KEY HABITATS

Oregon's State Wildlife Action Plan

Contents

KEY HABITATS

Key Habitats are habitats of conservation concern within Oregon that provide important benefits to **Species of Greatest Conservation Need**. There are 12 Key Habitats within Oregon's State Wildlife Action Plan, **designated by ecoregion**, including habitats found in the Nearshore ecoregion. The SWAP also describes **Specialized and Local Habitats** that represent important landscape features not adequately addressed through the 12 Key Habitats. Each Key Habitat includes a general description, conservation overview, and a list of limiting factors and recommended approaches. This information is intended to provide a broad summary of the habitat and its most significant conservation needs. Conditions may vary by site, watershed, or ecoregional level based on differences in soil, climate, and management history. Local conditions will need to be considered when determining site-appropriate conservation actions.

Strategy Habitat Methodology

In Oregon's original State Wildlife Action Plan, the Oregon Conservation Strategy (released in 2006), Key Habitats were determined in a two-step process. First, best available and most recent (in 2006) vegetation maps were compared to historical vegetation maps from 1850 to indicate vegetation types experiencing high degrees of loss since European settlement in Oregon. Second, similar vegetation types were classified into "habitats", which were then evaluated for historical importance at the ecoregional scale, emphasizing the amount of remaining habitat being managed for conservation values, known limiting factors and potential issues impacting habitats, ecological similarity of habitats, and the importance of each habitat to Species of Greatest Conservation Need. The habitats determined to be of the most importance throughout the state were defined as Key Habitats, and were designated by ecoregion. Nearshore Habitats describe the Coastal and Marine Ecological Classification Standard (CMECS) habitat classification approach. See **Appendix - Marine Habitat Classification** for more information.

ASPEN WOODLANDS

Aspen (*Populus tremuloides*) woodlands are woodland and/or forest communities dominated by aspen trees with a forb, grass, and/or shrub understory. Aspen woodlands also occur within conifer forests.

ECOREGIONS

Aspen woodlands are a Key Habitat in the Northern Basin and Range, Blue Mountains, and East Cascades ecoregions. Small pockets of aspen can also be found in the Klamath Mountains and Willamette Valley ecoregions.

CHARACTERISTICS

In open sagebrush habitat, aspens typically form woodland and/or forest communities, dominated by aspen trees with a forb, grass, and/or shrub understory. In forested mountain habitats, aspen typically occur within conifer forests. In drier landscapes, aspen primarily occur in riparian areas or in moist microsites. Aspen habitats evolved in areas that historically experienced fire. Given sufficient moisture and light, aspen will sprout annually, with a tendency to sprout more vigorously after disturbance, like wildfire. Within a stand, aspen trees reproduce vegetatively, producing clonal root sprouts arising from a parental root system. While the aspen clone or genet may last for thousands of years, individual trees may only live for 100-150 years.   Without disturbance, aspen stands tend to decrease in size (total acres covered) and may be lost to competition from encroaching conifer trees.

CONSERVATION OVERVIEW

Aspen woodlands are on the edge of their range in Oregon and are more common further east in the Rocky Mountains and north into Canada. One of the few deciduous trees found in eastern Oregon, Aspen Woodlands are especially important in the Northern Basin and Range and Blue Mountains ecoregions. In a landscape dominated by shrubs and grasses, aspen provide significant vertical structure that is useful as nesting and roosting sites for birds and bats and cover for wildlife. Aspen stands also generally have high invertebrate prey diversity and densities. Further, Aspen woodlands provide fawning and calving habitat, security cover, and forage for mule deer and Rocky Mountain elk. Other wildlife that use aspen include black bear, porcupine, beaver, rabbit, and grouse. Tree Swallows, woodpeckers, and other birds nest in aspen cavities.

Throughout the west, there is concern over the loss of aspen habitats and the lack of aspen regeneration and recruitment in remnant stands. The Northern Basin and Range ecoregion has lost a large percentage of its aspen woodlands since the 1800s. Aspen stands often depend on natural fire and disturbance to reduce competition from conifers and stimulate the growth of sprouts from roots. Chronic overgrazing can prevent overstory recruitment, allow invasive plant species to establish, and degrade understory plant communities. Overgrazing can also cause erosion, ultimately lowering the water table, which negatively impacts aspen habitats. Many existing aspen trees are reaching the end of their natural life cycle, and without the appropriate recruitment of young aspen, many stands will be lost completely. Aspen typically do not occur in the hottest, driest portions of the Northern Basin and Range ecoregion. As the climate changes, warming temperatures and alterations to hydrologic regimes may impact aspen life cycles and the distribution of this Key Habitat.

[Spotlight] Beaver Habitat and Beaver Modified Habitat

Beavers are widely distributed across Key Habitats statewide, including Flowing Water & Riparian, Wetland, and Aspen Woodlands. **Beaver habitat**, or habitat for beaver, is the specific combination of water, food, cover, and space that beaver need to support their survival on the landscape through time. Beaver are semi-aquatic species that require still or slow-moving, perennial water at stable depths for cover, protection from predators, access to food resources, and food storage in the winter. Beavers are slow on land and prefer to forage within 100 feet of their water source. They need sufficient early seral stage stream buffers of deciduous and herbaceous riparian vegetation for food and foraging activities. Beavers are highly territorial and require adequate lateral and longitudinal habitat quality and stability to support their occupancy on the landscape. n rivers and stream networks, one beaver family unit (on average two adults, two sub-adults, and two kits) needs approximately 0.5 to 1.5 linear stream miles for ample space to survive, reproduce, and thrive. **Beaver habitat**, habitat for beaver, supports the building blocks that beaver need to create **beaver-modified habitats**, or habitat by beaver.

Beaver-modified habitat, or habitat by beaver, are the specific conditions beaver create when they alter their terrestrial and aquatic habitat to improve their fitness and survival. Habitat modifications include denning, damming and ponding water, creating canals or side-channels, importing woody and vegetative materials into flowing water and wetlands, and changing the structure of riparian vegetative communities. This suite of habitat modifications and their cumulative effects can provide benefits such as increased complexity and connectivity of Key Habitats and habitat, structure, and refugia for SGCN. Nevertheless, beaver activity can also result in flooding, loss of vegetation, economic loss on working lands, and conflict with private landowners. Actions focused on beaver habitat and beaver-modified habitats should also include efforts to mitigate negative impacts and reduce potential conflicts.

Habitat limitations for beaver such as declining surface water availability, altered floodplain disturbance regimes, conversion and loss of wet meadow and wetland habitats, and altered riparian vegetation communities are also primary limiting factors for many SGCN.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Altered Fire Regimes

Aspen stands often depend on natural fire and disturbance to reduce competition from conifers and stimulate the growth of sprouts from roots. Fire suppression has resulted in conifer encroachment and lack of reproduction in aspen communities.

Recommended Approach

Carefully reintroduce natural fire regimes using site-appropriate prescriptions, accounting for the area size and vegetation characteristics that affect resiliency and resistance to disturbance. Prescribed fire has been successful with regenerating aspen groves by increasing sprouting. Use mechanical treatment methods (e.g., masticating, cutting for firewood) to control encroaching conifers. Apply treatments appropriately with respect to season, size, and location. Pursue landscape level treatments, working to restore connectivity of aspen communities. The inclusion of mechanical ground disturbance to stimulate the growth of sprouts from root structures may be one approach to offsetting the lack of fire, but the results of this type of treatment are less predictable.

Limiting Factor: Overgrazing

Overgrazing has limited aspen recruitment through direct consumption or trampling of sprouts and indirect effects such as limiting water availability. When conditions are over-grazed, aspen may sprout but not fully grow into trees. Heavy cattle and ungulate pressure can also impact the soil, herbaceous layer, and recruitment. The direct consumption of aspen and terminal buds tends to be the greatest when sites are used by multiple species such as cattle, sheep, deer, and elk.

Recommended Approach

Limit over-grazing. Use fencing and exclosures to encourage reproduction at high priority sites until trees exceed browse height. Grove protection may be necessary for up to 10 years if elk are also present. Implement grazing plans to maintain aspen health, such as limiting grazing during spring and summer.

Limiting Factor: Invasive Species

Invasive plants, introduction of non-native pasture grasses, and historical overgrazing have altered the understory of many aspen stands. Invasive plants may also limit aspen suckering by crowding out and overtopping young sprouts. Juniper have reduced soil moisture in many rangeland aspen groves, increasing the presence of more drought-tolerant upland plants. Prolonged intensive grazing by livestock can lead to increased noxious weeds if grasses and sedges are overutilized. Stewardship actions intended to help aspen (e.g., conifer removal, fire) often stimulate noxious weeds, which thrive in disturbed and open areas.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. Control invasive plants using site-appropriate herbicides and methods. Reintroduce native bunchgrasses and flowering plants at priority restoration sites. Minimize soil disturbance in high priority areas to prevent the establishment of invasive plants.

Limiting Factor: Drought

Persistent drought is already occurring in regions and climate change is increasing the frequency and severity of extreme weather events, including heatwaves and droughts. Climate change models predict that more frequent, longer, and more severe regional drought conditions will increase as summer precipitation continues to decrease, exacerbating wildfire risk and reducing water availability. Drought has been shown to increase aspen mortality and reduce recruitment, which could lead to long-term declines in aspen habitat. The interactive effects of increased drought, chronic grazing, and fire suppression are an increasing concern in Oregon.

Recommended Approach

Implement monitoring to detect changes in regeneration, growth, and mortality in drought prone areas. Manage grazing to reduce effects on the water table. Reduce or eliminate encroaching vegetation that compete with aspen for water. Actions that reduce the impacts of other stressors will also improve aspen resilience to drought.

RESOURCES FOR MORE INFORMATION

Land Manager's Guide to Aspen Management in Oregon

US Forest service Guide on Managing Aspen

Guide to Quaking Aspen Ecology and Management (2017)

COASTAL DUNES

Occurring along the Oregon coastline, coastal dunes provide habitat for species that prefer open, sandy habitats with a high degree of disturbance from winds and tides.

ECOREGIONS

Coastal dunes are a Key Habitat in the Coast Range ecoregion.

CHARACTERISTICS

The Coastal Dunes Key Habitat includes beaches, foredunes, sand spits, deflation plains, and active dunes to stabilizing back dunes. The vegetation varies from sparse to forested, as influenced by sand scour, deposition, movement, and erosion. Species composition is also influenced by salt spray, storm tidal surges, wind abrasion, and substrate stability. Beaches and sandspits are directly impacted by tidal action and are unvegetated. Foredunes generally have unstable sand and sparse to moderate vegetative cover, including native beachgrass, seashore bluegrass, gray beach peavine, largehead sedge, beach morning glory, yellow sand verbena, and silver beachweed. In dunes with greater sand stability, red fescue, seashore lupine, beach pea, coastal strawberry, dune tansy, beach knotweed, and pearly everlasting are dominant. Over time, with plant succession, dunes convert to coastal prairies and grasslands, then to shrublands dominated by salal, and evergreen huckleberry, and eventually to forests dominated by shore pine, Sitka spruce, western hemlock, and Douglas-fir.

CONSERVATION OVERVIEW

Coastal dune communities have been altered dramatically through the introduction and spread of non-native European beachgrasses, which outcompetes native vegetation and stabilizes foredunes. The stabilized foredunes block movement of sand inland and artificially accelerate plant succession toward shrubland and forest. Dunes artificially stabilized by non-native beachgrasses have contributed to commercial and residential development of sandy habitats that were once naturally active, shifting shoreline ecosystems. In Oregon, almost all coastal dunes have been altered from their natural state since 1850.

Species that live in coastal dune habitats generally prefer open, sandy environments with a high degree of disturbance from winds and tides. Species of Greatest Conservation Need associated with coastal dunes include the Western Snowy Plover, pacific marten, pink sand verbena, Wolf’s evening primrose, silvery phacelia, and seaside gilia.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: European Beachgrass and other Invasive Plants

European beachgrass stabilizes dunes, resulting in changes in vegetative communities and loss of open sandy habitats that are vital to native species. Stabilized dunes are vulnerable to other invasive non-native species, such as hybrid beachgrasses, Scotch broom, and gorse, which displace native plants and animals and accelerate succession. Encroachment by shore pine and other woody species is also an issue.

Recommended Approach

Use mechanical and chemical treatment to control European beachgrass in priority areas, such as western snowy plover nesting areas and near pink sand verbena populations. Build on existing restoration efforts to control beachgrass. Control key invasive non-native plants using site-appropriate tools, such as mechanical (e.g., mowing, girdling, hand-pulling), chemical, and biological control (for gorse) treatments.

Limiting Factor: Development

Stabilized dunes are targeted for development for residential housing, which leads to habitat loss and increased direct/indirect impacts to wildlife through disturbance.

Recommended Approach

Use voluntary cooperative approaches, such as financial incentives, Candidate Conservation Agreements with Assurances, and conservations easements with private landowners to maintain dune habitats. Work with agency partners to support and implement **Statewide Land Use Goal 18**, “Beaches and Dunes”.

Limiting Factor: Recreational Impacts

In some areas, recreational use can disturb wildlife habitat (e.g., western snowy plover nesting areas). Off-leash dogs may also disturb habitat and chase or harass wildlife. Off-highway vehicles can also impact vegetation and disturb wildlife.

Recommended Approach

Work with land managers to direct recreational use away from sensitive areas. Close areas to access during sensitive or vulnerable periods. Provide recreational users with information on coastal dune conservation issues and low impact uses.

HABITAT CHANGE TRENDS ANALYSIS

Loss of Coastal Dunes

To investigate loss of coastal dune habitat, the Institute of Natural Resources (INR) compared the total area and spatial overlap of vegetation classes in two baseline maps (1855-1910 and 2016). The analysis showed loss of coastal dune habitat over time. By 2016, the total area of coastal dunes had declined by 24% when compared to historical data. There was also evidence of significant shifts in where open dune habitat is located, with some previously open dunes becoming vegetated and stabilized, and new open sand dunes established where dunes was previously stabilized.

RESOURCES FOR MORE INFORMATION

Oregon Coastal Management Program

Oregon Dunes Cooperative Weed Management Area: Management Plan

An analysis of coastal sand dune management in Oregon (United States) from the 19th to the 21st century.

Oregon Dunes Restoration Collaborative

REFERENCES

Brunner, R. and E. Gaines. 2025. Oregon Vegetation Change 1851-2023. Trends analysis conducted for Oregon Department of Fish and Wildlife. Institute for Natural Resources, Portland State University, Portland, OR, USA.

Weidemann, A.M., L.J. Dennis, and F.H. Smith. 1999. *Plants of Oregon Coastal Dunes*. Oregon State University Press, 120 p.

OPRD's Ocean Shores Management Plan: https://www.oregon.gov/oprd/PRP/Documents/PRP_PLA_OS_FinalOceanShoresMP052305.pdf

Snowy Plover Habitat Conservation Plan: https://www.oregon.gov/oprd/PCB/Documents/WSP-HCP_08182010-web.pdf

ESTUARIES

Estuaries are broadly defined as partially enclosed coastal bodies of tidally influenced water with one or more inputs of freshwater, and with a free or intermittent connection to the open sea. Estuaries typically occur at locations where freshwater from rivers, streams, or creeks meets saltwater from the nearshore ocean, creating a tidal basin that experiences frequent flooding and draining and periodic changes in salinity and other water parameters. Freshwater tidal estuaries can also occur in large floodplain rivers, such as the Columbia River, that are strongly influenced by riverine and estuarine hydrology.

ECOREGIONS

Estuaries are identified as a Key Habitat within the Coast Range and Nearshore ecoregions.

CHARACTERISTICS

Estuaries are characterized by the mixing of fresh and salt water within a semi-enclosed tidal basin, by the flux and dynamics of sediments and nutrients, and by the composition and functions of distinct biological communities. The spatial extent of each Oregon estuary begins on the seaward side where it meets the ocean and extends upstream and inland to where the average difference between tidal water levels is 0.2 ft (0.06 m). In many cases, the estuarine tidal basin encompasses a marine-dominated zone, a mixing zone, and a brackish-to-fresh zone that can extend many miles inland away from the ocean.

Oregon's statewide framework for management planning within estuaries (Goal 16) seeks to recognize and protect the unique environmental, economic, and social values of each estuary, and (where appropriate) develop and restore the long-term environmental, economic and social values, diversity, and benefits. The statewide planning framework classifies estuaries as development (deep or shallow draft), conservation, or natural, which define the prominent use or activities in the estuary and specify allowed locations for various uses (Figure 1). All of Oregon's estuaries are crucial to the coastal and nearshore ecology and support a diversity of habitats and species.

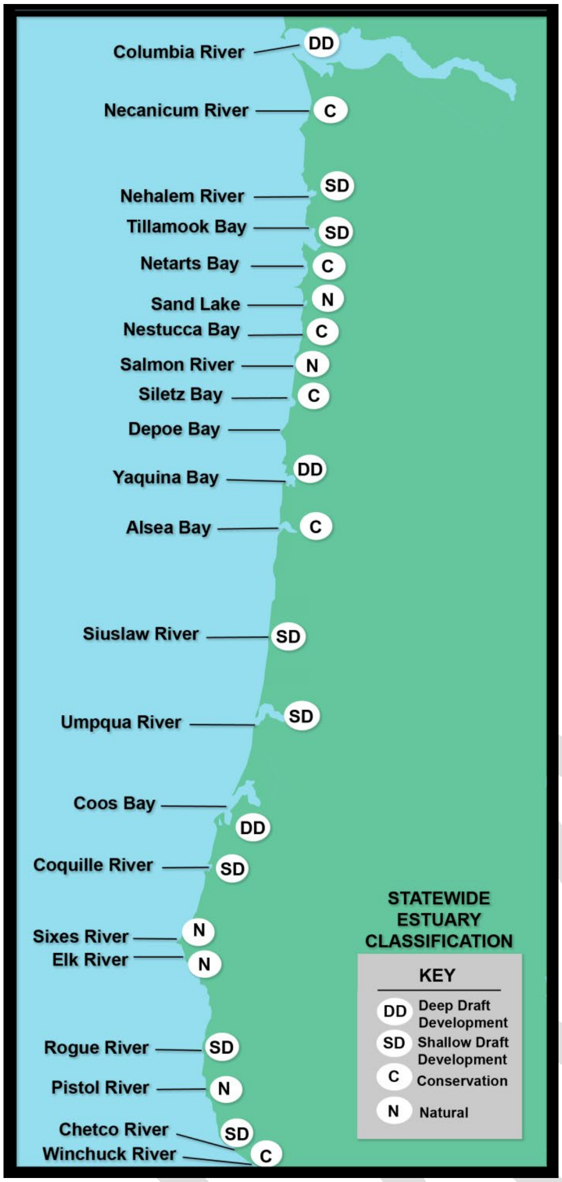

Figure 1. Oregon's major estuaries are classified into four levels for development and planning purposes.

Physical Environment

Several distinct geomorphic types of estuaries occur on the Oregon coast and along the Columbia River. The geological and hydrodynamic forces that created each estuary differ from place to place, and the physical environment that maintains them varies substantially over space and time. Estuaries have been grouped using a number of different classification schemes that may account for differences in geomorphology, region, or the relative importance of marine and watershed inputs. These classifications include:

River-dominated drowned river mouth estuaries: (i.e., Columbia River, Necanicum, Nehalem, Nestucca, Salmon River, Siletz, Alsea, Siuslaw, Umpqua River, Coquille River, Rogue River, Chetco River) The mouths of these river-dominated estuaries were inundated by rising sea levels, and they are characterized by substantial in-flows of freshwater that drain coastal watersheds. The strong riverine input has a primary influence on the shape of the tidal basin, level of salinity, sediment dynamics, and ecological characteristics of the waters and shoreline habitats, rather than marine forces such as the ebb and flow of daily tides.

Tide-dominated drowned river mouth estuaries: (i.e., Tillamook Bay, Yaquina Bay, Coos Bay) These are low-lying coastal areas where a former river valley was flooded by rising sea levels, and the geomorphology of the estuarine tidal basin is primarily shaped and influenced by strong tidal currents and only weakly influenced by river flows. These estuarine tidal basins are typically very broad and shallow, and contain numerous inlets, sloughs, submerged aquatic vegetation (eelgrass and saltmarshes) and submersible lands such as tideflats, mudflats, and shoals.

Bar built basins and lagoons: (i.e., Netarts Bay, Sand Lake, Lake Lytle, Smith Lake) These bar-built estuaries and lagoons are formed by periodic deposition of sand and other sediments to create a restriction or semi-permanent barrier to inundation by saltwater. Bar built basins and lagoons typically contain calm waters and protected habitats that are isolated to some extent from the driving forces of nearshore ocean waters.

Blind drowned river mouth estuaries: (i.e., New River, Sixes River, Elk River, Pistol River, Winchuck River) These estuaries were formed when small coastal river valleys were inundated and flooded by rising sea levels, but the openings to the ocean are partially or completely blocked by a natural barrier such as sandbars or sandy berms. These “blind” estuaries do not have a permanent open connection to the sea.

Tidally restricted coastal creeks: (i.e., Beaver Creek, Yachats River, Siltcoos, numerous others) These small estuaries occur in areas where rivers, small coastal creeks and streams empty into the ocean, typically across gravel bars or sand. At some times of the year, the outflow from these coastal creeks may be partially impaired and the protected waters can become influenced by the tides.

Marine coves, inlets, and harbors: (Depoe Bay, Sunset Bay, others) These small marine-dominated coves or sheltered inlets have narrow entrances that protect them from the direct forces or waves and wind, and they are often accompanied by minor outflows from small freshwater creeks or streams.

Oregon’s estuarine habitats are characterized and described using the **Coastal and Marine Ecological Classification Standard** (CMECS; 2018), a federal classification system that provides a common framework for presenting, classifying, and interpreting spatial data and observational information. The CMECS framework is used to both enhance scientific understanding and advance ecosystem-based resource management. (see **Appendix - Marine Habitat Classification**)

The CMECS Oregon Estuarine Aquatic System is composed of riverine subsystems (tidal riverine, diked) and the more saline subsystems found lower in the estuary (coastal, diked, open water). These subsystems are divided where the average salinity during the annual low flow period is less than 0.5 practical salinity units. Aquatic species that inhabit the tidal riverine coastal and tidal riverine open water subsystems differ greatly from those that inhabit the more saline coastal and open water subsystems in all tidal zones.

Oregon estuaries are also classified by their CMECS Geoform Components (Figure 2 and 3). Geoforms are structural features of the estuarine ecosystem that are geologic in origin, including sloughs, tidal inlets, tidal channels, creeks, deltas, fans, shoreline fans, flats, islands, lagoons, marsh platform, natural levees, and shores. Biogenic geoforms also exist in Oregon estuaries, and include shell beds, burrows in tideflats, and areas of extensive bioturbation. CMECS also recognizes the classification of anthropogenic altered areas as geoforms (i.e., shorelines hardened by rip-rap structures, artificial aquaculture structures, man-made levees, docks and piers, dredge deposits, dredged and excavated channels, fill areas, harbors, marinas, boat ramps). Similarly, Oregon’s estuarine habitats include a diversity of CMECS Substrate Components, including natural bedrock, gravel, sand, and mud as well as anthropogenic substrates such as breakwaters, rock jetties, bridge support structures, or artificial materials (pilings) used for construction of docks and piers.

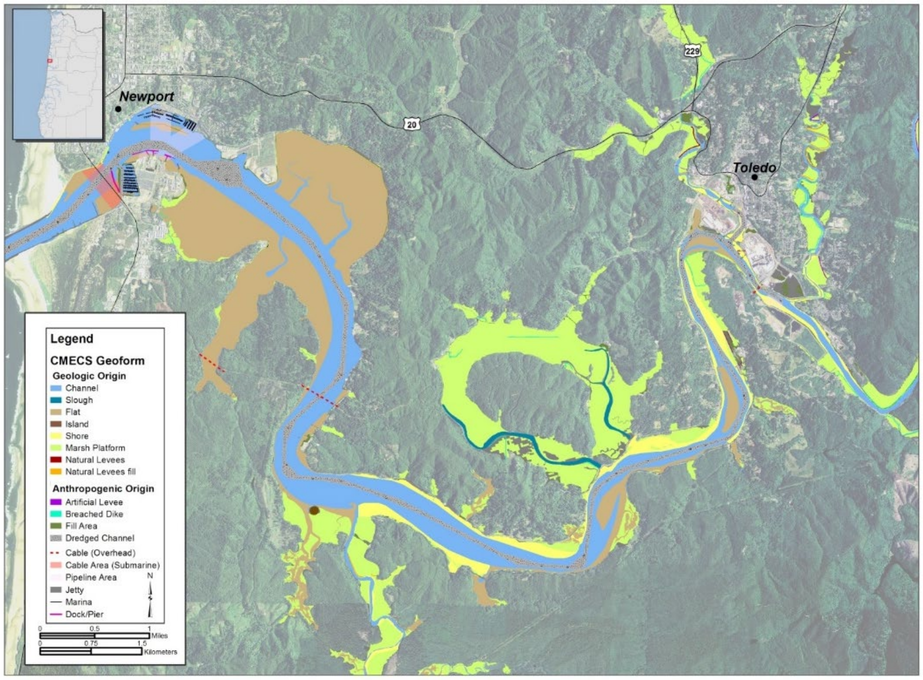

Figure 2. Map of Yaquina Bay depicting CMECS Geoform Components of geologic and anthropogenic origin.

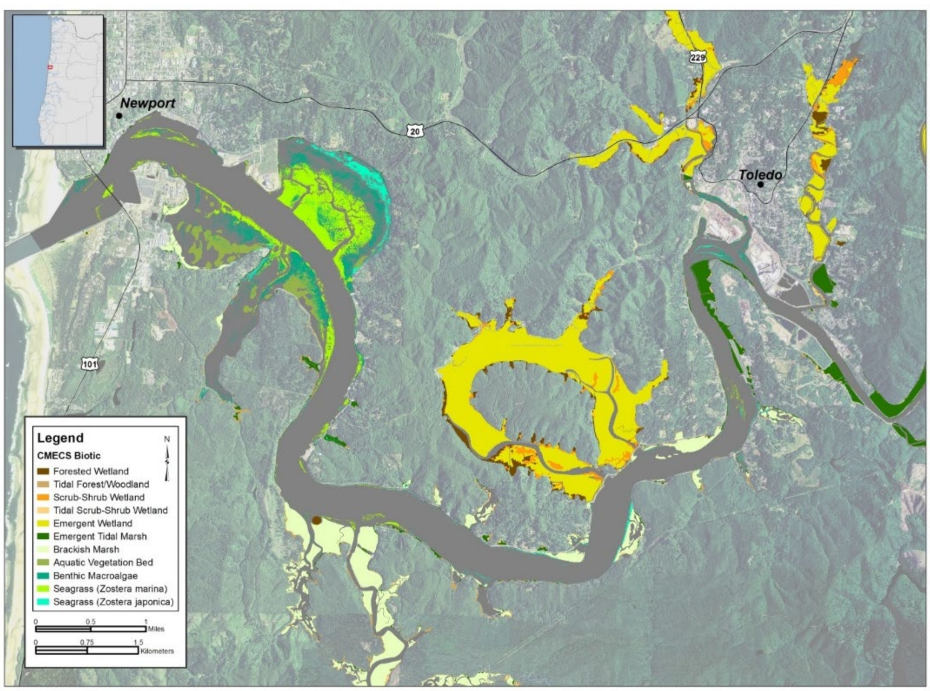

Figure 3. Map of Yaquina Bay with CMECS Biotic Components.

Biological Community

Oregon estuaries encompass a broad diversity of highly complex, productive habitat that is critical for many species of fish and wildlife, including salmon, rockfish, perch, sculpin, crab, shrimp, bay clams, infaunal invertebrates, marine mammals, and birds. By some estimates, Oregon estuaries support some component of the life cycle for up to three-quarters of all harvested species of fishes, largely due to the high productivity and diversity of habitats, including those provided by eelgrass beds. Rates of primary production in estuarine habitats are very high, and both the emergent vegetation (macroalgae, eelgrass, marsh plants) and microscopic algae (diatoms, others) produce tremendous amounts of organic material that supports the base of the estuarine food web.

Eelgrass beds are particularly important because they provide several essential ecosystem functions, including foraging areas and shelter for young fish and invertebrates, production of organic material and detritus, food for migratory waterfowl, and spawning surfaces for species such as the Pacific herring. Eelgrass beds also reduce erosion along the shorelines of Oregon estuaries where the blades and roots trap sediment, stabilize soft unconsolidated substrata, and dissipate the force of wind and waves. Eelgrass improves estuarine water quality by producing oxygen, filtering polluted runoff, absorbing excess nutrients, and reducing localized concentrations of carbon dioxide (See Specialized and Local Habitats). Tidal marshes are also an ecologically productive component of biological communities in Oregon estuaries. Organic materials produced in tidal marshes are broken down by microbial processes to serve as food for many organisms, which in turn are eaten by larger ones as they are distributed throughout the estuary with the tides. Tidal swamps provide complex habitat with layered vegetation, including low-growing herbaceous plants, shrubs, and trees. In addition, tidal swamps generate large quantities of above- and below-ground woody debris, and they provide deep, sheltered tidal channels and deep soils rich in organic matter.

Many other species of fish and wildlife also use estuaries. Elk herds graze in tidal marshes and shelter in tidal swamps, bears forage in tidal swamps, river otters build dens, racoons forage along the shore, and rails, snipe, and songbirds nest in the dense vegetation. Estuaries also provide important wintering habitat for waterfowl, including the Black Brant, and migration stopover feeding areas for many shorebirds. Native eelgrass is an important component of an estuary, providing important habitat for several Species of Greatest Conservation Need (SGCN) and other species of conservation interest, including **Black Brant**, **Dungeness crab**, **black rockfish**, **copper rockfish**, and **kelp greenling**. Beds of **eelgrass** provide important spawning substrate for herring (an important forage fish species), blue mud shrimp, native Olympia oysters and native littleneck clams.

CONSERVATION OVERVIEW

Tidal channels, inlets, sloughs, tideflats, marshes, embayments, and sandy barrier spits that characterize Oregon estuaries are dynamic coastal and riverine systems that respond readily to disturbance by natural and anthropogenic events. The long-term health and sustained productivity of these estuaries are of conservation. Particular attention should be focused on the chronic adverse effects of anthropogenic disturbances and ecological stressors (i.e., invasive species, industrial contaminants, aquaculture operations, habitat alterations, shoreline development, and recreational activities) on the physical structure and ecological functions of estuarine habitats.

The spatial extent of Oregon estuaries and tidal wetlands has been significantly reduced over the past 150 years due to road building, diking and filling, development of shoreline municipalities and industries, and conversion of historic tidal wetlands to shoreline agricultural purposes. Oregon's historic estuarine areas have been lost due to anthropogenic disturbance, and even greater losses of historic estuarine habitat have occurred within low-lying estuarine tidal basins that were altered to accommodate shoreline dairy operations. Large expanses of historic forested tidal wetlands (>90%) have been lost, along with substantial losses of salt and freshwater marshes and other tidal wetlands that were diked, drained, and converted to agricultural purposes. Shrub habitat and forested tidal wetlands were historically common around the perimeter of Oregon estuaries, and these habitats were also heavily impacted and experienced substantial habitat loss.

In accordance with the Oregon Statewide Planning Program (**Goal 16**), local government comprehensive plans and zoning ordinances have been prepared for all of Oregon's estuaries. Additionally, both estuaries and eelgrass beds are habitat types that have been designated as a Habitat Area of Particular Concern under National Marine Fisheries Service's (NMFS) **Essential Fish Habitat** regulations for salmon and groundfish species, designations that require federal agencies to consult with the NMFS before actions are taken. Eelgrass beds are also identified as Aquatic Resources of Special Concern per the Oregon Department of State Lands, which means they are identified as waters of the state that provide functions, values and habitats that are limited in quantity because they are naturally rare or have been disproportionately lost due to prior impacts.

Oregon's remaining estuarine habitats provide a broad diversity of valuable ecological benefits and services, including protection of shorelines from erosion, cycling of nutrients, trapping of sediments, improvement of water quality, production of aquatic vegetation beds, generation of organic material to support food webs, provision of nursery areas and forage sites for fish and shorebirds, and provision of protected waters for recreational and commercial harvest of fish and shellfish. Efforts to conserve healthy estuarine areas and restore degraded habitats will benefit many species, including several commercially important fish and wildlife species.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Increased Shoreline Development, Land Use Conversion, and Altered or Blocked Tidal Flow

Oregon's estuarine habitats have been altered and lost to a variety of causes, including large-scale dredge and fill operations, diking, ditching, installation of tide gates, residential and industrial development, and drainage of wetlands for dairy operations and other agricultural purposes. Additional estuarine habitat has been lost due to inadequate hydrologic flow through culverts under roads and railroads, creation of log storage areas, and construction of levees, roadways, bridge structures, pilings, docks, and boat launches. Some types of commercial shellfish mariculture practices impact estuarine habitats by disruption of sediment dynamics and causing disturbance to eelgrass beds and their associated communities. Shoreline development projects in the marine-dominated regions of estuaries can impact habitats through the building and maintenance of jetties, piers, breakwaters, marinas, and navigation channels, and disposal of dredge materials can bury and/or alter estuarine habitats and impact nearshore SGCN.

Recommended Approach

Provide technical assistance and incentives to local municipalities, counties, and landowners to protect, conserve, enhance, and restore estuaries. Participate in the planning for local, state and federal permits associated with dredging of estuary navigation channels and identify mitigation actions necessary to offset unavoidable damages and disturbance. Where appropriate, work to restore hydrology to tidal wetlands by removing dredge spoil materials, opening dikes and levees, filling ditches, and replacing undersized culverts. Continue successful education and outreach programs focused on recognizing the beneficial functions and services provided by estuaries. Work with local governments and agency partners to support and implement existing land use regulations that preserve and restore habitats. For example, refer to seasonal in-water work windows for estuaries designed to minimize impacts to out-migrating salmon. Continue to develop and refine "best management practices" for commercial shellfish mariculture operations within estuaries. Monitor, maintain, protect and restore eelgrass beds and forested wetlands as key habitat features. (KCI: **Land Use Changes**)

Limiting Factor: Alteration of Freshwater Inputs into Estuaries

The amount and timing of freshwater inputs into estuaries are critical to maintaining the hydrological regime that supports delicate estuarine ecosystems. Disruption of freshwater delivery systems can contribute to decreased flushing, inundation of floodplains, increased sedimentation, decreased residence time of water (which reduces the filtering benefits of estuaries), altered fish community dynamics, and/or increased stress on juvenile fish, nekton, or other animals. Changes in hydrological regimes can also make estuaries more susceptible to the establishment and invasion by non-native species as well as accumulation of marine debris and waterborne pollutants.

Recommended Approach

Evaluate the potential impacts of water diversions away from estuaries (e.g., for agriculture, residential, or industrial purposes) on floodplain dynamics and other functions of estuarine systems. Prioritize watersheds and tidal basins for the acquisition of sufficient instream flows.

Limiting Factor: Degraded Water Quality

Water quality in estuaries is frequently degraded by both point and non-point sources of pollution. The sources of degraded waters may originate from the nearshore Pacific Ocean, within the estuary, and/or from sources in the adjacent watershed. Marine waters that flood into estuaries may be impaired (acidified) by elevated concentrations of carbon dioxide or hypoxic (low) levels of dissolved oxygen. In addition, marine waters are periodically contaminated by fuel oil spills, diesel, and other hydrocarbons released by vessels at sea. Contaminated runoff from residential, agricultural lands, commercial forest land, failing septic systems, animal waste, and storm events can enter estuaries and negatively affect water quality. Estuarine water temperatures can become elevated by dredging, sedimentation, stormwater runoff, and altered patterns of tidal circulation. Other discharges, including polluted runoff from commercial boatyards and marinas, discharges from commercial seafood processors, and shore-based cleaning operations, all can contribute to poor estuarine water quality. Estuaries are also susceptible to increased loads of fecal indicator bacteria that can enter the tidal basin from multiple sources. Stormwater runoff that collects water from impervious surfaces and roadways can contribute fertilizers, herbicides, sediments, oil and grease, and other pollutants directly into estuaries and bays.

Recommended Approach

Continue current efforts to consider the impacts of local land-use planning decisions on estuarine water quality. Support efforts of the Oregon Department of Environmental Quality (DEQ) to assess water quality and develop Total Maximum Daily Loads and water quality management plans where necessary to address issues. Continue coordination with local governments and agency partners to ensure that plans and goals consider impacts to water quality sufficient to protect fish and wildlife in addition to other goals (i.e., recreation). Work with cities to improve stormwater management from impervious surfaces, and work with the Oregon Department of Transportation (ODOT), County roadmasters, and industrial forest landowners to reduce stormwater and sediment delivery from roads. Prioritize restoration of eelgrass beds, saltmarshes, and forested and scrub-shrub estuarine wetlands to assist with buffering and filtering water that enters estuaries. (KCI: **Water Quality and Quantity** and **Pollution**)

Limiting Factor: Non-Native and Invasive Species

Introduced, non-native, and invasive species present a substantial threat to the biodiversity of Oregon's estuarine habitats. Large estuaries that support maritime trade and commercial mariculture activities (such as the Columbia River and Coos estuary) are particularly vulnerable to colonization by new species of invertebrates, fishes, and plants. Dredge spoils deposited within estuaries provide new habitat that can be rapidly colonized by non-native species, and hydroelectric projects on rivers that flow into estuaries disrupt freshwater inflows and the ecology of estuarine communities. It is estimated that over 100 non-native species have become established into the Coos estuary. Many of these species are cryptic, but some displace native species and have the potential to alter habitat structure and energy flow through the estuarine habitats and communities.

Commercial shipping vessels transport large volumes of ballast water from one port to another, and they function as vectors for the introduction of living marine organisms. For example, the purple varnish clam was probably transported via ballast water from Japan to British Columbia before 1993. By 1997, this bivalve spread to Oregon, presumably via natural transport of larvae by ocean currents.

Some non-native species have been introduced deliberately into Oregon as cultivated seafood products (i.e., Pacific oysters and Kumamotu oysters), while others have become established as inadvertent hitchhikers associated with commercial mariculture operations. For example, large sections of Oregon's estuarine tideflats have been colonized over the past 35 years by Japanese eelgrass, which takes root in the upper region of muddy tideflats and may compete with native eelgrass. Other undesirable species associated with mariculture operations include seaweeds, predatory oyster drills (snails), mud blister worms and colonial tunicates.

The European green crab became established in Oregon estuaries in the mid-1990s, and populations persisted at low abundance for about 20 years. Following a substantial marine heatwave and several successive periods of warm ocean temperatures, the population of European green crab increased rapidly to the point where they are abundant in the mid and upper regions of Oregon estuaries where they prey on small native clams, worms and juvenile flatfish. Other examples of non-native invasive animals found in Oregon estuaries include the parasitic Griffen's isopod (which has been linked to declines of native blue mud shrimp populations), the New Zealand mudsnail, and the New Zealand burrowing isopod. Invasive species can also be introduced into estuaries through recreational or commercial boating, or the aquarium trade where they have the potential to spread quickly because they have no natural predators or competitors. An extensive list of non-native and invasive species that have been found in the Nearshore ecoregion, including in estuaries, can be found in **Appendix – Nearshore Species**.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. Control key invasive plants using site-appropriate tools, such as hand-pulling, covering with geotextile cloth, repeated mowing, flooding, and/or herbicides focusing on spot treatment. Monitor estuaries for potential invasive species, and use site-appropriate methods to detect, trap, and control newly established species (i.e. mud blister worms) for which management can be most effective. Work with state and federal partners to implement existing ballast water regulations, including development of potential methods to treat and disinfect ballast water. Work with partners to limit the spread of invasive species that have become established and naturalized. Explore options to allow for increased harvest of species suitable for human consumption such as purple varnish clams and European green crab. (KCI: **Invasive Species**)

Limiting Factor: Management and Planning Needs

Many jurisdictions and agencies have management authority and interest in Oregon estuaries, which can make land-use planning, decision-making for permits, and other actions more complex and difficult. In Oregon, cities, counties, port districts, and many state agencies have planning and management responsibilities for estuaries. In addition, the federal government and coastal tribes have some level of management authority for activities in estuaries. Further, most of Oregon’s estuary management plans have not been updated with the best available information to guide land use decisions affecting estuarine habitats since the 1980s.

Recommended Approach

Coordination among agencies, local governments and tribes is a high priority. Because estuarine issues are complex, clear identification and communication of conservation opportunities, goals, and threats should precede management actions, ensuring that all interests are considered and coordinated. Prioritization should include updates to estuary management plans to incorporate the best available data for decision-making, including new challenges from climate change such as rise sea level rise and warming ocean temperatures. In 2024, the Yaquina Bay Estuary Management Plan was the first plan in more than 40 years to be adopted and can be a model for other jurisdictions to utilize. Develop a process to provide advanced notice and share information among federal, tribal, state and local governments to assist with conservation, protection, enhancement, and restoration of estuarine habitats.

Develop and implement science-based management strategies for estuarine resources. Expand upon management objectives previously identified and further develop plans that identify restoration or conservation targets for individual estuaries. Encourage and assist in estuarine research to identify data and knowledge needed for management planning.

Limiting Factor: Loss of Habitat Complexity

Habitat complexity provides refugia for estuarine fish and wildlife. Complex habitat supports diverse ecological communities, contributing to resiliency to climate change impacts. Removal or loss of large, downed trees not only reduces habitat complexity but also insect production and food and cover for juvenile salmonids. Disconnection of habitats from the tidal basin and floodplain interrupts the natural transition zones between the aquatic, intertidal, and upland ecosystems. Dredging, ditching, channelization, and filling in estuaries alters marine and freshwater inputs and reduces habitat function. In-water (e.g., pilings, jetties, seawalls) or overwater (e.g., roadways, dikes, levees, mooring buoys, floating docks) structures can reduce habitat complexity, as can bayside development that extends into intertidal areas. Natural factors can also reduce habitat complexity, such as damage or movement caused by seasonal runoff or significant storm events, especially where the estuary has already been compromised, and floodplains have been lost.

Recommended Approach

Ensure that permit application reviews consider alternative sites and practices to avoid and minimize impacts and provide full and effective mitigation to offset unavoidable damages. Encourage and participate in cooperative efforts and incentives to promote habitat complexity in estuaries and consider the scale of development proposals in reference to historical and future baselines. Prioritize conservation and restoration efforts to restore floodplain connectivity, tidal marshes, and forested wetlands, and to conserve eelgrass. Increase outreach and education about the importance of habitat complexity, including the benefits of increased complexity associated with recovering populations of native Olympia oysters.

Limiting Factor: Climate Change

Climate change is expected to have significant impacts to Oregon estuaries. Rising sea levels are expected to more fully inundate estuarine tidal basins, resulting in changes to the delivery of marine-derived nutrients and tidal hydrology, shifts in water temperatures, disruption of salinity regimes, advancement of the tidal prism, changes in the deposition and erosion of sediments, and losses of tidal wetlands and submerged aquatic vegetation (coastal squeeze). Acidified ocean waters are impacting estuaries and contribute to biogeochemical shifts in the composition of estuarine waters and difficulties in shell-building for estuarine bivalves. Shifts in habitat conditions within estuaries may contribute to increased colonization by non-native species, and alteration of estuarine food webs. Further inland, warming and drying conditions in coastal watersheds may impact the characteristics of freshwater flows into estuaries.

Recommended Approach

Use emerging models of future sea level rise and changing salinity regimes to inform conservation actions in estuaries. Work with property owners, land use planners, and restoration practitioners to focus attention on vulnerable areas. Support efforts to restore natural processes of tidal exchange and sediment deposition, which will enable tidal wetlands to maintain their elevation relative to rising sea levels. Support efforts to re-connect floodplains to adjacent uplands by removing barriers, placement of large woody debris, and planting of riparian areas. Conserve areas that will become new marshes and forested wetlands with sea level rise. Inform communities about climate change impacts and support community preparedness. (KCI: **Climate Change**)

Limiting Factor: Oil Spills and Hazardous wastes

Oregon estuaries are susceptible to periodic exposure and contamination by fuel oil, petroleum products, creosote, and other hazardous materials. Hazmat spills are of particular concern in deep-draft estuaries that support transport, loading, and unloading of large commercial vessels, and areas with busy marinas that provide for refueling and berths for commercial and recreational vessels. Estuarine tidal basins have also been contaminated by legacy pollutants (heavy metals, oil and grease, etc.) and industrial waste, and some sites are treated as USEPA “Superfund Cleanup” sites (i.e. Port of Portland, Tongue Point). All of Oregon’s estuarine areas are at risk from oils spills that occur in the ocean or along the open coast because buoyant hydrocarbons may enter estuarine tidal basins on flooding tides. If a spill occurs, accumulation of oil and hazardous materials can have long lasting impacts.

Recommended Approach

Participate in the periodic review and updates to the Oregon Geographic Response Plans and oil spill contingency plans and ensure that the maps for the coast and estuaries contain up-to-date information regarding living marine and estuarine resources. Maintain status as emergency Hazwoper Responders and participate in interagency drills and training exercises. Work with the Oregon Department of Geology and Mineral Industries, Oregon Department of Environmental Quality, the US Coast Guard, and local emergency officials to identify hazardous material use and storage sites in high-risk areas and seek ways to minimize these risks. Coordinate with agencies to periodically communicate about Hazardous material storage, transportation, and response issues to decrease environmental risks and increase understanding of the impacts of Hazmat spills. (KCI: **Pollution**)

RESOURCES FOR MORE INFORMATION

Oregon Coastal Atlas Estuary Data Viewer, and background on CMECS classification system

Pacific Marine and Estuarine Fish Habitat Partnership

[National Water Quality Assessment Program]

[South Slough National Estuarine Research Reserve]

[ODFW Workshop on Estuaries, Climate Change, and Conservation Planning (2010)]

[Yaqulna Bay Estuary Management Plan Update (2024).]

REFERENCES

Barbier, E.B., S.D. Hacker, C. Kennedy, E.W. Koch, A.C. Stier, and B.R. Silliman. 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs 81: 169-193.

Bottom, D.L., K.K. Jones, T.J. Cornwell, A. Gray, and C.A. Simenstad. 2005. Patterns of Chinook salmon migration and residency in the Salmon River estuary (Oregon). Estuarine, Coastal and Shelf Science 64: 79-93.

Brophy, L.S., C.M. Greene, V.C. Hare, B. Holycross, A. Lanier, W.N. Heady, K. O'Connor, H. Imaki, T. Haddad, and R. Dana. 2019. Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands. PLOS ONE 14(8): e0218558

Brown, C.A. and R.J. Ozretich. 2009. Coupling between the coastal ocean and Yaquina Bay, Oregon: importance of oceanic inputs relative to other nitrogen sources. Estuaries and Coasts 32:219–237.

Good, J.W. 2000. Summary and current status of Oregon's estuarine ecosystems. In, Oregon State of the Environment Report. Oregon Sea Grant and Oregon State University, Technical Supplement to the progress Board (September 2000) https://www.oregon.gov/DSL/WW/Documents/soer_ch33.pdf

Flitcroft, R. et al., 2016. Expect the unexpected: place-based protections can lead to unforeseen benefits. Aquatic Conservation: Mar. Freshwater. Ecosystem. 26 (Suppl. 1): 39–59.

Hessing-Lewis, M.L., S.D. Hacker. 2013. Upwelling-influence, macroalgal blooms, and seagrass production; temporal trends from latitudinal and local scales in northeast Pacific estuaries. Limnology and Oceanography 58:1103-1112.

Hickey, B.M. and N.S. Banas. 2003. Oceanography of the U.S. Pacific Northwest coastal ocean and estuaries with application to coastal ecology. Estuaries 28:1010-1031.

Howard, B.R., F.T. Francis, I.M. Cote, T.W Therriault. 2019. Habitat alteration by invasive European green crab (*Carcinus maenas*) causes eelgrass loss in British Columbia, Canada. Biological Invasions 21: 3607-3618.

Lee, II, H., and C.A. Brown. 2009. Classification of regional patterns of environmental drivers and benthic habitats in Pacific northwest estuaries. U.S. Environmental Protection Agency / Office of Research and Development. National Health and Environmental Effects Research Laboratory, Western Ecology Division. EPA/600/R-09/140.

Mapping efforts of Oregon's estuaries utilizing CMECS components is underway and an online tool for viewing estuary maps is available at: http://www.coastalatlas.net/estuarymaps/

Rumrill, S.S. 2006. Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve. OR Department of State Lands / NOAA. 197 pp.

Rumrill, S.S., D.C. Sowers. 2008. Concurrent assessment of eelgrass beds (*Zostera marina*) and saltmarsh communities along the estuarine gradient of the South Slough, Oregon. Journal of Coastal Research 2008(10055): 121-134.

Simenstad, C.A., Burke, J.L., O'Connor, J.E., Cannon, C., Heatwole, D.W., Ramirez, M.F., Waite, I.R., Counihan, T.D., and Jones, K.L., 2011, Columbia River Estuary Ecosystem Classification—Concept and Application: U.S. Geological Survey Open-File Report 2011-1228, 54 p.

Tallis, H.M., J.L. Ruesink, B. Dumbauld, S. Hacker, and L.M. Wisehart. 2009. Oysters and aquaculture practices affect eelgrass density and productivity in a Pacific Northwest estuary. Journal of Shellfish Research 28: 251–261.

Wagner, E., B.R. Dumbauld, S.D. Hacker, A.C. Trimble, L.M. Wisehart, J.L. Ruesink. 2012. Density-dependent effects of an introduced oyster, *Crassostrea gigas*, on a native intertidal seagrass, *Zostera marina*. Marine Ecology Progress Series 468:149-160.

Yamada, S.B. 2001. European green crab – a global invader. Oregon Sea Grant, Corvallis. ORESU-B-01-001, 123 pp.

FLOWING WATER AND RIPARIAN HABITATS

Flowing Water and Riparian Habitats include all naturally occurring flowing freshwater streams and rivers throughout Oregon as well as the adjacent riparian habitat.

ECOREGIONS

Flowing Water and Riparian Habitats are identified as a Key Habitat in all ecoregions.

CHARACTERISTICS

Flowing Water Habitats

Flowing creeks, streams, and rivers are a key feature of the Oregon landscape and our natural resources heritage. They support diverse ecosystems and fisheries, and provide significant social, economic, and recreational values. Healthy flowing freshwater systems are crucial to support iconic Pacific Northwest salmon and steelhead as well as amphibians, aquatic insects, and other Species of Greatest Conservation Need (SGCN). People also rely on healthy waterways to irrigate crops, generate hydroelectric power, operate manufacturing plants, treat wastewater, and for drinking water.

Natural, freshwater flowing waters are dynamic systems that typically start as small, high elevation creeks that merge with mid-elevation streams and then combine to form large river systems. Flowing waters are fed by a variety of sources, including melting glaciers and snow, direct runoff from the surrounding landscape or watershed, and via groundwater discharge such as springs. Flowing water habitat includes perennial, intermittent, and ephemeral creeks, streams, and rivers. Perennial waterways are those that flow year-round, whereas intermittent waterways only flow part of the year, typically during the wet season, and ephemeral waterways only flow during a short period after a precipitation event. Protection of habitats surrounding perennial, intermittent, and ephemeral creeks, streams, and rivers helps to minimize impacts to flowing waters while providing benefits to water temperature and water quality.

Healthy streams include structural variability essential for SGCN to meets their life cycle needs. For example, pools and riffles provide a range of stream flows, and backwater alcoves and side channels are essential for refugia during high flows. Ephemeral streams, though flowing only during snowmelt or rain events, provide important refugia for anadromous and local fish species during spring high waters. The shape and dynamics of a stream or river are typically defined by high winter/spring flows and flooding patterns, width of the available floodplain, geology/soils in the adjacent floodplain and watershed, and the degree of human impact on water quantity, water quality, and the surrounding landscape. Healthy streams are typically connected with their floodplain, exhibit natural variability in flow amount and timing, and are dynamic and free to evolve based on natural events such as wood falling into the river, channels changing course, high flow events, and landslides. The complexity of the flowing water habitat directly contributes to the health and function of fish-bearing streams.

Climate-related changes in precipitation patterns, snowmelt cycles, and fire frequency, as well as increased demand for out-of-stream water use will alter flowing water systems relative to historical conditions. A changing climate has the potential to alter hydrologic regimes and water availability, leaving less water to meet various flowing water and floodplain needs.

Protection, maintenance, and restoration of our ecosystems is needed to enhance resiliency by increasing natural storage capacity, improving instream habitat and fish passage, protecting and restoring wetlands and water instream, eradicating invasive species, protecting native plant communities, and protecting groundwater-dependent ecosystems. Land management activities need to protect and improve water quality, including protecting our watersheds and drinking water sources from contamination and pollution.

Riparian Habitats

Riparian habitat zones are adjacent to flowing water in creeks, rivers, and streams as well as springs, seeps, and terraces. They occur at all elevations, from valley bottom floodplains to alpine torrents, and are shaped through seasonal flooding, scour, and soil deposition.

Floodplains are diverse habitats adjacent to rivers, streams, lakes, estuaries, or other water bodies that are subject to flooding. In their undisturbed, natural state, these areas act to store excess floodwater, which can protect downstream property from flooding, and release water slowly, extending availability. Floodplains also provide essential habitat for fish and wildlife, including refugia from high stream flows and corridors for wildlife.

Riparian zones are the dynamic interface between land and flowing water. The plant assemblages and communities in riparian zones help buffer inputs and the cycling of nutrients, as well as provide habitat for aquatic and terrestrial life. The vegetative composition and structure of riparian zones varies, and is a function of elevation, precipitation pattern, stream gradient, aspect, floodplain width, storage capacity of the soil, groundwater supply, and disturbance (i.e., flooding).

In many areas of the state, native riparian vegetation is comprised mostly of deciduous trees and shrubs, such as big-leaf maple, alders, aspen, cottonwood, dogwood, willows, and Oregon ash. Conifers, such as pines, firs, and spruce, dominate some riparian zones at higher elevations and are important in some lower elevation areas as well (e.g., interior Rogue basin). Riparian shrublands may include willows, red osier dogwood, western birch, hawthorn, alder, and chokecherry. Riparian meadows are dominated by grasses, sedges, and rushes. Riparian habitats provide food, cover, and/or breeding sites for many fish and wildlife species throughout the year.

The Flowing Water and Riparian Key Habitat does not include irrigation structures (e.g., ditches) or other man-made waterbodies such as reservoirs. **Natural lakes** are covered separately, as are **Springs, Seeps, and Headwaters** and **Spring-fed Streams**. The riparian zones around the edges of natural lakes are included within the **Wetlands** Key Habitat.

CONSERVATION OVERVIEW

Flowing water and the riparian habitat found along its banks are defined together as a **Key Habitat** because their distribution and conservation roles are interconnected. Water is crucial for all fish and wildlife, and high-quality freshwater aquatic systems provide essential habitat to many at-risk species, including important spawning and rearing habitat for salmonids, breeding habitat for amphibians, and habitat for freshwater mussels and other invertebrates. Flowing water is important to connect ecosystems across elevations throughout the year. In many locations throughout Oregon, water flow and hydrology have been impacted by development, including barriers (e.g., roads, dams, and culverts) and water diversions for out-of-stream uses that can reduce instream flow, increase summer stream temperatures, and interfere with **fish and wildlife migration**. Channelization and floodplain development can restrict the natural ability of streams to meander over time, limiting the quality and availability of these habitats, as well as affecting floodplain function.

Riparian habitats often have high species diversity and are critical for fish and wildlife, especially for those species that prefer moist shrubby or forested habitats. Riparian habitats can maintain favorable water temperature for fish and provide a cooler temperature refuge for terrestrial species in a warming climate through shading. These areas also provide essential travel corridors for birds, amphibians, reptiles, mammals, and other wildlife. In arid areas, such as the **Blue Mountains** , **Northern Basin and Range**, and **Columbia Plateau** ecoregions, riparian habitats can provide abundant insects, plants, and moisture throughout the year. Riparian meadows include natural spring-seep habitats that are extremely important for a wide variety of species, including **Greater Sage-Grouse**.

In addition to providing habitat for birds and other wildlife, riparian habitats have important ecological functions. Healthy riparian vegetation serves an important role in slowing water velocities during periods of high runoff and protecting streambeds from scouring and downcutting. Riparian vegetation also protects stream banks from erosion, influences in-channel aquatic habitats, filters run off, drives channel complexity in valley bottoms, and provides nutrients to support terrestrial and aquatic life. Riparian habitats often link upland and aquatic habitats, which facilitates the role upland habitats play in watershed function.

Riparian habitats have declined from historical levels and are now greatly reduced in area and connectivity, especially those in low-elevation areas and valley bottoms. Non-native and often invasive vegetation dominates in many areas. Development, logging, roads, agricultural practices, beaver removal, and grazing can further degrade riparian habitat. Removal or reduction of riparian habitat allows runoff containing contaminants such as fertilizers and pesticides to reach streams and rivers where it can negatively impact aquatic life.

[Spotlight] Beaver Habitat and Beaver-Modified Habitat

Beavers are widely distributed across Key Habitats statewide, including Flowing Water & Riparian, Wetlands, and Aspen Woodlands. **Beaver habitat**, or habitat for beaver, is the specific combination of water, food, cover, and space that beaver need to support their survival on the landscape through time. Beaver are semi-aquatic species that require still or slow-moving, perennial water at stable depths for cover, protection from predators, access to food resources, and food storage in the winter. Beavers are slow on land and prefer to forage within 100 feet of their water source. They need sufficient early seral stage stream buffers of deciduous and herbaceous riparian vegetation for food and foraging activities. Beavers are highly territorial and require adequate lateral and longitudinal habitat quality and stability to support their occupancy on the landscape. In rivers and stream networks, one beaver family unit (on average two adults, two sub-adults, and two kits) needs approximately 0.5 to 1.5 linear stream miles for ample space to survive, reproduce, and thrive. **Beaver habitat**, habitat for beaver, supports the building blocks that beaver need to create **beaver-modified habitats**, or habitat by beaver.

Beaver-modified habitat, or habitat by beaver, are the specific conditions beaver create when they alter their terrestrial and aquatic habitat to improve their fitness and survival. Habitat modifications include denning, damming and ponding water, creating canals or side-channels, importing woody and vegetative materials into flowing water and wetlands, and changing the structure of riparian vegetative communities. This suite of habitat modifications and their cumulative effects can provide benefits such as increased complexity and connectivity of Key Habitats and habitat, structure, and refugia for SGCN. Nevertheless, beaver activity can also result in flooding, loss of vegetation, economic loss on working lands, and conflict with private landowners. Actions focused on beaver habitat and beaver-modified habitats should also include efforts to mitigate negative impacts and reduce potential conflicts.

Factors that are currently limiting habitat for beaver include declining surface water availability, altered floodplain disturbance regimes, conversion and loss of wet meadow and wetland habitats, and altered riparian vegetation communities.

Oregon Planning and Regulatory Background for Flowing Waters

Under Oregon law, water is a public resource, meaning that all water belongs to the public. Cities, irrigators, businesses, and other water users must obtain a permit or license from the **Oregon Water Resources Department** (OWRD) to use water from any source whether it is underground, or from lakes or streams, with some exceptions. OWRD is responsible for allocating new uses of water, whether in cities, farms, factories, or for improvement of fish habitat, and follows a careful process to preserve the investments already made in the state.

Oregon's Water Code, established in 1909, created a system of water allocation and distribution that did not consider water for instream uses, leading to degradation of Oregon's flowing water and freshwater habitats. Over time, it became clear that a legal system was needed to protect flows in support of ecological uses. In response, the 1987 Instream Water Rights Act officially recognized instream flows as a beneficial use that could be protected by a water right, giving them the same legal status as consumptive water rights. Instream water rights are the state's mechanism to provide water for fish and wildlife needs and healthy ecosystems that support multiple public uses (e.g., recreation, fishing, tourism). If there is a conflict between users, however, the date of priority determines who may use the available water and most instream water rights are quite junior compared to many out-of-stream water rights.

Oregon's Planning and Regulatory Background for Riparian Habitats

Oregon's planning and regulatory framework provides tools to address riparian habitat conservation issues. Riparian habitat is considered a **Goal 5** resource, where local governments can adopt protective ordinances through comprehensive plans to establish riparian buffers. Streamside buffers implemented through the **Northwest Forest Plan** (NWFP) on public land and the **Oregon Forest Practices Act** on state and private land are designed to protect riparian health in forested landscapes. On agricultural lands, Agricultural Water Quality Management Area Rules and Plans have been adopted across the state to address riparian conditions and other **water quality issues**. While each riparian rule is slightly different depending on the local area, the riparian rules generally require agricultural activities to allow establishment, development, and maintenance of riparian vegetation consistent with site capability to provide moderation of solar heating, filtration of overland flow, and streambank stability. The Oregon Water Resources Department also has rules that require the riparian area to be restored or enhanced if it is disturbed in the process of developing a point of diversion.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Water Quantity

Multiple factors are affecting the amount of water in Flowing Water Habitats. **Water availability** is currently limited in much of the state, especially during the low flow summer and fall months, and this is expected to increase under a changing climate. Riparian bottomland habitats compete for water with other uses, particularly in the Blue Mountains, Columbia Plateau, East Cascades, Klamath Mountain, and Northern Basin and Range ecoregions. Water diversions for out-of-stream uses occur on all major streams, and valley bottoms often have multiple canals that divert water away from the natural channel. As a result, low flows are associated with higher water temperatures and higher nutrient and contaminant concentrations in creeks, streams, and rivers.

Recommended Approach

Conduct instream flow studies to develop ecological flow targets and apply for associated instream water rights. Engage with regulatory agencies to ensure consideration of fish and wildlife needs in water right and hydropower processes. Identify priority locations for voluntary instream transfers and leases and continue to apply for new instream water rights. Implement water conservation actions to protect or increase instream flows (quantity, timing, and duration) following the natural hydrological cycle. Increase pace and scale of voluntary flow restoration through instream leases, transfers, and irrigation efficiency improvements. Manage beaver populations to contribute to water storage and availability, when compatible with existing land uses. Pursue collaborative water planning and implementation processes to secure balanced solutions for water management. Provide incentives and information about water conservation and sharing at key times of low flow conditions (e.g., late summer). Assess riparian habitat condition and consider planting projects to promote shade, which can limit thermal maxima in summer months.

Limiting Factor: Invasive Aquatic Species

Alterations in hydrology can make flowing water habitat more susceptible to invasive plants, invertebrates, and fish. Invasive fish species (e.g. bass, crappie, bluegill, yellow perch, bullhead, carp, brook trout, fat head minnow, non-native ringed crayfish) can compete with native fish and amphibians for food resources and habitat, prey on native species, alter habitat, or hybridize with native fish. For example, non-native carp can overgraze aquatic vegetation and stir up sediment, depriving native fish and amphibians of egg-laying sites or preventing eggs from absorbing enough oxygen to develop. Invasive mollusks (e.g. zebra mussel, quagga mussels) can disrupt food chains by reducing the availability of food for larval and juvenile fishes. They also attach easily to boats, docks and buoys and can clog intake pipes as well as drains. Invasive plants (e.g. ludwigia, watermillfoil, parrot feather, hydrilla) can reduce light penetration, lower species diversity, alter temperature, reduce dissolved oxygen & pH, and disrupt nutrient cycling, leading to algae blooms and toxicity.

Recommended Approach

Restoration and maintenance of historical hydrological regimes ensures that habitat conditions best support native fish and wildlife. Work with community partners to restore flow and water input levels. Continue working with the public to stress the importance of preventative measures for excluding and detecting quagga and zebra mussels from Oregon waterways. Where appropriate, work to minimize predation on sensitive native species. Where non-native aquatic species threaten SGCN, consider site-appropriate tools (e.g., mechanical or chemical treatment) in locations and during seasons where they will not harm native amphibians, fish, or invertebrates. Educate and inform people about the problems that can be caused by invasive species, including the harm of releasing aquarium fish or nonnative fish into our rivers or dumping nonnative aquarium plants in waterbodies and the importance of having boats cleaned before moving to a different waterbody.

Limiting Factor: Passage Barriers and Channel Complexity

Fish and wildlife depend on natural flow regimes and substrates for breeding, foraging, cover, and migration. Channel complexity is important for fish and wildlife. For example, woody debris and other natural structures provide nutrient cycling and refugia from predators and high temperatures. Dams, road culverts, or other human-made barriers can restrict movement of fish and wildlife, alter or affect instream flow, and restrict bedload movement and the fluvial processes necessary to create the types of riparian and stream habitats to which native species are adapted. The large dams disrupt natural hydrologic regimes, which decreases the amount of bottomland habitat, and impacts anadromous and other migratory fish passage upstream and downstream. Additionally, altered flow regimes can contribute to higher temperatures in some streams, making habitat inhospitable.

Misaligned culverts with the downstream end above the water level disconnect stream passage corridors, block fish passage, and may force wildlife to cross over roads where they are vulnerable to vehicles and predators. Undersized or improperly sized culverts can alter the transport of sediment and wood, creating an uneven distribution of instream habitat.

Recommended Approach

Work with landowners and regulatory agencies to protect and restore natural flow and channel conditions on streams impacted by barriers. **Eliminate passage barriers** or improve passage at existing barriers to provide travel corridors for fish and wildlife. Design future projects with appropriately sized culverts to accommodate adaptation to modeled hydrologic regimes with climate change. Replace culverts or other passage barriers with structures that mimic natural conditions as closely as possible (e.g., bridges or open-bottom arch culverts). Provide additional passage structures for fish and wildlife at culverts. Provide sufficient channel complexity to maintain ecological benefits for fish and wildlife.

Limiting Factor: Pollution

Point and non-point source pollution are of concern in both rural and urban areas. Non-point source pollution in flowing waters and adjacent floodplains can contain fertilizers, pesticides, or oil-based pollutants at levels high enough to cause significant lethal or sub-lethal effects in native fish and wildlife. Point source pollution from industrial, domestic, and stormwater treatment may contain high levels of contaminants. High concentrations of livestock in or near streams can degrade water quality through excessive nutrient input and may also contaminate water with bacteria. Agricultural runoff from irrigated fields also increases nutrients in streams and carries pesticides from treated fields into flowing waterways. High nutrient concentrations in streams can cause anoxic conditions, excessive aquatic vegetation, and harmful algae blooms. Pesticides in flowing waterways have the potential to damage all forms of aquatic life and may accumulate in the tissue of fish and waterfowl consumed by other wildlife and humans.

Recommended Approach

Increase awareness of the impacts of urban and rural runoff. Treat stormwater runoff that flows directly into streams to address tire-wear particles and their associated contaminants (e.g. 6PPD-q), an emerging concern in the Pacific Northwest. Reduce stormwater runoff and increase permeability in urban areas with bioswales. Use stormwater catchment basins designed for larger volume, longer residence, and a high degree of shading to mimic the delay, treatment, infiltration, and cooling functions of natural wetlands. Reduce sewage overflows during major rain events where raw sewage is discharged directly into streams. Increase awareness and manage timing of pesticide applications that have the potential to harm aquatic communities. Improve compliance with water quality standards and pesticide use labels administered by the **DEQ** and **U.S. Environmental Protection Agency (EPA)**. Reduce water pollution from agricultural sources and improve watershed conditions throughout the state through implementation of ODA rules and **DEQ Total Maximum Daily Load** water quality plans. Establish riparian buffer zones along streams adjacent to livestock feeding operations and farmland. Improve efficiency of irrigation systems to reduce agricultural runoff and increase instream flow. Increase interaction of rivers and floodplains. Encourage opportunities for restoration of “fringe” wetlands and channel meander to increase water storage. During restoration, remove pipes and provide stream channels to promote flow, nutrient, and oxygen exchange. Where possible, provide sufficient room to **restore meanders and other functions**.

Limiting Factor: Water Temperature

High water temperatures, particularly summer stream temperatures, are a major threat to self-sustaining populations of native species and can severely limit population viability for Oregon’s native anadromous and cold-water species. Aquatic animals have specific requirements for a tolerable temperature range. Moreover, warmer water holds less dissolved oxygen, resulting in hypoxic conditions, especially during seasonal low flows. Hypoxia, which refers to low or depleted oxygen in a water body, may be lethal to organisms that extract oxygen from water, such as fish and amphibians. Water temperature may become too warm for native aquatic life because of alterations in stream flow, thermal pollution, or reduced riparian shading, especially during seasonal low flows. This threat to native species is likely to increase with predicted regional climate change effects that include prolonged droughts, higher air temperatures, lower snowpack, and shifts in timing of rainfall and snowmelt.

Recommended Approach

Maintain or increase native riparian habitat cover to provide shading and other benefits. Maintain and restore in-stream flow to help preserve favorable water temperatures (KCI: **Water Quality and Quantity**). Advance real-time water temperature monitoring and forecasting techniques and conduct monitoring in priority areas. Identify and protect cold-water resources and refugia. Minimize release of unnaturally warm water from dams and reservoirs when instream temperatures are high by altering intake/release structures and management.

Limiting Factor: Sedimentation

Sediment flows into streams from natural processes; however, it is exacerbated through human activities. Deposition of fine sediment in gravel-bottom rivers and streams fills the interstices of the gravel, reduces the velocity of water flow through the gravel, and decreases the dissolved oxygen content. An excess of fine sediments can cover eggs of native fish and amphibians, reduce cover and protection from predators, and create adverse physical conditions. Salmonids such as salmon and trout rely on clean gravel to build redds. When fine sediment fills the spaces between gravel it prevents water from flowing through redds and oxygenating trout and salmon eggs, which reduces egg survival. In more severe cases, sediment fills the spaces between gravel and can harden the streambed rendering it unusable to spawning salmonids. Sediment can also bury aquatic mollusks and freshwater mussels. Aquatic insects rely on interstitial spaces between boulders, cobble, and gravel and many feed on periphyton that grows on these hard substrates. When sediment fills the spaces between large substrate or covers it completely, this habitat is lost, and streams can no longer support the invertebrate communities that feed fish and other wildlife.

Recommended Approach

Reduce run-off of fine sediment from logging, agriculture, grazing, roads, and other activities that could disturb soil or destabilize streambanks. Implement strategies and best management practices to reduce sedimentation including filtering run-off before it enters aquatic systems, decommissioning roads, installing green infrastructure, terracing fields, installing sediment control basins to reduce erosion, planting cover crops, and practicing conservation tillage. When constructing new roads, consider sediment removal capabilities in road design. Maintain and restore native riparian and wetland vegetation to filter sediments. Utilize large wood instream to improve stream channel complexity by increasing sediment retention, creating gravel bottom habitat, and promoting the formation of pool habitat.

Limiting Factor: Loss of Riparian Habitat, Floodplain Function, and Habitat Complexity

A large percentage of Oregon’s low-elevation and valley bottom riparian habitats have been altered or lost. Riparian habitat is often cleared, diked and converted into developed land, including urban areas, agricultural fields, or grazing pastures. Extensive removal of riparian habitat can lead to altered hydrological regimes, warmer water temperatures, erosion promoting downcutting or widening of stream banks, and loss of habitat complexity as floodplains and side channels become disconnected from streams. This loss of floodplain connectivity is a key limiting factor for nearly all listed anadromous fish species and many wildlife species. In addition, the increases in stream temperatures as a result of depleted riparian habitat often provide ideal habitat for non-native species (e.g., game fish such as bass), allowing the non-native species to thrive and out compete native cold-water salmon and steelhead. Development within historical floodplains can restrict the natural ability of streams and riparian habitats to meander, limiting the creation and maintenance of new aquatic and riparian habitats. Lack of channel forming and flushing flows resulting from flood control efforts have also reduced floodplain processes, habitat creation, and habitat complexity. Developed floodplains are less effective in storing water and slowly releasing it back into the streams, filtering sediment and pollutants from surface water, and providing habitat for fish and wildlife. Losses of riparian habitat complexity and connectivity limit the value of these important places for wildlife to meet crucial life history needs.

Recommended Approach

Enhance or restore the extent and connectivity of existing riparian habitats. Promote lateral connectivity of the floodplain to off and side channel habitat. Use voluntary cooperative efforts and incentive programs (e.g., Conservation Reserve Enhancement Program, Riparian Lands Tax Incentive Program) to conserve, maintain, and restore riparian habitats on private lands. Identify and apply lessons learned from successful riparian restoration efforts on private lands to guide future projects. Develop tools and financial incentives to assist landowners with erosion prevention, as well as riparian area and streambank management best management practices. Provide outreach and education on the functions of riparian habitat and best management practices for landowners. This may include coordination with local governments on implementing Goal 5 protections and ODA for Agricultural Water Quality Management Area Plans.

Maintain and restore riparian buffers and minimize impacts from development actions. Close and revegetate unused roads on public lands. Support and encourage beaver occupancy and their canal and dam building activities, where possible, to restore floodplain-riparian processes and function when compatible with existing land uses.

Maintain channel integrity and natural hydrology. Ensure that adequate native riparian vegetation remains following management activities to prevent erosion, preserve water quality, and maintain water temperatures favorable for aquatic life. Restore lost vegetation through planting of native trees, shrubs, and ground cover. Manage for future sources of large woody debris. Maintain and/or expand existing tracts of large trees, such as cottonwoods, to benefit riparian habitat function.

Limiting Factor: Riparian Habitat Degradation

In the Blue Mountains, Northern Basin and Range, East Cascades, and Columbia Plateau ecoregions, historical overgrazing has led to soil erosion, poor regeneration of hardwood trees and shrubs, changes in plant species composition and structure, and degradation by invasive plants. Although some areas are slowly recovering, many miles of stream are still lacking adequate riparian vegetation. Ongoing grazing impacts remain in some areas, especially at low and mid elevations. Western juniper is encroaching in some riparian areas of eastern Oregon.

Recommended Approach

In cooperation with landowners, land managers, and grazing lessees, encourage approaches such as off-site watering or active management that keep livestock out of riparian areas. Develop and implement grazing regimes that are compatible with riparian conservation objectives. Selectively fence restoration sites or other high priority areas to exclude ungulates. Evaluate impacts by encroaching western juniper and remove juniper from upper reaches of higher elevation watersheds, if appropriate. Plant riparian vegetation using native species at priority sites. Work with landowners and grazing permittees to support riparian conservation and land management objectives.

Limiting Factor: Invasive Plants in Riparian Habitat

Invasive plants, such as knapweeds, knotweeds, reed canary grass, Himalayan blackberry, thistles, poison hemlock, and teasels, degrade riparian habitats by competing with and replacing native plants. In the Columbia Plateau and Northern Basin and Range ecoregions, pasture grasses and cheatgrass commonly dominate the understory. Invasive plants can alter the structure of riparian habitats, creating dense monocultures that hinder the growth of native vegetation and changing the physical structure of the streambank. They often provide insufficient food and habitat resources, displacing fish and wildlife and reducing biodiversity.

Recommended Approach

Control key invasive plants using site-appropriate tools, including fire and mechanical, biological, and chemical treatments. Use chemical treatments carefully and where compatible with water quality concerns, focusing on spot treatment during the dry season.

Partner with Soil and Water Conservation Districts or other experts to control invasive weeds and restore riparian habitats. In the Columbia Plateau and Northern Basin and Range ecoregions, focus control at low-elevation sites. Provide information to local governments and landowners about potential invasive plants. Where necessary, develop and implement grazing management regimes that are compatible with riparian conservation objectives. Replace invasive plants with local native species so there is no net loss of wildlife habitat in the long term.

RESOURCES FOR MORE INFORMATION

OWEB's Field and Technical Guides Webpage (several guides to inform restoration and monitoring including Low Tech Process Based Restoration): https://www.oregon.gov/oweb/resources/Pages/Field-Tech-Guidance.aspx

Oregon Riparian Assessment Framework

DEQ's resources for volunteer water quality monitoring: https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Volunteer.aspx

Oregon Water Resources Department's Water Conservation Tools

ODFW Water Program Priorities

ODA Agricultural Water Quality Plans and TMDL Implementation Plans

ODEQ Total Maximum Daily Loads

Beaver Created Refugia from Wildfire

GRASSLANDS

Grasslands include a variety of upland grass-dominated habitats, such as upland prairies, coastal bluffs, and montane grasslands.

ECOREGIONS

Grasslands are a Key Habitat in the **Blue Mountains**, **Coast Range**, **Columbia Plateau**, **Klamath Mountains**, **West Cascades**, and **Willamette Valley** ecoregions. Additional grassland habitats, such as alkali grasslands, perennial bunchgrasses, and montane grasslands, can also be found in **Specialized and Local Habitats**.

CHARACTERISTICS

Grasslands generally occur on dry slopes or plateaus with well-drained sandy or loamy soils. Although species vary across Oregon, perennial bunchgrasses and forbs dominate native grasslands. In some areas, grasslands are similar to wet prairies and wet meadows in structure and share some of the same prairie-associated plants and animals (wet prairies and wet meadows are included within the **Wetlands Key Habitat**). In all but the shallowest rocky soils, grasslands are maintained through disturbances, such as periodic fire, soil upheaval by rodents, frost heave, wind, or salt spray, and by humans through prescribed fire, grazing, and mowing.

ECOREGIONAL CHARACTERISTICS

Blue Mountains

Bunchgrass grasslands occur primarily in the northeastern portion of the ecoregion, although other grassy habitats occur throughout the ecoregion. At low elevations, semi-desert grasslands are dominated by drought-resistant perennial bunchgrasses, such as needle-and-thread, dropseed, threeawn, and muhly, and may have scattered shrubs. Mid-elevation plateau grasslands include extensive bunchgrass prairies of Idaho fescue, junegrass, and bluebunch wheatgrass. At high elevations, ridgetop balds and alpine parks are dominated by green or mountain fescue, needlegrass, and/or bluegrass species. High-elevation grasslands often are on south-facing slopes surrounded by subalpine conifer woodlands. There are several important grassland sites currently being managed for wildlife and habitat conservation. The Zumwalt Prairie Preserve in northeast Oregon protects native bunchgrass prairie, with a portion of the reserve designated as a National Natural Landmark.

Coast Range

Coastal bluff and montane grasslands are dominated by low-growing vegetation, such as perennial bunchgrasses, forbs, mosses, and dwarf shrubs. They occur within a matrix of conifer forests. In forested ecoregions, such as the Coast Range and West Cascades, grasslands are particularly important for rare plants and invertebrates. Outer coastal bluffs and headlands are influenced by wind and salt spray, which limit the growth of woody vegetation. Montane grasslands include dry meadows and balds and occur on dry, south- or west-facing slopes with shallow sandy or gravelly soils. They are primarily influenced by periodic fire, soil upheaval by rodents, and drought conditions.

Columbia Plateau

Grasslands include river terrace grasslands, prairies, canyon slopes, and rocky ridges. At low and mid elevations, semi-desert grasslands are dominated by drought-resistant perennial bunchgrasses, such as needle-and-thread, dropseed, threeawn, and muhly, and may have scattered shrubs. Palouse grasslands once dominated most uplands above 1,000 feet in elevation. Palouse grasslands now occur in flat areas with deep soils and are dominated by bluebunch wheatgrass, Idaho fescue, and other grasses and forbs. Canyon and foothill grasslands are found on the steeper, rocky slopes surrounding the major rivers in this region and are dominated by bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, balsamroot, and other forbs.

Klamath Mountains

Grasslands in the Klamath Mountains are very diverse. They can be found on valley bottoms, and include mounded prairie often associated with vernal pools (upper Rogue Valley and Agate Desert). Dry meadow grasslands and balds occur on south and west facing mid elevation slopes of the Rogue and Umpqua basins, often in a mosaic with chapparal and oak savanna. Oak savannas are grasslands with scattered trees that are usually large with well-developed limbs and canopies. The diversity of grasslands also includes the open serpentine barrens (such as in the Illinois watershed and eastern portions of the Kalmiopsis Wilderness), and in high mountain meadows and glades of the Siskiyou mountains which are a coastal sub-range of the Klamath mountains near the Oregon/California border. The Cascade Siskiyou national monument in the southern range of the Klamath Mountains ecoregion has remaining grasslands comprised of bunchgrasses.

West Cascades

Montane grasslands include open dry meadows, grasslands, and balds. Montane grassland habitats occur in a matrix of mixed conifer forests and woodlands. Mid- and high-elevation dry meadows tend to have deeper and better-drained soils than the surrounding forests and are dominated by grasses and wildflowers, such as Roemer's fescue, alpine or western fescue, California brome, timber oatgrass, broadleaf lupine, and beargrass. Balds and bluffs generally occur on south- to west-facing slopes on shallow, well-drained soils and are dominated by bunchgrasses, forbs, and mosses.

Willamette Valley

Grasslands, also called upland prairies, are dominated by grasses, forbs, and wildflowers. Grasslands have well-drained soils and often occur on dry slopes. Willamette Valley grasslands were historically maintained by cultural burning practices. Some of the primary species include Roemer's fescue, tufted hairgrass and culturally significant species like camas, brodiaea, and madia. They are similar to wet prairies in structure and share some of the same prairie-associated plants and animals (wet prairies are included within the **Wetlands Key Habitat**). Oak savannas are grasslands with scattered Oregon white oak trees, generally only one to five trees per acre (denser oak stands are included in the **Oak Habitats**). Oak trees in savannas are usually large with well-developed limbs and canopies.

CONSERVATION OVERVIEW

As a whole, native grasslands are one of the most imperiled habitats in the western United States and are disappearing rapidly around the globe. In Oregon, the estimated loss of grasslands ranges from 50 percent to more than 90 percent, depending on the ecoregion. Compared to historical grassland distributions, grassland loss has been extremely high in in valley bottoms and foothills in the Coast Range, West Cascades, and Willamette Valley ecoregions. These historical grasslands have been impacted by conversion to agriculture, development, succession to forested habitats, and invasive plant species. The deep soils and moderate climates of many grassland habitats make them especially valuable for agricultural land uses such as crop, hay, or pasture lands. Areas with deep soil were disproportionately lost to agricultural cultivation while areas with shallower soils were more likely to experience intensive grazing. Chronic grazing has impacted grasslands, affecting plant composition and structure. Also, non-native species were historically seeded for livestock forage in some grasslands, decreasing the abundance and diversity of native plants. However, grazing practices have become more sustainable over time, and carefully managed grazing can help to maintain grassland structure where prescribed fire is not practical or desired. Disruption of historical fire regimes has allowed for shrubs or trees to encroach, replacing grasslands with forest. In addition, some foothill grasslands have been converted to forests through tree planting.

As human population growth increases, urbanization may present a significant challenge for grassland habitats. While agricultural areas may still mimic some grassland structure and function and retain some value for wildlife, development and urbanization results in the direct loss of habitat and habitat fragmentation.

Species of Greatest Conservation Need (SGCN) associated with grasslands vary by ecoregion but include the: **Burrowing Owl**, **Common Nighthawk**, **Grasshopper**

Sparrow, **Long-billed Curlew**, **Ferruginous Hawk**, **Oregon Vesper Sparrow**, **Streaked Horned Lark**, **Western Bluebird**, **Western Meadowlark**, **Fender's blue butterfly**, **hoary elfin butterfly**, **Kincaid's lupine**, **Oregon silverspot butterfly**, **Taylor's checkerspot butterfly**, **Coast Range fawn lily**, **Cascade Head catchfly**, **Lawrence's milkvetch**, **Spalding's campion**, and **Tygh Valley milkvetch**.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Altered Fire Regimes

At sites with deep soils, maintenance of grasslands is dependent, in part, on periodic fire. Fire suppression has led to encroachment by shrubs and conifer trees in some areas and has aided in an increase in fuel loads, which can lead to high-intensity wildfires. The introduction and rapid spread of cheatgrass and other non-native grasses throughout eastern Oregon can increase the frequency, intensity, and spread of fires. In the Willamette valley in particular, grasslands and the species that inhabit them, are dependent on managed fire due to coevolution with cultural burning practices. In the Coast Range, prescribed fire is difficult due to high precipitation and wet conditions. When conditions are dry enough to use prescribed fire, there may be concerns about risk to surrounding forests. In the Klamath Mountains and Willamette Valley, prescribed fire poses challenges, such as conflicts with surrounding land use, smoke management and air quality, and safety.

Recommended Approach

Maintain open grassland structure by using multiple site-appropriate tools, such as prescribed burns, mowing, controlled grazing, hand-removal of encroaching shrubs and trees, or thinning. Re-introduce fire at locations and at times where conflicts, such as smoke and safety concerns, can be minimized. Work with partners to update smoke management and air quality standards to allow more fall, winter, and spring burn windows. For all tools, minimize ground disturbance and impacts to native species. Minimize the spread of cheatgrass. Carefully manage livestock grazing to maintain native plants and soil crust (cryptogrammic crust). Control fires in cheatgrass-dominated areas.
(KCI: **Disruption of Disturbance Regimes**)

Limiting Factor: Invasive Species

Invasive plants have degraded grassland habitats, displacing native plants and animals. Some intentionally planted non-native species, such as crested wheatgrass, are highly competitive with native bunchgrasses and, once established, limit the growth and establishment of native plants. Depending on the area, invasive species include cheatgrass, medusahead, ventenata, rush skeleton weed, spikeweed, Hungarian brome, yellow star-thistle, knapweeds (diffuse, spotted, and purple), leafy spurge, Canada thistle, St. John's wort, tansy ragwort, Armenian (Himalayan) blackberry, evergreen blackberry, Scotch broom, false-brome, Harding grass, and tall oatgrass. Many low-elevation grasslands are almost entirely dominated by invasive grasses, forbs, and shrubs. In the Blue Mountains and the Columbia Plateau, juniper encroachment has displaced grasslands in many areas. Disturbed sites are especially prone to invasive species establishment.

Recommended Approach

Identify remaining native grasslands and work with landowners to maintain quality and limit the spread of invasive species. Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. To control encroaching junipers, use mastication, cut and pile, lop and scatter, or cutting for firewood. Develop markets for small juniper trees as a special forest product to reduce restoration costs. Prioritize control efforts and use site-appropriate methods to control newly established invasive plant species for which management can be most effective. Promote the development of additional native seed resources. Re-seed with site-appropriate native grasses and forbs after control efforts. Conduct research to determine methods to manage established species, such as cheatgrass, medusahead, Hungarian brome, and annual ryegrass. Where appropriate, manage livestock grazing and recreational use, especially motorized use, to minimize new introductions. Support current prevention programs, such as weed-free hay certification (KCI: **Invasive Species**). Clean vehicles and other equipment when relocating between sites where invasive species are present. Establish and implement management plans for all soil-disturbing activities.

Limiting Factor: Land Use Conversion

Remnant grasslands are subject to conversion to agricultural, residential, urban, energy, and infrastructure uses. Grasslands are frequently converted into croplands or pasturelands because of their deep soils and high productivity. The expansion of cities and towns often includes converting grasslands into urban and rural residential areas and associated infrastructure. The conversion of grasslands into other land uses results in habitat loss and fragmentation, degradation of ecosystem services, such as carbon sequestration, and biodiversity loss.

Recommended Approach

Because many of these areas are privately-owned, **voluntary cooperative approaches** are the key to long-term conservation. Important tools include financial incentives, technical assistance, regulatory assurance agreements, and conservation easements. Use and extend existing incentive programs, such as the Conservation Reserve Program and Grassland Reserve Program, to conserve, manage, and restore grasslands and to encourage no-till and other compatible farming practices. Support and implement existing **land use regulations** to preserve natural habitats. Use a landscape approach in conservation plans and incentive programs to create large, contiguous blocks of grassland habitat by expanding buffers around key grassland sites. Connect grassland habitats, such as fallow fields, pastures, and natural meadows, to create contiguous grassland habitat and improve connectivity between patches.

Limiting Factor: Land Management Conflicts

Resource conflicts can arise because high quality grasslands are often high-quality grazing resources. Although grazing can be compatible with conservation goals, it needs to be managed carefully because Oregon's bunchgrass habitats are more sensitive to grazing than the sod-forming grasses of the mid-western prairies. Overgrazing can lead to soil erosion, degradation of biological soil crusts, changes in plant species composition and structure, and establishment of invasive plants. Agricultural management practices, such as mowing, haying, burning, and herbicide/insecticide application, can be detrimental to grassland species.

Recommended Approach

Use incentive programs and other voluntary approaches to manage and restore grasslands on private lands. Manage public land grazing to maintain grasslands in good condition. Conduct research and develop incentives to determine grazing regimes that are compatible with a variety of conservation goals. Restore native grassland habitat when possible, removing woody growth and invasive weeds to create a mosaic of clumped vegetation, bare ground, and a mixture of grasses and forbs with a variety of heights. Promote use of native plants and seed sources in conservation and restoration programs. Promote operation of grassland management practices (e.g., mowing, haying, burning, and herbicide application) to outside of the primary breeding season for grassland-associated wildlife (roughly April-August).

Limiting Factor: Loss of Oak Savannas

In the Klamath Mountains and Willamette Valley ecoregions, large-diameter oak trees with lateral limb structure and cavities continue to be lost. **Oak Habitats** complement grassland habitat and should be maintained. Many native wildlife species utilize large-diameter oaks for nesting, feeding, and shelter. Prior to European settlement, cultural burning practices helped to maintain the open structure of widely spaced, large-crowned trees with an understory of perennial native grasses and forbs.

Recommended Approach

Maintain large oaks, remove competing conifers or densely stocked small oaks, and create snags to provide cavity habitat. Management practices like prescribed fires, controlled grazing, or mowing can maintain oak savanna conditions and help to control invasive species and encroaching woody vegetation.

HABITAT CHANGE TRENDS ANALYSIS

To investigate juniper encroachment into grassland and sagebrush habitats, the Institute of Natural Resources (INR) compared the total area and spatial overlap of vegetation classes in three baseline maps (1851-1937,1998, 2016). The analysis showed significant increases in the total area of Juniper Woodlands and corresponding losses of Grassland habitats to juniper encroachment. By 2016, the total area of Juniper Woodlands had increased by 115% when compared to historical data, largely replacing Sagebrush and Grassland habitats. An estimated 15% of Grassland habitats were lost to juniper encroachment between 1851 and 1998. This analysis also showed that significant efforts by land managers and agencies, such as the BLM and Forest Service, to remove juniper have slowed encroachment in grassland habitats in recent years.

To address concerns regarding annual grass invasion of both Grassland and Sagebrush Habitats, INR conducted an analysis using the Rangeland Analysis Platform (RAP) annual vegetation cover maps to track the total area that is dominated by annual grasses in Oregon in 1986, 2001, 2016, and 2023. The analysis documented significant increases in annual-dominated vegetation since 1986. By 2001, the total area of annual-dominated vegetation increased by 118%. Between 2001 and 2016, the total area of annual-dominated vegetation increased by an additional 69%. In all years, annual-dominated vegetation was mostly found in the grassland and sagebrush habitats of southeast Oregon and in the Columbia Basin ecoregion.

RESOURCES FOR MORE INFORMATION

Prairie Vegetation Monitoring Protocol for the North Coast and Cascades Network

The Willamette Valley Landowner’s Guide to Creating Habitat for Grassland Birds

Partners in Flight Conservation Strategy for Landbirds in Lowlands and Valleys of Western Oregon and Washington

Benton County Prairie Species Habitat Conservation Plan

Cascadia Prairie-Oak Partnership

Restoring Oak Habitats in Southern Oregon and North California: A Guide for Private Landowners

Patterns of Vegetation Change in Grasslands, Shrublands, and Woodlands of Southwest Oregon

REFERENCES

Allred, B.W., B.T. Bestelmeyer, C.S. Boyd, C. Brown, K.W. Davies, M.C. Duniway, L.M. Ellsworth, T.A. Erickson, S.D. Fuhlendorf, T.V. Griffiths, V. Jansen, M.O. Jones, J. Karl, A. Knight, J.D. Maestas, J.J. Maynard, S.E. McCord, D.E. Naugle, H.D. Starns, D. Twidwell, and D.R. Uden. 2021. Improving Landsat predictions of rangeland fractional cover with multitask learning and uncertainty. Methods in Ecology and Evolution.

Brunner, R. and E. Gaines. 2025. Oregon Vegetation Change 1851-2023. Trends analysis conducted for Oregon Department of Fish and Wildlife. Institute for Natural Resources, Portland State University, Portland, OR, USA.

LATE SUCCESSIONAL MIXED CONIFER FORESTS

Late successional mixed conifer forests provide a multi-layered tree canopy, including large-diameter trees, shade-tolerant tree species in the understory, and a high volume of dead wood, such as snags and logs.

ECOREGIONS

Late successional mixed conifer forests are a Key Habitat in the **Blue Mountains**, **Coast Range**, **East Cascades**, **Klamath Mountains**, and **West Cascades** ecoregions.

CHARACTERISTICS

Late successional mixed conifer forests are defined by plant species composition, overstory tree age and size, and the forest structure. While a range of tree ages are present in late successional forests, the predominant stand age is over 150 years. They include characteristics such as a multi-layered tree canopy, shade-tolerant tree species growing in the understory, large-diameter trees, and a high volume of dead wood, such as snags and logs. These characteristics can take hundreds of years without stand replacing disturbance to develop. Historically, fire was the major natural disturbance in all but the wettest areas. Depending on local conditions, fires in the Coast Range and West Cascades conifer forests were of moderate- to high-severity, with fire return intervals averaging 100 to more than 400 years. These stand replacing events were interspersed with periodic low severity understory burns every 15 to 30 years. This historical fire regime created a complex mosaic of stand structures across the landscape.

ECOREGIONAL CHARACTERISTICS

Blue Mountains

A mixture of conifer species is found throughout many forest sites in the Blue Mountains ecoregion. Mixed conifer forests can be divided in two subtypes based on temperature and moisture conditions. Douglas-fir and grand fir are the primary late successional tree species in the warmer drier climates of this ecoregion. Ponderosa pine and western larch may also be present. The cool mixed conifer type is indicated by the addition of more moisture-demanding and cold-tolerant species, such as subalpine fir and Engelmann spruce, at upper elevations or along streams where cold water-drainage and deep frost eliminate some species. The understory in this ecoregion generally includes huckleberry, serviceberry, oceanspray, snowberry, wild ginger, goldthread, starflower, bead lily, and oak fern.

Coast Range

Late successional mixed conifer forests in the Coast Range are generally dominated by two types of conifer trees: Sitka spruce and Douglas-fir. Sitka spruce forests occur within a narrow fog- and salt-influenced strip along the coast and extend into some valleys. Soils tend to be deep, acidic, and well-drained. Sitka spruce dominates the overstory, but western hemlock, western redcedar, Douglas-fir, big leaf maple, and red alder may be present. The lush understory has salmonberry, vine maple, salal, evergreen huckleberry, sword fern, deer fern, and a high diversity of mosses and lichens. Inland, Douglas-fir forests dominate. The understory of Douglas-fir forests includes shrub and forb species, such as vine maple, salal, sword fern, Cascade Oregon grape, western rhododendron, huckleberries, twinflower, vanilla leaf, and oxalis. Due to high precipitation in both Sitka spruce and Douglas-fir forests, fires are infrequent but do occur during hot, dry, east wind conditions after prolonged drought. When fires do occur, they are likely to be high severity, stand-replacing events. Other disturbances include small-scale windthrow events and floods driven by atmospheric river storms.

East Cascades

Late successional mixed conifer forests span the eastern slopes of the Cascade Mountains. This habitat contains a wide variety of tree species with Douglas-fir, grand fir, and western hemlock as the most common forest tree species that co-dominate most overstories. Several other conifers may also be present, including western redcedar, western white pine, western larch, ponderosa pine, and lodgepole pine. Undergrowth vegetation in the East Cascades ecoregion includes vine maple, Oregon grape, huckleberry, oxalis, thimbleberry, manzanita, ceanothus, and twinflower. Many sites once dominated by Douglas-fir and ponderosa pine (formerly maintained by wildfire) may now be dominated by grand fir (a fire sensitive, shade-tolerant species).

Klamath Mountains

Late successional mixed conifer forests in the Klamath Mountains ecoregion are characterized by high tree diversity. Douglas-fir is usually dominant. Depending on site characteristics, other canopy trees may include white fir, sugar pine, ponderosa pine, and incense cedar. Port-Orford cedar occurs on moist sites, such as riparian areas. Jeffrey pine and knobcone pine occur on serpentine soils. Broadleaf trees, such as tanoak, canyon live oak, golden chinquapin, big leaf and vine maple, and Pacific madrone, may occur in the subcanopy. A range of understory communities may be present, including those mostly dominated by shrubs, forbs, or grasses, or may be relatively open. However, with an increase in frequency of droughts, high instances of Douglas-fir mortality in the Klamath Mountains is quickly shifting the composition of these forests, creating conditions that result in catastrophic wildfires.

West Cascades

Late successional mixed conifer forests are found scattered throughout the **West Cascades Ecoregion**. While Douglas -fir dominates these forests, western hemlock is almost always co-dominant and usually dominates the understory. In the absence of stand replacing disturbance, Douglas-fir forests eventually convert to western hemlock. Other common trees include grand fir and western redcedar in the northern portion of the ecoregion, or incense cedar, sugar pine, white fir, and western redcedar in the southern portion of the ecoregion. The understory has shrub and forb species, such as vine maple, salal, sword fern, Cascade Oregon grape, western rhododendron, huckleberries, twinflower, vanilla leaf, and oxalis.

CONSERVATION OVERVIEW

Since the 1850s, both timber harvest and large-scale fires have replaced many of the late successional forests in Oregon with younger forests. Many of the remaining late successional forests occur in a patchwork with the younger forests that are managed with shorter rotations to generate timber products. While a mosaic of forest age classes contributes to landscape-scale diversity, many species associated with late-successional forests require large patches of older or mature forests to survive and may be sensitive to changes in the forest seral stage.

The Northwest Forest Plan (**NWFP**) is a comprehensive natural resource planning effort that includes all or part of the Siuslaw, Rogue River-Siskiyou. Mt. Hood, Willamette, Deschutes, Umpqua, and Fremont Winema National Forests in Oregon. The NWFP identifies conservation priorities for species affected by loss and fragmentation of large patches of late successional forests, assessing over 1,000 species. Late Successional Reserves established under the NWFP are intended to ensure enough high-quality habitat to sustain identified species. However, many of the federal lands that are designated as Late Successional Reserves do not include forests at the late successional stage, while others are relatively small “checkerboards” of forests embedded in a matrix of private industrial timber lands, particularly in the Coast Range and Klamath Mountains. From 1994 until 2020, there was an increase in the acres of late successional stage forest in the NWFP area. However, in 2020, wildland fires driven by strong east winds in the Mt. Hood, Willamette, Umpqua, and Rogue Siskiyou National Forests destroyed many acres of late successional forest. While the 2020 fires were a setback, the gains of 1994 to 2020 demonstrated that the NWFP can successfully increase late successional mixed conifer forests over time.

The US Forest Service’s Wildfire Crisis Strategy Implementation Plan and Oregon Department of Forestry’s 20 Year Landscape Resiliency Strategy are examples of federal and state efforts to address uncharacteristic wildland fire behavior in Oregon’s forests. These plans address historical fire suppression, exclusion of cultural burning practices, and the impacts of recent catastrophic and uncharacteristic wildfires by recommending a variety of active management techniques for forests to increase forest resiliency to wildland fire.

The Northwest and Southwest State Forest Management Plans provide management direction for all Board of Forestry Land and Common School Forest Lands. The plans include management strategies for 16 resources, including fish and wildlife, timber, recreation, and water resources. The plans describe long-term desired future conditions, which include older forest structure.

The Private Forest Accord (PFA) is a compromise agreement made between representatives from Oregon's timber industry, the Oregon Small Woodlands Association, and prominent conservation and fishing organizations, to modify portions of Oregon's forest practice laws and regulations in a way that expands protections for fish and amphibians. The changes to the Oregon Forest Practices Act are aimed to avoid and minimize the effects that timber harvests and other forest management activities on private forestlands have on these species and the aquatic habitats they depend on. The PFA included new standards for stream classification and protection or stream buffers, steep slopes, roads, and culverts, as well as a grant program to fund riparian and stream habitat restoration projects. These standards may also help to restore some late successional mixed conifer forests located in riparian areas adjacent to streams.

In the southwest Cascades, white firs in overstocked stands are often full of disease, creating a buildup of fuels and putting large ponderosa pines at risk for severe wildfire. These ladder fuels are a product of fire suppression, exclusion of cultural burning practices, and past logging practices. Removing these patches of will help create more early seral openings for the benefits of deer and elk and provide a greater mosaic of habitats across the landscape.

Late successional mixed conifer forests are particularly important for wildlife, mosses, and lichens. Depending on the ecoregion, **Species of Greatest Conservation Need** associated with late successional conifer forests include **ringtail**, **fisher**, **Pacific marten**, **red tree vole**, **Marbled Murrelet**, **Northern Spotted Owl**, **Oregon slender salamander**, and many others.

[Spotlight] Pileated Woodpecker

The forest's engineer in the Pacific Northwest

The Pileated Woodpecker plays a vital role in the health and biodiversity of the Pacific Northwest's mature forests. As the largest woodpecker in the region, it is an ecological powerhouse that helps shape the forest around it.

Pileated Woodpeckers are expert excavators, carving out large rectangular holes in old decaying trees to find food and create cavities for nests and roosts. This in turn can create habitat for secondary cavity nesters/roosters like Pacific marten, Flammulated Owls, silver-haired bats, of Vaux's Swifts. For many species, availability of cavities for nesting and roosting is a limiting factor.

Additional impacts of Pileated Woodpecker activity include the creation of foraging opportunities for other species, acceleration of decomposition and nutrient cycling, increased heart rot fungi growth and inoculation, and mediation of damaging insect outbreaks.

The Pileated Woodpecker was included in the first two iterations of Oregon's State Wildlife Action Plan as a management indicator species of mature and old growth habitats. Pileated Woodpeckers were once considered an indicator of old growth forests in the Pacific Northwest, but studies of habitat use and preference suggest that they are more accurately indicators of the structural elements that are characteristic of mature or old growth forests, or forestry practices that ensure older trees are retained. While populations of Pileated Woodpecker in Oregon are currently secure, conservation and management of this species can provide broad positive impacts to species that rely on mature forests with these characteristics.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Loss of Structural Habitat Elements

Where historical stands were perpetuated for 200 to more than 1,000 years, commercial forestlands are now commonly harvested every 60 years or less, which limits the maintenance and future recruitment of late-successional characteristics. In addition, the number of large-diameter snags and logs, which contribute to understory structure, has been reduced over time through wildfire and timber harvest.

Recommended Approach

Develop programs, incentives, and market-based approaches to encourage longer rotations and strategically located large-diameter tree tracts. Where feasible, maintain structural elements, such as large-diameter tall trees, snags, and logs. Create snags from green trees or high-cut stumps where maintaining snags is not feasible or where snag management goals are not being met. Maintain forest stand structures on private industrial forest lands, and provide technical assistance to landowners to leave large-diameter downed wood, green trees, or snags in the upland portion of harvested forests, as well as along riparian areas, to provide benefits for a diversity of wildlife and fish. Follow Oregon Forest Practices Act rules, which help to maintain a diversity of structural components on the landscape.

Limiting Factor: Loss of Late Successional Stand Size and Connectivity

Late successional forest stands have been greatly reduced in size and connectivity, particularly at lower elevations. This can impact species that are highly adapted to late successional conditions, require large tracts of intact habitats, and/or species that have limited ability to move over long distances to find new suitable areas. It also allows edge species to compete with those adapted to extensive interior forest habitat.

Recommended Approach

Maintain existing plans to protect and develop late successional habitat. Use active management to accelerate development of late successional structural characteristics in key areas to expand existing patches into larger areas; these will provide greater blocks of habitat for species with large area requirements or those that require interior forest habitat and are vulnerable to "edge effects". Continue to carefully plan forest practices to maintain connectivity (KCI: **Barriers to Animal Movement**), particularly when species vulnerable to fragmentation are present. ODFW has mapped **Priority Wildlife Connectivity Areas (PWCAs)** to provide information on places across the landscape with the highest overall value for facilitating wildlife movement.

Seek opportunities to coordinate management of public and private lands (e.g., All-Lands Approach) whenever possible to address conservation needs. Use voluntary conservation tools, such as financial incentives and forest certification to achieve conservation goals on private lands. Work to maintain a diversity of forest types and ages to support wildlife habitat connectivity and ecosystem services at a landscape scale.

HABITAT CHANGE TRENDS ANALYSIS

Following disturbance, such as timber harvest, regenerating conifer forests often succeed to deciduous or mixed deciduous-conifer forests without active management (e.g. replanting with Douglas-fir), especially on the west side of the state. These deciduous forests are primarily dominated by red alder and bigleaf maple. To investigate the transition from late successional mixed conifer forests to deciduous forest, the Institute of Natural Resources (INR) analyzed the change in total area of west-side deciduous and mixed conifer-deciduous forests between 1851 and 2016. The analysis showed a massive 243% increase in deciduous forests between 1851 and 1998, likely reflecting a shift towards earlier successional forests following logging.

RESOURCES FOR MORE INFORMATION

Northwest Forest Plan

Status and Trends of Late Successional and Old Growth Forests

Oregon Private Forest Accord

REFERENCES

Brunner, R. and E. Gaines. 2025. Oregon Vegetation Change 1851-2023. Trends analysis conducted for Oregon Department of Fish and Wildlife. Institute for Natural Resources, Portland State University, Portland, OR, USA.

Hagman, R.K. et. al. 2021. Evidence for widespread changes in the structure, composition, and fire regimes of western North American forest. Ecological Applications. Volume 31, Issue 8.

NATURAL LAKES

Natural lakes are relatively large bodies of freshwater surrounded by land that were formed through geological processes, such as glacial scouring, tectonic movements, volcanic activity and river meander cutoffs. In Oregon, natural lakes are defined as standing water bodies larger than 20 acres, including some seasonal lakes. Depth is not a reference for characterization of a natural lake.

ECOREGIONS

Natural Lakes are identified as a Key Habitat in all inland ecoregions.

CHARACTERISTICS

Natural lakes are distributed throughout Oregon, although the highest concentrations and largest lakes are found in the **West Cascades**, **East Cascades**, and **Northern Basin and Range** ecoregions. Sources of water for Oregon's natural lakes include rainfall, snowmelt, seeps and stream flows. The diversity of natural lakes is reflected in the processes that formed them. These processes include glaciation, volcanism (calderas and lava flows), coastal dune impoundment, faults and rifts, and riverine erosion (oxbow lakes). Natural lakes provide important habitat for **Species of Greatest Conservation Need** (SGCN), contribute to ecosystem services, and attract visitors for tourism and recreation year-round throughout Oregon's communities.

Crater and Waldo Lakes, Oregon's largest clear water lakes, are both located in the West Cascades ecoregion, and have been designated by the Department of Environmental Quality (DEQ) as Outstanding Resource Waters. The designation provides special protections to maintain the exceptional water quality, ecological, cultural and recreation values of these lakes. Clear Lake in the McKenzie basin is another naturally clear and cold lake in the Cascades, with a maximum depth of 175 feet. There are many volcanic lakes in the Cascade Mountain Range that are also notably clear, supporting diverse aquatic life by allowing light to penetrate deeper and enhancing their aesthetic value.

The eastern half of the state contains several playa lakes, formed when runoff from precipitation and mountain snowpack flows into low-lying areas, then evaporates and leaves mineral deposits. Playas are valuable for their role in water storage, groundwater recharge, and as critical habitat for migratory birds and other wildlife. In south central Oregon, Lake Abert has provided essential habitat and food sources for a myriad of migrating birds in the Pacific Flyway. Lake Abert is also the only hypersaline lake in Oregon and one of only three hypersaline lakes in the United States.

The Natural Lakes Key Habitat does not include irrigation ditches, reservoirs, or other man-made water bodies. The wet zone and riparian zones around the edges of natural lakes is mapped as **Wetlands Key Habitat**.

CONSERVATION OVERVIEW

Many of Oregon's larger natural lakes are important destinations for tourism and recreation, especially in the summer, and many are desirable locations for year-round commercial and residential development. These uses can have direct impacts on water quality and quantity. Pollution and sedimentation are also concerns associated with development and recreation. Once established, invasive plants and animals can dominate natural lake environments, reducing biodiversity and impacting recreational activities. Rising temperatures and altered precipitation regimes associated with climate change will affect water levels and ecosystem health. In eastern Oregon and at higher elevations, rising temperatures from climate change are affecting the ice regime (the dates that ice freeze and thaw) which impacts access to the lake to feed and to drink water. Some of Oregon's lakes contain unique assemblages of species and habitat features that have high conservation value. For example, many amphibian and fish SGCN rely upon Oregon's lakes for breeding each year.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Drought

Many lakes in south central and southeast Oregon have been drying naturally since the last glacial period. The effect of this natural drying process is being exacerbated by anthropogenic climate change. Droughts have resulted in a change in precipitation patterns, loss of natural runoff, and increase in evapotranspiration from natural lakes. Increased demand for out-of-stream water use is associated with prolonged drought, and ground water pumping and management are drying out some natural lakes, especially in south central and southeastern Oregon. These dry or diminished lake beds impact waterfowl, recreation, water availability, water quality, aesthetics and human health. Lake Abert has been affected by many drought-related factors including reduced water flow into the lake, increased salinity, impacts to food sources for the migrating waterfowl, and decreased habitat and biodiversity. In Crater Lake, scientists have observed an increase in the lake's temperature, a decrease in snowfall, and impacts on species such as American pika and whitebark pine. Drought limits water availability for recreation, fish and wildlife, and human use and puts stress on the fish and wildlife species that depend on these lake systems.

Recommended Approach

Monitor and measure stream flows, groundwater levels, lake levels, and water use. Implement modern technology to monitor water use from natural lake systems. Where applicable, work toward improving irrigation efficiency and delivery systems to use less water while protecting agricultural interests. Develop and implement groundwater management plans. Develop and adopt instream water rights for high priority natural lakes and upstream river reaches contributing flow. Continue to support collaborative water management solutions to identify, develop and implement voluntary projects that result in reliable water supplies to natural lakes in late summer, when water quality impacts are the highest. Manage water in the state with the long-term health and sustainability of natural lakes as a goal. Continue to educate Oregonians about conscientious water use.

Limiting Factor: Water Quality

Nonpoint source pollution may contain fertilizers, pesticides, or oil-based contaminants at levels high enough to cause significant lethal or sub-lethal effects in native fish and wildlife. Nonpoint source pollution can enter lakes through runoff from surrounding lands or streams, and from groundwater. In some lakes, use of motorized recreational watercraft can degrade **<u>water quality</u>** through pollution.

Cyanobacteria blooms have become more common and prevalent in natural lakes and waterways. Cyanobacteria can produce cyanotoxins that can cause serious illness or death in pets, livestock and wildlife. These toxins can also make people sick, and in sensitive individuals, cause a rash or skin, ear and eye irritation. The frequency, extent, and magnitude of harmful algal blooms in waterbodies is a response to a variety of individual and combinations of factors, including changes in water temperature, nutrient loading, and hydrologic conditions within watersheds.

During wildfires, ash can enter the natural lake and increase heavy metal concentrations in the water. Ash adds nutrients like nitrogen and phosphorus into the ecosystem. Algae feed on these nutrients and the nutrients and algae affect the food chain and the clarity of the lake water.

Recommended Approach

The diffuse, intermittent nature of nonpoint source pollutants make traditional management and control of pollutants very challenging. One of the most effective means of controlling nonpoint source pollutants is through education and the regulation of land use and associated land management practices. When recreating, carefully consider recreational vehicle use and timing of use in sensitive water bodies. Minimize use of pesticides and herbicides, and follow pesticide use labels for proper application. Implement Agricultural Water Quality and DEQ Total Maximum Daily Load water quality plans. Plant vegetation around driveways, shorelines and on slopes, so the vegetation can absorb nutrients, filter out pollutants, and trap sediment. Maintain septic tanks with regular pumping and inspection at least every 3-5 years. Pick up pet waste and dispose of it in the trash. Educate recreational users of projected and actual cyanobacterial blooms in natural lakes and waterbodies.

Limiting Factor: Habitat Loss

Habitat loss has occurred in natural lakes from residential housing, shoreline development, energy development, agriculture, and infrastructure development. This results in the loss of natural buffer zones, which are essential for filtering sediments and nutrients, stabilizing shorelines by slowing water flow, reducing erosion, and providing critical habitat for various fish and wildlife species by offering food sources and shelter along lake edges. Water withdrawals (both surface and groundwater), water diversion, and drought can significantly alter the natural flow and levels of lakes, impacting the availability of lake habitats.

Recommended Approach

Provide outreach and education on avoidance and minimization of impacts from development actions. This may include limiting development, including residential housing, road and rail placement along the shoreline of natural lakes to protect fringe wetlands that buffer the lake, or utilizing a raised trail to maintain hydrology. Support managed public access to lakes to promote self-education and advocacy of natural habitats. Limit the footprint of docks and boathouses on natural lakes, follow ODFW Residential Dock Guidelines, or use established public ramps. Protect native, intact habitat along the shoreline. Where possible, remove dikes along the shoreline of natural lakes or modify dike location and structure to restore fringe wetlands along the shoreline of the lake. Restore damaged habitat by re-grading the shoreline to the natural slope, planting native vegetation, controlling erosion with better management of stormwater and culvert replacement. Where natural lakes have been modified with dams, explore options for dam removal and restoration of more natural hydrology of the lake. Minimize future water diversion and water use to protect the water flow into and depth of natural lakes.

Limiting Factor: Invasive species

Invasive species can compete with native species for food and space, spread diseases, and produce toxins. Zebra and quagga mussels are highly invasive and can enter natural lakes from boat hulls, motors, trailers, livewells, and standing water. New Zealand mud snails can hitchhike on watercraft and fishing gear. Some of the Asian carp species degrade natural lakes by outcompeting native fish species, increasing water turbidity, and limiting waterfowl and shorebird production and use. Eurasian watermilfoil spreads through seeds and vegetative fragments. Invasive turtles and frogs can spread naturally or through introduction by a previous pet owner.

Recommended Approach

Provide outreach and education to the public regarding the impacts of invasive and exotic species on natural lake ecosystems. This includes outreach about the requirement to stop at ODFW boat check stations to inspect motorized boats and canoes, kayaks and paddleboards for invasive species (i.e., aquatic zebra or quagga mussels, snails, and aquatic plants) to ensure that the invasive species are not being transported between water bodies. Support programs to prevent carp and other non-native fish (i.e. catfish and non-native trout), bullfrogs, pet turtles, Eurasian milfoil, purple loosestrife and other invasive species from being transported and released into natural lakes. Conduct voluntary monitoring and control efforts.

Limiting Factor: Wildfires

Wildfires can have detrimental impacts on natural lakes and can compromise lake water quality both during active burning and for months and years after the fire is contained. Accidental human caused fires during the fire season can also create severe impacts to the lake and surrounding area. Wildfires and accidental human caused fires remove vegetation that, when intact, helps slow precipitation and hold soil in place, which can lead to increased stormwater runoff and erosion. Runoff and smoke can carry debris, sediment, ash, nutrients and other contaminants into the lakes. Wildfires can affect air quality and the recreation at natural lakes. Forest fires near and at Crater Lake have resulted in such poor air quality and visibility that the Crater Lake National Park has been closed, through-hikers on the Pacific Crest Trail have been rerouted, and major events have been cancelled.

Recommended Approach

Continue education regarding the impacts of wildfires on natural lakes' air quality, water quality and recreational opportunities. Continue educating the public to follow recreation rules for lakes and the surrounding area (i.e., do not build fires outside of an authorized camping/fire pit or build fires at the lake edge, do not drive vehicle on grass roads or in natural areas during posted fire seasons). Enforce fire bans and increase awareness when they go into effect. Where appropriate, thin forests and manage fuels in high priority areas surrounding lakes.

Limiting Factor: Water Quantity

Water is limited in some parts of the state and is projected to become scarcer under a changing climate and expanded human use. In standing waterbodies, water scarcity can lead to higher concentrations of contaminants, lowering water quality as less fresh water is available to dilute nutrients or pollutants. As water quantity diminishes in lakes and adjacent floodplains, fish are unable to access the shoreline habitat for spawning and access upstream habitat for life cycle requirements and/or to move to more favorable conditions. Groundwater pumping and water diversions for out-of-stream uses occur in every basin, and these uses can impair water quality and quantity, and aquatic species use and conditions upstream, within and downstream of the lakes. Late summer is a time of particular concern regarding water quantity.

Recommended Approach

Maintain, protect, or restore the natural hydrological cycle for stream flow into lakes. (KCI: **Water Quality and Quantity**). Develop and adopt instream water rights to increase quality habitat in and along natural lakes. Develop and implement groundwater management plans in the lake basins. Manage water in the state with the long-term health and sustainability of surface and groundwater sources. Continue to educate Oregonians about conscientious water use.

RESOURCES FOR MORE INFORMATION

Department of Environmental Quality: National Aquatic Resource Surveys: Water Quality: State of Oregon

Oregon Natural Desert Association: Lake Abert

Oregon Health Authority Website: Cyanobacteria

Climate Change at Crater Lake

USGS: Wildfire Impact on Water Quality of California Lakes

The Center for Lakes and Reservoirs at Portland State University

Oregon Lake Watch, 2014 Annual Report

Atlas of Oregon Lakes

Oregon Lakes Association

For information on boating safety and information about invasive species and other concerns, see the Oregon State Marine Board

OAK HABITATS

There are several oak habitat types in Oregon, where oaks comprise most of the canopy. These can include oak woodlands, oak forest, oak chaparral, and riparian oak. Oak savannah is covered in the Grassland Key Habitat. Oaks may also co-dominate a canopy in oak/fir, oak pine, and oak hardwood habitats.

ECOREGIONS

The range of oak habitats are a Key Habitat in the Coast Range, East Cascades, Klamath Mountains, West Cascades, and Willamette Valley ecoregions.

CHARACTERISTICS

In general, the understory of an Oregon white oak woodland is relatively open with shrubs, grasses, and wildflowers. The tree canopy of most oak woodland obscures 25-75 percent of the sky, and an oak forest typically has more than 75 percent cover. Oak chaparral has a short, shrubby vegetation understory. Riparian oak can tolerate wetter conditions and may be mixed with other tree species including ash and willow. Oak habitats are ideally maintained through periodic, low-intensity fire, which removes small conifers and maintains a moderate cover of low shrubs.

Depending on the ecoregion and site characteristics, oak habitats may also include ponderosa pine, California black oak, Douglas-fir, madrone, canyon live oak, and tanoak. Tanoak is closely related to true oaks, sharing a family, but is not a true oak. Tanoak, however, is an important mast producer often associated with canyon live oak.

ECOREGIONAL CHARACTERISTICS

Coast Range

Oak habitats are typically found in drier landscapes, such as south-facing slopes and foothills bordering the Willamette Valley. The southwestern Oregon coast range is the northerly extent of the range of canyon live oak and tanoak.

East Cascades

In the East Cascades ecoregion, oak woodlands occur primarily on the north end of the ecoregion and in the south along the Klamath River Canyon. They are located at the transition between ponderosa pine or mixed conifer forests in the mountains, and the shrublands or grasslands to the east. Oak habitats in the East Cascades are different in structure and composition than those in western Oregon but are just as important to a variety of wildlife and rare plants.

Klamath Mountains

Oak habitats are found in lower elevations in the valley floors up to 4000', on dry sites, or in areas with frequent, low-intensity fires. Oak woodlands may occur in a mosaic with chaparral and dry conifer woodlands. Nearing the northern extent of its range in this ecoregion, chapparal is dominated by shrubs species including buckbrush and manzanita thickets, with deer brush, yerba santa, and silk tassel making up the rest of the shrub component.

West Cascades

Oak woodland habitats are found in drier landscapes, such as south-facing slopes and foothills bordering the Willamette Valley. Oak habitats extend up to 3500' in southwestern Oregon in the West Cascades. Portions of the West Cascades may have historically had a more closed canopy oak habitat as well as very expansive chaparral that filled the understory.

Willamette Valley

In the Willamette Valley, Oregon white oaks were originally found in a mosaic of oak savanna, forests, and riparian habitats throughout the valley floor and low-elevation slopes. One variation of oak habitat, that has almost disappeared due to historic harvest, is white oak and Willamette Valley ponderosa pine. This habitat type is found in valley bottoms and is tolerant of seasonal flooding. Oaks were most common on flat to moderately rolling terrain, usually in drier landscapes, and often between prairie remnants and conifer forests. Today, oak woodlands generally are found in small pockets and some corridors surrounded by other land uses, such as development or agriculture.

CONSERVATION OVERVIEW

Oak habitats, traditionally managed on a landscape scale by Indigenous people, once covered almost one million acres in the Coast Range and 400,000 acres in the Willamette Valley. However, the Coast Range now has very little of its estimated historical oak woodlands, and the Willamette Valley has even less. Habitat loss has been less severe in the East Cascades, where fire suppression may have led to expansion of oaks into former shrub-steppe and grassland habitats. Valuing Traditional Ecological Knowledge and cultural burning in oak management is critical to protecting and restoring oak habitats.

Oak habitats have been impacted by conversion to other land uses, invasive species, and vegetation changes due to fire suppression. As a result of conifer plantings and changes in fire frequency and intensity after European settlement, Douglas-fir now dominates in many areas of the Coast Range and Willamette Valley foothills.

Oak habitats have been converted to agriculture, residential, and other uses in the Willamette Valley, the Coast Range foothills, and the coastal hills in southern Oregon. Development continues to threaten these habitats in all ecoregions where they are found. The same rolling hills and scenic landscapes that indicate healthy pine-oak habitat also attract new residents and developers. Because much of the remaining oak habitats are in private ownership and maintenance of these habitats requires active management, cooperative incentive-based approaches are crucial to conservation.

Oak habitats provide important food sources, shelter, and resting places for a large range of birds and other wildlife, including a variety of species that are oak-obligates like Oak Titmouse and the Acorn Woodpecker. Loss of oaks, particularly large-diameter, open-structured trees valuable to wildlife, is of particular concern because oak trees have a slow growth rate, slowing restoration success. In addition, reproduction and recruitment of younger trees are poor in many areas.

Sudden oak death, a fungal tree pathogen identified in northern California in the 1990s has been slowly spreading north. In 2001, the pathogen was detected in Curry County, which continues to be the only area in Oregon where the pathogen is known to occur in a natural setting. Mediterranean oak borer was found in Oregon in 2018 and is also being tracked.

Depending on the area, Species of Greatest Conservation Need associated with oak habitats include Columbian white-tailed deer, Chipping Sparrow, Slender-billed White-breasted Nuthatch, Lewis's Woodpecker, Western Bluebird, Fender's blue butterfly, Kincaid's lupine, white rock larkspur, and wayside aster among others. Northern spotted owl may utilize oak trees in a mixed forest setting.

[SPOTLIGHT] Oak Habitat Conservation and the Acorn Woodpecker

There are many landbird species unique to oak and prairie habitats of western Oregon, including Acorn Woodpecker, Blue-gray Gnatcatcher, Bewick's Wren, California Scrub-Jay, California Towhee, Hutton's Vireo, Oak Titmouse, Red-shouldered Hawk, White-tailed Kite, and Wrentit. As one of the most conspicuous residents of Oregon's oak habitats, the Acorn Woodpecker can be an effective catalyst for conservation of this Key Habitat.

Acorn Woodpeckers are visually striking, social birds found in western Oregon's oak woodlands. Known for their black-and-white plumage and red cap, they rely on oak trees for food and nesting. These woodpeckers store acorns in trees, creating "granaries" that serve as both food storage and breeding sites. They are highly social and often live in groups, working together to protect their acorn caches and raise their young. The Acorn Woodpecker is a year-round resident of oak woodland and savanna habitat in western Oregon, primarily found in the Willamette Valley and Klamath Mountains ecoregions, though occasionally found in the East Cascades.

Acorn Woodpeckers have been expanding their range in Oregon since the arrival of Euro-American settlers, expanding north from Roseburg to Eugene between 1920 and 1950, then further north to Washington County by the early 1990s. Although more than 95% of the oak woodlands have been lost in the Willamette Valley since European settlement, Acorn Woodpecker expansion into the Willamette Valley in the last 100 years was likely assisted by the reduction of fires that maintained grasslands and savanna, transforming some of those habitats into oak woodlands (mixed with pine or fir) that had larger and older trees that produce more acorns and provide more dead limbs for granaries and nests.

Unfortunately, many other landbird species that are associated with oak habitats are experiencing severe population declines. The Partners in Flight (PIF) conservation plan "*Population and habitat objectives for landbirds in prairie, oak, and riparian habitats of western Oregon and Washington*" examined long-term population trends derived from Breeding Bird Survey data for 33 focal species. Their analysis found that at least 50% of the species in each habitat type (prairie, oak, and riparian) have significantly declining population trends in one or more ecoregions. Several species or subspecies associated with oak and prairie are identified as imperiled by the PIF plan, including SWAP SGCNs: Lewis's Woodpecker, Oregon Vesper Sparrow, Streaked Horned Lark, Western Bluebird, White-breasted Nuthatch (Slender-billed), and Western Meadowlark. Conservation recommendations included in the PIF plan would also benefit a broad suite of species in decline that rely on oak and prairie habitats.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Fire Suppression and Fir Encroachment

With fire suppression, Douglas-fir encroaches into oak habitats and eventually shades out oak trees and seedlings, as well as other plants that require open growing conditions. Many oak woodlands are now dominated by Douglas-fir or have transitioned to fir-oak habitats due to fire suppression. Without active management, these areas will eventually become conifer forests. In some areas of the East Cascades, fire suppression combined with grazing has influenced fine fuel production and led to encroachment by conifers and establishment of dense patches of small, shrubby oaks.

Large wildfires, like those experienced across the West Cascades and Eastern Oregon have galvanized public interest in fuels reduction treatments across public and private lands. When conducted in a manner to retain some understory habitat for wildlife, such as thinning of small diameter conifers and small diameter oak-on-oak encroachment with piles and habitat clumps, oak habitats can be restored to fire resiliency and prepped for low-intensity controlled burns.

Recommended Approach

Work with partners to update smoke management and air quality standards to allow more fall, winter, and spring burn windows for prescribed burning. The Certified Burn Manager program and cultural waivers have increased equitable access to prescribed fire. Use multiple tools, including prescribed fire, mowing, grazing, and selective harvest to maintain open canopy oak-dominated habitats. Ensure that tools are site-appropriate and implemented to minimize impacts to native species. Re-establish site-appropriate native grasses, herbaceous plants, and shrubs. (KCI: Disruption of Disturbance Regimes)

Limiting Factor: Land Use Conversion and Habitat Loss

Particularly in the Willamette Valley and Klamath Mountains ecoregions, oak habitats continue to be converted to agricultural (e.g., vineyards), rural residential, urban, and other land use changes. Remaining oaks can be impacted by soil compaction in agricultural and residential settings. The conversion of oak habitats into other land uses results in habitat loss and fragmentation for wildlife, invasive species, and the spread of diseases.

Recommended Approach

Much of the remaining oak habitat requires active management and occurs on private land, where cooperative incentive programs are the best approach. Work with private landowners to maintain and restore oak habitats and implement outreach and education efforts. Promote oak conservation on working lands through incentive programs and other collaborative efforts, such as the Wildlife Conservation and Management Program. Create new opportunities for acquisition and conservation easements to protect oak habitat, such as through the Oregon Agricultural Heritage Program. Work with local governments to protect and conserve oak habitat in local land use planning, through Statewide Planning Goal 5 as significant wildlife habitat for SGCN.

Limiting Factor: Loss of Habitat Structure

Large-diameter oak trees with lateral limb structure and cavities have been lost. In many areas, there are not sufficient numbers of replacement trees to maintain these habitat elements over time. In the absence of fire, densely stocked, regenerating oaks often do not develop open-grown structures due to shading. In the East Cascades, grazing or very hot fires can lead to development of brushy-structured trees. The shaded or grazed oaks do not develop the lateral limbs, cavities, and higher acorn crops of open-grown trees, and are thus less valuable to wildlife. Woodcutting often removes snags, which are necessary for cavity nesting species.

Recommended Approach

Maintain a diversity of tree sizes and ages across the stand, with emphasis on large oak and other key tree species appropriate to the habitat type. Remove conifers that are competing with larger oaks. Maintain existing snags and create new snags from competing conifers to provide cavity habitat. Encourage oak reproduction through plantings or protective exclosures. It may be appropriate to use nest boxes as temporary cavity habitat in oak restoration project areas. Improve methods to promote oak reproduction and creation of open-grown structures.

Limiting Factor: Invasive Species and Diseases

In many remaining oak habitats, the overstory is intact but the understory is highly degraded. Depending on the ecoregion and site, invasive plants, such as Armenian (Himalayan) blackberry, bird cherry, evergreen blackberry, Scotch broom, English hawthorn, false brome, yellowstar thistle, diffuse knapweed, and puncturevine, have established and degraded oak habitats.

Invasive insects, such as the Mediterranean oak borer and carpenter worm moth spread diseases, cause defoliation, and weaken the structure of the trees. Fungal diseases such Sudden Oak Death and Armillaria root rot can also significantly impact oak trees.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. Prioritize control efforts and use site-appropriate methods to control newly established invasive plant species for which management can be most effective. In high-risk areas, use weed-wash stations for machinery during mechanical restoration or treatment of a site. Re-seed with site-appropriate native grasses and forbs after control efforts. Prescribed burning may be useful for management of some invasive species, particularly shrubs. Support efforts toward expanding native seed resources. (KCI: Invasive Species)

Limiting Factor: Climate Change

The mean annual air temperature in the Pacific Northwest is projected to increase under a changing climate. This warming is projected to be the highest during the summer. Annual precipitation patterns in the Pacific Northwest are also predicted to change, with decreases in summer precipitation. While oaks may be tolerant of warmer and drier summer conditions, the severity of the impact may have detrimental effects.

Recommended Approach

Protect and restore a diverse portfolio of oak habitats to preserve genetic diversity. Continue efforts to restore currently degraded areas and re-establish former oak habitats to increase resiliency. Engage in strategic, landscape-scale planning efforts to create a connected network of oak habitats to increase adaptive capacity. Identify where future climate conditions may support oak habitats, including areas upslope of their current range where they were not historically found. Identify data gaps and support research needs, including the protection of oak habitat on natural and working lands to mitigate the impacts from climate change.

HABITAT TRENDS ANALYSIS

Open Oregon white oak and black oak woodlands were common across western Oregon prior to Euro-American settlement. Subsequent fire suppression and development pressures of the 20th century led to a loss of oak woodlands. To investigate the magnitude of loss of oak habitats, the Institute of Natural Resources (INR) compared the total area of oak habitats in three baseline maps (1851-1937,1998, 2016). The analysis showed significant of oak habitats over time. By 2016, the total area of oak habitats had decreased by 72% when compared to historical data. Oak habitats were largely replaced by mixed hardwood and conifer forests and agricultural land uses.

RESOURCES FOR MORE INFORMATION

Pacific Northwest Oak Alliance

Partners in Flight Conservation of Landbirds and Associated Habitats and Ecosystems in the East Cascade Mountains of Oregon and Washington

Land Manager's Guide to Bird Habitat and Populations in Oak Ecosystems of the Pacific Northwest

Oregon White Oak Restoration Strategy for National Forest System Lands East of the Cascade Range

Cascadia Prairie Oak Partnership

Restoring Oak Habitats in Southern Oregon & Northern California v2.0

Restoring Oak Habitats in Southern Oregon & Northern California: A Guide for Private Landowners v3.0

Wildlife-friendly Fuels Reduction in Dry Forests of the Pacific Northwest

Population and habitat objectives for landbirds in prairie, oak, and riparian habitats of western Oregon and Washington

REFERENCES

Altman, B. and J. L. Stephens. 2012. Land Managers Guide to Bird Habitat and Populations in Oak Ecosystems of the Pacific Northwest. American Bird Conservancy and Klamath Bird Observatory. 82 pp.

Brunner, R. and E. Gaines. Institute for Natural Resources. 2025. Oregon Vegetation Change 1851-2023. Trends analysis conducted for Oregon Department of Fish and Wildlife.

Hosten P.E., O.E. Hickman, F. Lang. 2007. Patterns of vegetation change in grasslands, shrublands, and woodlands of southwest Oregon. USDI, Bureau of Land Management, Medford District, OR. Website https://www.blm.gov/or/districts/medford/files/pattvegchange.pdf

PONDEROSA PINE WOODLANDS

Ponderosa pine woodlands are common in Oregon's eastside ecoregions. While dominated by ponderosa pine, these woodlands may also have lodgepole pine, western juniper, aspen, western larch, grand fir, Douglas-fir, mountain mahogany, incense cedar, sugar pine, or white fir, depending on ecoregion and site conditions. Known for their open forest structure, these woodlands generally have fewer than 40 large trees per acre, with tree canopy cover between 10 and 60%. Understories consist of variable combinations of fire tolerant shrubs, herbaceous plants, and grasses. Ponderosa pine forests generally occur in regions with arid conditions with little rainfall during summer months, and can be found at a range of elevations, from 100 ft to over 6000 ft.

ECOREGIONS

Ponderosa pine woodlands are a Key Habitat in the **Blue Mountains**, **East Cascades**, and **Klamath Mountains**.

CHARACTERISTICS

The open structure of ponderosa pine habitats was historically maintained by frequent, low-intensity surface fires, with some intermittent higher-intensity fires. The thick bark of mature ponderosa pines provides protection against moderate fires, allowing these trees to survive and regenerate after fire events. The structure and composition of ponderosa pine woodlands vary across the state, depending on local climate, soil type and moisture, elevation, aspect, and fire history. The soils in ponderosa pine woodlands are often well-drained and sandy or loamy. Ponderosa pine woodlands typically have an open canopy structure, allowing sunlight to penetrate and support a diverse understory of herbaceous plants and shrubs.

ECOREGIONAL CHARACTERISTICS

Blue Mountains

In the Blue Mountains, ponderosa pine often coexists with other conifers, such as Douglas-fir, western larch, and grand fir. The understory is diverse, including shrubs like mountain big sagebrush, bitterbrush, mahogany, snowbrush and various native grasses and forbs such as Idaho fescue and bluebunch wheatgrass. Ponderosa pine habitats also include savannas, which have sporadic, widely spaced trees that are generally more than 150 years old. The structure of a savanna is open with an understory dominated by fire-adapted grasses and forbs as well as shrub fields. Ponderosa pine habitats in the Blue Mountains generally occur at mid elevation and are replaced by other coniferous forests at higher elevations.

East Cascades

East of the foothills of the Cascades, within the rain shadow cast by the mountains, land becomes more arid and ponderosa pine woodlands become dominant. In these woodlands, other conifer species may be present, including Douglas-fir, western larch, and, in some areas, lodgepole pine. The understory is characterized by a mix of shrubs and herbaceous plants. Common shrubs include bitterbrush, mountain big sagebrush, and snowberry. The herbaceous layer often includes native grasses such as Idaho fescue and bluebunch wheatgrass. Ponderosa pine habitats in the East Cascades generally occur at mid elevation, where climatic and soil conditions support the growth of these trees, and are replaced by other coniferous forests at higher elevations.

Klamath Mountains

In the Klamath Mountains, pine woodlands are usually dominated by ponderosa pine, but may be dominated by Jeffery pine, depending on soil mineral content, fertility, and temperatures. Ponderosa pine and ponderosa pine-oak woodlands occur on dry, warm sites in the valley margins, foothills, and mountains of southern Oregon. The understory often has shrubs, including green-leaf manzanita, buckbrush, and snowberry.

CONSERVATION OVERVIEW

Ponderosa pine habitats historically covered a large portion of the Blue Mountains ecoregion, as well as parts of the East Cascades and Klamath Mountains. Ponderosa pine is still widely distributed in eastern and southern Oregon. However, the structure and species composition of ponderosa pine woodlands have changed dramatically. In the past, ponderosa pine habitats had frequent low-intensity fires that maintained an open understory, as well as some high-intensity fires. Due to certain timber harvest practices, the exclusion of Indigenous peoples’ burning practices, and fire suppression, dense patches of smaller conifers have overtaken the understory of many ponderosa pine forests. Depending on the region, these conifers may include shade-tolerant Douglas-fir, grand fir, white fir, and lodgepole pine as well as young ponderosa pines. These dense stands are highly vulnerable to drought stress, insect outbreaks, and disease. Many of these mixed conifer forests are in fire-prone areas where the risk of loss of key ecosystem components is high. Due to this unnatural density of understory trees in these areas, low intensity fires can quickly become severe and kill large, mature ponderosa pine trees that would survive a smaller fire. Fire suppression has also led to the accumulation of a thick layer of needle duff in the understory. Large trees will send roots into this duff layer, which are then destroyed when the duff layer burns, often killing mature trees even in lower intensity fires.

Loss and conversion of ponderosa pine woodlands to shrubland and other habitat types is occurring largely as a result of the increased scale and frequency of high intensity wildfires. While ponderosa pines readily re-establish after disturbance, high intensity, landscape scale wildfires make it difficult for successful regeneration post-fire due to a lack of natural seed source within seed dispersal ranges. Of particular concern is the loss of large-diameter ponderosa pine habitats. Most old-growth ponderosa pine stands are greatly reduced in size and connectivity, occurring in a patchwork with much younger forests. Younger stands can provide habitat for some wildlife species, but old-growth ponderosa pine forests provide critical habitat for wildlife that prefer open, dry forests.

Ponderosa pine woodlands support a diversity of wildlife species, including Species of Greatest Conservation Need (SGCN). One SGCN, the white-headed woodpecker, requires large-diameter trees and an open understory and is sensitive to changes in the forest seral stage. As a result, white-headed woodpeckers are entirely dependent on open, late-successional ponderosa pine woodlands. Other SGCN associated with ponderosa pine habitats include **Flammulated Owl**, **Lewis's Woodpecker**, **long-legged myotis**, and **pallid bat**.

On federal and private lands, especially in the wildland-urban interface, ponderosa pine habitats are increasingly being restored or managed in a manner consistent with wildlife conservation goals through fuel reduction treatments, retention of large-diameter trees, and maintenance of high densities of snags.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Altered Fire Regimes and Addressing Risk of Uncharacteristically Severe Wildfire

Certain timber harvest practices, the exclusion of Indigenous peoples' burning practices, and fire suppression have resulted in dense growth of young pine trees and young mixed conifer stands, replacing the open understory of ponderosa pine woodlands. These dense stands are at increased risk of uncharacteristically severe wildfires, drought, disease, and damage by insects. Over time, some stands will convert to Douglas-fir and grand fir forests, which do not provide adequate wildlife habitat for species dependent on open ponderosa pine habitats. While normally drought tolerant, large old-growth ponderosa pines are dying due to these dense young trees that would historically have been controlled by frequent, low intensity fires.

These dense understories, along with numerous insect-killed trees, make it difficult to reintroduce natural fire regimes in some areas, particularly in the Blue Mountains and East Cascades ecoregions. In parts of the Blue Mountains, East Cascades, and Klamath Mountains, increasing development of homes and resorts in forested habitats limits the ability of managers to use prescribed fires due to concerns about smoke and escaped burns, further increasing the risk of high-intensity wildfires. Some ponderosa pine woodlands are also being inundated with invasive annual grasses such as cheatgrass and medusahead, increasing fuel continuity and altering natural fire behavior.

Recommended Approach

Use an integrated approach to forest health issues that considers historical conditions, including roads and human use, wildlife conservation, natural fire intervals, and silvicultural techniques. Develop implementation plans for thinning overstocked stands and applying prescribed fire, and ensure plans are acceptable for management of both game and non-game species. Evaluate individual stands to determine site-appropriate actions, such as monitoring in healthy stands, or thinning, mowing, and application of prescribed fire in at-risk stands. Develop markets for small-diameter trees and implement fuel reduction projects to reduce the risk of forest-destroying wildfires. Manage for a landscape mosaic that includes structural complexity and species diversity in the understory and overstory across multiple spatial scales. Fuel reduction strategies need to consider the habitat structures that are required by wildlife, including snags, downed logs, and hiding cover. Reintroduce fire where feasible. Engage with Tribal Nations to bring Traditional Ecological Knowledge of prescribed fire to the overstocked forests. Implement prescribed fire at a frequency and scale that improves regeneration and establishment of native shrubs

Support community-based forest collaboratives to increase the pace and scale of forest restoration. Engage in frequent outreach to educate the public about the ecological importance of fire to ponderosa pine forests. Monitor forest health initiatives and use adaptive management techniques to ensure efforts are meeting habitat restoration and uncharacteristic fire prevention objectives with minimal impacts on wildlife. Work with landowners and resort operators to reduce vulnerability of properties to wildfires while maintaining habitat quality. Highlight successful, environmentally sensitive fuel management programs. Retain features that are important to wildlife, including snags, downed logs, forage, and hiding cover for wildlife species, and replant with native shrub, grass, and forb species. Manage reforestation after wildfire to create species and structural diversity based on local management goals. (KCI: **Disruption of Disturbance Regimes**)

Limiting Factor: Loss of Size and Connectivity of Large-structure Ponderosa Pine Habitats

Old-growth ponderosa pine habitats have been greatly reduced in size and connectivity by timber harvest, the exclusion of Indigenous peoples' burning practices, and fire suppression, particularly in the Blue Mountains and East Cascades ecoregions. These changes have led to overstocked stands. Alongside the loss of open understories and encroachment by dense stands of young trees, many ponderosa pine habitats have been lost to conversion to rural residential uses and other activities. As a result, few large, contiguous blocks of ponderosa pine habitat remain.

Recommended Approach

Maintain large blocks of large-diameter ponderosa pine habitat. Identify current and potential movement **corridors** between habitat blocks for protection and restoration. In areas experiencing rapid development, work with local communities to minimize development in large blocks of intact habitat.

Limiting Factor: Invasive Species

Throughout the state, non-native plants are invading and degrading ponderosa pine woodlands. In parts of the Blue Mountains and East Cascades, diffuse and spotted knapweed and Dalmatian and common toadflax are significant invaders. Additionally, in many areas the spread of cheatgrass and medusahead rye can result in an invasive plant understory that is highly susceptible to burning, with a high-fuel content vegetation that carries wildfire more easily than the native vegetation. In the Klamath Mountains, Armenian (Himalayan) blackberry and Scotch broom are significant invaders, along with annual invasive grasses.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new **invasive species** from becoming fully established. Prioritize efforts and control key invasive species using site-appropriate methods. Control wildfires in cheatgrass-dominated areas of the Blue Mountains. Fortunately, many areas within the Blue Mountains and East Cascades still have few invasive species currently threatening ponderosa pine habitats. In these areas, invasive plants should be monitored and controlled as they first arrive when control is more efficient, practical, and cost-effective. Reintroduce site-appropriate native grasses and forbs after invasive plant control. Prescribed burning may be useful for management of some invasive species in the Klamath Mountains.

RESOURCES FOR MORE INFORMATION

Oregon Department of Forestry Forest Practices Monitoring Program

Partners in Flight Conservation of Landbirds and Associated Habitats and Ecosystems in the Northern Rocky Mountains of Oregon and Washington

Partners in Flight Conservation of Landbirds and Associated Habitats and Ecosystems in the East Cascade Mountains of Oregon and Washington

Managing for Cavity-Nesting Birds in Ponderosa Pine Forests

SAGEBRUSH HABITATS

Sagebrush habitats include all sagebrush steppe- and shrubland-dominated communities found east of the Cascade Mountains.

ECOREGIONS

Sagebrush habitats are a Key Habitat in the **Blue Mountains**, **Columbia Plateau**, **East Cascades**, and **Northern Basin and Range** ecoregions.

CHARACTERISTICS

Sagebrush habitats in eastern Oregon are both extensive and diverse, ranging from low-elevation valleys to high mountain areas and from grassland-like shrub-steppe to relatively dense shrublands. Sagebrush-dominated communities differ in structure and species composition depending on ecoregion, elevation, soils, moisture regimes, and fire history.

Sagebrush habitats are often classified as sagebrush steppe or sagebrush shrublands. Sagebrush steppe is characterized by grasses and forbs with an open or more dispersed shrub layer. Sagebrush shrublands are dominated by shrubs, with less understory area covered by grasses and forbs than in steppe habitats.

In Oregon, sagebrush habitats are dominated by mountain big or Wyoming big sagebrush. Both mountain big and Wyoming big sagebrush habitats historically experienced natural fire regimes that maintained a patchy distribution of shrubs and predominance of native grasses. Big sagebrush, including mountain, Wyoming, and basin, thrives in deep, well-drained soils. Low sagebrush, however, prefers shallow, wet soils.

ECOREGIONAL CHARACTERISTICS

Blue Mountains

The Blue Mountains ecoregion has both mountain big and Wyoming big sagebrush habitats. These habitats have different plant associations depending on elevation and soils including several different subspecies of sagebrush such as low sagebrush, silver sagebrush, rigid sagebrush, basin big sagebrush, and threetip sagebrush. Other common plant species include **bitterbrush**, mountain mahogany, and rabbitbrush. Soils vary in depth and texture but are non-saline.

Columbia Plateau

Columbia Plateau shrub-steppe habitats are open grass-dominated communities and are usually found on loamy, wind-deposited (loess) soils. In this ecoregion, shrub-steppe communities can be broadly divided into two elevational types. Within 10 miles of the Columbia River, sandy shrub-steppe communities occur on unstable, well-drained soils with a component of bare ground or open sand present. These communities range from sagebrush steppe dominated by bitterbrush and needle-and-thread grass or Indian rice grass, to sand dune communities characterized by sagebrush, bitterbrush, and western juniper. Further from the Columbia River, both mountain big and Wyoming big sagebrush communities include basin big sagebrush, needle-and-thread grass, basin wildrye and bluebunch wheatgrass steppe, and Wyoming big sagebrush and bluebunch wheatgrass (which formerly occupied the low-elevation, loess uplands in the Columbia Plateau).

East Cascades

Sagebrush habitats occur in the East Cascades transition zone between the Cascade Mountain forests and the drier sagebrush steppe habitats of the Columbia Plateau and Northern Basin and Range Ecoregions. The number of species and acreage dominated by sagebrush is lower in the East Cascades ecoregion than most other east side ecoregions, especially the Northern Basin and Range. Mountain big sagebrush and Wyoming big sagebrush habitats are both found in the East Cascades Ecoregion depending on elevation and soil type with Wyoming big sagebrush habitats found mainly along the eastern edge.

Northern Basin and Range

Big sagebrush habitats include mountain, basin, and Wyoming big sagebrush shrublands and shrub-steppe. Structurally, these habitats are composed of medium-tall to tall (1.5-6 feet) shrubs that are widely spaced with an understory of perennial bunchgrasses. Basin big sagebrush communities occur on deep silty or sandy soils along stream channels, in valley bottoms and flats, or on deeper soil inclusions in low sagebrush or Wyoming big sagebrush stands. Wyoming big sagebrush communities occur on shallower, drier soils. Mountain big sagebrush communities occur at montane and subalpine elevations on deep-soiled to stony flats, ridges, nearly flat ridge tops, and mountain slopes. The fire frequency in big sagebrush habitats ranges from 10-25 years for mountain big sagebrush and 50-100 years for Wyoming big sagebrush.

Although big sagebrush communities tend to be the dominant habitat type, other sagebrush types also provide important habitat for wildlife and may need to be considered at the local and watershed scale, or for the conservation of particular species like the **Greater Sage-Grouse**. For example, low sagebrush provides critical wildlife habitat for many sagebrush-obligate species. Low sagebrush habitats cover large areas of the Northern Basin and Range ecoregion, but low sagebrush communities are slow (150-300 years) to recover from significant soil disturbance or fire. Soil disturbance in these sites often results in the establishment of invasive annual grasses.

CONSERVATION OVERVIEW

There are many species and subspecies of sagebrush, which are associated with different grasses and herbaceous plants, depending on site conditions. General ecology and conservation issues vary by sagebrush community type, so conservation actions must be tailored to local conditions and conservation goals. Detailed descriptions of the different sagebrush plant communities are available from sources included in the references.

Although sagebrush habitats are still common and widespread in eastern Oregon, some sagebrush habitat types have high levels of habitat loss and are of conservation concern. These types vary by ecoregion. In the **Blue Mountains**, valley-bottom sagebrush types, including threetip or basin big sagebrush, that occur on deep soils are particularly at risk. Also important are the valley margin steppe types with Wyoming big sagebrush, squaw apple, and **bitterbrush**. Overall, the sagebrush habitats in the Blue Mountains ecoregion have experienced steep declines since colonization.

In the lower elevations of the **Columbia Plateau**, shrub-steppe communities have been almost entirely replaced by irrigated agriculture. Remnant habitats occur on public lands, such as the Boardman Bombing Range, and in scattered patches along roadsides and fields. Loss of sagebrush habitats in the Columbia Plateau is also high compared to historical acreages.

In the **Northern Basin and Range** ecoregion, several types of big sagebrush are combined into a single Key Habitat, including mountain, basin, and Wyoming big sagebrush shrublands and shrub-steppe. This part of Oregon has some of the largest blocks of high-quality sagebrush habitat left in the United States, but it is estimated that more than half of this habitat has been lost since the 1800s. Basin big sagebrush communities have had the greatest loss as compared to historical distribution. These communities historically occurred on deep soils and have been converted to agriculture, residential housing and industrial uses in some areas. The deep soils of basin big sagebrush are important for pygmy rabbits to create burrows.

Although Wyoming big sagebrush habitats are still common and widespread in the Northern Basin and Range, they have been altered to some degree by unmanaged grazing, invasive species, and altered fire regimes. With overgrazing and fire suppression, shrub (mostly sagebrush) density increases, bunchgrass and forb density decreases, and invasive annual grasses increase. In many areas, these habitats have shifted from mosaics of native perennial grasses, forbs, and shrubs to landscapes heavily dominated by shrubs and invasive annual forbs and grasses. Juniper encroachment is an important issue in mountain big sagebrush communities between 4,500 and 7,000 feet.

Big sagebrush habitats have high structural diversity, thus more places to forage, hide, and build nests. As a result, the number of bird species generally increases with sagebrush height. Habitat values are also dependent on a diverse understory of bunchgrasses and flowering plants.

Throughout eastern Oregon, loss of grassland-shrub mosaics across landscapes and the degradation of understories have contributed to the decline of species dependent on high-quality sagebrush habitats. **Species of Greatest Conservation Need** (SGCN) associated with sagebrush include the **Greater Sage-Grouse**, **Ferruginous Hawk**, **Loggerhead Shrike**, **Sagebrush Sparrow**, **Brewer's Sparrow**, **northern sagebrush lizard**, **Washington ground squirrel**, **burrowing owls,** and **pygmy rabbit**.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Altered Fire Regimes

Fire suppression has resulted in undesirable changes in vegetation and contributes to increases in the intensity of wildfires. In some fire-suppressed areas, western junipers have encroached into sagebrush habitats. Dense juniper stands are not suitable for species that require open sagebrush habitats. Replacement of native bunchgrasses by cheatgrass and other invasive annual grasses has increased fire frequency and intensity in sagebrush habitats. Prescribed fire, which can be a useful tool when tailored to local conditions, is not necessarily suitable for all sagebrush habitat types. Some sagebrush habitats, including low and Wyoming big sagebrush, are extremely slow to recover from disturbance such as prescribed fire. Fire, both prescribed and natural, can increase dominance by invasive plants.

Recommended Approach

Carefully evaluate sites to determine if prescribed fire is appropriate, taking into consideration the extent of invasive annual grasses and other fire prone invasive species in the area and the recovery potential of the sagebrush community. If determined to be ecologically beneficial, reintroduce natural fire regimes using site-appropriate prescriptions. Use prescribed fire to create a mosaic of successional stages and avoid large burn patches. To control encroaching junipers, use treatment methods such as mastication, cut and pile, lop and scatter, or cutting for firewood. To ensure the long-term success of juniper removal, it may be necessary to re-treat stands on a regular basis. Develop markets for small juniper trees as a special forest product to reduce restoration costs. Maintain juniper trees with old-age characteristics, which are important for nesting birds, mule deer winter range, and other wildlife.

Limiting Factor: Invasive Species

Invasive plants, such as cheatgrass, medusahead, yellow-star thistle, knapweeds (diffuse, spotted, and purple), rush skeleton weed, spikeweed, leafy spurge, and perennial pepperweed, invade and degrade sagebrush habitats. The introduction and spread of annual grasses, such as cheatgrass and medusahead, has increased the frequency, intensity, and extent of fires in these habitats. Sagebrush and native bunchgrasses are adapted to infrequent, patchy fires, and are eliminated by hot fires. Invasive grasses also provide little nutritious value for wildlife and decrease available forage on the landscape. While not nearly as extensive as invasive plants, non-native animals have also impacted native fish and wildlife populations. Unregulated horse and burro herds are a concern in many areas, competing with native wildlife for vegetation and access to limited water sources, spreading invasive plant seeds via their manure, and trampling sensitive habitats.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. Prioritize control efforts and use site-appropriate methods to control newly established species for which management can be most effective (e.g., leafy spurge and perennial pepperweed). Cooperate with partners through habitat programs and County Weed Boards to address invasive species problems. Oregon's SageCon Invasives Initiative can be used for state-wide planning and coordinating implementation and funding toward shared priority areas. Reintroduce shrubs, grasses, and forbs at control sites through seeding and/or planting. In some cases, it may be desirable to use "assisted succession" strategies, using low seed rates of non-invasive, non-native plants in conjunction with native plant seeds as an intermediate step in rehabilitating disturbances to sagebrush habitat. Prevent and control wildfires in areas where cheatgrass dominates in the understory. Conduct research to determine methods to manage established species such as cheatgrass and medusahead. Minimize soil disturbance in high priority areas to prevent the establishment of invasive species. Work with public land managers to develop effective and enforceable travel management rules to prevent the spread of noxious weeds. Promote dialogue between wildlife managers, landowners, and land managers to develop horse management plans based on common priorities. Provide outreach to explain the issue to the public and the impacts of unregulated herds on wildlife and habitat.

Limiting Factor: Damage to Microbiotic Soil Crusts

The soil surface of many sagebrush habitats is made up of a community of lichens, bryophytes, algae, bacteria, and fungi that make up the microbiotic soil crust. These soil crusts contribute to biodiversity and nutrient cycling and improve soil stability and structure but are sensitive to disturbance. Unmanaged grazing, agricultural practices, development, and unregulated OHV use can damage soil crusts, which leads to soil erosion, changes in plant species composition and structure, and degradation by invasive plants.

Recommended Approach

Because most of the Columbia Plateau ecoregion is privately-owned, **voluntary cooperative approaches** are the key to long-term conservation in this ecoregion. Use tools such as financial incentives, technical assistance, regulatory assurance agreements, and conservation easements to achieve conservation goals. Work with public land managers to ensure grazing is carefully managed and that soil crusts are considered in management plans. Create effective travel management laws for off-highway vehicle use that can be successful and enforced.

Limiting Factor: Conversion to Other Land Uses

Remnant shrub-steppe habitats are subject to **land use conversion,** such as to agriculture, urban and rural development, and energy projects. For example, in the Columbia Plateau and Northern Basin and Range ecoregions, thousands of acres are being converted to largescale solar energy projects. Large solar array installations can impact wildlife habitats and block migratory corridors with the development footprint or through exclusion by project fencing. Mining exploration and development also contribute to sagebrush habitat loss with both a direct loss as a result of the mine development and extraction processes, and indirect impacts such as runoff as a result of the mining operations. Recreation can have negative impacts from off-highway vehicles or dispersed camping in sensitive habitat or during wet seasons. In the Blue Mountains and East Cascades ecoregions, rapidly growing human populations, especially near Bend, Redmond, and Madras, are resulting in land use conversion, habitat loss, and habitat fragmentation.

Recommended Approach

Use tools such as financial incentives and conservation easements to conserve priority sagebrush habitats on private lands. For example, re-establishing the shrub component of lands enrolled in the Conservation Reserve Program has helped to restore habitat structure. Work with community leaders and agency partners to ensure that development is planned and consistent with local conservation priorities. Support and implement existing **land use regulations** to preserve farm and range land, open spaces, recreation areas, and natural habitats from incompatible development.

Limiting Factor: Loss of Habitat Connectivity

In the Columbia Plateau, remnant shrub-steppe habitats often occur in small patches, such as roadsides and field edges. These patches are valuable habitat for some species, especially some SGCN plants. However, small size and poor connectivity of remnant patches limit dispersal for sagebrush-associated species.

Recommended Approach

Maintain high priority patches and improve connectivity. (KCI: **Barriers to Animal Movement**)

HABITAT CHANGE TRENDS ANALYSIS

Transition to Juniper Woodlands

Western juniper is distributed across most of eastern Oregon and historically formed open woodlands with sparse understories. After settlement, however, western juniper began establishing and spreading into new areas, often forming dense stands with substantial understories, while open, old growth woodlands declined. With this expansion, juniper has invaded many of the grasslands and shrublands in eastern Oregon, altering the structure and function of many sagebrush habitats.

To investigate juniper encroachment into grassland and sagebrush habitats, the Institute of Natural Resources (INR) compared the total area and spatial overlap of vegetation classes in three baseline maps (1851-1937,1998, 2016). The analysis showed significant increases in the total area of Juniper Woodlands and corresponding losses of Big Sagebrush habitats to juniper encroachment.

By 2016, the total area of Juniper Woodlands had increased by 115% when compared to historical data, largely replacing Sagebrush and Grassland habitats. An estimated 38% of Big Sagebrush habitats were lost to juniper encroachment between 1851 and 1998. Between 1998 and 2016, an estimated 25% of Big Sagebrush habitats were replaced by Juniper Woodlands. This analysis shows that significant efforts by land managers and agencies, such as the BLM and Forest Service, to remove juniper have slowed encroachment in sagebrush habitats in recent years.

RESOURCES FOR MORE INFORMATION

Partners in Flight Conservation Strategy for Landbirds in the Columbia Plateau of Eastern Washington and Oregon

Characteristics of Western Juniper Encroachment into Sagebrush Communities in Central Oregon

For information from the Bureau of Land Management about rangeland issues, fire management, and fire and invasive species assessment tools, see: https://www.blm.gov/learn/blm-library/subject-guides/greater-sage-grouse-subject-guide/documents-and-resources.

Convened by the Governor's Office, the Sage-Grouse Conservation Partnership (SageCon) is a diverse group of stakeholders working together since 2012 to develop an "all lands, all threats" plan to address sage-grouse conservation needs and support community sustainability in Oregon.

Sagebrush and Sage Grouse | U.S. Geological Survey

The SageCon Invasives Initiative | Oregon State University

Threat Based Ecostate Map | Oregon State University

Cheatgrass Toolkit

Defend the Core: Maintaining intact rangelands by reducing vulnerability to invasive annual grasses | Working Lands For Wildlife

Partnering to Conserve Sagebrush Rangelands - IWJV

Sagebrush Conservation Initiative – WAFWA

Sagebrush Resources | Grassland & Sagebrush Conservation Portal

Oregon Department of Agriculture Noxious Weeds webpage

https://sagebrushconservation.org/

REFERENCES

Brunner, R. and E. Gaines. 2025. Oregon Vegetation Change 1851-2023. Trends analysis conducted for Oregon Department of Fish and Wildlife. Institute for Natural Resources, Portland State University, Portland, OR, USA.

Gabler, K. I., J. W. Laundré, and L. T. Heady. 2000. Predicting the Suitability of Habitat in Southeast Idaho for Pygmy Rabbits. The Journal of Wildlife Management 64:759–764.

Hagar, J. C., and G. Lienkaemper. 2007. Pygmy Rabbit Surveys on State Lands in Oregon. US Department of the Interior, US Geological Survey.

Kagan, J., K. Zaret, J. Bernert, E. Henderson, E. Gaines. 2018. 2018 Oregon Habitat Map. Oregon Biodiversity Information Center, Portland State University, Portland, Oregon, USA.

WETLANDS

Wetlands are habitats that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support vegetation typically adapted for life in sodden soil conditions. While dominated by periods of inundation, the natural ecological cycle may also include dry intervals. Permanently wet habitats include backwater sloughs, oxbow lakes, peatlands, and marshes, while periodically wet habitats include seasonal ponds, vernal pools, and wet prairies. The Oregon Department of State Lands identifies many wetland habitats as Aquatic Resources of Special Concern, such as wet prairies, bogs, fens, interdunal, forested and alkali wetlands, which provide functions, values and habitats that are limited in quantity because they are naturally rare or have been disproportionately lost due to prior impacts.

ECOREGIONS

Wetlands are identified as a Key Habitat in all inland ecoregions.

CHARACTERISTICS

Wetlands are characterized by the presence of water, specific types of vegetation, and soil conditions. Wetland habitats are highly diverse and include the following general types, which can be distinguished by differences in their hydrology, vegetation communities and soils:

Alkaline wetlands occur in depressions in more arid areas and are intermittently saturated. An impermeable soil layer prevents water from percolating through the soil, concentrating salts in some areas. Soil salinity varies greatly by soil moisture and type and affects the composition of plant species. Plant species are tolerant of saline conditions due to the concentration of salts by water evaporation. Alkaline wetland vegetation includes salt-tolerant grasses, rushes, sedges, and shrubs such as black **greasewood**. Examples of this habitat type are found in the Klamath Lake and Goose Lake areas of the **East Cascades** ecoregion, and in the **Northern Basin and Range** , **Blue Mountains**, and **Columbia Basin** ecoregions.

Bogs are wetlands that form slowly, which as a result are habitat to rare species. These wetlands are characterized by constant saturation, accumulation of peat, low nutrient availability, acidic soil (pH <5.5), and vegetation that tolerates these conditions. Bogs typically have sphagnum moss, shrubs in the heath family, and if present, evergreen trees tend to be stunted.

Deciduous swamps and shrublands occur in depressions, around lakes or ponds, or on river terraces. They generally flood seasonally with nutrient-rich waters and are dominated by woody vegetation, including willows, hardhack, alder, red osier dogwood, Pacific crabapple, and ash.

Marshes (including emergent marshes) occur in depressions, fringes around lakes, and along slow-flowing streams, especially in valley bottoms. Marshes are seasonally or continually flooded and have water-adapted plants, such as sedges, bulrushes, spikesedges, rushes, cattails, and floating vegetation. Marshes can have mucky soils, resulting in water with high mineral content and vegetation dominated by herbaceous species. Saltmarshes and tidal marshes are flooded and drained by tides. In brackish estuaries, they provide habitats for both freshwater and marine fish and wildlife.

Off-channel riverine habitats, such as oxbow lakes, stable backwater sloughs, and flooded marshes, are created as rivers change course. They have less current than the main channel, with slower-moving or standing water. These areas provide important rearing habitats for young fish as well as refuge from high flow events, especially during the migration of young salmon to the ocean. These habitats may also support an array of aquatic plants, marsh grasses, and terrestrial vegetation.

Seasonal ponds and vernal pools hold water during the winter and spring but typically dry up during the summer months. Vernal pools are seasonally inundated depressions underlain by an impermeable claypan or hardpan layer, occurring in complexes of networked depressions that vary by region. For example, vernal pools in the Columbia Plateau may be located on shallow basalt bedrock. They host a variety of plant and animal species with unique adaptations. These habitats can be very important for native invertebrate species (e.g., **vernal pool fairy shrimp**), plants (e.g., **big-flowered wooly meadowfoam**, **Cook's desert parsley**), **amphibians**, and **birds**. For example, native amphibians may be able to reproduce in the short time frames when water is present in seasonal ponds, while invasive non-native bullfrogs cannot. This reproductive advantage can help native amphibians that are sensitive to competition and predation from bullfrogs. Drying vernal pools can provide nesting habitat for **streaked horned larks**.

Wet meadows (including montane wet meadows) occur on gentle slopes near stream headwaters, in mountain valleys, bordering lakes and streams, near seeps, in large river valley bottoms, and in open wet depressions among montane forests. Montane wet meadows may have shallow surface water for part of the year, are associated with snowmelt, and are not typically subjected to disturbance events such as flooding. Wet meadows are dominated by tufted hairgrass, sedges, certain types of grasses, spikesedge, rushes, and wildflowers.

Wet prairies (including wet rock outcrops) occur in lowlands (valley floors), especially in floodplains, whereas wet meadows occur in depressions surrounded by forests and are associated with snowmelt. Wet prairie wetlands usually dry out by late spring, although depressions may retain water longer. Wet prairies are dominated by grasses, sedges, and wildflowers including camas. In the Willamette Valley, very few historic wet prairies remain, and these remnants are key to dependent species such as grassland birds and several federally listed rare plants.

[Spotlight] Beaver Habitat and Beaver Modified Habitat

Beavers are widely distributed across Oregon SWAP Key Habitats statewide, including Flowing Water & Riparian, Wetlands, and Aspen Woodlands.

Beaver habitat, or habitat for beaver, is the specific combination of water, food, cover, and space that beaver need to support their survival on the landscape through time. Beaver are semi-aquatic species that require still or slow-moving, perennial water at stable depths for cover, protection from predators, access to food resources, and food storage in the winter. Beavers are slow on land and prefer to forage within 100 feet of their water source. They need sufficient early seral stage stream buffers of deciduous and herbaceous riparian vegetation for food and foraging activities. Beavers are highly territorial and require adequate habitat quality and stability to support their occupancy on the landscape. In rivers and stream networks, one beaver family unit needs approximately 0.5 to 1.5 linear stream miles for ample space to survive, reproduce, and thrive. **Beaver habitat**, habitat for beaver, supports the building blocks that beaver need to create **beaver-modified habitats**, or habitat by beaver.

Beaver-modified habitat, or habitat by beavers, are the specific conditions beaver create when they alter their terrestrial and aquatic habitat to improve their fitness and survival. These habitat modifications include denning, damming and ponding water, creating canals or side-channels, importing woody and vegetative materials into flowing water and wetlands, and changing the structure of riparian vegetative communities. This suite of habitat modifications and their cumulative effects can provide benefits such as increased complexity and connectivity of Key Habitats and habitat, structure, and refugia for SGCN. Nevertheless, beaver activity can also result in flooding, loss of vegetation, economic loss on working lands, and conflict with private landowners. Actions focused on beaver habitat and beaver-modified habitats should also include efforts to mitigate negative impacts and reduce potential conflicts.

Factors that are currently limiting habitat for beaver include declining surface water availability, altered floodplain disturbance regimes, conversion and loss of wet meadow and wetland habitats, and altered riparian vegetation communities.

ECOREGIONAL CHARACTERISTICS

Blue Mountains

In the Grand Ronde and Baker Valleys, much of the lower elevation wetlands have been drained and converted to agriculture. Most remaining wetlands in this ecoregion are found in high-altitude basins and depressions, although some important valley bottom wetlands occur along rivers and streams, in floodplains, and in basins and depressions that collect runoff or groundwater. **Ladd Marsh Wildlife Area** offers an example of the importance of intact wetland habitat for wetland dependent species.

Coast Range

Salt marsh habitats provide vital stopover points for migratory birds and support a diversity of marine species. Wetlands in this ecoregion are vulnerable to development, especially as coastal populations grow. The ecological processes that create coastal wetlands, such as landslides, beaver activity, or logjams blocking streams, often are not compatible with current land uses, especially in more developed areas. Early planning that allows for appropriate riparian buffers along coastal rivers and streams can maintain many important wetland and stream functions, including flood control, water retention and storage, shading, and decreased contaminant inputs. Many of these functions will help to maintain higher stream flows and lower water temperatures in months with less precipitation. The Coast Range ecoregion is also home to **Darlingtonia State Park** where a serpentine wetland has a population of rare Darlingtonia (pitcher pants). This park demonstrates the variety of wetland habitats and the plants that inhabit them.

Columbia Plateau

Historical wetlands along the Columbia River have been inundated by reservoirs, while floodplain wetlands along the Umatilla and Walla Walla rivers and other tributary streams have mostly been developed for agriculture. This ecoregion once had extensive springs and vernal pools, many of which have been lost as water tables lowered. Currently, many wetlands in this ecoregion are man-made, such as marshes established along the edges of reservoirs and wetlands created as a result of crop irrigation practices. The **Wanaket Wildlife Area**, managed by the Confederated Tribes of the Umatilla, is a network of wetlands created through irrigation of pastureland that provides important habitat for many wetland-dependent species. Similarly, ponds on the Umatilla National Wildlife Refuge use runoff from the fish hatchery to support seasonally wet shallow pools for migrating shorebirds and to provide breeding habitat for amphibians. Irrigation wetlands in this ecoregion can provide important habitat but can also be adversely impacted by runoff containing fertilizers or other chemicals.

East Cascades

The upper Klamath Basin once had an extensive shallow lake and marsh system, but much of that system has been lost due to drainage and conversion to agriculture and urban uses. These changes have contributed to the complex issues surrounding water use and species conservation in the basin. The remaining wetlands in the Klamath Basin support one of the largest concentrations of waterfowl in North America, with millions of ducks, geese, and other waterfowl migrating through the basin annually. In the winter, the Klamath Basin hosts the largest assemblage of wintering Bald Eagles in the continental United States. The Klamath Basin provides Oregon's only permanent nesting areas for **Red-necked Grebes** and most of the nesting areas for **Yellow Rails**. High quality wetland habitats are also found in the Upper Deschutes River Basin.

Klamath Mountains

Most low-elevation, seasonal wetlands have been lost due to conversion to agriculture, urban and rural residential uses, energy development, and transportation systems. Altered hydrology and upland activities like groundwater withdrawal impact many remaining wetland habitats. High elevation wetlands are severely impacted by livestock grazing. Scarce vernal pool wetlands in the Agate Desert near Medford support several rare plant and animal species. These vernal pool wetlands are formed in areas with unusual topography and soil layering and are very difficult to replace when ground is leveled for development.

Northern Basin and Range

The **Northern Basin and Range** ecoregion contains several large, deep freshwater marshes. Significant wetlands are associated with the large lake basins, including Lake Abert, Summer, Malheur, and Harney Lakes, and the Warner Basin. However, many of the ecoregion's smaller historical wetlands have been lost due to conversion or degradation from stream channelization, water use, water diversions, and historical overgrazing. Creation of watering holes for livestock and wildlife has altered the hydrology at many major alkaline wetlands, making them one of the most altered habitat types in the ecoregion.

In some areas, flood-irrigation of private pasture and hay meadows provides important seasonal habitat for migrating and breeding birds. Nevertheless, flood irrigation can negatively impact water quality, increase sedimentation, and increase water loss due to evaporation. Cooperative projects, such as settling ponds designed for cleaning flood irrigation "tail water", or conversion to piped sprinkler systems may offer a way to address water quality issues.

West Cascades

Wetlands in this ecoregion are generally in good condition, although some areas, such as those located around Mt. Hood and Mt Jefferson, can be impacted by uncontrolled livestock grazing, camping, or off-highway vehicle use. **Climate change** projections estimate that wetland hydrology in the West Cascades could be impacted by shifts in rainfall and snowmelt and increasing temperatures.

Willamette Valley

Almost all remaining wetlands in this ecoregion have been degraded to some degree by altered water regimes, pollution, and invasive plants and animals. The Willamette Valley ecoregion also used to have extensive networks of off-channel habitat, deciduous swamps and shrublands, marshes, seasonal ponds, and vernal pools. However, most of these habitats have been lost to agriculture and urbanization.

Wetlands in the Willamette Valley serve important ecological functions for communities, provide habitat for amphibians, reptiles, birds, and fish, and offer key bird and fish migratory pathways. Once an abundant ecosystem within the Willamette Valley, native wetland prairies have declined dramatically in extent since the mid-1800s due to a variety of factors including a growing human population, agricultural conversion, urbanization, drainage, and colonization by invasive and woody vegetation. In particular, wetland prairie habitat is regarded as one of the most imperiled in the Willamette Valley ecoregion.

CONSERVATION OVERVIEW

Wetlands and wet meadows provide important habitat for migrating and breeding shorebirds, waterbirds, waterfowl, songbirds, invertebrates, mammals, amphibians, and reptiles. Floodplain wetlands and backwater sloughs and swamps are important rearing habitats for juvenile salmon. Wetlands have direct value for people because they improve water quality by trapping sediments and pollutants, recharge aquifers, store water and carbon, stabilize erosion, and reduce the severity of floods. Seasonal wetlands that dry up during the summer provide important ecological functions, such as supporting water quality and sequestering carbon.

With most wetlands in private ownership, working with landowners to restore and manage wet meadow systems and other wetlands can increase sustainable production of forage for livestock and increase late-season stream flows while also providing fish and wildlife habitats. Restoration and retention of wetlands, especially those with high water storage potential in arid regions, may help to maintain ground water levels into drought periods.

Even when converted to pasture ponds, highly productive off-channel habitat is present if hydrologic connections are maintained.

In general, wetlands across the state face a range of pressures from human activity and environmental changes. Wetland loss is primarily due to land conversion for agricultural, urban, rural, and energy development, or infrastructure projects. Most wetland habitat loss has occurred at lower elevations and valley bottoms. Invasive species can quickly take over degraded wetlands, leading to loss of function. One of the most pervasive invasive plant species is reed canary grass, which will dominate a wetland, degrading its ecological function and outcompeting native species. **Climate change** is expected to affect Oregon's wetlands through shifting precipitation patterns, increased droughts, more high severity wildfires, and warmer temperatures.

[SPOTLIGHT] White-faced Ibis

The White-faced Ibis is a colonial breeding bird that breeds in semi-permanent wetlands that are regularly impacted by drought and floods. This bird is highly nomadic, allowing it to compensate for poor conditions at traditional colony sites by moving between years to new breeding locations, resulting in local population fluctuations and colony abandonment in response to system dynamics.

Oregon has historically been peripheral to the core of the range of the White-faced Ibis in the intermountain west, recorded sporadically during the 19*th* century and with the first documentation of a breeding colony in the state in 1908. Breeding colonies were established in Oregon periodically in the following decades, becoming more common towards the end of the 20*th* century with an estimate of about 4000 pairs in Oregon in the early 90s. Prior to 1984, most of Oregon's ibises were located in central Malheur Lake, though colonies have since been documented in Lake, Harney, and Klamath Counties.

This nomadic nature highlights the importance of considering the regional context in management decisions and population monitoring, to allow land managers to understand the bigger picture of how wetland management in their area relates to the whole. With increasing impacts from climate change and mega-droughts throughout the intermountain west, wetland conservation in Oregon may become more and more important to the conservation of White-faced Ibises within the Great Basin.

LIMITING FACTORS AND RECOMMENDED APPROACHES

Limiting Factor: Habitat Loss

A high percentage of low-elevation and valley bottom wetlands have been lost or degraded through diking and draining, particularly in the Klamath Mountains and Coast Range ecoregions. In other areas, overgrazing has lead to soil compaction, changes in plant species composition, and spread of invasive plants. Due to short growing seasons and other factors, degraded wet meadows can be slow to recover if overgrazed. Saltmarshes have experienced substantial losses over historical condition from diking, installation of tide gates, draining, and filling of tidally influenced marshes. Wetlands provide vital habitat for migrating shorebirds and waterfowl. Loss or degradation of wetland habitat in the Pacific Flyway could potentially have large impacts on bird populations while early season haying in wetland habitats can result in poor reproduction of ground-nesting birds due to destruction of nests and direct mortality of young.

Many wetlands are lost through urbanization, which involves filling or draining the wetland for development. Unfortunately, this removes wetlands from locations where the functions they provide might have the most value for SGCN. Maintaining wetland and adjacent habitats provides social benefits, such as storage of flood water and treatment of contaminants before reaching streams and ground water.

Recommended Approach

Protect and conserve priority wetland habitat that provides vital breeding habitat for **Species of Greatest Conservation Need** and stopover sites for migrating species (KCI: **Barriers to Animal Movement**). Identify wetlands that have been altered or lost and determine their potential for restoration. Build upon current cooperative efforts to maintain and restore wetlands in partnership with private and public landowners. **Cooperative voluntary approaches** are important for wetland conservation on private lands. Continue to provide incentives to protect, maintain, or restore wetlands, such as the **Wetland Reserve Enhancement Partnership (WREP)** offered through the Natural Resources Conservation Service and private mitigation banking. Prioritizing development of **wetland mitigation banks** to support SGCN also provides a strategic landscape approach to addressing wetland loss.

Develop and implement grazing regimes that are compatible with wet meadow conservation objectives. Use cooperative efforts and incentive programs to establish semi-permanent livestock exclusion zones in priority areas. In partnership with landowners, implement later haying dates in critical bird nesting areas (see **The Willamette Valley Landowner's Guide to Creating Habitat for Grassland Birds**). Manage beaver populations to contribute to wetland creation and maintenance, when compatible with existing land uses.

Promote outreach and education programs to educate individuals, communities, city and county planners, agricultural groups, and forest industries about the function and services provided by wetlands. Work with the **local planning process** and the **Oregon Department of State Lands** to promote the value of maintaining wetlands and habitat corridors, especially along floodways, where they can best function to protect structures, infrastructure, and water quality.

Limiting Factor: Drought

Drought affects the quality and extent of wetlands across the state. Drought has resulted in less precipitation, interception, infiltration, and percolation of water into the soil, falling water tables, increased evaporation, decreased transpiration, decreased plant and animal diversity and distribution, and the acidification, cracking, and compaction of wetland soils. These changes in hydrology and soils affect plant and animal diversity, connectivity with other aquatic resources and upland habitats, the proportion of invasive plant species in the wetland, and wetland functions. Climate change patterns are expected to exacerbate and or extend drought periods resulting in wetland loss of acreage and functional changes.

Recommended Approach

Educate the public and water users to conserve water. Look for opportunities to restore and enhance wetlands (i.e. Barnes and Agency Wetland Restoration- Upper Klamath National Wildlife Refuge), reuse water for multi-benefit solutions, and improve wetland habitat through water use efficiencies (i.e. Lower Klamath and Tule Lake National Wildlife Refuges). Coordinate with ODFW Fish Passage and District Fish Biologist staff on appropriate approvals for instream, beaver-mimicry (e.g., beaver dam analogs, small and/or large wood structures) and/or coexistence (e.g., pond levelers, culvert exclusion devices) structures to raise the water table, restore wetland and waterway connections, and improve habitat conditions (i.e. Sprague Watershed).

Limiting Factor: Water Quantity

Water is extremely limited in much of the Blue Mountains, East Cascades, and Northern Basin and Range ecoregions. As a result of water availability, there is competition for water resources, particularly in late summer. Lowered water tables affect wetland habitats. Competition for water harms both ecological and economic goals. Water diversions for other uses change the seasonality of flooding, slow habitat recovery, and increase invasion of non-native grasses. Drought years intensify water shortages.

Recommended Approach

Use cooperative efforts and incentive programs, such as financial incentives for wetlands restoration, water rights acquisition, and wetland mitigation banking, to manage water allocation and wetland habitats. Implement water conservation actions, where possible, to increase availability (quantity, timing, and duration).

Limiting Factor: <u>Degraded Water Quality</u>

Although wetlands have a role in purifying water, water quality is poor in some wetland systems. High temperatures affect water quality in some areas. Non-point source runoff from agricultural and residential areas contains pollutants that can affect water quality and nutrient levels, and these levels may increase as water evaporates throughout the season. High nutrient loads can contribute to toxic algal blooms.

Recommended Approach

Provide incentives to decrease and manage the release of potential contaminants, such as fertilizers or pesticides, by controlling the timing of application. Use incentives to promote substitutes that are less toxic to wildlife and break down quickly in the environment. Promote the creation of stormwater treatment projects, fencing of aquatic habitats to exclude livestock, and restoration of riparian buffers and additional wetlands to increase filtering capacity. Support irrigation systems that conserve, re-collect, and re-use water more effectively, use gray water, and provide shaded treatment areas that can provide cooling and habitat. In the Willamette Valley, adopt critical actions recommended by the **<u>Willamette Restoration Initiative</u>** on Clean Water, such as: reduce the levels of toxins and other pollutants in the Willamette Basin, provide incentives to decrease water pollution, and promote education and outreach programs for landowners.

Limiting Factor: <u>Invasive Species</u>

<u>Invasive species</u>, such as reed canary grass, purple loosestrife, ludwigia and Japanese knotweed, invade and degrade wetlands, thereby displacing native plants, reducing plant community diversity, reducing sources of food for wildlife, and altering water flow and storage function. Invasions of non-native grasses, such as reed canary grass, can also create conditions more prone to wildfires.

Invasive, non-native carp can impact wetlands by consuming important plants and by increasing turbidity, disturbing sediments, and altering biological dynamics for sediment-associated plants and animals. Turbidity also contributes to higher water temperatures and lower levels of dissolved oxygen. Non-native bullfrogs have had a devastating impact on native amphibians and reptiles, leading to the extirpation of Oregon spotted frog and leopard frogs from much of their historic range. Emerald ash borer is now present in the Willamette Valley and threatens to cause extensive losses to ash trees, which are a critical component of off-channel wetland habitats.

Native trees and shrubs can become invasive due to the exclusion of fire from wetlands. Without fires from natural ignitions and Indigenous peoples cultural burning practices, encroachment by native vegetation can overwhelm wetlands and out compete wetland grasses and flowers by reducing water availability, shading, and changing soil chemistry.

Recommended Approach

Emphasize prevention, risk assessment, early detection, and quick control to prevent new invasive species from becoming fully established. Control key invasive plants using site-appropriate tools, such as flooding (reed canary grass), biological control (purple loosestrife), and mechanical treatment including mowing. Use chemical treatment carefully and where compatible with water quality concerns, focusing on spot treatment during the dry season. Consider screening or adjusting water levels to control carp. Use revegetation and other means to establish and maintain native plant communities that are relatively resistant to invasion and that also meet other land use objectives.

RESOURCES FOR MORE INFORMATION

Oregon Department of State Lands, Wetlands

Oregon Wetland Program Plan

Oregon Statewide Wetlands Inventory

Practical Guidelines for Wetland Prairie Restoration in the Willamette Valley, Oregon: Field-tested Methods and Techniques

Klamath Wetland Restoration

Williamson River Delta Wetland Restoration

Harney Basin Wetland Collaborative

Partnership for Lake Abert and the Chewaucan

NEARSHORE HABITATS

Nearshore Habitats encompass the coastal and marine habitats in the area from the 3 nautical mile outer limit of Oregon’s territorial sea, where water depths average 66 m and range from 17 m to 194 m (56 to 308 ft), to the supratidal areas of the shoreline affected by wave spray and overwash at extreme high tides.

Nearshore Habitats describe the Coastal and Marine Ecological Classification Standard (CMECS) habitat classification approach (see **Appendix - Marine Habitat Classification**) for the major habitat types found in Oregon’s nearshore, including neritic, soft bottom subtidal, rocky subtidal, rocky shore, sandy beaches. For information on Estuaries, which also occur in the nearshore, see the **Estuaries** Key Habitat.

ECOREGIONS

Nearshore Habitats are a Key Habitat in the **Nearshore Ecoregion**.

CHARACTERISTICS

Neritic Habitat (Open Water)

The neritic habitat encompasses the waters and biological communities over the continental shelf, including nearshore and offshore marine subsystems as defined by CMECS. It spans the surface, upper water column, pycnocline, and lower water column, extending westward to the continental shelf break at about the 200 m depth contour. Constantly in motion, this habitat is shaped by the California Current System, seasonal upwelling and downwelling, El Niño/La Niña events, and the Pacific Decadal Oscillation, which all drive water movement across various time scales.

The CMECS biotic component identifies planktonic biota as the primary setting, with species composition varying by water mass. The ecology of the neritic habitat is affected by processes taking place at scales varying from global to local. The dynamics of the neritic habitat affect all the other habitats described later in this section.

Physical Environment

Many physical and chemical environmental factors affect neritic ecology. These factors include but are not limited to solar light and radiation influence, salinity, temperature, layer position, physical mixing, hydrostatic pressure, biogeochemical composition, atmospheric exposure and influence, surface and underwater currents, swells, waves, and water mass movements. Many of these factors can change by location and time of year. The neritic habitat encompasses many water column habitats that shift, expand, and contract over time and space in both predictable and stochastic patterns.

Coastal upwelling is perhaps the most defining feature of Oregon's neritic habitat with its alternating upwelling-relaxation events. Upwelling is a water column hydroform, described by CMECS as an upwardly-directed current caused by divergence of water masses. In spring and summer months, strong northerly winds push surface and upper water layers westward towards the deep ocean. This movement causes deep, cold, oxygen-poor but nutrient-rich waters to rise to the surface near the coast replacing the water that was driven offshore. These nutrients, brought to the upper layers of the water column, help propagate and sustain the rich biota of Oregon's coastal waters. The relaxation events, when the northerly winds briefly cease or reverse, allow the upper water layer to move back towards shore bringing its rich biotic content with supplies of food, larvae, and juvenile organisms. In the fall and winter months when winds blow predominantly from the south, the surface and upper water layers move shoreward and downward in a process called downwelling. Downwelling is an important part of the annual seasonal cycle that forces oxygen rich waters from the upper layers downward in the water column. Surface water temperatures provide a good indication of these seasonal wind forcing differences that bring the cold, nutrient-rich waters to the surface in the summer and the warmer waters from offshore to the coast in the winter (see **Nearshore Ecoregion**).

Large-scale changes in water masses, temperatures and currents result in changes in plankton species composition and abundance, which impact the survival and distribution of organisms within coastal and oceanic ecosystems. These large-scale oceanic events, such as El Niño/La Niña and the Pacific Decadal Oscillation, occur at multi-year or decadal time scales.

Another water column component that affects Oregon's neritic habitats is river plumes. CMECS does not characterize the marine waters affected by these plumes as estuarine because they are not meaningfully enclosed by landforms. Riverine waters entering the ocean often carry high concentrations of nutrients, create gradients in salinity, cause physical mixing, and create areas of high turbidity. Large river plumes, such as that from the Columbia River, may serve as a microhabitat within neritic habitats and can potentially act as biogeographic barriers between marine areas to the north and south. The Columbia River plume stretches hundreds of miles offshore and shifts predictably over the course of each year. In the summer the plume spreads south and offshore from the river's mouth, while during the winter the plume is found to the north of the river mouth and is usually directly adjacent to the coast. This plume has important ecological effects, not only to neritic habitats, but to nearshore and offshore habitats as well. The oceanographic fronts created by the Columbia River plume in the marine systems generate productive conditions that attract many species of invertebrates, fish, seabirds, and marine mammals.

Biological Characteristics

Neritic habitats support two basic types of marine organisms: plankton and nekton. Planktonic organisms live in the water column and are incapable of swimming against currents, instead drifting with them. Plankton are often categorized as either phytoplankton or zooplankton. Phytoplankton are microscopic photosynthesizing organisms (e.g., diatoms), and are the primary producers that form the base of the marine food web. Huge surges in phytoplankton populations, known as “blooms,” are commonly associated with upwelling events. Zooplankton are heterotrophic organisms that range in size from microscopic single-celled organisms to enormous jellyfish a meter or more in diameter. Some plankton, called holoplankton, like many diatoms, copepods, krill and jellyfish spend their entire lives as drifters in the water column. Many species like sea urchins, mussels, crabs, some snails and many fishes have planktonic stages as eggs or larva, called meroplankton, before either settling to the bottom or growing large enough to be nekton. The CMECS biotic component uses these planktonic classes and subclasses to describe the open water neritic zone. They can be further refined by taxonomic groups and communities that are dominant in any given area of interest. Dramatic changes in plankton communities occur in Oregon waters with water masses changes. For example, warm water species are brought into nearshore water with El Niño events.

In contrast, nektonic marine organisms are capable of swimming against currents and include animals such as adult crustaceans, mollusks, and vertebrates. Highly migratory and schooling species are typical of nekton in neritic habitats. Many species of invertebrates, fish, birds, and marine mammals travel and forage within this habitat.

Many nearshore Species of Greatest Conservation Need (SGCN), Watch List and commonly associated species utilize the open water neritic habitat during their life history (see **Appendix - Nearshore Species**). Many forage fishes such as northern anchovy, Pacific herring, topsmelt, Pacific sardine, surf smelt, Pacific sand lance and longfin smelt feed in this open water neritic habitat. Juvenile rockfish are found in the water column. Breeding birds such as Tufted Puffin and Common Murre are central place foragers that feed on the forage fish and other species while nesting. The majority of nearshore SGCN depend on this habitat for some phase of life. This is also the habitat that supports primary production by phytoplankton and secondary production by zooplankton, which is at the base of the food web for the nearshore ecosystem. Ocean currents transport and disperse larvae and juveniles of many invertebrate and fish species throughout the region.

Human Use

Human uses of the neritic habitat include commercial and recreational fishing, nonconsumptive recreational pursuits such as boating or whale watching, scientific research, commercial maritime transportation, and military operations. Development of renewable energy sources from both wind and waves is an emerging use of the neritic habitat.

Soft Bottom Subtidal

Soft bottom subtidal habitat includes all of the unconsolidated substrate areas (e.g., mud, sand, granule pebbles and various mixes thereof) on the ocean bottom. Soft bottom subtidal habitats are characterized by CMECS as being within the subtidal zones of the nearshore and offshore marine subsystems. Subtidal soft bottom habitats are diverse based on distinct organism assemblages that are influenced by differences in substrate type (sand vs. mud), organic content and bottom depth. The distribution and relative abundance and mixes of these substrates are not yet well described for much of Oregon's nearshore ocean waters.

Physical Environment

The primary substrate types in Oregon's soft bottom subtidal areas range from sand to pebble. CMECS defines unconsolidated mineral substrates based on particle diameter. Here we consider soft bottom habitats to be composed of the various mixes defined by CMECS of particles <64 mm in diameter. Because the Oregon coast is primarily an exposed, high-energy environment, most soft bottom subtidal areas are sandy. However, mud can be the more prevalent substrate type in areas receiving less energy from water movement, including isolated and sheltered areas, and deeper areas. The distribution of these unconsolidated sediment types in Oregon waters is influenced by currents in both the nearshore and offshore subsystems. Areas close to outfalls and discharge pipes would be expected to show localized differences based on the displacement of substrate and the increased availability of organic and small particulate material. The smaller the particle size, the smaller the pores (or spaces between the particles) are. Pore size dictates the amount of water and the water chemistry of the substrate, which can define what types of organisms can live in that sediment.

Biological Characteristics

Most soft bottom subtidal communities are dominated by infaunal (burrowing) invertebrates such as polychaetae worms. However, other organisms such as crustaceans, echinoderms and mollusks may be locally abundant. Common epifauna (found on the sediment surface) can include species of shrimp, crabs, snails, bivalves, sea cucumbers, and sand dollars. Dungeness crab are an important component of soft bottom subtidal communities and are found both on the surface as well as buried in the substrate. Sea pens (*Ptilosarcus* sp.), colonial relations to sea anemones, are common on more muddy bottoms. In some areas of the coast, shallow sandy habitats support extensive beds of dense sand dollars that may extend miles in length. Common fish in this area include several species of flatfish (e.g., sanddab, English sole, and sand sole), and important burrowing forage species such as Pacific sand lance and sandfish.

Species associated with soft bottom subtidal habitats provide a spectrum of ecosystem services. Most widespread but least apparent of these services are the nutrient cyclers:

deposit feeders and microbes living within the sediments. Emergent species such as sea pens are only found in this habitat. There are a vast array of worms and other invertebrates that live in the soft subtidal bottom. Soft bottom habitats are important to many SGCN, Species of Greatest Information Need (SGIN), Watch List and other commonly associated species at various life stages (see **Appendix - Nearshore Species**). For example, big skate, starry flounder, sand sole, Pacific sand lance burrow or cover themselves to hide in these sediments. Gray whales feed by sifting buried amphipods from the sediments and scooping clouds of mysid shrimp from above the sediment surface sometimes at the edges of rocky reefs. Many invertebrates like razor and native littleneck clams live in the subtidal soft bottom habitat. Both juvenile and adult Dungeness crab forage here and sometimes hide in these soft sediments. The young of commercially valuable fish species can often be found here and utilize these areas as nursery habitat. The young of many species use the nearshore area for foraging and are themselves prey for larger fishes and birds. Sand lance is a particularly valuable forage species for birds, other fishes, and marine mammals. Diving birds such as the Common Murre forage for food for their young in soft bottom areas taking juvenile flat fish back to their chicks while they are nesting.

Human Use

Commercial and recreational harvest of Dungeness crab, surf perch, and species of nearshore flatfish are the principal human uses of the soft bottom subtidal habitat. Sand and mud from dredging projects are sometimes deposited over soft bottom habitats. Soft bottom subtidal habitats could also soon be utilized for siting renewable energy projects and their associated infrastructure. Finally, the soft bottom subtidal offers many opportunities for scientific research

Rocky Subtidal

Rocky subtidal habitat includes all hard substrate areas of the ocean bottom. The geologic origin substrate components include cobble and boulder in the CMECS unconsolidated mineral substrate class and bedrock and megaclasts in the rock substrate class. Anthropogenic origin hard substrates are also here. Anthropogenic reefs include any areas where hard, persistent material has been placed either purposely or accidentally by humans. Examples include rock jetties at the entrance to many bays, shipwrecks, anchoring systems for renewable energy projects, and unburied portions of underwater cables or pipelines. Rocky subtidal areas are often referred to as reefs, rocky reefs, rocky banks, pinnacles, or “hard bottom.” Rocky subtidal habitats, including both the natural and anthropogenic components, are characterized by CMECS as being within the subtidal zones of the nearshore and offshore marine subsystems. Although most areas are never exposed to air, the CMECS subtidal definition does include areas that are exposed intermittently each month when tide levels fall below the Mean Lower Low Water (MLLW) level. Rocky subtidal habitats are found in both the nearshore subsystem and offshore subsystem and some of the differences are discussed below.

Some rocky subtidal areas are extensions of shoreline rocky features such as headlands, cliffs, or rocky intertidal habitat, while others exist as isolated regions of rock surrounded by habitat with soft bottom substrate. Rocky reefs have varied topography; some may barely come above the surrounding seafloor, while others may rise from the seafloor many meters, or extend above the surface to form islands in the Territorial Sea. There are more than 1,800 islands off the coast of Oregon, the bases of which form rocky subtidal habitat.

Physical Environment

The physical characteristics of rocky subtidal habitats reflect proximity to shore, depth of the water, local seafloor geology, erosional forces, and biological influences. The geology of many rocky subtidal areas mimics the geology of adjacent landforms, often consisting of erosion-resistant basalts or metamorphic rock common in Oregon’s rocky headlands. Over geologic time, the underwater rock features have been uplifted, bent, deformed, and alternately exposed to ocean and terrestrial erosional forces as successive ice ages and geologic forces caused massive sea level changes. These forces have shaped a variety of physical habitat features within reefs, including flat rocky benches, stacks, jagged ridges, broken boulder fields, and a vast number of cracks and crevices that provide shelter and substrate to abundant life.

Oceanographic processes and features strongly influence the rocky subtidal environment. Subtidal reefs are exposed to pounding wave action, underwater currents, and the physical and chemical properties of the water. These factors in turn influence the biological community on the reefs. Generally, nearshore reefs are more exposed to wave action than offshore reefs, and the wave action is much stronger in winter than during summer. Wave action is a key factor in determining the types of organisms that can live on the very shallow reefs. Ocean currents vary widely by location, time of year, and over tidal cycles. Currents influence reefs in a variety of ways including direct erosion, sand scour or burial of reef areas, and movement of organisms to and from reefs, including plankton and larva. Large-scale or long-term variation in the ocean environment such as upwelling, seasonal current directional shifts, shifts in ocean circulation, water temperature variation, local and global weather patterns, ocean acidification, and biological processes combine to determine the ambient chemical and physical composition of the water in rocky subtidal habitats. The CMECS water column components can be used to describe important features of the waters surrounding and overlying rocky reefs that are important in shaping the biological communities which live there.

The 30 m depth contour is defined by CMECS as the boundary for the nearshore subsystem and the offshore subsystem. Nearshore rocky reefs differ from offshore reefs in some key physical characteristics. Light penetration is adequate to support algal life on nearshore reefs, while offshore reefs support far less algal growth. For example, kelp is only found in nearshore subsystem rocky areas. Wave action, currents, and storms produce a higher energy environment on nearshore reefs than their deeper counterparts. Organisms adapted to higher energy environments are more prevalent in the nearshore area. On some reefs, strong currents can scour and seasonally bury or expose the rocks with sand, considerably influencing the types of organisms that can utilize those rocky subtidal environments.

Biological Characteristics

Subtidal rocky reefs are known for their abundant and diverse biological communities. The variety in topography, substrate characteristics, and depths within and among rocky reefs produces a plethora of microhabitats, often within relatively small geographic areas. This in turn provides for a diversity of species adapted to life in these different microhabitats. Habitat-forming organisms, such as kelp or attached invertebrates, provide additional microhabitats used by reef species.

Most nearshore rocky reefs have rich algal, invertebrate, fish, bird, and marine mammal communities. Depending on water depth, light penetration, wave energy, and other physical and biological processes, algae and macroalgae can provide extensive or sporadic cover and food for other species in the nearshore subsystem. Algae and macroalgae include encrusting forms that grow close to the rock surface, turf forms that can create a dense layer up to a foot thick or more, subcanopy forms that provide added subsurface habitat structure, and canopy forms that create kelp “forests” which may break the surface of the water. Offshore rocky reefs in deeper water do not have kelp forests. Free-swimming (nektonic), drifting (planktonic), and attached invertebrates are common in both the nearshore and offshore rocky subtidal habitats.

Many Nearshore SGCN, SGIN, Watch List, and other commonly associated species inhabit rocky subtidal habitats (see **Appendix - Nearshore Species**). These include many fish as well as a wide variety of filter or suspension feeding invertebrates attach to hard substrates such as sponges, anemones, barnacles, bryozoans, hydrozoans, tunicates, and cold water corals. Mobile invertebrates abound here as well. Red and purple urchins, red and flat abalone eat algae attached to the rocks. Ochre, sunflower and other sea stars forage in subtidal rocky habitats as do crabs, shrimps, brittle stars, nudibranchs, chitons, and worms.

The diversity of producers and consumers found in the rocky subtidal creates complex food webs and interdependence among organisms. Reefs are linked to surrounding environments by ocean currents and organism movements. Reef topographic structure often slows currents, enhancing the local community’s ability to capture drifting organisms, an effect enhanced by the occasional presence of large kelp beds. Many organisms move on and off reefs, some in large-scale migrations and others in short feeding forays to other areas. While most nearshore reef fishes occupy both nearshore and offshore reefs, there are differences in depth preferences of some species and life history stages.

Several fish species depend on nearshore rocky reefs during early life history stages before moving off to deeper reefs, the continental shelf, or other areas as they grow. Conversely, some fish depend on estuaries or rocky intertidal habitat for early life history stages before moving to rocky subtidal areas as adults. For example, kelp greenling, cabezon, and grass rockfish tend to be more prevalent on the nearshore reefs. Canary and yelloweye rockfish move from nearshore to offshore reefs as they grow. Many fish species are entirely dependent on reefs for parts of their life cycle, while others are visitors. Common visitors include herring, smelt, sharks, ratfish, and salmon.

Ecological linkages within and between rocky subtidal habitats help to shape their biological communities and the diversity of species found in this type of habitat. Currents bring in planktonic organisms and transport drifting larvae to and from disparate rocky subtidal habitats. The location of reefs with respect to other “upstream” or “downstream” reefs has a dramatic effect on the types, abundance, and recruitment rates of the reef’s communities and organisms. This complexity of organism interrelationships makes the outcome of natural or human disturbance to reefs difficult to measure or predict.

Kelp beds form a small but important subset of Oregon’s rocky subtidal habitat. CMECS classifies kelp beds as a biotic component of Oregon’s rocky subtidal habitat, and more specifically as canopy-forming algal beds. Kelp canopies in Oregon consist almost exclusively of bull kelp (*Nereocystis luetkeana*), a brown macroalgae that grows from the seafloor to the ocean surface and forms a floating canopy, though a few locations have historically featured small amounts of giant kelp (*Macrocystis pyrifera*). The strip of coast from Cape Arago south has historically contained approximately 92 percent of the state’s kelp beds (Figures 1 and 2). Kelp canopies are relatively scarce habitats in Oregon’s waters, covering less than one percent of the nearshore area. This distribution is driven historically by the locations of subtidal rocky seafloor shallow enough for sufficient light penetration to support kelp growth. More recently, the even more limited distribution reflects reductions in the total abundance of kelp in response to changes in oceanographic stressors such as warming ocean temperatures, marine heat waves, changes in ocean chemistry associated with climate change (kelps need cool, nutrient-rich waters to thrive) and recent increases in populations of grazing sea urchins (see **Specialized and Local Habitats**).

The presence and attributes of kelp beds depend on a number of physical and biological variables. The primary variables determining where kelp might exist include water depth and substrate availability. In Oregon’s waters, kelp beds only form on rocky substrate and are limited to the nearshore subsystem. Beyond that depth, low light levels on the seafloor limit the growth of kelp. However, light and substrate are not the only limiting factors; many rocky reefs in the appropriate depth range rarely or never support kelp beds. Factors that may limit kelp on these reefs include seasonal sand burial of the reef, sand scour of the rocks, overexposure to wave and storm energy, locally high turbidity, lack of nutrients, distance of the reef to “seeding” sources of kelp, abundance of organisms that consume kelp (e.g., sea urchins), and competition with invertebrates and other algae for rock substrate available for attachment. Kelp beds in Oregon display pronounced seasonal and annual variation in extent and density. Bull kelp beds grow rapidly in spring and summer, followed by a winter period when storms dislodge much of the algae, leaving little or no surface canopy. The biomass of kelp beds can also vary ten-fold or more from year to year due to interannual variation in the combinations of physical and biological variables that affect their growth.

Kelp beds are biologically rich habitats due to both the primary productivity of the kelp and the effect kelp beds have on the surrounding environment. Bull kelp is one of the fastest growing organisms in the world, annually providing a large biomass available for consumption directly or as detritus after the kelp dies. Kelp furnishes a vertical habitat structure that otherwise would not exist on the reef. Kelp beds also slow water currents and reduce waves and wind chop, helping to trap drifting larva and nutrients and providing shelter. Kelp beds and their canopies can also support a rich understory of algal and attached invertebrate cover. On Oregon reefs, dense understory algae coverage gives way to dominant invertebrate cover at about 5 to 10 m water depth. Thick kelp cover reduces light penetration and can limit the density of understory algae. The kelp bed and underlying reef support a diverse array of fish and invertebrate species and provide cover and foraging areas for diving seabirds and marine mammals. In Oregon, the mix of fish species on kelp bed and non-kelp bed reefs is similar, reflecting a lack of kelp-specialist fish species that is perhaps unsurprising given the relatively low proportion of Oregon’s rocky seafloor that is covered in kelp canopy.

Human Use

Human uses of nearshore rocky reefs include fishing, scientific research, sightseeing, and a number of other recreational and industrial pursuits. Commercial and recreational fishing for many types of rockfish species, lingcod, cabezon, and kelp greenling are the primary human uses of this habitat to date. SCUBA diving and underwater photography are among the other less prevalent uses. Much of the commercial live fish fishery takes place on shallow nearshore reefs. Recreational anglers also favor shallow nearshore reefs, if they are available. Commercial fishing effort targeting nearshore species tend to be higher on the south coast and recreational effort more prevalent on the north coast. Many reefs are used recreationally by SCUBA divers, sea kayakers, boaters, and surfers. Reefs with extensive kelp beds and islands provide sightseeing and bird watching opportunities for coastal residents and visitors. However, many reefs have no features extending to the ocean surface, and thus many people are unaware of the teeming life existing just below the water’s surface.

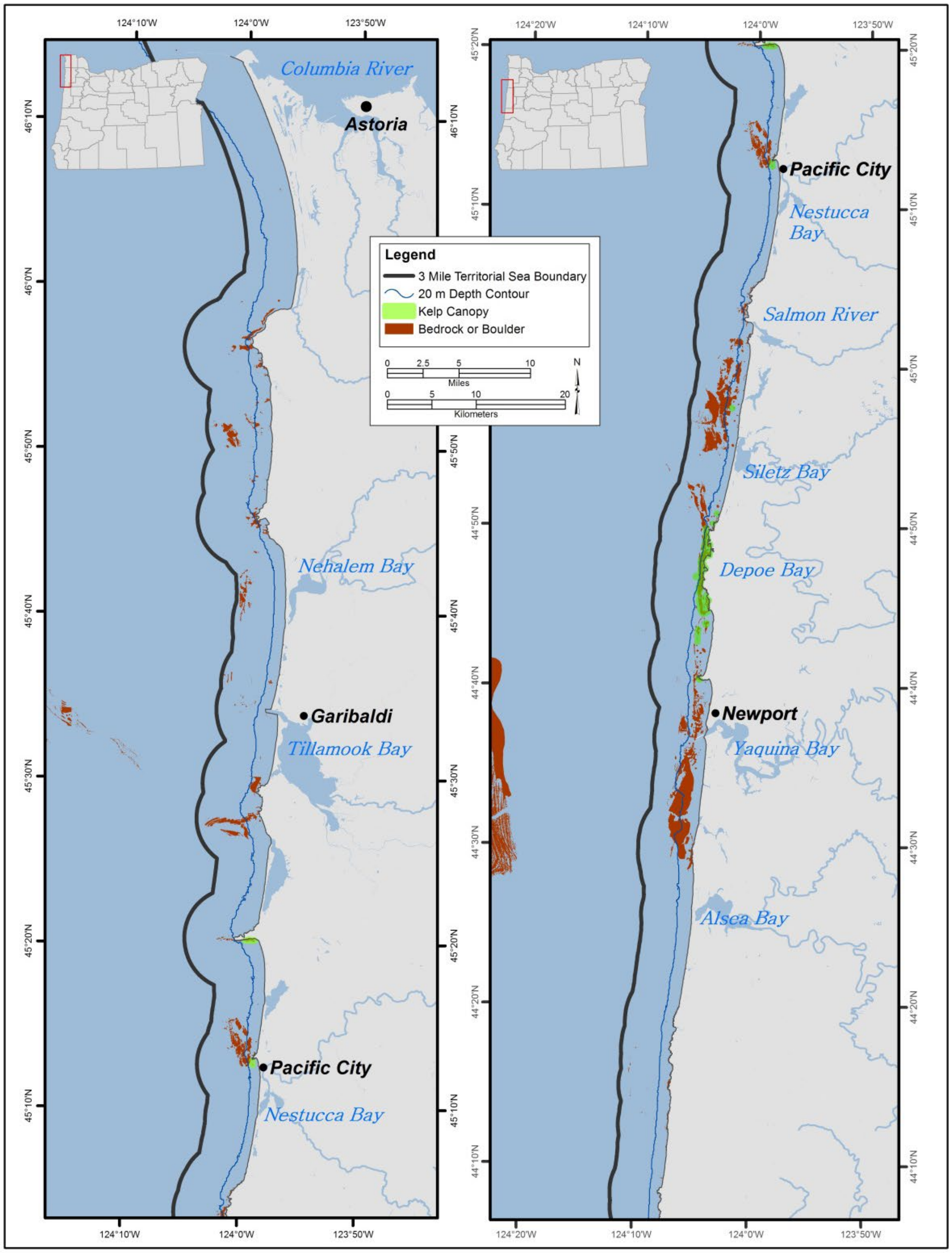

Figure 1. Maximum historical extent of kelp beds along the north Oregon coast**.**

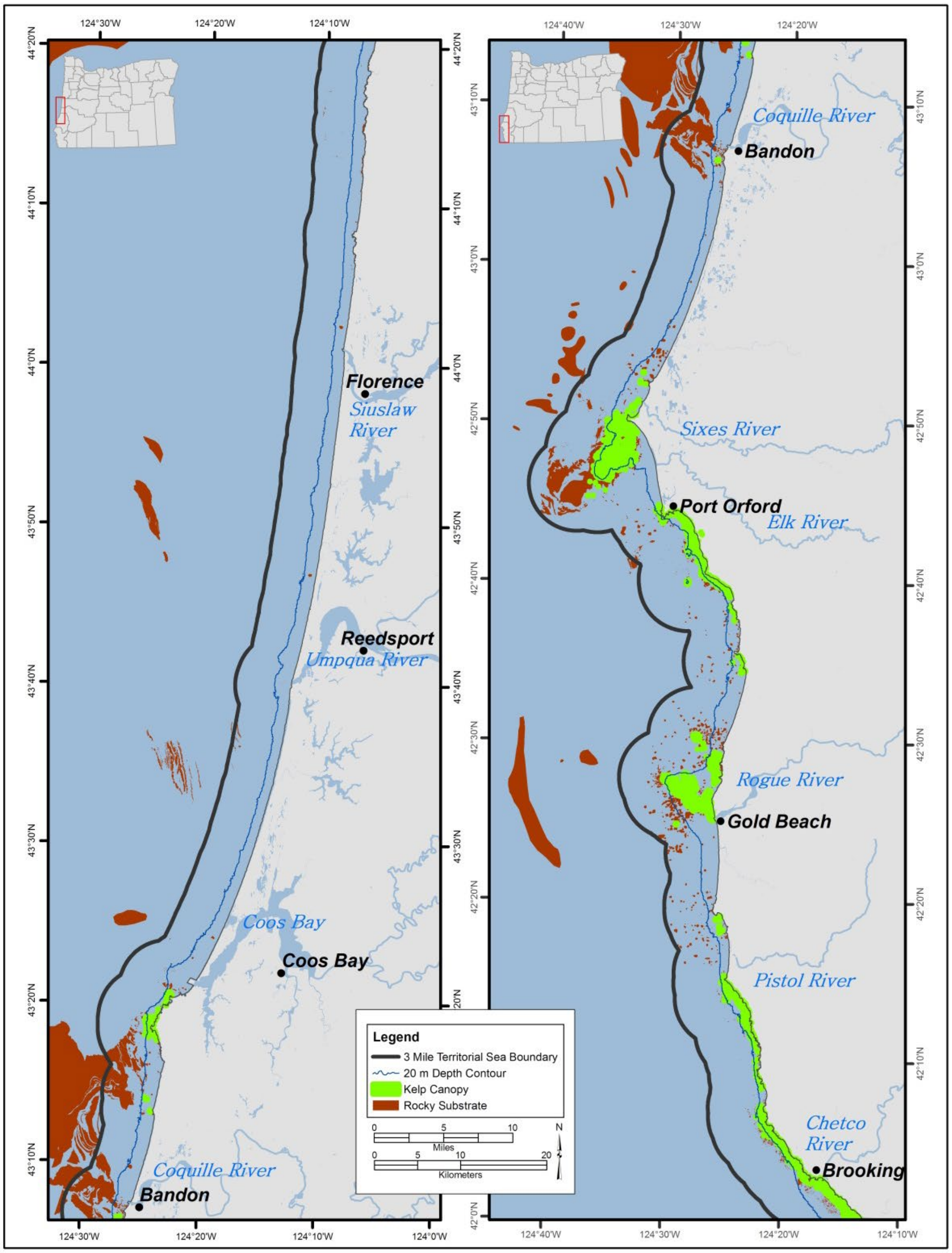

Figure 2. Maximum historical extent of kelp beds along the south Oregon coast.

Rocky Shore

Oregon's rocky shores, often referred to as rocky intertidal or tidepool areas, form parts of the shoreward boundary of the nearshore planning area and can extend from the extreme low tide to the extreme high tide. They are characterized by CMECS as marine nearshore areas in the Intertidal and Supratidal zones, which include all hard substrate areas along the shoreline that are alternately exposed and covered by tides or are affected by wave splash and overwash, but not areas affected only by wind-driven spray. Everything beyond the reach of ocean waves is considered terrestrial habitat. The substrates making up Oregon's rocky shores include both volcanic and sedimentary bedrock as well as megaclasts, boulder, cobble and human-made (anthropogenic) structures. Some rocky shore areas are extensions of other shoreline rocky features such as headlands or cliffs, others exist as isolated regions of rock surrounded by sandy beach habitat, and some are anthropogenic in origin, having been deposited intentionally or unintentionally by humans. Oregon's coastline has approximately 152 linear miles of rocky shore habitat, and some 20 miles of jetties.

An example of a naturally occurring geoform component found in Oregon's rocky shores would be a tidepool. Some of the anthropogenic geoforms found in Oregon's rocky shores include breakwaters, jetties, and rip rap deposits. All rocky shore habitats in Oregon are contained entirely within the SWAP's planning area.

Physical Environment

The physical characteristics of rocky shores reflect local shoreline geology, exposure to ocean waves and currents, and biological influences. The Pacific Ocean exerts tremendous energy on Oregon's rocky shoreline, eroding coves, widening crevices, and reducing bedrock to rubble. On the north and central coast volcanic basalt dominates the hard shoreline, but sedimentary sandstone and mudstone rock can be found at several locations. Between Coos Bay and the Coquille River the geology is characterized by sedimentary rock. South of the Coquille River, headlands and rocks are primarily remnants of ancient metamorphic rocks over 200 million years old. Because of the variety of geologic origins and processes, Oregon's rocky shores consist of an assortment of cliff faces, wave-cut platforms, boulder fields, outcrops, and rubble. Each geoform presents a unique mixture of habitats that provide shelter and substrate to support a wide variety of life.

Ocean forces and weather strongly influence rocky intertidal environments. Tides are the primary influence on organisms and communities. The physical environment of intertidal areas changes dramatically as the tide rises and falls, alternately covering everything with salt water or exposing it to air, fresh water from rain and runoff, and the sun. Wave exposure also has a primary influence on this environment. Intertidal areas protected from waves due to shoreline orientation or geology provide dramatically different habitat than areas directly exposed to wave action. Local alongshore currents and ocean circulation processes introduce additional variables in the habitat, including sand scour of rocks, seasonal sand burial of rocky areas, and transport of nutrients, larvae, and adult organisms to and from intertidal sites.

Biological Characteristics

Rocky shore habitats are known for and crucial to their abundant and diverse biological communities. The variety in tidal elevations, wave exposure, and geologic structure within and among intertidal habitats produces a variety of microhabitats, often within relatively small geographic areas. This, in turn, provides for a diversity of species adapted to life in these different microhabitats. Organisms contribute to the variety of habitats as well. For instance, mussels and algae attach to the rocks, sometimes in huge numbers, providing additional structure and biogenic habitat used by intertidal species. Anthropogenic geoforms like jetties often take on similar biological characteristics of natural rocky shore geoforms, with similar biological communities using them.

Biological communities associated with rocky intertidal habitat include algae, marine plants, attached and mobile invertebrates, fish, marine mammals and birds (see **Appendix - Nearshore Species**). Algae cover many intertidal areas with dense growth, often layered with several different species. Surfgrass, a marine vascular plant, often forms thick beds in lower intertidal areas, providing additional habitat structure for invertebrates and fish. Most rocky shore areas are extensively covered with attached invertebrates. Common types of attached organisms include sponges, anemones, barnacles, bryozoans, tunicates, and mussels. The rocks, algae, and attached invertebrates provide homes for a variety of mobile invertebrates such as crabs, snails, limpets, sea stars, urchins, brittle stars, nudibranchs, chitons, and worms. Free-swimming invertebrates, such as shrimps and drifting (planktonic) invertebrates also occur in tidepools or drift in with the tides. The algal and invertebrate communities in rocky intertidal areas often form distinct horizontal bands or zones of life according to the amount of time exposed to the air or covered by the tides.

The upper reaches of the supratidal and intertidal zones experience the greatest variation in moisture, exposure, and salinity, and are often highly dependent on strong wave action to bring in nutrients and life. Compared to other rocky shore areas, fewer species are found in the high intertidal and supratidal. These zones are typically characterized by vegetated rocks and boulders, along with isolated crevices and tidepools that hold water even during low tides. Greater abundance and diversity of life is associated with the lower intertidal areas. The distribution of organisms living in the mid-intertidal is generally limited at upper elevations by environmental stressors (such as high temperatures and desiccation) and at lower elevations by biological interactions (such as predation and competition). Organisms in the lowest parts of the rocky shore area experience almost continual tidal inundation and must be able to withstand the mechanical and biological stresses associated with this high-energy environment.

The low intertidal serves as an important connection in the marine food web. Wave activity helps convert kelp and other organic debris into small fragments that are consumed by grazers and filter feeders and provide some nutrients to algal communities. Invertebrates and small fish provide a source of food for numerous bird species that forage along rocky shores.

Fishes using the rocky shore include species adapted to live in tidepools and subtidal species that move in and out of the intertidal area with the tides. Tidepool fishes include a variety of sculpins, gunnels, and pricklebacks, among others. Rockfish species, greenlings, and surfperch often move into the intertidal area during high tide to feed and take refuge from subtidal predators. The rocky shore area is especially important to juvenile life stages of these fishes. The rocks and islands associated with Oregon's rocky shores and the subtidal rocky reefs provide important seal and sea lion haul out and pupping areas, and support some of the largest seabird nesting colonies on the contiguous U.S. West Coast. Islands and rocky intertidal areas are also utilized for nesting by birds that nest in colonies such as the Common Mure. Islands are another example of geoforms in the CMECS framework. Several seabird species that do not nest in colonies in Oregon do feed and take refuge here, including Black Turnstones and surfbirds.

Rocky shores are linked to surrounding habitats by ocean currents and organism movements. Currents bring in planktonic organisms that help feed intertidal animals, and transport drifting larvae to and from intertidal environments. Currents also bring nutrients that feed the lush algal growth. Many organisms move in and out of intertidal habitats to feed or take refuge. Fish move in during high tides and terrestrial animals move in during low tides. Rocky intertidal areas are also linked to each other, primarily through transport of larvae by ocean currents. The proximity of intertidal habitat to other "upstream" or "downstream" habitats has dramatic effects on the types, abundance, and recruitment rates of communities and organisms.

Ecological linkages within and between rocky shore areas help to shape biological communities and contribute toward the biological abundance of this habitat type. The diversity of producers and consumers in the intertidal create complex food webs and interdependencies among organisms. This complexity of organism interrelationships makes the outcome of natural or human disturbance to rocky shore habitats difficult to predict or measure. For instance, while human foot traffic can result in inadvertent trampling of organisms, anthropogenic structures such as jetties provide a unique and valuable rocky shore habitat at the transition between estuaries and the marine environment.

Human Use

Human uses of rocky intertidal areas include fishing, invertebrate and algae harvest and collection, education, scientific research, sightseeing, and other recreational, economic, and social pursuits. Due to their accessibility and the fascinating array of marine life, rocky intertidal areas receive more public use than many other marine habitats. Visitation by school groups and others curious about marine life comprises the majority of public use. For many visitors, their first and sometimes only interaction with the wonders of marine life comes from tidepool visits. Visitation of rocky shore areas has generally been increasing over the past five decades.

Rocky shores are used extensively by researchers as a natural laboratory to increase understanding about general marine ecological principles. The Rocky Habitat Management Strategy is part of the Oregon Territorial Sea Plan (TSP), specifically Part Three, and governs the protection and management of Oregon's rocky coastal habitats. The Rocky Habitat Management Strategy contains three types of rocky habitat management areas including Marine Gardens, Marine Research Areas, and Marine Conservation Areas. In 2023, eight new rocky habitat management areas were formally adopted (see Appendix - Marine Spatial Management). As of 2025, there are twenty-four intertidal and subtidal sites along the Oregon coast that have special regulations as recommended by TSP Part Three, limiting harvest or collection of organisms to enhance scientific research, as well as education and enjoyment benefits. Maps and regulations for these areas are available here. Separately, Marine Reserves and Marine Protected Areas are also implemented in Oregon and conserve primarily rocky habitats; however, it is not within the TSP Part Three.

Detailed descriptions of types and amount of human use at individual rocky shore sites along Oregon's coast can be found in the "Oregon Rocky Shores Natural Resources Inventory."

Sandy Beaches

Sandy beaches are a widespread feature of the entire Oregon coast and make up approximately two-thirds of the coastline. Their distribution is interrupted by rocky shores, rocky headlands, river mouths, estuaries, and human constructions. Oregon's sandy beaches are characterized by CMECS as marine nearshore areas in the intertidal and supratidal zones that are composed of very fine to very coarse sand substrate; they extend in a continuum from the Mean Lower-Low Waterline to the areas above the Mean Higher-High Waterline that are affected by wave splash and overwash at extreme high tides, but not areas affected only by wind-driven spray. Sandy beaches stretch inland until they are stopped by a continuous line of vegetation, debris, rocks, or other barrier. Everything beyond the reach of the waves and splash zone is considered terrestrial habitat.

Physical Environment

Oregon's sandy beaches are high-energy environments that experience significant wave and wind energy. Several million cubic meters of sand are transported to the nearshore area annually by river systems. Seasonal variation in wind and wave energy and currents move substantial amounts of sand onto or off beaches, which results in significant changes in beach character as underlying rock structures (bedrock and/or cobble) are exposed. In some areas, patches of ancient forest where the land dropped during past subduction zone earthquakes may become exposed. Currents and wave energy are other significant factors in moving sands onto or off of beaches at elevations that are frequently immersed; the lateral width of the beach will govern the area over which current and wave energy is dispersed and hence determines the slope of the beach as sands are deposited or swept away. At higher elevations that are dry and experience infrequent immersion by tides, wind is the predominant factor in distributing sand and can create windows and mobile dunes from a few centimeters to several meters tall, while dunes further inland may be several stories high.

The lateral (north-south) extent of sandy beaches is punctuated by rivers or rocky headlands where the transition from sand to volcanic rock can be quite abrupt. Rivers can frequently become “bar-bound” during the summer and early fall months when river flows diminish due to reduced precipitation, and the energy of flowing water is insufficient to maintain an open, flowing channel to the sea. In such cases, the river or stream will flow *through* the sand in its final stages. Bar-bound rivers are generally freed by fall rains on the Oregon coast that increase river flows and wash sand out of the river mouths to re-establish a channel of flow. Fall rains and the breaking of blocking bars are important in restoring access to fresh-water streams for anadromous fishes.

The supratidal zone and upper range of the intertidal zone are subject to the greatest variation in temperature and moisture and the least physical energy from the ocean. The intertidal zone, particularly its lower reaches, receives much greater physical energy from waves and currents, and experiences the least variation in temperature.

Biological Characteristics

The movement of sand by water and wind energy makes sandy beaches largely unsuitable for rooted and attached organisms. However, between the grains of sand in the intertidal zone is a vast multitude of life too small to see with the naked eye, including diatoms, harpacticoid copepods, amphipods, and algae, among others. Larger invertebrates can be found here as well, including crustaceans, mollusks, and diverse worm taxa. Many of the resident invertebrates burrow in the sand during periods of exposure for protection from desiccation and/or predation and emerge to forage as tides permit.

Biological communities of the upper intertidal and supratidal zones of sandy beaches are often based on the resources provided by the incoming tides and deposited at the high tide line. Once in the intertidal zone, the detritus is broken down by the mechanical force of waves pounding against the shore and the industry of the many organisms that live and forage there. Organisms of the mid and lower intertidal, particularly the small invertebrates, provide food resources for numerous larger invertebrates, fish, and bird species. Some marine mammals intentionally use this zone to rest, hauling themselves out of the ocean to lay on the sand.

Several SGCN, Watch List, and commonly associated species are also connected with general sandy beach habitats, or specific to distinct sandy beach types (see **Appendix - Nearshore Species**). Surf smelt use particular beaches to lay their eggs in the intertidal zone. Native littleneck and razor clams burrow below the sand and feed on plankton when the ocean water covers them. Western Snowy Plover nest either in the supratidal zone or above and feed in the intertidal sandy areas. Sanderlings gather in loose flocks in the winter months to feed on the rich array of invertebrates under the sand as the waves recede. Harbor seals rest on sandy beaches and northern elephant seals come ashore to molt, usually in the supratidal zone.

Human Use

Sandy beaches attract substantial human use at all levels of the intertidal and supratidal. Their easy access and wide variety of organisms and ecological processes attract scientific interest. Thanks to their uniform, comfortable surface, sandy beaches are valued for a wide variety of recreational activities including sightseeing, picnicking, walking, running, agate-hunting, dog walking, recreational drone use, and kite flying. Lower portions of beaches are also launch and recovery areas for surfers, windsurfers, kite boarders, sea kayakers, and some sailboats, power boats, and personal watercraft. Wildlife found at sandy beaches is highly valued by humans for everything from bait or dinner to instructional or aesthetic uses. Driving is permitted on some Oregon beaches, but not all. All beaches in Oregon are free for the public to access.

CONSERVATION OVERVIEW

There are many Key Conservation Issues (KCIs) affecting Nearshore habitats and the species that live there, including **Climate Change**, **Disruption and Disturbance Regimes**, **Land Use Changes**, **Invasive Species**, **Pollution**, and **Water Quality and Quantity**.

LIMITING FACTORS AND RECOMMEDED APPROACHES

Limiting Factor: Public Awareness

Oregon’s nearshore waters are part of the California Current Ecosystem. What occurs in the ocean waters of the Pacific, such as El Niño and La Niña, and Pacific Decadal Oscillation, and the timing of spring and fall transition can greatly influence not only the nearshore habitats and species, but also such things as rainfall, snowpack and drought conditions throughout the state. A well-informed public helps drive policy and management decisions as well as individual actions that support a heathy ecosystem and the many benefits it offers.

Recommended Approach

There are a series of recommended approaches in the **Nearshore ecoregion** Recommendations under the category of education and outreach that include: 1) developing creative ways to engage with the general public, constituent, and advisory groups and exploring technologies that support alternative methods of communication and participation in addition to traditional paths such as issue-specific advisory groups; 2) broadening outreach materials and information available electronically to deepen public appreciation of Oregon's nearshore environment; and 3) developing new and expanding existing partnerships for communication, education, and outreach on nearshore topics and issues like best practices to minimize human related disturbances. This approach depends on having the necessary research and monitoring to provide the public with information about the issues listed above and how those issues translate into direct threats to fish, wildlife and their habitats in the nearshore.

Limiting Factor: Climate Change and Disruption and Disturbance Regimes

Oregon's ocean is already experiencing effects from climate change and increased carbon dioxide, including ocean acidification, hypoxia, other changes in water chemistry, warming ocean temperature, and changes in upwelling and other characteristics of the nearshore ocean and estuaries. These changes will continue to grow and intensify in the future. Oregon's upwelling ecosystem is experiencing many of these changes sooner and in greater magnitude than other parts of the nation, increasing the urgency for collecting the needed information and formulating the necessary management response. This is a global problem that requires rigorous scientific information to solve, and partnership between scientists inside and outside of agencies to both understand the phenomena and try to mitigate its effects. Desired outcomes are to increase ecosystem and community resilience and sustainability of Oregon's nearshore resources.

Recommended Approach

Expanding research and monitoring activities are required to generate the data and information needed. This is especially true in the areas where human activities are intense and information on species and their habitats is sparse. Develop and implement research and monitoring efforts to understand, track, and work toward predicting effects of climate change and increased carbon dioxide on Oregon's nearshore species and ecosystems. Focus research on species and ecosystems most at risk, and foster collaboration between scientists and managers to optimize research outcomes for use in management and conservation. Continue and expand research and monitoring efforts on nearshore species and habitats. Gather scientific information on the abundance and distribution of species and habitats, the interactions among species and between species and their physical environment, and changes in those resources and interactions over time. Priorities for research and monitoring needs include oceanographic data, ecosystem data, habitat data, human dimensions and the impacts of human development (see **Appendix - Nearshore Research and Monitoring**). Promote use of climate change information in management decision-making and policy development in statewide, regional and global arenas. Build climate resilience and climate change adaptation into decision-making to maximize the long-term benefits of today's public investment in natural resource management.

Limiting Factor: Land Use Changes (Marine Spatial Planning)

The **Land Use Changes** KCI provides an overview of the issues associated with land use throughout the state and information about **Oregon's 19 Statewide Land Use Planning** Goals. Goals 16-19 are particularly relevant to the Nearshore environment and ecosystem, especially Goals 16 and 19 on estuarine and ocean resources, respectively. In the wider marine realm "land use" is often referred to as "marine spatial planning". Oregon utilizes its **Territorial Sea Plan** to guide state agency actions. Changes to land use in coastal areas directly and indirectly affect nearshore species and habitats in a variety of ways, that include such things as shoreline armoring, leasing mariculture plots, siting renewable energy developments such wave or wind energy facilities, as well as designating marine reserves, marine gardens, and research areas. In addition to state agencies, federal agencies also have various roles in marine spatial planning such as USWF, USCG, and BOEM. There is growing demand for ocean and coastal resources, and competing use of space has increased the need to move beyond single-sector management and plan for ocean uses more holistically. Marine planning processes require comprehensive spatial information on location, abundance and distribution of marine resources and their uses.

Recommended Approach

Participate in marine planning processes to ensure Oregon's interests in marine natural resource conservation and use are fully represented in marine policy. Develop marine natural resource spatial information and incorporate it into marine planning processes to ensure they use the best available science to formulate plans concerning Oregon's marine resources and uses. This will require partnerships with State and federal natural resource agencies, sport and commercial fishing interests, local, state, regional, and federal governments, community groups, non-governmental organizations, tribes, and the general public.

Limiting Factor: Pollution and Water Quality

Pollution in all its various forms can directly impact nearshore species and their habitats. **Water quality** is affected not only by pollution of the nearshore environment, but also by climate change effects that cause ocean warming, ocean acidification and hypoxia, all of which impact nearshore species and habitats.

Recommended Approach

Determining the vulnerability of species and habitats to various types of pollution requires research and monitoring in the nearshore. Similarly, the goals of monitoring water quality also depend on research and monitoring efforts in the nearshore. Expanding existing research and monitoring efforts on these topics will enhance our understanding of their effects, help inform the public, and drive management and policy choices to help achieve these goals.

Limiting Factor: Non-native and Invasive Species

Many non-native and invasive species have made their way to Oregon’s nearshore waters or to those of our neighboring states (see **Appendix - Nearshore Species**). These have been introduced through a variety of mechanisms that include hitch-hiking in ballast water or in ocean currents. These species can affect food sources, alter habitats, expose native communities to diseases or toxins, or act as parasites of juvenile and adult members of coastal species. For many species, the severity of the potential ecological threat is not yet known. Many of these species could be deemed invasive in the future, but further efforts to assess impacts are needed.

Recommended Approach

Achieving the goals to meet the challenges non-native and invasive species pose take a collaborative effort. This work need will include education and outreach, research and monitoring, and policy and management to be successful.

RESOURCES FOR MORE INFORMATION

Appendix - Nearshore Climate Change Fact Sheets

Appendix - Nearshore References

Rocky Habitat Management Strategy

SPECIALIZED AND LOCAL HABITATS

Some natural communities and landscape features are not adequately represented through **Key Habitats**. These communities and features often occur at the local scale and have a patchy distribution across the landscape. They may be difficult to map from satellite data and may not be represented well in available datasets. Some of these habitats provide functions and values that are highly specialized to the local environment, are limited in quantity, and host a suite of rare or endemic species. To address the conservation needs of these habitats and their associated species, “specialized and local habitats” were identified through review of geographic vegetation data, rare plant or animal occurrences, importance to **Species of Greatest Conservation Need,** and occurrences of animal concentrations. Many of these habitats are also identified in other state priorities, such as **Aquatic Resources of Special Concern** through the Oregon Department of State Lands.

ALPINE HABITATS: MEADOWS, DWARF SHRUBLANDS, ALPINE TUNDRA, AND WHITEBARK PINE

Ecoregions

BM, EC, KM, NBR, WC

Alpine habitats provide important foraging and breeding areas for many mammals and birds as well as critical resources for birds during migration periods. These habitats are at risk from increased recreational activity and are extremely vulnerable to climate change as temperatures warm and snowpack decreases. Alpine habitats provide important resources for many at-risk species, such as the federally listed (threatened) whitebark pine (*Pinus albicaulis*) that is particularly vulnerable to white pine blister rust, outbreaks of mountain pine beetles, and fire suppression resulting in replacement by more shade-tolerant tree species.

Conservation Actions

Mitigate effects of climate change and provide refugia for fish and wildlife. Manage recreation, human disturbance, and grazing to minimize impacts to soil and plant communities. Monitor and control invasive plants. Re-introduce fire into the ecosystem to prevent fuel build-up and canopy closure as feasible and appropriate to the local area. Identify blister rust resistant whitebark pine trees and collect the seeds for nursery stock.

AQUATIC VEGETATION BEDS

Ecoregions

All

Aquatic vegetation beds are a component freshwater ponds, riverine sloughs and alcoves, and estuaries and nearshore waters. They are at the base of the food chain and provide habitat for a host of organisms from bacteria, protozoa, and invertebrates to fish, amphibians, reptiles, birds, and mammals. Vital to maintaining the ecological integrity of aquatic ecosystems, their preservation and restoration are essential for supporting biodiversity, improving water quality, and providing numerous ecosystem services that benefit both wildlife and human communities.

Conservation Actions

Retain and restore natural water flow regimes. Maintain consistent water levels. Mitigate impacts from climate change. Monitor for and control invasive plants such as reed canary grass and Ludwigia. Mitigate effects of runoff from agricultural fields and roadways. Limit or prohibit dredging in estuarine algal beds.

ASH FLOWS, ASH BEDS AND LAVA FIELDS

Ecoregions

BM, EC, NBR

Ash flows, ash beds, and lava fields provide habitat for many rare and endemic and other specialized plants and invertebrates, such as the Oregon lava hole bee (*Atoposmia oregona*). These sites can also be important fossil localities.

Conservation Actions

Manage grazing, mining, and off-highway vehicles to minimize erosion and disturbance to rare plants and invertebrates.

BALDS AND BLUFFS

Ecoregions

BM, CR, EC, KM, WC, WV

Balds and bluffs provide habitat for unique plant communities and invertebrates such as butterflies. In the Coast Range ecoregion, these habitats include coastal bluffs and headlands. In the Klamath Mountains ecoregion, these habitats include serpentine barrens and outcrops. In the Willamette Valley ecoregion, these habitats include wet rock outcrops dominated by camas (*Camassia spp.*) and other wet prairie species.

Conservation Actions

Better mapping and documentation of balds and bluffs are needed. Control encroaching conifers and shrubs. Monitor for and control invasive plants. Minimize disturbance (e.g., trail or road construction, recreation) to help protect rare plant communities. Protect hydrology to maintain perched wetland and wet rock outcrop function. Consider impacts from changing fire regimes.

BAYS

Ecoregions

CR, NS

Bays provide winter habitat for waterfowl and other waterbirds, rearing areas for juvenile anadromous salmonids, and habitat for intertidal and subtidal shellfish beds, including native oyster beds.

Conservation Actions

Provide areas of low disturbance during critical life history needs and time periods. Minimize impacts from in-water activities such as dredging, as well as impacts from overwater structures. Coordinate with landowners, communities, local governments, development interests and other partners to properly plan development to avoid, minimize and mitigate impacts to bay ecosystems.

BITTERBRUSH COMMUNITIES

Ecoregions

BM, EC, KM, NBR, WC

Antelope bitterbrush (*Purshia tridentata*) is an important habitat component that provides forage, cover, and nesting habitat for a variety of wildlife. It provides high value winter forage for deer, elk and pronghorn, supports a variety of insect pollinators, and provides seeds that support a diversity of small mammals. In some areas, juniper encroachment threatens bitterbrush communities by outcompeting and shading bitterbrush.

Conservation Actions

Improve understanding of bitterbrush regeneration methods. Continue restoration and monitoring efforts. Manage grazing pressure based on site conditions. Bitterbrush can be impacted by prescribed fire; caution is needed if considering this tool in proximity.

CANYON SHRUBLANDS

Ecoregions

BM, CP, EC, NBR

Also known as moist deciduous shrublands, canyon shrublands provide nesting habitat for songbirds and winter habitat for SGCN such as Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*).

Conservation Actions

Maintain healthy shrubs stands and restore degraded stands. Some degraded stands can benefit from prescribed fire, removal of encroaching invasive junipers, or management of grazing season timing.

CAVES AND OLD MINES

Ecoregions

BM, CR, EC, KM, NBR, WC

Caves and old mines provide habitat for rare invertebrates and cave-roosting bats, such as Townsend's big-eared bat (*Corynorhinus townsendii*) and several *Myotis* species. In the East Cascades ecoregion, these habitats include lava tubes.

Conservation Actions

Use gates or seasonal closures to protect known roost sites from recreational caving and other disturbance. When mines are closed for human safety, provide openings for bat entry and exit. Be aware of the potential for white-nosed syndrome; thoroughly sanitize all clothing, footwear, and equipment between caves to prevent potential contamination.

CHAPARRAL AND CEANOTHUS SHRUBLAND

Ecoregions

BM, CR, EC, KM, WC, WV

Chaparral and ceanothus shrublands provide cover, nesting, and foraging habitat for songbirds, kingsnakes, and a variety of invertebrates, including some butterfly species. These shrublands occur in open areas, so may be found in early successional habitats or at high elevations, where temperatures and other factors inhibit tree growth. In the Klamath Mountains ecoregion, chaparral is often removed as a fire hazard, as some species are highly flammable and dependent on fire for seed germination. Chaparral is also increasingly removed during development, particularly in lowland valleys. These habitats are at risk from fire suppression—many ceanothus species become senescent without the fires needed for regeneration. Chaparral is also unusual habitat in the Willamette Valley, which makes protecting existing sites important for maintaining local species diversity.

Conservation Actions

Maintain shrub diversity during forest management activities. Delay replanting with conifers where shrub habitat is limited. Control key invasive plants (e.g., Scotch broom and Armenian (Himalayan) blackberry) and animals such as feral horses at priority sites. Implement controlled burns or other fire management techniques where appropriate to the local area.

EELGRASS BEDS

Ecoregions

CR, NS

Eelgrass beds support the aquatic food chain and provide essential habitat for many species to fulfill their life history needs. They provide habitat to support intertidal and subtidal shellfish beds, including native oyster beds. They also provide important rearing habitat for juvenile fish, including commercially important species, and foraging habitat for birds, such as Brant (*Branta bernicla*).

Conservation Actions

Ensure that development activities that may disturb eelgrass beds avoid, minimize and mitigate direct and indirect impacts. Discourage dredging or fill of estuaries and eelgrass beds. Monitor and control invasive species. Restore and monitor eelgrass habitats. Research the role of eelgrass in mitigating the impacts from climate change. Protect genetic diversity within eelgrass populations. Also see **Estuaries**.

FEN PEATLANDS

Ecoregions

BM, CR, EC, KM, WC

Fens are peat-accumulating wetlands that form where groundwater discharge is low but constant, and where appropriate geologic conditions occur, such as glacial deposits with pumice. Fens provide habitat for sensitive plant species and provide long-term carbon storage in the form of peat. They are highly sensitive to climate change, which may reverse the process of peat accretion and lead to carbon loss. Serpentine fens are a unique subset of these groundwater dependent wetlands.

Conservation Actions

Maintain groundwater recharge areas, especially at higher elevations. Use conservation incentives, and where applicable, maintain existing protection standards to provide buffers around fen areas. Seek opportunities to enhance recharge from local aquifers supporting the fens.

FOREST OPENINGS

Ecoregions

BM, CR, EC, KM, WC, WV

Forest openings provide essential structural complexity and plant diversity within forests. Forest openings provide foraging habitat for a variety of species that are adapted to open meadows, early seral habitat, and forest edges. They support bird species like Olive-sided Flycatchers, Willow Flycatchers, and Common Nighthawks, as well as species that prefer open habitat with snags such as Purple Martin and Western Bluebird. Clouded salamanders live in large logs and stumps in openings, and their populations increase following wildfires. Disturbances such as wildfire, windthrow, disease, and insect outbreaks reset succession and often result in large or small openings with high forb and shrub diversity and woody structure (e.g., large snags and logs). Management of older successional forest stages on public land typically does not include maintaining forest openings, and private forestlands are usually intensively managed for production, which leads to a rarity in forest openings with structural complexity and plant diversity.

Conservation Actions

During salvage logging or other timber harvest, minimize ground disturbance, and maintain and create snags and downed logs. Pursue forest management activities that create forest openings and maintain natural forb, grass, and shrub species. Control key invasive plants in openings. After burns, reseed with native grasses and forbs, and delay replanting with conifers. Carefully evaluate salvage logging in burned late successional forests. Continue post-fire research efforts to better understand the effects of post-fire management on vegetation communities. Provide education to the public about how not to spread invasive plant species and the importance of control and management.

UNIQUE GRASSLAND HABITATS

Ecoregions

EC, KM, NBR

Unique grassland habitats in Oregon include alkali grasslands, perennial bunchgrass, and montane grasslands. These habitats are important for raptors, grassland birds, and rare plants.

Conservation Actions

Maintain and restore these unique grasslands using site-appropriate tools. Monitor for invasive species. Manage grazing to minimize impacts to native species.

GREASEWOOD FLATS AND WASHES

Ecoregions

BM, CP, EC, NBR

Greasewood (*Sarcobatus vermiculatus*) is typically found in flats, washes, and terraces with saline soils and shallow water tables. Flats, washes, and terraces flood intermittently but remain dry for most of the growing season, providing habitat for rare plants. Greasewood is an important browse species for deer and pronghorn, as well as SGCN like white-tailed jackrabbit and North American porcupine. These habitats are threatened by changing fire regimes and the spread of invasive annual grasses.

Conservation Actions

Maintain and restore greasewood habitats. In the Blue Mountains, include black greasewood habitats when managing for a mosaic of valley bottom habitats.

INLAND DUNES

Ecoregions

CR, CP, NBR

Inland dunes include active and partially stabilized dunes in arid inland regions. These dunes provide habitat for a variety of species including reptiles, small mammals, and rare plants. In the Columbia Plateau ecoregion, stabilized dunes often support basin big sagebrush and bitterbrush. In the Northern Basin and Range ecoregion, the Christmas Valley Sand Dunes are the largest inland shifting sand dune system in the Pacific Northwest. The alkaline sands of the Northern Basin and Range ecoregion support salt desert dune shrubs such as greasewood and saltbush. Inland dunes along the Columbia River have stabilized in recent decades after the damming of the Columbia River. Historically these dunes were fed by sand transported and deposited annually by the river. Inland dunes are threatened by the spread of non-native species such as Russian thistle.

Conservation Actions

Maintain and enhance existing habitat. Monitor for and control invasive species. Protect dunes from uncontrolled off-highway vehicle use.

INTERDUNAL LAKES AND WETLANDS

Ecoregions

CR

These habitats are comprised of shallow lakes and wetlands located in areas between coastal sand dunes. Wetlands in the dunal system may occur in the deflation plains, depressions, swales or low areas. They are typically seasonally inundated, usually without a naturally occurring inlet or outlet, and often with significant cover of native plant species. Water levels in interdunal lakes and wetlands are dependent on local precipitation to recharges sand dune aquifers. These lakes and wetlands provide breeding habitat for SGCN, including northern red-legged frogs, and support unique wetland plant communities.

Conservation Actions

Maintain groundwater recharge areas at sand dune aquifers. Protect these habitats from off-road vehicle use and other impacts from human recreation and development.

INTERTIDAL MUDFLATS

Ecoregions

CR, NS

Intertidal mudflats provide foraging habitat for shorebirds, which is critically important during migration. Mudflats also serve as habitat for a diversity of invertebrate species such as clams and other shellfish.

Conservation Actions

Manage water flows to maintain mudflat habitats. Maintain or restore water quality and natural sedimentation patterns to preserve habitat quality for invertebrates. See **Estuaries**.

KELP BEDS

Ecoregions

NS

Limited to subtidal rocky areas in relatively shallow water, kelp beds are designated as essential fish habitat for both groundfish and salmon. These areas provide important habitat for a diversity of other species in the nearshore ecoregion as well.

Conservation Actions

Reduce coastal runoff that increases turbidity in nearshore ocean waters. Minimize risk of oil spills and pollution. Fill data gaps on the gametophyte stage of the kelp life cycle. Monitor status of kelp bed densities at index sites. Expand research and monitoring efforts needed to generate the data and information required to develop effective kelp bed restoration methodologies. Foster collaboration between scientists and managers to optimize research outcomes for use in management and conservation, specifically to address limiting factors (e.g. grazer abundance, ocean conditions, etc.) that impact kelp bed health (See **Nearshore Habitats** and **SWAP Appendix - Nearshore Climate Fact Sheets**.

MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND

Ecoregions

BM, EC, NBR

Mountain mahogany (*Cercocarpus spp.*) communities have expanded in some areas due to fire suppression but depend on low-intensity fire for long-term maintenance and regeneration. Many stands are threatened by non-native understory vegetation and juniper encroachment is a threat in some areas, especially in the Northern Basin and Range. In the East Cascades ecoregion, mountain mahogany is more diverse than in other ecoregions.

Mountain mahogany in the East Cascades includes birchleaf mountain mahogany, which is found throughout moist shrublands in the southern portion of the ecoregion. Mountain mahogany serves as important nesting habitat for birds because it provides tree structure in otherwise open, shrub-dominated landscapes. Mountain mahogany also provides forage and cover for a diversity of mammal species.

Conservation Actions

Develop methods to manage mahogany stands and encourage regeneration. Restore native understory vegetation at priority sites. Conduct conifer management within and adjacent to stands, particularly western juniper management.

OFF-CHANNEL HABITAT

Ecoregions

All inland ecoregions

Off-channel habitat, such as alcove and side channels, provide critical rearing, security, and foraging habitat for juvenile salmonids and other native fish, northwestern pond turtles, freshwater mussels, and other invertebrates.

Conservation Actions

Protect and restore off-channel habitat, including restoration of stream hydrology. Avoid, minimize, and mitigate impacts to off-channel and riparian habitat from development actions. Manage beaver populations to provide for beaver-modified habitats, while minimizing conflicts with other land uses. Restoring tidal and riverine inundation to these areas and restoring/enhancing connectivity are key conservation actions. See **Flowing Water and Riparian Habitat**.

PORT ORFORD CEDAR FORESTS

Ecoregions

KM, CR

Endemic to southwestern Oregon and northwestern California, Port Orford cedar (*Chamaecyparis lawsoniana*) forests are associated with serpentine soils and are characterized by unusual plant and animal associations, co-occurring with SGCN such as large-flowered rush lily. These habitats have been severely impacted by an introduced, fungus-like tree disease, the Port Orford cedar root disease, particularly near the coast.

Conservation Actions

Maintain and protect existing habitat. Minimize vehicular traffic and/or new road construction where potential exists to spread the invasive root pathogen.

ROCK HABITATS: CLIFFS, RIMROCK, ROCK OUTCROPS, AND TALUS

Ecoregions

BM, CR, CP, EC, KM, NBR, WC, WV

Rocky areas provide habitat for peregrine falcons and other cliff-nesting birds, cliff-roosting bats, rare plants, and wildlife that use rocks for shelter and/or foraging areas. Talus slopes provide habitat for Larch Mountain salamander, pika, and several invertebrates. In the Willamette Valley, rock outcrops serve as hibernacula for snakes, including western rattlesnakes. In dry ecoregions, rock habitats are particularly important for salamanders as a refuge from hot, dry weather.

Conservation Actions

These habitats have few limiting factors in most ecoregions. In the East Cascades, residential development at the edge of rims alters vegetation and disturbs nesting birds. Work with local planners to implement existing setback distance standards through the Statewide Planning Program. Rock mining should be avoided in talus areas where known populations of Larch Mountain salamander and rare invertebrates occur. For all ecoregions, if important roosts, hibernacula, or nest sites are known, minimize disturbance.

ROCKY SHORES, TIDEPOOLS, AND OFFSHORE ROCKS (E.G., SEA STACKS)

Ecoregions

CR, NS

Rocky shores and offshore rocks provide critical nesting, roosting, and foraging habitat for seabirds and shorebirds, including SGCN like Tufted Puffin and Black Oystercatcher. These areas also serve as haul-outs for marine mammals, and as roosting areas for raptors, including peregrine falcons. Rocky shores, tidepools, and offshore rocks also provide habitat for a variety of marine invertebrates and fish.

Conservation Actions

Work with local communities and land management agencies to avoid and minimize impacts from tidepool viewing, and to minimize disturbance to birds and marine mammals during sensitive nesting and pupping seasons. Increase research to better understand the impacts of thermal heatwaves and other climate-related stressors. See Nearshore Habitats.

SALT DESERT SCRUB

Ecoregions

NBR

This low-to-medium shrub habitat can be found on dry sites with saline soils, such as dry lake beds, flat desert pavements, low alkaline dunes, around playas, or on gentle slopes above playas. Salt desert scrub provides habitat for a diversity of reptiles and mammal species, including species that are primarily or exclusively associated with this habitat, such as kit fox and long-nosed leopard lizard.

Conservation Actions

Salt desert scrub is threatened by invasion of non-native annual grasses, particularly cheatgrass. Microbiotic soil crusts are particularly critical in these habitats, so it is important to minimize activities that cause soil disturbance, such as hiking, biking, and off-highway vehicle use.

SAND SPITS, SAND BARS, AND SPARSELY VEGETATED ISLANDS

Ecoregions

CR, EC, NBR, NS

Sparsely vegetated sandy habitats that are isolated from disturbance due to humans and mammalian predators are important roosting and nesting sites for colonial waterbirds, such as American White Pelicans, Brown Pelicans, and Caspian Terns. In eastern Oregon, this habitat occurs around large lakes and wetlands. Sparsely vegetated island habitat can be surrounded by either saltwater or freshwater.

Conservation Actions

Maintain open habitat characteristics and minimize disturbance at key sites. Manage water levels to preserve island habitats.

SPRINGS, SEEPS, AND HEADWATERS

Ecoregions

All inland ecoregions

Springs, seeps, and headwaters provide habitat for amphibians, invertebrates, and rare plants. The isolated nature of springs is one of the factors resulting in high levels of invertebrate endemism in the East Cascades. Spring systems in the Northern Basin and Range also contain endemic species, including vertebrates (e.g., Hutton tui chub and Foskett speckled dace). In dry ecoregions, spring and seep habitats are important as a source of water for wildlife and as habitat for amphibians and invertebrates. These habitats have been impacted by livestock watering and agricultural uses. Springs, seeps, and headwaters are critical to protect for climate resiliency, particularly for water quantity and quality, and are a refuge for multiple species during and following wildfire.

Conservation Actions

Encourage use of incentives, and where applicable, maintain existing protection standards to provide buffers around springs, seeps, and stream headwaters during development actions, such as forest management and road building activities. Maintain and protect groundwater recharge areas and cold water refugia. Use open-bottomed culverts or bridges when building roads or upgrading culverts to allow fish and wildlife passage. In dry ecoregions, use cooperative incentive programs to fence spring heads, which provides benefits to wildlife but allows water to be available for other uses. Minimize impacts from climate change.

SPRING-FED STREAMS

Ecoregions

BM, EC, KM, WC, WV

Streams dominated by groundwater rather than surface runoff are characterized by more stable flow and thermal regimes. Spring-fed rivers often display relatively static morphology compared to runoff systems, and habitat complexity is provided by aquatic plants and large wood inputs. These factors, along with nutrient rich inputs from underlying geology, contribute to ecological productivity. These streams support cool-water species such as bull trout and provide refugia for other temperature-limited species. Spring-fed streams are also a critical resource for climate resiliency.

Conservation Actions

Identify and protect the state’s cold-water resources. Conduct real-time flow and temperature monitoring in priority areas. Maintain and protect groundwater recharge areas, especially at higher elevations. Maintain, protect, and restore natural water flow regimes. Maintain and protect supporting aquifers. Minimize impacts from climate change.

WESTERN JUNIPER SAVANNA WITH MATURE TREES; LATE SUCCESSIONAL WESTERN JUNIPER WOODLANDS

Ecoregions

BM, CP, EC, NBR

Western juniper savannas consist of scattered, often large, juniper trees within shrub-steppe. Late successional juniper woodlands may have a higher density of trees but are characterized by large-diameter trees. These juniper habitats are important for songbirds and raptors. In the Columbia Plateau ecoregion, the remaining Ferruginous Hawk nest sites are primarily juniper trees.

A small percentage of Oregon's juniper woodlands are considered late successional. A high percentage of old-growth juniper in Central Oregon near Bend, Redmond, and Madras has been lost. Remaining stands are highly fragmented and are threatened by encroaching small junipers. In contrast, recruitment of juniper in the sandy shrub-steppe of the Columbia Plateau is naturally poor, so young juniper trees are not replacing older ones lost to cutting or natural death.

Conservation Actions

Remove small diameter encroaching juniper trees while maintaining larger diameter junipers and connectivity of juniper patches. Reintroduce fire where practical. Collect better spatial data on the distribution of mature juniper savanna. In the Columbia Plateau, maintain existing large juniper trees and examine factors affecting tree recruitment. Research is underway to determine the age, composition, structure, and wildlife usage of old growth juniper woodlands (for more information, see the **Eastern Oregon Agricultural Research Center website**).

WESTERN LARCH FOREST AND WOODLAND

Ecoregions

BM, EC

Western larch (*Larix occidentalis*) forests and woodlands occur on cool, moist sites interspersed with ponderosa pine habitats. These habitats may have been much more common historically in the Blue Mountains ecoregion.

Conservation Actions

Maintain large-diameter larch trees and patches of larch forest to provide local diversity.
Control key invasive plants.