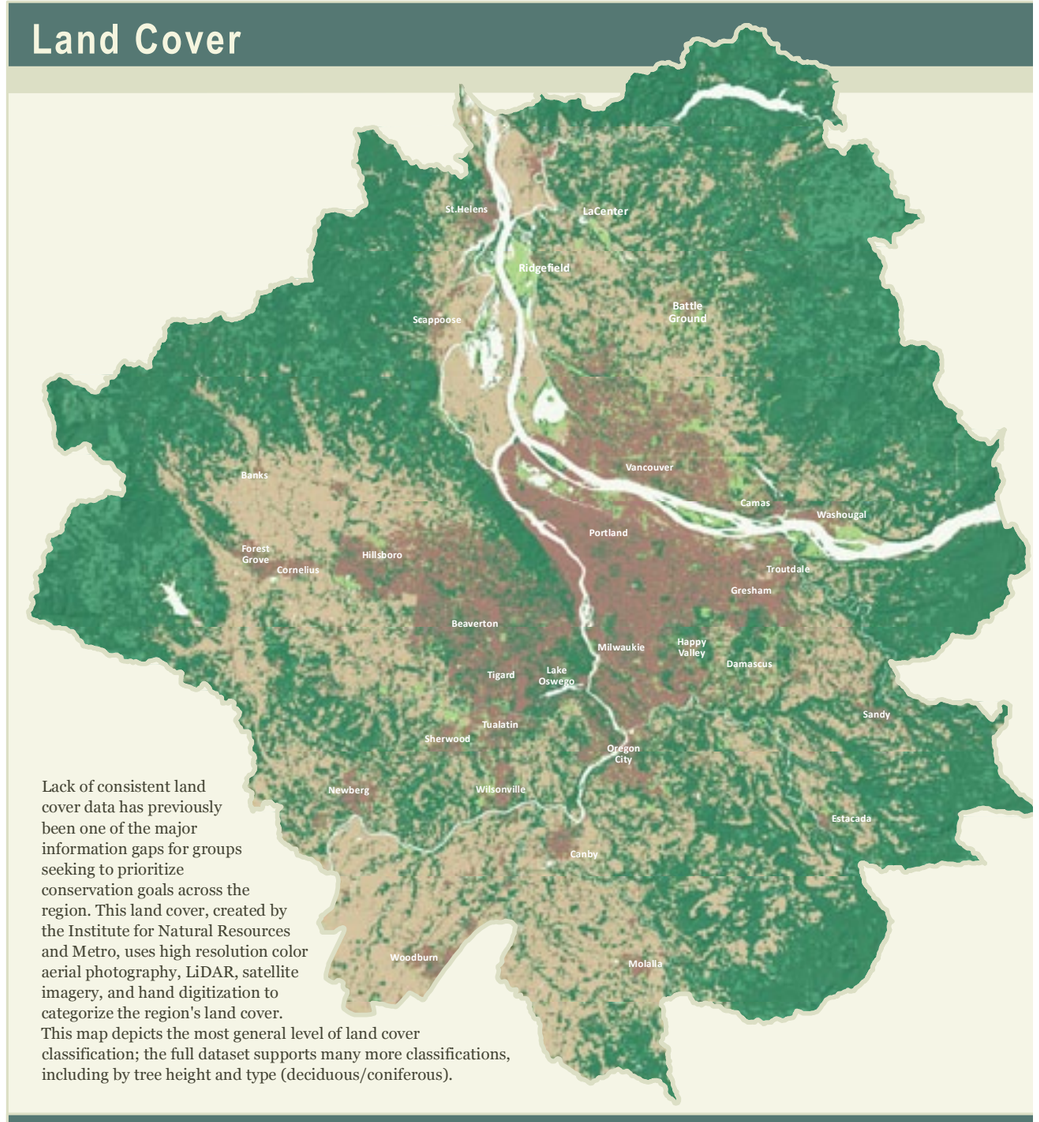
Elevation range 200 - 600 feet
34.2% of the Region (627.000 acres)
Mostly Agricultue and Urban areas

Elevation range 600 - 1,000 feet
16.4% of the Region (301.000 acres)
Transition lands; mix of agriculture and forest

Elevation range 1,000 - 4,380 feet
21.6% of the Region (396.000 acres)
Natural and industrial forest lands

FIGURE A-4

Land Cover



Lack of consistent land cover data has previously been one of the major information gaps for groups seeking to prioritize conservation goals across the region. This land cover, created by the Institute for Natural Resources and Metro, uses high resolution color aerial photography, LiDAR, satellite imagery, and hand digitization to categorize the region's land cover. This map depicts the most general level of land cover classification; the full dataset supports many more classifications, including by tree height and type (deciduous/coniferous).

Conifers & hardwoods over 14ft tall
49.1% of the Region (898,000 acres)

Clear cuts or recently modified forest
5.0% of the Region (92,000 acres)

Sparse vegetation/grasses/low shrubs 0-13ft
7.7% of the Region (141.500 acres)

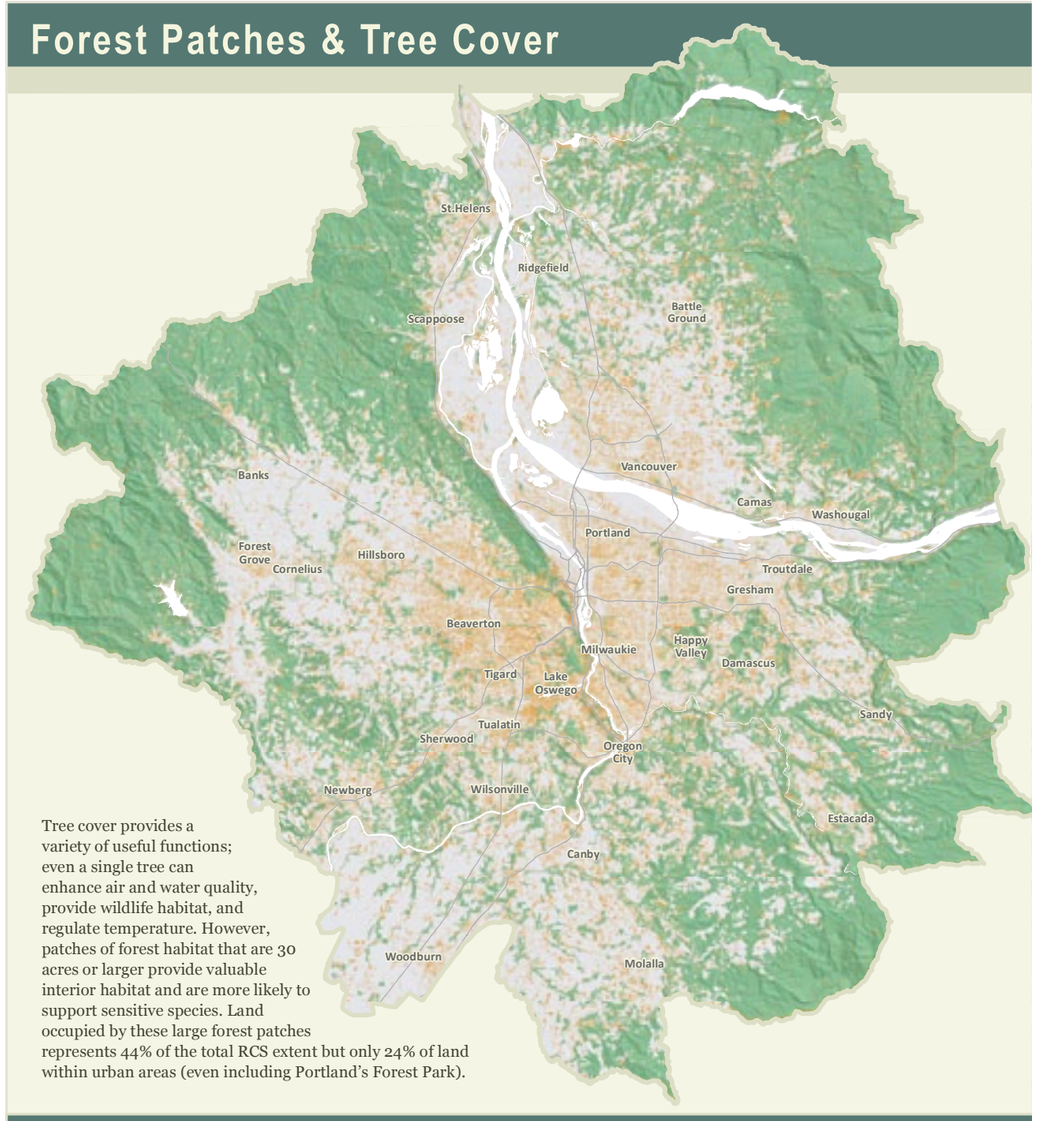
Agriculture
22.1% of the Region (405,000 acres)

Developed - paved areas and buildings
12.9% of the Region (235,000 acres)

Water
3.1% of the Region (57,000 acres)

FIGURE A-5

Forest Patches & Tree Cover



Tree cover provides a variety of useful functions; even a single tree can enhance air and water quality, provide wildlife habitat, and regulate temperature. However, patches of forest habitat that are 30 acres or larger provide valuable interior habitat and are more likely to support sensitive species. Land occupied by these large forest patches represents 44% of the total RCS extent but only 24% of land within urban areas (even including Portland's Forest Park).

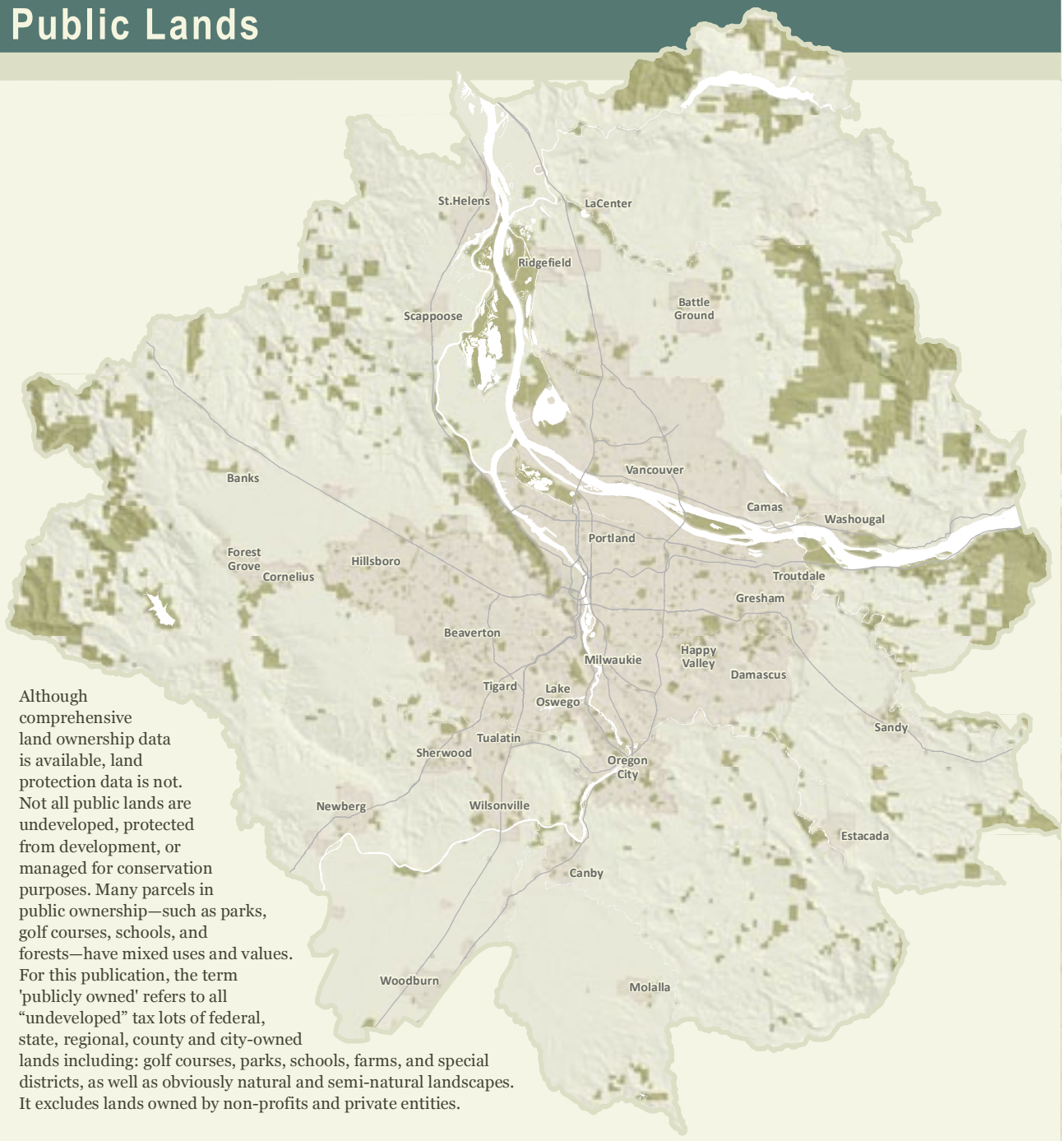
Forest patches 30 acres or larger - 44% of the region. The largest of these patches are in the mountainous, sparsely-populated fringes of the region.

Trees in patches smaller than 30 acres - 54% of the region. Urban areas contain substantial tree cover but few large forest patches.

All other land cover types - 46% of the region. This category includes developed lands, agriculture, grasses, water and shrubs.

FIGURE A-6

Public Lands



Although comprehensive land ownership data is available, land protection data is not. Not all public lands are undeveloped, protected from development, or managed for conservation purposes. Many parcels in public ownership—such as parks, golf courses, schools, and forests—have mixed uses and values. For this publication, the term 'publicly owned' refers to all "undeveloped" tax lots of federal, state, regional, county and city-owned lands including: golf courses, parks, schools, farms, and special districts, as well as obviously natural and semi-natural landscapes. It excludes lands owned by non-profits and private entities.

Public lands in the RCS:

- 13% of total acreage	Federal: 3.8% State: 6.1% Local, regional, and special districts: 3.2%
- 9% of urban acreage (UBGs, UGAs)	Federal: 0.2% State: 0.5% Local, regional, and special districts: 8.2%
- 14% of non-urban acreage	Federal: 4.8% State: 7.5% Local, regional, and special districts: 1.9%

B. Habitat Prioritization Modeling

In November 2010, when The Intertwine Alliance launched the effort to produce a regional conservation strategy and biodiversity guide for the greater Portland-Vancouver region, there was no data-driven map of priority areas for conservation that adequately covered both the urbanized and rural portions of the region. Previous efforts either worked on a larger regional scale that for the most part discounted the habitat value of urban areas (this was the case with the state conservation strategies and Willamette Valley Synthesis Project), focused on localized geographies and abruptly ended at jurisdictional boundaries (e.g., Title 13), or covered most of the region but were based solely on expert opinion (e.g., the Natural Features charrette process). The goal of the *Regional Conservation Strategy for the Greater Portland-Vancouver Region* and the accompanying *Biodiversity Guide* was to add a unified regional perspective to local efforts and to encourage a shared vision that could facilitate cooperation to protect remaining valuable habitat.

We aimed to develop data-driven, science-based scalable models for determining the relative conservation value of habitat in a way that would complement and support the *Regional Conservation Strategy* and accompanying *Biodiversity Guide*. We also wanted to (1) represent urban habitat in a way that makes the best fine-scale habitat within or near urban areas "competitive" with large, intact habitat blocks in the urban fringe, (2) cooperate with stakeholders to ensure their buy-in on the resulting product, and (3) create a foundation of work that others throughout the region could use for future conservation efforts, such as wildlife connectivity mapping and conservation and restoration prioritization.

Overall Approach

The modeling effort was overseen by the GIS Subcommittee of the Regional Conservation Strategy (RCS) Steering Committee, which included representatives of federal, state, and local jurisdictions and nonprofit organizations. The Institute for Natural Resources (INR) conducted the primary data development and modeling with input from the GIS Subcommittee. INR provided multiple drafts and iterations for review by the GIS Subcommittee and RCS Steering Committee. In establishing the criteria, methods, and threshold values for the models, the modeling team took into consideration the results of extensive stakeholder consultation and basic conservation science principles and incorporated scientific expertise.

The modeling effort produced two regional map outputs (with accompanying GIS data): a high-value habitat map (Figure B-1) and a riparian habitat map (Figure B-2). Each map was based on a distinct set of criteria for relative habitat value.

We used a raster-based analysis format to map and analyze the region as square pixels in a rectangular grid. Each pixel was scored uniquely based on the science-based criteria. A high-resolution (5-meter) regional land cover map that INR created for The Intertwine Alliance (Figure A-4) served as a foundational data set for several criteria, but the models also required regional data on wetlands, bodies of water, floodplains, soil types, and roads. In several cases, we faced a tradeoff between using the best available local data and creating or using a regionally consistent data set. In general, we used or created data sets that provided consistent spatial information across the region. In limited cases, such as with wetlands, we integrated local and regional data sets to produce a composite that we thought was more accurate while still reasonably consistent. Compiling data from numerous sources can cause variable results. For example, the density of mapped wetlands in Clark County is higher than in the rest of the region in part because of the mapping methods used to compile this data set.

Two Habitat Models, Two Sets of Criteria

The approach used to determine the conservation value of habitats consisted of developing two separate models—one for the entire region (the high-value habitat model) and one for riparian areas (the riparian habitat model). For each model, the modeling team developed spatial data sets that represented criteria for calculating the value of habitat.

High-value Habitat Model

The high-value habitat model covered the entire region (see Figure B-1). Every pixel received a score from 0 (lowest priority) to 100 (highest priority), yielding a multi-scale habitat prioritization for the entire greater Portland-Vancouver region (1,829,500 acres, or 2,812 square miles).

Pixel scores for the high-value habitat model were assigned by considering the following criteria:

- **Habitat interior.** Interior forest patches typically are more valuable than edge habitat because they have better three-dimensional structure, contain proportionately more native plant and animal species, and are further away from disturbances. Interior habitat was defined as areas more than 50 meters from the forested patch edge. Pixels located within interior habitat received higher scores. Pixels within the 50-meter buffer received progressively smaller scores as distance from the interior increased, with the increase dropping to zero at 50 meters.

- **Influence of roads.** Roads harm wildlife through direct mortality, loss of connectivity, and disturbance. To create a measure of habitat disruption, pixels adjacent to roads were assigned lower scores for habitat value.

- **Total patch area.** Larger habitat patches better support natural processes and provide more habitat value than small patches. Accordingly, pixels located within the largest patches (larger than 30 acres) received a relatively high score. Pixels in patches between 10 and 30 acres in size received somewhat lower scores.

- **Relative patch area.** Because the region has a widely diverse set of land uses and patch sizes, we also scored habitat patches according to their size and abundance relative to surrounding patches. This contextual approach accounts for the difference in conservation value between a 30-acre patch within a dense urban area and an identical 30-acre patch surrounded by wildlands.

- **Habitat friction.** In general, this criterion estimates how difficult it is for organisms to move from one pixel to the next across the landscape. To represent habitat friction, land cover values were reclassified with values that were cross-walked with professional input from previous studies.

- **Wetlands.** Wetlands were not mapped as a land cover type in our 5-meter RCS land cover. However, wetlands and their immediate surroundings provide very valuable habitat resources and support water quality and groundwater recharge. Pixels that fell within wetlands received higher scores than similar pixels that were not within wetlands. Pixels within 100 feet of a wetland were scored progressively based on proximity.

- **Hydric-rating soils.** Hydric soils are strongly associated with wetlands. Pixels within hydric soil areas received slightly higher scores than similar pixels outside hydric soil areas. This metric was helpful in differentiating habitat within agricultural areas and other areas with incompletely mapped wetland features.

Criteria layers were combined by adding assigned values or varying weights of the criteria to create a high-value habitat metric for each pixel. Throughout the process, we regularly evaluated model results for consistency with known areas of high-value habitat and used these comparisons to adjust the model.

Because of a lack of region-wide data, the model is limited in accounting for certain high-value habitats or habitat attributes, including:

- Oak savanna and woodlands
- Prairies and grasslands
- Old-growth forests
- Habitat composed of native species versus non-native species

The Intertwine Alliance intends to address these shortcomings over time, but for the near term, consideration of these habitat types in conservation planning will continue to require local expert knowledge.

Riparian Habitat Model

The extent of the riparian habitat model was determined by the location of the region's water features and an appropriate buffer around them. Buffers for major streams and water bodies were calculated using a variable model that assigned buffer widths to stream reaches by considering each reach's attributes, such as stream flow, stream volume, surrounding land cover, and the presence of salmonids. All perennial streams mapped in the U.S. Geological Society's National Hydrography Dataset—even those lacking stream reach attributes—received a minimum buffer and thus were included in the analysis. All Federal Emergency Management Agency (FEMA) floodplains and all wetlands (buffered by 30 meters) within 200 feet of streams were included. Altogether, nearly 464,000 acres received scores in the riparian habitat model. This figure accounts for nearly 25 percent of the greater Portland-Vancouver region (Figure B-2). Within urban areas alone, 80,000 acres were evaluated; this accounts for 21 percent of the urban areas in the region. As with the high-priority habitat model, the fine-scaled raster-based nature of this approach provides for a high level of local detail.

Pixel scores for the riparian habitat model were assigned by considering the following criteria:

- **Curve value-surface runoff (i.e., infiltration potential) of an area based on its land cover type.** In urban and agricultural areas, high volumes of water entering streams at high velocity can wreak havoc on stream function. Vegetation, particularly trees and shrubs, slow the flow, stabilize banks, and promote healthy channel structure. We derived surface runoff for each pixel by reclassifying our 5-meter land cover using previously published research on soil and land cover absorption rates.

- **Cost distance from various bodies of water, including wetlands, target stream, floodplains, and other streams and river edges.** Riparian areas vary in width, depending largely on elevation changes. Cost distance is a combination of linear distance and topography and is a measure of how closely a particular pixel is associated with a stream. This criterion helps capture the strength of the influence that the surrounding land form and condition have on the water body.

Features and buffered areas were then weighted and combined in a similar manner as the high-value habitat metric to create a riparian habitat metric for each pixel.

Results

The models can depict areas of significant conservation value across the region (Figure B-1), or only within a specified geography e.g., only within urban areas (Figure B-3). At a regional scale, the results align with those of previous efforts, such as the Willamette Valley Synthesis Project. As one zooms in, the models have much richer detail than any previous regional maps for the region. Preliminary comparisons with local conservation mapping efforts and expert knowledge have validated the overall modeling approach.

Although we initially intended to create polygonal conservation opportunity areas, as in the *Oregon Conservation Strategy* and Willamette Valley Synthesis Project, we decided to publish the model results in raster format. Publishing in this format allows the raster data sets to provide useful maps and data at a range of scales (Figure B-4) for a wide variety of users and applications. End users can generate their own polygons based on their specific area of interest, conservation strategy, or criteria. For example, an Intertwine partner working in a subset of the region can create maps showing the top-priority habitat within a particular boundary (e.g., Clark County, the Tualatin River watershed, or the city of Gresham). However, drawbacks to this decision are that the data sets are large, analysis may require GIS skills or custom software, and some practitioners and decision makers prefer to use polygon data.

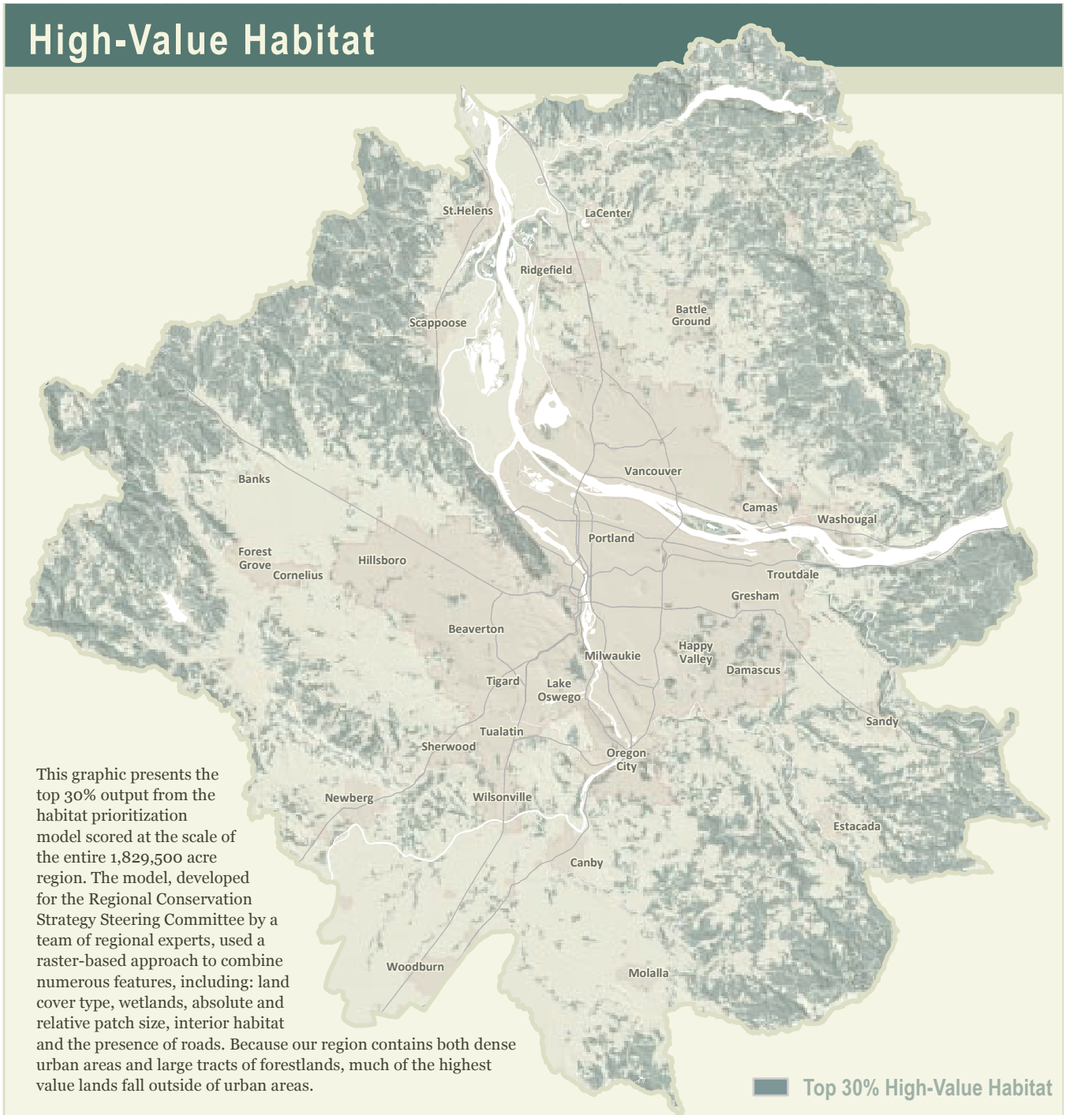
Conclusions and Next Steps

This data-driven approach is meant to complement rather than replace local knowledge by validating and challenging what we know and informing us about areas we know less well. Our intent was to provide a common metric for diverse stakeholders across the region. With limited funding available for conservation activities and a diverse set of stakeholders, there is a need for regional priority setting that can assist jurisdictions, agencies, and nonprofits in making more efficient and effective conservation decisions. Moving forward, we hope that this modeling effort will continue to undergo refinement and analysis as partners begin to apply the results to their particular geography and approaches. The following are some immediate potential uses for the model results:

- Helping nominate urban additions to the Willamette Valley Synthesis Project
- Identifying conservation opportunity areas (i.e., focal areas) for subregions where partners may have funding
- Helping to create potential biodiversity corridors
- Helping regional partners create programmatic priorities for investment
- Linking particular strategies for conservation or restoration to specific areas identified by the models

FIGURE B-1

High-Value Habitat



This graphic presents the top 30% output from the habitat prioritization model scored at the scale of the entire 1,829,500 acre region. The model, developed for the Regional Conservation Strategy Steering Committee by a team of regional experts, used a raster-based approach to combine numerous features, including: land cover type, wetlands, absolute and relative patch size, interior habitat and the presence of roads. Because our region contains both dense urban areas and large tracts of forestlands, much of the highest value lands fall outside of urban areas.

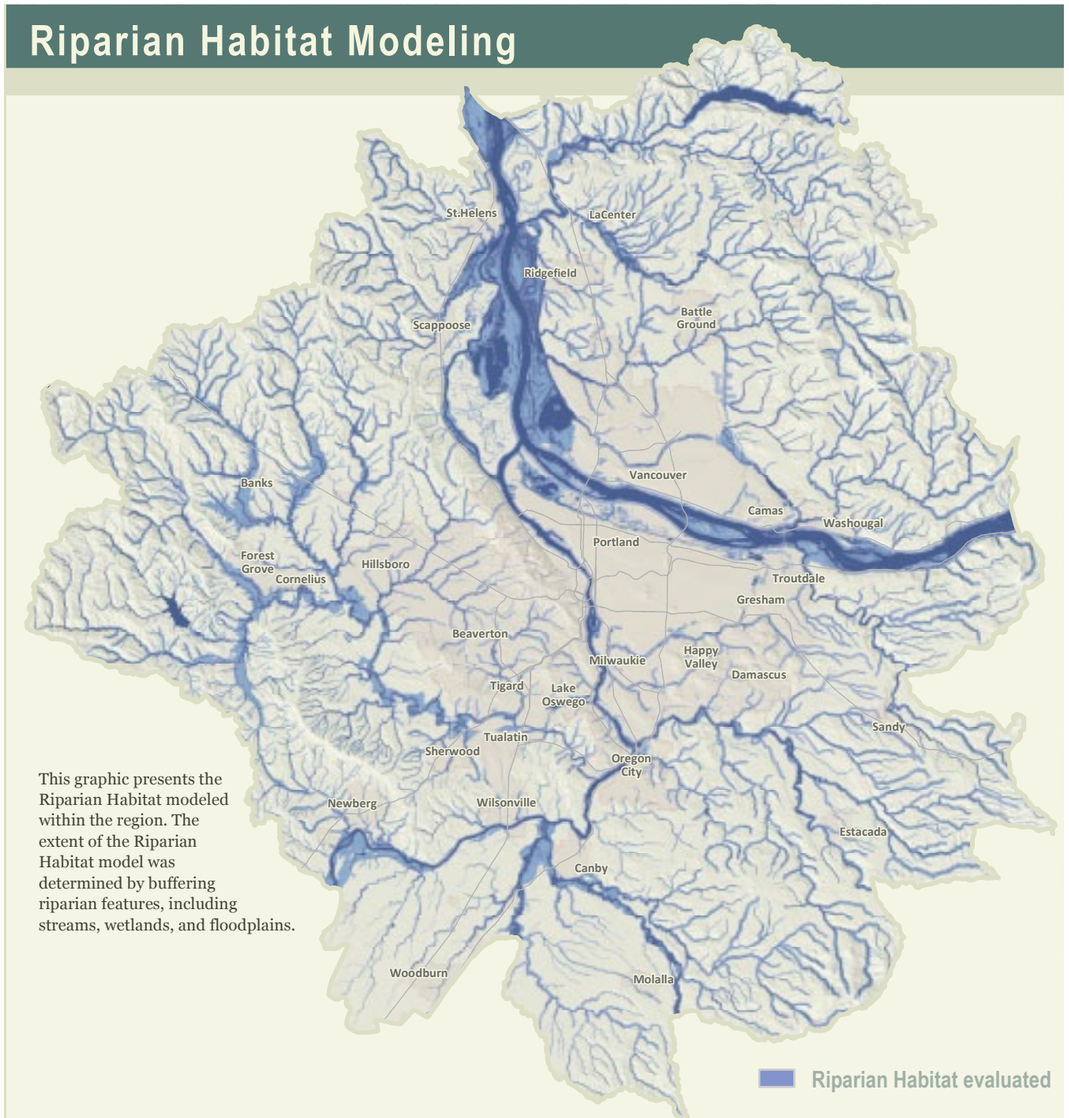
High-Value Habitat - Top 30% of the RCS region, based on modeled output

Of the 552,000 acres in the top 30%:

- 381,000 acres are in Oregon (28.5% of Oregon RCS extent; 20.8% of total RCS)
- 171,000 acres are in Washington (34.6% of Washington extent; 9.3% of total RCS)
- 19,400 acres are in RCS urban areas (5.2% of urban areas; 1.1% of total RCS)

FIGURE B-2

Riparian Habitat Modeling



This graphic presents the Riparian Habitat modeled within the region. The extent of the Riparian Habitat model was determined by buffering riparian features, including streams, wetlands, and floodplains.

Extent analyzed by the Riparian Model

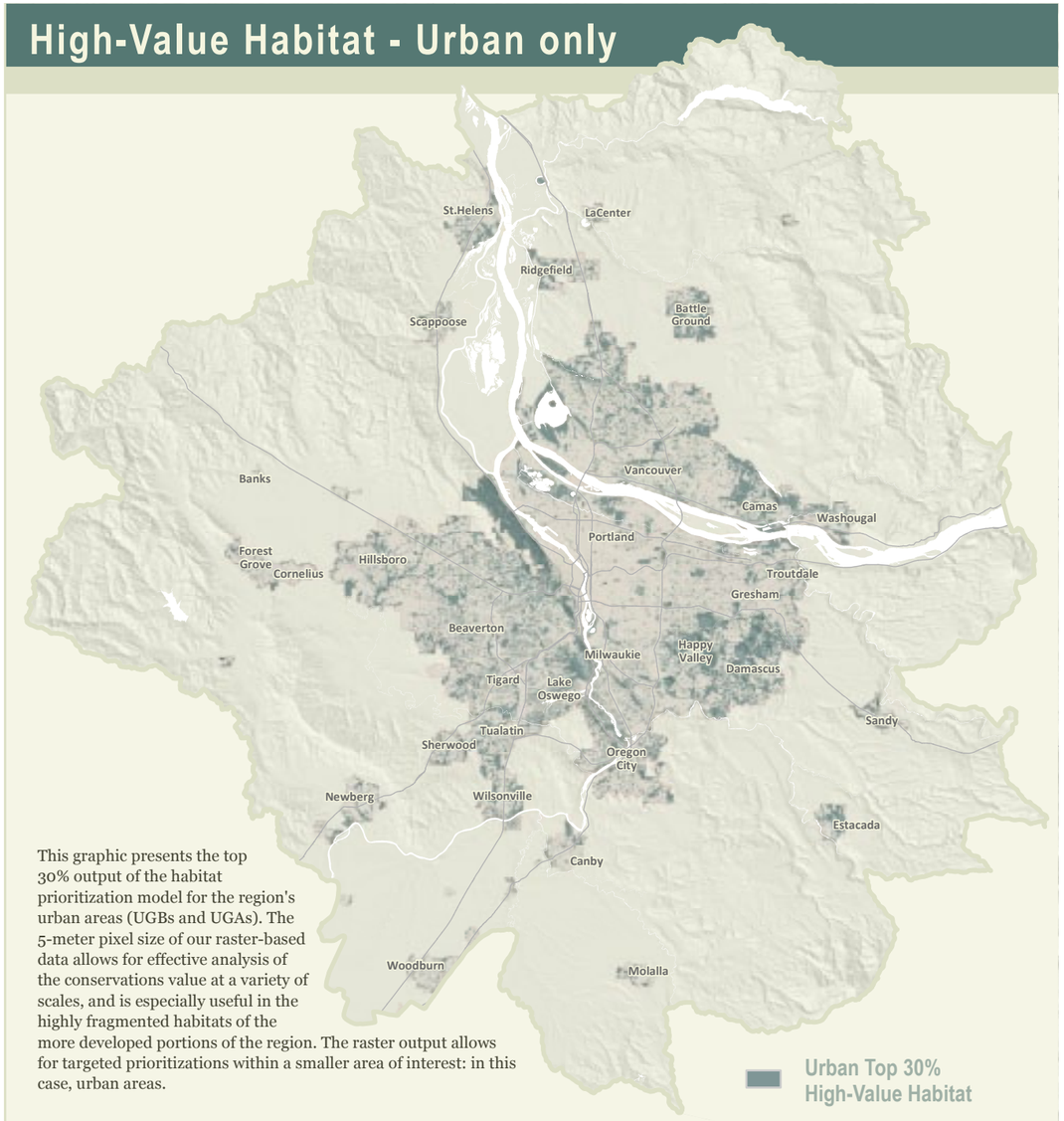
numbers below include water features

The area analyzed by the riparian model includes:

- 463,500 acres total (25.3 of RCS extent)
- 323,000 acres in Oregon (24.2% of Oregon RCS extent)
- 140,000 acres in Washington (28.3% of Washington RCS extent)
- 79,500 acres in urban areas (21.3% of RCS areas)

FIGURE B-3

High-Value Habitat - Urban only



This graphic presents the top 30% output of the habitat prioritization model for the region's urban areas (UGBs and UGAs). The 5-meter pixel size of our raster-based data allows for effective analysis of the conservations value at a variety of scales, and is especially useful in the highly fragmented habitats of the more developed portions of the region. The raster output allows for targeted prioritizations within a smaller area of interest: in this case, urban areas.

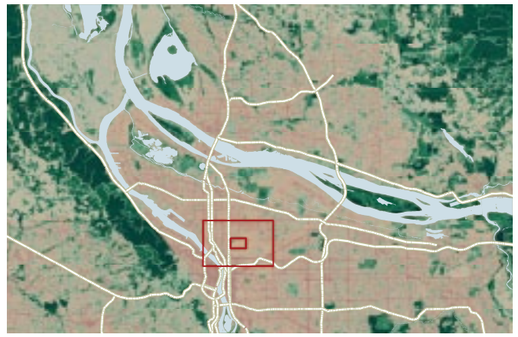
High-Value Habitat - Top 30% of urban areas, based on modeled output

Of the 114,000 acres in the urban top 30%:

- 85,400 acres are in Oregon (30.1% of Oregon RCS urban areas; 4.7% of total RCS)
- 28,600 acres are in Washington (32.3% of Washington RCS urban areas; 1.6% of total RCS)

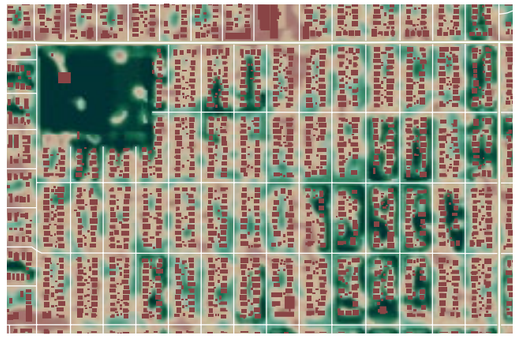
FIGURE B-4

Understanding Conditions at Multiple Scales



Regional 1"=6.3 MILES, OR 33,333 FEET

Local 1"=0.85 MILES, OR 4,500 FEET



Neighborhood 1"=0.19 MILES, OR 1,000 FEET

- Highest Value
- High Value
- Medium-High Value
- Medium-Low Value
- Low Value
- Least Value

An important benefit of our approach is the flexibility to analyze data at any scale, from the 3,000-square-mile region to the local neighborhood. The following examples represent patterns of land cover and relative conservation value as one zooms in from the regional to the neighborhood scale.

Regional

At the regional geographic scale, most small, local habitats are not apparent. Only the most prominent features stand out, such as rivers and large forest blocks. The highest scoring areas reflect habitats that have significant conservation value within the 3,000-square-mile region. Most highly fragmented urban habitats are not represented at this scale even though these areas are critical to regional biodiversity.

Local

At this intermediate scale, finer habitat patterns are more apparent while regional elements are still prominent. In this example, blocks of habitat barely visible at the regional scale become more dominant. For example, patterns of street tree density within east Portland become recognizable as a potential regional planning element. Opportunities to create ecological connections between regional sites are suggested. Only the highest scoring areas at this scale are likely to have regional significance.

Neighborhood

At the local scale, the neighborhood, features that appear less significant at the regional scale are apparent. Habitats barely or not recognizable at larger scales, such as local parks, creeks, vegetated hillsides, or tree patches can be woven into a meaningful framework and incorporated into local habitat conservation planning, neighborhood by neighborhood.

C. Natural Areas Ownership

Land protection and public ownership are not identical. While numbers for public ownership are available (statistics for our region are presented in Chapter 1, p14), the future management status of most public properties is legally uncertain. Furthermore, definitions of current management concepts like "natural area," "nature park," and "multiple use area" are uneven at best. Here we present brief descriptions of the land portfolio and management philosophy of many of our regions public and private land managers who have biodiversity conservation as at least part of their organization's mission. Each organization submitted draft text which was edited for consistency in style and brevity by the *Biodiversity Guide* steering committee, which takes full responsibility for all errors or omissions. We apologize in advance to those organizations or entities our funding limitations did not allow us to include.

Audubon Society of Portland

The Audubon Society of Portland owns or manages the 150-acre Audubon Sanctuary adjacent to Forest Park in Southwest Portland. The site consists of 64 acres owned by Audubon and 86 acres owned by Metro. Management of this mature forest that supports minor streams focuses on biodiversity protection. The site is bisected by Cornell Road, contains a small parking lot, visitor center, and wildlife recovery center. Public access is permitted via a pedestrian trail system.

Bureau of Land Management

The Bureau of Land Management (BLM) manages 35,285 acres in the greater Portland-Vancouver region. The majority is in the Salem District and is currently managed under the Western Oregon Plan Revision (WOPR). A total of 339 acres are managed by the BLM's Spokane Office.

Under the current management framework, 5,530 acres were administratively withdrawn from the harvest land base for specific purposes (e.g., species management, recreation, roads). Much of the remainder is for timber management (20,704 acres). There also are 6,269 acres in riparian management areas, 134 acres in late-successional management areas, 60 acres in deferred timber management areas, and 2,391 in National Landscape Conservation System (NLCS). Other BLM designations within the greater Portland-Vancouver region include the Horning Seed Orchard (806 acres), Larch Mountain Environmental Education Site (176 acres), Oxbow County Park (267 acres), Sandy River Gorge Area of Critical Environmental Concern (ACEC) (437 acres) and Wilhoit Springs ACEC (147 acres).

BLM's NLCS lands include wild and scenic rivers, including parts of the Clackamas, Sandy, and Salmon rivers (see www.blm.gov/or/plans/wopr/rod/files/wopr_salem_RMP.pdf). In addition, congressionally designated areas under BLM administration include the Mt. Hood Corridor (4,644 acres), which is managed to protect and enhance scenic quality and fire safety, and the Bull Run Watershed Management Unit (658 acres), which is managed to protect and enhance water quality.

Large habitat areas are distributed throughout much of the landscape in the greater Portland-Vancouver region, and large-scale planning helps guide timber harvest and habitat protection. Some areas are managed for federally listed species, such as salmon, northern spotted owl, and marbled murrelet. The harvest land base results in a heterogeneous landscape important to many wildlife species.

Clackamas County Parks

Clackamas County Parks owns or manages 22 properties with more than 1,000 acres of park and natural areas within the northwest portions of Clackamas County. These areas are mostly within the urban-rural interface and in rural settings; very few are in urban areas. Most sites are located along three major regional rivers—the Clackamas, Molalla, or Willamette—or one of their tributaries.

Clackamas County Park's mission is to provide park recreation areas but also to preserve the natural environment. Management focuses on both developed parks, including a golf course; parks with fishing access, trails, camping, and other park elements; and undeveloped open spaces. Most of these parks and open spaces still retain large tracts of healthy, predominantly forested and riparian habitat with some wetlands and open water. Unique elements include natural mineral springs, old-growth forest, rocky cliffs with madrone stands, and salmonid spawning habitat. Stone Creek Golf Club is located on 165 acres, is a certified as an Audubon Cooperative Sanctuary, and in 2009 was voted the eighth most environmentally friendly golf course in the country by *Links* magazine.

City of Hillsboro

The City of Hillsboro owns more than 850 acres of non-built park and greenway lands. The city's Parks and Recreation department owns and manages 448 acres of the 725-acres Jackson Bottoms Wetlands Preserve. More than 300 acres of greenways and open spaces (riparian tracts) are preserved for natural resource, stormwater management, aesthetic, and potential passive recreation values. Other notable natural area parks include good examples of older Douglas fir and riparian forests, such as Noble Woods Park (39 acres), Rood Bridge Park (73 acres), Dairy Creek Park (24 acres), Orchard Park (21 acres), and the Rock Creek Trail (42 acres). Hillsboro also owns and manages numerous smaller, neighborhood-scale parks in a mixture of natural and landscaped settings. Some of these include playing fields and playgrounds that provide a mixture of outdoor recreational amenities. A map of Hillsboro's parks is available at www.ci.hillsboro.or.us/ParksRec/documents/HillsboroParksMap.pdf.

City of Portland

Portland Parks and Recreation (PP&R) is the steward of 11,000 acres of land at more than 250 locations. PP&R City Nature was formed in 2004 to raise awareness of the importance of natural areas and their contribution to the livability of the city. City Nature promotes and implements the stewardship of natural areas. City Nature manages more 8,000 acres of natural areas within the city limits, ranging from Forest Park (at more 5,000 acres) to a web of small natural areas along the Willamette River and throughout the city. Additional natural areas are managed as part of developed (i.e., hybrid) parks. Habitats represented in PP&R natural areas and parks include oak habitat, upland forest (including interior coniferous forests), diverse wetland types, grasslands (not native prairie), and riparian and bottomland forests.

In 2003, PP&R was the nation's first park system to be Salmon Safe Certified. In 2010 PP&R completed a natural area restoration plan that includes a prioritized list of projects with their objectives and desired ecological outcomes for natural areas. This plan will guide PP&R in reaching the desired outcome of protecting and enhancing the biodiversity and ecological health of the City's natural areas, provide direction for near- and long-term actions, and establish management priorities.

Clark County/Vancouver-Clark Parks and Recreation

Clark County has almost 80,000 acres of land managed by public agencies for their natural resource and recreation values. Major landowners include the Washington Department of Natural Resources (60,000 acres), the Washington Department of Fish and Wildlife (3,067 acres), the U.S. Fish and Wildlife Service (6,243 acres), the Gifford Pinchot National Forest (1,239 acres), and Clark County/Vancouver-Clark Parks and Recreation (7,277 acres).

Vancouver-Clark Parks and Recreation (VCPR) land ownership spans a variety of lands for recreation and conservation, including several regional parks larger than 50 acres that provide diverse recreational activities for residents from Clark County and beyond. Designed to accommodate many people, regional park facilities may include sports fields, trails, large picnic areas, and significant natural areas. VCPR's regional parks plan recommends maintaining the development level in theses parks at 18 percent of the site. Master planning helps guide various parks' functions, values and desired future conditions. Throughout Clark County, VCPRD's 17 regional park sites encompass 2,314 acres. Regional natural areas, trails and greenways, and special-use areas cover an additional 3,350 acres. Urban parks within the City and its urban growth area cover more than 1,000 acres on 136 sites. Urban natural areas that may have some degree of public access conserve an additional 533 acres on 36 sites.

VCPR's parks include a variety of habitat types and unique natural features. Camp Lewisville contains fragments of old-growth forest that escaped the Yacolt Burn. Lacamas Park includes a population of camas lilies on a rock outcropping. Frenchman's Bar and William Clark parks include Columbia River floodplain forest remnants, and East Fork, Burnt Bridge Creek, and other parks conserve wetlands, floodplains, and riparian corridors.

Concentrations of public ownership occur from Vancouver Lake north to the Ridgefield National Wildlife Refuge Complex, Lower Salmon Creek from Lakeshore Drive to I-5, the Lower East Fork of the Lewis River from its mouth to Lewisville Park, the north and south ends of Lacamas Lake, and the Cottonwood Beach-Steigerwald National Wildlife Refuge vicinity east of Washougal. The Columbia River Gorge National Scenic Area encompasses land from the first ridgeline north of the Columbia River from east of Washougal to the Skamania County border. The Department of Natural Resources (DNR) manages concentrations of forest lands south of Lake Merwin and east of Yale Lake, south of the East Fork Lewis River to Camp Bonneville. The Gifford Pinchot National Forest extends from east of the DNR lands south of the East Fork to the Skamania County border. Once ordnance remediation is completed, Camp Bonneville, too, will become a significant component of the legacy lands system.

Columbia Land Trust

The Columbia Land Trust owns or manages 1,050 acres within the greater Portland-Vancouver region. Ownership includes 285 acres over 14 sites that together protect riparian, wetland, and forest habitats along the East Fork Lewis, Clackamas, Tualatin, Sandy, and Columbia rivers. A total of 505 acres in 18 conservation easements adjacent to public natural areas such as Forest Park expand the conserved areas and protect wetlands, wet prairie, oak habitat, upland forest, and riparian areas in several watersheds. Columbia Land Trust holds 230 acres of land in partnership with Clark County that will be transferred to the County to become part of its system of parks and natural areas. Management aims to maintain and restore native plant and wildlife communities with public access allowed within that context.

Forest Park Conservancy (FPC)

The Forest Park Conservancy owns and manages the 38-acre "Ancient Forest Preserve" and eight conservation easements totaling roughly 300 acres north of Forest Park and adjacent to a Metro natural area. The preserve is managed for old-growth forest conditions and contains 29 acres of never-harvested forest and a section of Burlington Creek. Limited public access is permitted via a 0.4-mile pedestrian trail. Terms of the conservation easements support the goals of surrounding natural areas by limiting timber harvest, restricting future development, and supporting onsite restoration.

Metro

Metro owns or manages 16,000 acres of natural areas and parks scattered throughout the Oregon portion of the region in 27 "target areas." Roughly 12,000 acres were acquired since 1995 through two bond measures. Included are three developed nature parks totaling 695 acres with visitor facilities and maintained trails, along with approximately 600 acres of land leased for agriculture. Roughly 3,400 acres include Oxbow Regional Park, Blue Lake Park, Smith and Bybee Wetlands, and Chinook Boat Landing; all of these areas provide substantial ecological benefit but contain developed portions, too. Metro anticipates acquiring 2,000 additional acres with funds from the 2006 bond.

Metro's holdings represent diverse habitats, including upland forest, riparian and bottomland forest, oak habitats, wetlands, and prairie. Significant regional natural areas are scattered throughout the region, including substantial holdings in the lower Sandy River, lower Clackamas River, Clear Creek, Johnson Creek, Willamette Narrows, middle Tualatin, Newell Canyon, East Buttes, Chehalem Ridge, Lower Gales Creek, greater Forest Park (including Multnomah Channel), and the Smith and Bybee Wetlands.

Management generally aims toward pre-1850 conditions, but the desired future condition is selected based on the site's position in the landscape, soils and hydrology, and local opportunities for water quality and wildlife habitat enhancement and public enjoyment.

The Nature Conservancy

The Nature Conservancy owns 489 acres of natural areas in the greater Portland-Vancouver region. Most (471 acres) are in the lower Sandy River Watershed between Dodge and Oxbow parks and help protect large contiguous tracts of floodplain, riparian, and upland forest within the Wild and Scenic River Corridor. The 27-acre Camassia Natural Area and 12-acre Little Rock Island are in the Willamette Narrows area and protect relatively high-quality remnants of prairie, oak savanna, and mixed woodland.

Biodiversity conservation and the needs of the priority conservation targets are the overwhelming management priority; public access is allowed within that context. Although management goals generally align with pre-1850 conditions, desired future conditions are selected to be consistent with the needs of the site's conservation targets, position in the landscape, soils, and hydrology.

North Clackamas Parks and Recreation District

North Clackamas Parks and Recreation District (NCPRD) owns or manages 800 acres of parks, open spaces and natural areas within a 36-mile radius of the North Clackamas urban area, including unincorporated Clackamas County, the City of Milwaukie, and Happy Valley. Although these parks and natural areas are spread throughout the north Clackamas area, many of the larger natural areas are located along Mount Scott Creek; this includes Mount Talbert Nature Park (230 acres), which is co-owned by Metro.

NCPRD's mission focuses on developed parks and recreation; however, recently NCPRD's management has expanded to also focus on natural resource areas. Although most of the parks are developed, with trails and other park elements, a few of the sites are designated as open space. NCPRD's lands host a range of habitat types, including upland woodlands (includes closed-canopy Douglas fir and oak habitat), mixed oak, riparian and floodplain, wet prairie, open water, and forested wetlands. Although these areas are fragmented urban islands, they support an array of native habitats and species, some which are now a concern because of their limited distributions, such as the western gray squirrel at Mount Talbert.

Oregon Department of Forestry

The Oregon Department of Forestry (ODF) owns approximately 23,000 acres of land at the western edge of the greater Portland-Vancouver region, mostly in the Gales Creek, Sunday Creek, and Scoggins Creek basins, which are headwaters to the Tualatin River. This area, which is part of the Tillamook State Forest, is composed mostly of a mix of young to middle-aged stands, with a smaller component of mature upland conifer forests. ODF ownership blocks range in size from 5 to 7,000 acres. The two largest blocks are contiguous with the rest of the Tillamook State Forest, which comprises a block of approximately 320,000 contiguous acres of forest managed by ODF. Ownership between ODF blocks is primarily private, with a smaller component owned by the cities of Forest Grove and Hillsboro and BLM. The majority of ODF ownership was involved in a series of fires between 1933 and 1945 that are referred to as the Tillamook Burn. The land was deeded to ODF in the 1940s and 1950s to be reforested and managed. The forest receives substantial recreational use. The Gales Creek area, a non-motorized recreation area, is host to the Gales Creek Campground, Gales Creek Overlook, Summit Trailhead, Storeyburn Trailhead, and Gales Creek Trail. Motorized recreation occurs in an area called Rogers Basin just south of Gales Creek. Rogers Camp Trailhead and the Rogers Camp Road trail are found in this area.

ODF Board of Forestry lands are managed for the "greatest permanent value" for the citizens of Oregon, under the *Northwest Oregon Forest Management Plan* (April, 2010). Greatest permanent value is defined as "healthy, productive, and sustainable forest ecosystems that over time and across the landscape provide the full range of social, economic, and environmental benefits to the people of Oregon" (OAR 62-035-0020(1))." These lands are retained as forests and managed to provide sustainable timber harvest as well as other forest resource values such as clean air and water, wildlife and aquatic habitat, and recreational opportunities.

Oregon Department of Fish and Wildlife

The Oregon Department of Fish and Wildlife (ODFW) owns approximately 12,100 acres of land within greater Portland-Vancouver region, excluding "developed" properties such as office facilities and fish hatcheries. The great majority is contained within the Sauvie Island Wildlife Management Area (SIWA) (approximately 11,500 acres). The remaining approximately 600 acres consists of dispersed parcels that primarily were acquired to provide public recreational fishing access.

The SIWA was established in 1947 primarily to protect and improve waterfowl habitat, and to provide public waterfowl hunting opportunities. The SIWA contains a number of diverse habitats, including extensive wetlands of several types, open water, riparian and bottomland hardwood forests, grasslands, oak habitat/savanna, beach, and areas in agricultural production for wildlife forage. Several are identified as priorities in the *Oregon Conservation Strategy*, and management is focused on protecting, maintaining, and restoring habitats to benefit fish and wildlife species.

Public fishing access areas owned by ODFW range in size from several acres up to 260 acres. Most remain largely undeveloped and provide angling access to major rivers such as the Sandy, Clackamas, and Molalla, although several provide access to man-made ponds (e.g. Wilsonville Pond, Woodburn Pond, and the St. Louis Ponds public fishing area). Public fishing areas support upland conifer and hardwood forest, riparian areas, wetlands, open water, grasslands, and wet prairie. Habitat management at these sites varies, with a primary objective being to minimize damage associated with public uses and maintain existing habitat values.

Oregon Parks and Recreation Department

Oregon Parks and Recreation Department (OPRD) owns more than 11,000 acres in the Oregon portion of the greater Portland-Vancouver region and manages an additional 2,200 acres on Government Island. OPRD's ownership includes large parks such as Stub Stewart State Park, Tryon Creek State Natural Area, Rooster Rock State Park, Milo McIver State Park, and Champoeg State Historic Area, popular parks on the Sandy River and in the Columbia River Gorge, and several smaller parks and properties scattered throughout the region. Major recreational uses in these parks range from disc golf and equestrian to swimming, hiking, and camping. The larger parks contain significant tracts of undeveloped or lightly developed acreage (e.g. low-impact trails).

A diverse array of native habitats can be found in the state parks in the region, including riparian and bottomland forest, upland forest, oak savanna and prairie, wetlands, and aquatic habitats. OPRD's mission is multi-fold, providing and protecting natural, scenic, cultural, historic, and recreational resources. OPRD works to restore and enhance the natural resources in the state's parks, often working with partners in the region to identify opportunities and leverage resources. Natural resource management is guided by park master plans, natural resource management plans, and state and regional conservation plans. In addition to restoration and enhancement, OPRD works to protect natural resources from damage associated with public use and park development.

PacifiCorp Lewis River Wildlife Habitat Management Lands

PacifiCorp owns approximately 11,105 acres in the Lewis River basin in Southwest Washington. These lands, known as Wildlife Habitat Management Plan lands (WHMP lands), fulfill Federal Energy Regulation Commission license obligations by offsetting habitat impacts resulting from the continued operation of the Lewis River Hydroelectric Projects (Merwin, Yale, and Swift No. 1 Hydroelectric Projects). For the duration of the 50-year license, WHMP lands are managed to benefit a broad range of wildlife, fish, and native plant species, including, but not limited to, large and small game, amphibians, bats, forest raptors, neotropical migrant birds, and culturally significant native plants. Management decisions are approved by the Terrestrial Coordination Committee, a partnership of the Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Cowlitz Indian Tribe, and Rocky Mountain Elk Foundation.

Approximately 10,000 acres of the WHMP lands lie within the greater Portland-Vancouver region, mostly surrounding Merwin Reservoir with a small portion to the north and east near Yale Reservoir. The dominant cover type is a mix of Douglas fir, western red cedar, hemlock, and bigleaf maple typical of low-elevation Western Cascades forest. Most stands are the typical young, closed-canopy forests of the region, but they range in age from recently planted following timber harvest activities to mature and old-growth (approximately 5 percent). Other forested habitats include mixed stands of deciduous and coniferous trees, upland deciduous stands dominated by red alders, and small oak sites that exist on rocky outcrops.

WHMP lands support many other habitats and several Washington Department of Fish and Wildlife priority habitats and species. Many of the non-forested habitats are managed to provide optimum wildlife forage and include natural and created meadows, farmland pastures, orchards, shrublands, and—where possible—the transmission line right-of-way. There is a diverse array of natural and created wetlands. All wetland, riparian, and shoreline areas are buffered to protect habitat. Significant habitat features such as talus slopes, large snags, and rock outcrops are also protected where possible. The lands within the greater Portland-Vancouver region are within two spotted owl management circles, have known Larch Mountain salamander locations, and currently support two bald eagle nesting territories, two bald eagle roosts and a staging area, and numerous osprey and red-tailed hawk nests.

Port of Portland

Founded in 1891, the Port of Portland is one of the largest landowners in the Portland metropolitan area, with more than 10,000 acres of property holdings. These include three airports, four marine terminals, industrial and commercial parks, undeveloped land available for development, dedicated open space, and 764 acres of wetland mitigation, re-vegetated sites along the Columbia Slough, and riverbank enhancements. Over 3,000 acres are natural areas.

The Port implements an environmental management system that sets standards for environmental performance and encourages continuous improvement. Guided by a comprehensive environmental policy (adopted by the Port Commission) and a specific natural resources policy, Port staff look for opportunities to enhance and sustain natural resources, going beyond regulatory compliance by using practices that increase habitat value and function. The Port works closely with regional partners such as the Northwest Ecological Institute, Xerces Society, Oregon Wildlife Institute, and Oregon Department of Fish and Wildlife to monitor and conduct surveys on Port properties and evaluate overall biological function. Current projects focus on western painted turtles, amphibians, grassland pollinators, and aquatic invertebrates on Port-owned sites.

Port facilities are located along and near significant ecological resources, including the Columbia and Willamette rivers, the Columbia Slough, and Smith and Bybee Wetlands Natural Area. Wetland mitigation sites are managed to ensure high-functioning hydrology and connectivity to neighboring sites.

Vanport Wetlands, a 91-acre mitigation site in North Portland near Smith and Bybee Wetlands Natural Area, has been restored from a reed canarygrass-dominated site to a diverse wetland ecosystem dominated by native species.

The Port owns more than 800 acres on the west side of Hayden Island, one of the largest undeveloped tracts in the Portland metro area. This area features shallow-water habitat, riparian forest dominated by black cottonwood stands, and upland meadows. The site is being evaluated for 500 acres of open space and 300 acres of industrial development via a City of Portland annexation process. Approximately 100 acres of the 300-acre proposed development site is an active dredge material placement site.

The Port recently acquired a 453-acre industrial site in Troutdale consisting of 366 acres of developed or developable land, 75 acres of open space, and 12 acres of wetland mitigation land.

The Port partnered with the Oregon Department of Transportation, Clean Water Services, and the City of Hillsboro to restore and enhance wetlands at the Jackson Bottom Wetlands Preserve for wetland mitigation credit; the "Bobcat Marsh" project will also enhance the educational and recreational value of the preserve.

Over the next few years, the Port will be implementing a new initiative on a portion of Port-owned land on Government Island, part of a 2,220-acre island complex in the Columbia River. The Port will be mitigating for future aviation-related impacts to grasslands on Portland International Airport land by improving 300 acres of upland grassland habitat on the island. Government Island also is home to the 426-acre Jewett Lake mitigation site, which was enhanced in the early 1990s to compensate for development at PDX. The island is being evaluated further for use as mitigation for several other anticipated Port-related developments.

Port of Vancouver

The Port of Vancouver USA is a multi-purpose port authority located in Vancouver, Washington, within the Vancouver Lake lowlands. Established in 1912, the Port ensures public ownership of trade docks on the Columbia River. Port lands include 1,970 acres along 4 miles of the Columbia River in southwest Clark County. Operations occur on an 800-acre area of land zoned for heavy industrial use. Port ownership includes more than 600 acres of natural areas adjacent to the developed property that may be developed for heavy (500 acres) or light (100 acres) industrial use in the future. An additional 570 acres of natural areas—primarily contiguous lowlands—have been set aside in perpetuity for habitat to mitigate current and future developments. In addition to the 570 acres, the Port of Vancouver is establishing a 157-acre wetland mitigation bank, the first of its kind in Clark County, which will make mitigation credits available to developers within the Lower Columbia River watershed. The port is adjacent to and part of a larger bi-state system of natural areas that includes Washington State Fish and Wildlife's Shillapoo Wildlife Area, U.S. Fish and Wildlife Service's Ridgefield National Wildlife Refuge Complex, the Vancouver Lake lowlands, and—on the Oregon side—Hayden Island, Sauvie Island, and the confluence of the Columbia and Willamette rivers.

Tualatin Hills Park & Recreation District

The Tualatin Hills Park & Recreation District owns or manages 1,300 acres of natural areas in more than 100 different sites in the greater Beaverton area, including 220 acres co-managed with Metro at Cooper Mountain. The district has owned natural areas for more than30 years and has taken an increasingly active role in maintaining them since the 1990s. Most sites provide some public access for wildlife viewing, hiking, or biking.

The park district's land includes upland forest, oak habitat, wetlands, remnant prairie, and riparian corridors. The most significant properties include the Tualatin Hills Nature Park (233 acres), Cooper Mountain Nature Park, and a string of properties along Rock Creek and its tributaries, as well as along Beaverton's South Johnson Creek.

District staff strive to support robust urban ecosystems that approximate pre-1850 conditions to benefit wildlife and provide the community with an understanding of the historical habitats representative of their region.

USDA Forest Service

The U.S. Department of Agriculture (USDA) Forest Service administers 27,462 acres in the greater Portland-Vancouver region. About half of this area (13,830 acres) falls in the Columbia River Gorge National Scenic Area (CRGNSA),and the remainder is on the other portions of the Mt. Hood and Gifford Pinchot National Forests (7,768 acres and 5,864 acres, respectively). The CRGNSA lands are managed for their scenic value. Other national forest lands provide valuable wildlife habitat, wilderness, water, fish habitat, and related natural values.

All of the area falls within the *Northwest Forest Plan* area. Of the total 27,462 acres, 14,316 acres are administratively withdrawn from timber harvest to provide for the special recreation area of the CRGNSA or special interest areas (botanical, historical archaeological, geologic, and scenic purposes, and research natural areas), or they are designated as wildlife habitats and conservation areas. Of the remaining 13,146 acres, 5,816 acres are designated as late-successional reserves in order to meet the habitat needs of the northern spotted owl and other species associated with old-growth forest. Two acres fall within Congressionally withdrawn wilderness. The remaining 7,328 ac are considered "matrix" in the *Northwest Forest Plan*. These lands have a multiple-use emphasis, including timber extraction.

U.S. Fish and Wildlife Service

Through the National Wildlife Refuge System, the U.S. Fish and Wildlife Service manages five national wildlife refuges (NWRs) within the greater Portland-Vancouver region. Four are adjacent to the Columbia River and managed as the Ridgefield NWR Complex; they are the Ridgefield NWR downstream of Vancouver, Washington (5936 acres), Steigerwald Lake (1,356 acres), Franz Lake (695 acres), and Pierce (329 acres) NWRs between Washougal, Washington, and Bonneville Dam. The two units of the Tualatin River NWR (Wapato and Tualatin, totaling 7,370 acres) are in the southeastern portion of the study area.

The region's national wildlife refuges support diverse habitats, including riparian, floodplain and upland forest; wetlands; oak savanna and wet prairie; and farmland managed for grain production for waterfowl.

Refuges must be managed to fulfill the National Wildlife Refuge System's mission and the specific purpose(s) for which the refuge was established as specified in or derived from the related laws, regulations, and proclamations or administrative memorandum. When a conflict exists between the refuge system mission and the purpose of an individual refuge, the refuge purpose supersedes the mission. Management strategies are identified in comprehensive conservation plans (CCPs), which have been completed for the Ridgefield, Steigerwald Lake, Franz Lake, and Pierce national wildlife refuges. The Tualatin River NWR is in the process of developing a CCP.

Washington Department of Fish and Wildlife

The Shillapoo Wildlife Area and a portion of the Mount Saint Helens wildlife area are located within the greater Portland-Vancouver region. The 2,370-acre Shillapoo Wildlife Area, which is located within the floodplain of the Columbia River in Clark County, is managed as three units. Annual flooding and scouring, which formed the area's topography, have been substantially reduced as a result of hydropower, irrigation, and flood control projects upstream.

The area is currently a mix of agricultural land and developed pasture intermixed with fragmented pieces of natural habitat of varying quality. Himalayan blackberry and reed canarygrass are two exotic plants that limit habitat quality in almost all habitat types. Sharecrop and grazing agreements with local farmers and ranchers have been used to maintain habitat for migrating and wintering waterfowl and sandhill cranes. Corn and small grains are left standing for forage. Recent and ongoing major projects focus on restoring a large portion of the agricultural land to wetland habitat.

As a major wintering area for waterfowl in the Pacific Flyway, the Shillapoo supports Canada geese, mallards, and other dabbling ducks. Bald eagles nest in adjoining areas and can be present in significant numbers on the wildlife area, particularly in winter. Sandhill cranes use the wildlife area and surrounding lands primarily as a staging area during the fall and spring, but a few overwinter in the area. The area also supports mink, great blue heron, black-capped chickadee, western meadowlark, yellow warbler, and other species. Listed salmonids found in the Columbia River, Lake River, and Vancouver Lake adjacent to the wildlife area lands include lower Columbia coho and Chinook salmon, Columbia River chum salmon, Snake River sockeye, and steelhead. Shillapoo is also within the historical range of the Columbian white-tailed deer and western pond turtle (both state endangered) and is considered potential habitat for both species.

Four smaller units of the Mount Saint Helens Wildlife Area are also located in the greater Portland-Vancouver region. Although these units represent only a segment of the wildlife area as a whole, they do provide habitat and recreational opportunities. The Eagle Island unit is the agency's most recent addition to the wildlife area. At 279 acres, this is the largest of the four Saint Helens units in the planning area. Although a large portion of this island is covered by invasive scotchbroom, much of the interior is made up of tall stands of cottonwood, Douglas fir, and western red cedar. The island's margins, wetlands, and side channels provide some of the most important

rearing habitat for wild fall Chinook salmon that make their way along the Lower Lewis River.

All WDFW wildlife areas in the greater Portland-Vancouver region are in the Willamette Valley-Puget Sound-Georgia Basin ecoregion with the exception of the Mount Saint Helens' Cedar Creek unit. This 127-acre unit lies just in the West Cascades near La Center, Washington. Cedar Creek, a tributary of the Lewis River, demarcates the unit's northern boundary. Dominant habitat features include Douglas fir/western hemlock forest, mixed riparian forest, and mineral springs. The Cedar Creek unit is managed primarily for band-tailed pigeons and includes a mineral spring used by the birds. Stream restoration has also occurred to benefit salmon and steelhead.

The last two units are quite small. At just under 50 acres, the Two Forks unit lies just west of La Center. This unit is found at the confluence of the East Fork Lewis and Lewis rivers. It is primarily used for river access and is managed for the protection of critical riparian habitat. Just to the northeast of Two Forks is the Jenny Creek unit. This 20-acres site once sustained mineral springs used by band-tailed pigeons. The site is dominated by pasture but also includes hardwood and Douglas fir forest.

Washington Department of Natural Resources

The Washington Department of Natural Resources (DNR) owns nearly 50,000 acres within the greater Portland-Vancouver region, including approximately 45,000 acres of trust lands managed for timber income. The largest holdings are in the western Yacolt Burn State Forest (40,000 acres) and lands around Lake Merwin and Yale; timber is typically harvested at 50- to 60-year intervals.

DNR also owns lands in the state's Natural Area Preserves (NAP) program. Washougal Oaks NAP (214 acres) protects one of the state's largest high-quality Oregon white oak habitats, including three animal and four plant species listed as priorities in the Natural Heritage Plan. Columbia Falls NAP (514 acres) lies at the edge of the boundary of the greater Portland-Vancouver region, protecting two state threatened and four sensitive plant species and nine plant species that only in the Columbia River Gorge. Lake Merrill NAP (114 acres) is an important conifer-hardwood shoreline forest and is prime habitat for birds of prey, including osprey. DNR is also actively pursuing acquisitions in the Lacamas Prairie Natural Area Preserve, where Clark County and Columbia Land Trust have acquired 249 acres.

The Wetlands Conservancy

The Wetlands Conservancy owns 13 wetland preserves in the greater Portland-Vancouver region, totaling 131 acres. These preserves range in size from small pocket wetlands in Multnomah, Clackamas, and Washington counties to the 31-acre Hedges Creek Marsh and Pascuzzi Pond in Tualatin. The preserves protect a wide variety of wetland and upland habitat types, including ponds, forested wetland, and scrub shrub and upland prairie.

Biodiversity conservation and the needs of the wetlands' functions and values are the overwhelming management priority; public access is allowed within that context. Restoration goals and desired future conditions are selected to be consistent with the needs of the site's conservation targets, position in the landscape, soils, and hydrology.

The information provided in this section is not comprehensive. Most local jurisdictions within the RCS extent own or manage natural areas or parks. They may be small, but such areas can provide very important access to nature, as well as habitat and stepping-stones for birds and other wildlife to move between larger habitat patches. For example, the City of Camas owns Lacamas Park, a 311-acre natural area with a lake, oak habitat and public amenities, as well as smaller and more developed parks. Trees in developed parks can still provide important habitat and elements of wildlife connectivity. Collectively, all of these natural areas, parks and open spaces conserve a great deal of habitat in the region. The following table summarizes the information provided above.

TABLE C-1

Major Owners of Natural Areas in the Region

Owner	Approx. Acres in Greater Portland-Vancouver Region	Description
Audubon Society of Portland	150	Adjacent to Forest Park. Audubon manages all, but part is owned by Metro.
Bureau of Land Management	35,285	Majority is in the Salem District. Includes timber lands and Wild and Scenic River segments of the Clackamas, Sandy, and Salmon rivers.
Clackamas County Parks	1,000	Most within the urban-rural interface and in rural settings along three major regional rivers or their tributaries: the Clackamas, Molalla, and Willamette.
City of Gresham	800	Includes public parks with natural areas such as Main City Park, significant holdings along the Springwater Corridor on Johnson Creek, water quality areas, and a few parcels that are slated for future development.
City of Hillsboro	850	Includes a large portion of Jackson Bottom Wetlands preserve.
City of Portland	11,000	Includes more than 8,000 acres within city limits, including 5,000 acres in Forest Park.
Clark County/Vancouver Clark Parks & Recreation	7,277	Includes 17 regional parks and a variety of park types and uses. Regional natural areas, trails and greenways, and special use areas cover 3,350 acres.
Columbia Land Trust	1,050	Manages 1,050 acres; 505 acres in conservation easements, partners with Clark County on 230 acres, owns 285 acres.
Forest Park Conservancy	300	Owns and manages a 38-acre "Ancient Forest Preserve" and eight conservation easements totaling roughly 300 acres north of Forest Park.
Metro	16,000	Includes three developed nature parks (695 acres) and approximately 600 acres of land leased for agriculture; remaining acres are natural areas.
North Clackamas Parks and Recreation District	800	Owns or manages 800 acres of parks, open spaces, and natural areas, including holdings in unincorporated Clackamas County, Milwaukie, and Happy Valley.
Oregon Department of Forestry	23,000	Mostly in the Gales Creek, Sunday Creek, and Scoggins Creek basins, which are headwaters to the Tualatin River, in the Tillamook State Forest.
Oregon Department of Fish and Wildlife	12,100	Most (11,500 acres) in the Sauvie Island Wildlife Management Area.
Oregon Parks and Recreation Department	11,000	Includes Stub Stewart, Tryon Creek, Rooster Rock, McIver, Champoeg, and other state parks. Manages an additional 2,200 acres on Government Island.
PacifiCorp	10,000	All in the Lewis River basin in southwest Washington; offsets habitat impacts from hydropower.
Port of Portland	3,133	Includes owned mitigation and natural areas along the Columbia Slough, three river islands, and open space in Troutdale.

TABLE C-1 *(continued)*

Major Owners of Natural Areas in the Region

Owner	Approx. Acres in Greater Portland-Vancouver Region	Description
Port of Vancouver	1,327	Includes 600 acres of natural areas that may be developed and 570 acres of dedicated natural areas; is establishing a new 157-acre wetland mitigation bank.
Tualatin Hills Park & Recreation District	1,300	Owns or manages 1,300 acres of natural areas in more than 100 different sites, including 220 acres co-managed with Metro at Cooper Mountain.
The Nature Conservancy	489	Includes 471 acres in the lower Sandy River watershed between Dodge and Oxbow parks, plus the 27-acre Camassia Natural Area and 12-acre Little Rock Island.
The Wetlands Conservancy	131	13 wetland preserves totaling 131 acres in Oregon, including many small wetlands and the 31-acre Hedges Creek Marsh and Pascuzzi Pond in Tualatin.
U.S. Department of Agriculture Forest Service	27,462	About half is in the Columbia River Gorge National Scenic Area, with the remainder in the Mt. Hood and Gifford Pinchot national forests.
U.S. Fish and Wildlife Service	15,357	Includes the Ridgfield, Steigerwald Lake, Franz Lake, Pierce, and Tualatin River (Wapato and Tualatin) National Wildlife Refuge complexes.
Washington Department of Fish and Wildlife	2,370	Includes Shillapoo and part of the Mount St. Helens wildlife areas, plus several smaller holdings.
Washington Department of Natural Resources	50,000	Includes 40,000 acres in the Yacolt Burn State Forest managed for timber harvest, plus four natural area preserves.
Total	**229,381**	

D. Upland Forest Wildlife in the Region

This appendix lists examples of terrestrial vertebrate species that find optimum habitat for foraging or nesting or both in Douglas fir-western hemlock forest ecosystems of early, middle, and old growth successional seral stages.

Light shading = associated with habitat.

Dark shading = strongly associated with habitat.

Under "Status," "Federal" refers to the federal Endangered Species Act, "State" refers to fish and wildlife agencies; "Heritage" refers to NatureServe/Natural Heritage Network ranks, "ORBIC" refers to Oregon Biodiversity Information Center, and "PIF" refers to Partners in Flight. Information sources are below the table.

Information Sources

- Oregon Biodiversity Information Center. Rare, Threatened and Endangered Species of Oregon. 2010. Available online at http://orbic.pdx.edu/documents/2010-rte-book.pdf.
- Partners in Flight. Species Assessment Database. 2012. Available online at http://pif.rmbo.org/
- Washington Department of Fish and Wildlife. Washington State Priority Habitats and Species List. 2008. Available online at http://wdfw.wa.gov/conservation/phs/list/.

Codes and Abbreviations

Federal Status

LE = Listed as an endangered species
LT = Listed as a threatened species
PE = Proposed as an endangered species
PT = Proposed as a threatened species
C = Candidate for listing as threatened or endangered
SOC = Species of concern. Taxa for which additional information is needed to support a proposal to list under the ESA.

State Status—Animals (Oregon)

LE = Listed as an endangered species
LT = Listed as a threatened species
PE = Proposed as an endangered species
PT = Proposed as a threatened species
SC = Sensitive – Critical
SV = Sensitive – Vulnerable

State Status—Animals (Washington)

SC = State candidate for listing
SS = State sensitive
ST = State threatened
SE = State endangered
LE = Listed as an endangered species
LT = Listed as a threatened species
PE = Proposed as an endangered species
PT = Proposed as a threatened species
SV = Sensitive – vulnerable

Natural Heritage Ranks

G1 = Critically imperiled throughout its range
G2 = Imperiled throughout its range
G3 = Rare, threatened, or uncommon throughout its range
G4 = Not rare, apparently secure throughout its range
G5 = Widespread, abundant, and secure throughout its range
S1 = Critically imperiled in Oregon
S2 = Imperiled in Oregon
S3 = Rare, threatened, or uncommon in Oregon
S4 = Not rare, apparently secure in Oregon
S5 = Widespread, abundant and secure in Oregon
T = Rank for a subspecies, variety, or race
Q = Taxonomic questions
H = Historic, formerly part of the native biota with the implied expectation that it may be rediscovered
X = Presumed extirpated or extinct
U = Unknown rank
? = Not yet ranked
B = Rank of the breeding population (migratory birds)
N = Rank of the wintering population (migratory birds)

ORBIC Lists

1 = Threatened or endangered throughout range
2 = Threatened, endangered, or extirpated from Oregon, but secure or abundant elsewhere
3 = Review
4 = Watch

APPENDIX D

Upland Forest Wildlife in the Region

Group	Common Name	Scientific Name	Forest Seral Stages Used*			Associated Attributes	Status					
			Early	Middle	Old		Heritage Rank	Federal	State OR	State WA	ORBIC list	PIF
Amphibian	Clouded salamander	*Aneides ferreus*	■	■	■	Forest or burned areas. Large decaying logs.	G3, S3		SV		4	N/A
Amphibian	Dunn's salamander	*Plethodon dunni*		■	■	Talus, logs, springs.				SC		N/A
Amphibian	Ensatina	*Ensatina eschscholtzii*	■	■	■	Logs, woody debris, or moist talus w/wood.						N/A
Amphibian	Larch Mountain salamander	*Plethodon larselli*		■	■	Esp. forest w/gravel, fractured rock in soil.	G3, S2	SOC	SV	SS	2	N/A
Amphibian	Northern red-legged frog	*Rana aurora aurora*		■	■	Pond breeder; adults require forested uplands.	G4T4, S3S4		SV		4	N/A
Amphibian	Northwestern salamander	*Ambystoma gracile*		■	■	Also needs ponds, streams.						N/A
Amphibian	Oregon slender salamander	*Batrachoseps wrighti*	■	■	■	Large older conifer logs, bark debris, talus.	G3, S3	SOC	SV		4	N/A
Amphibian	Pacific treefrog	*Hyla regilla*		■	■	Needs breeding ponds, uplands.						N/A
Amphibian	Western red-backed salamander	*Plethodon vehiculum*		■	■	Talus, logs, springs.						N/A
Bird	American Kestrel	*Falco sparverius*	■	■		Secondary cavity nester; hunts in open areas.						
Bird	American Robin	*Turdus migratorius*	■	■	■	More abundant in young-medium forests.						
Bird	Black-capped Chickadee	*Poecile atricapilla*	■	■		Associated with alder/hardwoods.						
Bird	Black-throated Gray Warbler	*Dendroica nigrescens*				Associated with alder/hardwoods.						
Bird	Brown Creeper	*Certhia americana*	■	■	■	Probes for insects in bark crevices.						
Bird	Chestnut-backed Chickadee	*Poecile rufescens*		■	■	Depends more on hemlock in winter.						CS, RS
Bird	Dark-eyed Junco	*Junco hyemalis*	■	■	■	Abundant in heavily thinned young forests.						
Bird	Downy Woodpecker	*Picoides pubescens*		■		May be associated with alder/ hardwoods.						

Group	Common Name	Scientific Name	Forest Seral Stages Used*			Associated Attributes	Status					
			Early	Middle	Old		Heritage Rank	Federal	State OR	State WA	ORBIC list	PIF
Bird	Evening Grosbeak	*Coccothraustes vespertinus*				Low tree density, possibly alder in spring.						
Bird	Golden-crowned Kinglet	*Regulus satrapa*				High tree density.						RC, RS
Bird	Gray Jay	*Perisoreus canadensis*				Found at middle–higher elevations.						
Bird	Hairy Woodpecker	*Picoides villosus*				Older forest with fewer trees/acre.						
Bird	Hammond's flycatcher	*Empidonax hammondii*				Older forest with fewer trees/acre, good mid-story.						
Bird	Hermit Warbler	*Dendroica occidentalis*				Closed canopy.						CS, RS
Bird	House Wren	*Troglodytes aedon*				Associated with alder/ hardwoods.						
Bird	Hutton's Vireo	*Vireo huttoni*				Assoc. with shrub cover, deciduous sub-canopy.						RS
Bird	Northern Goshawk	*Accipiter gentilis*				May feed over younger forests.	G5, S3	SOC	SV	SC	4	
Bird	Northern Pygmy-owl	*Glaucidium gnoma*				May be associated with alder/hardwoods.						RS
Bird	Northern Spotted Owl	*Strix occidentalis*				Generally nests in snags.	G3T3, S3	LT	LT	SE	1	RC
Bird	Olive-sided Flycatcher	*Contopus cooperi*				Assoc. w/ older forest nr. clearing w/snag(s).	G4, SB3	SOC	SV		4	RC
Bird	Orange-crowned Warbler	*Vermivora celata*				Associated with shrub cover.						RS
Bird	Pacific (Winter) Wren	*Troglodytes pacificus*				Dense trees, complex forest floor, dead wood.						
Bird	Pacific-slope Flycatcher	*Empidonax dificilus*				Dense tree cover, hardwood, hemlock, cedar.						CS, RS
Bird	Pileated Woodpecker	*Dryocopus pileatus*				Large snag, conifer, also forage early succession.	G5, S4			SC	4	

Group	Common Name	Scientific Name	Forest Seral Stages Used*			Associated Attributes	Status					
			Early	Middle	Old		Heritage Rank	Federal	State OR	State WA	ORBIC list	PIF
Bird	Pine Grosbeak	*Pinicola enucleator*				Associated with conifer cone crops.	G5, S2?				3	
Bird	Pine Siskin	*Carduelis pinus*				Associated with conifer cone crops.						
Bird	Red Crossbill	*Loxia curvirostra*				Associated with conifer cone crops.						RC, RS
Bird	Red-breasted Nuthatch	*Sitta canadensis*				Low tree density; conifers, esp. grand fir.						
Bird	Song Sparrow	*Melospiza melodia*				Associated with shrub layer.						
Bird	Townsend's Warbler	*Dendroica townsendi*				Closed overstory forest for foraging and nesting.						RS
Bird	Varied Thrush	*Ixoreus naevius*				Mid-story tree layers.				SC		
Bird	Vaux's Swift	*Chaetura vauxi*				Large snags. Will also forage over clearings.						RS
Bird	Western Tanager	*Piranga ludoviciana*				Associated with upper canopy.						
Bird	Western Wood-peewee	*Contopus sordidulus*				More open canopy, good shrub layer.						
Bird	White-crowned Sparrow	*Zonotrichia leucophrys*				Early successional shrublands.						
Bird	Little Willow Flycatcher	*Empidonax traillii brewsteri*				Associated with shrub cover.	G5T3T4; S3S4B		SV		4	RC, RS
Bird	Yellow-rumped Warbler	*Dendroica coronata*				Canopy for feeding, breeding; tends to flycatch.						
Mammal	American Marten	*Martes americana*				May den in snags, down logs, rock outcrops.	G5, S3S4		SV		4	N/A
Mammal	Big brown bat	*Eptesicus fuscus*				Snags, cliffs, caves, bridges; forage older forest.						N/A
Mammal	Black bear	*Ursus americanus*				Dens: Large root wads, hollow logs, trees, snags.						N/A
Mammal	Coast mole	*Scapanus orarius*				Soil texture is important.						N/A

Group	Common Name	Scientific Name	Forest Seral Stages Used*			Associated Attributes	Status					
			Early	Middle	Old		Heritage Rank	Federal	State OR	State WA	ORBIC list	PIF
Mammal	Douglas squirrel	*Tamiasciurus douglasii*				Feeds on cones.						N/A
Mammal	Hoary bat	*Lasiurus cinereus*				May roost in snags.	G5, S3		SV		4	N/A
Mammal	Long-eared myotis	*Myotis evotis*				Roosts in large stumps, logs, hollow trees, caves	G5, S4	SOC			4	N/A
Mammal	Long-legged myotis	*Myotis volans*				Dens in larger snags, down logs, rock outcrops.	G5, S3	SOC	SV		4	N/A
Mammal	Northern flying squirrel	*Glaucomys sabrinus*				May nest in snags.						N/A
Mammal	Red tree vole	*Arborimus longicaudus*				Feeds medium-age, breeds/ feeds in old forest.	G3G4, S3S4	SOC	SV		4	N/A
Mammal	Silver-haired bat	*Lasionycteris noctivagans*				Feeds forest/openings, breeds in older forest.	G5, S3S4	SOC	SV		4	N/A
Mammal	Western red-backed vole	*Clethrionomys californicus*				Associated with Cascade Range.						N/A
Reptile	Northern alligator lizard	*Elgaria coerulea*				Logs, rock outcrops.						N/A
Reptile	Ring-necked snake	*Diadophis punctatus*				Logs, rock outcrops.						N/A
Reptile	Rubber boa	*Charina bottae*				Logs, rock outcrops.						N/A

E. Vertebrate Species in the Region

About This Appendix

This appendix lists:

- All known native vertebrate species that currently exist in at least one location within the greater Portland-Vancouver region for at least a portion of the year and could be found in the region through diligent search by a knowledgeable person. Vagrant species (those that do not typically occur every year) are not included in this appendix.
- Some extirpated (i.e., locally extinct) native vertebrate species known to have inhabited the region in the past.
- Nonnative vertebrate species with established breeding populations in the region.

This appendix is based on the opinion of numerous local wildlife experts, augmented by information from Johnson and O'Neill's 2001 Wildlife-habitat Relationships in Oregon and Washington, state natural heritage programs, and the U.S. Fish and Wildlife Service. Taxonomic standards for bird common and scientific names are from the American Ornithological Union's Check-list of North American Birds, 7th edition.

Key to Special-status Species

FEDERAL STATUS (see http://www.fws.gov/endangered/)
LE = Listed as an endangered species.
LT = Listed as a threatened species.
PE = Proposed as an endangered species.
PT = Proposed as a threatened species.
PS = Partial status. Taxa for which some, but not all, intraspecific taxa have status.
C = Candidate for listing as threatened or endangered.
SoC = Species of concern. Taxa for which additional information is needed to support a proposal to list under the Endangered Species Act.
FD = Delisted.

STATE STATUS—OREGON (see http://orbic.pdx.edu/documents/2010-rte-book.pdf)
LE = Listed as an endangered species
LT = Listed as a threatened species
PE = Proposed as an endangered species
PT = Proposed as a threatened species
SC = Sensitive – Critical
SV = Sensitive – Vulnerable
State Status—Washington Priority Habitats and Species List (www.wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=All&orderby=AnimalType)
SC = State candidate for listing
SS = State sensitive
ST = State threatened
SE = State endangered

STATE STRATEGY SPECIES REFERS TO OREGON AND WASHINGTON'S STATEWIDE CONSERVATION STRATEGIES.
Oregon: http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp
Washington: http://wdfw.wa.gov/publications/00165/wdfw00165.pdf

NATURAL HERITAGE NETWORK RANKS (see state status websites)
Global rank begins with a "G." If the taxon has a trinomial (a subspecies, variety, or recognized race), this is followed by a "T" rank indicator. State rank begins with an "S."

G1 = Critically imperiled throughout its range
G2 = Imperiled throughout its range
G3 = Rare, threatened, or uncommon throughout its range
S1 = Critically imperiled in Oregon
S2 = Imperiled in Oregon
S3 = Rare, threatened, or uncommon in Oregon
T = Rank for a subspecies, variety, or race
Q = Taxonomic questions
H = Historic, formerly part of the native biota with the implied expectation that it may be rediscovered
X = Presumed extirpated or extinct
U = Unknown rank
? = Not yet ranked
B = Rank of the breeding population
N = Rank of the wintering population

ORBIC LISTS
1 = Threatened or endangered throughout range
2 = Threatened, endangered, or extirpated from Oregon, but secure or abundant elsewhere

3 = Review
4 = Watch

Birds

STATUS OF BIRDS IN THE REGION AND MIGRATORY HABITS

Many bird species have migratory habits that vary across populations and among individuals, making precise categorization difficult. These are general categories that indicate either (a) the dominant trend for the majority of individuals within the region, or (b) patterns vary but the species can be reliably found each year during the indicated season. For example, greater white-fronted geese are predominantly migrants, but some wintering white-fronts may be found in very low numbers in some but not all years; this species' code is W.

M = Migrates through the region without stopping for long time periods (for example, some shorebirds). May also be N.

W = Winters in the region; some individuals may also migrate through the region without wintering.

R = Resident. Some individuals live in the region year-round. All resident species are also "B."

B = Known to breed in the region.

N = Neotropical migratory species. The majority of individuals breed in the region or northward and migrate south of U.S./Mexico border for the winter.

PARTNERS IN FLIGHT FOCAL SPECIES

Code = "yes" or "no"

(See http://cain.ice.ucdavis.edu/prbo/orwapif/consplan.html) Partners in Flight uses a focal species approach to set biological objectives and link priority species with specific conservation recommendations. This is a multi-species approach in which the ecological requirements of a suite of focal species are used to define an "ideal landscape" to maintain the range of habitat conditions and ecological processes required by land birds and many other species. Focal species are considered most sensitive to or limited by certain ecological processes (e.g., fire or nest predation) or habitat attributes (e.g., patch size or snags). The requirements of a suite of focal species are then used to help guide management activities.

AUDUBON WATCH LIST

(2007: http://audubonportland.org/issues/state-of-oregons-birds/audubon-watchlist)

The National Audubon Society used the latest available research from the bird conservation community along with citizen science data from the Christmas Bird Count and the annual Breeding Bird Survey to identify species in the continental United States that are in need of immediate conservation help. The data track trends over a 40-year period. Note that Audubon also keeps a Common Birds in Decline list online at http://birds.audubon.org/common-birds-decline.

- **Red.** Species in this category are declining rapidly and/or have very small populations or limited ranges, and they face major conservation threats. These typically are species of global conservation concern.
- **Yellow.** This category includes species that are either declining or rare. These typically are species of national conservation concern.

Habitat Types

Open Water: Year-round bodies of water—rivers, lakes, bays, ponds, and sloughs.

Shorelines and Mudflats: Mudflats, sandbars, beaches, and other sparsely vegetated habitats found bordering river islands, deltas, and river shores and around wetlands and lakes.

Riparian and Bottomland Hardwood Forests: Forests alongside flowing water, including perennial and intermittent streams, springs and seeps, and floodplain habitat. The latter is characterized by frequent and patchy disturbance events such as floods that over time that create a mosaic of habitats with varying stand ages and compositions.

Shrub: Woody-stemmed plants that reach relatively low heights (1 to 20 feet) at maturity or that are in early successional stages (young forests). Shrub habitat occurs most often in riparian areas or as an early successional stage following disturbance such as clear cuts and fire.

Wetlands: Swamps, marshes, bogs, and other transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. May be herbaceous/forbs, shrubs, forested or a combination.

Upland Forests (by general seral stage: young, mid, mature): Conifer and mixed conifer/deciduous forest outside of the riparian zone dominated by conifers, hardwoods or a mix of the two. Riparian habitat is typically embedded within larger blocks of upland forest.

Oak Habitat and Savanna: Characterized by an open canopy (i.e., 30 to 70 percent coverage) dominated by Oregon white oak; depending on conditions, may also have ponderosa pine, Douglas fir, Oregon ash, or big leaf maple components.

Upland Prairie, Wet Prairie, and Grassy Balds: Natural or uncultivated areas composed of bunchgrasses, grass-like plants (sedges and rushes), herbaceous plants (forbs, commonly referred to as wildflowers), mosses, and lichens. Trees and shrubs occasionally are present.

Agriculture and Pasture: Areas actively managed as croplands, including hayfields, grain, fruit, nurseries, grass seed farms, and areas grazed by livestock.

TABLE E-1

Fish Species That Occur Annually in the Region

This list includes a total of 70 fish species, including 22 non-native species (**bold**) and one extirpated species.

		Special status species				
Common Name	**Genus/Species**	**Federal Status**	**State Status OR / WA**	**State Strategy Species**	**ORNHP Rank**	**ORBIC List**
Pacific Lamprey	*Lampetra tridentata*	SoC	OR=SV	OR WA	S3	4
River Lamprey	*Lampetra ayresi*	SoC	WA=SC	WA	S3?	3
Western Brook Lamprey	*Lampetra richardsoni*		OR=SV	OR		4
Green Sturgeon	*Acipenser medirostris*	SoC	WA=SC	OR WA	G3 S3	4
White Sturgeon	*Acipenser transmontanus*			WA		
American Shad	*Alosa sapidissima*					
Coastal Cutthroat Trout, Oregon Coast ESU	*Oncorhynchus clarki*	SoC		WA	T3Q S3	4
Coastal Cutthroat Trout, SW WA/ Columbia R ESU	Oncorhynchus clarki	SoC	OR=SV	OR WA	T3Q S2	1
Coastal Cutthroat Trout, Upper Willamette R. ESU	Oncorhynchus clarki	SoC		OR	TNQ S3?	4
Pink Salmon	*Oncorhynchus gorbuscha*			WA		
Chum Salmon, Columbia River ESU	*Oncorhynchus keta*	LT	OR=SC WA=SC	OR WA	T2Q S2	1
Coho Salmon, Oregon Coast ESU	*Oncorhynchus kisutch*	LT	OR=SV	OR	T2Q S2	1
Coho Salmon, Lower Columbia R. ESU	*Oncorhynchus kisutch*	LT	OR=SE	OR WA	T2Q S2	1
Rainbow Trout	*Oncorhynchus mykiss*			WA		
Steelhead (anadr. rainbow trout), OR Coast ESU	*Oncorhynchus mykiss*	SoC	OR=SV	OR	T2T3Q S2S3	1
Steelhead, Lower Columbia R. ESU winter/summer	*Oncorhynchus mykiss*	LT	OR=SC WA=SC	OR WA	T2Q S2	1
Steelhead, Upper Willamette River winter ESU	*Oncorhynchus mykiss*	LT	OR=SV	OR	T2Q S2	1

TABLE F-1 *(continued)*

Common Name	Genus/Species	Special status species: Federal Status	State Status OR / WA	State Strategy Species	ORNHP Rank	ORBIC List
Steelhead, Middle Columbia River summer ESU	*Oncorhynchus mykiss*	LT	OR=SC	OR	T2Q S2	1
Steelhead, Middle Columbia River winter ESU	*Oncorhynchus mykiss*	LT		OR	T2Q S2	1
Steelhead, Snake River Basin ESU	*Oncorhynchus mykiss*	LT	OR=SV WA=SC	OR WA	T2T3Q S2S3	1
Sockeye Salmon, Snake River ESU (extirpated in OR)	*Oncorhynchus nerka*	LE	WA=SC	WA	T1Q SXB, S1	1-ex
Chinook Salmon, Lower Columbia R. ESU, fall and spring	*Oncorhynchus tshawytscha*	LT	OR=SC WA=SC	OR WA	T2Q S2	1
Chinook Salmon, Upper Will. R spring run	*Oncorhynchus tshawytscha*	LT	OR=SC	OR	T2Q S2	1
Chinook Salmon, Snake River Fall-run ESU	*Oncorhynchus tshawytscha*	LT	OR=LT WA=SC	OR WA	T1Q S1	1
Chinook Salmon, Snake River Spr/ Summer-run	*Oncorhynchus tshawytscha*	LT	OR=LT WA=SC	OR WA	T1Q S1	1
Chinook Salmon, Upper Col. R. Spring-run	*Oncorhynchus tshawytscha*	LE	WA=SC	WA	xx	xx
Mountain Whitefish	*Prosopium williamsoni*					
Bull Trout	*Salvelinus confluentus*	LT	OR=SC WA=SC	OR WA	G3T2Q S2	1
Brown Trout	*Salmo trutta*					
Eulachon (Columbia River Smelt)	*Thaleichthys pacificus*	LT	WA=SC	WA	S3?	2
Tiger Muskie	*E. masquinongy x lucius or E. lucius x masquinongy*					
Chiselmouth	*Acrocheilus alutaceus*					
Goldfish	*Carassius auratus*					
Grass Carp	*Ctenopharyngodon idella*					
Common Carp	Cyprinus carpio					
Peamouth Chub	Mylocheilus caurinus					
(Oregon Chub – locally extirpated)	*Oregonichthys crameri*	LT	OR=SC	OR	G2S2	1
Northern Pikeminnow (Squawfish)	*Ptychocheilus oregonensis*					
Longnose Dace	*Rhynichthys cataractae*					
Leopard Dace	*Rhynichthys falcatus*		WA=SC	WA		
Speckled Dace	*Rhynichthys osculus*					

TABLE E-1 *(continued)*

Common Name	Genus/Species	Special status species: Federal Status	State Status OR / WA	State Strategy Species	ORNHP Rank	ORBIC List
Redside Shiner	*Richardsonius balteatus*					
Bridgelip Sucker	*Catostomus columbianus*					
Largescale Sucker	*Catostomus macrocheilus*					
Mountain Sucker	*Catostomus platyrhynchus*		WA=SC	WA		
Yellow Bullhead	*Ameiurus natalis*					
Brown Bullhead	*Ameiurus nebulosus*					
Channel Catfish	*Ictalurus punctatus*					
Banded Killifish	*Fundulus diaphanus*					
Three-spined Stickleback	*Gasterosteus aculeatus*					
Mosquitofish	*Gambusia affinis*					
Sand Roller	*Percopsis transmontanus*					
Oriental Weatherfish (Weather Loach)	*Misgurnus anguillicaudatus*					
Amur Goby	*Rhinogobius brunneus*					
Striped Bass	*Morone saxatilis*					
Pumpkinseed Sunfish	*Lepomis gibbosus*					
Green Sunfish	*Lepomis cyanellus*					
Warmouth	*Lepomis gulosus*					
Bluegill	*Lepomis macrochirus*					
Smallmouth Bass	*Micropterus dolomieu*					
Largemouth Bass	*Micropterus salmoides*					
White Crappie	*Pomoxis annularis*					
Black Crappie	*Pomoxis nigromaculatus*					
Yellow Perch	*Perca flavescens*					
Walleye	*Stizostedion vitreum vitreum*					
Coastrange Sculpin	*Cottus aleuticus*					
Prickly Sculpin	*Cottus asper*					
Shorthead Sculpin	*Cottus confusus*					
Reticulated Sculpin	*Cottus perplexus*					
Torrent Sculpin	*Cottus rhotheus*					
Starry Flounder	*Platichthys stellatus*					

TABLE E-2

Amphibian Species that Occur Annually in the Region

This list includes a total of 20 amphibian species, including one non-native species (**bold**) and one species that likely has been extirpated. Habitat associations are as follows: 1 = strongly associated, 2 =occurs in habitat, =not typically found in habitat. Habitat associations are not meant to be comprehensive or definite, but are based on the best knowledge available at this time.

Common Name	Genus/Species	Special status species					Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland & Savannah	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status	State Status	State Strategy Species	ORNHP Rank	ORBIC List						Young	Mid	Mature			
Northwestern salamander	*Ambystoma gracile*						1	1	1	2	2	2	2	1			2
Long-toed Salamander	*Ambystoma macrodactylum*						1	1	1	2	1	2	2	2	2	1	2
Cope's Giant Salamander	*Dicamptodon copei*		OR=SV	OR	G3G4 S2	2			1			2	2	2			
Coastal Giant Salamander	*Dicamptodon tenebrosus*						1		1			2	2	2			
Columbia Torrent Salamander	*Rhyacotriton kezeri*		OR=SV	OR	G3 S3	4			1			2	2	1			
Cascade Torrent Salamander	*Rhyacotriton cascadae*		OR=SV WA=SC	OR WA	G3 S3	4			1			2	2	1			
Rough-skinned Newt	*Taricha granulosa*						1	1	1		1	1	1	1	2		2
Larch Mountain Salamander	*Plethodon larselli*	SoC	OR=SV WA=SS	OR WA	G3 S2	2						2	1	1			
Dunn's Salamander	*Plethodon dunni*		WA=SS	WA					1				2	1	1		
Western Red-backed Salamander	*Plethodon vehiculum*								1			1	1	1			
Ensatina	*Ensatina eschscholtzii*								1			2	1	1	2		2
Clouded Salamander	*Aneides ferreus*		OR=SV	OR	G3 S3	4			2			2	1	1			2
Oregon Slender Salamander	*Batrachoseps wrightorum*	SoC	OR=SV	OR	G3 S3	4			2			2	1	1			
Western Toad	*Anaxyrus boreas*	SoC	OR=SV WA=SC	OR WA	S3	4	1	2	1	2	2	1	1	1	1	1	2
Coastal Tailed Frog	*Ascaphus truei*	SoC	OR=SV	OR	S3	4			1			2	2	1			
Pacific Tree (Chorus) frog	*Pseudacris regilla*						1	2	1	2	1	2	1	1	2	2	2
Northern Red-legged Frog	*Rana aurora aurora*	SoC	OR=SV	OR	S3S4	4	1	2	1	2	1	2	1	1	2		2
Cascades Frog	*Rana cascadae*	SoC	OR=SV	OR	G3G4 S3	4	1	2	2	2	1	2	2	2			
Oregon Spotted Frog (likely extirpated)	*Rana pretiosa*	C	OR=SC WA=SE	OR WA	G2 S2	1	1		2	2	1						1
American Bullfrog	*Lithobates catesbeianus*						1	1	1	2	1	2	2	2	2	2	2

TABLE E-3

Reptile Species That Occur Annually in the Region

This list includes a total of 16 reptile species, including two non-native species (**bold**). Habitat associations are as follows: 1 = strongly associated, 2 = occurs in habitat, = not typically found in habitat. Habitat associations are not meant to be comprehensive or definite, but are based on the best knowledge available at this time.

Common Name	Genus/Species	Special status species					Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland & Savannah	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status[3]	State Status[4]	State Strategy Species	ORNHP Rank[5]	ORBIC List[6]						Young	Mid	Mature			
Common Snapping Turtle	*Chelydra serpentina*						1	1	2		1	2					2
Western Painted Turtle	*Chrysemys picta bellii*		OR=SC	OR	S2	2	1	1	2	2	1				1	2	2
Western Pond Turtle	*Actinemys marmorata*	SoC	OR=SC WA=SE	OR WA	G3G4 S2	2	1	1	1	2	1	2	2	2	1	1	2
Red-eared Slider	*Trachemys scripta elegans*						1	1	2		1	2					2
Northern Alligator Lizard	*Elgaria coeruleus*								2	2	2		2	2	2	2	2
Southern Alligator Lizard	*Elgaria multicarinatus*								2	2	2	2	2		1	2	2
Western Fence Lizard	*Sceloporus occidentalis*									2		2	2	2	1	2	2
Western Skink	*Plestiodon skiltonianus*									2		2	2	2	1	2	2
Rubber Boa	*Charina bottae*								2	2	2		2	2	2	2	2
Racer	*Coluber constrictor*									2		2	2	2	1	1	2
Sharptail Snake	*Contia tenuis*	SoC	WA=SC	WA					2		2	2	2	2	1	2	2
Ringneck Snake	*Diadophis punctatus*								2	2	2		2	2	2	2	2
Gopher Snake	*Pituophis catenifer*									2		2	2	2	1	1	2
Western Terrestrial Garter Snake	*Thamnophis elegans*						1		1	2	1	2	2	2	2	2	2
Northwestern Garter Snake	*Thamnophis ordinoides*								2	2	2	2	2	2	2	2	2
Common Garter Snake	*Thamnophis sirtalis*						2		1	2	1	2	2	2	2	2	2

TABLE E-4

Bird Species That Occur Annually in the Region

This list includes a total of 229 bird species, including eight non-native species (**bold**) and two species that likely have been extirpated. Habitat associations are as follows: 1 = strongly associated, 2 = occurs in habitat, = not typically found in habitat. Habitat associations are not meant to be comprehensive or definite, but are based on the best knowledge available at this time.

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Greater White-fronted Goose	*Anser albifrons*	M								1	1			1						1
Snow Goose	*Chen caerulescens*	W			WA					1	1			1						1
Ross's Goose	*Chen rossii*	M								1	1			1						1
Cackling Canada Goose	*Branta hutchinsii minima*	W								1	1	2	2	1						1
Aleutian Cackling Goose (wintering)	*Branta hutchinsii leucopareia*	W			OR	S2N	2			1	1	2	2	1						1
Canada Goose	*Branta canadensis*	Var.								1	1	2	2	1						1
Dusky Canada Goose	*Branta canadensis occidentalis*	M			OR	S2S3N	1			1	1	2	2	1						1
Tundra Swan	*Cygnus columbianus*	W			WA					1	1	2		1						1
Trumpeter Swan	*Cygnus buccinator*	W			WA	S1?B, S3N	2		Yellow	1	1	2		1						1
Wood Duck	*Aix sponsa*	R/B			WA					1	1	1		1		2	1			1
Domestic waterfowl	*Various, incl. mallard hybrids*	R/B								1	2	1		1						2
Gadwall	*Anas strepera*	W								1	1			1						2
Eurasian Wigeon	*Anas penelope*	W								1	1			2						2
American Wigeon	*Anas americana*	W								1	1	2		1						1
Mallard	*Anas platyrhynchos*	R/B								2	1	1	2	1						2
Blue-winged Teal	*Anas discors*	N/M								1	1			1						1
Cinnamon Teal	*Anas cyanoptera*	N/B								1	1			1						1
Northern Shoveler	*Anas clypeata*	W								1	1			1						2

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Northern Pintail	*Anas acuta*	W								1	1		2	1						2
Green-winged Teal	*Anas crecca*	W								2	1	2		1						2
Canvasback	*Aythya valisineria*	W								1	1			1						
Redhead	*Aythya americana*	M/B								1	1			1						
Ring-necked Duck	*Aythya collaris*	W								2	2	1		1						
Greater Scaup	*Aythya marila*	W								1	2									
Lesser Scaup	*Aythya affinis*	W								1	2			1						
Harlequin Duck	*Histrionicus histrionicus*	W	SoC		WA	S2B, S3N	2			1	2	1		1		1	1			
Surf Scoter	*Melanitta perspicillata*	W								1										
Bufflehead	*Bucephala albeola*	W			OR WA	S2B	2			1		2		1						
Common Goldeneye	*Bucephala clangula*	M			WA					1				2						
Barrow's Goldeneye	*Bucephala islandica*	M			OR WA	S3B, S3N	4			1				2						
Hooded Merganser	*Lophodytes cucullatus*	R/B			WA					1		1		1		2	2			
Common Merganser	*Mergus merganser*	W								1	2	1		1		2	2			
Red-breasted Merganser	*Mergus serrator*	W								1						2	2			
Ruddy Duck	*Oxyura jamaicensis*	W								1	1			1						
Mountain Quail	*Oreortyx pictus*	R/B	SoC	OR=SV	OR WA		4		Yellow			2	1	2	1	2	2	2	2	2
California Quail	*Callipepla californica*	R/B										2	1	2	1	2	2	2	2	2
Ring-necked Pheasant	*Phasianus colchicus*	R/B										2	1	2	2	2		2	1	1
Ruffed Grouse	*Bonasa umbellus*	R/B										1	1	1	1	1	2	2		2
Sooty Grouse	*Dendragapus fuliginosus*	R/B										2	1	2	1	1	2	2		2
Wild Turkey	*Meleagris gallopavo*	R										2	1	2	1	1	1	2	2	2

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Red-throated Loon	*Gavia stellata*	W								1				2						
Pacific Loon	*Gavia pacifica*	W								1				2						
Common Loon	*Gavia immer*	W		WA=SS	WA					1				2						
Pied-billed Grebe	*Podilymbus podiceps*	R/B								2		2		1						
Horned Grebe	*Podiceps auritus*	M				S2B	2			1				1						
Red-necked Grebe	*Podiceps grisegena*	M		OR=SC		S1B	2			1	2			1						
Eared Grebe	*Podiceps nigricollis*	M								1				1						
Western Grebe	*Aechmophorus occidentalis*	W		WA=SC	WA	S3B, S2S3N	4			1				1						
Clark's Grebe	*Aechmophorus clarkii*	W		WA=SC	WA	S3B,S2N	4		Yellow	1				1						
Doubled-crested Cormorant	*Phalacrocorax auritus*	R/B								1	1	2		2		2	2			
American White Pelican	*Pelecanus erythrorhynchos*	N/M		OR=SV WA=SE	OR WA	G3 S2B	2			1	1			2						
American Bittern	*Botaurus lentiginosus*	N/B												1						2
Great Blue Heron	*Ardea herodias*	R/B			WA					1	1	1	2	1		2	2	2	2	1
Great Egret	*Ardea alba*	W								1	1	1	2	1		2	2	2	2	2
Green Heron	*Butorides virescens*	N/B								1		1	2	1	2	2	2			
Black-crowned Night Heron	*Nycticorax nycticorax*	W			WA					1	1	2	1	1						
Turkey Vulture	*Cathartes aura*	N/B										2	2	2	2	2	2	2	2	2
California Condor (extirpated)	*Gymnogyps californianus*	R/B	LE			G1SX	1-ex		Red			2		2						
Osprey	*Pandion haliaetus*	N/B								1		2	2	2		2	2	2		2
White-tailed Kite	*Elanus leucurus*	R/B				S2B, S3N	2					1	2	2	2	2	2		1	1
Bald Eagle	*Haliaeetus leucocephalus*	R/B	FD SOC	OR=LT WA=SS	OR WA		4			1	1	2	2	2	2	2	2	2	2	2

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Partners in Flight focol species	Audubon Watch List						Young	Mid	Mature			
Northern Harrier	*Circus cyaneus*	R/B						Yes				2	2	2					1	1
Sharp-shinned Hawk	*Accipiter striatus*	R/B											2	2	1	1	1	2	2	2
Cooper's Hawk	*Accipiter cooperii*	R/B						Yes				2	2	2	2	2	2	2	2	2
Northern Goshawk	*Accipiter gentilis*	W	SoC	OR=SV WA=SC	OR WA	S3	4					2	2	2	2	2	1	2		
Red-shouldered Hawk	*Buteo lineatus*	R/B						Yes				2	2	2		2	2			2
Swainson's Hawk	*Buteo swainsoni*	N/M		OR=SV	OR	S3B	4		Yellow			2	2	2	2	2	2	2	2	1
Red-tailed Hawk	*Buteo jamaicensis*	R/B										2	1	2	1	1	2	2	2	1
Rough-legged Hawk	*Buteo lagopus*	W										2	2	2				2	2	1
American Kestrel	*Falco sparverius*	R/B						Yes				2	2	2	1	2		2	2	2
Merlin	*Falco columbarius*	W				SHB	2-ex				2	2	2	2	2	2	2		2	2
Peregrine Falcon	*Falco peregrinus*	R/B	FD SOC?	OR=SV WA=SS	OR WA	S2B	2			1	1	2	2	2	2	2	2	2	2	2
Prairie Falcon	*Falco mexicanus*	W								2	2			2					2	2
Virginia Rail	*Rallus limicola*	R/B												1						2
Sora	*Porzana carolina*	N/B												1						2
American Coot	*Fulica americana*	R/B								1	1			1						2
Sandhill Crane	*Grus canadensis*	M		WA=SE	OR WA	S3N	4				1			1						1
Black-bellied Plover	*Pluvialis squatarola*	M								2	1									1
Semipalmated Plover	*Charadrius semipalmatus*	N/M								1	1									2
Killdeer	*Charadrius vociferus*	R/B								2	1	2	2	2				2	2	1
Spotted Sandpiper	*Actitis macularia*	R/B								2	1	1	2	1						1
Solitary Sandpiper	*Tringa solitaria*	N/M								2	1	1	2	1						2
Greater Yellowlegs	*Tringa melanoleuca*	M								2	1	2	2	1					2	2

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Willet	*Tringa semipalmata*	M								2	1	2		1					2	1
Lesser Yellowlegs	*Tringa flavipes*	M								2	1	2	2	1					2	2
Long-billed Curlew	*Numenius americanus*	N/M		OR=SV	OR	S3B	4		Yellow	2	1	2	2	2				2	1	1
Semipalmated Sandpiper	*Calidris pusilla*	M							Yellow	2	1									2
Western Sandpiper	*Calidris mauri*	M							Yellow	2	1			1						2
Least Sandpiper	*Calidris minutilla*	M								2	1		2	1						2
Baird's Sandpiper	*Calidris bairdii*	N/M								2	1		2	1						2
Pectoral Sandpiper	*Calidris melanotos*	N/M								2	1			1						2
Dunlin	*Calidris alpina*	W								2	1		2	1						1
Short-billed Dowitcher	*Limnodromus griseus*	M								2	1			2						2
Long-billed Dowitcher	*Limnodromus scolopaceus*	M								2	1		2	1						1
Wilson's Snipe	*Gallinago delicate*	R/B								2	1			1					2	1
Wilson's Phalarope	*Phalaropus tricolor*	N/M								1	1		2	2						
Red-necked Phalarope	*Phalaropus lobatus*	N/M								1	1									
Bonaparte's Gull	*Chroicocephalus philadelphia*	M								2	1									2
Mew Gull	*Larus canus*	W								1	1									2
Ring-billed Gull	*Larus delawarensis*	W								1	1			2						2
Western Gull	*Larus occidentalis*	W								2	1									
California Gull	*Larus californicus*	M								1	1			2						2
Herring Gull	*Larus agentatus*	W								1	1			2						2
Thayer's Gull	*Larus thayeri*	W							Yellow	1	1			2						2
Glaucous-winged Gull	*Larus glaucescens*	W								2	1									
Glaucous Gull	*Larus hyperboreus*	W								1	1			2						

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Caspian Tern	*Hydroprogne caspia*	N/M			OR					1	1			1						
Common Tern	*Sterna hirundo*	M								2	1									
Rock Pigeon	*Columba livia*	R/B											2						2	1
Band-tailed Pigeon	*Patagioenas fasciata*	R/B	SoC		OR WA	S3B	4	Yes				1	2	1	2	2	2	1		2
Eurasian Collared-Dove	*Streptopelia decaocto*	R/B									2	2	2	2	2	2	2	2	2	1
Mourning Dove	*Zenaida macroura*	R/B									1	1	2	1	2	2	2	2	2	1
Monk Parakeet	*Myiopsitta monachus*	R/B (ext.?)										1		1						2
Yellow-billed Cuckoo (likely extirpated)	*Coccyzus americanus*	N	C	OR=SC WA=SC	WA	SHB	2-ex	Yes				1		1						
Barn Owl	*Tyto alba*	R/B										2	1	2	2	2	2	2	2	1
Western Screech-Owl	*Megascops kennicottii*	R/B						Yes				2		2	2	2	2	2		2
Great Horned Owl	*Bubo virginianus*	R/B										2	2	2	2	2	2	2	2	2
Northern Pygmy-Owl	*Glaucidium gnoma*	R/B										2		2	2	1	1	2		2
Northern Spotted Owl	*Strix occidentalis caurina*	R/B	LT	OR=LT WA=SE	OR WA	G3T3 S3	1	Yes	Red								1	2		
Barred Owl	*Strix varia*	R/B										2		2	2	1	1	2		
Long-eared Owl	*Asio otus*	W											1	2	2	1		2	2	
Short-eared Owl	*Asio flammeus*	W			OR				Yellow				1	1					1	1
Northern Saw-whet Owl	*Aegolius acadicus*	R/B										2		2	2	2	2	1		2
Common Nighthawk	*Chordeiles minor*	N/B		OR=SC	OR		4	Yes		2	1	2	1	2	1	2	2	2	2	2
Black Swift	*Cypseloides niger*	N/B	SoC		OR	S2B	2	Yes	Yellow	1	2	1	2	2	2	2	2			
Vaux's Swift	*Chaetura vauxi*	N/B		WA=SC	WA			Yes		1		2	2	2	2	2	1	2	2	2
Anna's Hummingbird	*Calypte anna*	R/B										2	2	2	2	2	2	2		

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Partners in Flight focol species	Audubon Watch List						Young	Mid	Mature			
Calliope Hummingbird	*Stellula calliope*	N/B							Yellow			1	2	2	2	1	1	2	1	
Rufous Hummingbird	*Selasphorus rufus*	N/B						Yes				2	2	2	2	2	2	2	2	2
Belted Kingfisher	*Megaceryle alcyon*	R/B								1	1	1	2	1	2	2	2			
Lewis's Woodpecker	*Melanerpes lewis*	M	SoC	OR=SC WA=SC	OR WA	S2S3B	2	Yes	Red			2	2	2	2	2	2	1	2	2
Acorn Woodpecker	*Melanerpes formicivorus*	R/B	SoC	OR=SV		S3	4	Yes							2	2	2	1	2	
Red-breasted Sapsucker	*Sphyrapicus ruber*	R/B										2		2	2	2	2	2	2	2
Downy Woodpecker	*Picoides pubescens*	R/B						Yes				1		1	2	1	2	2	2	2
Hairy Woodpecker	*Picoides villosus*	R/B										2	2	2		2	1	2	2	2
Northern Flicker	*Colaptes auratus*	R/B										2	2	2	2	2	2	2	2	2
Pileated Woodpecker	*Dryocopus pileatus*	R/B		OR=SV WA=SC	OR WA		4	Yes				2	2	2		1	1	2		2
Olive-sided Flycatcher	*Contopus cooperi*	N/B	SoC	OR=SV	OR	S3B	4	Yes	Yellow			2		2		1	1			
Western Wood-Pewee	*Contopus sordidulus*	N/B						Yes				2		2		1	1	2	2	2
Little Willow Flycatcher	*Empidonax traillii brewsteri*	N/B		OR=SV	OR	S3S4B	4	Yes	Yellow			1	1	1	1			2		2
Hammond's Flycatcher	*Empidonax hammondii*	N/B						Yes								1	1	2		
Dusky Flycatcher	*Empidonax oberholseri*	N/M										2	2	2	2	2	2			
Pacific-slope Flycatcher	*Empidonax dificilus*	N/B						Yes				2		2	2	2	1	2		
Black Phoebe	*Sayornis nigricans*	R/B								2		1	2	2						2
Say's Phoebe	*Sayornis saya*	N/M											2		2	2	2			2
Western Kingbird	*Tyrannus verticalis*	N/B											2		2	2	2	1	2	2
Eastern Kingbird	*Tyrannus tyrannus*	N/B										1	2	2	2	2	2	2	2	1
Northern Shrike	*Lanius excubitor*	W											1	2					2	1
Loggerhead Shrike	*Lanius ludocicianus*	N/M	SoC	OR=SV WA=SC	OR WA	S3B	4						2						1	1

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Cassin's Vireo	*Vireo cassinii*	N/B													1	1	1	1		
Hutton's Vireo	*Vireo huttoni*	R/B						Yes				2	2	2	1	2	2	1		2
Warbling Vireo	*Vireo gilvus*	N/B										1	1	1	2	2	2	2		2
Red-eyed Vireo	*Vireo olivaceus*	N/B						Yes				1	2	1	1	1	1			
Gray Jay	*Perisoreus canadensis*	R/B										2		2		2	1	1		
Steller's Jay	*Cyanocitta stelleri*	R/B										2		2	2	1	1	2		2
Western Scrub-Jay	*Aphelocoma californica*	R/B										2	2	2	2	2	2	1	2	2
American Crow	*Corvus brachyrhynchos*	R/B									1	2	2	2	2	2	2	2	2	1
Common Raven	*Corvus corax*	R/B										2	2	2	2	2	2	2	2	2
Horned Lark	*Eremophila alpestris*	W											2						1	1
Streaked Horned Lark	*Eremophila alpestris strigata*	R/B	C	OR=SC WA=SE	OR WA	S2B	1	Yes					2						1	1
Purple Martin	*Progne subis*	N/B	SoC	OR=SC WA=SC	OR WA	S2B	2	Yes		1		2		2	2	2	2	2	2	2
Tree Swallow	*Tachycineta bicolor*	N/B						Yes		1		1	2	1	2	2	2	2	2	2
Violet-green Swallow	*Tachycineta thalassina*	N/B								2		2	2	2	2	2	2	2	2	2
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	N/B								1	1	1	2	1	2	2	2	2	2	2
Bank Swallow	*Riparia riparia*	N/M								1	1	1		2	2	2	2	2	2	2
Cliff Swallow	*Petrochelidon pyrrhonota*	N/B								1		1	2	1	2	2	2	2	2	2
Barn Swallow	*Hirundo rustica*	N/B								1		1	2	1	2			2	2	1
Black-capped Chickadee	*Poecile atricapilla*	R/B										2	2	2	2	2		2	2	2
Chestnut-backed Chickadee	*Poecile rufescens*	R/B										2		2		2	1	2		2
Bushtit	*Psaltriparus minimus*	R/B						Yes				2	2	2	2	2	2	2		2
Red-breasted Nuthatch	*Sitta canadensis*	R/B				S3						2	2	2		1	1	2		2

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Parrtners in Fllight focol species	Audubon Watch List						Young	Mid	Mature			
Slender-billed (White-breasted) Nuthatch	*Sitta carolinensis aculeate*	R/B	SoC	OR=SV WA=SC	OR WA		4	Yes				2	2	2	2	2	2	1	2	2
Brown Creeper	*Certhia americana*	R/B						Yes				2	2	2	2	2	1	2	2	2
Bewick's Wren	*Thryomanes bewickii*	R/B						Yes				2	1	2	2	2	2	2		2
House Wren	*Troglodytes aedon*	N/B						Yes				2	2	2	2	2		2	2	2
Pacific (split from Winter) Wren	*Troglodytes pacificus*	R/B						Yes				2	1	2		1	1	2		
Marsh Wren	*Cistothorus palustris*	R/B												1						
American Dipper	*Cinclus mexicanus*	R/B								1	1	1		1	2	2	2			
Golden-crowned Kinglet	*Regulus satrapa*	R/B										2		2	2	1	1	2		
Ruby-crowned Kinglet	*Regulus calendula*	R/B										2	2	2	2	2	2	2	2	2
Western Bluebird	*Sialia mexicana*	R/B		OR=SV	OR		4	Yes					2		2	2	2	1	2	2
Townsend's Solitaire	*Myadestes townsendi*	M										2	2	2	2	2	2	2		2
Swainson's Thrush	*Catharus ustulatus*	N/B						Yes				2	1	2	2	2	2	2		2
Hermit Thrush	*Catharus guttatus*	W										2	2	2	2	2	2	2		2
American Robin	*Turdus migratorius*	R/B										2	2	2	1	1	2	2	2	2
Varied Thrush	*Ixoreus naevius*	R/B						Yes	Yellow							1	1	2		2
European Starling	*Sturnus vulgaris*	R/B										1	2	1	2	2	2	2	2	1
American Pipit	*Anthus rubescens*	W						Yes					2	2	2	2	2		2	1
Cedar Waxwing	*Bombycilla cedrorum*	R/B										2	2	2	2	2	2	2		2
Orange-crowned Warbler	*Oreothlypis celata*	N/B						Yes				2	1	2	1	2	2	2	2	2
Nashville Warbler	*Oreothlypis ruficapilla*	N/M						Yes				2	2	2	2	2	2	2		2
MacGillivray's Warbler	*Geothlypis tolmie*	N/B										2	1	2	2	2	2	2		2
Common Yellowthroat	*Geothlypis trichas*	N/B										1	2	1	2	2	2	2	2	2
Yellow Warbler	*Setophaga petechia*	N/B						Yes				1	1	1	2	2				

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Partners in Flight focol species	Audubon Watch List						Young	Mid	Mature			
Yellow-rumped Warbler	*Setophaga coronata*	R/B										2	2	2	1	2	2	2		2
Black-throated Gray Warbler	*Setophaga nigrescens*	N/B						Yes				1	2	1	1	2	2	1		2
Townsend's Warbler	*Setophaga townsendi*	N/B										2	2	2		2	1	2		2
Hermit Warbler	*Setophaga occidentalis*	N/B						Yes	Yellow			2	2	2	2	1	2	2		
Wilson's Warbler	*Cardellina pusilla*	N/B										1	1	1	2	2	2	2		2
Yellow-breasted Chat	*Icteria virens*	N/B	SoC	OR=SC	OR		4	Yes				1	1	1	1			2		2
Spotted Towhee	*Pipilo maculatus*	R/B										2	1	2	1	2	2	1		2
Chipping Sparrow	*Spizella passerina*	N/B			OR			Yes				2	2	2	2	2	2	2	2	2
Oregon Vesper Sparrow	*Pooecetes gramineus affinis*	N/B	SoC	OR=SC WA=SC	OR, WA	S2B, S2N	2	Yes					1		2	2	2		1	1
Savannah Sparrow	*Passerculus sandwichensis*	M/B										2	2	2	2	2	2		1	1
Fox Sparrow	*Passerella iliaca*	R/B										2	1	2	1	1	2	2		2
Song Sparrow	*Melospiza melodia*	R/B										2	1	2	1	2		2	2	2
Lincoln's Sparrow	*Melospiza lincolnii*	W						Yes				1	1	1	1	1	1			2
Swamp Sparrow	*Melospiza georgiana*	W										1	1	1						2
White-throated Sparrow	*Zonotrichia albicollis*	W										2	2		2	2	2			2
White-crowned Sparrow	*Zonotrichia leucophrys*	R/B										2	1	2	1			2	2	2
Golden-crowned Sparrow	*Zonotrichia atricapilla*	W										2	2	2	2	2	2	2	2	2
Dark-eyed Junco	*Junco hyemalis*	R/B										2	2	2	1	2	2	2		2
Western Tanager	*Piranga ludoviciana*	N/B										2		2	2	1	2	1		
Black-headed Grosbeak	*Pheucticus melanocephalus*	N/B										2	2	2	2	2	2	2		2
Lazuli Bunting	*Passerina amoena*	N/B										2	1	2	1	1	2	2	2	1
Red-winged Blackbird	*Agelaius phoeniceus*	R/B										2	2	1					2	2
Western Meadowlark	*Sturnella neglecta*	R/B		OR=SC	OR		4	Yes					1	2	2	2	2		1	1

TABLE E-4 *continued*

Common Name	Genus/Species	Migratory Status	Special status species							Open water	Shorelines mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
			Federal Status[3]	State Status[4]	State Strategy Species	OR NHIC Rank[5]	ORBIC List[6]	Partners in Flight focol species	Audubon Watch List						Young	Mid	Mature			
Yellow-headed Blackbird Brewer's Blackbird	*Xanthocephalus* *Euphagus cyanocephalus*	N/B R/B										2	2	1 2	2	2	2	2		2 1
Brown-headed Cowbird	*Molothrus ater*	N/B										2	2	2	2	2	2	2	2	1
Bullock's Oriole	*Icterus bullockii*	N/B						Yes				1		1	2	1	1	1		2
Purple Finch	*Carpodacus purpureus*	R/B										1	2	1	2	2	2	1		2
House Finch	*Carpodacus mexicanus*	R/B										2	2	2	2	2	2	2	2	1
Red Crossbill	*Loxia curvirostra*	R/B						Yes				2		2		2	1	2		
Pine Siskin	*Spinus pinus*	R/B										2	2	2		2	1	2		2
Lesser Goldfinch	*Spinus psaltria*	R/B										1	2	1	2	2	2	1	2	2
American Goldfinch	*Spinus tristis*	R/B										2	2	2	2	2	2	2	2	2
Evening Grosbeak	*Coccothraustes vespertinus*	R/B										2		2		2	2	2		
House Sparrow	*Passer domesticus*	R/B																		1

TABLE E-5

Mammal Species That Occur Annually in the Region

This list includes a total of 78 mammal species, including ten non-native species (**bold**) and two species that likely have been extirpated. Habitat associations are as follows: 1 = strongly associated, 2 = occurs in habitat, = not typically found in habitat. Habitat associations are meant to be comprehensive or definite, but are based on the best knowledge available at this time.

Common Name	Genus/Species	Special status species					Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status[3]	State Status[4]	State Strategy Species	ORNHP Rank[5]	ORBIC List[6]						Young	Mid	Mature			
Virginia Opossum	*Didelphis virginiana*								2	2		2	2	2	2	2	1
Vagrant Shrew	*Sorex vagrans*								2	2	2	2	2	2	2	2	2
Pacific Marsh (Water) Shrew	*Sorex bendirii*							1	1	2	2	2	2	2	2		
Water Shrew	*Sorex palustris*							1	1	2		2	2	2			
Baird's Shrew	*Sorex bairdi*									2		2	2	2	2		
Trowbridge's Shrew	*Sorex trowbridgii*								2	2		1	1	1	2		
Montane Shrew	*Sorex monticolus*								2	2		1	1	1	2	2	
Shrew-mole	*Neurotrichus gibbsii*								2	2	2	1	1	1	2		2
Townsend's Mole	*Scapanus townsendii*								2	2	2	1	1	1	2	2	2
Coast Mole	*Scapanus orarius*								2	2		1			2	2	2
Yuma Myotis	*Myotis yumanensis*	SoC		WA	S3	4	1		1	2	1	2	2	2	2	2	2
California Myotis	*Myotis californicus*		OR=SV	OR	S3	4	2	2	2	2	2	2	2	2	1	2	2
Little Brown Myotis	*Myotis lucifugus*			WA			2		2	2	2	2	2	2	2	2	2
Long-legged Myotis	*Myotis volans*	SoC	OR=SV	OR, WA	S3	4	2		2	2		1	2	1	2	2	2
Fringed Myotis	*Myotis thysanodes*	SoC	OR=SV	OR, WA	S2	2	2		2	2	2	2	2	2	2		2
Long-eared Myotis	*Myotis evotis*	SoC		WA		4	2		2	2	2	2	2	1	2	2	2
Silver-haired Bat	*Lasionycteris noctivagans*	SoC	OR=SV	OR	S3S4	4	2		2	2	2	2	1	1	2	2	2
Big Brown Bat	*Eptesicus fuscus*			WA			2		2	2	2	2	1	1	1	2	1
Hoary Bat	*Lasiuris cinereus*		OR=SV	OR	S3	4	2		2	2	2	2	2	2	1	2	2
Pacific Western Big-eared Bat	*Corynorhinus townsendii townsendii*	SoC	OR=SC WA=SC	OR, WA	S2	2	1		2	2	2	2	2	2	2	2	2
Brush Rabbit	*Sylvilagus bachmani*								2	1		2	2	2	2	2	2
Eastern Cottontail	*Sylvilagus floridanus*								2	2		2	2	2			2

TABLE E-5 *continued*

Common Name	Genus/Species	Special status species					Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status[3]	State Status[4]	State Strategy Species	ORNHP Rank[5]	ORBIC List[6]						Young	Mid	Mature			
Snowshoe Hare	*Lepus americanus*								2	2	2	1	1	1	2	2	2
Mountain Beaver	*Aplodontia rufa*								1			1	2	2			1
Black-tailed Jackrabbit	*Lepus californicus*		WA=SC	WA						1						2	2
American Pika	*Ochotona princeps*								2	2		2	2	2			
Townsend's Chipmunk	*Tamias townsendii*								2			1	1	1	2		2
California Ground Squirrel	*Spermophilus beecheyi*														2	2	2
Cascade Golden-mantled Ground Squirrel	*Callospermophilus lateralis*								2	2		1	1	1			2
Eastern Fox Squirrel	*Sciurus niger*									2		2	2	2		1	1
Eastern Gray Squirrel	*Sciurus carolinensis*														1		2
Western Gray Squirrel	*Sciurus griseus*	SoC	OR=SV WA=ST	OR, WA		4						2	2	2	1		2
Douglas' Squirrel	*Tamiasciurus douglasii*								2			2	1	1	1		
Northern Flying Squirrel	*Glaucomys sabrinus*								2			2	2	1	1		
Western (Mazama, Brush Prairie) Pocket Gopher	*Thomomys mazama douglasii*	C	WA=ST	WA								1	1	1	2	2	2
Camas Pocket Gopher	*Thomomys bulbivorus*	SoC			G3G4	4										1	1
White Salmon Pocket Gopher (subspecies of Northern)	*Thomomys talpoides linosus*									2		2	2	2	2	2	1
American Beaver	*Castor canadensis*						1	1	1	2	1	1	1	1	1		2
Deer Mouse	*Peromyscus maniculatus*								1	1	1	1	2	2	1	1	1
Bushy-tailed Woodrat	*Neotoma cinerea*								2	2		1	1	1	1		1
Dusky-footed Woodrat	*Neotoma fuscipes*								1	2		2	1	1	2	2	2
Western Red-backed Vole	*Clethrionomys californicus*								2				1	1			
White-footed Vole	*Arborimus (= Phenacomys) albipes*	SoC			G3G4 S3S4	4			1			1					

Common Name	Genus/Species	Special status species					Open water	Shorelines & mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status[3]	State Status[4]	State Strategy Species	ORNHP Rank[5]	ORBIC List[6]						Young	Mid	Mature			
Red Tree Vole	*Arborimus (= Phenacomys) longicaudus*	SoC	OR=SV	OR	G3G4 S3S4	4			2				2	1	1		
Gray-tailed Vole	*Microtus canicaudus*		WA=SC	WA												1	1
Townsend's Vole	*Microtus townsendii*								2	2	1	2			2	2	2
Long-tailed Vole	*Microtus longicaudus*								1	2	1	2			2	2	2
Creeping Vole	*Microtus oregoni*								2	2		2			2	2	2
Common Muskrat	*Ondatra zibethicus*						1	1	1		1						2
Black Rat	*Rattus rattus*																2
Norway Rat	*Rattus norvegicus*																2
House Mouse	*Mus musculus*									2							1
Pacific Jumping Mouse	*Zapus trinotatus*								1	2	2	2			2		2
Common Porcupine	*Erethizon dorsatum*								1	2	2	1			1		2
Nutria	*Myocastor coypus*						1	1	1		1						2
Coyote	*Canis latrans*								2	2	2	2			2	2	2
Domestic Dog (feral)	*Canis familiaris*							2	2	2	2	2	2	2	2	2	2
Red Fox (Lowland)[1]	*Vulpes vulpes*								2			2			2	1	2
Gray Fox	*Urocyon cinereoargenteus*								2			1			2	2	2
Gray Wolf – (extirpated)[2]	*Canis lupus*	LE	OR=LE WA=SE	WA	S1S2	2			2	2		2			2	2	2
Black Bear	*Ursus americanus*								2	2	2	2	2	1	2	2	2
Grizzly Bear (extirpated)	*Ursus arctos horribilis*	LT	WA=SE	WA	SX	2-ex			2	2		2	2	2		2	
Common Raccoon	*Procyon lotor*						2	1	1	2	1	2			2	2	1
Ermine (Short-tailed Weasel)	*Mustela erminea*								2			2			2	2	2
Long-tailed Weasel	*Mustela frenata*								2	2	2	2			2	2	2
Mink	*Mustela vison*						1	1	1	2	1	2			2	2	2

TABLE E-5 *continued*

Common Name	Genus/Species	Special status species					Open water	Shorelines mudflats	Riparian & bottomland	Shrub	Wetlands	Upland Forests			Oak woodland	Prairies (wet & dry) and balds	Agriculture and pasture
		Federal Status[3]	State Status[4]	State Strategy Species	ORNHP Rank[5]	ORBIC List[6]						Young	Mid	Mature			
Striped Skunk	*Mephitis mephitis*							1	2	1	2	2			2	2	2
Western Spotted Skunk	*Spilogale gracilis*								2	2		2			2	2	2
American Marten	*Martes americana*		OR=SV	OR, WA	S3S4	4			2				2	1	2	2	
Northern River Otter	*Lontra canadensis*						1	1	1		1						
Mountain Lion (Cougar)	*Puma concolor*								2	2	2	2			2		
Bobcat	*Lynx rufus*								2	2	2	2			2	2	2
Domestic Cat (feral)	*Felis domesticus*							2	2	2		2	2	2	2	2	1
California Sea Lion	*Zalophus californianus*						1										
Steller (Northern) Sea Lion	*Eumetopias jubatus*	FT	WA=ST		S2	2	1	1									
Roosevelt Elk	*Cervus elaphus roosevelti*			WA					1	2	2	2			2	2	2
Columbian White-tailed Deer	*Odocoileus virginiana leucurus*	LE	OR=SV WA=SE	OR, WA	T2Q S2	1			1	2	2	2			1	2	2
Columbian Black-tailed Deer	*Odocoileus hemionus columbianus*			WA					1	2	2	2			2	2	2

*1 Lowland subspecies may be introduced, although Oregon Department of Fish and Wildlife formally only recognizes red fox (*V. vulpes*) in state administrative rules and regulates it as a native wildlife species. Cascades red fox (V.* vulpes cascadensis*) is native but lives in the Washington Cascades outside of the region.*

2 Although there have been no reliable sightings within the region, it is possible that wolves will become re-established within the region in the future.

F. Rare Flora of the Greater Portland-Vancouver Region

Includes Clackamas, Clark, Washington, and portions of Hood River, Yamhill, and Columbia Counties

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat	
Tall agoseris	*Agoseris elata*			No	S		G4	S1/S3	Open forest, ridgetops at high elevations	
Tall hairy groovebar	*Agrimonia gryposepala*			No			G5	SNR/	Thickets, fields	
Howell's bentgrass	*Agrostis howellii*	SOC	C	No			G2	S2/	Moist cliffs near waterfalls	
Grand ammania	*Ammannia robusta*			No	T		G5	SNR/S1	Mudflats associated with Columbia River	
Cascade rockcress	*Arabis furcata*			No			G4	S3/	Alpine ridges, subalpine meadows and in Columbia gorge	
Sickle-pod rockcress	*Arabis sparsiflora*			No			G5T3	S2/	Rocky slopes and talus	
Texas bergia	*Bergia texana*			No			G5	S3?/SNR	Margins of vernal pools and mudflats along river	
Oregon bolandra	*Bolandra oregana*		C	No	S		G3	S3/S2	Riparian; moist places in dark shade	
Bristly sedge	*Carex comosa*			No	S		G5	S1/S2	Tidal wetland, lake shores and wet meadows	
Dense sedge	*Carex densa*			No	T		G5	SNR/S1	Wet prairie	No federal status; Oregon rank not reviewed or you can leave blank, i.e. "/S1"
Pale sedge	*Carex livida*			No			G5	S2/	Bogs and fens	
Alaska long-awned sedge	*Carex macrochaeta*			No	T		G5	S2/S1	Wet cliffs, vertical rock faces	
Retrorse sedge	*Carex retrorsa*			No			G5	S1/	Tidal wetland, lake shores and wet meadows	
Golden Paintbrush	*Castilleja levisecta*	T	E	Yes	E		G1	SH/S1	Low elevation prairie	
Cliff paintbrush	*Castilleja rupicola*	SOC		No			G3G4	S3/	Alpine rock crevices	

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat	
Tall bugbane	*Cimicifuga elata var. elata*	SOC	C	No	S	Yes	G4TNR	S4/S3	Mixed or mature coniferous forest	Oregon/ORBIC just reviewed the state rank for this species last year and assigned an S4. By rank rules, you cannot have a global rank higher than the state rank so the highest full rank is a G4.
Three-leaf goldthread	*Coptis trifolia*			No	T		G5	S1/S1	Margins of seepy areas in mature conifer forest	
Cold-water corydalis	*Corydalis aquae-gelidae*	SOC	C	No	S		G3	S3/S2S3	Stream and river riparian areas	
Short-pointed cyperus	*Cyperus acuminatus*			No			G5	S1/	Damp ground	
Great plains nut sedge	*Cyperus lupulinus ssp. lupulinus*			No			G5T5?	S1/	Wet areas	
Mountain lady's-slipper	*Cypripedium montanum*			No			G4	S3S4/	Partly shady mixed or conifer forest.	
Poverty oatgrass	*Danthonia spicata*			No			G5	SNR/	Prairie and grassland	
White-rock (Pale) Larkspur	*Delphinium leucophaeum*	SOC	E	Yes	E		G2Q	S2/S1	Oak, prairie, rock outcrop	
Nuttall's larkspur	*Delphinium nuttallii*			No			G4	S1/	Wet prairie, grassland and outcrops	
Willamette Valley larkspur	*Delphinium oreganum*	SOC	C	No			G4?	S1/	Open grassy meadows and prairies	
Peacock Larkspur	*Delphinium pavonaceum*	SOC	E	Yes			G1Q	S1/	Prairie and grassland	
Smooth-leaved douglasia	*Douglasia laevigata*			No			G3	SNR/	Talus slopes and rocky ridges	
Nuttall's waterweed	*Elodea nuttallii*			No			G5	SNR/SNR	Aquatic	
Yellow willow-herb	*Epilobium luteum*			No			G5	S3/	Streambanks and seepage areas from mid-high elevation	
Willamette Valley Daisy	*Erigeron decumbens*	E	E	Yes			G1	S1/	Prairie	
Howell's daisy	*Erigeron howellii*	SOC	C	No	T		G2	S2/S2	Moist, shaded vertical rock faces or cliffs	

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat
Oregon daisy	*Erigeron oreganus*	SOC	C	No	T		G3	S3/S2	Moist, shaded vertical rock faces or cliffs
Many-spiked cotton-grass	*Eriophorum angustifolium*			No			G5	S3/	Peat bogs, acidic meadows
Oregon coyote-thistle	*Eryngium petiolatum*			No	T		G4	/S1	Wet prairie
Western wahoo	*Euonymus occidentalis*			No	S		G5	S3*/S1	Moist forest in shaded draws
Indian rice	*Fritillaria camschatcensis*			No			G5	S1/S1	Wet prairie
Diffuse stickseed	*Hackelia diffusa var. diffusa*		C	No	T		G4T3	S3/S2	Talus, base of cliffs, rocky areas in mixed conifer forests
Western sweetvetch	*Hedysarum occidentale var. occidentale*			No	S		G5T5	/S1	Meadows and talus slopes
Long-bearded hawkweed	*Hieracium longiberbe*			No			G4G5	S3/	Shaded, moist vertical rocky faces or cliffs
Umbellate hawkweed	*Hieracium umbellatum*			No			G5	SNR/	Open forest at higher elevations
Holy grass	*Hierochloe odorata*			No			G5	S3/	Wet prairie
Shaggy horkelia	*Horkelia congesta ssp. congesta*	SOC	C	No			G4T2	S2/	Meadows and open woods at low elevations
Water Howellia	*Howellia aquatilis**	T	T*	No	T		G3	S1/S2S3	Aquatic
Fir club-moss	*Huperzia occidentalis*			No			G5	S3/	Late Seral Conifer Forest
Gorman's iris	*Iris tenax var. gormanii*			No			G4G5T1	S1/	Openings in conifer forests, roadsides
Nuttall's quillwort	*Isoetes nuttallii*			No	S		G4?	/S1	Vernal pools or seepages.
Dwarf rush	*Juncus hemiendytus var. hemiendytus*			No	T		G5T5	SNR/S1	Wet meadows
Kellogg's dwarf rush	*Juncus kelloggii*			No	E		G3?	SNR/S1	Wet meadow
Smooth goldfields	*Lasthenia glaberrima*			No	E		G5	/S1	Wet stream banks and vernal pools.
Thin-leaved peavine	*Lathyrus holochlorus*	SOC		No	E		G2	S2/S1	Oak, grasslands or shrubland.

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat
Torrey's peavine	*Lathyrus torreyi*	SOC		No	T		G5	S1/S1	Dry douglas-fir forest
Columbia lewisia	*Lewisia columbiana var. columbiana*			No			G4T4	S2/	Rocky outcrops
Bradshaw's Lomatium	*Lomatium bradshawii*	E	E	Yes	E		G2	S2/S1	Prairie
Kincaid's lupine	*Lupinus sulphureus ssp. kincaidii (=oreganus)*	T	T	Yes	E		G2	S2/S1	Open grassy meadows and prairies
Northern bog clubmoss	*Lycopodiella inundata*			No	S		G5	S2/S2	Wetlands and bogs
Stiff clubmoss	*Lycopodium annotinum*			No			G5	S3/	Coniferous and mixed forest
Ground cedar	*Lycopodium complanatum*			No			G5	S2/	Coniferous and mixed forest
Hair water-fern	*Marsilea vestita*			No			G5	SNR/	Aquatic
Branching montia	*Montia diffusa*			No	S		G4	/S2S3	Vernal pools and wet prairie
Howell's montia	*Montia howellii*		C	No		Yes	G3G4	S3S4*/	Wet prairie
Sweet gale	*Myrica gale*			No			G5	S1?/	Wetlands and bogs
California broomrape	*Orobanche californica a ssp. grayan*			No	S		G4T3T4	SNR/X	Open forest, meadow
Western yellow oxalis	*Oxalis suksdorfii*			No	T		G4	/S1	Meadows, moist woods or dry slopes
Flett's grounsel	*Packera flettii*			No			G4	S2/	Rocky open places and talus slopes
Oregon yampah	*Perideridia oregana*			No			G4G5	SNR*/S1	Prairies, dry meadows and oak wooodlands
Dotted smartweed	*Persicaria punctuata*			No			G5	SNR/	Wetland, riparian
Loose-flowered bluegrass	*Poa laxiflora*			No	S		G3G4	S3/S2S3	Moist woods to rocky open slopes
Weak bluegrass	*Poa marcida*			No			G4G5	S4/	Wet to moist meadows, swamps and alluvial forests
Wheeler's bluegrass	*Poa nervosa*			No	S		G3>	/S2	Rock outcrops and talus slope

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat
Great polemonium	*Polemonium carneum*			No	T		G4	/S1S2*	Woody thickets, open and moist forests, prairie edges
Slender pondweed	*Potamogeton pusillus ssp. tenuissimus*			No			G5T5	SNR/	Ponds at high elevations
Racemose pyrrocoma	*Pyrrocoma racemosa a var. racemos*			No			G5T3T4	S1/	Grasslands
White beakrush	*Rhynchospora alba*			No			G5	S2/	Freshwater marsh, bogs and fens
Suksdorf's mistmaiden	*Romanzoffia suksdorfii*			No			G3G4	S3?/	Wet cliffs and ledges
Columbia cress	*Rorippa columbiae*	SOC	C	No	E		G3	S3/S1S2	Columbia River riparian zone
Toothcup	*Rotala ramosior*			No	T		G5	S2/S1	Columbia River riparian zone
Soft-leaved willow	*Salix sessilifolia*			No	S		G4	/S2	Riparian forest, dredge spoils, intertidal zone
Scheuchzeria	*Scheuchzeria palustris ssp. americana*			No			G5T5	S2/	Lake margins and at the edges of bogs and fens
Pale bulrush	*Scirpus pallidus*			No			G5	S3/SNR	Wet prairie and emergent wetland along Columbia River
Drooping bulrush	*Scirpus pendulus*			No			G5	S1/	Wet areas
Northwestern yellow flax	*Sclerolinon digynum*			No	T		G5	SNR/S1S2	Grasslands
Lanceleaved stonecrop	*Sedum lanceolatum ssp. nesioticum*			No			G5T4?	SNR/	Open, rocky sites
White-topped Aster	*Sericocarpus rigidus*	SOC	T	No	S		G3	S2/S3	Prairie
Meadow checker-mallow	*Sidalcea campestris*		C	No		Yes	G4	S4/	Prairie and grassland
Bristly-stemmed sidalcea	*Sidalcea hirtipes*	SOC	C	No	T		G2	S2/S1	Prairie and grassland
Nelson's Sidalcea	*Sidalcea nelsoniana*	T	T	Yes	E		G2	S2/S1	Prairie
Western ladies-tresses	*Spiranthes porrifolia*			No	S		G4	/S2	Wet meadows, bogs, along streams or on seepy slopes
Kruhsea	*Streptopus streptopoides*			No			G5	S2/	Late seral conifer forest

Common Name	Scientific Name	Federal	Oregon	OR Strategy species	Washington	City of Portland	Global Heritage Rank	State Heritage Rank OR/WA	Habitat
Oregon sullivantia	*Sullivantia oregana*	SOC	C	No	E	Yes	G2	S2/S1	Moist cliffs near waterfalls
Hall's aster	*Symphyotrichum hallii*		No	T			G4	/S1	Dry open places in valleys and plains.
Strickland's tauschia	*Tauschia stricklandii*			No			G4	S1/	High elevation meadows in Columbia Gorge
Tufted clubrush	*Trichophorum cespitosum*			No			G5	SNR/	Emergent wetland
Small-flowered trillium	*Trillium parviflorum*			No	S		G2G3	/S2S3	Moist forest dominated by ash or oak
Lesser bladderwort	*Utricularia minor*			No			G5	S2/S2?	Aquatic
Wild bog cranberry	*Vaccinium oxycoccos*			No			G5	S4/	Wetland
Columbia water-meal	*Wolffia columbiana*			No		Yes	G5	S1/SNR	Freshwater lakes, ponds and slow streams
California compassplant	*Wyethia angustifolia*			No	S		G4	/SU	Meadows and rock outcrops
Golden alexanders	*Zizia aptera*			No			G5	SNR/	Mesic to wet prairie

Federal status refers to listings by the U.S. Fish and Wildlife Service. State statuses refer to listings by the Oregon Department of Agriculture Plant Conservation Biology Program and the Washington Natural Heritage Program. E = listed as endangered, T = listed as threatened, C = candidate for listing, SOC = Species of Concern (not a formal status).

State Heritage Ranks: Oregon refers to rankings provided by the Oregon Natural Heritage Program (October 2010, "Rare, Threatened and Endangered Species of Oregon, Oregon Biodiversity Information Center, Portland, Oregon), and the Washington Department of Natural Resources' "Washington Natural Heritage Program" web site (http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html). Global rank refers to a scale from 1 to 5. 1 = critically imperiled, 2 = imperiled, 3 = rare, uncommon, or threatened but not immediately imperiled, 4 = not rare and apparently secure, 5 = demonstrably widespread. A number preceded by a "T" means that it is the rank for the trinomial. State rank is the same as global ranking system, but on a state scale.

State listings: E = Endangered, T = Threatened, S = Sensitive, X = possibly extirpated.

Portland refers to the special-status species identified in the Natural Resource Inventory Update, City of Portland, Bureau of Planning and Sustainability 2009; http://www.portlandonline.com/bps/index.cfm?c=44745&a=216241

** Species has been listed federally, but Oregon Administrative Rules (OAR 603-073) have not yet been updated. All federally listed plant species occurring in Oregon are administratively protected by the State of Oregon*

? Inexact numeric rank. Taxa that can be ranked, but for which the rank is not certain.

G. Butterflies of the Region

	Primary Habitats Noted*						
	Upland Conifer-Deciduous Forest	**Oak**	**Prairie**	**Bottomland/ Riparian Forest**	**Wetlands**	**Shrublands**	**Status In Metro Area**
Skippers: Family Hesperiidae							
Silver-spotted Skipper (*Epargyreus clarus*)				X			Has probably declined
Persius Duskywing (*Erynnis persius*)	X			X			Generally uncommon
Propertius Duskywing (*Erynnis propertius*)		X					Decline with loss of oaks
Dreamy Duskywing (*Erynnis icelus*)	X			X			Generally uncommon
Two-banded Checkered Skipper (*Pyrgus ruralis*)	X		X				Declining, but still common
Common Checkered Skipper (*Pyrgus communis*)			X				Decline with loss of prairies
Arctic Skipper (*Carterocephalus palaemon)*	X				X		Uncommon and has probably declined
Juba Skipper (*Hesperia juba)*			X				Uncommon in the Willamette Valley
Sachem (*Atalopedes campestris*)			X		?		Recent increase; uses suburban lawns
Sonora Skipper (*Polites sonora*)			X				Decline with loss of prairies; very rare
Woodland Skipper (*Ochlodes sylvanoides*)	X	X	X	X	X		Common and widespread
Dun Skipper (*Euphyes vestris*)			X	X	X		Associated with moist microhabitats
Roadside Skipper (*Ambliscirtes vialis*)	X	X	X	X		?	Uncommon and infrequently observed
Swallowtails: Family Papilionidae							
Clodius Parnassian (*Parnassius clodius*)	X	X					Declining; lost from urban areas
Anise Swallowtail (*Papilio zelicaon*)	X	X	X	X	X		Widespread; tolerant of disturbance.
Western Tiger Swallowtail (*Papilio rutulus*)	X	X	X	X	X		Widespread; tolerant of disturbance.
Pale Tiger Swallowtail (*Papilio eurymedon*)	X	X		X		X	Not common in lowlands and cities

	Primary Habitats Noted (some expert opinion required)						
	Upland Conifer-Deciduous Forest	**Oak**	**Prairie**	**Bottomland/ Riparian Forest**	**Wetlands**	**Shrublands**	**Status In Metro Area**
Whites and Sulphurs: Family Pieridae							
Pine White (*Neophasia menapia*)	X						Strays from conifer areas during "outbreaks"
Western White (*Pontia occidentalis*)	?						Uncommonly strays to area from the east
Margined White (*Pieris marginalis*)	X	X		X			Declining with urbanization and herbicide use
Cabbage White (*Pieris rapae*)			X	X	X		Introduced; thrives in open, disturbed landscapes
Sara's Orange-tip (*Anthocharis sara*)	X	X	X	X		X	Declining with urbanization and herbicide use
Clouded Sulphur (*Colias philodice*)			?		?		Uncommonly strays to area from the east
Orange Sulphur (*Colias eurytheme*)			?		?		Sporadic summer visitor; not resident
Hairstreaks, Blues and Coppers: Family Lycaenidae							
Tailed Copper (*Lycaena arota)*				X			Unrecorded from Metro area; rare in Willamette Valley
Purplish Copper (*Lycaena helloides*)				X	X		Status unknown in Metro area; possibly declining
Perplexing Hairstreak (*Callophrys perplexa*)	?	?				X	Uncommon; a foothill species
Cedar Hairstreak (*Callophrys gryneus*)	X						Associated with western red cedar
Western Brown Elfin (*Callophrys augustinus*)	X	?				X	Populations are probably stable; tolerates some disturbance
Gray Hairstreak (*Strymon melinus*)			X	X	X	X	Widespread; tolerant of disturbance
Western Tailed Blue (*Cupido amyntula*)	X	X	X	X	?		Probably declining; needs natural moist habitats
Eastern Tailed Blue (*Cupido comyntas*)			X	X	X		Status unknown; not known from Vancouver Metro area
Echo Blue (*Celastrina echo*)	X	X		X		X	Common and widespread

	Primary Habitats Noted (some expert opinion required)						
	Upland Conifer-Deciduous Forest	**Oak**	**Prairie**	**Bottomland/ Riparian Forest**	**Wetlands**	**Shrublands**	**Status In Metro Area**
Silvery Blue (*Glaucopsyche lygdamus*)			X		?		Common in open habitats; tolerates some disturbance
Fender's Blue (*Icaricia icariodes fenderi*)			X				Endangered in the Willamette Valley; recently found near Metro area
Acmon Blue (*Plebejus acmon*)			X	?	?	X	Status unknown in Metro area; can tolerate disturbance
Brushfoots: Family Nymphalidae							
Great Spangled Fritillary (*Speyeria cybele*)	X	X	X	X		?	Appears to be in decline; requires native violets
Zerene Fritillary (*Speyeria zerene "bremnerii"*)			X				Willamette Valley form now considered extinct
Hydaspe Fritillary (*Speyeria hydaspe*)	X						A forest species; not found in urban areas
Western Meadow Fritillary (*Boloria epithore*)	X	?	X				Found in forest openings/meadows; tolerates some disturbance
Field Crescent (*Phyciodes pulchellus*)			X		X		Rare in Willamette Valley; possibly extirpated in the Portland area
Mylitta Crescent (*Phyciodes mylitta*)			X		X		Fairly common in open habitats, both natural and disturbed
Variable Checkerspot (*Euphydryas chalcedona*)	X	X	X	X		X	Lowland populations in decline; uses snowberry as larval host
Satyr Anglewing (*Polygonia satyrus*)	X	X		X			Still a common species; associated with stinging nettles
Zephyr Anglewing (*Polygonia gracilis*)	?						Uncommonly strays to area from the higher Cascades
Faun Anglewing (*Polygonia faunus*)	X	X					A forest species; not tolerant of highly modified landscapes
Dark Anglewing (*Polygonia oreas*)	X	X		X			Possibly declining within the Metro area; rarest anglewing in the area

	Primary Habitats Noted (some expert opinion required)						
	Upland Conifer-Deciduous Forest	**Oak**	**Prairie**	**Bottomland/ Riparian Forest**	**Wetlands**	**Shrublands**	**Status In Metro Area**
California Tortoiseshell (*Nymphalis californica*)	X	X		X		X	Widespread and common, especially during "outbreak" years
Mourning Cloak (*Nymphalis antiopa*)	X	?		X		?	Widespread, but uncommon; somewhat tolerates suburban landscapes
Milbert's Tortoiseshell (*Nymphalis milberti*)	X	?	X	X		X	Not common in the Metro area; requires nettles
American Painted Lady (*Vanessa virginiensis*)			X	X	X		A generally uncommon breeding immigrant
Painted Lady (*Vanessa cardui*)			X	X	X	X	A breeding immigrant; can be abundant during outbreak years
West Coast Lady (*Vanessa annabella*)			X	X	X		A moderately common breeding immigrant
Red Admirable (*Vanessa atalanta*)	X	X		X	?	?	A moderately common breeding immigrant
Lorquin's Admiral (*Limenitis lorquini*)	X	X		X	X	X	Widespread and fairly common; tolerates some disturbance
California Sister (*Adelpha californica*)		X					Relatively scarce in the Metro area; associated with oaks
Ochre Ringlet (*Coenonympha tullia*)			X				Common in natural and many disturbed grassland habitats
Large Wood Nymph (*Cercyonis pegala*)	X	X	X	X	?	?	Common in many habitats; less common in very disturbed areas
Monarch (*Danaus plexippus*)		?	X	X	?		Not a true resident; an uncommon summer migrant to the Metro area

**Primary habitats are a combination of field data and expert opinion*
? indicates uncertainty

H. Special Status Amphibians and Reptiles in the Region

Species	Status				Special Needs	Limiting Factors	Data Gaps	Conservation Actions
		State						
	Federal	WA	OR	Heritage Ranks				
Amphibians — Salamanders								
Clouded Salamander (*Aneides ferreus*)			SV	OR – S3	Forest habitats or burned areas. Require large decaying logs, especially Douglas fir.	Limited range (occurs primarily in Oregon). Loss of large logs	Habitat relationships with burns; effects of fires on populations.	Maintain large logs during forest management activities.
Oregon Slender Salamander (*Batrachoseps wrightorum*)	SoC		SU	OR – S2S3	Late successional and second-growth forest where there are abundant mid to advanced decay-stage, large-diameter Douglas fir logs and bark debris mounds at the base of snags. Talus and lava fields that retain moisture. Can clump together in groups to remain damp.	Restricted range (only occurs in Oregon); vulnerable to random events. Columbia River limits dispersal. Require habitat complexity characteristic of old-growth and unmanaged younger forests. High site fidelity for reproduction.	Maternal care and life history. Habitat requirements. Effects of habitat fragmentation on generics. Improved survey methods.	Maintain habitat with late successional attributes suitable for this species.
Cope's Giant Salamander (*Dicamptodon copei*)		SM	SU	OR – S2 WA – S3S4	Cold, fast-flowing, clear, permanent streams in coniferous forests. Deep cobble and small boulder substrate for foraging and hiding. Rocky streambanks or in-channel logs with crevices for eggs and larvae.	Limited range in Oregon. Rarely or never metamorphose, so highly vulnerable to channel dewatering and barriers; very small gill surface area, so sensitive to increases in temperature and sediment.	Information on reproduction (maternal, care, number of clutches per female per year). Frequency of naturally occurring terrestrial individuals.	Maintain stream buffers to maintain cool water temperatures and water clarity. Little or no sediment coating or embedding rocky substrates. Replace culverts as needed to remove barriers in continuous, natural streambed and streambank habitats.
Dunn's Salamander (*Plethodon dunni*)		SC		OR – S4 WA – S2S3	Cool, moist, usually older forests, wet talus, seeps, and stream edges.	Rare in WA. Populations may be isolated by roads and forest fragmentation.	Distribution in WA.	Protect habitats. Targeted surveys.
Larch Mountain Salamander (*Plethodon larselli*)	SoC	SS	SV	OR – S2 WA – S3	Basalt talus slopes of Columbia River Gorge and northern Cascade Mountains. Adapted to well-drained, gravel to small cobble-sized talus with significant amounts of fine litter and debris. Also occurs in late-successional forest, especially with gravel or fractured rock in the soil.	Specialized habitat. Presumed low dispersal capability. Relatively small clutch size. Pesticides or fertilizers can affect salamanders and their food supply.	Distribution and abundance. Reproduction and nesting ecology. Location of southern edge of species range.	Avoid disturbance of talus habitats (which can cause local extinctions); consider effects of potential ground-disturbing activities. Avoid use of pesticides adjacent to talus.

Species	Status				Special Needs	Limiting Factors	Data Gaps	Conservation Actions
		State						
	Federal	WA	OR	Heritage Ranks				
Amphibians — Salamanders continued								
Cascade Torrent Salamander (*Rhyacotriton cascadae*)		SC	SV	OR – S3 WA – S3	Cold, fast-flowing, clear, headwater streams, seeps, and waterfall splash zones in forested areas. Gravel or small cobble substrate with continuous but shallow water flow for larvae and adults foraging and hiding. May only occur in streams on basalt rock. Continuous access to cold water.	Larvae take several years to reach sexual maturity (4.5 yrs.). Small clutch size (7-16 eggs) and long time to hatch (up to 10 mo). Larvae have minute gill surface area, so very sensitive to increased temperature and sediment.	Species-specific breeding habits (because of relatively recent taxonomic split of torrent salamanders). Dispersal.	Maintain stream buffers to maintain cool water temperatures and water clarity. Little or no sediment coating or embedding rocky substrates. Replace culverts as needed to remove barriers in continuous natural streambed and streambank habitats.
Amphibians — Frogs and Toads								
Coastal Tailed Frog (*Ascaphus truei*)	SoC	SM	SV	OR – S3 WA – S4	Cold, fast flowing, clear streams within forested areas. Adults need streambanks, logs, headwater springs, and gravel seeps for foraging and hiding, and small boulders in streams for egg laying, Tadpoles need permanent streams with moss and sediment-free cobble and boulder substrate to cling to while scraping diatoms and algae.	Limited range (Northwest endemic). Low reproductive rate because of several-year larval stage. Remains close to water source; low dispersal abilities may limit recovery of populations. Sedimentation. Increases in water temperature.	Growth rates after metamorphosis. Internal reproduction dynamics.	Maintain stream buffers to retain cool water temperatures and water clarity. Little or no sediment coating or embedding rocky substrates. Replace culverts as needed to remove barriers in continuous, natural streambed and streambank habitats.
Western Toad (*Anaxyrus boreas*)	SC	SV	OR – S3 WA	– S3	Wetlands, ponds, lakes, and off-channel river pools for breeding. Extensive, sunny shallows with short, sparse, or no vegetation for egg laying and for tadpole schools to move widely as they forage on organic mud and surface diatoms.	Loss of breeding habitat as a result of changes in water level management. Egg-destroying water molds. Fungal disease. Siltation. Road kill adjacent to major breeding sites. Recreational impacts at certain sites.	Status and distribution. Impacts of water molds, and role of introduced fish in fungal spread. Causes of decline (e.g., role of ultraviolet radiation and global climate change). Survey to determine incidence of Chytrid skin fungus (Batrachochytrium dendrobatidis).	Maintain water levels and vegetation buffers at major breeding sites. Install culverts or drift fences at problem road crossings near breeding sites. Inform recreationalists about the importance of minimizing shoreline impacts. Periodic control of vegetation height and density at sites where these factors interfere with breeding.

Species	Status				Special Needs	Limiting Factors	Data Gaps	Conservation Actions
		State						
	Federal	WA	OR	Heritage Ranks				
Amphibians — Frogs and Toads continued								
Northern Red-legged Frog (*Rana aurora aurora*)	SoC		SV	OR – S3S4 WA – S4	Ponds and wetlands with shallow areas and emergent plants. Access to forested habitats (forested wetlands, uplands).	Loss and warming of egg-laying habitats in OR. Predation and competition by invasive fish and bullfrogs.	Identify overwintering habitat. Clarify impacts of pollutants, ultraviolet radiation, and parasites on populations.	Maintain wetland habitat with emergent plants. Maintain adjacent forested habitats. Control bullfrogs and invasive fish at key sites.
Cascades Frog (*Rana cascadae*)	SoC	SM	SV	OR – S3 WA – S3S4	Mountain meadows, bogs, ponds, or potholes above 2,400 feet elevation. Lays eggs in shallow sunny edges of ponds, or on low vegetation near ponds where warm sunlight speeds egg development and spring rains allow hatchlings to swim into ponds. Larvae "school" in large masses.	Montane species vulnerable to genetic isolation. Experiencing substantial reductions in southern parts of range (e.g., CA).	Feeding habits. Possible effects of introduced fishes, pathogens, and airborne environmental pollution. Habitat characteristics that could enhance migration and gene flow. Feasibility studies on reintroduction at historical sites	Maintain connectivity of habitat. Monitor effects of fish stocking and water quality on populations. Carefully manage livestock grazing in occupied wet meadows. Use prescribed burning or hand-felling of trees to set back plant succession. Reintroductions should use individuals from nearby populations; use results from feasibility studies to guide further actions. Conservation actions in Oregon are especially valuable given reductions in other parts of range.
[Oregon Spotted Frog (*Rana pretiosa*) – Extinct from Metro region]	C	SE	SC	OR – S2 WA – S1	Permanent ponds, marshes and meandering streams through meadows for breeding and foraging, especially with shallow water and a bottom layer of dead and decaying vegetation. Springs and other sites with low, continuous water flow for overwintering.	Slow to reach reproductive maturity. High fidelity to egg-laying sites. Predation and competition by invasive fish and bullfrogs. Siltation. Some populations are isolated and vulnerable to inbreeding and extinction. Livestock grazing removes cover along stream edges, allowing sediment and excessive aquatic vegetation to decrease habitat value. Altered hydrology can eliminate habitat. Loss of beaver pond creation.	Impacts of invasive fish and bullfrogs. Documentation of historical sites, and current range status. Feasibility studies on reintroduction at historical sites.	Maintain vegetation buffers around known populations; control bullfrogs and invasive fish at priority sites. Carefully manage livestock grazing at occupied montane wet meadows. Install small predator exclosures over parts of isolated breeding sites. Use results of feasibility studies to guide specific conservation actions and management decisions for reintroductions.

Species	Status				Special Needs	Limiting Factors	Data Gaps	Conservation Actions
		State						
	Federal	WA	OR	Heritage Ranks				
Reptiles — Turtles								
Western Pond Turtle (*Actinemys marmorata marmorata*)	SoC	SE	SC	OR – S2 WA – S1	Marshes, streams, rivers, ponds, and lakes. Sparsely-vegetated ground nearby for digging nests. Basking structures such as logs.	Loss of aquatic and nesting habitats (conversion, invasive plants). Predation by raccoons, invasive bass, and bullfrogs; competition with invasive turtles.	Population dynamics and population genetics. Impacts of raccoons and invasive species (turtles, fish, and bullfrogs).	Provide basking structures and nesting habitats, control invasive plants and animals. Protect important nesting sites from disturbance.
Western Painted Turtle (*Chrysemys picta bellii*)			SC	OR – S2 WA – S4S5	Marshy ponds, small lakes, slow-moving streams, and quiet off-channel portions of rivers; prefer muddy bottoms with aquatic vegetation; need open ground for nesting. Need logs/vegetation for basking.	Limited range in OR. Loss of aquatic and nesting habitats (conversion, invasive plants). Predation by raccoons, invasive bass, and bullfrogs; competition with invasive turtles.	Impacts from disease introduced and/or spread by non-native turtles. Population dynamics and population genetics. Impacts of raccoons and invasive species (turtles, fish, and bullfrogs).	Provide basking structures and nesting habitats, control invasive plants and animals. Protect important nesting sites from disturbance. Use wire cages to protect nests from raccoons at key sites in the short-term where this is a problem.
Racer (*Coluber constrictor*)		SM		OR – S4 WA – S5	Grasslands and talus. Communal winter den sites.	Probably extirpated from Puget Trough. Loss of grassland habitats.	Western WA distribution	Targeted surveys, protocol.
Gopher Snake (*Pituophis catenifer*)		SM		OR – S5 WA – S5	Prairie and dry woodlands. Communal winter den sites.	Probably extirpated from Puget Trough. Loss of grassland and oak habitats.	Western WA distribution	Targeted surveys, protocol.

STATUS CODES

Federal:

C – Candidate for Federal listing as Threatened or Endangered
SoC – Species of Concern

Oregon:

SC – Sensitive critical
SV – Sensitive vulnerable
SU – Sensitive undetermined status

Washington:

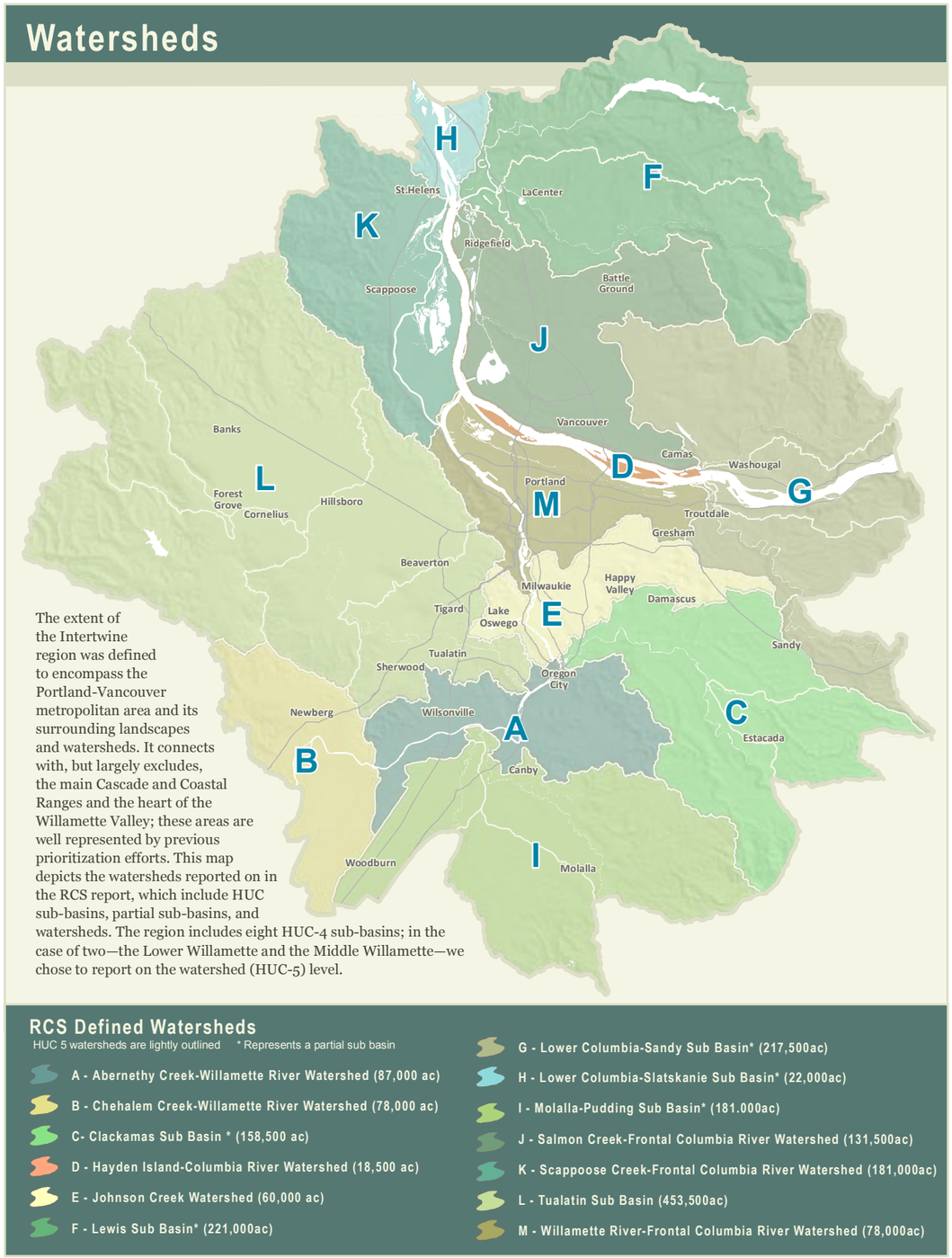
SE – State listed – Endangered
SC – State candidate for listing
SS – State sensitive
SM – State monitored (for status & distribution)

Heritage State Ranks:

S1 – Critically imperiled in the state
S2 – Imperiled in the state
S3 – Rare in the state
S4 – Apparently secure in the state
S5 – Secure in the state

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.

APPENDIX I

I. Watersheds

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.

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.

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

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
richardkennon@juno.com

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.east-forklewisriver.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
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dsmee@clarkcd.org
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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
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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.

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.

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.

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.

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.

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.
- 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 channelized. 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.

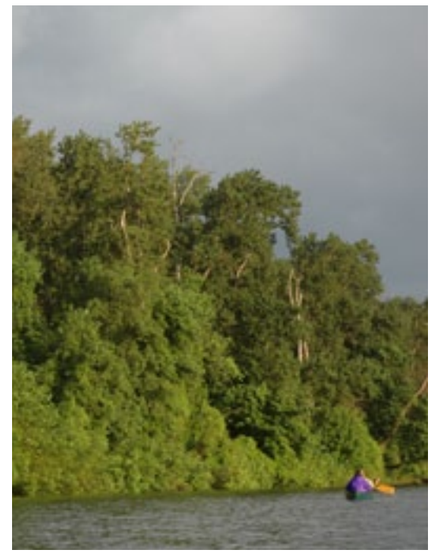
Currently most land is privately owned. The major land cover types and land uses are agricultural and rural residential land uses. Nine percent of the watershed is covered by impervious surfaces.

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.

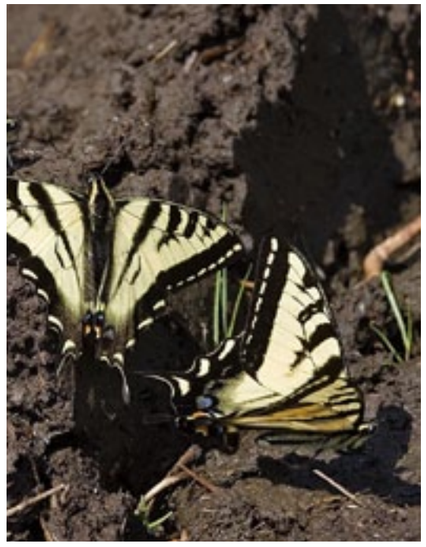
In the Chehalem Creek watershed, large floodplain wetlands continue to persist in the upper valley, forming a nearly continuous landform with the Wapato Lake complex to the north; however, many of the watershed's streams and wetlands have been altered, ditched, and drained for agriculture and development. 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 cold-water 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)

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