


the OREGON CONSERVATION STRATEGY




Chapter 2: Key Conservation Issues

2016
Oregon Department of Fish and Wildlife

OregonConservationStrategy.org

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OVERVIEW

Key Conservation Issues (KCIs) are large-scale conservation issues or threats that affect or potentially affect many species and habitats over large landscapes throughout the state. They also affect people by reducing land productivity, reducing opportunities for recreation, altering water supplies, or increasing risk of severe wildfires. As a result, problems affecting large areas must be considered across jurisdictional and ownership boundaries. This section of the Conservation Strategy describes the seven KCIs affecting Oregon, and the recommended conservation goals and actions needed to address them.

> The Oregon Department of Fish and Wildlife (ODFW) worked with the **Stakeholder Advisory Committee** to identify the **Key Conservation Issues** that pose the greatest potential impact to **Strategy Habitats** and **Strategy Species** statewide. They include:
>
> - **Climate Change**
> - **Land Use Changes**
> - **Invasive Species**
> - **Disruption of Disturbance Regimes**
> - **Barriers to Animal Movement**
> - **Water Quality and Quantity**
> - **Challenges and Opportunities for Private Landowners to Initiate Conservation Actions**

Each KCI provides an overview of the statewide threat and information on recommended actions. The background text is intended to serve as a starting point for agencies and organizations working on these issues to chart a course over the coming decade. The background text is also intended for landowners and natural resource managers looking for ideas and rationale for conservation actions.

Many of the KCIs are highly intertwined. For example, changes in fire and flood regimes often happen when land is developed for new communities. Invasive species can be spread as more people move into new areas. Climate change will affect how many of the other issues impact Oregon's landscapes. How all

of these issues play out over the coming decade will be influenced by changes in Oregon's community development patterns and anticipated population increases.

For all recommended actions, implementation will depend on cooperative efforts by a variety of entities and may be contingent on funding, statutory authority, and other factors. Actions need to be compatible with local priorities, local comprehensive plans and land use ordinances, as well as other local, state, or federal laws. Actions on federal lands must undergo federal planning processes prior to implementation to ensure consistency with existing plans and management objectives for the area. In many cases, these actions are already occurring and should be continued or expanded. In other cases, new actions are identified.

RECOMMENDED ACTIONS FOR ALL KEY CONSERVATION ISSUES

The overall goals for the Oregon Conservation Strategy are to promote healthy fish and wildlife populations by maintaining and restoring functioning habitats, preventing declines of at-risk species, and reversing any declines in these resources where possible. Reducing and reversing the impacts of the KCIs can contribute significantly to these goals, while also contributing to healthy human communities. Recommended actions for all KCIs include:

- Working with community leaders in both **urban** and rural areas, and working with agency partners to ensure planned, efficient growth and development, and to preserve fish and wildlife habitats, farms, forest and rangeland, open spaces, and recreation areas.
- Helping landowners and agency partners find reliable and useful information about fish, wildlife, and habitats early in the project planning process.
- Funding, utilizing, and improving financial incentive programs and other **voluntary conservation tools** to support conservation actions taken by landowners and land managers.
- Developing new voluntary conservation tools to fulfill identified needs.
- Promoting collaboration across jurisdictional and landownership boundaries. Integrating information about fish, wildlife, and habitats with collaborative frameworks, such as the Climate Adaptation Framework and the Integrated Water Resources Strategy.
- Helping private landowners, public land managers, and citizens find ways to restore and protect Strategy Habitats and ecosystem services. Working creatively to find new opportunities and solutions.
- Informing Oregonians of conservation issues and the actions everyone can take that will contribute to Oregon's collective success.

For information on issues impacting nearshore species and habitats, see the **Nearshore Strategy**.

KEY CONSERVATION ISSUE LEADERSHIP

Further efforts to develop specific action items are recommended, and should involve all parties that are key to success. The Stakeholder Advisory Committee recommended that the Conservation Strategy outline lead organizations for each KCI, and provide ideas for several supporting organizations that will be important for successful implementation. See the table below for recommendations, which are simply a starting point and are not intended to be all-encompassing.

Key Conservation Issue	Lead Organization(s)	Key Supporting Organizations
Climate Change	Oregon Global Warming Commission	Oregon Department of Energy, Oregon Department of Environmental Quality, Oregon Department of Land Conservation and Development, Oregon State University, University of Washington, Oregon Department of Fish and Wildlife, U.S. Geological Survey, Northwest Climate Science Center, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, U.S. Forest Service
Land Use Change	Oregon Department of Land Conservation and Development	Oregon Department of State Lands, Oregon Department of Energy, Oregon Department of Fish and Wildlife, Association of Oregon Counties
Invasive Species	Oregon Invasive Species Council	Oregon Department of Fish and Wildlife, Oregon Department of Agriculture, Oregon Department of Forestry, Oregon Department of Environmental Quality, Portland State University, Institute for Natural Resources, Oregon State Marine Board, Soil and Water Conservation Districts, U.S. Bureau of Land Management, U.S. Forest Service

Key Conservation Issue	Lead Organization(s)	Key Supporting Organizations
Disruption of Disturbance Regimes	Oregon Department of Forestry, Oregon Department of Land Conservation and Development	Federal Emergency Management Agency, Oregon Department of Fish and Wildlife, U.S. Bureau of Land Management, U.S. Forest Service, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers
Barriers to Fish & Wildlife Movement	Oregon Department of Fish and Wildlife	Oregon Watershed Enhancement Board, Oregon Department of Transportation, U.S. Fish and Wildlife Service, U.S. Forest Service
Water Quality & Quantity	Oregon Department of Environmental Quality, Oregon Water Resources Department	Oregon Department of Agriculture, Oregon Department of Fish and Wildlife, Oregon Department of Forestry, Oregon Department of State Lands, National Oceanic and Atmospheric Administration, U.S. Army Corps of Engineers
Challenges and Opportunities for Private Landowners to Initiate Conservation Actions	Oregon Department of Fish and Wildlife, Oregon Watershed Enhancement Board	Soil and Water Conservation Districts, Network of Oregon Watershed Councils, Coalition of Oregon Land Trusts, Defenders of Wildlife, Institute for Natural Resources, Trust for Public Land

Photo Credit: USFS

CLIMATE CHANGE

BACKGROUND

Climate has changed throughout history due to a variety of factors, with corresponding changes to natural systems. However, in recent centuries, humans have significantly altered the composition of the atmosphere by burning fossil fuels for energy and clearing forests and other natural habitats, contributing to accelerated changes in climate conditions.

There is clear and growing evidence that our continued use of fossil fuels and land conversion is increasing the concentration of carbon dioxide and other greenhouse gases in the atmosphere and is a primary contributor to the significant rise in global temperatures that has been observed since about 1950. The concentration of carbon dioxide in the atmosphere in 2015 (about 400 parts per million) is the highest known level in at least the past 700,000 years, and probably much longer, and it continues to rise rapidly.

The Intergovernmental Panel on Climate Change (IPCC), an international science body, concluded in 2007 and reaffirmed in 2014 that the evidence is "unequivocal" that the earth is warming at an accelerated rate due primarily to human activities, and that there have been and will be significant changes to the global climate this century. Rising temperatures and other direct and indirect climate effects of increased greenhouse gases make up the body of interrelated trends referred to as climate change or global warming. These substantial shifts in global climate variables are observable in today's climate, and they are expected to increase and accelerate through at least the next century or until well after human-caused emissions of greenhouse gases are returned to much lower levels. As a result, climate change will cause irreversible alterations to both human communities and ecological systems.

Climate change will bring significant impacts not only to wildlife and their habitats, but also to working landscapes and rural, urban, and tribal communities. These impacts will likely include threats to water resources, range degradation due to invasive species and increased drought, and increases in fire and

pest outbreaks in forests. Many of the available approaches to helping wildlife adapt to climate change can also help human communities cope with these changes.

CLIMATE CHANGE IN THE PACIFIC NORTHWEST

By the 2080s, the mean annual air temperature in the Pacific Northwest is projected to increase by 2.5-3.4°C (**IPCC report**). This warming is projected to be the highest during the summer. Annual precipitation patterns in the Pacific Northwest may also be changing. While there is always uncertainty in projections, the general trend shows winter precipitation to increase and summer precipitation to decrease by 10-15 percent. A majority of models (68-90 percent depending on period and scenario) project decreases in summertime precipitation, reaching a decrease of 14 percent in the Pacific Northwest by the 2080s.

In terms of how changes in air temperature affect fall and winter snowpacks and hydrologic regimes, the biggest signals are for changes from snow-dominated systems to rain-dominated systems. By the mid-century, with a projected 2°C winter warming, 9,200 square kilometers of currently snow-covered area in the Pacific Northwest would receive winter rainfall instead of snowfall. There has already been a significant shift toward earlier peak flows throughout the western U.S. Unregulated smaller, rain-fed and mixed rain/snow streams west of the Cascades are already susceptible to winter flooding, especially in wetter La Niña winters. Future changes in stream temperature in response to climate change in Oregon will depend on: 1) the degree to which warming results in a reduction of late summer streamflow, and 2) how warming influences riparian vegetation.

Global changes in the marine environment include sea level rise, ocean acidification, and temperature increase. Sea level will rise along some parts of the Oregon coast; in other areas, the impacts of rising global sea level will be offset by an upward shift in land elevation over this timeframe. As carbon dioxide increases in the earth's atmosphere, ocean waters become more acidic. The more acidic waters can weaken crucial marine life structures, such as shells and coral reefs, and even alter the metabolism for some marine species. Temperature changes also have great impact on the marine environment. Water temperatures are a key factor in the mixing of warmer, oxygen-rich nearshore waters with cooler, nutrient-rich off-shore waters. Marine organisms depend on cooler, nutrient rich waters brought to the surface by a process called "up-welling". Up-welling occurs in the spring and summer, driven by off-shore winds, supporting strong nearshore productivity. Conversely, "down-welling" occurs in the fall/winter, and brings oxygen rich nearshore water into deeper areas, supporting deeper-dwelling lifeforms. The warmer the upper layer of water is, the more resistant it is to mixing with the cooler water, reducing the intensity of up- and down-welling, and thus overall ocean productivity.

Each of these expected changes would cause a cascade of direct and indirect effects in the natural environment, further stressing systems that have already been impacted by disease, invasive species, habitat loss and fragmentation, land use changes, and rising water demands. For example, rising temperatures will likely continue to affect the state's forests and shrublands, exacerbating fire conditions in many woody ecosystems, drying soils, and increasing some forest pests. This may result in

major shifts in the types of vegetation found in some parts of the state, especially where severe fires set the stage for colonization by invasive non-native plants.

Warmer temperatures are already reducing spring snowpack. By 2040, early spring snowpacks are expected to decline as much as 40 percent in the Cascade Mountains, resulting in shifts in stream flows that will degrade habitat for native aquatic species.

RESPONDING TO CLIMATE CHANGE IN OREGON

Climate change presents unprecedented challenges for Oregonians and for fish and wildlife managers, but taking proactive measures to prepare for the impacts on the state's native species and habitats will make these challenges more manageable.

In 2007, the Oregon legislature established the Global Warming Commission to address the inter-related climate impacts on natural resources, communities, commodities, business, and our economy. The Commission brought together representatives from industry, transportation, agriculture, forestry, energy, public health and safety, and other key stakeholder groups.

As part of that effort, the ODFW co-hosted the Fish, Wildlife, and Habitat Subcommittee of the Oregon Global Warming Commission in 2008, which produced "Preparing Oregon's Fish, Wildlife, and Habitats for Future Climate Change: A Guide for State Adaption Efforts". This document outlined a set of basic guiding principles to assist Oregonians in addressing the impacts of changing climates. The four principles included:

- The maintenance and restoration of key ecosystem processes;
- The establishment of an interconnected network of lands and waters that support fish and wildlife adaptation;
- An acknowledgement and evaluation of the risks of proposed management actions in the context of anticipated climate conditions; and
- The need to coordinate across political and jurisdictional boundaries.

In 2010 and 2011, ODFW and partners hosted a series of expert **workshops** to identify climate change impacts on Strategy Habitats and begin to develop climate change adaptation strategies. These workshops focused on 3 of the 11 Strategy Habitats: estuaries, oak woodlands, and sagebrush habitats.

Oregon's Statewide Climate Adaptation Framework

Climate change is one of the most serious KCIs affecting Oregon's fish and wildlife populations. Climate has always influenced habitat for fish and wildlife, and affects the fundamental conditions in which a species can exist. As climate conditions change over time, the habitat conditions for fish and wildlife at many locations may also change.

Changes in climate have always occurred. Today, however, climate change refers to far more rapid changes that are generally accepted in the scientific community as resulting from the increase in the concentration of greenhouse gases in the earth's atmosphere. Oregon's climate is changing, as described in a statewide assessment completed in 2010 (**OCAR report**) and more recently in the **Pacific Northwest chapter** of the **National Climate Assessment**, completed in 2014.

In 2010, Oregon completed a state-wide **Oregon Climate Adaptation Framework**, which describes 11 climate risks that are anticipated to affect the state in the coming decades. Note that while most of these risks will occur across the whole state, they will occur in different ways and magnitudes in different parts of the state.

Climate Risks in the Oregon Climate Adaptation Framework include:

1. Increase in average annual air temperatures, and likelihood of extreme heat events
2. Changes in hydrology and water supply; reduced snowpack and water availability in some basins; changes in water quality and timing of water availability
3. Increase in wildfire frequency and intensity
4. Increase in ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification
5. Increased incidence of drought
6. Increased coastal erosion and risk of inundation from increasing sea levels and increasing wave heights and storm surges
7. Changes in the abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife
8. Increase in diseases, invasive species, and insect, animal, and plant pests
9. Loss of wetland ecosystems and services
10. Increased frequency of extreme precipitation events and incidence and magnitude of damaging floods
11. Increased incidence of landslides

The 2010 Framework lists climate risks and indirect risks related to climate change. The true climate risks include increased average temperatures (daily, monthly, seasonally, annually), changes in precipitation patterns and hydrology, and changes in ocean chemistry and water levels. These risks act as drivers that will affect landscape conditions like wildfires, flooding, drought, coastal erosion, landslides, invasive species and pests, wetlands, and fish and wildlife habitats. In other words, climate drivers will force changes in a range of landscape conditions that directly affect habitats for aquatic and terrestrial species. Climate change will exacerbate the effects of drought and fire on Oregon's fish and

wildlife and their habitats. Also, climate change can impact species directly, as described in the next section.

DIRECT IMPACTS OF CLIMATE CHANGE ON FISH AND WILDLIFE

Warming temperatures are already affecting Oregon's fish and wildlife and their habitats. Insects are moving up from states south of Oregon, and significant pest species, such as the mountain pine beetle, are increasing in numbers as a result of warmer winter temperatures. Many bird species are shifting their ranges to the north and migrating earlier in the year. Warmer temperatures are also causing longer, more intense fire seasons and increased fire damage in some forest types.

Potential impacts include not only the effects of increasing air temperatures, but also:

- Earlier arrival of spring-like conditions and changes in the timing of biological events, such as migration, reproduction, and flowering, potentially leading to mismatches in the life cycles of interdependent species
- Rising sea levels, leading to increased coastal erosion, coastal and estuarine flooding, saltwater intrusion into coastal freshwater wetlands and water tables, and loss (or inundation) of estuary wetlands and other coastal habitats
- Arrival of exotic pests and pathogens, and increased insect damage from existing pests in some forest ecosystems
- Warming of freshwaters beyond thermal tolerances of some aquatic species
- Increased introduction, spread, and dominance of invasive plant and animal species
- Drying of some freshwater wetlands and headwater streams
- Acidification of ocean waters and changes in plant photosynthesis as the direct result of increasing levels of carbon dioxide in the atmosphere
- Increased frequency and intensity of storms, particularly in coastal regions
- Changes in the type, timing, and amount of precipitation: wetter winters and drier summers, with some regions in the state transitioning from snow-dominated to rain-dominated winters

Any or all of these changes have the potential to directly and/or indirectly affect fish and wildlife populations and their habitats. In the face of rapidly changing climate conditions, some species will need to shift to new locations or adapt in-place to new conditions. Populations that fail to move or adapt may decline. Others may thrive. Some climate risks will directly jeopardize the success of organisms dependent on specific habitat components. In the case of ocean acidification, many organisms that depend on calcite and aragonite for shell and skeletal development may perish due to reduced availability of carbonate.

Species that can move to a more climatically suitable location will do so by migrating or shifting their range. Range shifts have already been noted for many species, including poleward and elevational movements of many insects, birds, fish, and vegetation communities. However, the rapid rate of change and the fragmentation of habitat will make it more difficult for many species to move.

Some species may have to stay in place, either because they have limited abilities to move or because suitable habitat is not available elsewhere. These species may need to alter their behavior or the timing of their migration or reproduction to respond to changes in habitat conditions, such as food availability, habitat loss, and novel species interactions. The rapid rate of climate change, compared to past shifts in climate, means that species adaptation may have to occur very quickly for the species to be successful. Species that are negatively affected by climate change will likely include species with very specific habitat requirements, including those that depend on high-elevation, coldwater, or wetland habitats. If species are unable to adapt to the rapidly changing environment as a result of climate change, they could potentially become locally extinct. In eastern Oregon, for example, the ranges of small mammals in mountaintop habitats are contracting along with the snow caps, and some of the state's native frog populations are declining due to the seasonal increases in temperature and associated drying of wetlands.

COPING WITH UNCERTAINTY

Uncertainty has always been recognized in climate models and in managing fish and wildlife populations for future conditions. On-the-ground research, combined with predictive models, will continue to help managers learn more about how fish, wildlife, and their habitats may respond to future conditions. Adaptive management continues to be an important tool for managers coping with unpredictable changes in natural and biological systems.

Lack of certainty about exactly how species or communities will respond to climate change should not prevent managers from identifying and implementing management actions that will help mitigate likely future changes. Given the serious broad-scale and progressive nature of climate change, the time to begin adapting to future climate conditions is now.

GOALS AND ACTIONS

Goal 1. Use the best available science, technology, and management tools to determine the vulnerability of species and habitats to climate change at a landscape scale.

Climate change is a global issue, and the responses of fish, wildlife, and habitats to changing climate conditions will play out across political boundaries and will require a new, more integrated approach to management. As a result, evaluation and planning needs to be done at a landscape scale. Many species may shift ranges so that they are no longer found within the borders of a particular state or protected area. Therefore, efforts to evaluate and mitigate vulnerability should focus on how a species or habitat will respond across the landscape.

Action 1.1. Work with partners to increase information on climate change vulnerability of habitats and species.

Building a body of information on climate change impacts and the vulnerability of Strategy Species and Strategy Habitats is an important first step to guiding management and policy decisions on climate change. Management priorities should drive the scientific information that is gathered to inform decisions. Collaboration with research institutions, such as the **Oregon Climate Change Research Institute**, **Department of the Interior Northwest Climate Science Center**, University of Oregon's Climate Leadership Initiative, and **University of Washington's Climate Impacts Group**, nonprofits, and other government agencies can help increase understanding of climate change vulnerability without overtaxing limited budgets. Many of these institutions have ongoing efforts to identify the most vulnerable species and habitats and develop assessment models for these species.

Participants in the three habitat-focused **workshops** identified priority information needs by asking, "What questions do we need answered in order to be able to move forward with climate change adaptation strategies?" A similar approach, based around the information requirements of land and resource managers, would help prioritize research needs.

Action 1.2. Support long-term research on climate trends and ecosystem responses.

To provide needed information on climate impacts on species and habitats, research and monitoring efforts will need to be conducted over longer periods of time. Long-term funding and institutional support will be needed to encourage long-term research. Existing long-term ecological research programs, such as **Oregon State University's (OSU) H.J. Andrews Experimental Forest**, the U.S. Forest Service's (USFS) experimental forests, and the **ODFW's Lifecycle Monitoring Sites** can be a cornerstone of such efforts. The results from these research efforts should be used to inform and adapt management strategies, monitoring protocols, and objectives for Strategy Species and Habitats.

> The Nature Conservancy (TNC) has undergone a project to identify **Resilient Terrestrial Landscapes in the Pacific Northwest**, which are areas that will best sustain native biodiversity, even as the changing climate alters current distribution patterns.
>
> "The purpose of this project, funded by the Doris Duke Charitable Foundation, is to identify the most resilient sites in the Northwest that will collectively and individually best sustain native biodiversity even as the changing climate alters current distribution patterns. The central idea is that by mapping key geophysical features and evaluating them for landscape characteristics that buffer against climate change, we can identify the most resilient places in the landscape in order to guide future conservation investments."
>
> Results of the project are provided as downloadable GIS data, interactive online maps, or high resolution PDF map graphics.

Action 1.3. Develop and implement monitoring and evaluation techniques for vulnerable Strategy Species and Strategy Habitats.

Because of the changes expected under future climates, new decision tools will be needed to help determine appropriate management actions. There is a need to develop monitoring protocols that can quickly detect climate-related shifts in populations and habitats, help tie existing and proposed management with on-the-ground results, and inform and refine vulnerability assessments. Evaluating actions will be critical to coping with future climate uncertainties. To make the most efficient use of available funding, monitoring should be coordinated and shared among relevant agencies and organizations. Monitoring across boundaries and jurisdictions will form the basis for decision-making in a variable and rapidly changing environment.

Goal 2: Identify, prioritize, and implement conservation strategies to mitigate the negative impacts of climate change on fish, wildlife, and habitats.

Action 2.1. Incorporate currently available climate change information into management plans for species and habitats. Focus on strategies that are robust to a range of potential future climates and that maintain or restore key ecosystem functions and processes.

Future climate conditions will vary in unpredictable ways; however, waiting for more details is not the best approach. Instead, it is important to make use of the best available science to immediately identify and implement adaptation strategies for Oregon's species and habitats. Examples of some of these strategies may include:

- improving the connectivity of natural landscapes to better link fish and wildlife populations and allow for range shifts;
- identifying and protecting cold water rearing and refugia habitat for salmon;
- setting population targets and management goals with future climate conditions in mind; and
- looking for opportunities to protect species and habitats in their likely future locations.

One way of coping with uncertainties about future climates and the responses of species and habitats is to focus on identifying and implementing management approaches that are likely to be successful under several climate scenarios. For example, scientists have a very high level of confidence that temperatures in the Pacific Northwest will continue to rise over the next several decades, on the order of 1-5°C by mid-century. However, it is less clear whether or how precipitation patterns are likely to change. Efforts to identify robust adaptation strategies for a particular species or habitat might involve considering two or more climate scenarios with different degrees of warming precipitation conditions. Management actions that are likely to be successful under multiple scenarios are preferable to those that only make sense under a narrow range of future conditions.

Because future climate conditions may not support the same fish, wildlife, and plant species found in Oregon today, another promising approach is to focus on restoring abiotic as well as biotic conditions in ecosystems. These might include actions that:

- improve water quality and quantity;
- increase natural water storage on the landscape;
- maintain nutrient cycling processes;
- promote an ecologically appropriate disturbance regime; or
- protect soil health.

Some researchers have even suggested that conservation planning should be based on geophysical classes rather than biological communities.

Action 2.2. Minimize other threats.

Many of the best available climate change adaptation strategies involve managing other threats to species and habitats. Because rapidly-changing climate conditions will interact with, and may exacerbate, the other KCIs described in the Conservation Strategy, working to reduce these other threats is a good way of moderating the effects of climate change on fish, wildlife, and habitats. Reducing non-climate threats also tends to be a low-risk approach with a relatively high likelihood of success, because many non-climate threats are better understood, managers have more experience in applying action plans, and the actions taken are not as dependent on the accuracy of future climate predictions.

For example, protecting a representative network of natural and semi-natural lands for long-term conservation management is one of the most effective tools for coping with both climate change and other conservation threats, because relatively intact ecosystems are more likely to be more resilient to climate change, will better sustain fish and wildlife populations facing climate threats, are more likely to facilitate migration, and may even transition more smoothly to future climate conditions.

Action 2.3. Develop regional and local partnerships to coordinate responses to climate change across political, cultural, and jurisdictional boundaries.

Climate change is a global phenomenon, and it greatly increases the importance of working across traditional boundaries to more effectively manage fish, wildlife, and natural systems. Coping with the challenges of a rapidly changing and less predictable climate will require stronger working relationships with both traditional and new partners at various scales. Some opportunities include:

- Using the work of regional and national efforts, such as the **Association of Fish and Wildlife Agencies' Subcommittee on Climate Change**, to identify policy options and goals for multiple

agencies and organizations to address common concerns related to local, regional, and national impacts of climate change.

- Working with agencies and stakeholders from different sectors to develop consensus-based regional policies that inform and direct local decisions on climate change. Both the causes and effects of climate change are closely linked to human communities, and the impacts of climate change on natural communities cannot be successfully managed in isolation from human systems.
- Developing comprehensive education and outreach tools for the public on the impacts of climate change on wildlife and their habitats.
- Providing information on climate change and its impact on both human and natural communities will help solidify public support for adaptation efforts. Local and regional governments and citizen-based nonprofits and organizations (e.g., SWCDs, watershed councils) can help develop and deliver these educational materials to their constituents.
- Strengthening current partnerships and collaborations, and developing new ones, to pool funding and resources and encourage cost-effective strategies for addressing climate change impacts and adaptation.
- Establishing mutual goals for managing species and habitats in response to climate change. Potential partners include: the **U.S. Geological Survey (USGS) Forest and Rangeland Ecosystem Science Center**, the Department of the Interior regional **Climate Science Centers** and **Landscape Conservation Cooperatives**, U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), and other state and federal agencies, academic institutions, and non-governmental organizations.
- Developing interagency and intra-agency strategies to identify research needs, establish database capacities, and share data can help reduce costs and avoid duplicative efforts.

> In mid-2014, the Oregon Coastal Management Program and Oregon Sea Grant initiated a proof-of-concept project to achieve several objectives related to climate adaptation. The project grew from an observed need to develop a collaborative approach to planning for climate change at "manageable landscape scale" and was intended to achieve several objectives:
>
> - Step down the state-level Oregon Climate Change Adaptation Framework
> - Implement a risk-based and landscape-scale approach to adaptation
> - Organize planning around the climate science and projections that apply to a particular place, as opposed to general continent- or global-scale research compilations
> - Implement a low-overhead process to collaborate on climate adaptation across sectors, jurisdictional boundaries, and all levels of government

- Identify the *priority climate risks* that need to be addressed in a specific area
- Develop *management objectives for adaptation* to address priority climate risks
- Facilitate the collaboration in four work groups that represent distinct *management regimes: Infrastructure, Public Health and Safety, Natural Systems, and Working Lands*
- Emphasize the need to address the effects of climate change on the systems we manage, as opposed to the specific changes in climate

The proof of concept project was accomplished in **three all-day workshops**.

STRATEGY SPOTLIGHT: CLIMATE CHANGE RESEARCH

Oregon Climate Change Research Institute

The **Oregon Climate Change Research Institute** (OCCRI) was created by the Oregon state legislature in 2007 to: foster climate change research among faculty of the Oregon University System, serve as a clearinghouse for climate information, and provide climate change information to the public. OCCRI also houses the **Oregon Climate Service** and serves as the anchor institution for two federally-funded regional climate science centers, the **Climate Impacts Research Consortium** (CIRC) and the **Northwest Climate Science Center**, which provides information and tools for adapting to a changing climate in the Northwest.

OCCRI has produced two assessment **reports** of climate change and impacts in Oregon and the Northwest and releases a monthly **newsletter** featuring recent articles and projects pertinent to the Northwest. A recent project, **Integrated Scenarios of the Future Northwest Environment**, evaluated and down-scaled global climate models for the Pacific Northwest and produced coordinated simulations of hydrology and vegetation for the region. The project's data are publicly available.

Climate Science Centers

The U.S Department of the Interior established eight regional Climate Science Centers (CSCs) to address environmental challenges resulting from climate change and to provide natural resource managers with rigorous scientific information and effective tools for decision making.

The **Northwest Climate Science Center** (NW CSC) was established in 2010 to give resource managers the scientific information and tools they need to anticipate, monitor, and adapt to climate change in Oregon, Washington, Idaho, and western Montana. The NW CSC is located in Corvallis, Oregon.

The NW CSC is supported by 14 academic institutions primarily led by Oregon State University, the University of Idaho, and the University of Washington. Scientists from the academic consortium, U.S. Geological Survey, and other agencies provide capabilities in climate science and modeling, ecology,

vulnerability assessments, and advanced information technology to address and respond to climate change in the Northwest. The NW CSC also communicates climate change impacts to various audiences, trains the next generation of climate scientists, provides easy access to data products, and develops strong ties with federal, state, and tribal resource management agencies.

Since fiscal year 2011, the NW CSC invested nearly $5 million in research projects that address critical climate-related issues in the Northwest. Significant efforts include projecting future climate trends for our region and understanding how warmer temperatures and altered snow and rainfall patterns will affect stream flows, flood events, droughts, and wildfire frequency.

Other NW CSC-funded research has focused on the effects of climate change on habitats of bull trout, Northern Spotted Owl, and Greater Sage-Grouse, all of which are Oregon Strategy Species. The NW CSC requires all projects point to ways in which research results can be used by managers to help conserve target ecosystems or species.

A full list of NW CSC projects can be found **here**.

The NW CSC has also developed a **Regional Climate Science Inventory**. This includes climate research efforts of the entire CSC network and partner agencies and organizations in the Northwest.

Photo Credit: ODOT

LAND USE CHANGES

BACKGROUND

People's presence on the land has always altered the shape, appearance, and function of ecosystems. Native Americans, European settlers, long-time Oregonians, and today's newcomers have contributed to land use patterns that affect fish and wildlife populations. Oregon's human population is increasing, which means greater demand for urban, residential, and industrial areas, including energy generation and transmission infrastructure. An estimated 3,930,000 people lived in Oregon in 2013, and Oregon's mild climate, spectacular vistas, and easy access to outdoor recreation will continue to attract new Oregonians.

The Willamette Valley is home to almost three-fourths of Oregon's population, which is anticipated to nearly double in the next 50 years. Much of this growth will be in the Portland metropolitan area. **Metro** was created in 1979 as the regional government for the Portland area, which includes Clackamas, Washington, and Multnomah Counties. It is the only directly elected regional government and **metropolitan planning organization** in the United States. Other areas of the state, such as Deschutes, Jackson, Hood River, Polk, and Yamhill Counties, are expected to see relatively high growth rates over the next 10 years (**Oregon Office of Economic Analysis**).

As a result, conversion of natural areas, farmland, and forestland to other uses is expected to increase. Land use change, whether from native vegetation to farmlands or from farmlands to residential neighborhoods, can result in the **disruption of natural disturbance regimes** (e.g., fire and flooding) and further result in habitat loss and fragmentation. Urbanization poses particular problems for natural resources. Conversion to urban and rural uses increases the amount of impervious surfaces, which alter surface and water flow, degrade water quality, and reduce vegetation cover and diversity. The changes made to the landscape through development tend to be permanent, and restoration to a natural state is difficult, if not impossible. However, contained, well-designed urban growth can minimize impacts to surrounding landscapes and conserve fish, wildlife, and habitat values, as well as working farms and forests. These landscapes represent a significant portion of Oregon's land and income base. They

provide key ecosystem services, as well as representing important tourist destinations showcasing Oregon's natural beauty. In addition, natural resources within urban areas provide essential functions and values to local communities and contribute to watershed health for fish and wildlife species (**Conservation in Urban Areas**).

The state must also balance its interest in clean energy development and emissions reduction with local natural resource preservation as described in the state's **10-Year Energy Action Plan**. The **Columbia Plateau** ecoregion has seen considerable wind energy development over the past decade given its high wind resource potential. Other portions of southern and eastern Oregon show potential for future solar and geothermal energy generation. Natural gas development is proceeding with many new plants throughout the state. The existing electric transmission system will need to be upgraded to maintain reliable service, meet new demand, and connect renewable energy development to electric loads. Infrastructure associated with energy, including access roads and pipelines, can also impact the landscape. Oregon has a renewable energy requirement of 25 percent by 2025 for the state's largest utilities. In addition, the regional demand for a cleaner energy system will continue to drive renewable energy development.

LAND USE PLANNING

Oregon has many opportunities today to conserve, restore, and improve fish and wildlife habitat. Oregon's statewide land use planning program provides a framework for the protection of farm, forest, and rangeland by limiting development on resource lands. Prior to the 1960s, population growth was not broadly perceived as a concern in Oregon. However, between 1940 and 1970, Oregon's population grew by 109 percent. Subdivisions sprouted next to farms in the Willamette Valley and Oregonians saw their pastoral landscape threatened by sprawl. Governor Tom McCall and farmer-turned-senator Hector MacPherson collaborated on legislation (**Senate Bill 100**) that created Oregon's **land use planning program** in 1973.

The **Department of Land Conservation and Development** (DLCD) is the state agency responsible for administering the statewide land use program, as well as supporting the local jurisdictions that implement the program on the ground. DLCD is guided by the Land Conservation and Development Commission (LCDC). The statewide land use planning program has been charged by the legislature to manage urban growth, and protect farm and forestlands and natural resource lands, including coastal and ocean resources. Oregon's land use laws have helped maintain the state's forest and farm working landscapes, which provide habitat for many fish and wildlife species. In addition, the planning process can provide more certainty to landowners, developers, and habitat resources. A **2008 report** by the Institute for Natural Resources at OSU concluded that the land use planning system has been effective in achieving many of its goals since the 1970s. The protection of natural resources is a key component of Oregon's land use planning program.

Comprehensive land use plans were put in place across Oregon starting in 1982. Each city and county must adopt and maintain a comprehensive plan and an implementing zoning code consistent with the **19 statewide planning goals**. The goals address:

- process goals – citizen involvement and land use planning
- development goals – destination resort siting, housing, and economic development
- farm and forest protection goals
- coastal goals that apply to Oregon's coast, estuaries, beaches, and territorial sea

When Oregon's statewide land use planning program was created, **Goal 5** required local governments to adopt programs to protect natural resources, and conserve scenic, historic, and open space resources. Goal 5 was designed to protect and conserve a wide range of natural resources, including:

- riparian areas
- wetlands
- fish and wildlife habitat
- wild and scenic rivers
- wilderness areas
- mineral and aggregate resources
- energy sources
- groundwater
- natural areas
- historic and cultural resources
- scenic views and sites
- open space

However, unlike some of the other more prescriptive goals, Goal 5 is more of a process goal, requiring decision makers to consider resource values rather than mandating their protection.

Consistency between local plans and the state goals was implemented via an "acknowledgment" process, where local plans were reviewed and approved by the LCDC. Conflicting uses are addressed through land use regulation in the acknowledged comprehensive plan. For example, this may include overlay zones (e.g., big game winter range overlay), siting standards for dwellings, setback or buffer requirements, dwelling density for big game winter range, an inventory process, and regulations for protection of wetlands and waterways. Since 1981, cities and counties have been required to review their comprehensive plans. However, in 2007, the legislature enacted a bill that revised the scope of

"periodic review" to include only those cities with a population greater than 10,000. While **Goal 2** requires that all local governments' comprehensive plans be maintained and updated, counties and smaller cities are no longer legally obligated to update their local inventories or code. This means the focus of long range planning is weighted toward meeting development objectives, rather than conservation issues. As a result, most Goal 5 inventories in local comprehensive plans are outdated and do not address new fish, wildlife, or habitat data, such as the Strategy Habitats or updated big game habitat maps.

The program's 19 goals include **Goal 14**, which establishes urban growth boundaries (UGBs) around each city or metropolitan area to separate urban land uses from farm and forest working landscapes. By concentrating urban development and associated impacts, the land use program has been reasonably successful in containing sprawl. In 2013, the Oregon legislature passed House Bill 2254, which now directs a new, streamlined process for evaluating UGB capacity.

The 2013 **Oregon Values and Beliefs survey** found that Oregonians value the state's natural beauty, outdoor recreation opportunities, and relatively clean air and water. They also value a good economy, but they want an approach to economic development that recognizes the importance of the state's natural environment to our quality of life. In addition, the survey found Oregonians greatly value farm and forestland and want to conserve it. Findings suggested that residents support concentrating growth within existing cities and towns to save farmland and stop sprawl. They see Oregon's land use system as a way to protect the livability and quality of life they want at the statewide and local levels.

Oregon's Land Use Planning System

Protecting and conserving fish, wildlife, and habitat resources should continue to be an integral component of the land use process for land within and outside of urban growth boundaries. Protection of resources can be balanced with efficient urban and rural development and local land use decisions. Smart and sustainable planning is necessary to maintain a healthy environment, habitat connectivity, and livability within the communities.

Oregon's land use planning system continues to evolve as discussions on regional planning proceed. Every legislative session, bills are introduced that have the potential to alter the effectiveness of the land use planning system.

Fish, wildlife, and habitats contribute to local and statewide economies and are valued as integral to our high quality of life (2013 **Oregon Values and Beliefs survey**). Oregon's statewide land use planning system offers an opportunity to continually re-affirm these values, even as community growth boundaries expand into areas with rich natural resources. Oregonians will need to continue working collaboratively and find common ground to maintain the heritage and culture of our public trust resources.

LAND USE PLANNING: GOALS AND ACTIONS

Goal 1: Manage land use changes to conserve farm, forest, and range lands, open spaces, natural or scenic recreation areas, and fish and wildlife habitats.

Action 1.1. Increase access to maps and scientific data to support energy siting and land use planning efforts while integrating fish, wildlife, and habitat resources. Provide greater access to continually updated information, and encourage the use of data throughout the planning process.

Local governments, state agencies, conservation organizations, private industry, and the general public need access to land use and habitat information so they can make sound decisions using best available data. Spatial information on Strategy Species, Strategy Habitats, Conservation Opportunity Areas, and other mapped information for Oregon is available using the **ODFW Compass** mapping application. Other organizations also provide information via online tools, GIS data, and reports (Some of these are presented in the **Land Use: Additional Resources** and **Energy Planning: Additional Resources**.). Agencies and organizations are encouraged to continue to share information, data, and analyses on habitat function, wetland permitting, restoration projects, and other information that can track changes in land use over time.

Oregon should continue to plan for future growth consistent with the statewide planning goals. The **DLCD Strategic Plan** calls for improved "capacity to gather, analyze, and distribute data and information to local jurisdictions and other stakeholders, and to guide policy development". Additionally, there is a need to evaluate the state-local coordination process. The current rules no longer require local governments to go through periodic review to update Goal 5 resource mapping. As a result, most local jurisdictions are not using the best available geospatial or scientific data for fish, wildlife, and habitat resources in their land use decisions.

Action 1.2. Conserve Strategy Habitats using voluntary, non-regulatory tools, such as financial incentives, conservation easements, landowner agreements, and targeted acquisitions.

People own land for different reasons and need a range of incentives and conservation tools to complement each landowner's unique circumstances. The Conservation Strategy provides a summary of voluntary, non-regulatory approaches to conserving **Strategy Habitats** and recommendations to further assist willing landowners. There are several **tools available** for conserving habitats. To ensure that limited funds address the greatest conservation need, many of these tools can and should be focused on Strategy Habitats when compatible with program purpose and intent.

Action 1.3. Encourage strategic land conservation and restoration within Conservation Opportunity Areas.

Conservation Opportunity Areas represent priority areas across the state for maintaining and restoring habitat through voluntary approaches. Because these areas are particularly important to specific Strategy Species, have some of the best remaining habitats, and have fewer limiting factors,

conservation focused in these areas is likely to be more efficient and effective at the landscape scale. These areas are priorities for investing conservation dollars to implement actions described above.

Oregon's Wetland Program Plan includes a Core Element of "voluntary wetland restoration and protection". Under this Core Element, there is a focus on restoration and protection, including actions for continuing stream and wetland restoration, and working with counties to enroll properties in the **Wildlife Habitat Conservation and Management Program**. The Wetlands Conservancy and the Institute for Natural Resources provide an informational tool for prioritizing **wetland conservation and restoration**.

Action 1.4. Work cooperatively within existing land use planning processes to conserve Strategy Habitats, and optimize use of transferred development rights, conservation banking, and other market-based tools to meet land use goals.

Land use planning laws are part of the existing **regulatory framework**. The Conservation Strategy is entirely voluntary and non-regulatory; it does not expand, replace, supersede, or contradict existing regulations. Rather, the Conservation Strategy encourages innovative solutions within the existing regulatory framework.

> There are a number of tools and resources available for tracking land use changes and assisting planners with land use related decisions. For example, the Oregon Department of Forestry (ODF) keeps track of land use conversion, the Oregon Department of State Lands (DSL) tracks wetland changes, and the Oregon Watershed Enhancement Board (OWEB) tracks restoration projects. **Oregon Explorer** is a resource that features a variety of content for land use planners (this **video** provides more information).

Action 1.5. Support informed conservation markets and incentive programs.

In addition to working within the existing planning and regulatory framework, the Conservation Strategy supports market and incentive programs. Outreach to cities and counties with information about incentives to conserve **Strategy Habitats** and **Conservation Opportunity Areas**, as well as incentives for conservation on working farm and forestlands, can expand conservation opportunities at the local level. Market-based approaches, such as conservation banking and Transfer of Development Rights (TDR), allow local communities to meet their goals while landowners and developers may continue to profit.

> Measure 37, passed in 2004, required that any government implementing a land use regulation waived the requirements of the regulation or compensated owners for any loss of value. Measure 49, passed in 2007, tempered the potential impact of Measure 37 and resulted in the authorization of over 6,000 new dwellings in rural areas. LCDC is adopting rules that would authorize the establishment of voluntary TDR programs for counties. This tool could provide incentives to shift development to locations where residential development would have less impact on farm, forest, and natural or environmentally sensitive areas. Strategy Habitats and Conservation Opportunity

> Areas could be used as incentives to offer "bonus credits" for landowners to transfer the development rights out of those areas.

Action 1.6. Support and encourage the development of local land use plans and ordinances that protect farmlands and forestlands and other fish and wildlife habitats in urban and rural areas.

Many important decisions about land use occur at the local level through local comprehensive land use plans, Goal 5 planning, ordinances, and other means. These local plans take into account local values, priorities, and needs. To implement the Conservation Strategy, agencies will need to work with local community leaders and other stakeholder groups to find opportunities to incorporate Strategy Species, Strategy Habitats, Conservation Opportunity Areas, and habitat connectivity corridors into local plans that conserve farmlands, forestlands, open space, and natural areas.

LAND USE PLANNING: ADDITIONAL RESOURCES

Oregon Statewide Planning Goals

Oregon Land Use Planning Online Training

Oregon Wetland Plan

Oregon Working Lands Map Viewer and **report**.

The Big Look (2009): The Oregon Task Force on Land Use Planning Final Report

Senate Bill 100

Governor's 10 Year Plan for Oregon Project: Healthy Environment Policy Vision

The Oregon land use system: an assessment of selected goals INR Report (2008)

Oregon Values and Beliefs Project

RENEWABLE ENERGY PLANNING

Oregonians value our native fish, wildlife, and habitats as well as scenic resources, clean energy, reduced greenhouse gas emissions, and a thriving economic sector. Over the coming decade, more clean energy development is likely to occur with increased regulation of power plant emissions in the face of climate change. Oregon's natural resource management agencies are increasingly challenged with the need to balance the state's interest in clean energy development with local natural resource conservation needs.

Energy projects offer environmental benefits but also have impacts on fish, wildlife, and habitats. So far, energy policy has focused on the broad need to reduce emissions (e.g., **Northwest Power Planning Council**), but typically does not address local or site-level impacts. At the same time, site evaluations for specific projects typically focus on the immediate and local effects of a project, without consideration of

its broader benefits. Climate change and the increasing call for clean energy challenges agencies and partners to work together in creative ways to bridge the gap.

As we look ahead to the future, policies to guide new clean energy development should outline a collaborative vision to siting success, recognize the immediate but dispersed value of clean energy across Northwest landscapes, and incorporate fish, wildlife, and habitat values.

RENEWABLE ENERGY PLANNING: GOALS AND ACTIONS

Goal 2: Strategically consider impacts to fish, wildlife, and habitats while meeting state and federal goals to increase reliance on renewable and domestic energy resources.

Action 2.1. Use the best available information about priority areas for fish, wildlife, and habitats to plan clean energy projects.

Reducing emissions is an important step towards alleviating climate change in the Pacific Northwest. Achieving these broad goals can be planned using the best available science, with additional technical assistance and local information from Oregon's natural resource agencies. Agencies and partners can work to provide the tools, scientific knowledge, and assistance needed to support consistent, defensible, and predictable siting decisions and operational requirements. The decision support tools outlined in this Conservation Strategy provide a foundation and a starting point (e.g., **Compass**). Currently available guidance documents include the **Oregon Columbia Plateau Ecoregion Wind Energy Siting and Permitting Guidelines (2008)** and the **USFWS Land-Based Energy Development Guidelines**. However, these guidance documents are just a beginning. Further actions to enhance the availability and use of best available science should engage natural resource agencies to develop clear and comprehensive mitigation strategies and siting guidance for all types of energy development.

RENEWABLE ENERGY PLANNING: ADDITIONAL RESOURCES

Association of Fish and Wildlife Agencies Energy and Wildlife Program

American Wind Wildlife Institute

Defenders of Wildlife Renewable Energy Program

National Energy Technology Laboratory Research

American Wind Energy Association Resources

Columbia Plateau Wind Energy Siting Guidelines

Renewable Northwest

USFWS Eagles in the Pacific Northwest: Energy, Utilities, & Guidance

STRATEGY SPOTLIGHT: WAFWA CHAT

The Western Association of Fish and Wildlife Agencies' Crucial Habitat Assessment Tool (**WAFWA CHAT**) was developed to bring greater certainty and predictability to planning efforts by establishing a common starting point for discussing the intersection of development and habitats. Spanning 16 states, CHAT is an online system of maps highlighting important fish and wildlife habitat areas, based on commonly agreed upon definitions originally developed by the Western Governor's Wildlife Council. CHAT was designed to be used during pre-planning phases of land-use development projects, with the intention to reduce conflicts and surprises throughout the project process. Incorporating wildlife values into a development (or conservation) project as early as possible has proven to drastically reduce project timelines, saving time and money. CHAT data are regularly updated, ensuring that as new data are collected or discovered, they are also incorporated into project planning.

Within Oregon, crucial habitat layers for CHAT are developed and maintained by ODFW. More details for these layers can be viewed within **ODFW Compass**. Documentation of crucial habitat rankings, data sources, and additional details can be found within the **Compass metadata**.

Photo Credit: ODFW

INVASIVE SPECIES

BACKGROUND

A biological invasion is underway around the globe. In Oregon, non-native organisms are arriving and thriving, sometimes at the expense of native fish and wildlife, their habitats, and the state's economy.

To define "invasive species", the Conservation Strategy uses the definition from the Oregon Revised Statute 570.755 as meaning "nonnative organisms that cause economic or environmental harm and are capable of spreading to new areas of the state. 'Invasive species' does not include humans, domestic livestock, or non-harmful exotic organisms". Many non-native species have been introduced to Oregon. While not all non-native species are invasive, some crowd out native plants and animals and become a serious problem.

Invasive Non-native Species

When an invasive species is introduced into a new environment, it leaves behind the natural enemies, such as predators, disease, or parasites, that controlled its population growth in its original home. Without this control, species can quickly expand, out-competing and overwhelming native species that may not have evolved the necessary survival strategies to fend off unfamiliar species or diseases.

Invasive non-native species can have many negative consequences throughout Oregon. Depending on the species and location, invasive plants can:

- affect food chain dynamics
- change habitat composition
- increase wildfire risk
- reduce productivity of commercial forestlands, farmlands, and rangelands
- modify soil chemistry

- accelerate soil erosion
- reduce water quality

Invasive species are the second-largest contributing factor causing native species to become at-risk of extinction in the United States. Invasive species also include disease-causing organisms, such as viruses, bacteria, prions, fungi, protozoans, and internal (roundworms, tapeworms) and external (lice, ticks) parasites that can affect the health of humans, livestock, and pets in addition to fish and wildlife. Non-native invasive species cause significant economic damage to landowners by degrading land productivity or values.

Pathways of Introduction

Every year, new non-native species are documented in Oregon, bringing with them the threat of ecological and economic damage. Many of these species are introduced unintentionally by people, escaping detection until it is too late to control their prolific expansion and devastating effects. As the pace of globalization and cross-border trade increases, so does the risk of introducing non-native species. Many new species will likely arrive as stowaways in agricultural commodities, seafood, livestock, wood products, packing materials, nursery stock imported into the state, and discharged ballast water from commercial shipping operations.

There are other ways people can unintentionally introduce or increase the spread of invasive species. Mud on the soles of hiking boots or treads of off-road vehicles can contain seeds of noxious weeds. Oregon's rivers and lakes are vulnerable to aquatic invasive species, such as the highly invasive zebra and quagga mussels. These are invaders from the Ponto-Caspian Sea region and have spread to the Great Lakes, Midwest, and Southwest. Zebra and quagga mussels can be unintentionally spread as adults attached to boat hulls, motors, or trailers, or as larvae in livewells or standing water found in boat motors.

People have also intentionally released new species into the environment; some may become invasive and others may not. People depend on a variety of non-native plants for food, livestock feed, and ornamental, medicinal, and other uses. While most of these plants have little environmental effect, some like the Scotch broom, Japanese knotweed, and Armenian (Himalayan) blackberry can escape into natural areas. When this happens, they can crowd out native plant communities. Non-native fish (both legal introductions and illegal releases), bullfrogs, feral swine, and birds have been released to provide new fishing and hunting opportunities. Nutria, which cause tremendous damage in agricultural areas, were released in Oregon after failed attempts at raising them commercially for fur. People release pet amphibians, reptiles, and mammals into backyards, and aquarium fish into local streams and ponds. In many cases, these releases are illegal in Oregon.

Once introduced, natural pathways may help to spread invasive species, especially plants whose seeds or parts are easily dispersed by wind, water, and wildlife. Certain land management practices can serve as conduits or create conditions that favor the spread of invasive organisms. Regardless of the pathway

or practice implicated in the problem, experts believe that environmental disturbance is often a precursor to invasion by non-native plants. Invasive non-native species are highly adaptable and competitive, using space, water, and sunlight of disturbed ground. Following introduction and successful establishment, these species may increase their dominance and distribution until they reach the environmental and geographic limits of their expansion. Populations of invasive species may stabilize eventually but often not before inflicting significant environmental and economic damage.

Although introductions of invasive species to Oregon may be inevitable, preventing invasive species from arriving in the first place is the most cost-effective way of controlling invasive species and is in everyone's best interest.

ASSESSING RISK

Evaluating the potential danger associated with the introduction of a new species is sometimes very difficult due to unknown variables on how the species will respond in a new environment or which species might arrive within the state. Many invasive species, especially those that are aquatic (e.g, invasive tunicates) can be difficult to detect before they pose a large threat. Once invasive species are established, controlling them can be difficult, expensive, and in some cases, impossible. Priority must be placed on preventing the introduction of new species. Also, not every new non-native species is equally threatening, so gauging the level of risk and responding accordingly is important to avoid misallocating limited resources on species of low ecological or economic concern.

The Conservation Strategy uses a systematic approach to assess the level of ecological threat from invasive species currently present in Oregon or likely to appear in the near future. These priority invasive species are listed by **Ecoregion**. To develop these lists, the ODFW coordinated with Oregon Department of Agriculture (ODA) invasive species program staff. The scope was limited to terrestrial and aquatic vertebrates.

Beginning in 2012, an effort was initiated to assess existing or potential threats to marine and estuarine ecosystems. The ODFW developed a list of non-native species, in consultation with the OSU, Environmental Protection Agency (EPA), USGS, and Williams College. This list includes fish, invertebrate, plant, and algae species within the nearshore ecoregion and is presented within the **Nearshore Strategy**.

Many non-native fish species are legislatively defined as game fish in Oregon and are managed by the **ODFW**. Managed appropriately, they provide a valuable fishery to the public and an economic stimulus to many communities in Oregon. The ODFW provides angling opportunities for some of these species by transplanting fish from one waterbody to another, stocking hatchery-produced fish in locations where impacts to native fish are believed to be acceptable, or transplanting fish to ponds more accessible for angling.

In some situations, non-native fish species move around naturally after environmental or habitat disturbance events, or are moved by people either unintentionally or illegally to stock them for harvest

or some other purpose. When this happens, non-native fish species can become naturally self-sustaining, potentially impacting Oregon's native species. The ODFW seeks to prevent the uncontrolled spread of these species and will evaluate situations on a case-by-case basis. In some situations where populations have already become established and there is little feasibility of eliminating their natural production, the ODFW will manage fisheries for the public, establishing seasons and take limits. In other situations where the introduction is very recent or particularly harmful to native fish and wildlife, the ODFW will assess management options to remove them, limit further dispersal, and prevent the illegal establishment of fisheries.

DOCUMENTED NON-NATIVE INVASIVE FISH AND WILDLIFE SPECIES

Species	Blue Mountains	Coast Range	Columbia Plateau	East Cascades	Klamath Mountains	Northern Basin & Range	West Cascades	Willamette Valley	Nearshore
American Bullfrog (*Lithobates catesbeianus*)	BM	CR	CP	EC	KM	NBR	WC	WV	NS
Amur Goby (*Rhinogobius brunneus*)		CR						WV	
Asian Clam (*Corbicula fluminea*)	BM	CR	CP	EC	KM	NBR	WC	WV	NS
Asian Marsh Snail (*Assiminea parasitologica*)		CR							NS
Asian Sea Squirt (*Styela clava*)		CR							NS
Australasian Burrowing Isopod (*Sphaeroma quoianum*)		CR							NS
Black Rat (*Rattus rattus*)		CR	CP	EC			WC	WV	
Brown Rat (*Rattus norvegicus*)	BM	CR	CP	EC	KM	NBR	WC	WV	

Species	Blue Mountains	Coast Range	Columbia Plateau	East Cascades	Klamath Mountains	Northern Basin & Range	West Cascades	Willamette Valley	Nearshore
Chinese Mysterysnail (*Cipangopaludina chinensis malleata*)		CR		EC	KM			WV	
Colonial Tunicate (*Didemnum vexillum*)		CR							NS
Common Carp (*Cyprinus carpio*)	BM	CR	CP	EC	KM	NBR	WC	WV	
Common Snapping Turtle (*Chelydra serpentina*)		CR			KM		WC	WV	
Eastern Fox Squirrel (*Sciurus niger*)	BM					NBR		WV	
Eastern Gray Squirrel (*Sciurus carolinensis*)						NBR		WV	
Eurasian Collared Dove (*Streptopelia decaocto*)	BM	CR	CP	EC	KM	NBR	WC	WV	
European Ear Snail (*Radix auricularia*)	BM			EC					
European Starling (*Sturnus vulgaris*)	BM	CR	CP	EC	KM	NBR	WC	WV	
Fathead Minnow (*Pimephales promelas*)		CR		EC				WV	

Species	Blue Mountains	Coast Range	Columbia Plateau	East Cascades	Klamath Mountains	Northern Basin & Range	West Cascades	Willamette Valley	Nearshore
Feral Goat (*Capra hircus*)		CR							
Feral Horse (*Equus caballus*)	BM			EC		NBR			
Feral Sheep (*Ovis aries*)	BM			EC					
Feral Swine (*Sus scrofa*)	BM	CR	CP	EC	KM	NBR		WV	
Freshwater Jellyfish (*Craspedacusta sowerbyi*)					KM			WV	
Golden Shiner (*Notemigonus crysoleucas*)	BM	CR		EC	KM	NBR	WC	WV	
Goldfish (*Carassius auratus*)		CR		EC	KM			WV	
Grass Carp (*Ctenopharyngodon idella*)*		CR	CP	EC				WV	
Griffen's Isopod (*Orthione griffenis*)		CR							NS
House Sparrow (*Passer domesticus*)	BM	CR	CP	EC	KM	NBR	WC	WV	

Species	Blue Mountains	Coast Range	Columbia Plateau	East Cascades	Klamath Mountains	Northern Basin & Range	West Cascades	Willamette Valley	Nearshore
Japanese Eel Grass (*Zostera japonica*)		CR							NS
Japanese Oyster Drill (*Ocinebrellus inornatus*)		CR							NS
Japanese Seaweed (*Sargassum muticum*)		CR							NS
Mute Swan (*Cygnus olor*)	BM			EC	KM			WV	
New Zealand Mudsnail (*Potamopyrgus antipodarum*)	BM	CR	CP	EC	KM	NBR	WC	WV	NS
Nutria (*Myocastor coypus*)	BM	CR	CP	EC	KM		WC	WV	
Purple Varnish Clam (*Nuttallia obscurata*)		CR							NS
Red-eared Slider (*Trachemys scripta elegans*)		CR		EC	KM			WV	
Red Fox (*Vulpes vulpes*)**	BM	CR			KM			WV	
Red Swamp Crayfish (*Procambarus clarkii*)		CR		EC				WV	

Species	Blue Mountains	Coast Range	Columbia Plateau	East Cascades	Klamath Mountains	Northern Basin & Range	West Cascades	Willamette Valley	Nearshore
Ringed Crayfish (*Orconectes neglectus*)		CR		EC	KM	NBR	WC	WV	
Rock Pigeon (*Columba livia*)	BM	CR	CP	EC	KM	NBR	WC	WV	
Siberian Prawn (*Exopalaemon modestus*)		CR	CP					WV	
Virginia Opossum (*Didelphis virginiana*)	BM	CR	CP	EC	KM		WC	WV	
Western Mosquitofish (*Gambusia affinis*)***		CR	CP		KM	NBR	WC	WV	
Yellow Bellied Slider (*Trachemys scripta scripta*)					KM			WV	

** Grass Carp may be permitted by ODFW for vegetation management in certain approved and controlled situations. (**Prohibited and Controlled Fish, Mollusks, and Crustaceans**). ** There is also a native Red Fox found in the Wallowa Mountains. *** The Western Mosquitofish is a controlled species that may be used in man-made troughs or ponds that are not connected to natural waterways, in certain situations to control mosquitoes (**Oregon Administrative Rule 635-007-0620**).*

*Data sources for this table: **ODFW Prohibited and Controlled Species List**; **USGS Nonindigenous Aquatic Species**; **iMap Invasives**; **BLM**; **ODA**; personal communications with regional experts*

MANAGEMENT APPROACHES

Building on Current Planning Efforts

Several other planning efforts are underway to protect Oregon from biological invaders. State statutes or **agency administrative rules** are in place to prohibit the unauthorized entry of undesirable invasive species. Together, the following plans and regulations provide a foundation for addressing invasive species and put the issue into clearer context for this Conservation Strategy:

- **Oregon Invasive Species Council Action Plan**
- **Invasive Species Report Card**
- **Aquatic Invasive Species Prevention Plan**
- **Oregon Noxious Weed Strategic Plan (ODA)**
- **Oregon Aquatic Nuisance Species Management Plan (Portland State University)**
- **Ballast Water Management Administrative Rules (DEQ)**
- **Wildlife Integrity Administrative Rules (ODFW)**
- **Oregon Dreissenid Mussel Rapid Response Plan**
- **Columbia River Basin Interagency Invasive Species Response Plan**

Other ongoing efforts provide information that would be helpful in addressing invasive species. For example, the **USFS's Forest Inventory and Analysis Program** uses remote sensing imagery or aerial photography to classify land into forest or non-forest. Permanently established field plots are distributed across the landscape, and 10 percent of these plots are visited each year to collect forest ecosystem data. A subset of these plots are sampled yearly to measure forest ecosystem function, condition, and health, including measurements of native and non-native plants, which can provide information about the spread of invasive species.

In April 2005, the USFS released its **Final Environmental Impact Statement "Preventing and Managing Invasive Plants"**. Although the record of decision has not been finalized, the proposed action amends all forest plans within the Pacific Northwest Region 6 to improve and increase consistency of invasive plant prevention, and allows the use of an expanded set of invasive plant treatment tools. The proposed action includes restoration requirements and an inventory and monitoring plan framework.

Meeting the Challenge: A Framework for Action

Invasive species can be effectively managed and their potential ecological and economic impacts mitigated if the right precautions and steps are taken. The National Invasive Species Council has identified a framework of approaches in its plan, "**Meeting the Invasive Species Challenge: National Invasive Species Management Plan**". These actions, or management approaches, are not a cure-all but

can give states, counties, private landowners, and public land managers a framework for prioritizing efforts to guard Strategy Species, Strategy Habitats, and working landscapes against invading organisms.

For maximum effectiveness, all approaches in this Framework for Action should be integrated and carried out in a coordinated manner. The approaches need to be implemented at different spatial scales and across all jurisdictional and ownership boundaries. For example, monitoring aids site-specific management decisions. Weed infestations on federally-managed land and on adjacent private property are more effectively controlled when federal land managers and private landowners join forces at the landscape level, across ownership boundaries. Reporting these data to a central database is also important for tracking changes in populations and distributions across the state.

Management Approach	Objective
Education	Inform the public about the impacts and costs of invasions.
Prevention	Preventing new species introductions is a top priority and the most cost-effective approach to protecting native species, ecosystems, and productivity of the land from invasive species.
Assessment/Risk Analysis	Defining the level of concern and risk associated with new introductions through an assessment process will help to identify the worst invaders and management priorities.
Monitoring	The importance of surveying cannot be overestimated when looking for first-time infestations of undesirable non-native species or evaluating efforts to control existing occurrences.
Early detection	Early discovery of infestations of previously undocumented non-native species is critical to controlling their spread and achieving complete eradication.
Rapid Response	Immediate treatment of new, isolated infestations will maximize eradication success and decrease the likelihood of populations expanding beyond the initial area of introduction.

Management Approach	Objective
Containment	Preventing invasive species from 'hitchhiking' via vulnerable pathways will slow the advance of well-established invasive species into unaffected areas. Some invasive species are tolerable if infestations can be contained and their impacts minimized.
Restoration	A system-wide approach to treating invasive species should consider habitat restoration as part of the ecological healing process. Helping native species and ecosystems recover is an important step following the removal of harmful species.
Adaptive Management	Land managers or landowners should change course on management prescriptions if treatments are not working. Monitoring the results of control actions is an important part of this process.

GOALS AND ACTIONS

Goal 1: Prevent new introductions of species with high potential to become invasive, and reduce the scale and spread of priority invasive species infestations.

Action 1.1. Focus on preventing the introduction of new invasive non-native species through collaborative efforts.

The cost and difficulty of managing invasive non-native species increases substantially once a species has established self-sustaining populations. Once established and widespread, invasive species are virtually impossible to eliminate, and control costs can become prohibitive. Therefore, every effort should be made to prevent first-time introductions of invasive species from becoming established in Oregon. By their very nature, however, state borders are porous and vulnerable to the entry of non-native organisms. A significant challenge is developing and implementing effective prevention strategies based on the best research of where and how new and potentially invasive organisms are likely to enter Oregon. An example of preventing the introduction of invasive species is the **watercraft inspection program** for aquatic invasive species (AIS). Inspection stations are located at entry points on major highways along the eastern and southern borders of Oregon. Personnel at these stations inspect watercraft for AIS and if any are found, the watercraft is decontaminated on the spot.

Action 1.2. Increased public awareness, reporting, and funding.

The Oregon Invasive Species Council (Council) coordinates statewide efforts to prevent biological invasions and seeks to mitigate the ecological, economic, and human health impacts of invasive species. Informed landowners, land managers, public officials, and the public can take action to further the Council's goals. Businesses, landowners, anglers, hunters, Oregon residents, and visitors should be reminded of the dangers posed by invasive species through targeted outreach and education. People can greatly reduce the accidental introduction or spread of these organisms into and within Oregon if they know what precautions to take. State and federal agencies can work with the Council to promote and raise public awareness of programs for which they have responsibility to reduce or eliminate the risk of introducing invasive species. For example, **ODA's Noxious Weed Program** provides statewide leadership for coordination and management of state-listed noxious weeds, and **ODFW's Wildlife Integrity Program** regulates the importation, possession, and transportation of non-native wildlife species. Encouraging Oregonians to report sightings of invaders is also important and can be key to the detection, control, and elimination of an invasive species. The Council's toll-free "hotline" is one such tool (1-866-INVADER).

Elected officials, industries, and the conservation community should work together to identify public and private funding to support the efforts of the Invasive Species Council and its partners to develop effective prevention measures. This investment will help protect the economic and ecological interests of all Oregonians, as well as protect Strategy Species and Habitats from the impacts of harmful invaders.

Action 1.3. Through collaborative efforts, continue to develop early detection and rapid response plans to facilitate swift containment of new introductions.

The potential dangers of new invasions to forestlands, agricultural and range lands, natural areas, and fish and wildlife should be determined as early as possible so that farmers, ranchers, fish and wildlife managers, and conservationists can be forewarned and better prepared. Response plans could be developed in a format similar to the "**Columbia River Basin Interagency Invasive Species Response Plan: Zebra Mussels and Other Dreissenid Species**". Teams composed of state, federal, and private experts would determine the likely impacts of newly discovered invasive species, predict the spread of new infestations, and decide which steps should be taken to alert the public. This approach could follow the format used by interagency wildfire coordination centers. Invasive species, like wildfires, ignore ownership boundaries and spread from property to property, underscoring the need to treat invasions wherever they occur on the landscape. Also, like wildfires, invasive infestations are best controlled when small in size.

In 2012, Governor Kitzhaber developed the Oregon Tsunami Debris Task Force to respond to marine debris coming ashore with high potential to carry invasive species. The task force, led by the Office of Emergency Management, was comprised of members from the Oregon Parks and Recreation Department, Oregon Department of Environmental Quality (DEQ), Oregon Health Authority, Oregon State Marine Board, Oregon State Police, Oregon Department of Transportation (ODOT),

ODFW, National Oceanic and Atmospheric Administration (NOAA), U.S. Coast Guard, tribal, state, and local government, and advocacy organizations. The task force developed the Japanese Tsunami Marine Debris Plan, with the purpose of coordinating a timely, comprehensive, effective, and well-managed response to marine debris that landed on Oregon's shores. While the plan is similar to that discussed above, it targets the mechanism of species introduction (e.g., marine debris), rather than specific species.

Rapid response plans need to be tested, refined, and practiced before implementing control efforts on a new infestation. Conducting exercises that simulate an infestation can promote better cooperation between government agencies and private organizations, and produce a more effective and successful battle against a newly detected species.

Action 1.4. Establish a system to track the location, size, and status of infestations of priority invasive species.

A number of local, state, and federal agencies and private organizations independently gather data on invasive plants, animals, and pathogens in Oregon, but the information is decentralized and often not integrated for analysis. Oregon lacks a comprehensive, coordinated, and centralized system for gathering and maintaining data on the location of non-native species on private and public lands. Efforts to institute a reporting system are also hampered, in part, by landowner privacy and disclosure concerns. Landowners may not report invasive species on their property due to concerns that disclosure of infestations may lower property values or that they may be held responsible for treatment costs.

There is a critical need to improve the integration and standardization of data on invasive species derived from independent monitoring efforts. Using existing data housed by the Institute for Natural Resources at OSU, a multi-partner, spatially-explicit database and mapping system of non-native plants, animals, and diseases could be developed. The data could be used to track changes and trends in invasive populations, better anticipate the spread of invasive organisms within the state, identify vectors or points of entry and high-risk environments for invasion, and evaluate the success of management actions. Voluntary reporting by private landowners should be encouraged by providing confidentiality, nondisclosure of sensitive information, and free technical assistance on control methods to increase landowner participation.

> Web-based information portals are an important tool for invasive data reporting and sharing. **iMap Invasives** is an online tool that allows users to report invasive species findings, and provides information on invasive species distribution, treatment efforts and effectiveness, and areas where invasive species were searched for but were not found. The **Oregon Invasive Species Council** also has an online reporting and sharing tool.

The West Coast Governor's Alliance has constituted a Marine Debris Action Coordination Team, with the goal of creating a framework to identify, assess, prevent, and reduce marine debris and the threats associated with debris, including invasive species. They have developed a **Marine Debris Database** that

allows anyone to record and track information about marine debris on land or in the water, or clean-up events. While the goals of the movement are much broader than invasive species, the work that is done is critical to tracking potential invasive species threats in estuarine and marine environments.

Action 1.5. Focus on eradication of invasive species in Strategy Habitats and other high priority areas where there is a clear threat to ecosystems and a high probability of success.

Some invasive species have spread to the point where it would be impractical or impossible to eliminate them from Oregon. Yet, some of these established invasive species negatively impact Strategy Species and Strategy Habitats and can be contained at the local level. In these situations, control efforts should be focused on those invasive species that are limiting factors to **Strategy Species** or **Strategy Habitats**, particularly within **Conservation Opportunity Areas**. In addition, other priorities may include controlling invasive species that disrupt ecological function or impact vulnerable, commercially valuable lands, such as rangeland, farmland, and timberland.

Local eradication of invasive species near high priority habitats and lands should be emphasized where practical, with the ultimate goal of restoring these lands to their full ecological or utilitarian potential. Controlling established invasive species often requires a long-term commitment. If funding runs out or the management priorities change, invasive species can quickly return. Restoration can repair habitats degraded by invasive species and may be necessary if aquatic or terrestrial ecosystems are too damaged to heal on their own. Restoration may be the best prescription for inoculating native plant communities against invasive plants because ecosystems are more resilient to invasion when they are healthy and functioning well. Entities involved in invasive species management should encourage landowners to consider ecologically-based restoration as part of any plan to manage invasive species.

Private landowners are increasingly partnering with watershed councils, ODFW, Soil and Water Conservation Districts (SWCDs), ODA, and federal land management agencies to manage invasive species across property lines. Such broad-scale efforts need to continue and be expanded.

Action 1.6. Work with the ODA, the Oregon Invasive Species Council, and other partners to develop an invasive species implementation tool that evaluates the ecological impact and management approaches for invasive species identified as priorities in the Conservation Strategy.

The ODFW is developing an invasive species implementation tool to further evaluate invasive species. Building on already-completed assessments, this tool will rank the severity of the ecological impact of each invasive species by analyzing four factors: ecological impact, current distribution and abundance, trends in distribution and abundance, and management difficulty. This information will be used to determine the best management approaches for individual invasive species. Current and potential partners include TNC, Oregon Biodiversity Information Center, Oregon Invasive Species Council, county weed boards, federal land management agencies, ODA, and others.

Action 1.7. Develop and test additional techniques to deal with invasive species, and share information with landowners and land managers.

Landowners and land managers need to know how to treat invasive organisms that lower the productivity and value of land, alter ecosystem processes, and threaten native species. They also need to know what level of investment is appropriate, and which techniques are most appropriate for each respective situation. Throughout Oregon, people are using a variety of methods to control individual invasive species with varying degrees of success.

Multiple site-appropriate control mechanisms (e.g., mechanical, chemical, and biological) should be evaluated to control individual invasive species. Increased coordination and communication is needed between researchers, agencies, watershed councils, county weed boards, and private landowners regarding what works under what conditions. Outreach materials should be developed to assist landowners and land managers in choosing and using the most appropriate techniques for their sites. Currently, there is no known effective way to control some widespread invasive plants, such as cheatgrass, medusahead, and false brome. Research efforts need to be supported and expanded to address these and other invasive species.

ADDITIONAL RESOURCES

- **Oregon Invasive Species Council**
- **National Invasive Species Council**
- **ODFW Invasive Species Resources**
- **ODFW Prohibited and Controlled Fish, Mollusks, and Crustaceans**
- **Oregon Administrative Rule 635-007-0620**
- **ODA Insect Pest Prevention and Management**
- **Global Invasive Species Database**
- **USFWS Invasive Species**
- **USGS Invasive Species Program**
- **USGS Nonindigenous Aquatic Species**
- **Oregon DEQ Invasive Species**
- **BLM Oregon Invasive Species**
- **BLM Oregon Wild Horse Program**
- **100th Meridian Initiative**
- **Oregon State University: Pacific Northwest Nursery Integrated Pest Management**
- **Oregon Sea Grant: Invasive Species**

STRATEGY SPOTLIGHT: INVASIVE PLANTS IN THE LUCKIAMUTE WATERSHED

The **Luckiamute Watershed Council** began a knotweed control program in 2010 with willing landowners along the upper Luckiamute River. Japanese knotweed is labeled one of the world's worst invasive species by the World Conservation Union.

After a few years of successful outreach and ongoing control, the Council pursued funding for the remaining extent of the infestation along the Little Luckiamute and Luckiamute Rivers. In 2013, the Council was awarded four-year funding from the Oregon Watershed Enhancement Board.

The Luckiamute mainstem is a Conservation Opportunity Area in both the Willamette Valley and Coast Range ecoregions. As of 2015, the Council is working with 161 (90 percent) of landowners along 50 miles of the river.

Photo Credit: USFS

DISRUPTION OF DISTURBANCE REGIMES

BACKGROUND

Historically, many of Oregon's open structured habitats, those dominated by grasses, forbs, and/or shrubs, were maintained by disturbance. Fire, floods, wind, storms, and salt spray have historically played a key role in shaping many of these native habitats. Natural disturbances shape Oregon's landscapes by resetting plant succession, releasing nutrients, moving materials, creating new habitats, and maintaining native habitats, such as grasslands and savannas.

Altered fire regimes have changed vegetation patterns, affecting wildlife dependent on open landscapes. Fires have become statewide issues in the past century as Oregon's population has grown, placing homes and communities closer to where these disturbances occur. Fires were suppressed to protect valuable timber and towns. The unintended consequences included increased tree density and fuel load of forests, which contributed to insect outbreaks, other forest health issues, and the risk of uncharacteristically severe fires.

Dams were constructed to protect towns from flooding, produce electricity, and provide irrigation for farms. The unintended consequences include impeded or blocked aquatic passage, as well as changes in hydrologic regimes that resulted in loss of floodplain function, loss of fish spawning and rearing areas, and degraded riparian habitats. These changes have all impacted Oregon's fish and wildlife populations.

The recommended approach in the Conservation Strategy is to restore or mimic fire and flooding disturbance regimes to benefit fish and wildlife and reduce risks to people.

ALTERED FIRE REGIMES

Fire Suppression and Uncharacteristically Severe Wildfire

For thousands of years, fire has been one of the most important forces shaping Oregon's landscapes, both forested and un-forested. Whether started by lightning or Native Americans, fire strongly influenced wildlife habitats by altering the structure, composition, and landscape pattern of native vegetation.

To understand the natural role of fire and how it should be managed, researchers have determined the "natural" (historical, pre-1850) fire regimes for many of Oregon's habitats. Natural fire regimes are classified based on the historical range of fire frequency (e.g., the average number of years between fires) and fire severity prior to European settlement. Human intervention over the last hundred years has altered the historical fire regimes in many of Oregon's landscapes. This has resulted in a cascade of unintended consequences for ecological health, wildlife populations, and people.

Fire regime condition classes are used to describe the amount of departure from natural (historical) fire regimes and were developed for all natural vegetation types. The following chart contains a simplified description of the fire regime condition classes and associated potential risks.

Fire Regime Condition Class	Relationship to historical range of variability (e.g., vegetation characteristics, fuel composition, fire frequency, severity, pattern)	Potential risk of losing key ecosystem components (e.g., native species, soil, large trees)
Condition Class I	Within the natural (historical) range of variability	Low risk
Condition Class II	Moderate departure from the natural (historical) range of variability	Moderate risk
Condition Class III	High departure from the natural (historical) range of variability	High risk

Forested Landscapes

In forested areas, vegetation changes following fire suppression have increased the likelihood of wildfires that are uncharacteristically large, severe, or both.

Nationally-developed maps that display coarse-scale fire regime condition classes show over one-third (39 percent) of Oregon's 27.5 million acres of forestland in Condition Class III and another 45 percent in

Condition Class II. The **West Wide Wildfire Risk Assessment** data add to the state information bank about fire regime condition classes.

The extent of change in natural fire regimes varies considerably among forest types. For the purpose of discussing fire, forests typically are grouped into three broad categories:

1. Drier forests that are or were dominated by species like ponderosa pine, Douglas-fir, and larch historically tended to experience frequent fires (average intervals between fires of less than 25 years) that burned small trees and shrubs, but had limited effects on overstory trees with thick, fire-resistant bark. This pattern of frequent, low-severity fires is often referred to as an understory fire regime.
2. Intermediate environments, such as mid-elevation areas supporting forests comprised of a variety of conifer species, had average fire return intervals ranging from around 25 to 100 years. The impact of fire on overstory trees could vary from minimal to severe (depending largely on weather and topography). This associated fire regime is often referred to as a mixed fire regime.
3. Forests in moist, cold areas (or at least with cool summers, as in the Coast Range or high elevation mountains) tended to experience infrequent fires (average intervals of more than 100 years) that killed most or all of the dominant trees, leading to a stand-replacement fire regime.

The greatest extent of alteration to natural fire regimes has occurred in forests that historically had an understory fire regime. These forests are **ponderosa pine** and some mixed conifer forest types in the **East Cascades**, **Blue Mountains**, and eastern (interior) portion of the **Klamath Mountains** ecoregions. Human intervention, particularly fire suppression and past selective logging of large overstory trees, has shifted the historical fire regime from an understory fire regime with frequent, low-intensity fires to a stand-replacing fire regime with less frequent, high intensity fires.

Fire suppression (particularly on federal lands) eliminated the frequent, low-intensity fires that historically occurred in these forests. The elimination of frequent, low-intensity fires resulted in increased fuel loads in the form of surface fuels, shrubs, and smaller trees, and increased stand densities. Increased stand densities favored understory trees like Douglas-fir and grand fir. Dense understory trees served as “ladder fuels” that linked surface fuels and overstory fuels. Selective logging removed the larger, more fire-tolerant trees and opened the canopy, allowing more small, fire-sensitive trees to grow in the understory. The increase in fuel loads and stand densities made it more likely that when fire did occur, it would reach the forest canopy and spread as a crown fire. As a result of increased stand densities, larger trees became stressed due to competition with other vegetation for water and became more prone to insect infestation and disease.

Because of their large size and intensity, uncharacteristic fires are more likely to cause adverse economic and environmental impacts. Fire has a negative economic impact on rural communities in Oregon whose economy and culture are based on forestry. Fire-fighting activities are a major expense for the state as a whole. In 2013, Oregon spent approximately $75 million on fire suppression efforts.

Uncharacteristically severe wildfires also pose higher risks to species and habitats because such fires can involve large areas and often result in complete mortality of overstory and understory vegetation (i.e., stand-replacing events). These stand-replacing fires can impact habitats, soils, and watersheds beyond their adaptive limits. Uncharacteristically severe wildfires impact aquatic habitats by removing riparian vegetation, which result in higher stream temperatures, decreased bank stability, and increased sedimentation in stream channels.

Many Oregon forests in fire regime Condition Class II or III contain **Strategy Habitats** or other important habitats for **Strategy Species**. Many of the Late Successional Reserves (LSRs) designated under the **Northwest Forest Plan** for management to preserve and produce late-successional forests are located in Condition Class II or III forests. These LSRs address the habitat needs of late-successional and old-growth forest-related species, such as the **Northern Spotted Owl** or **Marbled Murrelet**. Many riparian areas that provide habitat for fish species listed under the Endangered Species Act (ESA), including **steelhead**, **Chinook salmon**, **coho salmon**, and **bull trout**, are located in forests in Condition Class II or III. Many ponderosa pine forests in central and eastern Oregon are also located in Condition Class II or III.

Sagebrush, Grassland, Oak, and Aspen Habitats

Fire historically maintained many sagebrush, grasslands, oak savannas, oak woodlands, and aspen woodlands by removing competing vegetation and stimulating regeneration of native fire-associated plants. Fire suppression has allowed shrubs and conifers to encroach into **grasslands**, **oak woodlands**, and oak savannas. Similarly, it has allowed western juniper to encroach into **aspen woodlands**, some **riparian areas**, and mountain big sagebrush habitats. Maintenance of these habitats over time will require the careful reintroduction of natural fire regimes using site-appropriate prescriptions, accounting for the area size and vegetation characteristics that affect resiliency and resistance to disturbance. In some areas, other techniques, such as mowing or controlled grazing, can be used to mimic the effects of fire.

Vegetation in sagebrush steppe ecosystems is adapted to arid conditions, and strongly influenced by fire and by drought. Drought, defined as two growing seasons with below average precipitation, has a pronounced impact on shrubs, grasses, and forbs. Drought can reduce sagebrush growth and impact grasses and insect populations, which can in turn result in less food for **Greater Sage-Grouse** and lower chick survival.

The issues of altered fire regimes and **invasive species** interact to create unnatural fire cycles in eastern Oregon, particularly in the **Northern Basin and Range** ecoregion. The introduction of invasive annuals, particularly cheatgrass and medusahead, can increase the frequency, intensity, and spread of fires. Breaking this cycle will require proactive management to prevent introduction of annual invasive species, minimizing the spread of cheatgrass, controlling wildfires in invasive-dominated areas, avoiding prescribed fire in cheatgrass-dominated areas, and conducting research on how to better restore areas dominated by invasive species. Habitats formerly dominated by sagebrush and native grasses that are

now dominated by invasive annuals do not always meet the habitat needs of native wildlife, such as the Greater Sage-Grouse.

ALTERED FIRE REGIMES: GOALS AND ACTIONS

Goal 1. Reduce uncharacteristically severe wildfire and restore fire or ecologically equivalent action in fire-dependent ecosystems to reestablish vegetative structure and species composition representative of a typical disturbance regime for forested and other systems.

Action 1.1. Use wildfire risk classification maps to identify local zones with greatest risk of uncharacteristically severe wildfire and prioritize for further action. Refer to restoration needs assessments based on departure from historical structure and composition to prioritize local zones for restoration action.

Coarse-scale fire condition maps have been developed for Oregon, but further work is needed to determine wildfire risk at finer scales. Specifically, refinement is needed to verify whether site-specific conditions are actually in Condition Class I, II, or III. These maps can then be used to prioritize which local sites need management actions to reduce risks. For example, the **West Wide Wildfire Risk Assessment** data add to the state information bank about fire regime condition classes. See the ODF's Forest Resource Assessment for more information.

Setting priorities is essential, due to the magnitude of the areas requiring restoration and the limited resources allocated to their treatment. The risk of losing key ecosystem components is a factor that should be considered, with priority given to areas that currently are in fire regime Condition Class III (high risk of losing key ecosystem components) or Class II (moderate risk of losing key ecosystem components).

In identifying priorities for fuel reduction techniques, consideration should be given to both local site-specific conditions and the broader landscape context. Site-specific considerations should include identification of particular values at risk of loss from uncharacteristically severe wildfire, such as remnant large-diameter ponderosa pine. Larger-scale considerations should include factors such as the extent to which an area's landscape context makes it highly valuable to wildlife (e.g., travel corridors, breeding locations) or more likely to be vulnerable to fire or contribute to fire spread. Similarly, proximity to human residences or high-value watersheds needs to be considered.

Action 1.2. Work with landowners and other partners in these zones to lower risk of wildfires while maintaining wildlife habitat values, and to choose the sites and landscapes for fuel reduction and forest restoration.

Site-by-site decisions must be made on the type and extent of fuel reduction treatments that will be conducted. Fuel reduction treatments must be balanced in relation to other ecological objectives. Many of Oregon's habitats, including forests and high desert, are at risk for fire. Specifically, Oregon forests in

fire regime Condition Class II or III contain **Strategy Habitats** that provide habitat for a number of **Strategy Species**, including species listed under the Endangered Species Act. If fuel reduction treatments are not undertaken, the long-term risk of losing key ecosystem components to uncharacteristic fire is increased. However, fuel reduction treatments can impact species and habitat by disturbing soil or eliminating key habitat components, such as canopy cover, hiding cover, snags, large woody debris, or large live trees. These impacts will vary depending on the extent, pattern, and level of fuel reduction treatments. Decisions on the fuel reduction treatments must balance the need to maintain these key ecosystem components with management needed to reduce risk of long-term damage to wildlife from wildfires.

In high priority zones, use active management techniques to reduce surface, understory, and crown fuels. Fuel reduction treatments typically involve mechanical treatments followed by the use of prescribed fire, if appropriate. The most common mechanical treatment is the removal of smaller trees by understory thinning or thinning from below, although other forms of thinning may be employed, as well as mowing and crushing to reduce shrubs and surface fuels. Maintenance treatments will be essential to supporting desired conditions and successional trajectories. Maintenance of areas in Condition Class I, especially in dry forest types, will also be important. In the absence of maintenance, areas currently in Condition Class I and II will continue to progress into Condition Class III.

Action 1.3. Seek and support cost-effective methods for reducing fuels, especially innovative approaches that increase the pace and scale of forest restoration and contribute to local economies.

In some areas, carefully removing understory biomass can restore habitats with historically open understories while reducing the risk of uncharacteristically severe wildfire by reducing fuel loads and removing ladder fuels. Developing markets for these small-diameter trees can create jobs, contribute to local economies, and help pay for restoration. The **USFS's Stewardship Contracting Program** offers opportunities to implement and fund certain habitat restoration and management projects. Currently, there are several innovative projects to develop markets for small-diameter trees in Oregon.

Social acceptance for fuel management and other wildfire reduction efforts is likely to be greatest where various interests and values converge (for instance, in an accessible area of dry forest types where restoration would protect residences, restore or conserve habitats of concern, and provide a commercially valuable timber by-product that could be processed in a local mill). Given the great disparity between the extent of areas needing treatment and the limited resources to accomplish the necessary treatments, careful consideration of factors related to social acceptance, as well as fire risk and other ecological elements, should help identify areas where projects can both provide substantial benefits and have a high likelihood of being successfully implemented. Thus, collaborative approaches to prioritize and plan fuel reduction efforts must include diverse public interests. Collaboration between federal land management agencies and a variety of organizations, groups, and agencies is required for projects undertaken through the **Healthy Forest Restoration Act** and Stewardship Contracting.

Furthermore, the monitoring of fuel reduction techniques discussed above is essential for both refining techniques and building trust and confidence among stakeholders.

Community-based forest health collaboratives have been emerging across Oregon over the last 20 years. The emergence of these collaborative partnerships has been, in large part, to provide review and recommendations for federal forest management activities occurring near their communities. Starting with a handful of pioneering local partnership efforts in the 1990s, the number of community-based collaboratives now exceeds 20. As of 2012, there is at least one community-based collaborative group working with each of the 11 National Forests that are wholly, or in part, included within the state's boundaries.

These groups identify local forest health priorities through a community-based process, develop landscape-scale forest restoration plans, and develop agreement on active management and restoration approaches. Collaboratives bring together representatives from federal, state, and local governments, conservationists, timber interests, tribes, and other local groups to develop a clearly defined vision and strategic goals for cooperative restoration. The work of local forest collaborative partnerships has been shown to be an important means for establishing local support and agreement for forest restoration treatments, thereby increasing the potential for an acceleration in the pace and scale of forest restoration.

> OSU's **Oregon Forest Management Planning** site provides guidance and resources to woodland owners and forestry professionals who are writing forest management plans.

Action 1.4. Using site-appropriate prescriptions, carefully reintroduce natural fire regimes as part of an overall wildfire risk reduction and habitat restoration program in locations where conflicts, such as smoke and safety concerns, can be minimized.

Forested Landscapes

Because of high fuel loads in many areas, the most typical scenario will involve mechanical treatments followed by fire. Prescribed fire typically will involve intentional human ignitions, but strategic use of lightning-caused fires can also be beneficial under well-defined conditions. A program of active fire suppression will continue to be a necessary part of an overall fire-management strategy to protect local communities and private property.

Management actions, such as active thinning and prescribed burning, in at-risk green stands should eventually reduce the amount of effort and funding needed for fire suppression in those areas. As discussed previously, active maintenance may be needed in some areas. However, the overall goal should be the restoration of conditions where natural fire can perform its historical ecological role across more of the landscape and where compatible with existing land uses. Planning for wildfire risk reduction and habitat restoration should evaluate if it would be feasible, ecologically appropriate, and socially desirable to allow the historical fire regime to return once high fuel loads are addressed.

Unforested Landscapes

Prescribed fire can be a useful tool when tailored to local conditions. However, prescribed fire is not necessarily suitable for all situations. In the **Northern Basin and Range** and **Blue Mountains** ecoregions, low productivity communities are extremely slow to recover from prescribed fire and other disturbances. For example, low sagebrush communities have poor, shallow soils and are slow (150-300 years) to recover from significant soil disturbance or fire. Wildfires and prescribed fire can both increase dominance of invasive plants, dependent on the site conditions.

In the **Klamath Mountains** and **Willamette Valley** ecoregions, prescribed fire poses challenges, such as conflicts with surrounding land use, smoke management and air quality, and public safety. In the **Coast Range** ecoregion, prescribed fire is difficult due to high precipitation and wet conditions. When conditions are dry enough to use prescribed fire in coastal grasslands, there are usually concerns with risk to surrounding forests.

To address these issues, carefully evaluate individual sites to determine if prescribed fire is appropriate. Be particularly cautious in low productivity sites where recovery times are prolonged or in sites with invasive annual grasses. If determined to be ecologically beneficial, reintroduce natural fire regimes using site-appropriate prescriptions and considering conflicts, such as smoke and safety concerns. If prescribed fire is not appropriate or feasible, consider alternative methods that mimic the effects of fire (see Action 1.5 below).

Action 1.5. Use site-appropriate tools, such as mowing, brush removal, tree cutting, and controlled grazing to mimic effects of fire in fire-dependent habitats.

Use multiple site-appropriate tools to maintain open structure habitats. These may include mowing, controlled grazing, hand-removal of encroaching shrubs and trees, or thinning. For all tools, minimize ground disturbance and impacts to native species. Use mechanical treatment methods (e.g., chipping, cutting for firewood) to control encroaching conifers. In aspen habitats, reintroducing a disturbance regime may be necessary to reinvigorate aspen reproduction after mechanical removal of conifers. In areas where western junipers are expanding into sagebrush habitats, maintain older juniper trees, which are very important for wildlife.

Action 1.6. Develop tools that evaluate trade-offs between short-term loss of wildlife habitat values and long-term damage to habitat from wildfires *and*

Action 1.7. Evaluate effects of forest management practices that reduce wildfire risk to wildlife habitat values.

Efforts to reduce wildfire risk and restore habitats need to occur within an adaptive management framework in which actions are monitored and modified in response to results and changing conditions.

In some cases, wildlife habitat elements, such as hiding cover and snags, will be reduced by fuel reduction activities. However, not taking any action could result in complete habitat loss through severe wildfire. Thus, analytical tools are needed to evaluate and compare the short-term risk of fuel reduction treatments to species and habitats against the long-term risk to species and habitats posed by uncharacteristically severe wildfire. Such tools would assist landowners and land managers in determining appropriate actions for individual sites.

Fuel reduction techniques need to be monitored to determine the short-term impacts of fuel reduction techniques on species and habitat, and the long-term effectiveness of fuel reduction techniques in reducing the risk of uncharacteristic fire. Furthermore, research is needed to better understand the effects of historical fire regimes, severe wildfire, and fire suppression on wildlife. Also, historical disturbance regimes are not well-understood for all habitat types, so research is needed to determine the historical frequency and severity of disturbance that maintained **Strategy Habitats**. Formulate management approaches, including use of prescribed fire, accordingly.

Action 1.8. Use herbicides to minimize colonization of invasive winter annuals after wildfire in shrub-steppe communities.

After catastrophic wildfires in sagebrush-dominated communities in drier parts of the state, like the **Northern Basin and Range** ecoregion, herbicides can be used to kill invasive winter annuals, such as cheatgrass and medusahead, so they do not dominate the post-fire landscape. This can greatly improve the ability of native grasses and shrubs to re-colonize and establish.

ALTERED FLOODPLAIN FUNCTION

From time to time, Oregon's waterways, filled by rains and snowmelt, overflow their banks and spread across the landscape. Minor floods occur relatively frequently and on most Oregon streams at one time or another. Many streams flood once or more each season. Flooding occurs under different circumstances on the west side of the Cascades than on the east side. Floods on rivers in eastern Oregon are more often the result of spring snowmelt. The central and eastern areas of the state are also subject to summer thunderstorms that drop large amounts of rain in short periods, overwhelming the soil's capacity to absorb the moisture and river systems to transport it, resulting in flash floods. In western Oregon, winter storms and spring rain-on-snow events contribute to seasonal flooding.

The area of land adjacent to the river that absorbs overflow during floods is the river's floodplain. Rivers often carve new courses during floods. Over time, rivers gradually move across the landscape creating oxbows and excavating new channels and alcoves. This makes naturally flowing rivers good habitat for aquatic species and floodplains fertile habitat for terrestrial species.

History of Modification to Oregon's River Systems: Dams and Channelization

Oregon's first dams were built in the late 1800s to supply electricity to cities. Many "splash dams" were built to transport logs from forest to mill, but they did so much damage to streams they were outlawed in 1958. Significant dam building took place between the turn of the last century and the 1960s. Initially, the federal government built dams to provide irrigation water to farmers. The first of these projects in Oregon (under the 1902 Reclamation Act and managed by the Bureau of Reclamation) was the Klamath Project, a complex of dams and canals that drained extensive wetlands and diverted lake water to irrigate 225,000 acres of former rangeland. By 1940, over 70 percent of Oregon's current water storage capacity was in place behind eight Bureau of Reclamation dams. While many of these dams may provide a variety of services, flood prevention was not their primary purpose.

As human settlements grew along rivers, buildings, towns, and farms were subject to damage by floods as well as erosion from meandering river systems. Development of communities in floodplains increased the demand placed on these ecological systems. Dams increasingly became important for flood control. The Flood Control Act of 1936 declared that flood prevention was in the public interest and thus was a responsibility of the federal government. The U.S. Army Corps of Engineers currently operates 20 dams in Oregon, 11 of them west of the Cascades. Those constructed on the Columbia River (i.e., Bonneville, The Dalles, and McNary) were built to generate electricity, rather than provide storage. Today, the greater percentage of dams across the state are operated by cities, local districts, or individual landowners for a variety of purposes, including flood control. There are 1,100 dams in Oregon that are considered to be relatively large (at least 25 feet high).

In addition to dams, rivers have been modified in a number of other ways. Rivers have been dredged and deepened to improve their use for transportation, flood control, and irrigation needs, as well as to increase the area available for agriculture. Large stone riprap, levees, and deflectors harden and stabilize banks and redirect river flow to prevent erosion and channel movement. These structures constrain rivers to a single course, disconnecting them from their floodplains.

Effects on River Dynamics, Floodplain Function, and Fish and Wildlife Habitats

While dams and revetments provide valuable services to human communities, they alter river dynamics that affect aquatic and terrestrial communities in significant ways. Floods on wild rivers renew floodplain soils and aquatic habitat, and are part of the normal pattern of disturbances that shape Oregon ecosystems.

The loss of a river or a stream's connection to its floodplain reduces its ability to absorb floodwaters. When small streams and creeks reach flood stage and overflow onto adjacent lands, the pulse of floodwater slows before reaching larger rivers. The speed and severity of modern floods is increasing with the loss of this floodplain "sponge effect". In developed areas, modifications have been made throughout river and stream systems. Paved surfaces significantly limit infiltration into the ground and instead concentrate stormwater into pipes and directly into streams. In rural areas, agricultural ditches

move water off the land quickly. Across Oregon, many rivers have been channelized. As a result, floodwaters barrel downstream, overwhelming the larger rivers instead of spreading across the landscape and gradually infiltrating or evaporating.

One of the important functions of flooding is to move gravel from uplands to bottomlands. Clean gravel is an essential streambed surface for healthy salmon spawning beds. Side channels created by freshly-deposited gravel bars provide sheltered settings outside the main river current where young fish and other small aquatic creatures can rest or feed. When it flows through gravel, water gets cooler and changes chemistry, improving conditions for coldwater anadromous species. Dams trap gravel and silt, and constrain major floods that would normally move gravel downstream.

Channelization can contribute to greater streambank scouring and erosion as loss of stream complexity (e.g., bends, pools, eddies) destabilizes banks and interferes with gravel transport and deposition. Within a floodplain, modified flow limits channel migration, which in turn limits the creation of off-channel habitat, such as oxbow lakes, backwaters, and sloughs that provide important habitat for Strategy Species such as the **Oregon chub**. Since natural river channels are maintained by a dynamic equilibrium between erosion and deposition of gravel and silt, water moving without silt or through straightened channels can cause riverbed and riverbank erosion.

In natural systems, large floods send logs tumbling into mountain streams and topple trees along riverbanks. The force of floodwater moves submerged logs into new locations. These actions rearrange the river habitat, flushing out sediment and setting up new complex structures necessary for healthy aquatic habitat. Dams temper the force of floodwaters, diminishing the power of streams and rivers to move large wood, thus depriving streams of new structure that is important for fish habitat. Channelization removes the complexity of existing stream structure which straightens and speeds flows, thereby depriving streams of potential locations for large wood debris recruitment and retention.

Water temperature cycles are altered by impounding water behind dams, with resulting disruption of temperature-dependent life cycles of anadromous fish and their food sources. **Flowing water** in streams is full of nutrients and oxygen. **Riparian vegetation** provides important shade to keep water cool. Water held behind dams warms in the summer sun. The surface temperatures rise while cold water sinks and suspended material settles to the bottom. Phytoplankton, single-celled plants that make up the base of the food chain, proliferate at the top, releasing oxygen. When they die, they sink to the bottom where bacteria consume them and use oxygen. Over the course of the summer, the water at the top of a reservoir is warm and full of oxygen and food. The water at the bottom is cold and low in organic matter and oxygen. This is significant for fish because their life cycles, and those of their food sources, are triggered by temperature. Dam releases can be controlled to maintain appropriate temperatures for fish. Aquatic insects require a series of temperature cues to produce eggs, hatch, and develop into nymphs. Over time, dammed rivers behave more like lake ecosystems, losing their capacity to support riverine fish species.

The flood prevention modifications also have affected river floodplain habitats. Floods that used to occur every 10 years or so now occur every 100 years or more. Former floodplains no longer receive regular deposits of waterborne sediment. Disconnected from their rivers and drained, they no longer provide wetland and seasonally-flooded habitats. In addition, annual high-flow events have become "flashy" (e.g., shorter in duration and greater in intensity) in some areas where there has been extensive channelization and loss of floodplain function.

Development intensifies the loss of floodplain habitat or floodplain function. Rather than being absorbed by the ground, water drains off of impervious surfaces into waterways, which can increase stream and river water levels and cause downstream flooding.

ALTERED FLOODPLAIN FUNCTION: GOALS AND ACTIONS

Goal 2. Maintain and restore floodplain functions, such as aquifer recharge, water quality improvements, soil moistening, natural nutrient and sediment movements, animal and seed dispersal, and habitat variation.

Action 2.1. Restore floodplain function by: reconnecting rivers and streams to their floodplains, restoring stream channel location and complexity, removing dikes and revetments, allowing seasonal flooding, increasing infiltration or recharge, restoring and maintaining wetland and riparian habitats, and removing priority high-risk structures within floodplains.

Maintain functional floodplains and **riparian systems**. Work with local communities, watershed councils, landowners, and other partners to restore and reconnect natural stream channels and floodplains in rural areas. Explore opportunities for broad-scale floodplain restoration on main rivers and their tributaries. While restoration of entire rivers may not be feasible, seek opportunities to restore critical mainstem or tributary habitats, floodplain function, and critical off-channel habitats adjacent to the main channels. Use sub-basin plans and similar efforts for key information on floodplain issues and opportunities.

Reduce head-cutting of streams resulting from stormwater discharges by replacing culverts that are not at stream grade, reducing run-off to streams, and maintaining or replanting stream banks and riverbanks with native vegetation. When re-development is planned, explore opportunities to remove structures or pavement from floodplains and restore native vegetation.

Action 2.2. Provide outreach about the ecological benefits of allowing rivers to meander back and forth across the floodplain.

Facilitate discussions within urban and residential communities regarding building or development within the floodplain and riparian areas. Provide outreach about the dynamic, meandering nature of rivers and streams. Allowing rivers to meander back and forth across the floodplain reduces bank erosion and offers ecological benefits for local species. As the **Federal Emergency Management**

Agency (FEMA) continues to work with local governments to address floodplain issues, needs for floodplain management and restoration may become more recognized over the coming decade.

Action 2.3. Work with power companies, agencies, irrigation districts, and municipalities to time water releases to replicate natural flood cycles.

Restore or replicate natural timing where feasible. Work with power companies and municipalities to develop a schedule of releases timed to replicate natural flood cycles, while continuing to provide essential hydroelectric power and water storage services. Work with the FEMA and other floodplain managers to minimize potential for impacts from future new development and redevelopment in the channel migration zone, and to consider ways to maintain or incentivize floodplain protection.

Action 2.4. Identify and restore important off-channel habitats and oxbows cut off by previous channel modification.

While revetments protect riverside property, they simplify or eliminate the side channels, alcoves, seasonal wetlands, and islands that provide essential complex habitat structure for aquatic species. These are critical areas for juvenile salmonids, Oregon chub, amphibians, birds, and reptiles. Reconnect these habitats to rivers where feasible. Use bio-engineering instead of rip-rap on bank-stabilization projects. Update floodplain and channel migration maps, including projected floodways associated with climate change, and integrate them into the land use planning process.

Action 2.5. Support the use of green infrastructure in place of hard barriers to respond to flooding.

Green or **natural infrastructure** is a water management strategy that maintains or mimics the natural water cycle. Examples include increasing vegetation cover on roofs, use of permeable surfaces to allow flow from water runoff, or planting trees to increase the urban tree canopy. Green infrastructure can help maintain floodplain function and help mediate some of the impacts from climate change. Communities may also benefit from cost-savings, improvements in public safety, and increased opportunity for recreation. Successful examples include the **CleanWater Services Stormwater Program** and the **City of Portland Watershed Management Plan**.

Action 2.6. Support and encourage beaver dam-building activity.

Beaver dams can help restore floodplain function, reduce sedimentation, improve water quality and fish habitat, restore wetlands, and improve habitat for many other species of birds, amphibians, and other wildlife. Beaver dams can prolong the benefits of off-channel habitats, especially during summer months. Where beavers and beaver dams are present, work with cities, municipalities, and landowners to manage their properties to benefit beaver, and reduce conflicts with people to prevent the loss of dams. Limiting development adjacent to streams and sloughs, and planting with early floodplain successional plants such as willow, can allow beavers to maintain dams and limit flooding to private property or damage to streamside agriculture. Further outreach and informational materials about the role for beaver in restoration projects may be useful for landowners, land managers, and conservation

organizations. For example, see the **Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains**, a guidance document produced in collaboration by several federal agencies, including the USFWS, NOAA, USFS, and Portland State University. The ODFW also provides guidance on **living with beaver**.

Photo Credit: ODOT

BARRIERS TO ANIMAL MOVEMENT

BACKGROUND

Land use changes and energy development, including transmission lines, power lines and pipelines, water diversions and damming, and transportation development, can all impede fish and wildlife movement. The direct result can be mortality or injury to individuals. The indirect result can be fragmentation of fish and wildlife habitat, putting populations at risk and increasing stress on ecosystem services.

Recognizing the movement needs for species, fish and wildlife managers are working with land managers and the public to provide connectivity for fish and wildlife habitat across the landscape, often on working lands or even roadways to provide passage for animals. Providing habitat connectivity is a primary management strategy to maintain species and ecosystem services under a **changing climate**.

AQUATIC PASSAGE

Habitat connectivity is a key component to many facets of terrestrial and aquatic resource management. For Oregon's native migratory fish, connectivity between aquatic habitats is an important part of garnering successful and healthy populations. Without habitat connectivity, resident or river-dwelling fish species, such as native trout, suckers, and whitefish, become isolated, leading to reduced levels of genetic diversity and fitness. For anadromous (sea-going) populations, fish passage can restore access to habitats that are fertile spawning grounds and pivotal for re-building declining populations. In addition, fish passage also provides access to essential rearing habitats for juvenile species. Obstructions to fish passage can cause migratory fish populations to become genetically isolated and therefore more vulnerable to disturbances that cause mortality to populations or individuals. Currently, many miles of stream habitat in Oregon are not producing fish because of passage barriers.

Oregon's fish passage laws were in place even prior to statehood, but despite these laws, fish passage barriers are prevalent throughout the Oregon landscape. Over time, access to native fish habitats has

been blocked or impaired by the construction of impassable culverts, dams, tide gates, dikes, bridges, and other man-made infrastructure. Many of these barriers alter natural flow regimes, create drastic changes in water surface elevations, and interrupt the natural transport of sediment and wood, further contributing to downstream habitat loss. Similarly, improperly-sized culverts can impair passage of amphibians, small and large mammals, and other terrestrial species, forcing wildlife to cross roads where they are vulnerable to vehicles and predators. Providing passage at these artificial obstructions is vital to recovering Oregon's native migratory fish populations.

Currently, fish passage is required at all artificial obstructions where native migratory fish are or were historically present when a "trigger" event (e.g., abandonment, major replacement, construction, or fundamental change in permit status) occurs. As the state agency responsible for sustaining healthy fish populations, the **ODFW** works with owners and operators of artificial obstructions in several ways to ensure adequate passage of native migratory fish. Recognizing the unique nature of migratory fish in the Pacific Northwest, many other agencies and groups are also interested in assisting with construction of fish passage.

Fish screens and bypass systems are placed at water diversions (e.g., irrigation systems, hydropower systems) to prevent fish from entering irrigation ditches, turbines, and other habitats detrimental to their survival. Fish screening is an important part of the **Oregon Plan for Salmon and Watersheds**, a voluntary plan aimed at the protection, restoration, and recovery of native migratory fish, such as salmon and steelhead. Screens and bypass systems must meet the most recent regulatory criteria. Bypasses then move fish back into the stream. This aspect of downstream passage assures that fish stay within natural waterways and are not harmed by these structures. Many unscreened diversions currently result in fish being lost in irrigation systems.

Fish passage restoration is a key to helping native fish adapt to more extreme weather. Habitat connectivity for aquatic species means removing artificial barriers to migration, such as dams and poorly-placed culverts. Restoring fish passage ensures that all life stages of native migratory fish species, as well as aquatic wildlife, are able to move to habitat that meets their needs within a watershed.

Weather extremes may add to the challenges that dams and reservoirs pose to native fish and wildlife. Reservoirs can exacerbate turbidity following big storms by collecting large volumes of muddy water and slowly passing this runoff downstream, long after undammed portions of the watershed have cleared. Muddy water in winter and spring may be much more prevalent in dammed reaches compared to other portions of the individual watersheds.

AQUATIC PASSAGE: GOALS AND ACTIONS

Goal 1: Provide conditions suitable for natural movement of fish and aquatic animals throughout their native range.

Action 1.1. Continue work with the OWEB, ODOT, ODF, USFS, BLM, counties, local municipalities, irrigation districts, and other partners to inventory, prioritize, and provide fish passage at artificial obstructions, enhancing current work done by the ODFW Fish Passage Task Force to expand implementation of fish passage priorities.

Recently developed methods for prioritization of fish passage, incorporating considerations about transportation infrastructure and climate, may help agencies working on these issues in the coming decade. Gathering comprehensive information is an important and ongoing task. Beginning in 2007, the ODFW Natural Resource Information Management Program (NRIMP) began the inventory data management process by creating the **Oregon Fish Passage Barrier Data Standard** (OFPBDS). This data standard established the type of information (data content), and the format of those data (data structure), needed at every artificial obstruction site to accurately inventory and prioritize fish passage obstructions.

After the creation of the OFPBDS, NRIMP began compiling barrier inventory data from multiple sources throughout the state. Data were obtained from local, state, and federal agencies, watershed councils, tribes, counties, and other entities that possessed fish passage barrier data. These data were compiled, standardized to match the requirements of the OFPBDS, and were loaded into a GIS database. **This database** represents the most thorough statewide inventory of artificial obstructions to date, and includes information on the number and type of artificial obstructions in the state, as well as the level of fish passage at each barrier, and the physical characteristics of each obstruction. The spatial results of the OFPBDS can be viewed within the **ODFW Compass mapping tool**.

Ground-truthing is still important to verify the current conditions and severity of individual barriers. Fish passage artificial obstructions are structures, such as culverts, dams, tide gates, and levees, that are placed in fish-bearing streams that hinder, or have the potential to hinder, fish passage. The most current information shows that approximately 27,800 fish passage artificial obstructions exist in Oregon. This number continues to grow as our ability to detect structures across the state increases. About 17 percent of these barriers are documented as providing adequate fish passage, 21 percent are complete barriers to fish passage (i.e., block all species), 19 percent are partial barriers, and 43 percent have a "status unknown passage condition". Of the 27,800 artificial obstructions, culverts make up the vast majority with over 23,000 (83 percent) inventoried, while dams are the next most common barrier type with over 2,500 inventoried (9 percent).

In 2013, ODFW developed a systematic method to prioritize artificial obstructions based on their value to native migratory fish. **The list** contains 534 high priority fish passage barriers, with an additional 55 barriers characterized as "other significant barriers in need of more data". Of the 27,800 artificial

obstructions documented in Oregon, the 534 priority obstructions comprise less than 2 percent of the total. Among the priority obstructions, 289 (59 percent) are dams, 207 (39 percent) are culverts, and 38 (7 percent) include tide gates, fords, bridges, and other artificial obstructions. Dams make up the majority of the "top" priorities. This is due to the fact that dams generally block large segments of habitat on larger river systems. The priorities have been organized into classes, with each class representing barriers of similar priority ranking.

All barriers on the list are high priorities for the ODFW. The ODFW will continue to work with local, state, and federal partners to remove or provide fish passage at high priority barriers. Per **state fish passage law**, no new artificial obstructions can be constructed without fish passage, including artificial obstructions used for restoration. ODFW Fish Passage will continue to implement fish passage laws when trigger actions (e.g., new construction, major replacement, abandonment, fundamental change in permit status) occur at artificial obstructions, and will continue to encourage other voluntary actions that provide fish passage.

Action 1.2. Maintain and restore habitat to ensure aquatic connectivity in priority areas such as Conservation Opportunity Areas and areas with high road density such as urban centers.

Road-stream crossing structures include culverts and bridges. These structures have the potential to impact fish passage and aquatic ecosystems. Many culverts have been placed with the primary goal of moving water past the structure efficiently (rather than impounding it, such as occurs with a dam), without consideration of providing fish and wildlife access through the culvert.

Road-stream crossing structures, including habitat improvement projects or mitigation, should be designed and built with the goal of maintaining natural flow and hydrological regimes as well as providing a surface or substrate similar to natural conditions. This goal will ensure the best conditions for both fish and wildlife (including amphibians and aquatic insects) passage. Flow and passage should be maintained through restoration of aquatic habitat connectivity. These efforts should be prioritized based on benefits to aquatic species and location within priority areas, including **Conservation Opportunity Areas** and densely-populated urban centers. Efforts should also consult ODFW District Fish Biologists and the **aquatic barriers database** to identify high priority habitat for restoration.

In some situations, coordination among responsible parties and interested partners is required to address the effects of obstructions on the hydrological regime. Coordinating with multiple owners, multiple regulatory levels, and across jurisdictional boundaries, such as with railroads and some hydroelectric projects, can take much more time and negotiation to reach an acceptable outcome, but is critical to long-term success.

Fish passage structures, such as fishways and culverts, must be properly designed or they will be an expensive failure. The ODFW and the National Marine Fisheries Service have **existing criteria for fish passage**. Agency biologists, consultants, owners and operators of artificial obstructions, and other

regulatory entities must be aware of and understand the procedures, criteria, and guidelines in order to assure that the best possible fish passage and stream function are being provided.

Providing fish passage with a fish ladder or properly-sized culvert or bridge is an added expense to the owner or operator of an artificial obstruction. However, there are several financial incentive programs that can be of assistance. The ODFW has a **cost share grant program** to help with these costs. There also is a small tax credit available for landowners who install qualifying fish screening. Other entities, such as the **Oregon Watershed Enhancement Board**, also have funds available for high quality fish passage projects. Identifying additional funding sources and incentivizing voluntary landowner passage and screening would be greatly beneficial.

Action 1.3. When planning aquatic passage projects, consider the needs of other aquatic species and terrestrial wildlife in addition to fish.

Most efforts to address aquatic passage have emphasized fish, particularly salmonids, but do not provide adequate passage for all species of fish and wildlife. **Pacific lamprey**, for example, have a distinct set of passage needs that are not often met with common fish passage facilities. Specialized "lamprey ramps" have been used recently with success to provide adequate passage for lamprey, and these ramps are often needed in addition to salmonid fishways. Similarly, small details within a fishway, such as rounded corners, smooth transitions, and multiple flow paths, can often ensure that fish passage provides benefits to a broad array of species. Although there are currently no requirements to ensure passage for wildlife, ongoing efforts to replace culverts present opportunities for developing, testing, and implementing methods to maximize benefit for a variety of species. Aquatic invertebrates would benefit from making culverts as wide as possible to allow lateral movement of the stream. The embedment of culverts with natural streambed materials provides natural stream-like conditions for both aquatic and terrestrial species passage, including amphibians. In addition, maintenance and restoration of **riparian habitat** is important to provide wildlife passage adjacent to in-water habitats.

Action 1.4. Continue to screen ditch and pump water diversions to protect fish using funds from Oregon's Fish Screening and Passage Cost Sharing Program and working with state and federal funding partners. Implement outreach programs to encourage irrigators to screen intakes, and for construction crews and municipalities to learn best practices for culvert installation.

Barriers are frequently associated with irrigation, municipal, industrial, and hydroelectric water diversions that can cause fish loss in the millions. Continue to provide **fish screens** at water diversions to keep fish in their natural streams and lakes. Adequately designed screens can keep huge numbers of emigrating salmon and steelhead juveniles, as well as other resident species, from becoming entrained and eventually killed in irrigation diversions or hydroelectric projects. Continued funding, implementation, coordination, and collaboration with multiple stakeholder groups is important for native fish restoration. Provide outreach and technical assistance for irrigators, construction crews, and municipalities.

TERRESTRIAL ANIMAL MOVEMENT

Many species rely on the ability to move throughout the landscape to fulfill their needs for survival or complete their life cycles. Some species move seasonally, following food resources, moving to areas more suitable for raising young, or surviving the winter. This may mean moving north and south across thousands of miles, or higher and lower in elevation. Human-caused changes to the landscape can affect the ability of wildlife to move across terrestrial landscapes by adding obstacles, impacting critical stopover sites, and increasing habitat fragmentation. This can have a detrimental impact to many wildlife species.

Buildings, landscape development, roads, fences, power line corridors, and other structures can serve as obstacles. Migration is a strong urge in species, and migration routes are often used over decades or centuries by generations of wildlife. So, when a new obstacle pops up in the route, like a roadway or a housing development, wildlife may try to find a way through the area, rather than avoid it. This can lead to increased mortality to wildlife and can endanger human safety. In residential and urban areas, wildlife will move through an open landscape of lawns and backyards. Barking dogs and free-roaming cats, lights from houses, security lighting and street lights, vehicle traffic, and other features people take for granted can be frightening or even lethal to wildlife. Some wildlife species are not welcome in developed areas, and human-wildlife conflicts result. In rural areas, the impacts of roads on wildlife movement will depend on the type of road and the level of use, with impacts increasing with the amount of traffic.

Some wildlife, especially birds, need staging or stopover areas to rest and refuel during migrations. Habitat conversion or degradation can impact important staging or stopover sites, thus impacting the animals that depend on them. Power lines, tower guy wires, and wind turbine blades introduced into migratory flyways of birds and bats impose aerial barriers to flight. Habitat fragmentation can be a barrier to animal movement for vulnerable species. For species that require large continuous habitat, fragmentation reduces the success of the species.

How barriers and habitat fragmentation affect wildlife depends greatly on the species, habitat type, and type of barrier. For example, a two-lane highway may pose a relatively minor barrier to elk, but may be impossible for a turtle to cross. A wind energy facility may not impede deer or pronghorn on the ground, but the spinning turbine blades may pose substantial risk to migrating bats.

These issues can be addressed through careful planning. Human developments and infrastructure can be designed in ways that avoid crucial movement areas for wildlife. Habitat connectivity can be maintained for wildlife through conservation-based design of residential and industrial developments, provision of wildlife crossings along highways, careful siting of renewable energy development, open space conservation, and maintenance or restoration of important migratory stopover sites.

TERRESTRIAL ANIMAL MOVEMENT: GOALS AND ACTIONS

Goal 2: Provide connectivity of habitat for the broad array of wildlife species throughout Oregon.

When new development is proposed, consider its context within the surrounding landscape. Will it obstruct an important movement corridor for wildlife? How close is it to other developed areas, and what are the cumulative impacts at the landscape scale? Would a higher-density, clustered development leave more open space available for wildlife movement, or would a lower-density development provide greater permeability for wildlife? Leave habitat corridors intact where possible, or provide alternative connecting habitat nearby. Work with community leaders, planners, and agency partners to identify and conserve wildlife movement corridors and to fund and implement site-appropriate mitigation measures.

When evaluating animal movements, consider aerial, underground, seasonal, and nocturnal movement needs. Bat migration patterns are not well understood. Bats may be vulnerable to changing land use patterns, habitat management, and to direct mortality from wind turbines. More information about bat migratory patterns and corridors will help managers respond to growing communities, energy development, forest practices, and other landscape impacts.

Consider the species-specific responses of different types of animals to different types of barriers. For example, the number of lanes and daily traffic volume will have different impacts on animals with different life history traits. Riparian areas are important corridors with many species of wildlife using them to move through the landscape. Other less obvious corridors, such as power line right-of-ways, can play a role, especially in densely-populated urban areas. Corridors may not be appropriate in all cases, so explore other options for providing connectivity. For example, improve connectivity through habitat restoration by enlarging habitat patches and creating links between isolated habitat patches.

Action 2.1. Promote conditions suitable for habitat connectivity throughout Oregon.

Maintain and restore habitat connectivity for wildlife throughout the state by working with conservation lands as well as lands that may be managed primarily for other values, such as forestry, agriculture, residential development, and roadways. Incorporate wildlife information and key life history needs early in land use, energy, and transportation planning processes, and recognize the potential impacts of habitat fragmentation on reducing habitat quality and increasing stress on populations.

Consider distribution of at-risk **Strategy Habitats** and work to maintain or restore large blocks of native habitat types. Maintain **riparian** areas whenever possible, and plant them with native plants to provide food and cover. Remove or discourage **invasive species** to the extent possible.

Consider ways to provide for connections and migratory pathways among **Conservation Opportunity Areas** and other priority areas for conservation. Incorporate new information about the impacts of climate change.

Action 2.2. Continue to collect terrestrial wildlife movement data, and refine maps and models to better identify and prioritize wildlife movement corridors.

Two types of information are crucial to understand wildlife habitat connectivity: (1) documented wildlife observations, and (2) modeled information about vegetation, topography, and other aspects of the landscape. It is important to continue to collect and improve both types of information, using actual observations of fish, wildlife, and habitats to inform the models. The information should be made available to planning organizations and the public to facilitate conservation of habitat connectivity.

While some broad-scale, west-wide wildlife habitat maps are available from the Western Association of Fish and Wildlife Agencies **Crucial Habitat Assessment Tool**, there is a need to develop finer-scaled maps and more specific tools and interpretation guidelines. Finer-scaled maps could be used in the natural resource inventories of land use plans, to inform siting and design of renewable energy development, and to help refine connectivity among and within **Conservation Opportunity Areas**.

> Throughout the U.S., wildlife managers are finding value in partnering with transportation planners, land use planners, design experts, and others in innovative ways to address wildlife habitat connectivity. For example:
>
> - **Washington Wildlife Habitat Connectivity Workgroup** (WHCWG): This partnership is co-led by the Washington Department of Fish and Wildlife and Washington Department of Transportation, with close participation from other agencies, conservation organizations, and universities. The WHCWG uses wildlife science to produce tools and analyses that identify opportunities and priorities to provide habitat connectivity in Washington and surrounding habitats. The WHCWG has taken into consideration anticipated impacts from climate change. Efforts to validate models and interpret results are part of the workgroup's ongoing scope.
>
> - Oregon Wildlife Movement Strategy Working Group: From 2009-2012, an interagency working group made up of many partners, including the ODFW, ODOT, USFS, Federal Highways, USFWS, and BLM, created the Oregon Wildlife Movement Strategy (OWMS). The OWMS identified important **wildlife linkage areas** through collaborative, science-based workshops. The workshop participants mapped information about the wildlife linkages areas with an emphasis on areas near roads in Oregon. Focal species were selected to encompass an array of wildlife movement needs, and included game species (e.g., deer, elk, bear, pronghorn), small mammal Strategy Species (e.g., American marten, fisher, western gray squirrel, white-tailed jackrabbit), and amphibians and reptiles (e.g., turtles, frogs, toads). The working group integrated the datasets on wildlife movement, roadkill, and collision hotspots, and identified needs for design guidance, monitoring, and maintenance going forward.

Action 2.3. Enhance wildlife habitat and connectivity with consideration of climate change impacts.

Fluctuations in climate can impact the quality and quantity of wildlife habitat for some species, resulting in potential shifts in species ranges. The range for one species may decline or become fragmented, while expanding for another. Many species are not able to adapt quickly enough to shift their range as the **climate changes**.

Monitoring wildlife habitats and seeking opportunities to maintain or enhance natural landscapes, habitat connectivity, and providing refugia are primary management strategies to help balance species viability and distribution in response to a fluctuating climate. However, management actions intended to account for climate change will need to be continuously evaluated as new information becomes available so that we are developing refugia for future populations and species as the climate changes the environment. Provide species a range of options to adapt to climate change by restoring and expanding areas along a gradient of climates. As part of a region-wide effort, The Nature Conservancy produced a **map of landscape resiliency in Oregon**, available for consultation and inclusion with project and planning efforts.

Action 2.4. Identify, maintain, and restore important stopover sites for migratory birds and bats.

To fully address wildlife habitat connectivity needs in Oregon, connectivity planning efforts within the state should address the connectivity needs of aerial species, such as birds and bats.

Migrating birds may use stopover sites only briefly during a given year, but these stopover sites are as essential to wildlife survival as the territories they occupy for longer periods. When birds migrate, they expend a great deal of energy each day. They must stop to rest and feed one or more times each day and at night to refuel for the journey. Many sites, such as wetlands and mudflats, are in lowland areas which are important areas for development. Some areas, such as agricultural fields, can be important for migrating birds, especially shorebirds.

Use existing information on the location and value of known stopover sites when planning for new development. Work with partners to maintain and restore priority sites, such as **Audubon's Important Bird Areas** or **important shorebird areas**. In particular, look for ways to avoid or minimize impacts to important sites. If impacts are unavoidable, mitigate for any impacts by providing alternative sites nearby and minimize disturbance during critical migration periods, such as the spring and fall. Look for opportunities to work with landowners to provide and enhance bird habitat.

Action 2.5. Work with ODOT, county transportation departments, and other partners to identify and address key areas of wildlife mortality on highways and consider animal movements when planning new roads.

Wildlife cannot avoid roads, railroads, and other linear obstructions. The result is sometimes injury or death for wildlife. In the case of vehicle-wildlife collisions, people are at risk as well. Ideally, wildlife

movement should be considered during the planning phase of new roads to avoid known migratory routes and to design wildlife passage into the project.

Existing roads affect both waterways and wildlife. Some established wildlife migratory routes that intersect roads can be identified by local or state road crews who repeatedly remove road-kill carcasses at these spots. In these cases, bridge replacement and routine highway maintenance provide opportunities to address areas where highway mortality is high. For smaller wildlife species, a culvert under the road may help small mammals, reptiles, and amphibians cross safely. Install warning signs for drivers about wildlife crossings. Funnel larger species to larger culverts or underpasses. Additional studies may be needed to advance understanding of wildlife-transportation corridor conflicts, as well as design approaches, so that preventative, cost-effective solutions can be incorporated into project designs.

> Some efforts are already underway to incorporate wildlife habitat connectivity into transportation planning throughout Oregon. For example, the ODOT is exploring ways to reduce wildlife-vehicle collisions on state highways. The ODOT collaborated with the ODFW to develop passage designs that are economical as well as practical for wildlife. Passage across Highway 97 has been developed for a crucial migratory route for mule deer in south-central Oregon. In northwest Oregon, Metro has worked with road departments in its three-county area to develop a manual for dealing with wildlife crossings on roadways. The Port of Portland designed and installed culverts for turtles to cross beneath a busy transportation corridor.

Action 2.6. Promote strategies to increase permeability of urban landscapes for wildlife.

Examples include connecting urban natural areas and riparian corridors, supporting and promoting the use of green infrastructure in urban planning, and reducing direct hazards to wildlife. For more information, see the section on **Conservation in Urban Areas**.

STRATEGY SPOTLIGHT: U.S. 97 WILDLIFE CROSSING

In June 2012, the Oregon Department of Transportation (ODOT) completed an $18.9 million project on 3.7 miles of U.S. Route 97 between Lava Butte and South Century Drive, a few miles south of Bend in Central Oregon. The project's primary purpose was to increase highway capacity for growing traffic volume between Sunriver and Bend by expanding the single north/south travel lanes to two lanes in each direction.

When plans for the highway upgrade began to take shape in 2005, it was soon recognized that widening the highway would significantly impact wildlife movement. This included thousands of mule deer that move seasonally from the Cascade Mountains west of U.S. 97 to sagebrush flats and pine/juniper forests

east of U.S. 97 and back again. There is insufficient forage to support the mule deer herd year-round on either side of the highway, so the bi-annual migration across U.S. 97 is biologically necessary.

ODFW, the United States Forest Service (USFS), and ODOT worked together to tackle this problem. The group designed a suite of wildlife passage structures to provide safe highway crossings for mule deer and other wildlife. See a video on the wildlife undercrossing in central Oregon: **https://youtu.be/mSJGRs5KRP8**.

These structures include one underpass designed for wildlife use only, and one underpass for both wildlife use and for vehicles driving between the USFS Lava Lands Visitors Center west of the highway to the Lava River Cave on the east side.

Fences were built paralleling the highway that funnel animals to the underpasses. For those animals finding themselves on the wrong (highway) side of the fence, structures called "jumpouts" enable them to get back behind the right (safe) side of the fence. Electric solar-powered mats were installed across all roads that access U.S. 97 within the project area. These access points are essentially holes in the fence, but the low voltage mats quite effectively keep deer and other wildlife away from the U.S. 97 and on the safe side of the fence.

Monitoring of the completed structures began in 2013. Within the first year, 29 species ranging from deer and elk to bobcat, badger, and squirrels were documented using the underpasses, and deer/vehicle collisions were reduced by more than 90 percent. This is an obvious win for both wildlife and the traveling public.

Addressing the wildlife passage problem within the highway expansion area involved a substantial upfront investment of tax dollars. However, considering the project's success in reducing deer/vehicle collisions, the average cost of a single deer/vehicle collision in the U.S. ($6,633 in 2012), and that the structures will provide benefits for 50 to 75 years, it made good economic sense to address wildlife. The upfront costs are expected to be recouped in 10 to 12 years, and from that point on, the project will continue in the green for decades to come.

The enhanced ability of wildlife to move across the highway barrier is a great biological return on investment. Protecting and/or enhancing the ability of wildlife to move across the landscape is critical for healthy and vibrant ecosystems.

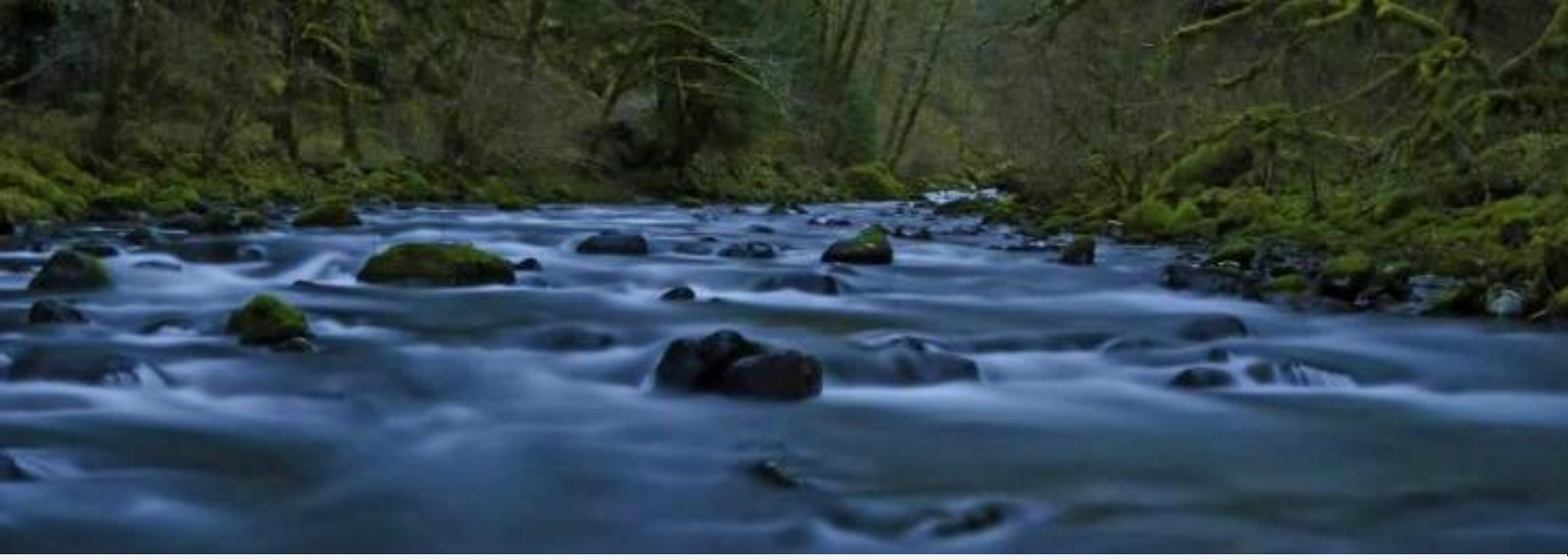

Photo Credit: Keith Kohl, ODFW

WATER QUALITY AND QUANTITY

BACKGROUND

The droughts of the early 21st Century have heightened awareness of the issues related to water quality and quantity. Ensuring high quality water supplies is a top environmental goal for western states in the coming decades as natural resources managers grapple with the impacts of **climate change**.

Limited water supply intensifies concerns about water quality. Low water levels could lead to warmer stream temperatures as well as increased algal growth and more frequent toxin-producing algae blooms. Variability in climate influences water quantity, and may influence water quality through increased intensity of precipitation events (**National Climate Assessment Report for the Pacific Northwest**, the **Oregon Climate Assessment Report**). Water quality is also influenced by measures taken to prevent, control, and treat pollution.

Water quality is an important issue for all **Strategy Species**. For example, conservation issues in the Klamath Basin Wetlands, Lake Abert, Malheur Lake, and Summer Lake place an entire network of migratory bird habitat at risk. Throughout the Pacific Northwest, watershed health is directly related to healthy populations of migratory salmon and other native fishes. In Oregon, many measures of ecosystem performance, water quality, and watershed health have been linked to native salmonid populations.

Oregon's Integrated Water Resources Strategy

During 2009, the 75th Legislative Assembly passed House Bill 3369, directing the Oregon Water Resources Department to develop a statewide **Integrated Water Resources Strategy** (IWRS) to help Oregon meet its water quantity, water quality, and ecosystem needs. The strategy was to take into account upcoming pressures, such as population growth, changes in land use, and future climate conditions.

Oregon's IWRS provides a blueprint to help the state better understand and meet its water needs, instream and out-of-stream, above ground and below ground, now and into the future. The state's first IWRS outlines a vision, goals, objectives, and guiding principles. It identifies a number of critical issues that need to be addressed, and offers recommended actions.

The **Oregon Water Resources Department** (OWRD) and the ODFW work closely together to meet the goals of the IWRS. Many of the actions identified in the Conservation Strategy relate directly to actions identified in the IWRS, which are highlighted in this section. Both efforts call for actions to:

- prevent and eradicate **invasive species**
- protect and restore instream flows, habitat, and **access for fish and wildlife**
- take into account changes in **land use** and population growth
- address future **climate conditions**

Overall Goal for Water Quality and Quantity: Maintain and restore water quality and quantity to support native fish and wildlife and habitats in balance with the economic and social needs of rural and urban communities.

WATER QUALITY

Water quality can be measured by temperature, dissolved oxygen, and turbidity (levels of fine suspended sediments and other variables). Water quality standards are set with consideration of daily cycles and seasonal precipitation events. In general, increased temperature, low dissolved oxygen, or high turbidity can indicate that water quality may be degraded. Both point and nonpoint source pollution, including toxic contaminants, bacteria, and nutrients, can degrade water quality. A major tool in identifying and prioritizing water quality problems in Oregon is the **Integrated Report** and list of impaired waters required under the federal Clean Water Act. This list of water bodies and stream reaches that do not meet water quality standards is updated approximately every two years. For the Conservation Strategy, the impaired waters list is used in development of **Conservation Opportunity Areas** to prioritize site selection and guide conservation actions.

The **Oregon Water Quality Index** is a method for quantifying water quality conditions throughout the state. The index considers dissolved oxygen, biological oxygen demand, pH, ammonia and nitrate nitrogen, phosphorous, total solids, and bacteria levels. A particularly useful comparative tool, the index describes water quality for various regions or reaches, and tracks trends over time. However, more information may be required to assess human health, ecological health of aquatic ecosystems, and the potential impacts of degraded water quality on fish and wildlife. Stream reach monitoring is needed to measure the current conditions for specific stream reaches. Moreover, there is a need for enhanced functional criteria to assess the success of aquatic restoration projects.

Oregon's Existing Framework for Water Quality

State agencies that manage major water quality programs include the ODFW, DEQ, ODA, and ODF.

Oregon Department of Fish and Wildlife Programs

The ODFW's role in vector control is to review and approve pesticides used by vector control districts or counties to protect fish, wildlife, and their habitats. State statutes ORS 452.140 and ORS 452.245 direct vector control districts and counties to obtain ODFW approval before applying pesticides to control vectors. The ODFW implements the statutes by reviewing and approving vector control plans annually, with the goal of minimizing effects on fish, wildlife, and their habitats while not significantly interfering with disease prevention and containment. The approval process is described in **ODFW's Vector Control Guidance for Sensitive Areas**.

The ODFW guidance contains recommendations to avoid direct impacts of pesticide applications on fish, wildlife, or their habitats, as well as attempting to minimize indirect, chronic, and long-term impacts. The guidance focuses on:

- Promoting natural mosquito predator diversity and healthy wetlands as an important part of an Integrated Pest Management plan
- Minimizing pesticide use when there is not a current health threat
- Using larval treatments that are more mosquito-specific before applying insecticides that may impact non-target species
- Minimizing use of pesticides targeting adult insects

The ODFW's approval only applies to defined and identified sensitive areas and species. The ODFW has identified three categories of sensitive areas for the purposes of the guidance: 1) Wildlife Areas and Refuges, 2) Wetlands of Concern, and 3) Unique, Rare, or Vulnerable Habitats. Maps of these sensitive areas are available on the **ODFW website**.

Oregon Department of Agriculture – Water Quality Plans and Rules

The Agricultural Water Quality Management Act was passed in 1993 and is the foundation of the **ODA Agricultural Water Quality Management Program**. Working with local stakeholders, the ODA completed 38 basin-specific agricultural water quality plans throughout the state to identify goals, objectives, and recommended management practices for agricultural landowners to improve water quality. The plans are updated every two years and include area-specific rules that require certain conditions to be met by law on all agricultural lands. Basin-specific plans and rules provide for tailoring to local conditions and needs. Plans and rules address controlling sources of pollution from agricultural lands, including erosion and sediment transport control, animal waste management, nutrient management, irrigation water management, and riparian area management. Plans and rules focus on outcomes, allowing landowners to choose the best practices for their operation to comply with the

rules. Although compliance with the rules is required, the focus is on voluntary solutions rather than enforcement. To meet the goals of the plans, landowners typically work with local SWCDs, the Natural Resources Conservation Service (NRCS) and Farm Service Agency, and the ODA to implement a variety of conservation practices.

> In 2014, the ODA began developing and testing a Strategic Implementation approach in which select areas around the state receive outreach and education to address priority water quality concerns. Two pilot locations (**Strategic Implementation Areas**) were tested, beginning with a Compliance Evaluation. The ODA and its partners worked with agricultural landowners to concentrate technical and financial help to change agricultural activities that were identified as potentially reducing water quality. The program is compliance-driven. Following outreach and opportunities to correct problems, properties that do not meet the requirements established in the local Area Rules (regulations) are then subject to a compliance investigation and further enforcement action.

Oregon Department of Environmental Quality – Water Quality Programs

The Oregon DEQ is responsible for protecting the state's surface waters and groundwater to keep them safe for a wide range of uses, such as drinking water, recreation, fish habitat, aquatic life, and irrigation. The DEQ:

- develops water quality standards
- monitors water quality
- regulates sewage, industrial discharge, and injection systems
- permits septic systems
- works with public drinking water systems
- works to control nonpoint source pollution

The DEQ develops **Total Maximum Daily Loads** (TMDLs) as a primary approach to address water quality impairments. A TMDL is the calculated pollutant amount that a waterbody can receive and still meet water quality standards. Per an agreement with the EPA, TMDLs are prepared by the DEQ and approved by the EPA for waterbodies in Oregon identified as water quality-limited and needing TMDLs (the 303(d) list). TMDLs are waterbody-specific and consider seasonal variation. They identify significant sources of pollution and then establish load allocations (portions of loading capacity to be allocated to existing nonpoint sources or background sources), wasteload allocations for point sources, and reserve capacity for the waterbody. Because they are waterbody-specific, TMDLs consider individual basin hydrography, climate, streamflow, dam and reservoir operations, land use and ownership, and local fish and wildlife. Successful implementation of the TMDL includes issuing discharge permits that incorporate appropriate wasteload allocations and developing and implementing nonpoint source plans as specified in the Water Quality Management Plans, Agricultural Water Quality Management Area Plans and Rules, Forest Practices Act rules, or federal Water Quality Restoration Plans. The DEQ has developed guidance for

state and local government designated management agencies on developing and implementing TMDL plans within their jurisdiction.

In 2012, the DEQ began implementing a **Toxics Reduction Strategy** to set priorities and guide the agency's future toxics reduction work. A high priority of the Toxics Reduction Strategy is to expand the state's **Pesticide Stewardship Partnerships Program** (PSP), which identifies potential concerns and improves water quality affected by pesticide use around Oregon through voluntary actions. With support from the 2013 Oregon legislature, the expansion and enhancement of the PSP is currently underway. In 2016, there were eight partnerships in place that included monitoring, stewardship, outreach, and technical assistance, and pesticide collection events in collaboration with the ODA, other state agencies (e.g., forestry, health), and numerous local partners (e.g., OSU).

Oregon Department of Forestry – Water Quality Programs

The ODF manages state-owned forestlands in Oregon and administers the Forest Practices Act (FPA) on non-federal forestlands to ensure that water quality and resource protections are maintained during and after commercial forest operations.

Forestlands supply abundant, clean water for Oregonians. The Private Forests and State Forests divisions ensure high water quality around the state by enforcing statues and rules that protect drinking water and fish habitat from unnecessary human-caused impacts. The ODF also conducts research and monitoring to verify that current forest management practices, and any new rules or policies, maintain water quality and fish habitat.

In January 2012, the Board of Forestry (Board) directed the ODF to analyze options the Board should consider for meeting the Protecting Cold Water (PCW) criteria of the water quality standard for temperature in small and medium fish-bearing streams that flow through non-federal forest lands in the state. The objective is to establish riparian protection measures for small and medium fish-bearing streams that maintain and promote shade conditions that ensure, to the maximum extent practicable, the achievement of the PCW criterion. The Board continues analysis and discussion of management options.

In 2013, the ODF began an annual compliance monitoring program designed to assess compliance rates across the state in a statistically valid manner. The program is designed to look at different rule sets each year on a rotating basis. The results will be integrated into an education and training program to increase awareness and compliance. In addition, ODF stewardship foresters play a significant role in implementing the voluntary conservation actions, such as those identified for the Oregon Plan for Salmon and Watersheds, which seeks to restore salmon runs to a sustainable level and improve water quality. Stewardship foresters help forest landowners identify opportunities for improving riparian function and stream habitat (e.g., large wood placement) and work with watershed councils to implement restoration projects. To date, there have been thousands of private landowner projects. Projects designed to improve stream complexity or remove artificial barriers to fish migration are the

most common. Private landowners have invested nearly $100 million in non-regulatory forest practice measures across the state since 1995.

Early in 2015, the EPA and the NOAA concluded that Oregon's coastal nonpoint pollution program was lacking additional management measures under the Coastal Zone Act Reauthorization Amendments (CZARA) to protect water quality in coastal areas of Oregon. The ODF continues to work with agency partners towards solutions.

WATER QUALITY: GOALS AND ACTIONS

Goal 1: Maintain or restore water quality in surface and groundwater to support a healthy ecosystem, support aquatic life, and provide fish and wildlife habitat.

Action 1.1. Reduce runoff from impervious surfaces.

[IWRS 6C: "Encourage low impact development practices"]

In **urban areas**, runoff from paved areas reduces water quality and can release contaminants into the water. Increase cooperation between governments, watershed councils, and businesses to reduce impervious surfaces and runoff to storm sewers in urban areas. Promote and permit "green infrastructure" that reduces runoff, such as **disconnecting downspouts**, installing **green ("living") roofs**, and using **permeable paving materials**. Manage stormwater to minimize transfer of contaminants to streams. Restore riparian vegetation buffer strips and use native landscaping (e.g., **ODFW's Naturescaping**) and bioswales to filter runoff. Continue ongoing water quality assessments and restoration programs (e.g., the City of Portland program to filter runoff via fallen leaves).

Action 1.2. Maintain and restore wetlands and riparian areas to increase filtration of sediments and contaminants and to provide shade, prevent channel erosion, and maintain stream habitat features.

[Similar IWRS action: Improve natural storage]

Wetlands often have low or no water flow, which allows sediments to fall out of the water column. Native wetland vegetation, such as cattails, rushes, and sedges, can concentrate certain contaminants in their leaves and roots, thereby removing contaminants from the water. Native riparian vegetation filters sediment before it reaches streams, provides thermal conditions that are favorable to fish and other aquatic species, and contributes large woody debris that is important for channel complexity. Restoring **wetlands** and **riparian** areas allows these natural processes to occur, maintaining habitats for terrestrial and aquatic species.

Action 1.3. Implement water quality improvement projects and management frameworks.

[Similar IWRS Action 12B: Reduce the Use of and Exposure to Toxics and Other Pollutants. IWRS Action 12C: Implement Water Quality Pollution Control Plans]

Minimize sediment delivery from land use activities that could disturb soil. Some strategies include: terracing fields, filtering run-off before it enters aquatic systems, installing sediment control basins to reduce erosion, and practicing conservation tillage. When constructing new roads, consider sediment catchment and removal in road design. Use tax credits, pollution credits, and other tools to reduce the amount of contaminants entering waterways. In urban areas, continue educational efforts, such as "Dump No Waste – Drains to Stream" postings at sewer drains. Continue implementing DEQ's TMDL planning and ODA Water Quality Management planning, which address water quality holistically throughout watersheds, including nonpoint sources of contaminants.

Manage for water quality within an adaptive management framework that incorporates new information and responds to emerging concerns. As climate changes, weather extremes may add to the **challenges that dams and reservoirs pose to native fish and wildlife species**. Although reservoirs can be a helpful management response to water shortages, reservoirs can exacerbate turbidity following big storms by collecting large volumes of muddy water and slowly passing this runoff downstream, long after undammed portions of the watershed have cleared. Muddy water in winter and spring may be much more prevalent in dammed reaches compared to other portions of the individual watersheds.

Action 1.4. Monitor structural, compositional, and functional parameters of aquatic habitats for changes in water quality.

National and regional programs use water quantity and quality indicators to assess ecological function (i.e., Heinz Center, Oregon Progress Board, National Research Council). Several indicators of water quality are well developed. Use of indicators can help characterize status to better detect change and to diagnose the causes of change.

Examples of biological indicators include:

- community indices (e.g., Index of Biotic Integrity)
- species richness, number of native taxa, relative abundance of sensitive taxa, biomass, productivity
- salmonid population, structure, abundance, productivity, diversity
- species interactions, including predation, competition, presence of invasive species

Examples of physiochemical indicators include:

- water clarity
- pH
- wetland area
- temperature
- dissolved oxygen
- nutrient levels

- chlorophyll A
- total suspended solids
- presence of specific toxic contaminants

Guidelines for sampling protocols and methodology can be found through the U.S. EPA. Indices can be linked to specific stressors using a weight of evidence approach that combines existing data, literature, and scientific judgment to make predictions about ecological characteristics.

Action 1.5. Maintain and restore native vegetation throughout watersheds, prioritizing riparian corridors, floodplains, wetlands, and upland areas.

In addition to restoring **riparian** and **wetland habitats**, restoring vegetation throughout the watershed contributes to water quality by maintaining water infiltration and flow, holding soil, and preventing contaminants from entering aquatic systems.

WATER QUANTITY

In many areas of the state, particularly during the summer, water supplies are fully allocated to meet existing uses, reducing the ability of watersheds to provide quality habitat. Water diversions are made for agriculture, municipal, industrial, domestic, and power generation uses. Other physical alterations affecting flow and habitat access include natural and artificial barriers, wetland drainage, or channelization. Timing of diversions and external factors influence disturbance regimes, sediment and bedload transport, and groundwater storage. For example, the timing and quantity of water releases from dams can have negative or positive implications for water temperature, which can impact important fish and wildlife life history events, such as the timing of salmonid migration. Global processes, including **climate change**, influence temperature and precipitation patterns and can potentially affect stream runoff and water supplies.

In Oregon, the OWRD is the state agency responsible for protecting instream water rights in trust to support the public interest, including uses for recreation, pollution control, navigation, and fish and wildlife habitat (Instream Water Rights Act of 1987). State agencies, including the DEQ and the Oregon Parks and Recreation Department, can apply for instream water rights for communities and to support state and federal scenic waterway designations. The ODFW applies for instream flows based on estimated monthly requirements to sustain healthy fish populations. Instream Water Right Rules (OAR 635-400) set the policy for ODFW's instream water right applications. Instream water rights are intended to protect flows instream for aquatic and fish life, wildlife, and their habitats, recreation, and water quality. The ODFW's policy is to apply for instream water rights on waterways of the state to conserve, maintain, and enhance aquatic and fish life for present and future generations of Oregonians. The long-term goal of this policy is to obtain an instream water right on every waterway that has value to fish and wildlife. ODFW biologists also provide advisory comments regarding impacts on fish and habitat from proposed water uses.

WATER QUANTITY: GOALS AND ACTIONS

Goal 2: Conserve, maintain, or enhance surface flows and groundwater levels that support healthy Strategy Species and Strategy Habitats. Seek opportunities to conserve, maintain, or enhance streams and lakes, as well as groundwater and spring-fed ecosystems that provide coldwater refugia for Strategy Species.

Action 2.1. Work with agencies, conservation groups, and other organizations to establish priorities, develop tools, and implement projects that maintain or restore streamflows.

The ODFW and the Oregon Water Resources Department (OWRD) have developed stream flow restoration priority maps showing flow restoration needs and priorities. The maps display each river basin, with rankings for streamflow restoration need, feasibility for streamflow restoration, and priorities for restoration. These prioritization maps and additional information, including a summary of the prioritization process and the criteria used to establish the priorities, are available in the **ODFW Data Clearinghouse**, with summer priorities provided as a layer within the **ODFW Compass mapping tool**.

Use these priorities to implement projects that restore streamflows. Collaborate with ongoing water quantity efforts taking place under the Oregon Plan (Oregon Watershed Enhancement Board). Use voluntary conservation tools, such as the **Allocation of Conserved Water Program**. Purchase or lease in-stream water rights to restore streamflows [IWRS, Chapter 4]. Support local or place-based efforts that are designed to meet instream needs while also providing for growing out-of-stream demands. Some emerging examples include water markets, water banks, and incentive programs.

Action 2.2. Seek opportunities to enhance aquifer recharge and maintain groundwater.

[Similar IWRS Action 3B: Determine Needs of Groundwater-Dependent Ecosystems]

Groundwater levels are declining in many areas. Seek opportunities to enhance aquifer recharge to restore and maintain groundwater that sustains surface flow and groundwater-dependent ecosystems. For example, restore floodplain function and restore **wetlands** to allow for greater water infiltration. Continue implementation of Oregon's Groundwater Quality Protection Act, implemented by the DEQ.

Action 2.3. Use established indicators to monitor watershed function and determine thresholds for action.

Water quantity and quality need to be monitored, and watershed function and processes need to be better understood to guide restoration. Use the existing indicators for watershed health, which have been extensively studied and linked to ecological function. These indicators include:

- altered hydrology (e.g., hydrography)
- floodplain presence and connectivity
- groundwater availability

- riparian condition (e.g., width, composition, fragmentation)
- stream connectivity
- channel condition
- habitat structure (e.g., habitat types, bank erosion, channel substrate, off channel habitat, large wood).

Integrated hydrologic and water quality models simulate flow and other important characteristics. Habitat equivalency analysis and net environmental benefit analysis models use habitat characteristics to predict ecological changes that might result from proposed hydrologic alterations. Continued use of these indicators, when combined with actions to address problems with watershed function, will help to ensure that watersheds provide essential ecological services to humans, fish, and wildlife. Continue to develop methods to determine if sufficient water supplies exist to maintain ecological functions that support **Strategy Species**, and further identify when conservation actions may be needed.

ADDITIONAL RESOURCES

- Oregon's first **Integrated Water Resources Strategy** was adopted by the Water Resources Commission in August 2012. As one of the supporting agencies and a member of the IWRS Project Team, ODFW supported the inclusion of instream needs, including water quality, water quantity, and ecosystem needs.
- The National **Climate Assessment**, 2014: "Changes in the timing of streamflow related to changing snowmelt have been observed and will continue, reducing the supply of water for many competing demands and causing far-reaching ecological and socioeconomic consequences. For every season, some models project decreases and some project increases (Ch. 2: Our Changing Climate, **Key Message 5**), yet one aspect of seasonal changes in precipitation is largely consistent across climate models: for scenarios of continued growth in global heat-trapping gas emissions, summer precipitation is projected to decrease by as much as 30 percent by the end of the century (Ch. 2: **Our Changing Climate**). Northwest summers are already dry and although a 10 percent reduction (the average projected change for summer) is a small amount of precipitation, unusually dry summers have many noticeable consequences, including low streamflow west of the Cascades and greater extent of wildfires throughout the region. Note that while projected temperature increases are large relative to natural variability, the relatively small projected changes in precipitation are likely to be masked by natural variability for much of the century."
- **Willamette Water 2100**: "**This project** is evaluating how climate change, population growth, and economic growth will alter the availability and the use of water in the Willamette River Basin on a decadal to centennial timescale. The five-year project began in October 2010, and is a collaborative effort of faculty from Oregon State University, the University of Oregon, and Portland State University. It is funded by the National Science Foundation."

- DEQ's **Water Quality Trading Program**
- DSL **Water Mitigation Guidance**

STRATEGY SPOTLIGHT: GREATER SAGE-GROUSE AND DROUGHT

During drought, sagebrush plants produce fewer stems, leaves, and flowering shoots, resulting in a smaller canopy coverage. Drought can reduce perennial grass and forb production and result in smaller insect populations. Both forbs and insects are of dietary importance to sage-grouse during brood rearing. During dry years, sage-grouse shift to wet meadow areas earlier in the summer and may switch to a sagebrush diet earlier in the year. Reduced forbs and insects and higher amounts of sagebrush in chick diets have been linked to lower chick survival.

Across the range of the bird, populations have cycled in relation to precipitation, with sage-grouse populations declining with below-average precipitation. However, other climate variables also influence sage-grouse populations, including the timing of precipitation and temperatures. Declines in the minimum spring population estimate also coincided with drought conditions in the late-2000s. For example, spring precipitation in 2007 was 60 percent of average, and the minimum spring population estimate in 2008 dropped 37 percent from approximately 24,900 birds in 2007 to 15,800 birds in 2008.

In Oregon, the effects of drought can be inferred from demographic parameters (age structure, sex ratios, nest success, and chicks per hen ratios) determined from plumage characteristics of wings voluntarily submitted by hunters who harvested sage-grouse. In 2014, production (as measured by the percent juveniles in the harvest) was 31 percent, lower than the 21 year average (1993-2013, 48 percent). The number of chicks per hen was 0.7. This represents a decrease from the 2013 production value of 2.0 chicks per hen and the long-term (1993-2014) average of 1.5. This is despite the fact that nest success improved in 2014, with an estimated apparent nest success of 51 percent. The low production and proportion of chicks in the harvest could be related to sub-optimal forage conditions resulting from on-going dry climatic conditions and presumable higher chick mortality. A similarly low chick per hen ratio occurred during a drought year in 2007 (0.6) and was followed by a 37 percent decline in the 2008 minimum spring population estimate. Thus, the 2014 low production is expected to result in a lower spring population in 2015.

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Photo Credit: NRCS

CHALLENGES AND OPPORTUNITIES FOR PRIVATE LAND-OWNERS TO INITIATE CONSERVATION ACTIONS

BACKGROUND

Across Oregon, motivated landowners are removing **invasive plants**, **replacing culverts**, restoring **wetlands**, establishing native plants, and taking large and small actions to enhance habitat for fish and wildlife. Landowners with an **urban backyard**, a few acres in the foothills of the Cascades, or a large ranch in eastern Oregon can all take action to benefit **Strategy Species** and **Strategy Habitats**. However, a number of challenges slow progress toward conservation success. Landowners need to assess which aspects of a project they can do themselves, which aspects require assistance, and know whom to ask for assistance.

Some challenges that a landowner might encounter include:

- Finding information relevant to a project
- Recognizing ways to create better habitat
- Setting priorities among several conservation needs
- Obtaining permits, particularly for projects involving streams, lakes, and wetlands
- Zoning restrictions and complex habitat tax deferral programs
- Selecting the appropriate plants for a particular site
- Avoiding inadvertently creating opportunities for invasive species to take hold
- Accessing labor, equipment, and plants to carry out a project
- Covering the costs of a conservation project

This section outlines challenges faced by many private landowners and opportunities to address those challenges, but collaborative leadership is still needed for the actions to succeed. Currently, no single organization has the charge to address the issues outlined below. Landowners are encouraged to work with state agencies, including the ODFW and OWEB, as well as SWCDs, watershed councils, land trusts, landowner organizations, and nonprofit conservation organizations. Additionally, further discussion among these organizations is needed to address the challenges outlined below.

In 2006, the Conservation Strategy recognized "Institutional Barriers to Voluntary Conservation" as a statewide Key Conservation Issue, and outlined some suggested solutions. In 2016, this chapter has been focused to address the needs of individual private landowners. Planners, municipalities, and other organizations will find additional information on this topic in **How to Use the Strategy**.

GOALS AND ACTIONS

Goal 1: Make it easier for landowners to find assistance on conservation projects.

For complex projects involving multiple partners and funding sources, it can be difficult to receive approval from several agencies or foundations, each of which may have different goals, criteria, and standards for monitoring, completion, or success.

Action 1.1. Expand technical assistance and site-specific restoration information for landowners. Technical support services include information to help evaluate habitat, information about best management practices, and monitoring.

Landowners often want help in designing projects, applying for funds, obtaining permits, and conducting on-the-ground work. At present, many agencies and conservation organizations have developed brochures and web resources on invasive non-native plants, native plant guides, habitat management guidelines, and other aspects of habitat restoration. But sorting through this information to find what is relevant to a landowner's property can be overwhelming. At the same time, excellent technical information that would be useful to landowners may not be finding its way into their hands.

Technical and communications staff across agencies should be urged to collaborate in this area. Some ways to increase technical assistance to landowners include increasing coordination between incentive program staff, providing training for groups that work with landowners, developing more targeted outreach materials, providing avenues for landowners to learn from one another, helping with setting up demonstrations and workshops, and developing information about funding and incentives programs.

Action 1.2: Build capacity among organizations to provide the technical expertise described in the above action item.

Landowners often turn to an organization with a local presence to help implement a conservation project. Organizations with field offices provide a natural entry point for landowners to find information. Examples include the NRCS, ODFW, SWCDs, watershed councils, land trusts, nonprofit conservation

organizations, and university extension offices. However, there is no single organization currently providing oversight or coordination. Collaborative discussion and leadership are needed to determine the best avenues to provide technical assistance throughout the state.

Since the Dust Bowl days, SWCDs have been working directly with landowners around the country, providing technical assistance on soil erosion and water quality issues. In recent years, however, as more landowners have requested help with habitat restoration projects, SWCDs have expanded into this area. In Oregon during this timeframe, watershed councils have also emerged to work one-on-one with landowners on projects, particularly those that impact salmon survival. However, the resources, capacity, and abilities of SWCDs and watershed councils are unequal across the state. Enhanced information sharing among agencies and organizations like SWCDs, watershed councils, and nonprofit conservation organizations will help landowners find consistent and reliable information.

Goal 2: Help landowners plan and prioritize conservation actions on their properties, evaluate results, and build long-term relationships to help them achieve their goals.

Action 2.1. Help landowners develop conservation plans that stress multi-year solutions, noting which conservation needs are most pressing.

Technical guidance should help prioritize actions and provide resources for information over time. Grants provided as incentives to landowners should be a starting point for a long-term relationship, with additional opportunities for technical assistance. Conservation projects are dynamic and require ongoing attention, and there is concern among landowners and the conservation community about the short-term nature of many grant cycles. Continuing education is one way that landowners can add to their knowledge base to inform future work even when grant cycles are complete.

Action 2.2. Improve data management, coordination, and sharing between conservation partners to support landowner-initiated conservation actions.

Effective restoration requires collecting, analyzing, and sharing data to adapt activities to changing conditions or to better meet goals. Currently, a variety of entities collect data using different protocols, and there is a need for greater coordination to improve adaptive management throughout the state. Additionally, agencies need to increase collaboration to make the most efficient use of limited resources and reach shared goals. Strengthening data management and distribution is also a key recommendation in the Conservation Strategy's **Monitoring Chapter**. Some approaches include:

- identifying critical data collection activities and associated data management efforts
- establishing a consistent data management system
- adopting and using standard protocols for database design, data collection, and metadata development
- mapping applications for information sharing

Goal 3: Provide information about financial incentives for conservation projects.

For example, forest thinning and invasive species removal can provide direct economic benefits to a property. There are also indirect ways to encourage conservation while also realizing economic gains. For example, conservation easements allow a property to remain in private ownership, while the landowner receives tax benefits in exchange for an agreement to manage the land for specific, agreed-upon conservation benefits.

> **The Wildlife Habitat Conservation and Management Program** (WHCMP) offers a property tax incentive to private landowners who want to provide wildlife habitat on their properties instead of, or in addition to, farming, growing timber, or other land uses. Under the WHCMP, land receives a wildlife habitat special assessment, where property taxes may be assessed at a lower value.

Action 3.1. Provide information about how conservation projects can enhance property values. Provide information about grants, cost sharing programs, property tax deferral, and conservation easements.

Agencies, SWCDs, and watershed councils all have an interest in helping landowners find information on habitat deferral programs, but currently there is limited capacity to organize and distribute this information effectively. One possibility to address this need would be to investigate collaboratively funding staff position(s) to meet this need throughout the state.

Action 3.2. Encourage state agencies and organizations serving landowners to recognize and support the conservation value of working landscapes (i.e., farm and forest land).

Working lands can provide significant value to fish and wildlife habitat, but this can be difficult to recognize and difficult to fund. Land zoning regulations and the “transfer of development rights” process can be confusing. State programs should work together to increase the options available for landowners to fund conservation and restoration actions, while maintaining all or part of the property as a working landscape.

Assist landowners in finding ways to generate revenue for implementing conservation actions, such as encouraging counties and municipalities to offer habitat tax deferral programs. Encourage creative new ways to value ecosystem services. A broader recognition of the conservation value provided by working landscapes could result in expanded grant programs or other support for landowners.