The impacts of climate change at Mount Rainier National Park

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Photo credit: Larry Workman

Past and future climate change

Average annual temperature in the Pacific Northwest has increased 0.83ºC (1.5ºF) since 1920 and is projected to increase an additional 2.0 - 4.0ºC (3.6 - 7.2ºF), or more, by the end of the century. In addition to higher temperatures, the region will likely experience wetter winters and drier summers, with a slight increase in annual precipitation. These alterations of the climate system are due in large part to human actions, namely the emission of greenhouse gases. Below are some of the ways Mount Rainier National Park could be affected by these changes in climate.

Glaciers, debris flows and floods

The Park's glaciers have decreased in area and volume over the last century in association with increasing temperatures. The retreat of the glaciers has exposed large amounts of loose soil that can be washed into river channels during heavy rain events. Once in the channel, this soil can mix with water to form a fast-moving slurry called a debris flow. These flows can be very powerful and dislodge large boulders or trees, and also destroy riverside buildings and roads. Much of the debris washed into the Park's rivers settles out at lower elevations and accumulates on the river bed. Some areas of the Park have experienced such high rates of accumulation that the beds of some stretches of river are actually above the surrounding landscape, making it more likely for waters to overtop river banks and flood large areas of land during intense rainstorms. For example, Longmire is 8.8m (29 feet) *below* the bed of the nearby Nisqually River. Future temperature increases will likely lead to greater retreat of the glaciers and perhaps increased risk of debris flows and flooding.

Air quality

Mount Rainier's location downwind of the Seattle-Tacoma metropolitan area can lead to high concentrations of air pollutants in the Park. In fact, high elevation sites such as Paradise often have higher average ground-level ozone concentrations than Seattle. Ground-level ozone is an air pollutant that harms humans and other organisms. Higher temperatures tend to lead to higher concentrations of ground-level ozone and other air pollutants. Therefore, future warming is expected to have a negative impact on the Park's air quality.

Forests

The abundances and distributions of the Park's tree species are strongly influenced by climate. Thus, climate change is expected to lead to shifts in the geographic ranges of tree species within the Park. But the long lifetimes of these trees suggest that climate change induced range shifts will be slow in the absence of major disturbances. However, background rates of tree mortality have increased in Pacific Northwest forests, a trend thought to be caused by higher temperatures and greater drought stress. This increased mortality could alter the structure, composition and carbon storage of Mount Rainier's forests. Also, the increased temperatures and decreased summer precipitation brought about by climate change would lead to drier conditions that could increase the frequency of forest fires. An increase in fire frequency could also lead to faster shifts in tree species ranges if fires kill adult members of cool-adapted species to allow seedlings of warm-adapted species to establish.

Subalpine and alpine meadows

Photo credit: Janneke Hille Ris Lambers

The subalpine and alpine meadows of the Park are found at high elevations where temperatures are too cold or snow covers the ground for too long for trees to grow. Over the last century, ecologists have documented tree establishment in subalpine meadows throughout the Park in association with increased temperatures. Higher temperatures and longer snow-free periods in the future will likely lead to the establishment of more trees in subalpine meadows and colonization of bare ground by alpine plants, leading to an overall upward movement of these meadows. This movement will probably result in a reduction of the area occupied by the meadows, because there is less land at higher elevations, which could lead to the loss of some subalpine and alpine plant species.

Species at risk

Virtually all of the species Mount Rainier supports will be affected by climate change in some way. Many of these species will likely be at risk of decline within the Park and throughout their range. Below, I discuss two species that could be in jeopardy. These case studies exemplify the risks species face and the complexities of predicting species responses to climate change.

Whitebark pine

The whitebark pines at Mount Rainier have been victim to a non-native disease called the white pine blister rust that has killed many of these trees in the Park. Climate change poses additional threats to this already imperiled tree species. One of these threats is a potential increase in outbreaks of the mountain pine beetle (a bark-boring insect) which can cause widespread mortality amongst whitebark pines. Although the mountain pine beetle is native to the Park, the high elevation habitats of whitebark pine have historically been too cold for beetle populations to reach epidemic proportions in most years. Rising temperatures would lead to whitebark pine stands becoming more suitable for the beetle, which could, in turn, lead to more beetle outbreaks and reduced numbers of whitebark pines.

The American pika

The American pika is a small mammal found at high elevations in the Park. The animal is sensitive to high temperatures and could be negatively affected by warming in parts of its range. Consistent with this expectation are observations in the Great Basin region of the Southwestern US that 10 out of 25 pika populations documented in the 20th century have apparently disappeared and that the extinct populations were in warmer locations than surviving populations. However, pikas currently occupy locations with a wide range of average temperatures, suggesting that a large portion of the species' habitat will continue to experience suitable temperatures even with substantial warming. Pikas have also been known to adjust their behavior to cope with high temperatures by resting inside shady boulder fields during hot weather and shifting their foraging to cooler times of day. Thus, the pika will likely face threats from climate change, but might be well suited to cope with these threats.

Further reading

For a more in-depth treatment of the topics discussed above, please see the full version of this report, which you can obtain by emailing the author at krford@washington.edu. Also, below is a list of additional sources of information about climate change and its impacts.

Mount Rainier Climate Friendly Parks Action Plan: nps.gov/climatefriendlyparks/parks/MORA.html
The Washington Climate Change Impacts Assessment: cses.washington.edu/cig/res/ia/waccia.shtml
The Intergovernmental Panel on Climate Change: ipcc.ch