Threats and Challenges

CHAPTER 7

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

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

Habitat Loss

Habitat can be defined as an area that provides the food, cover, water, and space that living things need to survive and reproduce. Species diversity and population numbers can be attributed to the quality, extent, distribution, and size of particular types of habitat. When a watershed or individual natural area is changed by human activities—such as agriculture, commercial or residential development, logging, road construction, or water diversion—the area may no longer be able to provide the necessary food, water, cover, and space to enable adult survival and successful reproduction. Obviously people need places to live and work, yet our patterns of settlement typically reduce the availability, quality, and function of habitat for native fish and wildlife. What is the scale of such habitat loss? Worldwide, approximately half the Earth's land area already has been transformed for human use: 11 percent each for farming and forestry, 26 percent for livestock pasture, and 2 to 3 percent for development (housing, industry, infrastructure, services, and transportation). In the greater Portland-Vancouver region, 22 percent of the land is identified as agriculture, 13 percent as developed, and an unknown but large number of acres is managed for forestry (see Table 1-1). Loss and degradation of habitat has resulted in the regional decline and extirpation of many plant, fish, and wildlife species, including the spotted frog, Lewis' woodpecker, western rattlesnake, black bear, and many plants and Neotropical migratory birds The most common types of habitat loss are habitat conversion, habitat fragmentation, and habitat degradation:

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

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

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

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

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

Barriers and Declining Landscape Permeability

Curt Zonick, Metro

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

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

Natural Versus Artificial Barriers

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

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

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

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

Types and Impacts of Artificial Barriers

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

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

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

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

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

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

Effects of Barriers on Different Types of Biota

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

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

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

How New Barriers Are Assessed

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

Strategies to Improve Regional Connectivity

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

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

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

FOR MORE INFORMATION

"How Do Highways Influence Snake Movement? Behavioral Responses to Roads and Vehicles"
K.M. Andrews, J.W. Gibbons, and T.W. Reeder. *Copeia* 2009;2005:772-782.

"Mitigation Measures to Reduce Highway Mortality of Turtles and Other Herpetofauna at a North Florida Lake"
M.J. Aresco. *Journal of Wildlife Management* 2005;69:549-560.

Use and Effectiveness of Wildlife Crossings: National Wildlife Crossing Decision Guide Protocol
J.A. Bisonnette and P. Cramer. NCHRP 25-27. 2007. National Academy of Sciences and Engineering, Transportation Research Board, National Cooperative Highway Research Program.

"Quantifying the Road-effect Zone: Threshold Effects of a Motorway on Anuran Populations in Ontario, Canada"
F. Eigenbrod, S.J. Hecnar, and L. Fahrig. *Ecology and Society* [online] 2009;14:Article 24.

"Estimate of the Area Affected Ecologically by the Road System in the United States"
R.T.T. Forman. *Conservation Biology* 2000;14: 31-35.

"Behavioral Barriers to Non-migratory Movement of Birds"
R. Harris and M.J. Reed. *Ann Zool Fennici* 2002;39:275-290.

Final Report on Oregon Wildlife Linkage Workshops Hosted by ODFW in 2007
A. Hatch, S. Wray, S.L. Jacobson, M. Trask, and K. Roberts. 1-23. 2007. Salem, Oregon, Oregon Department of Fish and Wildlife.

Wildlife Crossings: Development and Field Test of Methods for Assessing Corridor Permeability in the Portland Metropolitan Region
K. Keller. Thesis dissertation, 2009. Portland, OR, Portland State University.

Highway Median Impacts on Wildlife Movement and Mortality
A.P. Klevinger and A.V. Kociolek F/CA/MI-2006/09, 1-128. 2006. Sacramento, CA, State of California Department of Transportation.

Green Trails: Guidelines for Environmentally Friendly Trails
Metro Regional Government. 2004. Portland, OR.

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

"A Southern California Freeway Is a Physical and Social Barrier to Gene Flow in Carnivores"
S. Riley, J.P. Pollinger, R.M. Sauvajot, E.C. York, C. Bromley, T.K. Fuller, and R.K. Wayne. *Molecular Ecology* 2006;15:1733-1741.

"Limitations to Wildlife Habitat Connectivity in Urban Areas"
M. Trask. In C.L. Irwin, D. Nelson, and K.P. McDermott, International Conference on Ecology and Transportation. Proceedings of the 2007 International Conference on Ecology and Transportation. 2007. Raleigh, NC, Center for Transportation and the Environment, North Carolina State University.

"Assessing Functional Landscape Connectivity for Songbirds in an Urban Environment"
M. Tremblay. In C.L. Irwin, P. Garrett, and K.P. McDermott. Proceedings of the 2005 International Conference on Ecology and Transportation. 2005. Pp. 561-564. Raleigh, NC, Center for Transportation and the Environment, North Carolina State University.

"Road Crossing Structures for Amphibians and Reptiles: Informing Design through Behavioral Analysis"
H. Wolz and Gibbs. In C.L. Irwin, P. Garrett, and K.P. McDermott. Proceedings of the 2007 International Conference on Ecology and Transportation. 2007. Raleigh, NC, Center for Transportation and the Environment, North Carolina State University.

Water Quality

Lori Hennings, Metro

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

Clark County – Clark County DES Perspective

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

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

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

CONDITION OF INDIVIDUAL WATERSHEDS IN CLARK COUNTY

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

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

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

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

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

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

Lacamas Creek Watershed

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

Washougal River Watershed

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

Gibbons Creek Watershed

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

Vancouver Lake/Lake River Watershed

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

Burnt Bridge Creek Watershed

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

Columbia Slope Watershed

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

TRENDS IN STREAM HEALTH FOR CLARK COUNTY WATERSHEDS

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

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

STRATEGIES FOR CLARK COUNTY WATERSHEDS

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

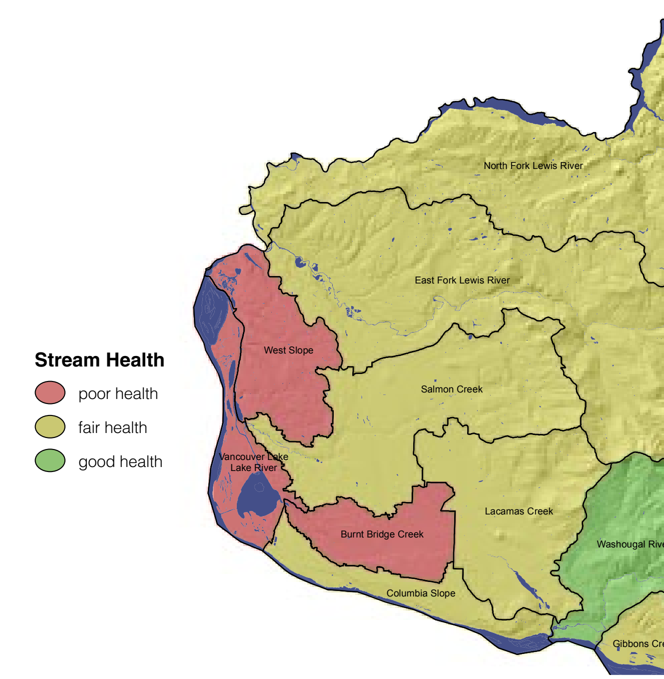
- Control invasive species.
- Reforest previously cleared forest lands.
- Restore streambanks, floodplains, and riparian vegetation.
- Support healthy riparian management practices in residential areas.
- Conserve intact forested areas.

Oregon Department of Environmental Quality (DEQ) Perspective

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

FIGURE 7-1

Clark County Stream Health by Watershed



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

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

CONDITION OF INDIVIDUAL SUBBASINS IN OREGON

Clackamas Subbasin

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

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

Lower Willamette Subbasin

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

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

Molalla-Pudding Subbasin

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

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

Tualatin Subbasin

The Tualatin subbasin is the second most urbanized subbasin in the Willamette Basin, with nearly 27 percent of the subbasin in urban land use. The watershed includes all or part of the cities of Beaverton, Hillsboro, Forest Grove, Tigard, Tualatin, and Lake Oswego. Of the five Oregon

TABLE 7-1

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

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

subbasins in the greater Portland-Vancouver region, the Tualatin has the second highest number of stream miles in disturbed biological condition for both aquatic vertebrates and aquatic macroinvertebrates (37 percent and 71 percent, respectively).

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

Yamhill Subbasin

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

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

CONCLUSIONS REGARDING OREGON SUBBASINS

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

TABLE 7-2
Land Use and Biological, Habitat, and Water Quality Indicators in Selected Willamette Basin Subbasins

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

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

STRATEGIES FOR OREGON SUBBASINS

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

FOR MORE INFORMATION

Clark County Stream Health Report (2010)

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

Willamette Basin Rivers and Streams Assessment Oregon Department of Environmental Quality. 2009. http://www.deq.state.or.us/lab/wqm/docs/WillametteBasinAssessment2009.pdf

Invasive Species

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There are several commonly used definitions of invasive species. Perhaps the most robust and succinct defines invasive species as "non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." A key element to all definitions is that invasive species can actively displace other (i.e., native) species and have long-lasting or even permanent detrimental effects on various habitats and the organisms that depend on them.

Next to outright conversion of land, invasive species and climate change are generally considered the most important threats to biodiversity. Invasive species play a significant role in altering the landscape and fundamental ecosystem processes, decreasing biodiversity, and damaging infrastructure. In an urbanized and fragmented area, invasive species pose a particularly acute threat to remaining habitats.

Invasive species such as non-native rats, insect pests, human and animal diseases, and many plants that now are considered weeds were first introduced to the greater Portland-Vancouver region by European trappers, explorers, and early settlers. The subsequent agricultural development and urbanization of the region over the last 150 years has resulted in a landscape that bears scant resemblance to its pre-developed state, with altered habitats for native plants and wildlife. This remaining, fragmented habitat is degraded by invasive species that already have become established and is under threat from new invaders that are continually and increasingly being introduced. The influx of invasive species is particularly pronounced in the greater Portland-Vancouver region, which not only supports two major ports, but also has interstate highways, powerline and gasline corridors, and commercial and recreational shipping/boating that serve as pathways for new introductions of invasive species.

Importance

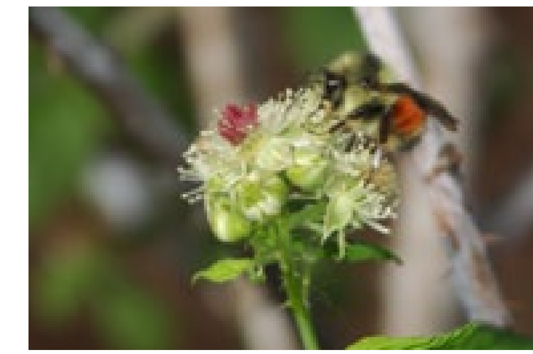
When invasive species become dominant or even merely common, populations of native species typically decline as a result of outright competition or secondary effects, such as changes in stream bank stability or the frequency and intensity of fire. New invaders often out-compete native species for food, light, and space. Examples include the English and Irish ivies (*Hedera helix* and *H. hibernica*) that dominate many mixed conifer, riparian and floodplain forests, or English starlings that compete with western bluebirds and birds in narrow riparian corridors for nest cavities. Competition may be direct, as in the case of bullfrogs that actively prey on native amphibians, but less direct effects also are important. For example, the grey garden slug (*Deroceras reticulatum*) prefers to eat native, annual forb seedlings, thus creating opportunities for non-native plants to flourish. When non-native grasses, such as slender false brome (*Brachypodium sylvaticum*), dominate the forest understory, it provides cover from predators, allowing rodents to eat native seedlings. Invasive garlic mustard can grow in interior forests, where its fungicidal properties may impair native plant establishment and health. Finally, the loss of one native species may result in the loss of other native species that rely on the first for essential resources, as in the dependence of Fender's blue butterfly (*Icaricia icarioides fenderi*) on Kincaid's lupine (*Lupinus sulphureus var. kincaidii*).

Although invasive species initially increase diversity by adding new species to an area, the temporary increase in the total number of species in a community is followed by an eventual decrease in regional-scale diversity as the region's (and world's) biota is homogenized toward fewer, dominant invasive species.

Invasive species can pose threats to both native species and human well-being. Invasive species affect watershed health by increasing erosion rates and sedimentation levels of waterways, and by eventually reducing canopy cover, which can increase water temperature. The dense growth of English and Irish ivies and old man's beard weighs down trees, increases fuel loads, and alters fire dynamics, resulting in increased fire severity and risk. Invasive plants alter and homogenize vegetation cover types; this can result in dramatically reduced stormwater interception as habitats are converted to an invasive monoculture. Aquatic animal invasives such as the New Zealand mudsnail (*Potamopyrgus antipodarum*) and quagga mussel (*Dreissena bugensis*), both of which have become established east of the greater Portland-Vancouver region, impose large and sometimes restrictive maintenance costs on fish hatcheries and hydroelectric power plants. Finally, invasive animals such as nutria (*Myocastor coypus*) and non-native mosquitoes can carry diseases such as Salmonella spp. and West Nile virus to which humans are susceptible.

TABLE 7-3
Typical Invasive Species by Major Habitat Type

Habitat Type	Examples of Invasive Species	Effects
Upland Conifer and Mixed Conifer Broadleaf Forest	English and Irish ivy *(Hedera helix and H. hibernica)* Garlic mustard *(Alliaria petiolata)* English holly *(Ilex aquifolium)* Himalayan blackberry *(Rubus armeniacus or Rubus discolor)* Scots' broom *(Cytisus scoparius)* Old man's beard *(traveler's joy, Clematis vitalba)* Spurge laurel *(Daphne laureola)* Gypsy moths *(Lymantria dispar)*	Vines climb and topple trees. Brooms prevent reestablishment of trees following harvest or blow-down. All species can dominate understory. Some species poisonous to animals and can cause dermatitis in humans. Insects can cause severe defoliation of hardwoods and conifers.
Riparian Forest	Knotweeds *(Polygonum spp.)* Himalayan blackberry Green alder sawfly *(Monsoma pulveratum)*	Alterations in streambank erosion dynamics and the large wood cycle; decreased structure variability. The sawfly defoliates and weakens alders *(Alnus spp.)*
Floodplain Forest	Old man's beard Black stem borer *(Xylosandrus germanus)*	Increases in fire severity and return interval Shading of understory Plants attack numerous tree species, spreading symbiotic fungal disease *(Fusarium sp.)* Possible extirpation of Oregon ash *(Fraxinus latifolia)* populations
Wet and Upland Prairie	Non-native grasses, thistles, blackberry, Scots broom Non-native slugs *(Arion ater complex, Deroceras reticulatum)*	Grasses form dense, rhizomatous (root) mats that prevent growth of natives and decrease habitat for ground-nesting birds. Slugs preferentially consume native annual forbs.
Oak Woodland and Savanna	One-seed hawthorn *(Crataegus monogyna)* Scot's broom Himalayan blackberry Pasture grasses Eastern gray squirrel	Displacement of native forbs/grasses Restricted Oregon white oak *(Quercus garryana)* recruitment Eastern gray squirrel out-competes western gray squirrel for resources
Wetlands	Reed canarygrass Common reed *(Phragmites australis ssp. australis)* Nutria	Displacement of native vegetation and avian nesting habitat Erosion Nutria out-competes native muskrat.
Freshwater and Upper Estuarine	Brazilian elodea *(Egeria densa)* Water primrose *(Ludwigia spp.)* New Zealand mudsnail *(Potamopyrgus antipodarum)* Siberian prawn *(Exopalaemon modestus)*	Dense monocultures that increase sedimentation and reduce water quality, navigational ability and recreational opportunities Dramatic alterations in trophic interactions and nutrient cycling, resulting in decreased growth rates for native animal species



Habitats Affected

The greater Portland-Vancouver region supports many habitat types, including pure and mixed coniferous forest, floodplain forest, wet and upland prairie, oak savanna and woodland, wetlands, and riparian and open-water ecosystems. (See Chapter 3 for descriptions of these and other habitat types.) These habitats all support diverse and unique assemblages of native species. Although invasive species have heavily affected many of these habitats (see Table 7-3), the extent of the effect differs. There is evidence that prairies, oak savanna, and wetlands have been the most altered by invasive species. This alteration of the vegetation leaves little habitat or resources for many at-risk species (see Chapter 3 for details).

Aquarium turtles that have been released to the wild, such as red-eared sliders, out-compete native turtle species in wetlands and can spread disease to native animals. The spread of exotic grass species, such as reed canarygrass (*Phalaris arundinacea*), in wet and seasonally wet habitats results in dense monocultures that can create an ecological desert where virtually all the biomass of the habitat is one species and is of little use to most native wildlife species.

Economic Impact

Invasive species result in lost resource potential and are being managed at the regional, state, and federal level. By the end of the 1990s, invasive plants alone cost the U.S. economy $13 billion dollars annually. These costs are primarily due to losses in crop and livestock production, control efforts, damage to property values, and reduced export potential and are being passed on to consumers through higher costs in the agricultural products consumers buy in the marketplace. The Oregon Department of Agriculture estimates that 21 invasive plant species in Oregon have reduced personal income in the state by $83 million per year.

In a study of 12 different invasive species, the median cost of early detection, control, and eradication was $1 dollar for every $17 dollars of future potential damage that would have been caused by that species. In 2008, Oregon spent an estimated $26 million on invasive species-related activities. This figure does not include resources expended by private entities such as homeowners and timber companies.

Estimates of the economic impact of invasive species do not account for future impacts such as the collapse of native pollinator services or the introduction of diseases that affect humans and domestic animals. Less tangible impacts include the loss of native bird and amphibian species that are essential components of a healthy ecosystem and that, for many people, increase the aesthetic value of the landscape.

Himalayan blackberry eradication has taken on new importance with the introduction of the spotted wing drosophila (Drosophila suzukii). This new pest of berry and tree fruit uses the invasive blackberry as a host and can build up huge populations to infest nearby crop land.

Strategies to Combat Invasive Species

Strategies to combat invasive species include prevention, early detection and rapid response control programs, research, monitoring, implementation of best management practices, effective policy, and education. Coordination at the appropriate geographic level is essential to successful invasive species management because invasive species can travel quickly over the landscape across multiple land ownerships and jurisdictions. Example of species that require national coordination include zebra and quagga mussels and the Emerald ash borer. To achieve success in the implementation of these strategies, additional capacity should be built on a local, regional, statewide, and national scale.

PREVENTION AND EDUCATION

Regional efforts must focus on preventing the introduction and establishment of invasive organisms. Education in all sectors, including natural resource agencies, the nursery/pet industries, and the general public, is an integral part of any prevention plan. Prevention efforts should be institutionalized in all levels of operation, ranging from day-to-day protocols (such as cleaning footwear, tires, and equipment) to the thoughtful sale and purchase of non-invasive organisms.

EARLY DETECTION AND RAPID RESPONSE

Early detection and rapid response (EDRR) programs are considered the most cost-effective strategy for preventing the spread of invasive species at the county or multi-county scale. EDRR is analogous to preventive medicine: we minimize cost and damage to our natural resources by finding and controlling high-priority new invaders early, when their populations are still manageable. This strategy increases the likelihood that invasions will be addressed effectively while populations are small enough to be contained and eradicated.

Although the concept of EDRR is intuitive and appealing to many land managers, actually achieving effective EDRR requires strong coordination and shared responsibility across federal, state, and local agencies and organizations, as well as with private landowners, hobby groups, and concerned citizens. A successful EDRR program integrates a target invasive species list, informed surveyors, reporting and mapping protocols, pre-determined local management responses, and thorough survey and follow-up protocols. Policies that provide resources and require the rapid treatment of the highest priority EDRR species would greatly enhance this strategy's functionality because often the main obstacles in EDRR programs are a lack of permission to treat lands and lack of funding.

RESEARCH AND MONITORING

Extensive research and monitoring in the realm of detection, vector control, integrated pest management, and existing control efforts are crucial to ensure effectiveness and allow for adaptive management. Timely research on controlling newly arriving species is critical. Additional intensive and proactive agency and academic efforts are needed to complete risk assessment studies and identify candidates for such studies. Information exchange and multiagency efforts should be coordinated through targeted networks, such as cooperative weed management areas (see sidebar) and shared databases to maximize regional success and to pinpoint program strategy areas and species.

RESTORATION/CONTROL PROGRAMS

Even if efforts to slow or stop the arrival and spread of new invaders are successful, there is a substantial need for and an enormous potential benefit to effective and efficient treatment of existing invasive species problems in the region's natural areas, parks, and unmanaged landscapes. Given the limited financial and personnel resources, prioritization of the removal and control of existing invasive organisms in key natural areas and working lands and waters should be done thoughtfully. Candidates for control should be determined by considering the invaders' ability to disrupt key ecological and economic services. Control efforts should be targeted in crucial habitat areas, biodiversity corridors, and working lands. Realistic long-term management plans for areas where invaders are treated are vital to success.

4-COUNTY COOPERATIVE WEED MANAGEMENT AREA

The Clackamas, Clark, Multnomah, and Washington County Cooperative Weed Management Area is a partnership of about 25 organizations in the four counties dedicated to combating invasive weeds for the benefit of native habitat and people. The 4-County CWMA is part of the Northwest Weed Management Partnership. Because weed issues typically extend across multiple ownerships, the CWMA emphasizes and supports collaborative weed management among land managers. The partnership actively engages in weed education and outreach and serves as a coordinating body for weed inventory and prevention and on-the-ground weed control activities, with a focus on members' early detection and rapid response lists. The CWMA meets monthly and maintains a master weed list as well as information on the status of invasive species in the region. For more information, go to www.4countycwma.org and http://www.westerninvasivesnetwork.org/pages/nwmp.html

Climate Change and Invasive Species

Climate change may complicate invasive species control efforts and further exacerbate already stressed ecosystems. Possible outcomes of concern include a higher likelihood of new species dispersing into the region and a loosening of the environmental constraints that, until now, have kept populations of certain exotic species present in the region from becoming invasive. Identifying and mitigating any of these effects will require many of the same strategies identified above, including monitoring, coordination at multiple scales, and careful use of available resources.

Successes

Although the impacts and sheer number of invasive species present and poised to establish themselves in the greater Portland-Vancouver region seem insurmountable, battles are being won. As of the beginning of 2010, the Washington Department of Fish and Wildlife had intercepted and decontaminated 17 boats with quagga and zebra (Dreissena polymorpha) mussels. Early detection of species such as the Gypsy moth, which could devastate Oregon and Washington's economies and landscapes, have resulted in prompt and coordinated eradication. Laws prohibiting the possession or release of certain plant and animal species within each state are being strengthened and modified to address new threats and risks. The Oregon and Washington Invasive Species Councils are national models in conducting a coordinated, comprehensive effort by multiple local, state and federal partners to keep invasive species out of the Pacific Northwest. Successful classical biological control of several of the most damaging plant and invertebrate pests has resulted from intensive research and coordination between partners such as Oregon State University, the Oregon and Washington State Departments of Agriculture, and the U.S. Department of Agriculture. Coordination of multiple entities through the 4-County Cooperative Weed Management Area has resulted in successful early detection and rapid response campaigns in the region and production of many outreach and education materials. Cities such as Portland lead the nation in progressive, multi-tiered approaches to mitigating and managing the effects of invasive species and leveraging resources available through partnerships at the state and federal level to advance collaborative efforts with NGOs, city bureaus, counties, regional governments such as Metro, and neighborhood groups.

For species that seem certain to arrive because of their dispersal abilities and difficulty to detect, such as the New Zealand mudsnail, any amount of time they are kept out of the region should be considered a cost-saving victory. For species that already are present, such as slender false brome, management, containment, and education will continue to mitigate future costs and damage to the environment.

Continuing the efforts to combat invasive species is essential to the region's economy, native habitats, and quality of life. World commerce and ease of travel continue to increase, providing ample opportunity for species to arrive in new locales. Perhaps the greatest future threat with regard to invasive species is apathy: as the public becomes more aware of the risks, costs, and damage inflicted by these species, a sense of futility may emerge. However, it is essential to the integrity of the region's ecology and inhabitants that these efforts continue.

FOR MORE INFORMATION

Online Resources

Four County Cooperative Weed Management Area
http://www.4countycwma.org

Weed Watchers EDRR (Early Detection and Rapid Response) ID Guide for Multnomah County & Sandy River Basin
http://www.wmswcd.org/public/file/EDRR%20Booklet/book_intro%20proof.pdf

Oregon Invasives Hotline
http://oregoninvasiveshotline.org/

Oregon Invasive Species Council
http://www.oregon.gov/OISC

http://www.oregon.gov/ODA/PLANT/index.shtml

City of Portland, Invasive Plant Management
http://www.portlandonline.com/bes/index.cfm?c=45696

iMapInvasives
http://www.imapinvasives.org/

Northwest Weed Management Partnership
http://www.westerninvasivesnetwork.org/index.php

Species Identification Guides

Urbanizing Flora of Portland, Oregon 1806-2008
John A Christy, Angela Kimpo, Vernon Marttala, Philip Gaddis, Nancy L Christy. 2009.

Weeds of the West
Western U.S. Cooperative Extension Services
Tom Whitson, Editor. 2001.

Northwest Weeds
Ronald J. Taylor. 2003.

Field Guide to Weeds of the Willamette Valley
Institute for Applied Ecology. 2008.

Human Activity

Bruce Barbarasch, Tualatin Hills Parks and Recreation District

For as long as humans have lived in the Pacific Northwest they have modified the environment to suit their needs. As post-1850 settlement progressed, roads, homes, businesses, and industrial areas were built across the region. These changes directly affected habitat and indirectly affected the behavior of wildlife in transition or edge areas. Although some wildlife benefit from human changes to the environment, most are negatively affected. For example, roads create edges between developed and natural areas or fragment natural areas. There are nearly 4 million miles of roads in the United States. Urban areas with high road densities can be deterrents, permanent barriers, or sources of mortality for wildlife when they attempt to cross these roads. Although some species of plants and animals thrive in edge environments created by roads, many others find roads problematic. In addition, roadways can be corridors for invasive and non-native weeds A review of wildlife studies found that the negative effects of roads on wildlife outnumbered positive effects by a factor of five.

Noise from roads primarily affects wildlife negatively, although in a few circumstances certain species may benefit. Road noise and related traffic can cause flight behavior in large mammals, increase stress response, and disrupt reproduction. Many native bird species—particularly neotropical migrants—are less attracted to areas with busy or many roads or avoid them altogether. A number of studies show that birds and frogs alter the pitch of their songs in the presence of road noise, possibly to be heard over the noise in order to attract mates or defend territories.

Artificial light from streetlamps, homes, and businesses often finds its way into natural areas. Lights allow for extended foraging time for certain reptile and bird species and enhanced foraging for bats that follow insects attracted by the lights. Some nocturnal animals are disoriented by light or experience navigation issues or temporary blinding, which can lead to an increase in predation. Migrating birds are known to be confused by tall buildings lit up at night, sometimes striking a building and falling to their deaths. Lights can also form barriers to large predators who avoid well-lit areas. In some cases, artificial lighting causes birds or frogs to sing at night or earlier in the morning than they naturally would, and waste valuable energy.

Although trails allow people access to nature and give them a sense of connection, trails also have a subtle but direct impact on wildlife. Physically, trails create edge habitat, cause soil compaction and erosion, serve as corridors for invasive plant species, and fragment habitat at a small scale. Trails can attract nest predators such as crows and jays. In addition, human use of trails in natural areas alters wildlife behavior; for example, nearly all birds will flee if approached too closely, although larger species and those that nest close to the ground may more tolerant of disturbances. Some wildlife appear to acclimate to human activities, while others become less abundant in areas with trails. Wildlife seem to be less affected by slower moving walkers than by joggers or bicyclists and are the least affected by people in slow-moving or stopped vehicles.

Dogs on or near trails have negative impacts beyond those of people alone. In one study, deer and small mammals stayed twice as far away from trails with dog activity than they did from trails with human use only; another researcher observed a 35 percent reductions of birds and small mammals near trails used by dogs compared to trails used just by people. Domestic cats may be abundant in urban natural areas and are prolific hunters who kill birds, snakes, lizards, and small mammals.

Strategies for Reducing the Impact of Human Activity

Although human activity can significantly alter wildlife habitat and behavior, there are many opportunities to foster nature in the city through the use of best management practices and behavior changes:

- Draw on the increasing body of knowledge about wildlife's response to roads—including manuals on wildlife crossings—to help provide for wildlife movement in new projects or to improve movement when retrofitting existing roads.
- Lessen unnecessary artificial lights through local building codes and other measures. Groups such as the International Dark-Sky Association already are working on this issue.
- Design and redesign trails to both provide access to nature and allow wildlife to pursue their normal activities.
- Engage in public education, create and enforce appropriate park rules, and actively manage sites to reduce the numbers of domestic animals in wildlife areas.

FOR MORE INFORMATION

Lights Out Portland
Audubon Society of Portland. Online information about bird kill studies and efforts to reduce light pollution. www.audubonportland.org/issues/metro/bsafe/lo

"Effects of Artificial Night Lighting on Terrestrial Mammals"
P. Beier. 2006. P. 19-42 in C. Rich, and T. Longcore [eds.], *Ecological Consequences of Artificial Night Lighting*. Island Press, District of Columbia, U.S.

"Quantifying the Road-effect Zone: Threshold Effects of a Motorway on Anuran Populations in Ontario, Canada"
Eigenbrod, F., S. J. Hecnar, and L. Fahrig. 2009. *Ecology and Society* [online] 4:Article 24.

"Human-caused Disturbance Stimuli as a Form of Predation Risk"
A. Frid and L. Dill. 2002. Conservation Ecology [online] 6:Article 11.

International Dark Sky Association. International nonprofit. Online resource available at http://www.darksky.org/.

Ecological Impacts of Recreational Use of Trails: A Literature Review
M. Jordan. 2000. The Nature Conservancy, Cold Spring Harbor, NY. Available online at www.parks.ca.gov/pages/1324/files/ecological%20impacts%20of%20recreational%20users.pdf

"Ecological Light Pollution"

T. Longcore and C. Rich. 2004. *Frontiers in Ecology* 2:191-198.

"Wildlife Responses to Pedestrians and Dogs"

S.G. Miller, R.L. Knight, and C.K. Miller. 2001. *Wildlife Society Bulletin* 29:124-132.
Noise Pollution Clearinghouse. National nonprofit. Online resource available at http://www.nonoise.org/index.htm.

"Disturbance by Traffic of Breeding Birds: Evaluation of the Effect and Considerations in Planning and Managing Road Corridor"
R. Reijnen, R.R. Foppen, and G. Veenbaas. *Biodiversity and Conservation* 6(4), 567-581. 1997.

Green Trails: Guidelines for Environmentally Friendly Trails
Metro Regional Government. 2004. Portland, OR.

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

Chemical Pollutants

Lori Hennings, Metro

Chemical pollutants affect water quality, fish and wildlife, and potentially human health. Sources of chemical pollutants include households, industry, agriculture, soil erosion, roads, and wastewater discharge; in the case of air pollution, sources can be local or global. Persistent pollutants are toxics that persist in the environment or bioaccumulate in the tissues of humans, fish, wildlife, or plants. Some persistent pollutants are known carcinogens, disrupt endocrine (i.e., hormone) functions, or are harmful via other mechanisms. Legacy persistent pollutants are those that have been banned or restricted for several years but remain detectable in sediment and tissue samples; the breakdown products of DDT are one example. Table 7-4 lists some of the persistent pollutants found in the greater Portland-Vancouver region.

Local, state, and federal concern over persistent pollutants has grown in recent years because scientists are more aware of harmful effects, more pollutants are being manufactured and used, and detection methods have improved. Recent studies in Oregon and Washington attest to these concerns. U.S. Geological Service studies in the Willamette Basin and U.S. Environmental Protection Agency studies of the Columbia River have shown significant levels of pesticides and other toxic pollutants, such as polychlorinated biphenyls (PCBs) and mercury, in water and some species of fish. These findings resulted in fish consumption advisories and restrictions in some areas.

Strategies

Both Oregon and Washington have statewide plans in place to reduce persistent chemical pollutants. The plans generally focus on prevention strategies, but some sites are being cleaned up under federal Superfund designations (see sidebar). The Washington Department of Ecology

TABLE 7-4
Selected Persistent Pollutants in the Greater Portland-Vancouver Region

Pollutant	Uses/Examples/Potential Effects
Polycyclic Aromatic Hydrocarbons (PAHs)	Combustion byproducts. Many of these have been identified as carcinogenic.
Halogenated/Polybrominated Flame Retardants	Flame retardants such as PBDEs or PBEs (polybrominated diphenyl ethers); are used ubiquitously. Many have been banned in Europe since 2003. Some are regularly found in breast milk or throughout the body. Long-term effects on humans can include liver damage, reproductive problems, severe skin irritation, and damage to the nervous system.
Pesticides and Herbicides	Used for agricultural, groundskeeping, and urban pest and weed control. Legacy pesticides often enter streams through eroded soils. Includes chlordane, DDT, dieldrin, endrin, heptachlor, and mirex. Some are carcinogenic, bioaccumulative, or endocrine disrupters. The breakdown products of DDT were responsible for several birds being listed under the Endangered Species Act listings because eggshell thinning caused reproductive failure.
Pharmaceuticals and Personal Care Product Ingredients	Includes synthetic hormones, antipsychotics, antidepressants, sedatives, caffeine, food additives, and disinfectants. Some of these are suspected of disrupting endocrine functions. Increasingly are found at low but detectable levels in local rivers.
Perfluorinated Surfactants	Anti-stain coatings.
Metals	Arsenic, tributyltin, cadmium, copper, lead, mercury, selenium. Some of these have been identified as carcinogenic. Mercury, copper, and lead at some locations in the greater Portland-Vancouver region were found at levels of concern for fish and/or human health. Mercury and lead are especially hazardous to children.
Stabilizers for Polymers and Plasticizers	Includes bisphenol A (BPA), which is used to make polycarbonate plastic and epoxy resins. Polycarbonate plastic is used to make products such as compact disks, eyeglass lenses, water bottles, and baby bottles. Many food and drink cans are lined with epoxy resins that contain BPA. Possible endocrine disrupter.
Polychlorinated Biphenyls (PCBs)	Used for cooling and insulating fluid in closed electrical systems (e.g., transformers). Frequently carcinogenic, tend to bioaccumulate, and may have endocrine or neurologic effects.
Polychlorinated Naphthalenes (PCNs)	Used in insulating coatings for electrical wires, in wood preservatives, and as rubber and plastic additives. In very limited production since 1976.
Dioxins and Furans	Dioxins are petroleum-derived and used to bleach paper and manufacture certain pesticides; furans are a byproduct of chemical manufacturing and metal refining. Likely carcinogens that tend to bioaccumulate. High levels found locally near industrial sites.

PORTLAND HARBOR SUPERFUND SITE CLEANUP

Portland Harbor is a heavily industrialized stretch of the Willamette River north of downtown Portland that was designated as a Superfund site in 2000. River sediments are contaminated with various toxics, including metals, PAHs, PCBs, chlorinated pesticides, and dioxin. River pollutant levels are highest near contaminated sites that sit adjacent to the river on the shore. The U.S. Environmental Protection Agency and Oregon DEQ, along with many other agencies, tribal governments, community groups, and companies, are working to investigate and clean up contamination in Portland Harbor. The EPA is the lead agency responsible for investigating and cleaning up contaminated sediments in the river itself, and the DEQ is the lead agency for investigating and cleaning up contamination on upland sites, working with individual property owners.

ALCOA SUPERFUND SITE CLEANUP

The Alcoa aluminum smelter site is located 3 miles northwest of Vancouver, on the north bank of the Columbia River. The smelter was closed in 2007, when cleanup began. Industrial and solid wastes from construction and operation of the smelter were stored in waste piles and consolidated in onsite landfills. Hazardous contaminants include hydrocarbons, PCBs, cyanide, fluoride, trichloroethylene (TCE), low-level organic chemicals, and metals. In December 2008, Alcoa and the Washington Department of Ecology agreed on a Cleanup Action Plan and Consent Decree for the upland cleanup and remediation of PCB-contaminated sediments in the Columbia River; groundwater cleanup beneath the landfill was not included in the decree. Alcoa finished dredging PCB-contaminated sediments from the Columbia River in early 2009. Smelter demolition and final removal of contaminated soils from the site were completed in March 2010. The Port of Vancouver purchased the site from Evergreen Aluminum and Alcoa, Inc., in 2009 and is redeveloping the area into a bulk storage and transport terminal.

recommends the following prevention strategies (www.ecy.wa.gov/toxics/):

- Prevent toxic chemicals from being used in the first place. Averting toxic exposures and avoiding future costs is the smartest, cheapest, and healthiest approach.
- Assist business in reducing or managing the amount of toxic chemicals that enter the environment.
- Clean up after toxics have polluted the air, land, or water. Cleanups are necessary but costly solutions to avoidable contamination.

Both Oregon and Washington toxics websites offer detailed information about toxics and what citizens can do to keep toxics out of the land, water, and air, as well as homes and food. DEQ and Metro offer support for recycling and disposing of hazardous household waste. DEQ's toxics website links to resources for electronics recycling, lawn, garden and household toxics alternatives and disposal venues, and other toxics advice: www.deq.state.or.us/wq/SB737/#work.

FOR MORE INFORMATION

Reducing Persistent Pollutants in Oregon's Waters: SB 737 Legislative Report
Oregon Department of Environmental Quality. 2010. Portland, OR. http://www.deq.state.or.us/wq/SB737/

USGS Toxic Substances Hydrology Program, 2010
H.T. Buxton. U.S. Geological Survey Fact Sheet 2010-3011.

http://pubs.usgs.gov/fs/2010/3011.

Columbia River Basin Toxics Reduction Plan
U.S. Environmental Protection Agency, Region 10, and the Columbia River Toxics Reduction Working Group. 2010.
http://www.epa.gov/region10/pdf/columbia/toxics-action-plan_sept2010.pdf.

Disease

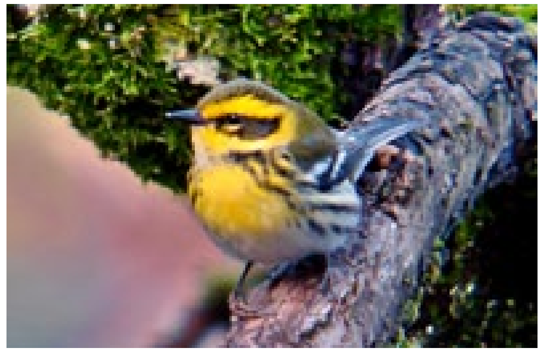
Susan Barnes, Julia Burro and Colin Gillin, Oregon Department of Fish and Wildlife

Like people, fish and wildlife and their habitats can get sick. Diseases caused by viruses, bacteria, fungi, and protozoans are a natural part of the web of life, but they can cause illness or death. Some diseases affect individual animals, some affect large numbers of animals, and some affect local or regional populations. Disease spreads more quickly when wildlife are concentrated. People can do their part to prevent disease outbreaks by not feeding wildlife, by vaccinating pets, and by managing habitat for wildlife.
Many diseases that affect the region's fish and wildlife are endemic (i.e., they are naturally occurring in the region). Examples include adenoviral hemorrhagic disease of deer and canine distemper in mammals, low pathogenic avian influenza in birds, and infectious hematopoietic necrosis virus and viral hemorrhagic septicemia virus in fish, plus many bacterial pathogens and parasites like trichinosis and a variety roundworms and tapeworms. However, some of the greatest disease concerns center on non-native pathogens that are introduced by non-native flora and fauna. Non-native diseases can have devastating effects on native organisms, human health, recreational opportunities, and local economies. The following are some introduced diseases that could affect biodiversity:

- Chronic wasting disease—affects deer and elk. Is endemic to the United States but not Oregon.
- Highly pathogenic avian influenza strains. Could be introduced or endemic.
- Whirling disease—affects juvenile fish, including salmonids.
- White-nosed syndrome—affects bats. Could be introduced (from Europe) or endemic.
- Sudden oak death.

Some of these diseases have not yet been detected in the greater Portland-Vancouver region. Infectious diseases in wildlife (particularly introduced species) are emerging at unusually high rates around the world. There is significant concern that disease may pose a substantial threat to biodiversity. Infectious diseases have the potential to play a significant role in regulating the composition, diversity, and richness of species found within communities, adding to natural mortality. This may occur because diseases can facilitate declines in local populations, cause contraction in the geographic ranges of populations, and evolve to infect numerous hosts. At the global scale, infectious disease has not been considered as significant a driver of species extinction as forces such as habitat loss and overexploitation, but the role of disease in global biodiversity loss may change with accelerated changes in global climatic conditions.

Although disease is well recognized as a threat to biodiversity, there is new evidence that the loss of biodiversity results in increased emergence, transmission, and spread of infectious disease. The connection between two developing crises—emerging novel diseases and unprecedented declines in biodiversity—has long been suspected, is difficult to quantify, and is not completely understood. Recent scientific analyses indicate that biodiversity seems to protect organisms, including humans, from transmission of infectious diseases. For example, research indicates that high microbial diversity on the skin of frogs can prevent infection with a lethal fungus that is devastating many amphibian populations around the world. In addition, there is a strong correlation between low bird diversity and increased risk of disease transmission (West Nile virus) to humans in the United States. In addition, a local



study has shown that increased diversity of small mammals is tied to decreases in occurrence of hanta virus. Finally, communities with low avian diversity tend to be dominated by species that amplify the virus—thus increasing the prevalence of infection in mosquitoes and people—while communities with high avian diversity have many species that are less competent hosts. On the other hand, for novel diseases, greater diversity may provide a larger potential pool of hosts. Hotspots for novel disease emergence sometimes occur in areas where growing human populations come in contact with many wild animal species. Theoretically, the more host species present, the more pathogen species they will harbor and the greater the opportunity for transmission to people. In other words, naturally high biodiversity should increase the potential pool of sources for new pathogens. Recent studies indicate that although biodiversity could be a source of new diseases, once a disease emerges, greater biodiversity appears to protect against the spread of the new disease.

Despite the unanswered questions, connections between biodiversity and disease are sufficiently clear to support increased efforts to preserve natural ecosystems and the biodiversity they contain. Conservation of biodiversity, to the greatest extent possible, may be our best strategy to guard against harmful infectious disease. Other actions needed to address disease concerns are related to surveillance, hygiene protocols, management of wildlife-human interactions, and control of non-native species. Public education is a key component of any effort.

Recommended Priority Strategies to Address Threats Linked to Disease

- Preserve large intact areas of natural habitat where it exists.
- Restore habitats to endemic plant communities to protect and increase biological diversity (both plant and animal).
- Enforce existing regulations and develop new regulations, policies, and protocols to prevent or minimize the spread of disease and minimize human contact with wildlife (e.g., ban feeding of wildlife, conduct disease surveillance, and restrict unregulated animal translocation).
- Strengthen regulations and policies related to (1) handling, moving, and relocating native fish and wildlife, and (2) importing, possessing, and releasing non-native species, to prevent the introduction and spread of non-endemic disease.
- Improve systems at multiple scales (city, county, state, and regional) for the surveillance, detection, and control of emerging diseases.
- Increase public awareness of the issues surrounding disease through interagency and multi-organization communication efforts.
- Support and continue research on emerging infectious diseases that adopts a multidisciplinary approach to identifying their underlying causes and controlling their spread.

Applicable Regulations

The Lacey Act of 1900

The Non-Indigenous Aquatic Nuisance Prevention and Control Act of 1990

Oregon Revised Statute 498.052 (Release of domestically raised or imported wildlife without permit from ODFW prohibited)

Oregon Administrative Rule 635-056 (regulates importation, possession, confinement, transportation and sale of non-native fish and wildlife)

OAR 635-007-0960 thru 0995 Fish Health Management Policy

OAR 635-044-0200 Wildlife Rehabilitation rules

OAR 635-049- 0065, 0067 Diseases and Captive Cervids rules

Various Oregon Department of Agriculture ORSs and OARs that are designed to prohibit disease like CVI and that require animal import permitting.

FOR MORE INFORMATION

"Emerging Infectious Diseases of Wildlife: Threats to Biodiversity and Human Health"
P. Daszak, A.A. Cunningham, and A.D. Hyatt. 2000. 21 January 2000 Vol 287 *Science*
www.sciencemag.org Pages 443–449.
http://irceb.asu.edu/amphibians/pdf/science.pdf

"Wildlife Diseases Threaten Biodiversity and Human Health"
Global Biosecurity Media Release. Dec. 9, 2009.

"Impacts of Biodiversity on the Emergence and Transmission of Infectious Diseases"
Keesing, F., L.K. Belden, P. Daszak, A. Dobson, C.D. Harvell, R.D. Holt, P. Hudson, A. Jolles, K.E. Jones, C.E. Mitchell, S.S. Myers, T. Bogich, and R.S. Ostfeld. 2010. Nature, Vol. 468, Pages 647–652.
http://www.nature.com/nature/journal/v468/n7324/full/nature09575.html

http://oregonstate.edu/ua/ncs/archives/2010/dec/nature-study-loss-biodiversity-can-increase-disease-transmission

http://www.nature.com/news/2010/101201/full/news.2010.644.html

"Local Scale Effects of Disease on Biodiversity"
K.F. Smith, M. Smith, D. Behrens, and D. F. Sax. 2009. *EcoHealth* 6, 287–295.

"Naturally Occurring Fish and Wildlife Diseases"
Oregon Department of Fish and Wildlife. 2006. Pages 372-375 in *Oregon Conservation Strategy.*
http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

ODFW's Wildlife Health Program
http://www.dfw.state.or.us/wildlife/health_program/

An Overview of Contemporary Biological Diversity Conservation in Oregon: A White Paper for the Oregon Board of Forestry
A. Yost (editor). 2011. Feb. 1, 2011
http://www.oregon.gov/ODF/BOARD/docs/2011_March/BOFATTCH_20110309_03_01.pdf?ga=t

Anthropogenic Hazards

Susan Barnes, Oregon Department of Wildlife

Urbanization and, to a lesser extent, development for agriculture are characterized by built structures such as buildings, roads, electrical lines, fences, lights, and communications towers that, together with associated human activities, can displace, injure, or kill fish and wildlife or otherwise alter wildlife behavior. Although some human activities involve intentional killing of wildlife—for commercial purposes, as food, or out of fear—many anthropogenic injuries and mortalities occur purely by accident, such as when motor vehicles collide with animals on the roadway.

The degree of impact of anthropogenic injuries and mortalities depends not simply on the number of incidents but also on the kinds of wildlife killed (male vs. female, adult vs. juvenile, reproductive vs. non-reproductive) and the timing of mortality (e.g., before or after the reproductive season). It is difficult to quantify the impact of anthropogenic activities on a given species, and estimates by individual cause of injury or mortality often vary by an order of magnitude. However, cumulative mortality from anthropogenic hazards is believed to be significant—for example, up to 1 billion birds a year in the United States.

Anthropogenic Hazards to Fish and Wildlife in the Region

COLLISION HAZARDS

Automobiles, Trains, and Boats

All types of wildlife are at risk from collisions with motor vehicles, trains, boats, and even bicycles. Each year some of Oregon's native turtles (western pond and western painted) are found injured or killed on roadway and railroad tracks. Many of these are pregnant females migrating to nesting sites.

Airplanes

Birds are especially susceptible to injury and mortality resulting from collisions with airplanes, either on runways or in the air. Portland International Airport staff actively haze wildlife from the airfield to minimize wildlife-related air strikes.
Buildings and Windows
Conservative estimates are that windows kill one billion birds annually in the United States. Windows are basically invisible to birds, and casualties occur from head trauma after a bird leaves a perch from as little as 1 meter away in an attempt to reach habitat seen through—or reflected in—clear and tinted panes. There is no window size, building structure, time of day, season of year, or weather conditions that allows birds to elude the lethal hazards of glass in urban, suburban, and rural environments.

Communication Towers, Aviation Lights, and Guy Wires

Communication towers and the aviation lighting and high-tension lines or guy wires that are sometimes associated with them pose a hazard to birds in flight, especially night-migrating birds. Communication towers kill an estimated 4 to 5 million birds in the United States each year.

Wind Turbines

Wind energy facilities can adversely affect wildlife, especially birds and bats, with the greatest hazard during spring and fall bird and bat migration. Mortality occurs from direct impact with turbines or by changes in air pressure near the rotating blades. In the Oregon portion of the Columbia Plateau ecoregion, it has been estimated that the existing wind energy facilities result in a mean of 2.5 bird fatalities per megawatt per year and a mean of 1.2 bat fatalities per megawatt per year.

Electrical Power Lines

Utility poles and electrical lines can benefit raptors and other birds by providing perching or nesting structures where there are few natural perching or nesting options. However, utility poles and electrical lines also pose electrocution and collision threats, most typically with larger birds such as raptors and great blue herons, although smaller birds also are at risk. Nationwide mortality estimates from electrocution are not available.

Hazards from Materials

Monofilament Fishing Line, Hooks, and Nets
Improperly discarded fishing gear—especially barbed hooks and nets—are a hazard to a variety of wildlife, from herons and seabirds to turtles and otters.

Baling Twine, Plastics, and Styrofoam

Birds and other wildlife are injured or die from becoming entangled in these materials. Baling twine is the cause of death for many adult osprey and their chicks. It has been estimated that, in some areas, baling twine alone kills about 10 percent of osprey chicks.

Glue Strips and Traps

Sometimes used by people to catch and kill "pests" such as house mice, rats, and flying insects, sticky glue traps and strips can be hazardous to native small mammals, such as bats. Licensed wildlife rehabilitation facilities regularly receive bats that have been trapped by sticky glue fly strips. In most cases these bats do not recover.

HAZARDS FROM HUMAN BEHAVIOR

Artificial Feeding of Wildlife

Whether deliberate or accidental, artificial feeding is hazardous to all wildlife for a variety of reasons. Introduced food is often unhealthy. Artificial feeding unnaturally concentrates animals, thus increasing the spread of disease, changing wildlife behavior and migratory patterns, and making animals more susceptible to anthropogenic causes of injury, death, and predation.

Persecution

Some species have historically been subject to systematic mistreatment by humans, out of fear, hostility, or competition for resources. Individual species usually are targeted. Coyotes, snakes, and bats often are persecuted because they are viewed as dangerous, gross, and carriers of disease. Even more "popular" wildlife species such as deer, squirrels, and woodpeckers are subject to persecution if they are viewed as pests. Although not all causes of persecution can be addressed, attitudes can be changed over time through education and the provision of alternative solutions to common nuisance wildlife situations.

Illegal Take (Poaching)

Despite laws that regulate hunting and fishing, many species are threatened by poaching, which affects species viability at local and regional scales. A recent ODFW research study of deer estimated that poachers are killing almost the same number of animals as legal hunters are. Although the poaching of game fish and wildlife species is most often highlighted, no species is exempt from poaching. In addition, ODFW has confirmed the illegal collection of native turtles for the pet trade industry and local and overseas food markets.

OTHER HAZARDS

Rodenticides and Other Poisons

All wildlife are at risk from poisonous substances dispersed into the environment deliberately or by accident. Poison meant for Norway rats or house mice may be consumed by native rodents and other small mammals such as squirrels and chipmunks. Localized die-offs occur in wintering goose populations that have foraged on agricultural fields treated with rodenticide (e.g., zinc phosphide). Other wildlife that are frequently exposed include carnivores such as mountain lions, bobcats, hawks and owls; omnivores such

as coyotes, foxes, skunks, and raccoons; and granivores and herbivores such as squirrels and deer.

Fences

Although fences can help reduce wildlife-human conflicts, such as motor vehicle collisions with wildlife, they also can be hazardous to a variety of wildlife species. Fences can restrict or alter animal movement patterns, thus disrupting daily, seasonal, and dispersal movements and potentially reducing the probability of survival of some wildlife populations.

Introduced Predators

As the most common introduced predators, cats and dogs pose a real hazard to biodiversity, causing nearly 100 million bird deaths in the United States annually. Birds that spend the bulk of their life cycle in the low- to mid-canopy vegetation layer are particularly susceptible to cat predation. Cats and dogs also prey on small mammals, reptiles, and amphibians. Even when on leash, dogs are hazardous to most wildlife. Dogs directly injure or kill wildlife, and their presence can alter normal feeding, mating, and parental behaviors. When chased by dogs (even if the chase is unsuccessful), the potential prey wastes significant energy, subjecting them to higher rates

of mortality. Cats and dogs also can transmit pathogens, including parvovirus, muscle cysts, leptospirosis, and external parasites such as ticks, keds, tapeworms, and fleas. Free-roaming dogs also degrade habitat by trampling vegetation and adding nitrogen to the soil (via feces); both of these impacts encourage the growth of non-native plants at the expense of natives. Dogs also cause mortality of salmonid or amphibian eggs or juvenile salmon by direct disturbance or by causing eggs to be covered with sediment.

Lack of Knowledge

An often overlooked but very real hazard to all fish and wildlife and their habitats is the lack of knowledge or awareness by the public about biodiversity issues and values, conservation practices, and applicable regulation that is intended to protect and enhance biodiversity. Sometimes because of ignorance, even well-intentioned individuals can harm and create hazards that threaten and challenge the health of fish and wildlife and their habitats.

Strategies to Minimize Hazards to Fish and Wildlife

- Reduce collisions by doing the following:
  - Work with partners to inventory, prioritize, and remove wildlife movement barriers, leveraging current work done by state wildlife management agencies and their partners.
  - Maintain and restore habitat to ensure habitat connectivity, especially in urban centers.
  - When planning transportation projects, consider the movement needs of fish and wildlife; incorporate safe passage features into transportation designs. Work with public transportation departments and railroad companies to identify and address wildlife mortality. Where significant wildlife mortality is known to occur, install wildlife underpasses or overpasses and direct wildlife to safe crossing areas.
  - Implement efforts similar to the Audubon Society of Portland's BirdsSafe Program to promote education, monitoring, and proper response to bird injuries and mortalities caused by buildings and windows. Educate boaters on how to report and safely respond to injured wildlife.
  - Continue wildlife management efforts at airfields aimed at preventing and reducing wildlife-related airplane strikes. Employ hazing techniques, modify habitat, and install physical barriers.
  - Implement existing and future guidance on the siting and design of communication towers, wind energy facilities, and electrical power lines and supporting structures. The Edison Electric Institute's Avian Power Line Interaction Committee (APLIC) and U.S. Fish and Wildlife Service have developed guidelines on electrical power lines, and the U.S. Fish and Wildlife Service has guidance regarding communication towers.
- Compile information on the effects on fish, wildlife, and habitat of hazards from dogs, fences, and materials (i.e., monofilament fishing line, hooks, nets, baling twine, plastics, Styrofoam, and glue strips and traps). Compile information on the effects of rodenticides and other poisons on non-target animals and habitat.
- Enact stronger laws and regulations to ban the feeding of certain wildlife species (state and local regulations), stop persecution of wildlife (federal, state, and local regulations), reduce illegal take of wildlife (federal and state regulations), and regulate the use and application of various chemicals that are known to affect non-target fish and wildlife species (federal and state laws).
- Support and expand existing programs to provide seasonally appropriate informa¬tion on preventing and resolving conflicts with wildlife. Based on ODFW's, WDFW's and Portland Audubon's existing Living With Wildlife series, initiate a broad-scale campaign to educate the general public regarding common "nuisance" wildlife situations and provide alternative legal and biologically appropriate solutions. Continue to promote naturescaping as the wildlife-friendly and more economical alternative to artificial feeding.
- Because human-wildlife conflict issues often are biologically and socially complex, create multi-stakeholder/interagency task forces to ad¬dress major issues.
- Reduce impacts from domestic cats and dogs. Work with the Feral Cat Coalition, the Humane Society, county animal control departments, state fish and wildlife agencies, and others to reduce hazards posed by outdoor cats, especially feral cats, and work with dog organizations and others to promote observance of leash laws, particularly in areas designated as natural or wildlife areas. Initiate a local pilot project to better understand the effects of dogs on wildlife and wildlife habitats.
- Initiate a campaign to educate the general public about the issues, values, and ecosystem services related to biodiversity; hazards that threaten and challenge biodiversity; and recommended actions to address hazards.
- Improve coordination and communication between conservation partners to maximize benefits from various educational efforts.

Applicable Regulations

Federal Migratory Bird Treaty Act (16 U.S.C. 703-712)http://migratorybirds.fws.gov/intrnltr/mbta/mbtintro.html

The Federal Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

Federal Endangered Species Act (16 U.S.C. 1531-1544)

ORS 498.002 Wildlife as state property; taking, angling, hunting or trapping in violation of wildlife law or rules prohibited

ORS 498.046 Making toxic substances accessible to wildlife prohibited

ORS 498.022 Purchase, sale or exchange of wildlife prohibited

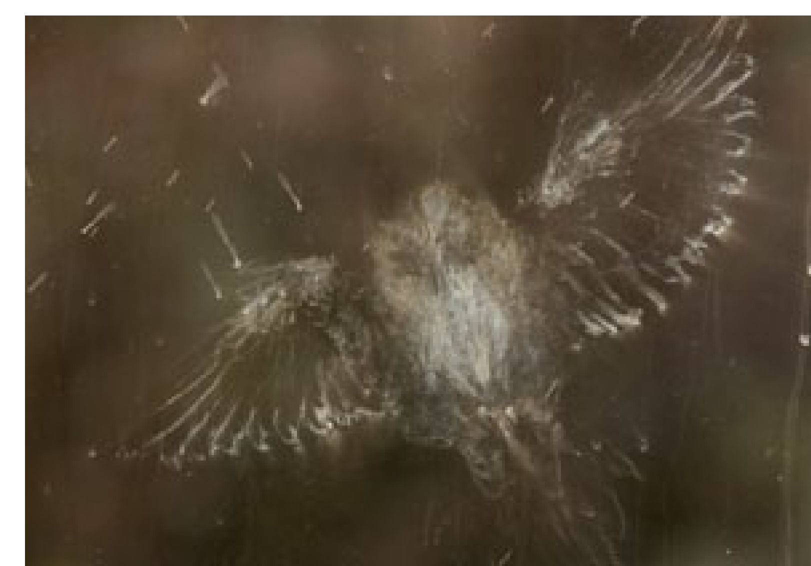
ORS 498.006 Chasing or harassing of wildlife prohibited.

ORS 498.102 Use of dogs to hunt or tack game mammals or birds. Regulates dogs hunting, running or tracking any game mammals or game bird.

FOR MORE INFORMATION

"A Place for People and Wildlife: Conservation in Urban Areas"
Oregon Department of Fish and Wildlife. 2006. Oregon Conservation Strategy. http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp

Every year, window strikes kill millions of birds like this mourning dove.



Additional Resources

TOPIC	RESOURCES
Collisions with Autos, Trains and Boats	A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. W.P. Erickson, G.D. Johnson, and D.P. Young Jr. 2005. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191. http://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_1029-1042_erickson.pdf http://www.fhwa.dot.gov/publications/research/safety/08034/08.cfm
Collisions with Airplanes	http://www.portofportland.com/PDX_WldLife_Mngmnt.aspx
Collision with Buildings and Windows	http://audubonportland.org/issues/metro/bsafe http://training.fws.gov/EC/Resources/mig_birds/handouts/avian_mortality_at_windows.pdf
Collisions with Communication Towers	http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm http://www.fws.gov/habitatconservation/com_tow_guidelines.pdf http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf
Collisions with Wind Turbines	http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf http://wdfw.wa.gov/publications/pub.php?id=00294
Electrical Power Lines	http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/APP/AVIAN%20PROTEC-TION%20PLAN%20FINAL%204%2019%2005.pdf http://www.aplic.org/uploads/files/2643/SuggestedPractices2006(LR-2).pdf http://www.fs.fed.us/psw/publications/documents/psw_gtr191/Asilomar/pdfs/1051-1064.pdf
Baling Twine, Plastic, Styrofoam	http://www.dfw.state.or.us/wildlife/living_with/docs/osprey.pdf
Human Dimensions	http://www.nature.nps.gov/socialscience/docs/archive/SSRR_6.pdf
Illegal Take (Poaching)	http://www.democratherald.com/news/local/article_7a25ad0a-a9e8-5a11-a409-9aa808393c96.html
Introduced Predators	http://audubonportland.org/backyardwildlife/brochures/cats/?searchterm=cats http://www.abcbirds.org/abcprograms/policy/cats/materials/predation.pdf
Rodenticides and Other Poisons	http://www.sfromp.org/rodenticides_mitigation_decision.pdf