CLIMATE IMPACTS – NORTHWEST US

From the Adaptation Workbook: www.adaptationworkbook.org/explore-impacts

This region was defined in the National Climate Assessment (2014) and includes the states of Idaho, Oregon, and Washington. For more information, see: National Climate Assessment (2018) – Northwest

Summary of Climate Impacts (details and citations on subsequent pages):

Temperatures in the Northwest are projected to increase by 3.5 to 8.5 degrees Fahrenheit by 2085.

By the middle of the century, the Northwest region is expected to experience 3 to 18 more days per year with a maximum temperature exceeding 95 degrees F.

The Northwest region is expected to experience between 5 and 30 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

Climate conditions may increase wildfire risks in in the Northwest by the end of the century.

By the end of the century, average annual precipitation is projected to increase slightly in the Northwest.

The number of days per year with more than 1 inch of precipitation will increase across the Northwest by the middle of the century.

The freeze-free season is expected to increase by 20 to 40 days in the Northwest by the middle of the century.

Warmer temperatures, reduced snowpack, and greater water demand for agriculture may reduce available water for natural ecosystems.

Climate change will amplify many existing stressors to forest ecosystems in the Northwest, such as insect pests , tree diseases, and wildfire.

Many tree species and ecosystems in the Northwest may decline under climate change.

Low-diversity systems are at greater risk from climate change.

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Temperatures in the Northwest are projected to increase by 3.5 to 8.5 degrees Fahrenheit by 2085.

All climate models agree that temperatures are projected to increase over the 21st century across the Northwest, with almost uniform temperature increases across the entire region. The greatest warming is expected in southern Idaho and along the coast. The greatest warming is expected during summer months, particularly in Idaho and Oregon. Warming is generally smaller in spring.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

By the middle of the century, the Northwest region is expected to experience 3 to 18 more days per year with a maximum temperature exceeding 95 degrees F.

The largest simulated increases occur in southern Idaho, with as many as 18 more days above 95 degrees F each year. The smallest increases in hot days occur in high-elevation areas of the Cascades and Rocky Moutains, because projected temperature increases are still not enough to increase the chance of such warm days.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

The Northwest region is expected to experience between 5 and 30 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

The largest decreases are expected in the inland of the region, particularly in high-elevation areas in central Idaho. The smallest decrease in cold days is expected coastal and southern parts of the region, where these kinds of cold days rarely occur. Similarly, high-elevation areas are expected to have up to 40 fewer days with a minimum temperature below 32 degrees by the middle of the century, particularly in the mountains of Oregon and Washington, and northern Idaho.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

Climate conditions may increase wildfire risks in in the Northwest by the end of the century.

Although wildfires are a natural part of most Northwest forest ecosystems, warmer and drier conditions have helped increase the number and extent of wildfires in western U.S. forests since the 1970s. Wetter, cooler, high-elevation ecosystems in the Northwest will likely have increasing wildfire probability with future warming and potentially drier summers. By the 2080s, the median annual area burned in the Northwest would quadruple relative to the 1916 to 2007 period to 2 million acres (range of 0.2 to 9.8 million acres) under the A1B scenario. Averaged over the region, this would increase the probability that 2.2 million acres would burn in a year from 5% to nearly 50%. The limitation for these sorts of projections is that they do not account for changes in land use, fire suppression rates, or vegetation changes.

P. Mote, A. Snover, and others. 2014. National Climate Assessment – Northwest. U.S. Global Change Research Program.

By the end of the century, average annual precipitation is projected to increase slightly in the Northwest.

There is general agreement between different climate scenarios for future precipitiation projections in the Northwest. Generally, the largest increase is projected for northern Washinton (9-12% increase), with increases becoming smaller toward southern Oregon and Idaho (0-3% increases). Precipitation decreases appear more likely for summer months across the entire region (average decline = 11%), particularly in high-elevation areas. Winter months may experience slightly increased precipitation, and projections for fall and spring are mixed across the region.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

The number of days per year with more than 1 inch of precipitation will increase across the Northwest by the middle of the century.

The largest increases in days per year with more than 1 inch of precipitation is projected for areas east of the Cascades in Oregon and Washington (40% increase). For the rest of the region, projected changes in extreme rainfall are smaller than normal year-to-year variation.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

The freeze-free season is expected to increase by 20 to 40 days in the Northwest by the middle of the century.

The freeze-free season is defined as the period of time between the last spring frost (daily minimum temperature below 32 degrees F) and the first fall frost. The length of the annual freeze-free season has been increasing since the 1980s, and all climate models agree that it will continue to increase in the future. The largest increases are projected for the areas west of the Cascades, with some areas increasing by more than 40 days. The rest of the region is expected to have roughly 25-day increases in the growing season.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Northwest. NOAA.

Warmer temperatures, reduced snowpack, and greater water demand for agriculture may reduce available water for natural ecosystems.

Winter snowpack, which slowly melts and releases water in spring and summer, is key to the Northwest's hydrology and water supplies. Since around 1950, area-averaged snowpack on April 1 in the Cascade Mountains decreased about 20%, spring snowmelt occurred 0 to 30 days earlier, late winter/early spring streamflow increases ranged from 0% to greater than 20% as a fraction of annual flow, and summer flow decreased 0% to 15% as a fraction of annual flow. Under climate change, the largest changes are expected in basins that typically recieve lots of snow. Warming will increase winter stream flows and advance the timing of snowmelt as much as 3-4 weeks earlier by the middle of this century. Summer flows in these basins are projected to be substantially lower.

P. Mote, A. Snover, and others. 2014. National Climate Assessment – Northwest. U.S. Global Change Research Program.

Climate change will amplify many existing stressors to forest ecosystems in the Northwest, such as insect pests , tree diseases, and wildfire.

Forest pests, diseases, and droughts are expected to become more damaging under climate change, and these factors may interact in unpredictable ways. Many impacts will be driven by water deficits, which increase tree stress and mortality, tree vulnerability to insects, and fuel flammability. Higher temperatures and drought stress are contributing to outbreaks of mountain pine beetles that are increasing pine mortality in drier Northwest forests. Between now and the end of this century, the elevation of suitable beetle habitat is projected to increase as temperature increases, exposing higher-elevation forests to the pine beetle, but ultimately limiting available area as temperatures exceed the beetles' optimal temperatures. As a result, the proportion of Northwest pine forests where mountain pine beetles are most likely to survive is projected to first increase (27% higher in 2001 to 2030 compared to 1961 to 1990) and then decrease (about 49% to 58% lower by 2071 to 2100).

P. Mote, A. Snover, and others. 2014. National Climate Assessment – Northwest. U.S. Global Change Research Program.
J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.

Many tree species and ecosystems in the Northwest may decline under climate change.

For many tree species, the most climatically suited areas will shift from their current locations, increasing vulnerability to insects, disease, and fire in areas that become unsuitable. Projections indicate that 21 to 38 currently existing plant species may no longer find climatically appropriate habitat in the Northwest by late this century. Subalpine forests and alpine ecosystems are especially at risk and may undergo almost complete conversion to other vegetation types by the 2080s. For example, Climate is projected to become unfavorable for Douglas-fir over 32 percent of its current range in Washington by the end of the century.

P. Mote, A. Snover, and others. 2014. National Climate Assessment – Northwest. U.S. Global Change Research Program.

J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.

Low-diversity systems are at greater risk from climate change.

Studies have consistently shown that diverse systems have exhibited greater resilience to extreme environmental conditions and greater potential to recover from disturbance than less diverse communities. This relationship makes less diverse communities inherently more susceptible to future changes and stressors. The diversity of potential responses of a system to environmental change (response diversity), is a critical component of ecosystem resilience. Response diversity is generally reduced in less diverse ecological systems. Genetic diversity within species is also critical for the ability of populations to adapt to climate change, because species with high genetic variation have better odds of producing individuals that can withstand extreme events and adapt to changes over time.

T. Elmqvist , C. Folke, and others. 2003. Response diversity, ecosystem change, and resilience. Frontiers in Ecology and the Environment.
A. Hoffman and C. Sgrò. 2011. Climate change and evolutionary adaptation. Nature.

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Habitat fragmentation can hinder the ability of tree species to migrate to more suitable habitat on the landscape, especially if the surrounding area is nonforested. Modeling results indicate that mean centers of suitable habitat for tree species will migrate between 60 and 350 miles by the year 2100 under a high emissions scenario and between 30 and 250 miles under milder climate change scenarios. Based on data gathered for seedling distributions, it has been estimated that many northern tree species could possibly migrate northward at a rate of 60 miles per century. Fragmentation makes this disparity even more challenging, because the landscape is essentially less permeable to migration.

L. Iverson, M. Schwartz, and others. 2004. How fast and far might tree species migrate in the eastern United States due to climate change? Global Ecology and Biogeography.

C. Woodall, C. Oswalt, and others. 2009. An indicator of tree migration in forests of the eastern United States. Forest Ecology and Management.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Some species and forest types are confined to particular habitats on the landscape, whether through requirements for hydrologic regimes, soil types, or other reasons. Similar to species occurring in fragmented landscapes, isolated species and systems face additional barriers to migration. Widespread species may also have particular habitat requirements. For example, sugar maple is often limited to soils that are rich in nutrients like calcium, so this species may actually have less available suitable habitat than might be projected solely from temperature and precipitation patterns. Riparian forests are not expected to be able to migrate to upland areas because many species depend on seasonal flood dynamics for regeneration and a competitive advantage. Similarly, lowland conifer swamps contain a unique mix of species that are adapted to low pH values, peat soils, and particular water table regimes. These species face additional challenges in migration compared to more-widespread species with broad ecological tolerances.

A. Jump and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. Ecology Letters.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Disturbances such as wildfire, flooding, and pest outbreaks are expected to increase in the future. Forests that are adapted to gap-phase disturbances, with stand-replacing events occurring over hundreds or thousands of years, may be less tolerant of more frequent widespread disturbances. Mesic hardwood forests can create conditions that could buffer against fire and drought to some extent, but these systems are not expected to do well if soil moisture declines significantly. Forest systems that are more tolerant of drought, flooding, or fire are expected to be better able to withstand climate-driven disturbances. This principle holds true only to a given point, because it is also possible for disturbance-adapted systems to experience too much disruption. For example, dry pine forests and woodlands might benefit from drier conditions with more frequent fire, but these systems might also convert to savannas or open grasslands if fire becomes too frequent or drought becomes too severe.

G. Nowacki and M. Abrams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. BioScience.

E. Gustafson and B. Sturtevant. 2013. Modeling Forest Mortality Caused by Drought Stress: Implications for Climate Change. Ecosystems.