# Climate-Related Technical Resources for OWEB Applicants

*Version 1.1, April 11, 2023*

## Background and Purpose

The Oregon Watershed Enhancement Board (OWEB) is a state agency that provides grants to help Oregonians take care of local streams, rivers, wetlands, and natural areas. OWEB investments have climate benefits. OWEB-funded project activities build resiliency in ecological systems; help native fish and wildlife species adapt to changing conditions; and help mitigate for emissions that contribute to climate change (see references beginning on page 14 of this document for additional information). OWEB funds several different types of grant offerings at various geographic scales. At a broad scale, climate actions with benefits for biological diversity and habitat connectivity contribute to system-wide climate resilience. At the project scale, OWEB funded activities contribute many climate benefits for native species, water quality and quantity.

In 2020, the OWEB board indicated its intent to more directly account for climate benefits through its grant-making. In 2021, OWEB is beginning to gather information about climate impacts and proposed projects at the grant application stage, and is providing the information in this document to assist applicants and grantees with finding information to inform their project planning.

Climate change has known and projected impacts on Oregon's natural systems, including increased potential for extreme events as well as general trends associated with warming conditions, as published in peer-reviewed scientific literature and summarized in this document. Many online planning tools have been developed by universities, governments, non-profits and other organizations to bring together data about current and future climate impacts in searchable geographic format.

The purpose of this document is to summarize information about climate impacts in Oregon, and to provide some selected online climate planning tools to assist applicants to OWEB grant offerings with finding information relevant to their project area. The information presented in this document is provided as a starting point, and applicants may find additional or more specific information sources relevant to their work.

Beginning in July 2021, this document will be made available in PDF format on OWEB's website: https://www.oregon.gov/oweb/resources/Pages/Field-Tech-Guidance.aspx

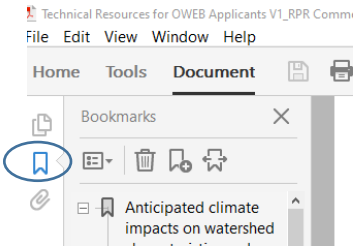
## Index to this document

This document provides information about:

- Anticipated climate impacts on Oregon's watersheds, including native fish and wildlife species; habitats; water quantity and water quality, including:
    - Anticipated changes in temperature, precipitation, storm and fire events, and habitat distribution
    - Informational resources to help OWEB applicants understand potential future climate impacts in the proposed project area
    - Informational resources to help OWEB applicants address potential climate impacts through project planning
- Background information and some online resources about climate benefits from OWEB project activities related to:

- Adaptation: Species, habitat or community adjustment in response to climate events and/or trends
- Resilience: the capacity of a natural system to prevent, withstand, respond to, and/or recover from disturbance related to climate impacts. Biodiversity and habitat connectivity help to confer resilience because they apply to a broad array of species and ecological systems.
- Mitigation: Limiting or preventing greenhouse gas emissions (i.e., carbon dioxide, methane), and by enhancing activities that remove these gases from the atmosphere, such as through carbon sequestration on natural and working lands.

To jump to the section of interest as you navigate this document, use the "Bookmarks" feature In Adobe Acrobat Reader, as shown below:




# Anticipated climate impacts on watershed characteristics and functions in Oregon

## Temperatures and Heat Events

### Increase in average annual air temperatures, and likelihood of extreme heat events

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document. RCP = Resource Concentration Pathway, emissions trajectories defined by the Intergovernmental Panel on Climate Change (IPCC) to describe different climate futures possible under different emissions scenarios. RCP 4.5 is the "intermediate" scenario, where emissions peak around 2040 and then begin to decline. RCP 8.5 is considered a high emissions or "worst case" scenario.

- Depending on low (RCP 4.5) or high (RCP 8.5) emissions projections, the state of Oregon is anticipated to warm 4-9°F by 2100.
- Subject to natural climate variability, warming to be continuous through all seasons (greater during winter and spring at high elevations).
- Likelihood of greatest temperature increases inland, and to the East.
- Extreme heat events increase in frequency, duration, and intensity (for example, in the Willamette Valley, top public health risks are anticipated in Multnomah and Benton counties).

### Online resources about climate data for OWEB applicants

To understand how climate at the project location will be impacted, here are some tools that can be used to search by location (watershed; map coordinates; town or city):

| Potential question from OWEB Applicant | Informational Resource |
|---|---|
| How will climate change in the project area, including temperature; water availability; and fire risk?<br><br>How do historical, and projected future datasets influence your planning processes for the project area (for example, mitigation plans; anticipating specific risk factors)?<br><br>What are past and projected climate variables, by county or region? | Oregon State University Climate Impacts Research Consortium: https://climatetoolbox.org/<br>Including the following topics:<br>Agriculture—climatetoolbox.org/agriculture<br>Climate—climatetoolbox.org/climate<br>Water—climatetoolbox.org/water<br>Wildfire—climatetoolbox.org/wildfire<br><br>For a nation-wide data source providing information by county, city or zip code:<br>Climate Explorer: https://crt-climate-explorer.nemac.org/<br>Provides graphs and maps of temperature, precipitation, weather, and flooding for U.S. counties. Information derived from Intergovernmental Panel on Climate Change (IPCC) global climate models and covers historic information and two scenarios (lower and higher emissions). Accompanies U.S. Climate Resilience Toolkit. |
| How can I access climate models for the Pacific Northwest to explore datasets relevant to Oregon? | University of Washington Climate Impacts group: https://cig.uw.edu/resources/analysis-tools/<br>Including the following:<br><br>Average projected changes in temperature and precipitation: Pacific Northwest Climate Projection Tool \| Climate Impacts Group (uw.edu)<br><br>Tableau Northwest region climate change projections tool: Regional Climate Projections \| Climate Impacts Group (uw.edu)<br><br>Northwest trends in temperature, precipitation and snow water equivalent: PNW Temperature, Precipitation, and SWE Trend Analysis Tool \| Office of the Washington State Climatologist |
| Are there tools to help tribes with climate planning? | Oregon State University Climate Impacts Research Consortium: https://climatetoolbox.org/<br><br>Tribal climate tool: Tribal Climate Tool (northwestknowledge.net)<br><br>University of Washington Tribal Vulnerability Assessment (includes Oregon tribes, and a staffed phone line): https://cig.uw.edu/resources/tribal-vulnerability-assessment-resources/ |

## Hydrology and water supply

### Changes in hydrology and water supply; reduced snowpack and water availability in some basins; changes in water quality and timing of water availability

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document. RCP = Resource Concentration Pathway, emissions trajectories defined by the Intergovernmental Panel on Climate Change (IPCC) to describe different climate futures possible under different emissions scenarios. RCP 4.5 is the "intermediate" scenario, where emissions peak around 2040 and then begin to decline. RCP 8.5 is considered a high emissions or "worst case" scenario.

- By 2080: Long-term annual precipitation increases ranging from 3.4% (RCP 4.5) to 6.3% (RCP8.5); entire state (with exception of parts of Blue Mtns.) to become rain-dominant. Wetter winter and fall seasons; drier summers (a decrease of 14% by 2080). Mt. Hood glaciers: Around 2057 will be about 61% of present day area.
- *Snow-water equivalent (SWE):* Under RCP 8.5, Cascade snowpacks projected at ½ or less than those from early 2000s; but highest peaks with only 11-33% decline. Under low-high emissions, SWE projected to decrease 30% by 2050s and 40%-50% by late century. Impacts vary across watersheds with greatest water supply changes in basins relying on snowmelt. (Upper McKenzie River sub-basin models project snowmelt decrease from 1960-89 period of 52% by 2040s, up to 78% by 2080s.) Largest declines in low-intermediate elevations (3,300-6,600 ft): mixed snow-rain watersheds of Cascades and mountain ranges of central and northeastern Oregon. April 1 SWE continues to decline earlier in season.
- *Streamflow, runoff and timing projected to shift*:* Higher in winter statewide with rapid runoff and potential flood risks in some basins. Lower in summer and fall likely in western and northeastern regions; earlier peak runoff (most vulnerable: snow-reliant basins and low-intermediate elevations of Cascades). Low streamflow extremes projected to become more frequent, prolonged and severe (summer flows reduced as much as 50% in some basins). Summer flow sustainable in High Cascades (deep groundwater systems), but basins east of Cascades experiencing future low flows as groundwater recharge declines over time. Mt. Hood glacial retreats likely resulting in 27% loss of late summer discharge affecting streamflow in Upper Middle Fork Hood River.
- *Stream Temperatures*: projected to increase in summer with decreases in rainfall, higher air temperatures and where summer streamflow is reduced (especially western Cascade basins under RCP 8.5, John Day River Basin, and small streams in eastern Oregon). Urban streams especially vulnerable (lack of natural vegetation).
- *Water quality*: All regions affected, with cyanobacterial Harmful Algal Blooms (HABs) a problem in lakes. Regions with low summer streamflow most sensitive to temperature and precipitation affecting water quality.
- *Water supply vulnerability*: Highest east of Cascades. Columbia River Basin irrigation demands increase 5% by 2030s depending upon adaptive management decisions. Willamette Valley summer water scarcity. Water demands increase (especially in urban areas).

* Streamflow changes vary by season, basin size, and ecoregion. Riparian vegetation influences streamflow timing and amount. Future runoff modelling uncertainties arise from compound variable inputs and lack of information about vegetation responses. For more information see *"References about climate impacts on watersheds in Oregon. "*

### Anticipated climate impacts on watersheds

Climate impacts on stream flow are not uniform in Oregon. Streamflows are controlled by the amount and timing of rain compared with snow. Geologic characteristics influence the recharge and discharge of water.

| Current watershed characteristic | Anticipated future watershed characteristic |
|---|---|
| Watersheds mostly dominated by snow | Shift to rain/snow mix<br>Earlier and reduced spring peak flow<br>Increased winter flow<br>Reduced late summer flow |
| Mixed rain-snow watersheds: | Projected to shift toward rain-dominant conditions |
| Rain-dominant watersheds: | Could experience higher winter streamflows if winter precipitation increases, but little change in streamflow timing |
| Dalton, M.M., K.D. Dello, L. Hawkins, P.W. Mote, and D.E. Rupp (2017) The Third Oregon Climate Assessment Report, Oregon Climate Change Research Institute, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR.<br><br>Dalton, M., and E. Fleishman, editors. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. https://blogs.oregonstate.edu/occri/oregon-climate-assessments/<br>*Also available at* https://ir.library.oregonstate.edu/concern/technical_reports/pz50h457p | |

**Online resources for OWEB applicants about climate impacts on water**

| Potential question from OWEB Applicant | Informational Resource |
|---|---|
| How can I find information on potential future alterations in streamflow? | For information about streamflow throughout the western U.S., including historical and future projections from global climate models: Climate Toolbox<br><br>Pacific Northwest trends in temperature, precipitation on snow water equivalent: University of Washington Climate Toolkit |

## Precipitation Events and Floods

***Increased frequency of extreme precipitation events and incidence and magnitude of damaging floods***

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Atmospheric river events likely to increase in frequency and intensity, increasing potential for flood events.
- Severe winter storms with heavy rainfall projected to occur more often along the coast, impacting low lying areas with storm surge, large waves, and flooding, resulting in coastal erosion and habitat loss (e.g., Tillamook County flood events double through 2050, and double again by 2100).
- Increased risk in mid-elevations of mixed rain-snow basins and areas already prone to flooding.

## Coastal Erosion and Inundation Risk

**Increased coastal erosion and risk of inundation from increasing sea levels and increasing wave heights and storm surges**

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Sea level rise (SLR) tracks global average (2-4 ft. by 2100).
- North central coast is subsiding, so SLR greater than global average could result.
- Until mid-century, local tectonic uplift near mouth of Columbia River and coast south of Florence will result in very little apparent SLR; by mid-century rate of SLR will exceed vertical land movement.
- Storms in the future will compound the impacts of increasing sea levels and high waves, resulting in severe episodes of coastal erosion and flooding and potential damage to coastal community infrastructure. (Example hot spots for coastal storm erosion include: Netarts, Waldport, Port Orford.)
- By 2100 under RCP 8.5, chances for annual flooding 4' above current high tide line are: 70% for Astoria, 100% for South Beach, and 86% for Charleston.

## Drought conditions

### Increased incidence of drought

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Extended periods of drought conditions are projected. Willamette Valley and western Cascades show high increase in 3-6 month droughts through 2100 (per several global climate models) mainly due to decreased summer precipitation.
- Mid- to low- mountain regions of Cascades and eastern Oregon experience prolonged drought increases from reduced snowpack and earlier snowmelts. Declining snowpack drought considered top public health risk in Wasco, Sherman, Gilliam, and Crook Counties.

### Soil Moisture

For information on soil moisture, a critical land surface variable for agricultural monitoring, drought and early flood prediction, see the National Soil Moisture Monitoring Network: https://www.drought.gov/drought-in-action/national-coordinated-soil-moisture-monitoring-network

The Network includes a drought map and trend data for Oregon: https://www.drought.gov/states/oregon

## Landslide Risks

### Increased incidence of landslides

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Repeat landslide events most anticipated along the coast and Coast Range mountains.
- Increased risk in low- to mid-elevation mountains with rain on melting snow events.
- Atmospheric river events will magnify risks of landslides.

## Wetland Habitat Losses

### Loss of wetland habitats, ecological systems and services

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Losses (expected in all regions) degrading nutrient regulation, water quality and quantity, soil stabilization, storm surge and flood mitigation, carbon sequestration, downstream productivity, habitat and biological diversity.
- Coastal losses arising primarily from SLR, shifts in chemistry of nearshore waters, changes in timing and intensity of coastal upwelling. Upwelling importing waters with low pH and low dissolved oxygen conditions from coastal shelf into estuaries impacting calcifying organisms.
- Increased potential for Harmful Algal Blooms (HABs).
- Changing species range; increased marine mammal interactions; increased restrictions to commercial fishing industry
- Inland losses driven mainly by temperatures, drought, flooding, and precipitation changes.

## Wildfire Frequency and Intensity

**Increase in wildfire frequency and intensity**

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- With declining snowpack, earlier spring snowmelt and drier summers projected, fire risk projected to increase statewide by 2050 for all major forest types (estimate 78% increase in area burned by mid-century for the Pacific Northwest). Warm, dry summers associated with higher area burned. Duration and intensity of fire increasing with warmer temperatures and drier vegetation.
- Greatest increased risk: Lower elevation wildlands (especially Coast range, Cascade range, and southwestern Oregon). Central and eastern Oregon (Blue Mtn. range), and grasslands, also high risk.

[ Projected 160% increase in airborne particulate levels from wildfires by mid-century in NW US under RCP 4.5.]

## Diseases, invasive species, and pests

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

Increases are projected for:

- Exposure to algal toxins and Harmful Algal Blooms (HABs), waterborne pathogens, and water contaminants in freshwater and marine ecosystems.
- Incidences of vector-borne diseases from mosquitos and ticks.
- Increased range, earlier emergence, increased longevity and multiple generations of mammal and insect pests throughout year (e.g., exotic insect pest of small fruits).
- Cheatgrass (highly flammable and invasive in rangelands) projected to expand.
- Generally, Insects and disease are projected to expand northward, toward the coast, and upward in elevation.
- Damage from insects in Blue Mountains ecoregion, central Oregon, and eastern Cascade Range forests
- Damage from pathogens in Southwest Oregon and high elevations of Coast range forests.

## Habitat Shifts, Degradation or Loss

### Changes in the abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife

The information about climate impacts described below has been adapted from Oregon's Climate Change Adaptation Framework (2010) and additional information included in the "References about climate impacts on watersheds in Oregon" section of this document.

- Rising temperatures, invasive species, inland water temperatures, frequency and intensity of disturbances (wildfires, droughts, floods, landslides, diseases, and pests) create habitat shifts, degradation or loss.
- Field habitat inventories are essential to address knowledge gaps in vegetation change predictions.
- Shifts from changes in hydrology and water supply over longer term (streams and wetlands).
- With increases in ocean acidification and hypoxia along coast, there is potential for alteration of marine food web base and restructuring of benthic systems.
- SLR (Sea Level Rise) affecting waterfowl and aquatic habitat (especially juvenile salmon). Increase in salinity in some estuaries converting coastal freshwater swamp and marsh habitats to salt or transitional marsh; may force inland migration of plant and animal communities. Tidal wetlands migration inland may be thwarted by hardened shorelines and bulkheads. Estuarine intertidal loss, if no adjustment to sediment input.
- Vegetation models: Coastal region conifer forests shift to mixed evergreen and subtropical mixed; Subalpine forests and tundra shrinking; southeastern Oregon (sagebrush-steppe ecosystem) invasive grasses (especially cheatgrass) and encroaching woody vegetation
  .

## Anticipated climate impacts on upland habitat

| Upland habitat | Anticipated future characteristics |
|---|---|
| Forests in Higher elevation watersheds | Higher tree growth |
| Forests in Lower elevation watersheds | Slower tree growth |
| Forest limited by water availability | Longer, more severe water limitation; reduced warm season precipitation. Result: slower tree growth |
| Sub alpine trees | Decline and have limited ability to migrate upslope. Result: Habitat loss |
| Willamette Valley | Grass-dominated prairies and oak savannas may expand under warmer and drier conditions: they are adapted to periodic drought<br>May be emerging needs to select new tree species for planting, depending on landowner goals |
| Sagebrush steppe | Sensitive to altered precipitation patterns and invasive species spreading under changing climate.<br><br>May find tendency for woodland and forest encroachment. |

For more information see:

Dalton, M.M., K.D. Dello, L. Hawkins, P.W. Mote, and D.E. Rupp (2017) The Third Oregon Climate Assessment Report, Oregon Climate Change Research Institute, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR.

Dalton, M., and E. Fleishman, editors. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. https://blogs.oregonstate.edu/occri/oregon-climate-assessments/

*Also available at* https://ir.library.oregonstate.edu/concern/technical_reports/pz50h457p

**Online resources for OWEB applicants about upland restoration**

| Potential question from OWEB Applicant | Informational Resource |
|---|---|
| How can I find information to help prioritize and target areas for conservation (biodiversity, connectivity and climate resilience goals), including acquisitions and restoration efforts? | The Nature Conservancy's resilient lands project: https://maps.tnc.org/resilientland/<br><br>provides a searchable map with sites ranked by general resiliency level; the capability to download data including carbon estimates for soil and forests. For more information about the ranking process see: https://maps.tnc.org/resilientland/coreConcepts.html |
| How can I find information to help select species and vegetation types suitable based on climate zones? | The Seedlot Selection Tool is a collaboration between the US Forest Service, Oregon State University, and the Conservation Biology Institute: https://seedlotselectiontool.org/sst/<br>The tool provides a mapping application to help natural resource managers match seedlots with planting sites based on climatic information, including current and future scenarios. The user can search for seedlots at a planting site; and to find new planting sites.<br><br>Information on plant zones:<br>Gurney's: Find Your USDA Hardiness Zone with our Zone Map (gurneys.com) |
| What are some resources for acquiring reforestation information and source materials? | Information about planting forest trees under climate change: https://oregonstate.app.box.com/s/1behdjkuz06oora2513awc6dqdpqqt76<br><br>NativeTreesPlants.pdf (oregon.gov) Oregon-specific plant recommendations for management and water conservation<br><br>Northwest Natural Resources Group: https://www.nnrg.org/climateadaptation/<br>Includes publications, videos and other resources on Northwest forest adaptation, and a template Forest Management Plan for climate adaptations |
| Where can I find informational resources to understand and promote reforestation, including in urban areas? | The Nature Conservancy's Reforestation hub:<br>Reforestationhub.org<br>Provides an interactive map showing county-level estimates of the potential area of new forests and how much carbon those areas could capture.<br><br>For information on the City of Portland's activities: Tree Planting \| Portland.gov |
| | To encourage planting in areas most in need based on socioeconomic and community variables, see the Tree Equity project: https://treeequityscore.org/<br><br>This site provides a searchable map for areas by Tree Equity Score, based on socioeconomic information. See https://treeequityscore.org/resources/ for action guides and case studies highlighting tree equity |
| What educational programs offer updated information about reforestation under climate change? | OSU Extension tree school: https://knowyourforest.org/TreeSchoolOnline |

## References about climate impacts on watersheds in Oregon

The following references were consulted to compile the information on climate impacts included with each section above:

State of Oregon. (Dec, 2010) The Oregon Climate Change Adaptation Framework 2010 *https://www.oregon.gov/lcd/CL/Pages/Adaptation-Framework.aspx*

Oregon Climate Change Research Institute (2010), Oregon Climate Assessment Report, K.D. Dello and P.W. Mote (eds). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR

Dalton, M.M., P.W. Mote, and A.K. Snover [Eds.]. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Washington, DC: Island Press.

Dalton, M.M., K.D. Dello, L. Hawkins, P.W. Mote, and D.E. Rupp (2017) The Third Oregon Climate Assessment Report, Oregon Climate Change Research Institute, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR.

*In addition to the information described in several sections above, Chapter 7, Human Health, includes information about socioeconomic and racial inequities impacting Oregon's communities.*

May, C., C. Luce, J. Casola, M. Chang, J. Cuhaciyan, M. Dalton, S. Lowe, G. Morishima, P. Mote, A. Petersen, G. Roesch-McNally, and E. York, 2018: Northwest. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1036–1100. doi: 10.7930/NCA4.2018.CH24 https://nca2018.globalchange.gov/chapter/24/

Mote, P.W., J. Abatzoglou, K.D. Dello, K. Hegewisch, and D.E. Rupp (2019) Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute.

*Oregon Climate Change Effects, Likelihood, and Consequences Workshop* (Fall, 2019) A workshop summary report prepared by The Oregon Climate Change Research Institute, Corvallis, OR, 71 pp.

### Additional References

The web sites below offer some additional information sources on climate-related topics.

While much information is available regarding potential changes in Oregon's climate variables, site-specific information is not available widely or consistently. Coordination with regional, county, watershed-based and community organizations will be important to tracking and documenting impacts. Some examples of local climate planning are provided below.

(1) Oregon Global Warming Commission. https://www.keeporegoncool.org/

(2) State of Oregon. Climate Change Resources. *Department of Land Conservation and Development*. https://www.oregon.gov/lcd/CL/Pages/Climate-Change-Resources.aspx

*Provides access links to climate adaptation plans and climate projection reports for:*

- Cities of*: Ashland, Corvallis, Eugene, and Milwaukie*
- *Portland and Multnomah County*
- *Clatsop and Tillamook Counties*
- Counties of*: Baker, Gilliam, Grant, Harney, Hood River, Lake, Malheur, Sherman, Wasco, and Wheeler*

(3) City of Bend (Dec, 2019) Bend Community Climate Action Plan Climate Mitigation Strategies and Actions: 2020-2025
https://www.bendoregon.gov/home/showpublisheddocument?id=43933

*Also available at: https://www.bendoregon.gov/city-projects/sustainability/community-climate-action-plan*

(4) McKenzie Watershed Council and Partners (Jun, 2016) McKenzie River Sub-basin Strategic Action Plan for Aquatic and Riparian Conservation and Restoration, 2016-2026 https://www.mckenziewc.org/wp-content/uploads/2016/12/McKenzieRiverAction-Plan_FINAL.pdf

*Also available at: https://www.mckenziewc.org/?page_id=322*

*Climate change impacts addressed on pp 46 and 110*

(5) Ocean Temperature and Hypoxia are known climate impacts. While not the primary focus of the majority of OWEB's grants, these issues may be of interest to some grantees.
As described in Oregon's Climate Change Adaptation Framework (2010):
- Coastal sea surface temperatures (SST) for the Pacific NW projected to increase by 2.2°F by 2030-2059.
- Ocean acidification (OA) in Oregon generally outpacing other areas globally due to seasonal upwelling of deep waters with more carbon and less dissolved oxygen (dissolved shells in some marine food base species already occurring).
- Hypoxia conditions increasing in frequency, intensity, duration, and spatial scale.
- Increases and alternatives in cycles of nutrient upwelling.

For additional information see: Ocean Acidification and Hypoxia Council's Action Plan for 2019-2025

(6) Climate impacts human health. The impacts are influenced by racial and socioeconomic inequity. For additional information see:
Oregon Health Authority (2020). Climate and Health in Oregon.
https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/CLIMATECHANGE/Pages/profile-report.aspx

For an example of nature-based solutions to urban heat in Oregon, see:
Makido, Y.; D. Hellman and V. Shandas. 2019. Nature-based designs to mitigate urban heat: The efficacy of green infrastructure treatments in Portland, Oregon. Atmosphere 10(5): 282.

## Potential climate benefits from proposed OWEB project activities

Climate benefits resulting from OWEB project activities include: enhanced climate resilience; species and habitat adaptation benefits; and mitigation (i.e., carbon sequestration and emissions reduction). The focus (species, habitat) and spatial scale (site, watershed, ecological function or process) of the proposed project will influence how the climate benefits and co-benefits are identified. Some known benefits from typical OWEB project activities, and resources for further information about these high-level benefits, are described below.

### Climate benefits resulting from example OWEB project activities

| | Mitigation (i.e., emissions reduction) | Sequestration | Adaptation and/or Resilience |
|---|---|---|---|
| Upland tree planting | | ✓ | |
| Riparian planting | | ✓ | ✓ |
| Grassland and rangeland restoration | | ✓ | ✓ |
| Estuary restoration | | ✓ | |
| Forest health treatments | | ✓ | ✓ |
| Land acquisition (forest, grassland, riparian, wetland, and/or rangeland) | | ✓ | ✓ |
| Wetland or estuarine habitat improvement | | ✓ | ✓ |
| Instream flow protection/restoration | | | ✓ |
| Irrigation efficiency | ✓ | | ✓ |
| Agricultural management | ✓ | | |
| Fish passage improvement | | | ✓ |
| Wildlife habitat connectivity<br>Aquatic habitat connectivity | | | ✓ |
| Protection of cold-water refugia and species strongholds | | | ✓ |

### Adaptation benefits for fish and wildlife habitats

Project activities that enhance streams, rivers, wetlands and natural areas have significant benefits for Oregon's native fish and wildlife. Several planning efforts outline species needs and recommend adaptation activities:

| **Potential Question from OWEB Applicant** | **Informational Resource** |
|---|---|
| Where can I find recommendations for conservation actions to benefit salmonids and other native fish under changing climate conditions? | ODFW recovery plans describe climate impacts and mitigation strategies: https://www.dfw.state.or.us/fish/crp/conservation_recovery_plans.asp<br><br>Overview of recovery planning process, data, and tracking tools:<br><br>https://www.dfw.state.or.us/fish/CRP/ |
| Where can I find recommendations for conservation actions to benefit Oregon's native species, and their habitats, under changing climate conditions? | Oregon Conservation Strategy Species and Habitats: https://www.dfw.state.or.us/conservationstrategy/global_climate_change.asp<br><br>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. |

| | |
|---|---|
| What information is available about identifying priority areas for native fish and wildlife under changing climate in the Northwest? | The Nature Conservancy's Northwest Climate Resiliency project, Conserving Nature's Stage, identifies the most resilient sites in the Northwest:<br><br>Conservation Gateway<br><br>Climate Adaptation Clearinghouse |
| Is there an online library with information about how to use information from climate vulnerability assessments? | Climate Adaptation Library is searchable by geographic area, activity, species, and climate impact: http://adaptationpartners.org/library.php |
| Where can I find information about adaptation strategies and actions? | EPA Adaptation Actions for water management and ecosystem protection.<br>Lists a suite of adaptation strategies including the following:<br>- Plant forests and floodplain habitat; control soil erosion in the watershed; control stormwater runoff<br>- Purchase upland development or property rights<br>- Identify and protect ecological significant areas<br>- Design estuaries with dynamic boundaries and buffers<br>- Restore barriers to tidal flow<br>- Connect landscapes with corridors to enable migrations |

## Resources for restoration strategies to manage for climate change impacts

Climate resilience is the capacity of a natural system to prevent, withstand, respond to, and/or recover from disturbance related to climate impacts. For an overview of ecological resilience in the face of climate change, including how biological attributes relate to the scale of restoration focus (species, habitat, system) and the scale of application (population, site, ecosystem), see: Timpane-Padgham, B.L.; T. Beechie; and T. Klinger. 2017. A systematic review of ecological attributes that confer resilience to climate change in environmental restoration. PLOS ONE March 16, 2017.

For additional information about restoration actions in the face of climate change, see:

Beechie, T.; H. Imaki; J. Greene; and A. A. Wade. 2012. Restoring salmon habitat for a changing climate. River Research and Applications 29 (8).

Perry, L.G.; L. V. Reynolds; T. J. Beechie; M. J. Collins and P. B. Shafroth. 2015. Incorporating climate change projections into riparian restoration planning and design. Ecohydrology (2015). DOI: https://doi.org/10.1002/eco.1645

## Mitigation benefits, including carbon sequestration

Natural and working landscapes provide climate mitigation benefits by sequestering carbon, lowering the level of greenhouse gases from the atmosphere.

In Oregon, Governor Brown's Executive Order on Climate Action (EO 20-04) called for a comprehensive, data-driven proposal for carbon sequestration on natural and working lands. The draft proposal includes recommendations to improve data inventory on forests, agricultural lands and estuaries; information about programs and practices intended to enhance sequestration; and background information including a short informational powerpoint about sequestration on natural and working lands. To read the proposal and other background information, see the Oregon Global Warming Commission's webpage: Oregon Global Warming Commission https://www.keeporegoncool.org/natural-working-lands

For additional information on this topic, see:

Drever et al., 2021. Natural climate solutions for Canada. Sci Adv 7 (23), eabd6034. DOI: 10.1126/sciadv.abd6034

Fargione et al. 2018. Natural climate solutions for the United States. Science Advances 4 (11). DOI: 10.1126/sciadv.aat1869

Graves et al. 2020. Potential greenhouse gas reductions from natural climate solutions in Oregon, USA. PLoS ONE 15
(4): e0230424. https://doi.org/10.1371/journal.pone.0230424

Griscom et al. 2017. Natural climate solutions. Proceedings of the National Academy of Sciences DOI: www.pnas.org/cgi/doi/10.1073/pnas.1710465114