



JULIE BENNETT



SHUTTERSTOCK.COM/NATALIA BRATSLAVSKY



JULIE BENNETT

Biodiversity in Washington

Biodiversity is the Web of Life 18

Why Biodiversity Matters 20

What is Happening to Washington's Biodiversity Resources? 24

Biodiversity is the Web of Life

The Washington Biodiversity Council defines biodiversity as:

The full range of life in all its forms. This includes the habitats in which life occurs, the ways that species and habitats interact with each other, and the physical environment and the processes necessary for those interactions.

This definition includes all species found within the state, from tiny soil microbes to towering Douglas-firs. The definition also includes the interactions that sustain each species, such as predator-prey relationships, and the physical processes on which life depends, including chemical and nutrient cycling, water filtration, and climate regulation.

Biological diversity can be considered at four principal levels or scales. Ranging from smallest to largest, these are:

- **Genetic diversity** within and between species—that is, the unique genetic composition of individual members of a species;
- **Species diversity**, or the number and type of different species found in an area;
- **Ecosystem diversity**, or the different types of ecological systems of land, water, and organisms; and
- **Landscape diversity**, also referred to as ecoregional diversity, where ecoregions encompass multiple ecosystems to reflect broad ecological patterns.

The following sections further explain these four levels of biodiversity. Understanding these levels is helpful to understanding the overall concept of biodiversity. These different levels, as well as the interactions among them, highlight the need to conduct conservation activities at multiple scales.

Genetic Diversity

Genetic diversity is the fundamental building block of biodiversity and refers to the unique genetic composition of individual members of a species. The natural variations found in a genetically diverse population or species can help the group fight off new environmental stresses, like disease, and to adapt to changing environments. Species with less genetic diversity may be less capable of adapting to these environmental changes and face greater threats of decline or extinction.

We are only beginning to understand how genetic diversity is distributed within and among species. Scientists have accumulated detailed knowledge on the genetic variability of only a limited number of species, including certain at-risk species such as the steelhead trout and the wildflower, golden paintbrush. These data have helped to guide conservation plans and actions for these particular species.

Species Diversity

Washington is home to a vast number of species ranging from mule deer to sea anemones. A species can be defined as a group of organisms that can interbreed in the wild and produce fertile offspring. The number of different species in a given area is referred to here as species diversity.

In addition to those that spend their entire life cycle within the state, Washington also hosts many species that spend only part of their lives in the state. For example, gray whales and southern resident orcas swim in waters both within and outside of our borders, and migratory birds are here only seasonally. Among the species found in our state, at least 53 species are found nowhere else on earth. Termed “endemic,” these species include the showy stickseed, a flowering plant found only on steep rocky slopes covered with granite scree in Chelan County, and the Van Dyke salamander, found only in the Olympic Mountains, Willapa Hills, and south Cascade Mountains.¹

Number of species found within the state's borders include:

Birds	341
Mammals	140
Fishes	470
Amphibians	25
Reptiles	21
Invertebrates	estimated at 20,000
Vascular plants	3,300
Mosses, lichens, liverworts, fungi	estimated in the thousands

Ecosystem Diversity

Ecosystems are integrated ecological systems of land, water, and living organisms in contiguous areas, the scale of which may range from a small wetland to Puget Sound.

Washington contains most of the major ecosystem types found in the western United States, including two found nowhere else in the world: the Olympic rainforest and the channeled scablands of the Columbia Plateau.

Various ways to classify ecosystems exist, and these approaches may differ between terrestrial and aquatic systems. For example, scientists estimate that Washington has about 100 terrestrial ecosystems, such as oak woodlands and interior sand dunes, and 60 aquatic ecosystems, such as estuaries and deep marine waters. Ecosystems can be grouped together to classify wildlife habitats, 29 of which have been identified in the state.²

Landscape Diversity

Ecosystems and their components interact with each other to form an even higher level of diversity—the patterns of ecosystems distributed across the landscape. This document uses the concept of ecoregions to reflect these broad ecological patterns.

Terrestrial ecosystems in the state have been grouped by similar flora, fauna, geology, hydrology, and landforms into nine ecoregions. These ecoregions extend past our state borders



Figure 1. Washington's ecoregions extend past the state's borders.

¹ V. D. Hipkins, B. L. Wilson, R. J. Harrod, and C. Aubry, "Isozyme Variation in Showy Stickseed, a Washington Endemic Plant, and Relatives," *Northwest Science* 77, no. 2 (2003): 170-177; Washington Biodiversity Project website, <http://www.dnr.wa.gov/nhp/refdesk/herp/speciesmain.html>

² D. A. Johnson and T. O'Neil, 2001, *Wildlife-Habitat Relationships in Oregon and Washington* (Corvallis, Ore.: Oregon State University Press, 2001), 736, <http://www.natureserve.org/explorer/>.

into British Columbia, Oregon, Idaho, Montana, Utah, and Nevada. Ecoregions are a practical unit on which to base conservation planning because they are large enough to encompass natural processes such as wildfire, entire populations of species, and related habitats.³

Why Biodiversity Matters

Biological diversity has provided humankind with enormous economic, health, and cultural benefits over the ages, and we have only recently begun to understand and quantify these benefits. They include the economic returns from the agriculture, forestry and fishing sectors, which generate roughly \$3.5 billion in income in Washington annually⁴; the 100 million gallons of water supplied to Seattle each day, filtered only by the forests of the Cedar River watershed; and the cultural and spiritual importance of interacting with nature for residents across the state.

Washington's Heritage

Washington's uniquely rich biodiversity heritage laid the foundation for our natural resource economy. Over the millennia, geological, climatic, and biological processes shaped the evolution of Washington's fertile soils, old-growth forests, and marine resources. These highly diverse ecosystems provided both sustenance and spiritual values for Washington's earliest peoples, who

harvested cedar, salmon, berries, camas, deer, and many other plants and animals.

The Pacific Northwest's abundance of natural resources astounded early European arrivals. British explorer George Vancouver wrote of the southern shore of the Strait of Juan de Fuca in 1792, "[T]he whole had the appearance of a continued forest extending as far north as the eye could reach," with "so delightful a prospect of fertility."⁵ In the following century, residents built fishing towns and salmon canneries to catch and process the seemingly endless stream of salmon, while timber mills and logging camps sprang up to harvest the huge evergreen trees.

Today's Economy—Benefiting from sustainable management

The bounty and riches of our biodiversity heritage, so crucial to the state's early success, continue to play a critical role in Washington's economy. In 2006, gross business incomes from forestry and logging approached \$2 billion;

Eelgrass exemplifies the marine richness that supports marine fisheries in Washington. Found in shallow bays, coves, and estuaries, eelgrass beds provide food, shelter, and breeding grounds to important commercial species such as herring, crab, salmon, and many other forms of marine life.



JULIE BENNETT



AARON BARNA

3 Map reprinted from Washington State Department of Natural Resources, *State of Washington Natural Heritage Plan* (Olympia, Wash.: DNR, 2003), 64. The delineation of these ecoregions was developed by The Nature Conservancy and many partners on the basis of work done by Robert G. Bailey (U.S. Forest Service), James Omernik (U.S. Environmental Protection Agency), and other scholars.

4 Center for the Study of the Pacific Northwest, "Evergreen State: Exploring the History of Washington's Forests," <http://www.washington.edu/uwired/outreach/cspn/Website/Resources/Curriculum/Curriculum%20Main.html>.

5 Center for the Study of the Pacific Northwest, "Evergreen State: Exploring the History of Washington's Forests," <http://www.washington.edu/uwired/outreach/cspn/Website/Resources/Curriculum/Curriculum%20Main.html>.

agricultural gross incomes totaled approximately \$715 million, while supporting activities for agriculture and forestry totaled another \$536 million; and commercial fishing incomes in Washington totaled \$238 million.⁶ Profitable specialty crops, such as organic produce and wine grapes, benefit directly from biodiversity. Soils rich in microorganisms improve crop productivity, while various bird and invertebrate species help pollinate and control insect pests and weeds. Specialty agriculture industries are the mainstays of many local economies; for example, the tree-fruit industry employs roughly 19,000 Washingtonians, primarily in the Wenatchee and Yakima valleys in central Washington.⁷

While the resource-based industries of forests, farms, and fisheries continue to provide a key source of jobs and economic vitality, the growth of sectors such as nature-based tourism also contribute to the state's prosperity. The growing value of outdoor recreation has enabled small communities to develop tourist economies that depend on experiencing the local biodiversity. Activities such as fishing, hunting, and birding generated roughly \$2.7 billion in 2006 in Washington.⁸ Many of these dollars are spent on local goods and services, such as food, lodging, wildlife-watching festivals, and guide services.

While difficult to measure directly, Washington's biodiversity contributes to our quality of life in ways that draw new businesses, residents, and visitors crucial to our economy. For example, a survey of the 3.3 million visitors to Olympic National Park in 2000 indicated that scenery, wildlife, and natural beauty are among the top draws of the park.⁹ Many Washington residents live close to areas of spectacular biodiversity. Even in Washington's largest urban center, Seattle families can walk along beaches and look at wildlife without leaving the city limits. The degree to which we take advantage of these natural areas indicates that biodiversity is clearly of value to us: since 1987, Washington has ranked at least sixth in the nation in per-capita visits to parks.¹⁰

Ecosystem Services—Essential to our prosperity

"Ecosystem services" is a term used to refer to the benefits that healthy ecosystems produce. These services, including flood control, water purification, and crop pollination, are vital to human health and well-being. For example, agriculture in Washington thrives because of the honeybees, native insects, and birds that pollinate the apples, pears, peaches, berries, and other crops vital to our economy.



THOMAS G. BARNES

From December through February, hundreds of bald eagles visit the upper Skagit River to feast on salmon. Visitors to the Upper Skagit Bald Eagle Festival have increased tenfold since the 1980s, boosting the economies of several small towns.

⁶ Washington State Department of Revenue, <http://dor.wa.gov/content/AboutUs/StatisticsAndReports/Default.aspx>.

⁷ Washington State Horticultural Association and Washington Tree Fruit Research Commission, *Washington's Billion Dollar Secret – The Tree Fruit Producers Who Help Grow our Economy* (2004).

⁸ U.S. Fish and Wildlife Service, *2006 National Survey of Fishing, Hunting, and Wildlife-associated Recreation: State Overview* (2007).

⁹ State of Washington, Office of Financial Management, "Attendance at Federal Parks Located in Washington State," *Washington State Data Book* (2005); Chad Van Ormer, Margaret Littlejohn, and James H. Gramann, *Olympic National Park Visitor Study: Summer 2000*, Visitor Services Project, Report 121 (2001).

¹⁰ Washington State Economic and Revenue Forecast Council, *Washington State Economic Climate Study* (2006).



RALPH NAESS

Benefits of ecosystem services: The diverse forests of the Cedar River watershed serve as an effective filtration system for the 100 million gallons of water supplied each day to roughly 1.4 million people in the greater Seattle area.* By protecting this 91,800-acre watershed, the city has avoided constructing a costly water filtration plant.

* Friends of the Cedar River Watershed, "The Watershed," <http://www.cedarriver.org/watershed/index.shtml>, last accessed July 2007; Seattle Public Utilities, "Water Sources and Treatment," http://www.seattle.gov/util/About_SPU/Water_System/Water_Sources_&_Treatment, last accessed July 2007.

"We should preserve every scrap of biodiversity as priceless while we learn to use it and come to understand what it means to humanity." – E. O. Wilson

We have only begun to quantify the value of these services, but examples include the flood protection benefits that wetlands offer. Flood protection through engineered approaches is expensive, as are flood damages. Between 1990 and 2005, Skagit County lost an estimated \$78 million due to flood damages.¹¹ Healthy wetlands, with a variety of plants and other life, capture water and delay runoff during storms, reducing or preventing flood damage. These flood protection benefits of wetlands have been valued at a range of \$7,800-\$51,000 per acre.¹²

Similarly, Portland, Oregon, maintains the natural filtration of its water supply by spending \$920,000 annually to protect and restore the Bull Run watershed rather than building a \$200-million water filtration plant.¹³

Medicinal Benefits—Diverse ecosystems as nature's pharmacies

Our health also depends on biodiversity. Besides providing us with clean water, diverse ecosystems are the sources for many medicines, a concept some have referred to as "nature's pharmacy." Taxol, a successful cancer treatment, was originally harvested from Pacific yews growing in diverse mixed-conifer forests. Taxol is one example of the roughly 40% of all prescriptions dispensed in the United States that are derived from substances originally found in plants, animals, or microorganisms.¹⁴ Not-yet-investigated organisms among our fungi, lichens, mosses, and invertebrates are expected to yield new cures and treatments. Most of these species have yet to be rigorously examined for potential medicinal use, which underscores the importance of conserving our biodiversity for future study and research.

Intrinsic Value—Helping us find our place

While some biodiversity values can be quantified, they do not replace the intrinsic value of natural, dynamic, biological diversity. The intrinsic value of our natural heritage is important to Washington's people, as well as to all the

11 Skagit County, "Flood Awareness," <http://www.skagitcounty.net/Common/Asp/Default.asp?d=Flood&c=General&p=floodmain.htm>, last accessed July 2007.

12 Asia Pacific Environmental Exchange, *Untold Value: Nature's Services in Washington State* (2004).

13 Asia Pacific Environmental Exchange, *Ecosystem Services Enhanced by Salmon Habitat Conservation in the Green/Duwamish and Central Puget Sound Watershed* (2005).

14 Washington Biodiversity Council, *Washington's Biodiversity: Status and Threats* (2007).

other species residing in Washington. The biodiversity of the Pacific Northwest plays an important role in our collective culture, as expressed by local artists and writers, by our food, and by our traditions of outdoor activities. Northwest writers frequently describe the interactions between people and their landscape, while the Northwest School of visual artists was influenced by the natural settings of western Washington, particularly the Skagit Valley¹⁵. Pacific Northwest cuisine is based on naturally abundant foods such as salmon, Dungeness crab, wild mushrooms, and berries. People around the state have many important outdoor rituals, from the start of fishing season or harvesting wild camas bulbs, to a Labor Day picnic or annual campout.¹⁶ Many residents feel ethical responsibilities to take care of our lands and waters to ensure a certain quality of the environment for future generations. Nature writers from John Muir to Aldo Leopold have noted the significance of diverse landscapes on the human psyche. As one writer noted, “Biodiversity records how life arrived at itself. Biodiversity plots the path to who we are.”¹⁷

“When one tugs at a single thing in nature,
he finds it attached to the rest of the
world.” - John Muir

Resilience—Staying healthy in the face of change

A rich and varied biodiversity increases the resilience of communities and ecosystems to environmental change. As our climate changes and our global lifestyles increasingly bring non-native species to our region, Washington’s biodiversity helps keep our ecological systems functioning. The relationships among biodiversity, ecological function, and the susceptibility of ecosystems to invasive species are complex and only beginning to be understood.¹⁸

We know, however, that the cumulative loss of species leads to reductions in our ecosystems’ abilities to provide valuable resources and eventually to function at all. Forests composed of many tree species, for example, are less susceptible than single-species monocultures to wholesale destruction from insects like mountain pine beetle or pathogens like pine blister rust. Similarly, each species differs in its ability to tolerate, move, or adapt to changes in temperature and rainfall. Accordingly, diverse communities are most likely to contain some species that can survive our changing climate and support continued ecosystem function in an uncertain future.

Biodiversity, like a diversified stock portfolio, keeps our options many and varied. Biodiversity moderates the chances that future changes will lead to the wholesale collapse of systems that we depend on for our basic needs, such as air, food, water, shelter, medicine, and spiritual well-being.

Why Biodiversity Matters Most—A legacy for our children

The scientist and writer E. O. Wilson has made eloquent cases for the protection of biodiversity, arguing that “[T]he one process now going on that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our

15 N. O’Connell, *On Sacred Ground: The Spirit of Place in Pacific Northwest Literature* (2003).

16 Greg Johnston, “Ancient Grasslands Are a Storehouse of History,” *Seattle Post-Intelligencer* (May 18, 2006).

17 Ed Zahniser, “Memory As Inspiration in Advocating Wilderness and Wildness,” Talk at the Wilderness Society (February 15, 2000).

18 S. Naeem, “Complexity Versus Diversity,” in S. A. Levin, ed., *Encyclopedia of Biodiversity*, vol. 1. (San Diego, Calif.: Academic Press, 2001), 831-843; R. Thompson and B. M. Starzomski, “What Does Biodiversity Actually Do? A Review for Managers and Policy Makers,” *Biodiversity and Conservation* 16 (2007): 1359-1378.



SHUTTERSTOCK.COM/GLENN R. MCGLOUGHLIN

Biodiversity gives us options in a variable world. Alaska's diversity of salmon species has allowed the total fishery to remain consistently productive despite annual variation in the abundance of any one species.*

* R. Hilborn, T. P. Quinn, D. E. Schindler, and D. E. Rogers, "Biocomplexity and Fisheries Sustainability," *Proceedings of the National Academy of Sciences* 100 (2003): 6564–6568.

descendants are least likely to forgive us.”¹⁹ Protecting Washington’s biodiversity will allow future generations to enjoy our current quality of life and economic vitality. Our children and their children can continue to enjoy the shellfish harvests, clean water, flood protection, blueberries, forest trails, and beautiful vistas that we enjoy and depend on today.

What is Happening to Washington’s Biodiversity Resources?

Current Status: Diverse and Declining

Washington is one of the most biologically diverse states in the nation, due to its varied topography, exposure to Pacific Ocean currents and weather patterns, and location on the migratory path of many wildlife species. As previously noted, Washington State has a tremendous variety of ecosystems, from estuaries to shrub-steppe landscapes, conifer forests to interior sand dunes, and deep marine waters to alpine meadows.

As the smallest and second-most densely populated of the rapidly growing western states, Washington has experienced a dramatic loss of its native biodiversity over the last 100 years and faces significant threats in the future. The following sections summarize the current status of our species and ecosystems and provide an overview of key threats affecting our biodiversity heritage.²⁰

Species

While a limited number of native species have increased in numbers, many species have experienced significant declines in Washington. In general, those species that can take advantage of disturbances or colonize altered environments have increased, such as the western scrub jay and the American robin. More frequently, changes in the landscape have resulted in significant declines for many of Washington’s native species, both aquatic and terrestrial.

Diverse systems like those in Washington have a certain amount of redundancy, such that several species may serve similar functions within an ecosystem. This diversity and redundancy can help ecosystems and species assemblages be more resilient in the face of change. Other species play unique roles, like the predatory seastars that eat fast-growing mussels in our intertidal zones. Loss of even a single critically important “keystone species” can quickly disrupt ecological function.

¹⁹ E.O. Wilson. “Resolutions for the 80s” Harvard Magazine January – February 1980, pp. 22-26.

²⁰ More details about Washington’s biodiversity may be found in the report *Washington’s Biodiversity: Status and Threats*, issued by the Biodiversity Council in January 2007 and available on the web at <http://www.biodiversity.wa.gov/council/docs.html>.

The federal Endangered Species Act (ESA) lists as endangered or threatened species that are of conservation concern nationwide. Currently, 40 animal species (including 15 fish species) and 10 plant species that occur in Washington are listed under the ESA. All are in danger of extinction.

However, the federal list of endangered and threatened species is not a true reflection of the number of species in Washington that warrant conservation attention. Many additional species are of conservation concern in Washington, though not nationwide. The Washington Department of Fish and Wildlife and Washington State Department of Natural Resources' Natural Heritage Program maintain lists that provide a more comprehensive view of the status of Washington's species. These listings include more than 500 species of plants and animals that are of concern in Washington.²¹ Many of these species are located in the Puget Trough and Columbia Plateau, which have had the highest levels of ecosystem conversion in the state.

Despite the long lists of threatened and endangered species, only two plants and two animals native to Washington are currently thought to have become globally extinct since European settlement. Other species are found elsewhere but appear to be extirpated from Washington, including the fisher, the Columbia River tiger beetle, and the yellow-billed cuckoo.²² The fact that populations of these species exist elsewhere provides us with an opportunity for reintroduction and recovery. However, the success of such efforts depends upon the existence of suitable habitat.

Native Washington species that appear to be globally extinct include pale bugseed, thistle milk-vetch, Tacoma pocket gopher, and Cathlamet pocket gopher.*

* Washington Department of Fish and Wildlife, *Status Report for the Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot* (2005).

Ecosystems and Landscapes

Since statehood in 1889, Washington has experienced the loss or moderate-to-severe degradation of many diverse and productive habitats, ecosystems, and landscapes.

- Marine, estuarine, and nearshore ecosystems have been converted, modified, and contaminated.
- Riparian and freshwater aquatic ecosystems have been eliminated or degraded.
- Old-growth forests have been converted and altered.
- Shrub-steppe and grassland ecosystems have been converted.

Many of Washington's ecosystems have undergone significant declines, with certain systems experiencing more pressure and faster rates of decline. To the extent that these ecosystems are in trouble, the species found in each ecosystem are likely also at risk. As more ecosystems are degraded or reduced in their extent, more species will decline to the point of peril. The sections below describe the status of particular ecosystems of concern.

Marine, Estuarine, and Nearshore Ecosystems

Human development has modified up to 52% of the central Puget Sound shoreline. For example,

21 Washington State Department of Natural Resources, *State of Washington Natural Heritage Plan: 2005 Update* (April 2005); Washington Department of Fish and Wildlife, *Washington's Comprehensive Wildlife Conservation Strategy* (September 19, 2005).

22 Washington State Department of Natural Resources, *Washington Natural Heritage Program Information System* (2006).



JULIE BENNETT

The Puget Trough ecoregion was the first in the state to be logged, the first to be turned to agriculture, and the first to become densely settled. Over the years, forest plantations, farms and fields, cities, towns, and suburbs have largely replaced the once-continuous forests of Western hemlock, Western redcedar, and Douglas-fir.

the Puyallup River estuary has lost 99% of its marsh ecosystem and 95% of its intertidal mud flats through conversion to port facilities.²³ Contamination of marine areas has also taken its toll; for example, the Puget Sound basin has multiple Superfund sites.

Riparian and Freshwater Aquatic Ecosystems

More than 1,000 dams affect the flow of Washington's waterways,²⁴ and a natural flood regime has been entirely removed from both the Columbia and Snake rivers. Smaller riparian systems show increased stream temperatures, increased sediment loads, and altered stream flows. In the Columbia Plateau ecoregion, ecosystems dominated by non-native species, little to no shrub or tree cover, and altered stream profiles have replaced many of the natural riparian ecosystems. In total, according to the Washington State Department of Ecology, 60% of Washington's rivers are in poor to only fair health.²⁵

Forested Ecosystems

Over two-thirds of Washington's historical old-growth forests have been harvested.²⁶ Much of the logging has occurred in southwestern Washington and the Puget Trough lowlands. Single-species plantations have replaced many stands of mixed species and varied tree ages. Many forests today have fewer downed logs and standing snags than their historical counterparts; these logs and snags are important components of habitat for wildlife species and for ecosystem processes. Changes to the structure of some forests have made them more vulnerable to fire. For example, open stands of fire-resistant ponderosa pine trees historically characterized low-elevation forests in eastern Washington. Fire suppression and timber management have significantly changed the structure and species composition of these forests, making them more susceptible to fire.

Shrub-steppe and Grassland Ecosystems

Since 1870, 94% of the original Palouse grasslands has been converted to crops, hay, or pasture. Today's shrub-steppe and grassland ecosystems are highly fragmented, with many small, isolated remnants, primarily due to conversion to agriculture. Weed encroachment, and the loss of pollinators for native plants, are slowly reducing the size of these remnant patches of big sagebrush, bluebunch wheatgrass, and associated species.²⁷ Lack of continuous habitat poses challenges for many key species, such as the sage-grouse and the burrowing owl.

²³ Washington State Department of Natural Resources, *Puyallup River Delta Estuary Landscape Restoration Plan* (1999).

²⁴ Governor's Sustainable Washington Advisory Panel, *A New Path Forward: Action Plan for a Sustainable Washington – Achieving Long-term Economic, Social and Environmental Vitality* (2003).

²⁵ Washington State Department of Ecology, "1998 Washington State Water Quality Assessment, Section 305(b) Report," in Washington State Office of Financial Management, *Environmental Chartbook: A Collection of Indicators on Washington's Environment* (1999).

²⁶ Washington State Department of Natural Resources, "Timberland Acres in Washington State," in Washington State Office of Financial Management, *Environmental Chartbook: A Collection of Indicators on Washington's Environment* (1999).

²⁷ Anne E. Black, J. Michael Scott, et al., "Biodiversity and Land-use History of the Palouse Bioregion: Pre-European to Present," in U.S. Geological Survey, *Land Use History of North America* (2003), <http://biology.usgs.gov/luhna/chap10.html>.

Primary Threats and Drivers of Change

The following section discusses the most significant threats contributing to the declines in our biodiversity detailed above. Many of these threats are historically unprecedented. The threats include habitat fragmentation and loss, invasive species, climate change, pollution, and the disruption of natural processes such as water cycles.

Before we can address these threats in a meaningful way, however, we must consider the context in which these threats operate. Economic and demographic trends have a profound effect on our landscape and biodiversity. The following section concludes with an overview of these trends, or drivers of change, to help clarify the causes of decline and identify areas in which we can take action to conserve existing species and ecosystems.

Key Threats to Washington's Biodiversity

Population Growth and Land Conversion—Leading to habitat loss and fragmentation

Population growth is a major driver of the decline of biodiversity in the state. Washington's population has doubled in the past 40 years from 3 to 6 million residents. The population is expected to increase to more than 8 million in the next 20 years, equivalent to the addition of four more Seattle-sized cities spread over the state.

Over 50% of the state's growth is expected to occur in the Puget Trough ecoregion. Meanwhile, areas of high biodiversity in the Okanogan, Columbia Plateau, and Northwest Coast ecoregions will face the most rapid growth as a percentage of current population. While Seattle and other urban centers will gain the most new residents, many new parcels are being developed in rural areas outside the urban core, reducing native habitat for biodiversity.²⁸ Population growth in rural

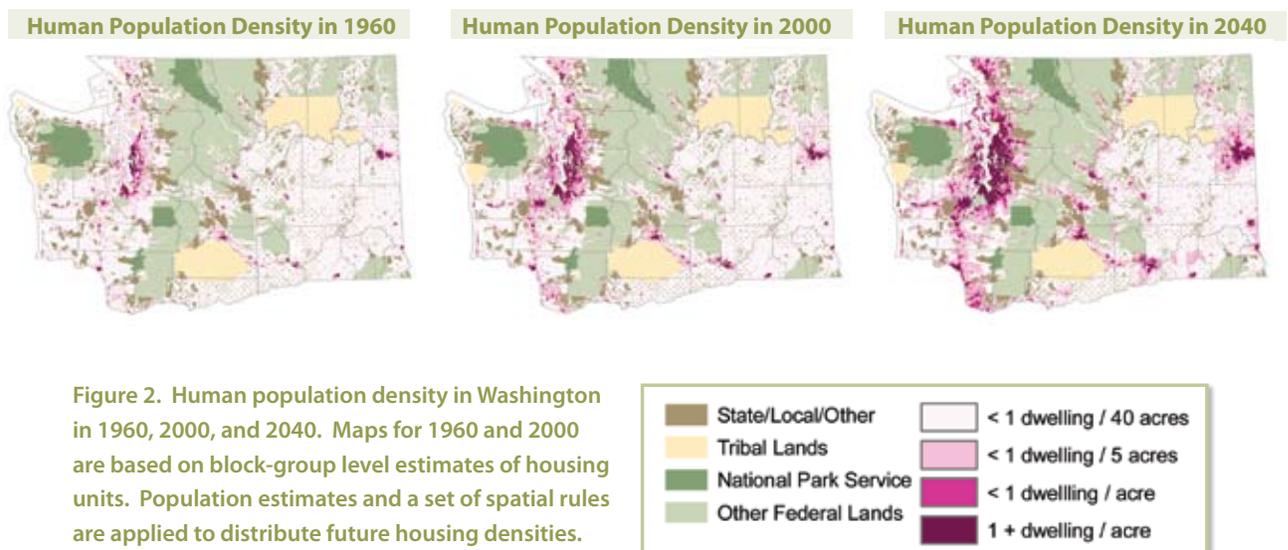


Figure 2. Human population density in Washington in 1960, 2000, and 2040. Maps for 1960 and 2000 are based on block-group level estimates of housing units. Population estimates and a set of spatial rules are applied to distribute future housing densities. More details are available at <http://www.centerwest.org/publications/pdf/futures.pdf>.

Source is W.R. Travis, D.M. Theobald, G.W. Mixon, T.W. Dickinson, Western Futures: A Look into the Patterns of Land Use and Future Development in the American West (2005).

²⁸ Doug Peters, Washington State Department of Community, Trade, and Economic Development, personal communication, May 5, 2006.

areas usually occurs in high-quality habitat, often converting agricultural and forest lands, and in a sprawling pattern which consumes 21% more undeveloped land than compact development (see Figure 2).²⁹

While the modification of native ecosystems to agricultural fields and managed timber lots has diminished biodiversity, working lands still offer a range of habitats for many species. Historically, intensive large-scale agriculture contributed fertilizers and pesticides to water bodies. Logging roads accelerated erosion and invasion of non-native species, while fire suppression altered forest structure and composition. Today, many farming and timber management practices protect biodiversity, whether through arrangements with land trusts, practices under the 1999 Forests and Fish Law and other Forest Practices rules, or enrollment in the Sustainable Forestry Initiative or Forest Stewardship Council certification. If current rates of land conversion continue, however, the good stewardship practiced by working landowners will ultimately have a limited impact in conserving Washington's biodiversity.

Climate Change

Climate change, fueled in part by land conversion and population growth around the globe, is emerging as a major threat to Washington's biodiversity. Washington is expected to have warmer weather and altered precipitation patterns, wetter in winter and drier in summer. This change will alter ecological relationships, affecting both larger natural systems and many individual species.

For example, reduced snow pack in warmer winters will affect stream-flow patterns, in turn affecting many freshwater systems. Higher temperatures and less summer precipitation will result in drier timber and grasslands, which will likely mean more frequent, intense, and extensive wildfires. Rising sea levels may inundate low-lying coastal areas and degrade nearshore habitats through coastal erosion, landslides, saltwater intrusion, and river-mouth flooding. Invasive species may be more successful in altered habitats; for example salmon are expected to face more competition from non-native, warm-water species.

A major concern for conservation efforts is how climate change will affect the ranges of species. Plant and animal species will tend to move, typically northward and upward, as temperatures increase and other conditions change. The most dramatic impact may be seen at the edges of a species' range, where its survival is already tenuous. Land conversion and habitat fragmentation may accelerate the loss of species at these margins. Species that are particularly sensitive to microclimates are expected to face the most severe habitat loss. For example, many amphibians may not be able to live in aquatic habitats with altered temperatures and nutrient concentrations. Thus, conservation efforts must consider not only current conditions but also predictions of future climate changes.³⁰

²⁹ R. W. Burchell and S. Mukherji, "Conventional Development Versus Managed Growth: The Costs of Sprawl," *American Journal of Public Health* 91, no. 9 (2003): 1534-1540.

³⁰ J. J. Lawler and M. Mathias, *Report on Climate Change and the Future of Biodiversity in Washington*, prepared for the Washington Biodiversity Council (2007).

Invasive Species

The rapid spread of invasive species across Washington currently poses a threat to an estimated 25% of the state's plant species. Non-native species are identified as a principal risk to the natural heritage in seven of Washington's nine ecoregions.³¹ Invasive species may not only out-compete native species for resources but also may prey on them and alter their habitats. Invasive species can alter key properties of an ecosystem (e.g., Eurasian water milfoil resulting in lower dissolved oxygen), change the physical structure of an area (e.g., *Spartina* converting open mud flats to grass meadows), or alter disturbance patterns (e.g., cheatgrass increasing fire frequency). Both the impacts on native species and the control of invasive species can be costly. Annual economic damage and control costs for all non-native species in the United States is estimated at \$122 billion per year.³²

Pollution

Pollution sources are many and varied, ranging from effluent and emissions from manufacturing facilities, to stormwater runoff from roads, buildings, lawns, and parking lots. For example, fertilizers and pesticides applied to lawns, golf courses, fields, and forests have found their way into streams, lakes, and Puget Sound. These sources and others contribute to the high levels of toxic chemicals that have been measured in shellfish, fish, birds, and marine mammals in Puget Sound.³³

Disruption of Natural Processes

Natural disturbances, such as fire, flooding, windstorms, and outbreaks of disease, play an important role in the patterns of abundance, distribution, and species composition of ecosystems. Human disruption of natural disturbance processes, such as fires and floods, has had far-reaching impacts on species and ecosystems in Washington. Population growth means increases in water demands, which in turn may lead to the construction of more water storage projects. Dams deprive downstream systems of such natural processes as flooding, scouring, and deposition of sediment and nutrients. An increasing number of houses in fire-prone areas on the urban fringe has yielded a more urgent need for fire suppression, which disrupts natural fire cycles.



WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

The invasive species *Spartina alterniflora* (cord grass) covered 10-15 acres in Washington in the early 1970s, growing to roughly 8,500 acres in 2003.* *Spartina* can displace native plants such as sea grasses which provide refuge and food for fish, crabs, waterfowl and other marine life.**

* Washington Invasive Species Council, *Biodiversity and Invasive Species in Washington State* (2007).

** Western Aquatic Plant Management Society, "*Spartina alterniflora* – Smooth Cordgrass," <http://www.wapms.org/plants/spartina.html>, last accessed August 2007.



SHUTTERSTOCK.COM/AARON WHITNEY

Orcas in Puget Sound's southern resident population, federally listed as endangered in 2005, have extremely high levels of polychlorinated biphenyls (PCBs) and fire retardants in their bodies. These toxic pollutants disrupt the orcas' endocrine systems and impair their reproduction and immune systems.‡

‡ Ken Olsen, "Orcas on the Edge," *National Wildlife* 44, no. 6 (2006).

31 Washington Invasive Species Council, *Biodiversity and Invasive Species in Washington State* (2007).

32 Washington Invasive Species Council, *Biodiversity and Invasive Species in Washington State* (2007).

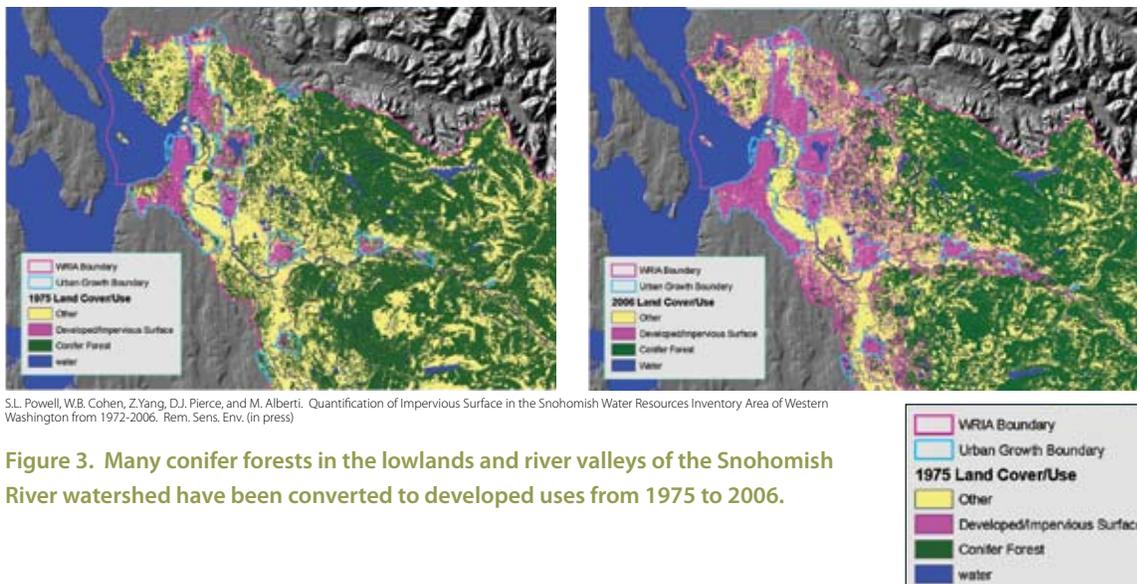
33 Washington State Department of Ecology, *Washington's Environmental Health 2004*, Publication No. 04-01-011 (2004).

Economic and Demographic Trends

Shifts in the nature of our economy, away from manufacturing and resource-based industries and toward knowledge- and service-based industries, will continue to affect both the threats to biodiversity as well as our ability to respond.³⁴

Shifts in the Economic Base

A primary shift is the decline of the resource-based economy, which puts pressures on farmers and foresters to convert their land to residential and commercial purposes. While scholars are still working to determine rates of conversion of forested lands and farms to more developed uses, conservative estimates are that 80 acres of forests in Washington are converted to other uses each day.³⁵ Many of these parcels are in areas of rich biodiversity, often near streams with high biological values.³⁶



As the resource-based economy declines, more than half of all the job growth in Washington will come from service-based industries over the next 25 years.³⁷ Most working farms and forests provide better habitat than the paved development that typically accompanies a service economy, and service jobs are growing in both urban centers and rural areas.

Prosperity and Consumption

Our increasingly consumptive lifestyles, facilitated by increasing wealth in the state, have brought benefits and increased living standards for many Washingtonians. This growth in consumption, however, puts pressure on our natural resources. The associated increases in housing development, commercial properties, energy and material use, roads, and waste can adversely affect natural habitats and biodiversity.

³⁴ Washington State Economic and Revenue Forecast Council, *Washington State Economic Climate Study* (2005).

³⁵ Ara Erickson, University of Washington, College of Forest Resources, personal communication, October 8, 2007.

³⁶ Kirk Hanson, Washington State Department of Natural Resources, personal communication, May 17, 2006.

³⁷ Office of Financial Management, State of Washington, *The 2005 Long-term Economic and Labor Force Forecast for Washington* (2005).

Demographic Shifts

Major demographic shifts accompany these economic shifts in Washington. These changing demographics affect the location of people on the landscape as well as the connections between people and the land. Several trends are worth noting, such as the prediction that 54% of Washington's population growth by 2025 will come from net migration³⁸. Rural counties, particularly in the Northwest Coast ecoregion, will see the fastest rates of growth from newcomers. Washingtonians aged 65 or older are expected to compose 19% of all residents by 2030, up from 11% today.³⁹ Some of these projected 1.7 million individuals are expected to accelerate demand for vacation or retirement homes. Others, including the more than 60% of current forest landowners older than 55, are expected to sell their working lands for development purposes at an increased rate.⁴⁰

Surging Real Estate Values

Real estate markets in many parts of Washington with rich biodiversity heritage can provide disincentives both to conserving land and to working the land. In many areas along suburban boundaries, land values for development uses are significantly higher than values for forestry uses. Washington also experiences real-estate pressures along its state borders. Tax policies in Canada encourage development in the Okanogan region, while job availability in Portland, Oregon, drives development in Clark County.

Expanding Tourism

The growing importance and value of tourism to Washington's economy, if well-managed, can be a great benefit to biodiversity. For example, wildlife-associated recreation (e.g., birding and hunting) was estimated to generate \$2.7 billion in spending in Washington in 2000. Another estimate put the total value of all outdoor recreation in the state at \$4.1 billion.⁴¹ Nature-based tourism dollars can form an economic alternative to resource extraction and development, and these resources may be applied to protect natural systems. It is important to note, however, that the infrastructure for recreational pursuits and the impacts of people in relatively wild areas can also negatively affect habitats.

A Global Economy

Washington depends on international trade more than any other state, with exports of foreign goods averaging 17% of personal income in the state in 2000-2004.⁴²



STOCK

The size of new single-family homes in the U.S. has more than doubled since the 1940s, from 1,100 to 2,340 square feet.*

* A. Wilson and J. Boehland, "Small Is Beautiful: U.S. House Size, Resource Use, and the Environment," *Journal of Industrial Economy* 9, nos. 1-2 (2005): 277-287.



JOAN FISH

38 Office of Financial Management, State of Washington, *Washington State County Growth Management Population Projections: 2000-2025* (2002).

39 Office of Financial Management, State of Washington, *Forecast of the State Population by Age and Sex: 1990 to 2030* (2005).

40 C. Mater, "The New Generation of Private Forest Landowners: Brace for Change," *The Pinchot Letter* 10, no. 2 (2005): 1-4.

41 Washington State Parks and Recreation Commission, *Washington State: Economic Impact of Visitors in National Parks* (2002).

42 Washington State Economic and Revenue Forecasting Council, *Washington State Economic Climate Study* (2005).

In this global economy, Washington's farmers and foresters must compete on a worldwide basis. To compete successfully, many farmers are compelled to use every acre possible to increase their efficiency, thereby increasing pressure on biodiversity. Increased out-of-state or foreign ownership of Washington's lands is another influence of globalization that can adversely affect biodiversity. International trade agreements and systems, such as the General Agreement on Tariffs and Trade and the World Trade Organization, also can limit the ability of state and federal governments to provide support for conservation activities.

Current Efforts to Protect and Conserve Our Biodiversity

In the face of these threats, state, federal, tribal, and local governments as well as nonprofits and private landowners are investing substantial time, energy, and resources to protect and conserve components of biodiversity across Washington State. The Council carefully examined these existing efforts to identify strengths, gaps, and opportunities to move forward. These ongoing activities provide the foundation for this Biodiversity Conservation Strategy. The strategy is intended to enhance these existing efforts by integrating them into a comprehensive, statewide approach to long-term biodiversity conservation.

It is beyond the scope of this report to describe the many ongoing activities related to biodiversity conservation in Washington State. Highlights are presented below. The specific recommendations in Chapter 3 also identify many of the listed public agencies and other organizations as potential partners for implementation of the strategy. While these named entities provide a starting list, many additional parties will also play important roles in implementation.

State Government—Multiple agencies managing natural resources and influencing landscapes throughout Washington

Washington State government is actively engaged in managing and conserving biodiversity as a landowner, regulator, technical assistance provider, and educator. Nearly a dozen state agencies are involved in direct and indirect conservation activities, such as stewardship, restoration, acquisition, assistance, enforcement, and education, as summarized below.

- The **Washington Department of Fish and Wildlife** owns or controls approximately 1 million acres of critical habitats and is charged with preserving, protecting, and perpetuating fish and wildlife. The statewide *Comprehensive Wildlife Conservation Strategy*, approved by the U.S. Fish and Wildlife Service in 2005, guides WDFW's management of these lands and wildlife resources.
- The **Washington State Department of Natural Resources** manages over 5 million acres of state trust lands, including forests and aquatic systems, for all generations and all people of Washington. Key programs include the Natural Heritage Program, the Aquatic Lands Enhancement Account, and resources for small forest landowners. The Department of Natural Resources also administers the Forest Practices Act, which regulates forest practices, including timber harvest, on private lands. DNR's mandate that trust lands be managed "forever" to benefit future generations provides an important basis for departmental policies, programs, and actions to conserve biodiversity.



BEN LEGLER



BILL LEONARD



KATHLEEN DEASON

- The **Washington State Recreation and Conservation Office** (formerly the Interagency Committee for Outdoor Recreation) administers several key programs designed to acquire and protect critical habitat and open space, protect working lands, and provide opportunities for recreation. In addition to the Recreational and Conservation Funding Board, the Forum on Monitoring Salmon Recovery and Watershed Health, the Biodiversity Council, and the Invasive Species Council, the agency supports the following efforts:
 - The **Washington Wildlife and Recreation Program**, which has received \$550 million since 1990 from the Washington State Legislature for the purchase of land and shorelines for open space, parks, habitat protection, and recreation.
 - The **Salmon Recovery Funding Board**, which provides grant funds to protect and restore salmon habitat.
- The **Washington State Department of Ecology** regulates air and water pollution, manages and enforces water rights and water use, regulates solid waste, and supports local Watershed Planning Units. Department of Ecology is actively engaged in conserving biodiversity through its regulatory role, and the agency recently initiated projects to improve the effectiveness and efficiency of mitigation programs such as wetland banking.
- The **Washington State Conservation Commission** guides and assists the 47 conservation districts across the state, with nearly 500 employees and volunteers assisting private landowners in voluntary conservation. These activities provide a core building block for any future expansion of biodiversity-related incentive programs.
- The **Washington State Parks and Recreation Commission** helps citizens experience and enjoy the outdoors, and the commission has recently undertaken new initiatives to promote stewardship and educate park visitors about biodiversity.

- The **Puget Sound Partnership**, established in 2007, is charged with leading efforts to protect and restore Puget Sound by 2020.
- The **Washington State Department of Community, Trade, and Economic Development** implements the state’s Growth Management Act, which provides for protection of rural lands and habitat by concentrating and regulating growth.
- The **Washington State Department of Transportation** is responsible for building and maintaining the state’s transportation infrastructure, and thus has a critical role in providing for habitat protection and biodiversity conservation while expanding and rebuilding the state’s roads, bridges, ferries, and other public transportation rights-of-way.
- Finally, the **Washington Office of the Superintendent for Public Instruction** is involved with developing new curriculum standards and programs that address environmental education and sustainability, both of which relate directly to biodiversity conservation.

Federal Government—Managing biodiversity on federal lands; regulating and funding species protection, pollution, and conservation on waterways and private lands

The federal government plays a critical role in managing natural resources and protecting biodiversity as both a landowner and regulator. The federal government has many land management responsibilities, including:

- **National Parks**, including Olympic National Park, Mt. Rainier National Park, and North Cascades National Park, which allow visitors to experience protected, intact ecosystems.
- **Wilderness Areas**, such as the Pasayten or Goat Rocks Wilderness, defined as “an area where the earth and its community of life are untrammled by man, where man himself is a visitor who does not remain.”⁴³ In Washington State, the U.S. Forest Service, National Park Service, Bureau of Land Management, and U.S. Fish and Wildlife Service manage the state’s 30 wilderness areas.
- **Forest Service** lands outside of designated wilderness, which are operated under a multiple-use policy that includes the protection of fish, wildlife, and habitats as well as recreation and commercial uses.
- Other roadless areas managed by the **Bureau of Land Management**.

As a regulator, the federal government is involved in enforcement of several laws that directly affect biodiversity, including:

- The **Endangered Species Act**, which provides for the identification and protection of endangered and threatened species, including the development of Habitat Conservation Plans.
- The **Federal Water Pollution Control Act (Clean Water Act)**, which regulates water pollution, including wetlands protection, and is administered jointly with the Washington State Department of Ecology.

⁴³ 16 U.S. Code, section 1131(c).

The federal government also serves as a source of funds for conservation practices, for example through U.S. Department of Agriculture's Nature Resources Conservation Service programs such as the Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), Grassland Reserve Program (GRP), Wetlands Reserve Program (WRP), and Wildlife Habitat Incentives Program (WHIP).

Local Governments—Responsible for zoning, growth management, shorelines protection, water use, and stormwater management

With responsibility for creating and enforcing local land use policies and zoning, local governments are on the front lines of efforts to conserve biodiversity. Local government decisions directly influence biodiversity every day. Key activities include:

- Responsibility for administering and enforcing many state laws with relevance to biodiversity, including the Growth Management Act, the Shoreline Management Act, and taxation policies such as current use taxation and the Public Benefit Rating System.
- Participation in Watershed Planning Units, which are developing approaches to managing the water quality, flows, and habitats of their local streams.
- Development of innovative strategies to address biodiversity conservation needs, such as the King County Biodiversity Plan, Spokane County's Rural Conservation category in its 2002 Comprehensive Plan update, and Pierce County's Biodiversity Management Areas.

Private and Nonprofit Organizations—Providing leadership and infrastructure to implement conservation programs on the ground

Private and nonprofit entities, as well as local stakeholder groups, play key roles in developing and implementing policies and programs to conserve biodiversity. Over the last two decades, land trusts, trade associations, and other groups have been critically active in stewardship, acquisition, restoration, and education about conservation and biodiversity in Washington State. Key private and nongovernmental entities include:

- Land trusts, ranging in scale and activity from the local Blue Mountain Land Trust and the North Olympic Land Trust, to the Cascade Land Conservancy and the national Trust for Public Lands.
- Nonprofit conservation organizations, including the American Farmland Trust, The Nature Conservancy, Trout Unlimited, the National Wildlife Federation, and Farming and the Environment.
- Associations of private landowners, including the Washington Forest Protection Association and the Washington Farm Forestry Association.
- Local sub-basin planning groups, which conduct salmon recovery and wildlife planning with funding from the Northwest Power and Conservation Council and the Bonneville Power Administration.
- Environmental education organizations, including the Pacific Environmental Institute and E3 Washington.

Tribes—Managing reservation lands and waters, collaborating in land use and resource management decisions in areas adjacent to reservations

The 29 federally recognized tribes in Washington State have a special connection to the landscape and its biodiversity. Although each is an independent sovereignty, the tribes hold many principles in common. Tribal cultures celebrate the full richness of life and the ways it supports tribal families economically and spiritually. This relationship to the ecosystem and stewardship considers the needs of the generations to come:

- Tribes are active managers of fish, wildlife, and plants that are important to their cultures. These efforts include all aspects of salmon management from habitat issues, hatchery management, and domestic and international harvest forums.
- Tribes are leading the salmon recovery efforts in many watersheds, while working closely with other resource managers and landowners toward common goals. Many recovery actions fall under the aegis of the Endangered Species Act, while tribal efforts typically focus more broadly on ecosystem health rather than specific species.
- Tribes actively participate with local governments on land use activities that may affect trust resources and treaty rights. Many tribes have partnered with local jurisdictions on revision of Critical Area Ordinances and Shoreline Master Program updates as well as Urban Growth Areas and domestic water issues.



AARON BARNA

Summary—Washington’s Biodiversity Is in Our Hands

Washington State’s diversity of species, ecosystems, and landscapes represents a vast and precious resource. Yet many of these species are at risk, and ecosystems vital to their survival have been degraded. The threats to biodiversity are many, but today we are well-equipped to refocus and expand our efforts to conserve biodiversity.

Landowners across the state are actively managing their land in ways that foster healthy ecosystems and species, while other Washington residents take part in restoration activities. Conservation districts and land trusts use incentive programs and acquisition programs to conserve lands and waters. Scientists at universities, state and local agencies, and nonprofits are conducting research into land management methods and are improving our understanding of biodiversity. At the same time, teachers and other educators around the state are raising the environmental awareness of Washingtonians, from kindergarteners to retirees.

In light of the many important activities currently underway, the work of the Washington Biodiversity Council represents a significant commitment by the Legislature and the Governor. This strategy establishes a framework for state policy on biodiversity conservation in Washington. The future of Washington’s biodiversity depends on enhancing current efforts as well as strengthening cooperation and coordination among all active players; Chapter 3 presents recommendations designed to bolster these efforts and foster such cooperation.