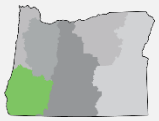



# REGION 2

## Observed & Projected Climate Changes

## Air & Water Temperature

| | |
|---|---|
| **Observed** | |
| Annual Air | • Temperatures in the region have increased since 1895, with mean annual temperature increasing between 0.05-0.13°C (0.09-0.23°F) per decade. |
| Seasonal Air | • Most warming has been observed in summer; spring had least warming. |
| Extreme Heat | • Increased number of extremely warm days (>90°F/32°C) in Medford since 1950.<br>• Increased number of extremely warm nights (>65°F/18°C) in Medford the past two decades. |
| Streams | • Mean August temperatures for a small number of unregulated river sites with long-term records indicate a warming rate of 0.28°C (0.5°F) per decade from 1976-2015.<br>• Historical trends indicate warming in summer and early fall months. |
| **Projected by 2100** | |
| Annual Air | • +2.4°C (4.3°F) to +5.6°C (10.1°F). |
| Seasonal Air | • Increased warming in all seasons, with the greatest amount of warming projected in summer (+5.2°C/9.4°F) and the least amount of warming in spring (+3.5°C/6.3°F).<br>• Projected increases in winter temperatures would make the winter climate of Medford like that currently observed in Sacramento, CA.<br>• Projected increases in summer mean maximum daily temperature - Medford: 32°C (89°F) in 2020s; 33.7°C (92°F) by 2050s.<br>• Projected increases in winter mean maximum daily temperature - Medford 10.6°C (51°F) in 2020s; 11.7°C (53°F) by 2050s.<br>• Increased growing season length. |
| Extreme Heat | • Longer, more frequent, and more intense heat waves.<br>• Increase in the annual number of days >90°F (32°C) by mid-century (+6 to +26 days) compared to 1971-2000.<br>  ○ Medford: 43 days in 2020s; 65 days by 2050s.<br>• Increased frequency and magnitude of days with extreme heat index (temperature + humidity). |
| Streams | • Outside of regulated reaches, stream temperature increases are relatively uniform except for smaller increases in streams at the highest elevations along the eastern and southern portions of the region.<br>• +2.23°C (4°F) for mean August stream temperature.<br>• River reaches on the Rogue and Applegate Rivers downstream of large dams and reservoirs projected to show minor temperature increases during summer months in comparison to free-flowing reaches. |

# Precipitation & Drought

**Observed**

| | |
|---|---|
| Annual | • No significant long-term trend in annual precipitation.<br>• Recent years (1987-2013) have been characterized by increased drought severity compared to 1960-1986.<br>• North Bend received 12-15% less annual precipitation during the last 20 years. |
| Seasonal | • Minor increase in spring precipitation; some studies suggest declines in fall and summer precipitation. |
| Snowpack | • Declining April 1 snow-water equivalent (SWE) since 1950, although SNOTEL data for Rogue River-Siskiyou National Forest and Umpqua National Forest locations show no significant trend from 1981-2010. |
| Drought | • Increased drought severity in recent years (i.e., 1987-2013) compared to 1960-1986. |

**Projected by 2100**

| | |
|---|---|
| Annual | • Models generally project either no change in annual precipitation or a slight increase. |
| Seasonal | • Increase in winter precipitation (Dec-Feb) and less precipitation during growing season (Apr-Oct). |
| Extreme Precipitation | • Increased intensity of atmospheric rivers.<br>• Increased number of days with an atmospheric river present. |
| Snowpack | • Substantial decline in mountain snowpack and an earlier snowmelt season.<br>• Low-elevation western area: little change in snow residence time and April 1 SWE because snow is already mostly absent or ephemeral; higher ridges and peaks are likely to maintain some snow although it will be shallower and not last as long.<br>• Transient or ephemeral snowpacks at mid-elevations in the Cascades will largely be eliminated and places with moderately persistent snowpacks will become more transient.<br>• Average snow residence time projected to decrease 6-8 weeks in the High Cascades.<br>• Annual mean snowfall in Jackson County: 3.81 in (97 mm) from 1981-2010; 2.08 in (53 mm) from 2025-2049. |
| Drought | • Increased frequency, severity, and duration of drought.<br>• Annual number of dry days in Medford: 181 in 1990s, 188 by 2050.<br>• Increased probability of more extreme droughts than those observed in the past century.<br>• Climatic water deficit (a measure of drought stress) is projected to at least double; largest percentage increases are projected for areas above 2,100 m (6,890 ft).<br>• Increased soil drought in the inland, southern portions of the region. |

# Hydrology & Sea Level Rise

**Observed**

| | |
|---|---|
| Sea Level Rise & Storm Surge | • Relative sea level in southern Oregon (Coos Bay and south) is falling or slightly stable; relative sea level rise rates in central Oregon have been 1-3 mm (0.04-0.12 in)/year since at least the 1970s. |
| Streamflows | • Summer flows have been decreasing.<br>• More of the annual flow has been occurring earlier in the water year. |

**Projected by 2100**

| | |
|---|---|
| Sea Level Rise & Storm Surge | • Rising sea level and increased storm surges.<br>• Increased frequency of major and moderate high-tide flood events. |

- Sea level at Port Orford projected to rise by 6-16 cm (2.4-6.3 in) by 2040 and 16-182 cm (6.3-71.7 in) by 2100.
- Sea level at Charleston projected to rise by 7-17 cm (2.8-6.7 in) by 2040 and 18-183 cm (7.1-72.0 in) by 2100.

**Streamflows**

- Overall, small increases in peak flow across the region, but large in those areas where snowpack changes are large (i.e., shifts from seasonal snowpacks to intermittent snowpacks in mid- to high-elevation Cascades).
- Slight increases in peak flows at the scale of small river basins in much of the western coastal mountains, although changes from seasonal to intermittent snowpacks along higher ridges may yield increased slope instability.
- Small decreases in low flows are expected over much of the region; the most notable declines in summer low flows are expected in the High Cascade streams, rivers to which they are a tributary (Rogue, Umpqua), and the northwestern Siskiyou Mountains.

## Disturbances

**Observed**

**Wildfire**

- Between 1985-2010, annual area burned has increased only slightly in the Pacific Northwest; the proportion of fires that burned at high severity has not increased, with low- and moderate-severity fire making up most of the area burned.
- Over the past several decades, a number of large mixed-severity fires have occurred in southwest Oregon.

**Projected by 2100**

**Wildfire**

- Increased fire potential or area burned.
- Increased annual probability of very large fires/increased suitability for large wildfire.
- Increased fire frequency and area burned.
- Potential increase in fire severity.
- Increased number of high fire danger days in summer and fall (e.g., Medford: 12 days in 2020s, 16 days by 2050s).

**Insects & Pathogens**

- Greater pathogen damage in areas where tree vigor is diminished due to hotter, drier summers and associated drought stress.
- Flooding and other extreme events can exacerbate the spread of *Phytophthora lateralis*, a nonnative pathogen that causes root disease in Port Orford cedar.
- Expansion of non-native insect herbivores as well as native insects south of the region, with potential impacts on tree species.
- Warmer winters and increased droughts (longer or drier) may enable some insects to increase reproductive rates and move into previously unsuitable habitat.
- Increased tree mortality from insects and pathogens as trees are exposed to more stress associated with growing-season drought.

**Invasive Plants**

- Altered distribution and spread of non-native plant species.
- Many invasive species found in the region will likely proliferate following fire/other disturbances.

**Information from the following references and the citations therein:**

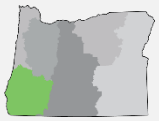

1. Halofsky, J.E., D.L. Peterson, and R.A. Gravenmier, eds. 2022. Climate change vulnerability and adaptation in southwest Oregon. Gen. Tech. Rep. PNW-GTR-995. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. 445 p.

2. Halofsky, J.E., D.L. Peterson, and R.A. Gravenmier, eds. 2023. Climate change vulnerability and adaptation in Coastal Oregon. Gen. Tech. Rep. PNW-GTR-XXX. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. XXX p.

3. Dalton, M. and E. Fleishman, eds. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University. 183 p.

4. Fleishman, E., ed. 2023. Sixth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University. 248 p.

5. Department of Land Conservation and Development. 2023. Climate Change Vulnerability Assessment Workshops, Regional Climate Change Projections Fact Sheets. https://www.oregon.gov/lcd/CL/Pages/Vulnerability-Assessment.aspx



SOUTH COAST

# REGION 2 Observed & Projected Changes for Habitats & Fish Species

## Habitats

### High-Elevation Forests & Parklands

credit: BLM

- Reduction in climatically suitable habitat for high-elevation forests.
- Increased conifer tree growth.
- Decreased meadow habitat as conifers establish and advance from the forest edge.
- Longer summer dry period and potential increase in area burned by high-severity fires.
- Increased competition between currently dominant species in the subalpine zone and those dominant at lower elevations.
- Lodgepole pine forests are likely to expand with increased fire frequency.

### Moist Forests

Credit: Linda Repplinger

- Fire- and drought-intolerant species (e.g., western hemlock, Pacific silver fir, western redcedar) likely to decrease in abundance; species such as Douglas-fir and tanoak favored given projected changes.
- Hardwood species (e.g., tanoak) and shrub species (e.g., Ceanothus) may successfully compete with conifer seedlings in areas that experience multiple high-severity wildfires, particularly on drier sites.
- Increased productivity due to increased growing season length, adequate moisture levels, and increased atmospheric $CO_2$; however, moisture may become limiting for tree establishment and growth on drier sites.

### Mesic Forests

Credit: Linda Repplinger

- Mesic forests in the region could transition to more xeric forests.
- White fir/grand fir abundance is likely to decline with drier conditions and increased fire frequency.
- Fire- and drought-tolerant species (e.g., Douglas-fir, incense cedar, sugar pine) likely to increase in abundance.
- Increases in temperature, drought, and extent of wildfire may increase the frequency of disturbance to fir forests by fir engraver.
- Increased area burned and drought severity will likely favor shrubs and larger patch size in mesic forests.
- Increasing summer drought stress will decrease growth for many species and increase vulnerability to insects and disease.

### Ultramafic Forests & Woodlands

credit: Bill Bouton

- Increased drought stress may cause declines of some species that occur in serpentine soils however, past records indicate that reduced water may not affect plant communities on serpentine soils as much as those that occur on more productive soils.
- Endemic species confined to specific soils may be unable to migrate to suitable sites.
- Increased fire activity will likely favor shrubs over conifers on serpentine sites.

## Dry Forests


credit: Jim Trodel

- Warmer temperatures, greater summer water deficit, and increased fire frequency could shift dry forests to woodlands or shrublands in the driest portions of the dry forest range.
- Large, high-severity fire patches may inhibit forest development and result in long-term shrub or hardwood dominance.
- More frequent fires will likely decrease tree density while the extent of shrub and hardwood patches will increase.
- Tree-canopy base heights will likely increase due to frequent fires removing lower branches.
- Occurrence and productivity of Douglas-fir may be limited by drought on drier sites.
- Potential increases in tree mortality due to interacting effects of drought, disturbance, & insects.

## Woodlands


credit: Sue Sierralupe

- Projected expansion of woodland types with hotter and drier conditions.
- Increased fire frequency could reduce conifer encroachment, favoring the development of relatively open oak woodlands.
- Fire exclusion and nonnative annual grass species may limit the capacity of oak woodlands to adapt to changing conditions.

## Shrublands


credit: Brewbooks

- Likely expansion with increased fire and summer water deficit.
- Chaparral shrub species likely to establish following high severity fire; repeated fire could perpetuate chaparral vegetation.

## Wetlands, Riparian, & Groundwater-Dependent Ecosystems (GDE)


credit: Don Henise

- Reduced water during summer could potentially reduce the duration and depth of standing water and increase water temperatures.
- Drying in riparian areas may alter plant community composition.
- Increased precipitation variability and extreme precipitation events will increase the risk of damaging floods.
- Some ephemeral montane wetlands could disappear while some intermediate wetlands may become ephemeral.

## Estuarine


credit: Frank Price

- Higher sea levels, stronger winter storms, and warmer, drier summer conditions will affect the spatial extent of estuarine habitats and interactions with coastal terrestrial habitats.
- Saltwater intrusion.
- Coastal flooding and erosion.
- Large mainstem rivers close to estuaries may experience greater tidal inundation and flooding in the winter in response to higher sea levels coupled with high flows from intense winter storms.
- Increased tidal inundation time on lowland marshes, altering vegetation composition and leading to a transition to mudflat or open water.

## Fish Species

### Steelhead Trout


credit: Greg Shields, cc

- Summer-run adult migration may be delayed by thermally stressful temperatures.
- Declines in summer flows that result in passage barriers may limit access to upstream spawning areas.
- Juveniles that rear in steep channels are vulnerable to more frequent or larger disturbances associated with wildfires and debris flows or floods and scour.
- Lower flows and warmer temperatures place additional stress on steelhead, which could increase pre-spawn mortality rates, impair spawning ability, or reduce viability of eggs and embryos.

### Coastal Cutthroat Trout


credit: Bureau of Environmental Services.

- Migrating adults and juveniles located in low-elevation streams may be affected by increased water temperatures; headwater populations are likely less vulnerable because temperature increases are projected to be smaller.
- Potential increased susceptibility to wildfire, debris flows, and large summer flow reductions for populations using steep headwater habitats.
- Downstream displacement of headwater-rearing fish, with increased exposure to warmer stream temperatures and potential for intensified biological interactions with native and nonnative species found lower in the watershed.

### Pacific Lamprey


credit: USFWS

- Temperatures exceeding 20°C (68°F) can cause thermal stress for rearing juveniles and migrating adults.
- Declines in summer flows may exacerbate fish passage issues as adult lamprey are relatively weak swimmers.
- Smallmouth bass become more active predators in warmer temperatures, which could increase the vulnerability of lamprey juveniles.
- Long residence time of immobile juveniles in stream substrates makes them vulnerable to increased peak flows and scour as well as wildfire-triggered debris flow that smother burrows.

### Umpqua Chub


credit: Doug Markle OSU Fisheries

- May persist in cooler locations upstream of smallmouth bass invasion front, as predation by smallmouth bass has reduced or eliminated chub populations in much of the Umpqua River.

### Coho Salmon


credit: USGS

- Warming water temperatures can accelerate egg incubation rates in winter or spring and potentially desynchronize the developmental phenology of juveniles from the temporal availability of seasonal habitats.
- Resident juvenile life stages are likely to be impacted by long-term summer flow declines and temperature increases, which can result in habitat loss, reduced population sizes due to increased competition for food and space, and mortality.
- Warming trends in summer may create chronic stresses for juveniles and could force upstream distribution shifts and range contractions.
- Increased channel disturbance (e.g., from larger peak flows, sediment deposition following fire) may affect coho during incubation and rearing life stages.

## Chinook Salmon


Credit: Greg Morgan, BLM

- Spring Chinook migrating upriver during the warm summer months may be vulnerable to increasing stream temperatures (e.g., altered migration timing or stopping migrations temporarily; reduced viability of eggs or increased pre-spawn mortality rates in adults).
- The South Fork Umpqua River and mainstem Umpqua River currently have the warmest temperatures in the region; future projections suggest further warming which, when coupled with enhanced predation by smallmouth bass and increased potential for disease outbreaks, likely makes these populations more vulnerable.
- Summer temperatures are less of a concern during adult migrations elsewhere in the region.

**Information from the following references and the citations therein:**


1. Halofsky, J.E., D.L. Peterson, and R.A. Gravenmier, eds. 2022. Climate change vulnerability and adaptation in southwest Oregon. Gen. Tech. Rep. PNW-GTR-995. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. 445 p.
2. Halofsky, J.E., D.L. Peterson, and R.A. Gravenmier, eds. 2023. Climate change vulnerability and adaptation in Coastal Oregon. Gen. Tech. Rep. PNW-GTR-XXX. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. XXX p.