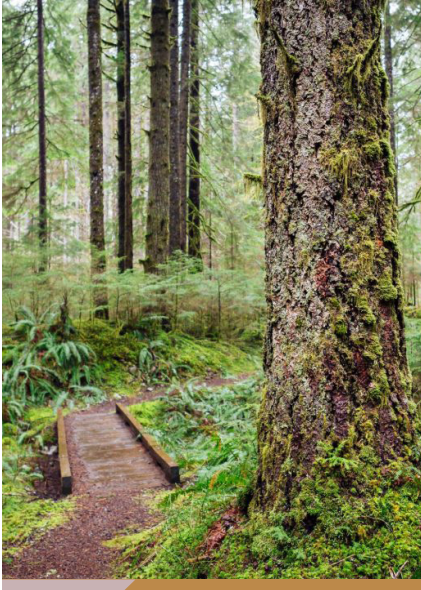


Changing Fire, Changing Forests: The Effects of Climate Change on Wildfire Patterns and Forests in the Pacific Northwest



Forests are an iconic feature of Northwest landscapes. From dense forests of towering conifers in the west to ponderosa pine forests in the east, these ecosystems provide water, wildlife habitat, timber, recreation and other benefits. But climate change is already altering Northwest forests and the resources they provide.

Climate change is bringing warmer and drier conditions that are leading to larger wildfires, droughts and insect outbreaks that stress our forests. When these disturbances interact, they are likely to affect tree regeneration (tree seedling establishment after disturbance), impacting the future structure and composition of our forested ecosystems.

Our forests *are* changing, but there are actions we can take now to help our forests become more resilient to future stresses and continue to provide services for society. Adapting forest management strategies can help forest ecosystems transition to changing climate conditions while continuing to provide benefits to lands, waters, wildlife and people. Starting the process of adaptation now, before a long-term increase in wildfire occurs, will help safeguard forests now and in the future.

Forest disturbances are changing

Wildfires in the Pacific Northwest have been immense in recent years. As the climate changes, warmer and drier conditions are likely to result in even more frequent and extensive fires than those in recent history. Warmer and drier conditions will also likely increase the frequency, intensity and severity of other forest disturbances such as drought and insect outbreaks. Interactions between these disturbances are likely to be the main drivers of forest ecosystem change in a warming climate.

Drought, fire and insect outbreaks are drivers of change

As temperatures in the Pacific Northwest become warmer year-round, there will be less water available in the summer to reduce the effects of drought. Historically, melting snowpack has delivered a steady supply of water throughout summer months. But as temperatures increase, more winter precipitation will fall as rain instead of snow, leading to less annual winter snowpack and less water availability throughout the summer. Decreased water availability in the summer stresses forests and can even be lethal, particularly for young tree seedlings establishing after past disturbance.

Drought also affects the frequency and intensity of wildfire and insect outbreaks. Drier forests and a longer fire season in the summer will create larger areas of dry fuel (flammable dead and live vegetation), which is more likely to ignite and sustain fire over longer periods. Reburns, or recurring fires in an area over a relatively short period of time, are also likely to occur more frequently with increasing temperatures and drought. Reburns, particularly severe reburns that occur at short intervals, can have significant effects on forest regeneration and the types of species that regrow.

Insect outbreaks have already expanded across the Pacific Northwest, driven by higher temperatures and unhealthy forests. Second-growth forests may be particularly vulnerable to drought, fire and insect outbreaks in the future because of their high density of trees.



In 2014, the Carlton Complex Fire set a record for the largest wildfire in Washington State history, burning 256,100 acres. Large wildfires have a significant effect on landscape pattern and forest structure and will become more common under climate change. Photo: Morris Johnson.



Regeneration of species such as Douglas-fir will likely be affected by warming temperatures, increasing drought severity and increasing fire frequency in the future. Photo: U.S. Forest Service, CC By 2.0

Forest regeneration is changing

Changing climate and disturbances are likely to influence forest regeneration, affecting the future structure and composition of forest ecosystems. In the Pacific Northwest, regeneration in dry forests, such as low-elevation ponderosa pine forest, may be sensitive to changing climate. Hotter and drier sites may be particularly at risk for regeneration failures. Dry forests at the warm and dry edges of their distribution (ecotones) may convert to grasslands or shrublands as temperatures increase.

Adapting forest management can increase forest resilience



Forest thinning and prescribed fire will likely help to increase dry forest resilience to fire, insects and drought in a warming climate.

Climate-Smart Forest Management

Larger and more severe wildfires in Pacific Northwest forests will be a major challenge facing resource managers of public and private lands in the future. Fortunately, many current forest management practices including reducing forest density and surface fuels in dry forests, and controlling invasive species, can be considered *climate smart* because they increase resilience to changing climate and disturbances. Although managers may not be able to affect the total area burned by fire, forest management practices such as thinning and prescribed fire can help decrease fire intensity and severity and improve forest resilience to fire, insects and drought.

In wetter, high-elevation and coastal forests, where reducing forest density is a less effective strategy, managers could instead consider installing fuel breaks around high-value resources. Managing for diverse tree species and forest structure across large landscapes, and reducing the effects of non-climatic stressors like landscape fragmentation and invasive species, can also help improve forest ecosystem resilience to a changing climate in wetter forests.

Drier forests are especially at risk of regeneration failures under a changing climate, but there are strategies managers can use to encourage natural regeneration of trees after disturbance. For example, managers can encourage natural regeneration after fire by increasing tree seed sources. This may be done by reducing fire severity (through thinning and prescribed fire) and increasing the number of live residual trees. When and where post-fire planting is an option, managers may consider planting different genetic stock than has been used in the past to increase seedling survival. Since regeneration in the driest locations may be less successful than in the past, planting seedlings on cooler, wetter microsites may also help to increase survival. Managers may need to consider where they will try to forestall change and where they may need to allow conversions to vegetation other than what is currently dominant.

Collaboration is key to protecting our forests



Collaboration among many groups—land management agencies, states, rural communities, private forest landowners, and local stakeholders (e.g., conservation groups)—is needed to manage increasing fire risk in a changing climate and to help Northwest forest ecosystems adapt to changing climate conditions. Working together will help ensure a common vision to protect forest resources now and in the future.

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