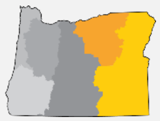


EASTERN & COLUMBIA BASIN

REGIONS 5 & 6

Observed & Projected Climate Changes

Air & Water Temperature

Observed

Annual Air

- Mean annual temperatures have increased by about 0.06°C (0.1°F)/decade between 1895-2013.
- In Oregon, the past 20 years (2000-2019), except 2011, were warmer than the 20th century (1900-1999) average.

Extreme Heat

- Increasing number of days >90°F (32°C) (e.g., +8 days/yr in Pendleton)
- Relative to 1981-2010, the average number of hours of exposure to heat indexes >80°F (27°C) or 90°F (32°C) has increased.

Streams

- Across the Pacific Northwest, stream temperature increases have occurred during summer, fall, and winter, with the highest rates of warming in the summer (0.2°C (0.4°F)/decade).

Projected by 2100

Annual Air

- +1.1°C (2°F) to +4.7°C (8.5°F) compared to 1970-99.

Seasonal Air

- Increased summer air temperature (+5.4°C/9.7°F by 2080s), with smaller increases during other seasons.
- Summer (mean maximum daily temperature):
  - La Grande: 29°C (85°F) in 2020s; 31.2°C (89°F) by 2050s.
  - Burns: 29°C (85°F) in 2020s; 30.1°C (87°F) by 2050s.
- Winter (mean maximum daily temperature):
  - La Grande: 5.6°C (42°F) in 2020s; 6.7°C (44°F) by 2050s.
  - Burns: 10°C (50°F) in 2020s; 11.1°C (52°F) by 2050s.

Extreme Heat

- Longer, more frequent, and more intense extreme heat events.
- Increase in the annual number of days ≥90°F (32°C) by mid-century (+17 to +33 days) compared to 1971-2000.
- Increased frequency and magnitude of days with an extreme heat index (temperature + humidity
  - Hermiston, Rome, and Ontario are projected to have the greatest increases in the number of extreme heat index days by the late 21st century.

Streams

- Temperature in low-elevation, warmer streams (less shade, less cool water groundwater inputs) will likely increase the most in the future.
- +2°C (3.6°F) for mean August stream temperature.

Precipitation & Drought

Observed

Annual

- No significant trend in annual precipitation in the region, although the last 30 years have generally been drier than the 20th century average.

Snowpack

- From 1982-2017, peak snow-water equivalent (SWE) declined in the Steens Mountains, Trout Creek Mountains, and Wallowa Mountains.

- Complete melting of snowpack has occurred slightly earlier (2-10 days earlier per decade) in the southern and northern Blue Mountains, Steens Mountains, and along the lower elevations of the Wallowa Mountains.

Drought

- Persistent and severe droughts have occurred in Oregon since 2000.

Projected by 2100

Annual

- Projections range from wetter to drier.

Seasonal

- Decreased summer precipitation and slight increases during other seasons.

Extreme Precipitation

- 60% increase in number of extreme rainfall events in Burns from the 1990s to 2050s.
- Increase in frequency and intensity of floods due to stronger storms and a shift from snow to rain.
- Increased risk of flash floods.
- Increased intensity of atmospheric rivers and possible penetration further inland.

Snowpack

- Declines in snowpack persistence and April 1 SWE, with largest declines in mid-elevation and wetter locations.
- In the Blue Mountains, large areas could lose all or significant portions of April 1 SWE by mid-century.
- Watersheds historically classified as mixed rain and snow will become rain-dominant.
- Annual mean snowfall in Union County projected to decline from 5 ft (1.5 m) in 1981-2010 to 3 ft (0.9 m) in 2025-2049.

Drought

- Increased severity and duration of droughts.
- Annual number of dry days:
  - Union County: 157 days in 1990s; 163 days by 2050.
  - Burns: 133 days in 1990s; 140 days by 2050.

Hydrology

Observed

Streamflows

- In the Western U.S., increased temperatures have led to earlier runoff timing in snowmelt-dominated and mixed rain-and-snow watersheds; spring, early summer, and late-summer flows have been decreasing and more of the annual flow has been occurring earlier in the water year.
- In the Blue Mountains, summer flows decreased 21-28% in the period from 1949-2010.

Projected by 2100

Streamflows

- Flood magnitude likely to increase in the Wallowa Mountains, Hells Canyon Wilderness Area, and northeastern portion of the Wallowa-Whitman National Forest, with mid-elevation areas the most vulnerable to rain-on-snow events.
- Locations with the greatest change in flood magnitude also show substantial changes in the frequency of largest flows in winter (i.e., these areas likely to have more frequent high flows).
- No change in frequency of mid-winter flood events.
- Runoff timing of streams projected to occur 9-23 days earlier in the year.
- Projections of future low flows show relatively minor decreases (<10%) in summer streamflow for 47% of perennial streams across the Blue Mountains region however, some portions (e.g., Wallowas, Greenhorn Mtns., Wenaha-Tucannon Wilderness) show greater decreases (>30%).

Disturbances

Observed

Wildfire

- In the northwestern U.S., large forest fires have become near-annual.
- Annual area of shrubland burned has increased.
- In the Blue Mountains, wildfires have moved upslope (i.e., spread into higher elevations that were previously cool and moist enough to deter fire expansion) at a rate of 12 m (39 ft)/yr from 1984-2017.

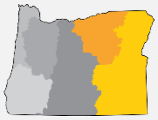
Projected by 2100

Wildfire

- Increased number of wildfires in national forests in the Pacific Northwest.
- Increased area with high fire danger in the summer.
- Increased number of high fire danger days in summer and fall.
  - LaGrande: 14 days in 2020s; 20 days by 2050s.
  - Burns: 13 days in 2020s; 19 days by 2050s.

Information from the following references and the citations therein:

1. Halofsky, J.E. and D.L. Peterson, eds. 2017. Climate change vulnerability and adaptation in the Blue Mountains. Gen. Tech. Rep. PNW-GTR-939. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. 331 p.
2. Dalton, M. and E. Fleishman, eds. 2021. Fifth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University. 183 p.
3. Fleishman, E., ed. 2023. Sixth Oregon Climate Assessment. Oregon Climate Change Research Institute, Oregon State University. 248 p.
4. 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



EASTERN & COLUMBIA BASIN

REGIONS 5 & 6 Observed & Projected Changes for Habitats & Fish Species

Habitats

Subalpine & Alpine

credit: Araddon

- Potential increase in productivity in response to warming and elevated atmospheric CO_2.
- Increased tree growth within the treeline ecotone and an upward advancement of treeline in some locations.
- Reduction in climatically suitable habitat for most cold upland tree species.
- Potential conversion to herbaceous parklands with ponderosa pine.
- High-elevation mountains (e.g., Wallowa Mtns., Seven Devils) may serve as refugia for some subalpine species.
- Longer summer dry periods may make wildfire events more common.
- Increased potential for insect and disease outbreaks, increasing stress and mortality in these forests.

Moist Upland Forests

credit: BLM

- Moderate warming may lead to increased productivity however, more extreme warming and increased drought stress in lower elevations and Malheur National Forest will likely cause decreased tree growth and forest productivity.
- Potential expansion into new available habitats.
- Increased summer drought stress may make these forests more vulnerable to other stressors.
- Increased wildfire activity and insect and disease outbreaks, potentially leading to reduced distribution of these forests.

Dry Upland Forests

credit: BLM

- Decreased tree growth and forest productivity in a warmer, drier climate.
- Shifts to woodland or steppe vegetation in the hottest and driest sites.
- Ponderosa pine is likely less vulnerable than Douglas-fir.
- More large and severe wildfires, which could cause conversion to shrublands or grasslands at lower elevations.

Woodlands

credit: Nick Perla

- Higher spring and summer temperatures may negatively affect hot and dry juniper woodlands at lower elevations.
- Years with increased spring and summer precipitation will likely facilitate expansion of juniper.
- Increased fire frequency and severity will likely lead to the conversion of some woodlands to persistent grasslands.

Shrublands


credit: OWEB

- Increased warming is likely to result in expansion of shrublands as they are better adapted to arid conditions.
- Increased fire frequency could result in conversion to nonnative annual grasslands.

Grasslands


credit: Karen Allen

- In a warmer climate, grasslands at lower elevations may shift towards more drought-tolerant species.
- With increased warming and fire occurrence, grasslands will likely expand, particularly in areas where shrublands and woodlands are no longer able to support woody species.
- Increased abundance and extent of nonnative annual grasses.

Riparian


credit: Sue Greer

- Conifer-dominated riparian areas will become more susceptible to drought, wildfire, and insect outbreaks; conifer-dominated communities will increase, particularly at lower elevations, encroaching on shrub-dominated riparian areas and herbaceous-dominated meadows.
- Riparian and wetland aspen communities will likely decrease in extent and decline in vigor due to drought and reduced water availability; some populations may be lost because of altered local hydrology.
- Cottonwood-dominated riparian areas likely to decrease in extent; reductions in late summer baseflows likely to impact persistence of existing stands and changes in timing and magnitude of spring runoff likely to influence recruitment and establishment of new individuals.
- Willow-dominated riparian areas likely to decrease in extent due to changes in frequency and magnitude of flooding and lower water table late in the growing season; species composition likely to shift, favoring more drought-tolerant willows and other shrub species.
- Other woody-dominated riparian areas will increase in extent in some areas, displacing more mesic willow species and communities and favoring drought-tolerant species; communities dominated by more drought-tolerant species could see increased conifer encroachment and potential replacement of some shrub species.
- Herbaceous-dominated riparian areas likely to decrease in extent due to decreased water availability and changes in the magnitude, duration, and extent of flooding; some sedge species may be replaced by more drought-tolerant native and nonnative grasses and invasive species will likely increase.

Groundwater-Dependent Ecosystems (GDE)


credit: BLM

- Drier summers, earlier onset and faster rate of snowmelt, and decreased snow-water equivalent (SWE) will affect groundwater recharge rates, which will influence groundwater levels and the amount of water available to support springs, groundwater-dependent wetlands, stream baseflows, and soil moisture.
- Aquifers in sedimentary or basalt formations are likely more sensitive to altered climate conditions; similarly, GDEs supported by small, local groundwater systems will likely be more sensitive (e.g., exhibit more variation in temperature and nutrient concentrations).
- Some GDEs will likely contract in response to decreasing surface water and groundwater and warming temperatures.
- Reduced productivity of GDEs, including springs and wetlands.

Fish Species

Steelhead & Redband Trout

credit: Greg Shields, cc

- Both species have relatively warm thermal niches, which makes them less affected by future stream temperature increases than bull trout and spring Chinook.
- Possible expansion of suitable habitat as upstream distributions are currently limited by cold temperatures in many streams.
- Some flexibility to adapt to warmer temperatures through different life histories, phenology, and distribution shifts.

Bull Trout

credit: Aubree Benson USFS

- Sensitive to future temperature increases, with spawning and juvenile rearing likely the most constrained by warmer water temperatures.
- Colonization of new upstream habitats unlikely due to stream slope and small flow volumes.

Spring Chinook Salmon

credit: Greg Morgan, BLM

- In the Blue Mountains, populations of spring Chinook are sensitive to future temperature increases as their primary spawning and rearing streams occur at low elevation and are relatively warm.
- Potential loss of habitat due to large body size and preference for spawning in unconfined valleys with gravel substrate (i.e., these factors may preclude colonization of new upstream habitats).

Information from the following references and the citations therein:

1. Halofsky, J.E. and D.L. Peterson, eds. 2017. Climate change vulnerability and adaptation in the Blue Mountains. Gen. Tech. Rep. PNW-GTR-939. U.S. Dept of Ag., Forest Service, Pacific Northwest Research Station. 331 p.