Major Habitat Types of the Region

CHAPTER 3

Rivers, Streams, and Open Waters

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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 clean-up 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.

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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.

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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.

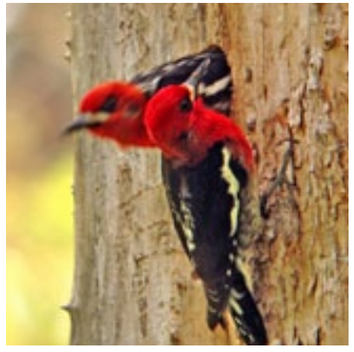
Old-growth conifer forests differ significantly from young forests in species composition, function (i.e., the rate and paths of energy flow and nutrient and water cycling), and structure. Most differences are related to four structural components of old growth: large live trees, large snags (i.e., standing 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 icariodes fenderi*), and Taylor's checkerspot butterfly (*Euphydryas editha taylori)*, have declined—often dramatically—in response to habitat loss and degradation.

Important Flora and Fauna

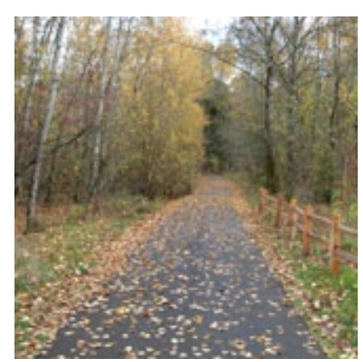
FLORA

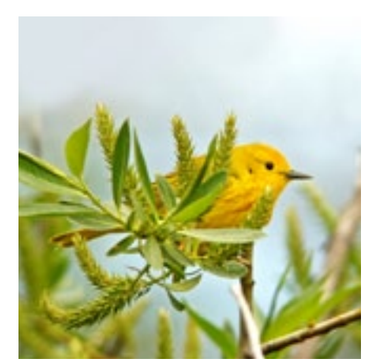
Native Willamette Valley prairies have extraordinarily diverse plant life. Approximately 375 native grass and forb species are highly or moderately dependent on prairie or savanna habitat in the greater Portland-Vancouver region. The following are some common native grasses found in prairies:

- 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.

FOR MORE INFORMATION

"Historical Vegetation of the Willamette Valley, Oregon, circa 1850"
J.A. Christy and E.R. Alverson 2011. Northwest Science, 85(2):93-107

Prairie Habitat Restoration and Maintenance on Fort Lewis and within the South Puget Sound Prairie Landscape
P. Dunn. 1998. The Nature Conservancy.

Ecology and Conservation of the South Puget Sound Prairie Landscape
P. Dunn and K. Ewing. 1997. The Nature Conservancy.

Wet Prairie Swales of South Puget Sound
R. Easterly and D. Salstrom. 2005. Saltrom & Easterly Eco-logic (SEE) Botanical Consulting together with Chris Chappell of Washington Department of Natural Resources, Natural Heritage Program.

Seattle pollinator program; http://www.pollinatorpathway.com/

Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington
U.S. Fish and Wildlife Service. 2010. U.S. Fish and Wildlife Service, Portland, OR. xi + 241 pp. Available at http://www.fws.gov/pacific/ecoservices/endangered/recovery/documents/100629.pdf

Wildlife Conservation in the Willamette Valley's Remnant Prairies and Oak Habitats: A Research Synthesis.
D.G. Vesely and D.K. Rosenberg. 2010. Oregon Wildlife Institute. Corvallis, Oregon

The Oregon Conservation Strategy
Oregon Department of Fish and Wildlife. 2006. Oregon Department of Fish and Wildlife, Salem, Oregon. www.dfw.state.or.us

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Oregon Department of Fish and Wildlife (Ann Kreager, editor). 2011. Produced as supplemental information to *The Oregon Conservation Strategy.*

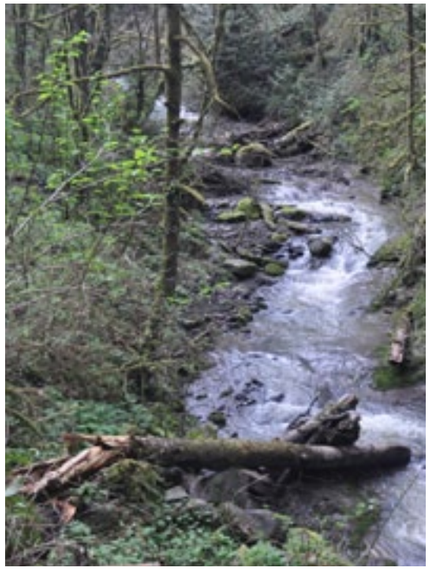
Special Habitat Features

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

Oregon State Conservation Strategy
http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

Washington State Comprehensive Wildlife Conservation Strategy
http://wdfw.wa.gov/conservation/cwcs/cwcs.html

Snags: The Wildlife Tree
Washington Department of Fish and Wildlife. http://wdfw.wa.gov/living/snags/

Oregon Wetlands Explorer: Major Wetland Types
http://oregonexplorer.info/wetlands/DiversityandClassification/WetlandTypes

Informational Guide: Streams, Springs and Seeps
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Draft Recovery Plan for Vernal Pool Ecosystems in California and Oregon
U.S. Fish and Wildlife Service. http://www.fws.gov/pacific/ecoservices/endangered/recovery/vernal_pool/