Climate Adaptation Recommendations for Forest Management Plans

in Northwest Oregon, the Willamette Valley, and Western Washington

Northwest Natural Resource Group

Overview

This publication provides recommended additions to Northwest Oregon and Western Washington forest management plans to address the impacts of climate change. This publication only includes sections of a management plan that are relevant to climate change, and represents a subset of the content in a standard forest management plan. For more detailed information on climate change projections and climate adaptation strategies, please refer to NNRG's Climate Adaptation Strategies for Western Washington and Northwest Oregon Forests at: https://www.nnrg.org/climateadaptation/

By understanding the projected effects of climate change on Pacific Northwest forests, land managers and forest owners can make informed decisions about adapting their management practices to continue to meet their goals and sustain their forests into the future. A changing climate makes proactive forest management much more important and can also lead forest managers to adjust management techniques they are already using to increase their forest's resilience to the changes predicted for our region.

This document contains information and strategies on forest management across a broad geographic area. To make best use of this approach, it is necessary to understand the predicted climatic shifts for your particular site. Please visit https://climatetoolbox.org/tool/Climate-Mapper to determine predicted climate conditions for your site, and adjust this plan accordingly.

This template includes three kinds of resources:

- Text in **black** is verbiage that the author of a forest management plan might incorporate directly into a plan they are preparing.
- Text in **red** directs the author to resources or site-specific considerations and should be modified or deleted based on what is appropriate to the forest in question.
- Brackets **[ ]** or underscoring **__** should be filled in with the appropriate information for your site.

Table of Contents

Introductory Overview of the Property

Climate

As the climate changes in response to anthropogenic global warming, we can expect to see several climatic shifts over the coming decades, well within the lifetime of the trees now growing on site. Wintertime low temperatures are expected to increase; summertime heat waves are likely to become more extreme, leading to longer periods of severe moisture stress for trees and other vegetation; and droughts are predicted to return more frequently.

The greatest risk to western Oregon and Washington forest ecosystems and individual species is the potential for climate change to exacerbate existing stressors, such as drought, insect and tree disease outbreaks, invasive species competition, wildfires, and habitat loss and fragmentation. Many of these impacts will be driven by water deficits, as greater frequency and intensity of drought conditions increases tree stress and mortality, tree vulnerability to insects, and fuel flammability.

The primary limiting resource for forest productivity will be available soil moisture during the growing season. Reductions in summer water availability can have negative consequences on stand density, drought-sensitive species, seedling establishment and survival, capability to resist pathogens and insects, and potential for invasive species to spread further. Increased temperatures and decreased soil moisture also increase the susceptibility of vegetation to fire.

While data on precipitation patterns is uncertain, warmer oceans and more available moisture in the atmosphere are expected to increase the frequency and intensity of storm events, including heavy precipitation and windstorms. Heavy rainfall associated with atmospheric rivers is anticipated to occur more often. These storms also bring with them episodes of high wind, which is a primary natural disturbance agent in western Oregon and Washington. Wind can cause significant tree mortality, particularly in late fall and winter, when windstorms occur in conjunction with heavy rains or wet snow, saturated soils, and ice storms. Although most wind disturbances involve individual trees or small groups of trees, large blow-down events also occur periodically.

To find out more specific information about the impacts to the site covered in this plan, please refer to the Climate Toolbox [https://climatetoolbox.org/tool/Climate-Mapper] for climatic range predictions under different emissions scenarios.

For sites at elevations that regularly receive accumulating snowfalls which help determine the length of the growing season, the anticipated increase in snow levels and decrease in the depth and duration of snow coverage at middle elevations is worth mentioning— it is a factor that actually stands to increase growth in those forest types.

Native vegetation

In the Puget Trough and Willamette Valley, the most significant anticipated change from current forest conditions will be the transition to forests comprised of more drought-tolerant species, including more pines (ponderosa, western white, and lodgepole) and more broadleaf species such as Oregon white oak, madrone and bigleaf maple. The vegetation and associated wildlife communities within these forests may take decades or centuries to adjust to changes in growing conditions, therefore making it difficult to project exactly how changes to dominant vegetation will actually occur. Maintaining connectivity of intact forests and waterways will help some terrestrial wildlife and plants to shift to more suitable conditions.

Identify the zone for your site and choose the appropriate template text from below:

Changes in the Douglas-fir zone

Climate models project the Douglas-fir zone to expand in size more than other vegetation zones. Across the Douglas-fir zone, increased fire disturbance over time may reduce the proportion of area occupied by large diameter, multi-story structural stage forests. With increased likelihood of fires, there is a greater probability of any single acre burning, and since west side forests have high levels of biomass per acre, there's a greater likelihood of stand replacement. While the literature does not predict an uptick in the frequency of “synoptic wind events,” in which dry east winds increase fire severity and enable wildfire to spread rapidly across the landscape, drier vegetation which is more susceptible to ignition means that those synoptic wind events are more likely to encounter a small fire that is at risk of being “blown up” into a major event. Mixed fire conditions and riparian areas like the fires that have burned through the Columbia River Gorge in the last 100+ years suggest there will still be larger diameter trees retained, but even some of the giants succumb to fire.

On portions of the current Douglas-fir zone at lower elevations, on south-facing aspects, and on well drained, glacial outwash soils, some stands could shift to grass and forb (flowering plant) communities that include oak savanna and camas prairies. At these locations, low soil moisture and higher soil temperature is common due to thin organic horizons, coarse soils, and temperature fluctuations.

Changes in the western hemlock zone

Western hemlock may move up in elevation, thereby displacing the current lower extent of the Pacific silver fir zone. In turn, a warmer climate with drier summers could favor a transition of a portion of the western hemlock zone to the Douglas-fir zone.

Forests in the western hemlock zone will continue to be dominated by Douglas-fir and other early seral plant associates as temperature and natural disturbance rates increase, preventing the forests from reaching the later seral stages during which western hemlock predominates. Shrubs could compete with tree seedlings in areas that experience multiple high-severity fire disturbances, particularly on drier sites where vine maple, giant chinquapin, or snowbrush are present prior to disturbance.

Changes in higher-elevation forest types

Above the western hemlock zone, predicted changes in climate will have the overall effect of pushing forest types upward to higher elevations. In general, impacts on higher-elevation forest types will be governed by the balance between three factors: increases in the growing season that favor energy-limited systems where light, temperature, and snow-free days constrain plants' ability to grow; decreases in productivity due to moisture stress as a result of prolonged summer dry spells; and increased pressure from insects, whose life cycles are favored by warmer winters. In addition, warmer, drier summers are apt to increase the chances of fire. In the mountain hemlock zone, higher-severity, infrequent fires can lead to the predominance of lodgepole pine, while lower-intensity, more frequent fires favor the establishment and maintenance of mountain hemlock overstory.

If climate change is anticipated to extirpate or seriously constrain the future distribution of any tree species on the site, mention it here.

RESOURCE CATEGORY I: Forest Health, Wildfire, Invasive Species

Disease

A diverse spectrum of pathogens — from fungi, bacteria, and viruses to parasitic plants, nematodes and other microorganisms — can all cause tree diseases, making it hard to generalize about the impact of climate change on forest pathogens. Thus, trends for forest pathogens in a changing climate are difficult to predict. Overall, environmental factors, particularly those related to moisture availability and heat waves. reduce trees' resistance to disease. Since insects serve as vectors that promote the introduction of disease-causing microorganisms, the factors that increase susceptibility to insect outbreaks will also tend to increase tree infection.

Specific effects of climate change on tree pathology may include:

- Root and canker diseases, such as *Armillaria* root disease and *Cytospora* canker, that are favored by warmer, drier summers may increase in presence and severity.
- Foliar and rust diseases favored by warmer and wetter winters, such as sudden oak death and *Phytophthora* root rot, may also increase.
- Swiss needle cast may also increase in areas where winter and spring temperatures are mild and where there is ample moisture.

Insects

Some insects will be favored by climate change, but it is not yet known exactly which ones, because many biotic and abiotic factors play into the response of forest insects, their host trees and community associates. Warmer, drier summers and winters with fewer freezes are expected to increase the frequency and extent of insect outbreaks in forests. Summer conditions may exacerbate moisture stress, making more trees more susceptible to insects. Warmer winter temperatures may further assist many insect species, such as pine beetles and spruce budworm, to overwinter and increase overall reproduction that can lead to larger outbreaks.

Insect outbreaks are typically observed the year of drought and the following year. Insect-caused mortality tends to be species specific, so large outbreaks can significantly alter vegetation structure and forest composition. These outbreaks can open up growing space that could be colonized by vegetation and trees in the understory as well as new vegetation.

Invasive species

The disruption of existing ecosystems that can be expected from climate change may also lead to increased pressure from invasive species. Many exotic and weedy species are already present in the region and are better colonizers of disturbed sites than native species. In the short to medium term, more severe summer droughts and heat waves can be expected to kill some trees and shrubs that make up various layers of the forest canopy, leaving sites that are only partially occupied by vegetation and creating an opening into which invasive species may intrude.

Wildfire

Although wildfire is quite scarce in the western part of Washington compared to the east side of the Cascade Mountains, it is still a relevant natural disturbance regime in this area. Fires tend to be most destructive in young, dense stands and stands with an abundance of downed woody debris and/or standing dead trees. A warming climate can be expected to bring with it an augmented risk of fire. Climate change projections for this region predict an increase in heat waves and summer drought, which will up the level of moisture stress on trees, in turn increasing their susceptibility to wildfire. Warmer, drier conditions in the summer may shift the start of the fire season earlier in the year and extend the duration of the season, thus increasing the probability of ignitions and the spread of fire.

Climate-change-induced mortality among drought-intolerant trees combined with increased mortality within overstocked forests and/or under-managed forests may lead to an increase in the volume of dead wood that serves as fuel during a forest fire. The growth of shrubs and other understory vegetation may increase due to heavier spring rains, creating more biomass that is susceptible to drying out during prolonged summer droughts. Dry understory vegetation can serve as a “ladder fuel” that carries ground fires up into the forest canopy. Dry understory vegetation is particularly susceptible to fire where it is adjacent to public roads and urban development.

Insert a sentence here addressing the specific vulnerabilities of the site to fire, if necessary.

Management recommendations

Disease & insects

Because many pathogens and insects are most virulent toward one species or life stage of tree, a diversity of tree species and age classes will help buffer a forest stand against a potentially catastrophic impact of a single, species-specific pathogen or insect. Further, ensuring tree species are growing on sites where they are most suitable will reduce stress and increase their inherent immunity to diseases and insects.

Invasive species

- Learn which invasive species are present in your area and practice early detection and rapid response eradication. The locations of all invasive species should be mapped and a plan for controlling and/or eliminating created.
- Regularly monitor the forest to detect new species and populations
- Remove and destroy invasive plants found on your property. Make sure to dispose of plants appropriately so that seeds are not dispersed in the process.
- Maintain closed forest canopies that provide sufficient shade to suppress shade-intolerant invasive plants (e.g. scotch broom, Himalayan blackberry).
- Prevent non-native plant introductions during harvest projects.

Wildfire

Complete prevention of all wildfire ignitions is not a realistic objective of fire management. Instead, a useful goal is to reduce the intensity of wildfire and limit it to surface fires that do not reach the canopy, becoming catastrophic, stand-replacing events. Managing lower forest stocking densities, minimizing woody fuels in the understory, and maintaining fire breaks and buffers are all strategies for mitigating the risk of fire and making it more likely to be brought under control before it escapes. Employing variable density thinning, particularly thinning from below, reduces the potential for a crown fire by increasing the spacing between trees. Thinning from below also creates larger, more vigorous, and fire-resistant trees and raises the base of tree crowns, thus reducing ladder fuels. Further, maintaining a wider spacing on newly regenerating trees in the understory, and minimizing the connectivity between the crowns of low trees and the crowns of dominant canopy trees will further reduce the potential of surface fires to reach the canopy.

Additional recommendations

- Maintain seasonal forest road access throughout property that is sufficient to allow emergency vehicle access (e.g. 4-wheel drive trucks).
- Prune trees to a minimum of 8'-12', or a height that is 3x the height of the dominant shrub layer, in particular along edges of forest and/or forest roads.
- Minimize fine branches and slash on the forest floor. During pruning and both pre-commercial and commercial thinning, avoid contiguous slash mats that exceed 24" thick. Slash should be placed on skid trails and incorporated into the soil as equipment runs over it, and/or aggregated and piled in up to five wildlife habitat piles and

constructed habitat logs per acre. Habitat structures should be located at least 15’ – 20’ away from any tree.

- Create a 100’ wide defensible fuel break around all structures and along either side of driveway and/or publicly used roads by removing all downed dead wood and/or dead shrubs and trees, reducing density of understory shrubs, thinning trees to create a 10’ gap between crowns, and pruning residual trees to at least 8’ - 12’ to eliminate ladder fuels.
- Over time, manage for older, larger diameter trees with thicker bark that are more fire resistant. Fire resistant species include: Douglas-fir, lodgepole pine, big leaf maple, red alder, oak and aspen.
- Maintain or add a higher percentage of hardwoods to the stand. Hardwoods transpire more moisture into the forest environment, thus increasing ambient air moisture and therefore decreasing fire risk. Hardwoods also tend to have a higher moisture content in their wood and less resinous content, making them less prone to fire.

RESOURCE CATEGORY II: Soil

Management recommendations

As the climate warms, the challenges of achieving reforestation are expected to increase, as seedlings lack sufficient root networks to cope with summer drought and the heightened evapotranspiration needs that accompany increasingly common heat waves. Knowing the soils and hydrologic conditions of a forest stand is important for understanding the most suitable sites for less drought-tolerant species such as western hemlock, Sitka spruce, black cottonwood, and red alder. However, these species should not be outright removed from the planting palette. Instead, they should be conserved or planted in local microsites (e.g. wet depressions, riparian areas, or the north-facing side of a legacy old-growth stump) that best support their ecological preferences. Knowing the site's soil type and its soil moisture capacity will help indicate which species to plant.



RESOURCE CATEGORY III: Water Quality/ Riparian and Fish Habitat

Overview

The overall trends of warmer temperatures, decreased precipitation in summer months, increased precipitation in winter months and increased frequency of extreme rain events associated with atmospheric rivers will have an impact on streamflows. In general, hydrological models project streams will experience greater flashiness, higher runoff and more flooding in fall, winter and spring. In the summer, higher temperatures and lower soil moisture will increase evaporation rates, resulting in decreasing streamflows and warmer water temperatures. Winter storm intensity is projected to increase, with rainfall and snowmelt concentrated into shorter time periods, leading the region to experience patterns of higher runoff and more flooding. Warming will also have an impact on summertime streamflows. Warmer air temperatures in summer will boost evaporation from streams and lakes and reduce soil moisture through evapotranspiration. Thus, even if total annual precipitation remains the same, summer flows will decline, with cascading effects on the aquatic environment.

Management recommendations

Overall, forests are essential to the water quality of the streams that run through them, moderating temperature, controlling sedimentation, and providing inputs of leaf litter and woody debris. In a warming climate, the shade and evaporative cooling provided by riparian forests will become especially important to cold-water aquatic life-forms such as anadromous fish and sensitive amphibians. It is therefore especially important to maintain riparian canopy along creeks that run through the property, retaining trees in excess of what state law requires. Streamflows are also affected by forest cover and stand ages. Younger stands (trees less than 40 years old) have lower soil moisture and higher transpiration rates, drawing up water from the system at a faster rate and thereby contributing to lower soil moisture and lower stream flows. Around stand age 40, tree effect on stream flows is approximately neutral. Older forests, conversely, have lower rates of transpiration and can maintain higher soil moisture which can substantially increase summer low flows.

RESOURCE CATEGORY IV: Forest Inventory/Timber and Wood Products

Overview

Forest cover across this property falls into the following categories:

FMU	Forest Type	Age	Acres

Desired future conditions

It is recognized that the desired future condition is not necessarily the past, as climate change and other anthropogenic and environmental factors may not support the historic forest composition. Therefore, this forest will be managed for resilience against climate change, fire, pests and disease by promoting a composition of native broadleaf and conifers of multiple age classes that can be expected to tolerate increasingly drier and warmer summers and wetter winters. This may translate to concentrating production of red alder, western hemlock, Sitka spruce and other drought-intolerant species in the lower areas of the property (e.g. around wetlands), and favoring Douglas-fir, western red cedar, grand fir, bigleaf maple, madrone, and other drought tolerant species on drier sites. When conducting a timber harvest, use individual tree selection, selection thinning, and variable density harvesting to achieve a more complex forest structure. Where even-aged harvesting is used, openings should be smaller (<6 acres) and a higher level of tree retention within the harvest unit is recommended to provide shade for planted seedlings.

Management recommendations for all FMUs

Monitor the forest & be ready to respond

Regular forest monitoring is essential in order to respond more promptly to trees or other vegetation affected by climate stressors, and to improve resiliency at various stages. It's important to be aware of specific risks for the forest and to be observant of forest conditions and how they are changing. This knowledge can inform decisions about tree species to plant, where to plant them, what stocking density to maintain, and how to plan and prioritize culvert and road work.

Questions specific to climate adaptation monitoring include:

- Is natural seedling regeneration occurring on expected sites?
- Which species are regenerating on their own? Are these seedlings surviving, or dying after they reach a certain age or size?
- Do some trees appear stressed?
- What is the species, size, age, soil type, slope, aspect?
- Which tree show signs of good vigor?
- Are trees dying in the forest? If so, what species and where?
- When do the first blossoms emerge in the forest, and when does bud-break occur for each species? How has that changed over time?
- Are invasive species appearing? Where and in what abundance?
- How do culverts and roads fare after large storm events?

Adjust planting strategies

Seed Stock Selection for Future Climates

Use the Seedlot Selection Tool (https://seedlotselectiontool.org/sst/) to identify seed zones whose current climate is akin to the predicted future climate of the site 30 to 60 years hence. Procuring 30 to 40 percent of seedlings to be planted from those more southerly seed zones can serve as a hedge against future reforestation failure.

Planting seedlings

Knowing the soils and hydrologic conditions of a forest stand is important for understanding the most suitable sites for less drought-tolerant species such as western hemlock, Sitka spruce, black cottonwood, and red alder. These species should not be outright removed from the planting palette. Instead, they should be conserved or planted in local microsites (e.g. wet depressions, riparian areas, or north-facing side of a legacy old-growth stump) that best support their ecological preferences.

Planting any of the following drought-tolerant tree species is an important component of this strategy.

Douglas-fir	Oregon oak	Grand fir	Pacific madrone
Mountain ash	Western red cedar	Lodgepole Pine	Western white pine
Bigleaf maple	Ponderosa pine	Black hawthorn	Pacific dogwood

In order to help seedlings cope with these challenges, managers would do well to plant robust seedlings, such as “1-1” planting stock which has spent a year in the seedbed and a year in a transplant bed, that are capable of tolerating difficult growing conditions. Planting in the late fall or early spring helps seedlings by giving them a chance to root before the high evapotranspiration of late spring and summer arrives. Retaining debris on the forest floor helps by providing a mulching effect that conserves soil moisture. Finally, reducing competition for moisture from understory species such as shrubs and grasses, be they invasive or native, is crucial to giving the seedlings a chance to become established.

RESOURCE CATEGORY V: Property Access/Roads and Trails

Management recommendations

Climatologists predict that a warming climate will lead to more intense rainstorms, leading to higher peak run-off events. As a result, culverts and other drainage structures on road systems must be re-evaluated for their capacity to withstand these higher-flow episodes. This may require the installation of larger culverts at stream crossings, and greater attention to waterbars, crowning, and rolling dips on improved forest roads. Since culvert replacement is an expensive undertaking, the small forest landowner may be able to fund this work only in conjunction with a timber harvest, or when a culvert reaches the end of its useful life and must be replaced anyway.

RESOURCE CATEGORY VI: Wildlife

Management recommendations

To account for climate change, authors of a management plan ought to consider whether a warmed climate would be apt to weaken populations of any wildlife species common to the site. For instance, species of concern might include any that are close to the southern or low-elevation extent of their range. If so, management recommendations should include provisions to create cooler refugia for these threatened species.

CREDITS

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