CONSERVATION GUIDEBOOK FOR THE SOUTHERN WASHINGTON CASCADES

A PLAN TO CONSERVE HABITATS
AND BUILD CLIMATE RESILIENCE

Conservation Guidebook for the Southern Washington Cascades: A Plan to Conserve Habitats and Build Climate Resilience

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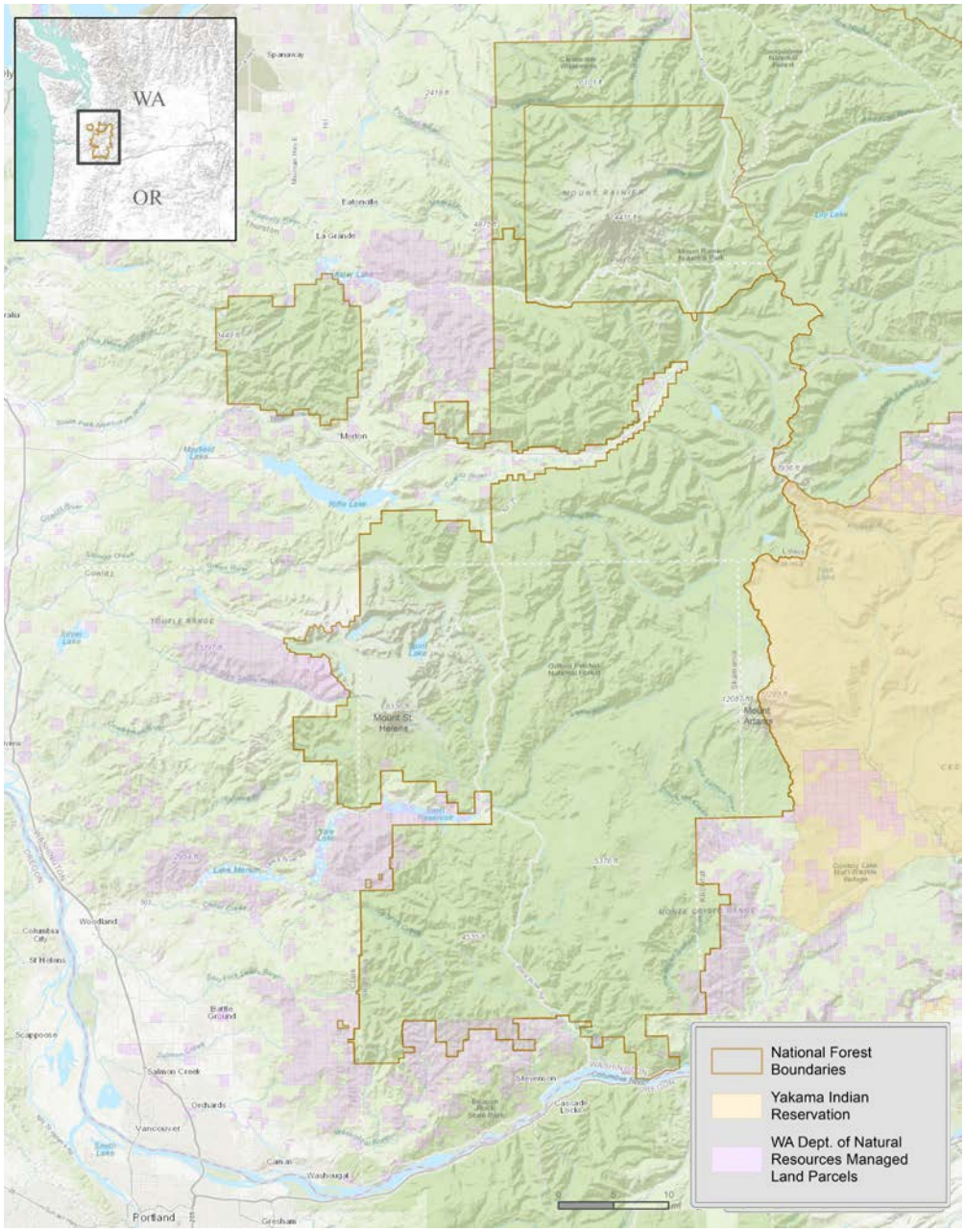
CHAPTER 1:
CLIMATE CHANGE AND THE SOUTHERN WASHINGTON CASCADES

View of Mount St. Helens, Goat Mountain, and the Green River Valley from Strawberry Mountain

Climate Change and the Southern Washington Cascades

Our goal in creating this guidebook is to identify and assess the threats of climate change to species and ecosystems in the southern Washington Cascades and to offer a set of conservation and restoration strategies for improving climate resilience and enhancing the general health and vitality of habitats. We begin by outlining the setting and then briefly discuss recent climate projections and what they may mean for our region. The information provided in this introductory chapter is not meant to be an exhaustive investigation into any of these areas. Rather, we aim to set the scene for the recommendations and strategies that are the main focus of this guide.

We then turn to analyzing the ecological challenges and needs of our region within four different subject areas. Chapter 2 addresses forest habitats while Chapter 3 focuses on rivers and other aquatic habitats. These chapters highlight the climate impacts we expect to see in these different ecosystems and our recommendations for addressing these impacts. Chapter



The southern Washington Cascades focus area

The Muddy River floodplain

4 outlines recommendations specific to regional and local forest plans that guide management of our national forests, with particular focus on the Gifford Pinchot National Forest. Chapter 5 explores the dynamics of forests and carbon and outlines strategies to improve carbon storage.

Many of these strategies are replicable and can be applied in other forest landscapes. This guidebook offers a blueprint for conservation and restoration action that non-governmental organizations, land managers, community members, and other interested stakeholders can use when considering next steps for building ecosystem health and resilience. In addition, the strategies outlined within will be used to inform parts of Cascade Forest Conservancy's strategic plan.

The Setting

The southern Washington Cascade Range lies within the Pacific Northwest and encompasses Mount Adams, Mount St. Helens, Mount Rainier, and the Columbia River Gorge. The crest of the Cascade Range bisects this region, with dry forests extending eastward and moist forests sweeping westward toward the ocean. The Gifford Pinchot National Forest is the centerpiece of this landscape and is integral to the continued health and resilience of the region. This diverse landscape is home to a wide array of ecosystems and wildlife, including many threatened and rare species. Streams and rivers of the region provide critical habitat for threatened salmon, steelhead, and bull trout. The forests are home to species including northern spotted owls, fishers, mountain lions, black bears, flying squirrels, and others. Upland meadows sustain a striking diversity of plants and animals, and alpine areas contain unique habitats and glaciers that feed the rivers below.

Around 36 million years ago, the North American Plate drifted westward and collided with the Farallon Plate to create the volcanically active Cascade Arc.[1] By the early Plio-Pleistocene, more regional folding, uplift, and erosion in the Cascadia Subduction Zone increased the rate of local volcanism, resulting in basalt and andesite flows dominating the southern Washington Cascades.[1,2] Stratovolcanoes like Mount Rainier, Mount Adams, and Mount St. Helens hosted many alpine and valley glaciers during the time of regional glaciation over the past two million years; some of these remain today. Erosional processes (e.g., fluvial, glacial, and precipitation) also greatly affected the terrain. The geology of the region is ever-changing, but for now, it has settled into steep, dissected valleys separated by corresponding ridge crests.

Indigenous peoples have lived on and cared for the lands of the Pacific Northwest since time immemorial. The regions discussed in this guidebook are the traditional homelands of the Chinook, Chehalis, Cowlitz, Klickitat, Nisqually, Puyallup, and Yakama Peoples, as well as many other bands and groups. Over thousands of years, they

An Indigenous woman drying huckleberries in southwest Washington, 1937

have developed techniques to harvest salmon, lamprey, and wild game. They maintain habitats for camas and huckleberries, make fibers and containers from cedar, and are masterful canoe-builders. The various peoples of the region each developed complex systems of local specialization and far-reaching trade networks, which enabled them to thrive for thousands of years. Prior to contact with Europeans, parts of the region were among the most densely populated on the continent. From initial contact with Europeans in the late 18th century until the present, the Indigenous peoples of the Pacific Northwest have suffered from the impacts of novel diseases, war, and broken treaties, but they have also persevered against unfavorable odds and survived by adapting again and again—all while maintaining their unique identities and rich cultural heritages. In the subsequent chapters, we discuss the roles that Indigenous people have played and currently play in shaping and defending habitats and species of the southern Washington Cascades, such as their use of fire as a forest management tool and their past and current work improving habitat for salmon.

Many of the ecosystem degradations we seek to address are outcomes of Euro-American colonization and resource extraction, which dramatically altered the landscape during the 1800s and 1900s. This includes the near or full loss of wolves, grizzly bears, fishers, and beavers and the lasting impacts of rampant timber harvest, fire suppression, dams, and road building. We work in a landscape that has been heavily altered in a relatively short period of time.

A skid road for removing logged timber in western Washington

Addressing this degradation is often the first step for improving resilience.

Today, human communities in southwest Washington continue to rely on the resources provided by the landscape, but there is also an increased focus on restoring ecosystem health and establishing a more sustainable balance between ecosystems and human influence. The future of all people in the region is inextricably linked to the fates of our forests and rivers.

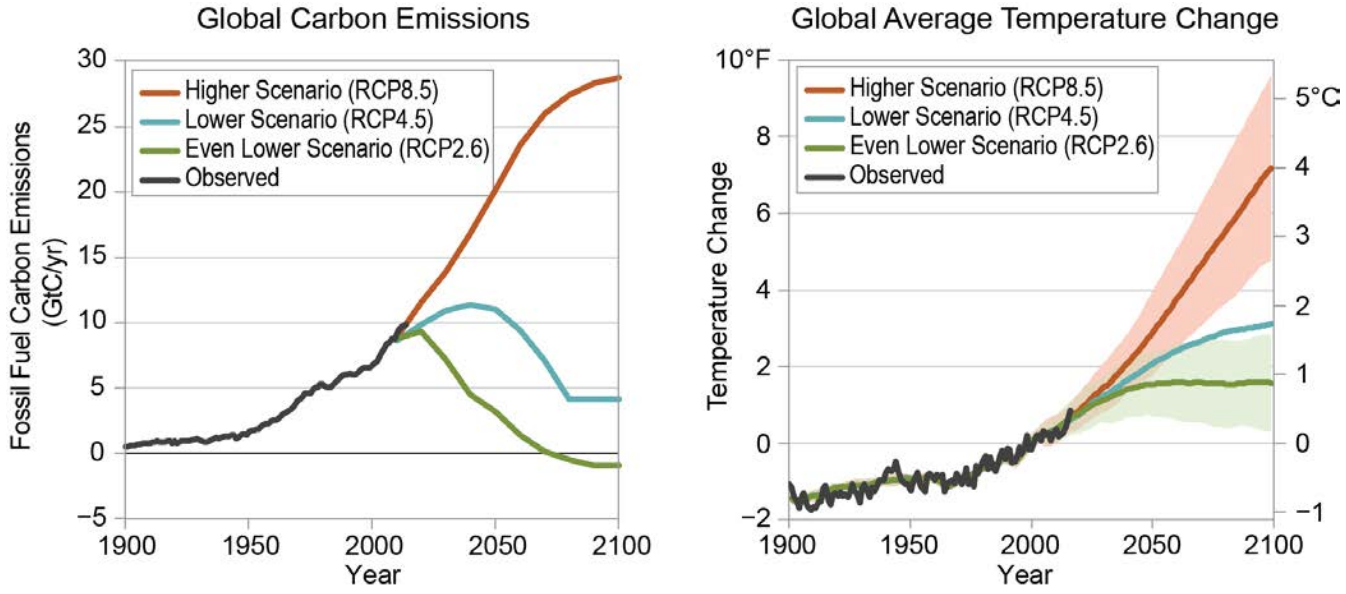
CLIMATE **PROJECTIONS**

Global

According to the Intergovernmental Panel on Climate Change (IPCC) report published in 2023, average global surface temperatures have risen 1.98 °F (1.1 °C) since the late 1800s.[3] Temperature increase over land, with a rise of 2.86 °F (1.59 °C), has been more pronounced than that over water.[3] The rate of change has accelerated over the last several decades, and temperatures have increased more since 1970 than over any other 50-year period during the last 2,000 years.[3]

Relative to averages from a 1986–2015 timeframe, by the end of the century (2080–2099), we could expect temperature increases ranging from 0.4–2.7 °F (0.2–1.5 °C) under a very low emissions scenario (RCP2.6) to 4.2–8.5 °F (2.4–4.7 °C) under a high emissions scenario (RCP8.5).[4]

Pacific Northwest forests and timberlands covered in snow

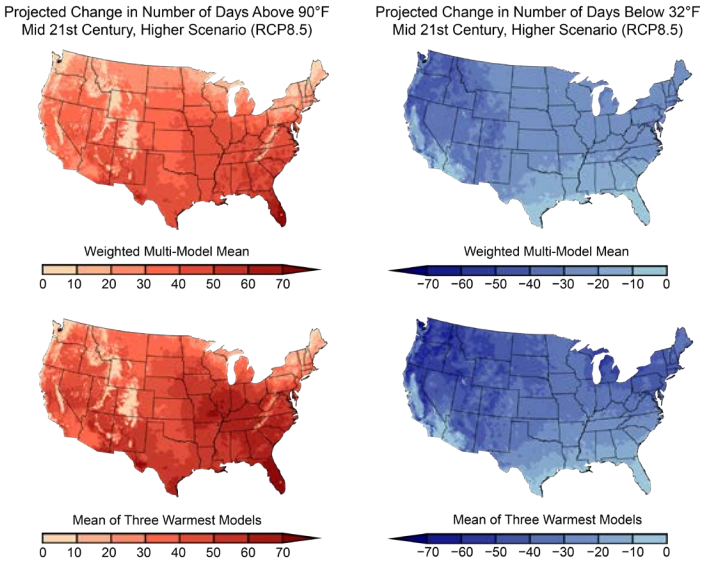


Graphic from Hayhoe et al. 2018 highlighting global dynamics of carbon and temperature. The authors explain the graphs in this way: "Observed and projected changes in global average temperature (right) depend on observed and projected emissions of carbon dioxide from fossil fuel combustion (left) and emissions of carbon dioxide and other heat-trapping gases from other human activities, including land use and land-use change. Under a pathway consistent with a higher scenario (RCP8.5), fossil fuel carbon emissions continue to increase throughout the century, and by 2080–2099, global average temperature is projected to increase by 4.2°–8.5°F (2.4°–4.7°C; shown by the burnt orange shaded area) relative to the 1986–2015 average. Under a lower scenario (RCP4.5), fossil fuel carbon emissions peak mid-century then decrease, and global average temperature is projected to increase by 1.7°–4.4°F (0.9°–2.4°C; range not shown on graph) relative to 1986–2015. Under an even lower scenario (RCP2.6), assuming carbon emissions from fossil fuels have already peaked, temperature increases could be limited to 0.4°–2.7°F (0.2°–1.5°C; shown by green shaded area) relative to 1986–2015. Thick lines within shaded areas represent the average of multiple climate models. The shaded ranges illustrate the 5% to 95% confidence intervals for the respective projections. In all RCP scenarios, carbon emissions from land use and land-use change amount to less than 1 GtC by 2020 and fall thereafter. Limiting the rise in global average temperature to less than 2.2°F (1.2°C) relative to 1986–2015 is approximately equivalent to 3.6°F (2°C) or less relative to preindustrial temperatures, consistent with the aim of the Paris Agreement (see Box 2.4). Source: adapted from Wuebbles et al. 2017."

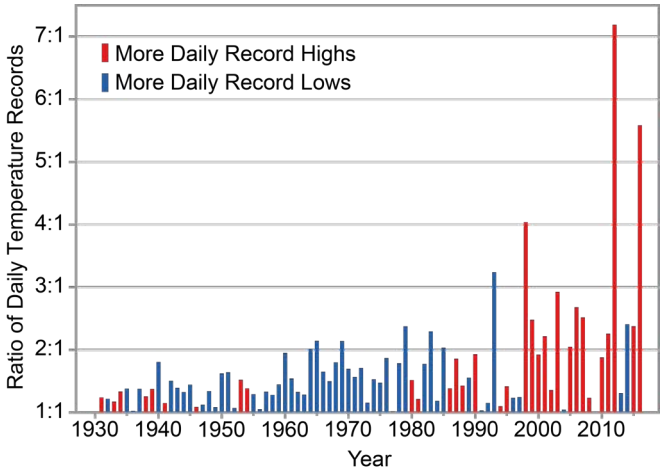
National

In both low and high emissions scenarios, over the coming decades, the United States will likely experience a 2.2 °F (1.2 °C) rise in annual average temperatures compared to the period of 1986–2015. Even more substantial temperature increases are projected for the late century, with increases in the ranges of 2.3–6.7 °F (1.3–3.7 °C) under a low emissions scenario (RCP4.5) and 5.4–11.0 °F (3.0–6.1 °C) under a higher scenario (RCP8.5).[4]

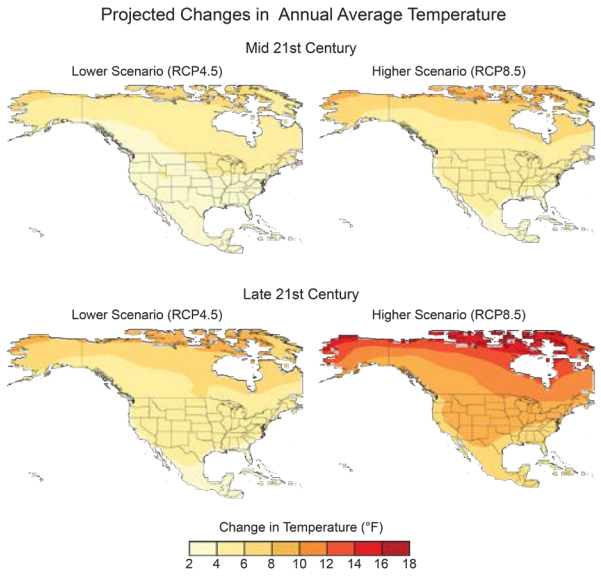
With these changes, heat waves are anticipated to become more severe, and the number of days with temperatures exceeding 90 °F is expected to rise.[4] Cold waves, on the other hand, are expected to decrease in intensity, with a similar decrease in the number of days below freezing.[4]



Vose et al. 2017, in "Climate Science Special Report: Fourth National Climate Assessment," highlight projected temperature changes in the contiguous United States. The authors explain the maps in this way: "Projected changes in the number of days per year with a maximum temperature above 90°F and a minimum temperature below 32°F in the contiguous United States. Changes are the difference between the average for mid-century (2036–2065) and the average for near-present (1976–2005) under the higher scenario (RCP8.5). Maps in the top row depict the weighted multimodel mean whereas maps on the bottom row depict the mean of the three warmest models (that is, the models with the largest temperature increase). Maps are derived from 32 climate model projections that were statistically downscaled using the Localized Constructed Analogs technique. Changes are statistically significant in all areas (that is, more than 50% of the models show a statistically significant change, and more than 67% agree on the sign of the change). (Figure source: CICS-NC and NOAA NCEI)."



*Vose et al. 2017 outline historical observations of record-setting temperatures in the contiguous United States. The authors explain the graph in this way: "Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. Estimates are derived from long-term stations with minimal missing data in the Global Historical Climatology Network–Daily dataset."
(Figure source: NOAA/NCEI).*

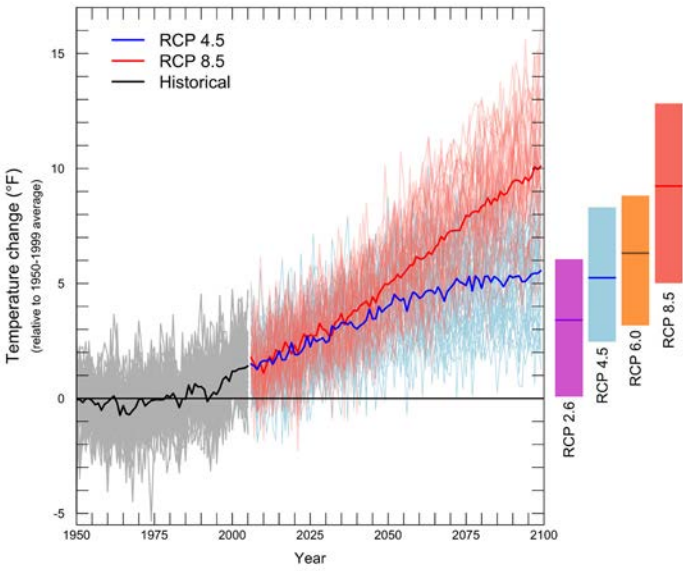


*Vose et al. 2017 highlight projected averages in temperature change in the United States and Canada. The authors explain the maps in this way: "Projected changes in annual average temperatures (°F). Changes are the difference between the average for mid-century (2036–2065; top) or late-century (2070-2099, bottom) and the average for near-present (1976–2005). Each map depicts the weighted multimodel mean. Increases are statistically significant in all areas (that is, more than 50% of the models show a statistically significant change, and more than 67% agree on the sign of the change)."
(Figure source: CICS-NC and NOAA NCEI).*

Regional

Western Washington has already seen a 1.7 °F (0.94 °C) rise in average temperatures over the past 120 years, and by mid-century, average summer temperatures are expected to increase 3.3 to 3.5 °F (1.8–1.9 °C) relative to the 1950–1999 average.[5] Expected increases in average winter temperatures range from 2.5–3.0 °F (1.4–1.7 °C) for the same time period.[5]

Zooming in further, projections for the southern Washington Cascades highlight a trend toward warmer temperatures and more intense heat waves in summer.[6–8] Compared to average temperatures in the 1950–1979 range, temperatures in the southern Washington Cascades may increase 4.5 to 7.6 °F (2.5 to 4.2 °C) by mid-century and 7.7 to 11.5 °F (4.3 to 6.4 °C) by the latter part of the century.[9] The largest temperature increases will occur in summer, with increases in summer averages ranging from 10.3 to 12.2 °F (5.7 to 6.8 °C).[9]



Graph from the Climate Impacts Group showing a warming trend over time in the Pacific Northwest using climate projections from the 2013 IPCC report. The Climate Impacts Group used projections from the 2013 IPCC report and explains the graph as follows: "[A]verage yearly temperatures for the Pacific Northwest relative to the average for 1950-1999 (gray horizontal line). The black line shows the average simulated temperature for 1950–2011, while the grey lines show individual model results for the same time period. Thin colored lines show individual model projections for two emissions scenarios (low: RCP 4.5, and high: RCP 8.5), and thick colored lines show the average among models projections for each scenario. Bars to the right of the plot show the mean, minimum, and maximum change projected for each of the four emissions scenarios for 2081-2100, ranging from a very low (RCP 2.6) to a high (RCP 8.5) scenario. Note that the bars are lower than the endpoints from the graph, because they represent the average for the final two decades of the century, rather than the final value at 2100."

Projections for rain and snow patterns are less certain, but climate models tend to agree that summer rain will decrease, snowpack will decrease, extreme weather events will increase, and more winter precipitation will fall as rain rather than snow.[8,10–14] For instance, the summer rainfall average of 6.4 in. (162 mm) in the region is expected to fall to 3.4 to 4.8 in (87-121 mm) by the end of the century.[9] Sproles et al. (2013) suggests the western Cascade Mountains in Oregon, a similar landscape, will experience a 56% reduction in basin-wide volumetric snow water storage, with strongest reductions likely to occur in the 3,200 to 6,500-foot elevation range.[12]

Forests will be severely impacted by drought. Models suggest the greatest projected temperature increases will occur in summer, which will result in drier conditions, affecting a wide array of forest species.[9,15–17] For aquatic environments, warming waters are expected to significantly threaten a variety of species, especially anadromous fish. Decreases in spring and summer streamflows will be pronounced in many areas, and an increased frequency of high flow events in winter and spring will compound the aforementioned effects.[18,19]

Researchers expect we will see upward or poleward movements of some terrestrial species as well as phenological or life history changes.[20] There are already documented shifts in annual life-history events, such as earlier plant flowering and amphibian mating and altered timing in migratory patterns and egg laying of birds.[20] Some of these phenological alterations, in addition to impacts from temperature, drought, and hydrology changes, may cause species extinctions or extirpations of local populations. Variations in topography and aspect will create different patterns of risk. Temperature and solar influences on ridge tops and south slopes, for instance, may be more pronounced than impacts in moist valley bottoms or north-facing slopes.

It is important that we reflect on this climate data to underscore the urgency of addressing the threats faced by the species and ecosystems of our region. Our goal in this guide is to provide a targeted set of conservation and restoration strategies that can mitigate the severity of climate impacts, enhance resilience, and forge new opportunities for adaptation. These strategies should be employed by NGOs, land managers, community members, and any other stakeholders interested in taking part in advancing climate resilience.

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CHAPTER 2:
FOREST ECOSYSTEMS

CHAPTER 2 **EXECUTIVE SUMMARY**

As the Pacific Northwest faces higher temperatures, more drought, and altered seasonal patterns due to climate change, forest ecosystems in western Washington are projected to undergo significant shifts. Potential impacts include inhibited seed germination, altered habitat distributions, mortality from drought, more severe forest disturbances from fire, insect infestations, and tree disease. These will vary among species communities, elevations, and latitudes. The severity of these impacts calls for a reimagined approach to forest management, placing an emphasis on conservation strategies that not only protect existing mature and old-growth forests but also consider the need for increased connectivity, strategic restoration, monitoring, and adaptive management.

Mature and old-growth forests have relatively cool and moist microclimates, rich biodiversity, resilience to temperature fluctuations, and heightened resistance to drought. These areas are important climate refugia and also serve an outsized role in storing carbon. Preserving these habitats is a critical part of our conservation approach for forest ecosystems.

Brief summaries of our strategies for forest ecosystem are outlined here and detailed within the chapter along with background information and an overview of climate risks for forests.

- **Reduce logging of old forests:** On both state and federal lands, harvest of mature and old-growth forests should be reduced in order to retain these important habitat features and enhance carbon storage.

- **Restoration in mixed-conifer forests:** Targeted thinning and prescribed fire in the mixed-conifer forests in the eastern part of the Gifford Pinchot National Forest (GPNF) can reduce fuel loads, align landscapes with their historical conditions, and improve resilience. This involves a careful consideration of short-term impacts and long-term resilience. Efforts should focus on strategic removal of small diameter trees, retention of large trees, and the use of prescribed fire. Collaborative efforts between agencies and local communities can aid in navigating challenges.

- **Designate new forest preserves and carbon storage areas on state lands:** Using a spatial analysis process, we highlight specific areas within Washington's state forest lands that should be considered for designation as Natural Area Preserves, Natural Resource Conservation Areas, or carbon storage zones. Leveraging tools like the Trust Land Transfer program and other policies and methods, these recommendations aim to balance extraction with conservation, climate mitigation, and ecological resilience.

- **Retain a strong National Environmental Policy Act (NEPA) and public engagement process on federal lands:** It is critical that we retain the strength and full breadth of the NEPA process and ensure that categorical exclusions are limited to small, low-impact projects, ensuring both public inclusion and ecological integrity.

- **Support Tribal involvement in land management:** A key element for promoting resilience should involve a collaborative approach that advances co-management strategies and integrates Traditional Ecological Knowledge and Tribal practices into land management.

- **Post-fire seeding and planting in successive burn areas:** In regions impacted by successive burns, post-fire seeding and planting can hasten ecological recovery, enhance soil health, provide forage for wildlife, and minimize the spread of invasive plants.

- **Increase wildlife crossings along roadways:** We recommend leveraging available funding, including the Wildlife Crossings Pilot Program, to increase the number of wildlife crossings over and under roadways. These enhancements can mitigate the negative impacts of roads by reducing collisions and providing safer pathways for movement between and within habitat patches for both terrestrial and aquatic species. These efforts serve the dual purposes of promoting both biodiversity and public safety. In areas prone to frequent collisions with large fauna, overpasses can improve habitat connectivity and also be economically beneficial, while in others, modified culvert designs can be utilized to address the needs of smaller aquatic and terrestrial species.

- **Support wolf recovery in the region:** The return and recovery of wolves, a keystone species, can yield significant ecological and climate resilience benefits. Advancing coexistence efforts, retaining policy protections, and ensuring multi-stakeholder collaborations can aid in this recovery.

- **Monitor changes to species and habitats:** On-the-ground monitoring to track changes to species and habitats can inform adaptive management, allowing for the fine-tuning of conservation and restoration efforts. Whether tracking the return of wolves or assessing the impact of prescribed burning, monitoring enables a localized and responsive approach that can help us adapt to new challenges and ensure the long-term survival of at-risk populations.

- **Update the Northwest Forest Plan or local forest plans to improve climate resilience on federal lands (outlined in Chapter 4):** We highlight five strategies to be implemented during forest plan updates. These include: 1) transfer a select subset of Matrix areas to Late-Successional Reserve (LSR) allocation, 2) update LSR objectives to include carbon storage and restoration guidance for dry and mixed-conifer forests, 3) protect all trees originating before 1920, 4) retain the Survey and Manage program and ensure the Species of Conservation Concern program is effectively addressing the health and resilience of species, and 6) protect specific areas that would benefit from additional safeguards through new designations.

- **Lengthen harvest durations on private timberlands (outlined in Chapter 5):** We outline a variety of approaches that can be employed to advance and ease a transition to longer harvest durations in order to increase carbon storage and increase the amount of timber coming off a plot of land. This also brings a number of added ecological benefits including less herbicide and fertilizer use, longer durations of favorable habitat conditions for forest wildlife, and fewer negative impacts to soil health, mycorrhizal communities, aquatic habitats, and water quality.

FOREST ECOSYSTEMS

From towering Douglas-fir forests where spotted owls and goshawks soar through the canopy, to mixed-conifer forests where great ponderosa pines stand like pillars on the ridgelines, the landscape of the southern Washington Cascades is a vital sanctuary for diverse wildlife and ecosystems. As the realities of climate change begin to impact these forest ecosystems, it is imperative that we employ management practices and adopt policies that preserve biodiversity and enhance resilience, enabling these forests to weather the upcoming changes.

Timber harvest: then and now

The forests of the Pacific Northwest have sat at the center of national conservation discussions and legislation for decades. Years of intense timber harvest have had a dramatic impact on the current state of the forest ecosystem, and this factor plays into almost every facet of our work developing climate resilience strategies for these areas.

Before the widespread exploitation of timber during the 1800s and 1900s, Indigenous communities managed these forest ecosystems by selectively harvesting trees and using fire to clear undergrowth to improve plant production and create openings for wildlife and access. Over the last two centuries, these forests faced a new form of human influence as a rapidly expanding population of settlers began exploiting the timber for building materials, leading to significant environmental changes and challenges for Indigenous land management practices.[1] In the late 1800s, scarcity of trees near the water and new technological advances pushed timber harvests inland, up steep slopes, and through narrow valleys of the region. By 1905, Washington state had become the top producer of timber in the nation, a position it held for the next several decades. By mid-century, the production of timber from federal lands was significantly increased as private timberlands in the area could not keep up with demand.[2] The rapid increase in timber harvest in the national forests led to Congress enacting the Multiple-Use Sustained-Yield Act of 1960.[1] This act recognized the need to consider a more sustainable approach to timber extraction, and it codified the multiple uses of the national forest, such as supporting

Log train crossing the Cowlitz River in 1949

wildlife, water quality, and recreation. Despite this, timber extraction continued to increase, and clearcuts spread rapidly across the region.

Congress began to take steps to further codify conservation values by protecting ecosystems with the Wilderness Act in 1964, the National Environmental Policy Act in 1969 (signed in 1970), the Clean Water Act in 1972, and the Endangered Species Act (ESA) in 1973. Congress also enacted the National Forest Management Act (NFMA) in 1976, largely as a response to the continued emphasis on timber harvest despite the federal push for more habitat protection. This required the Forest Service to use NEPA procedures and to employ an interdisciplinary team to create Forest Plans for all national forests. Through the 1980s, the Forest Service developed plans, but this only marginally reduced harvest, and habitat protection responsibilities under laws like the ESA were largely ignored.[3]

In the Pacific Northwest, these conflicts came to a head in the 1980s when the NFMA regulations required fish and wildlife habitat to be managed to support "viable populations" of species and also in the 1990s when the northern spotted owl was listed as threatened under the ESA.[4] The agency's Forest Plans were successfully challenged in court due to the Plans' inability to protect the threatened owl as required under the ESA. The court halted harvest in northern spotted owl habitat within national forests until a plan that would meet ESA requirements could be completed.[5] This halt occurred at the same time that automation in mills was increasing and rapidly changing the industry on its own, decreasing the amount of labor needed for lumber production. Decades of unsustainable harvest practices and a dwindling supply of trees were also creating a situation in which severe reductions in timber production were imminent. The combination of these factors had devastating economic impacts on timber-dependent communities of the region.

In response to the court case challenging the current Forest Plans, the agency made several attempts to make a plan that would satisfy ESA requirements as interpreted by the courts. Those attempts were not successful, and, eventually, a series of scientific committees were assembled to develop management alternatives for conserving old-growth forest ecosystems and their constituent species. These efforts culminated in the adoption of the Northwest Forest Plan (NWFP) by President Clinton in 1994. The NWFP reduced timber levels below what was being previously harvested, but enabled harvest operations to restart under a guided framework bounded by site-specific regulations in different types of management areas. The impact of logging on

A northern spotted owl perched in an old Douglas fir

national forest lands has decreased since the 20th century, but remains a primary factor affecting habitat distribution and fragmentation.

Old-growth forests

Old-growth forests are a hallmark of the Pacific Northwest. These forests are characterized by wide and tall trees, multi-layered canopies thriving with biodiversity, standing snags, and decaying logs of fallen giants that feed new life. As a climate refuge for a vast number of species and with the cooler, wetter microclimates they create, it is essential that we focus conservation efforts on stemming the fragmentation and loss of these forests. In recent decades, many old-growth stands throughout the Pacific Northwest have benefited from protective forest management policies that have slowed the destruction of these habitats.[3] This more nuanced management of old-growth resulted in a decrease in the rate of loss of old-growth habitat, however, there is still much work to be done in protecting forests, especially the mature forests that will be the next cohort of old-growth.

Finding a universal old-growth definition is no simple matter, as definitions vary widely and spatial data is imperfect.[6] Age is one of the primary indicators, but minimum thresholds can range from 100 years to 200 years, depending on who you ask and what type of forest is in question. In addition to age estimates, old-growth in our region is defined by metrics of other attributes such

Vegetation characteristics associated with older forest stands appeared to confer a strong, thermally insulating effect. Older forests with tall canopies, high biomass, and vertical complexity provided cooler microclimates compared with simplified stands.

Frey et al. 2016

as large living and dead trees, coarse woody debris on the forest floor, and presence of a multi-tiered canopy (also sometimes called a continuous canopy) with small, medium, and tall trees.

It is not uncommon to find old-growth stands with trees well over 200 years old and reaching sizes greater than 150 feet in height and several feet in diameter. In thin patches of sunlight and growing beneath the shadow of the large old trees are more shade-tolerant trees and plants that add to the varied layers of an old-growth system. Rich with life, forests with tall canopies represent distinct ecosystems, harboring a multitude of invertebrate species.[7] As centuries pass, natural disturbances—like wind, insects, and fire—will kill some of the ancient trees. Even in death, the trees perform crucial ecological roles by providing shelter and nutrients for other plants and animals. Taller snags, sometimes called "the standing dead," are preferred nesting sites for many small mammal and bird species in the forest, and when snags fall, they provide homes for various terrestrial species, reduce erosion, and can benefit streams by creating pools and cover for fish.

Other forest age classes, such as early successional and mid-successional stages, are important too and offer different values for ecosystems and wildlife. But, old-growth forests remain a primary focus for our efforts to improve climate resilience as these forests are relatively rare and of particular importance from a habitat and conservation perspective. Early seral habitats are also relatively rare, but we can expect to see the abundance of this type of habitat expand as wildfire and other climate change-related impacts increase over time.

WHAT IS THE ROLE OF **OLD FORESTS** IN BUILDING CLIMATE RESILIENCE?

With centuries of growth and accumulated biodiversity, old forest ecosystems have developed strong pathways of persistence and are critical for buffering the negative effects of climate change. Old forests serve as climate refugia for many species and can withstand stressors, such as drought and wildfire, that may be devastating to other ecosystem types.[8,9] Old-growth climate refugia is important at the landscape scale (large contiguous areas of old-growth habitat) and at a hyper-local scale (small remnant stands of old-growth forest).

Biodiversity is one of the features of old forests that provide long-term resilience in the face of disturbance and climate impacts. Biodiversity represents a "library of

possibilities" for local ecosystems and enables landscapes to have increased resilience in the face of disturbance.[10] With climate change being a force that will bring severe stresses and cause pockets of mortality, these old forests will act as refugia and species "banks."

The regulation of microclimates is a unique trait of old forest stands, and this adds a dynamic defense against climate change. Research has demonstrated the ability of old-growth to minimize temperature variation compared to clearcuts or heavily thinned forests.[8,9,11] Frey et al. (2016) explain the effectiveness of old-growth in microclimate regulation in comparison to simplified plantation stands in a study carried out in the H.J. Andrews Experimental Forest in Oregon:

> Vegetation characteristics associated with older forest stands appeared to confer a strong, thermally insulating effect. Older forests with tall canopies, high biomass, and vertical complexity provided cooler microclimates compared with simplified stands. This resulted in differences as large as 2.5°C between plantation sites and old-growth sites, a temperature range equivalent to predicted global temperature increases over the next 50 years.[11]

In another investigation, this one carried out in southern Washington state, Chen et al. (1993) found a significant difference between daily temperature change in the clearcut to that inside the intact forest. For instance, during the change from hot and sunny weather to windy and cloudy conditions, change in air temperature (maximum minus minimum) was "as high as 25–28 °C in the clearcut and at the edge, but considerably smaller (15–17 °C) inside the forest".[9] And, as it relates to soil temperatures, "[m]ean daily average soil temperatures were the highest in the clearcut" and "lowest in the forest."[9] Chen et al. (1993) also found soil moisture to be lowest and wind to be highest in the clearcut.

An old forest's ability to withstand temperature and drought variations better than young forests are likely due to a number of factors, including the multi-storied structure of old forest canopies, the wider root distribution, different uses of stored water compared to daily water, and a variety of other factors. Sap flux measurements in young and old Douglas-fir trees, for example, have shown that older and larger trees rely more on stored water than younger trees, with 20–25% of daily water use coming from water stored in xylem in older trees compared to 7% in younger trees, making older trees less sensitive to variable moisture conditions.[12] The tall canopy of an old forest also serves a very important function with its ability to collect a significant percentage of the forest's water through fog and cloud drip on high branches and leaves.[7] This helps mediate changes in moisture as well as temperature.

HOW WILL FORESTS BE **IMPACTED** BY CLIMATE CHANGE?

Western Washington has already seen an average of a 1.7 °F (0.94 °C) rise in temperatures over the past 120 years, and some areas have warmed as much as 3 °F (1.7 °C).[13,14] Climate models under a higher emissions scenario project that by mid-century, temperatures in the region will increase by 5–7 °F (2.8–3.9 °C).[15] Models suggest that the greatest projected temperature increases will occur in summer, which, in combination with a decrease in summer precipitation, will result in drier conditions, affecting a wide array of forest species.[16–18]

Summer drought and heat-related mortality of conifer trees in North America have spiked dramatically since the 1980s and 1990s, and this pattern is expected to continue.[19] Trees located on south-facing slopes, ridgetops, and areas with shallow soils are likely to be most impacted by drought stress.[12] In addition to direct mortality, higher than usual temperatures and drought can also inhibit seed germination.[12,20]

In addition to wildfire impacts, which are discussed on subsequent pages, warmer and drier summer months may also bring higher rates of forest disturbance from insects, diseases, and pathogens. Drought conditions can cause stress for trees and put them at greater risk from these types of disturbances.[21–23] However, climate change may also create unexpected competitive interactions and cause some disturbance types to decrease.[24] Due to the complex nature of these interactions, there is great uncertainty regarding the potential scale and severity of these types of impacts. Hudec et al (2019) reinforces this sentiment:

> Climate change may influence the incidence of tree disease in southwest Washington, but the effects of climate change on host physiology, adaptation or maladaptation, and population genetics that affect host-pathogen interactions are poorly understood (Kliejunas et al. 2009). Nevertheless, we can use existing knowledge of

> tree diseases in western North America to infer that climate change will result in reductions in tree health and advantageous conditions for some pathogens (Frankel et al. 2012, Kliejunas et al. 2009). Warmer, drier summers will probably favor some root and canker diseases. Armillaria root disease (*Armillaria (Fr.) Staude*), laminated root disease (*Phellinus weirii*), and cytospora canker of alder (*Cytospora spp. Ehrenb. Ex Fries, 1823*) are examples of pathogens known to exist in southwest Washington that may increase in severity under a warmer climate (Kliejunas et.al. 2009).[25]

In the absence of climate change, forest disturbances (such as insect outbreaks, tree diseases, and wildfires) would naturally affect the spatial patterning of forests, and these impacts benefit forest ecosystems by culling the weaker trees and creating a mosaic of varying age classes and canopy patterns. While these forces might be part of the natural process, disturbances may become more frequent and severe as a result of climate change.

Regional climate models suggest that forests will experience upward shifts in habitat distribution in which lower elevation species may encroach into higher locations. The following range shift projections have been adapted from Hudec et al. (2019).[25] Warmer temperatures may allow species such as grand fir (*Abies grandis*), western hemlock (*Tsuga heterophylla*), and Douglas-fir (*Pseudotsuga menziesii*) to outcompete upland forest species for nutrients and water, enabling them to move up in elevation into portions of the range currently occupied by Pacific silver fir and subalpine fir. Pacific silver fir (*Abies amabilis*) and subalpine fir (*Abies lasiocarpa*) distributions may move up in elevation in certain areas and displace mountain hemlock (*Tsuga mertensiana*) and whitebark pine (*Pinus albicaulis*), as the latter two species will likely be more impacted by drought stress. The abundance of mountain hemlock at the lower parts of its range "may decrease where growth is limited by low soil moisture in summer." Paleoecological records suggest that as disturbances increase, species such as red alder (*Alnus rubra*), lodgepole pine (*Pinus contorta var. latifolia*), and Douglas-fir may increase in relative abundance.

On the eastern portions of the southern Washington Cascades, ponderosa pine (*Pinus ponderosa*) may be impacted by a trilogy of threats: increases in the scale and severity of wildfire, insect infestations, and drought. Oregon white oak (*Quercus garryana*), western white pine (*Pinus monticola*), as well as giant chinquapin (*Chrysolepis chrysophylla*) may be less sensitive to warming temperatures and may expand into new ranges. Aspen (*Populus tremuloides*) is sensitive to temperature increases and decreases in moisture availability, but it also grows well in post-fire habitats. Therefore, aspen distributions may decrease in certain areas and expand in others, such as in recently burned areas. Halofsky et al. (2020) offer an overview of related projections:

> In Northwest forest ecosystems, warming climate and changing disturbance regimes are likely to lead to changes in species composition and structure, probably over many decades. In general, increased fire frequency will favor plant species with life history traits that allow for survival with more frequent fire (Chmura et al. 2011). These include (1) species that can resist fires (e.g., thick-barked species such as Douglas-fir, western larch [Larix laricina Nutt.], and ponderosa pine); (2) species with high dispersal ability that can establish after fires (e.g., Douglas-fir); and (3) species with serotinous cones that allow seed dispersal from the canopy after fire (e.g., lodgepole pine) (Rowe 1983; Agee 1993).[26]

While there may be suitable locations to support these shifts in species distributions, unexpected climate impacts may produce complex and deleterious interactions as shifts will not happen evenly or in predictable patterns.

Wildfire

Further complicating the threats and changes discussed above is the changing nature of wildfires. Fires do not burn through an area uniformly—some forest stands will ignite while others escape untouched. Some areas may experience high severity fire effects, including scorched tree crowns, while in other areas, fires will burn less

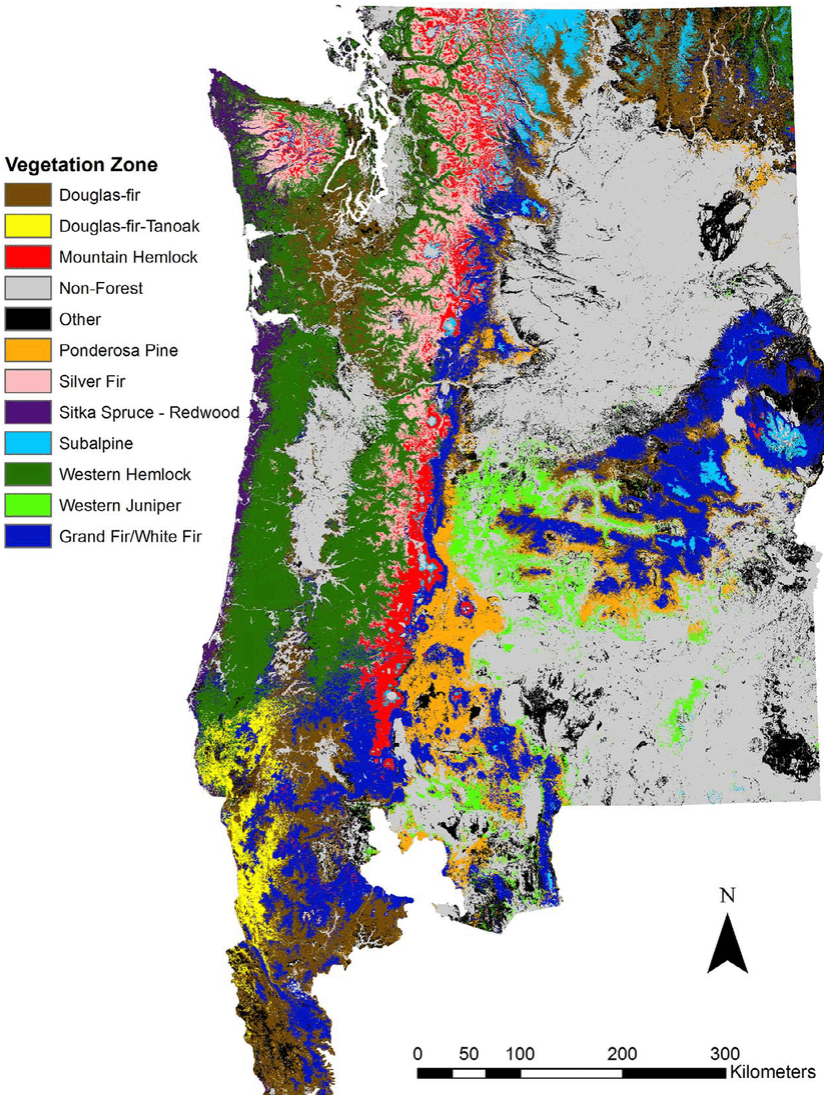
intensely and may stay close to the ground. The resulting pattern of varied habitats supports diverse communities of plants and animals, including some species that specifically thrive in post-fire conditions.[27–29]

To investigate the different fire trajectories in the southern Washington Cascades, we will be using a forest classification method commonly used for forest management and research: potential vegetation types. This methodology classifies forest zones based on potential dominant species in mature stands (those in climax condition).[30] Any classification system of an ever-changing system like a forest ecosystem will be imperfect, and this method is no exception. We chose this method because it allows us to use locally-refined projections of fire potential and history.

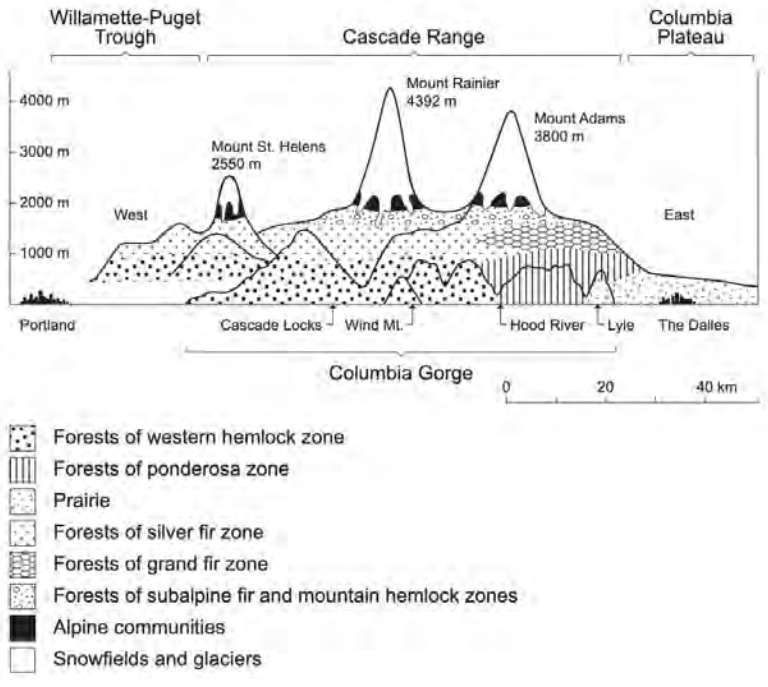
In the southern Washington Cascades, low-elevation forests (below 4,000 feet elevation) on the west side of the Cascade crest are generally part of the western hemlock zone. This zone is dominated by western hemlock and Douglas-fir and encompasses 30% of the Gifford Pinchot National Forest (GPNF) as well as much of the forest land extending west from the GPNF to Interstate-5.[25] The Pacific silver fir zone (approximately 2,800–4,500 ft) makes up 39% of the GPNF, and the mountain hemlock zone (approximately 4,000–6,000 ft) encompasses 28% of the GPNF.[25] There are other zones in the high elevation areas of these westside forests (such as the subalpine fir zone and parkland zone), but they represent a much smaller portion of the landscape.

To the east, the grand fir zone (approximately 3,200–5,000 ft) contains various combinations of ponderosa pine, grand fir, Douglas-fir, and western larch.[30] These forests are located south of Mount Adams, in and around the White Salmon and Little White Salmon River watersheds. The east-side Douglas-fir zone and ponderosa pine zone occupy drier sites farther east, and are largely outside of the focus of this guidebook.

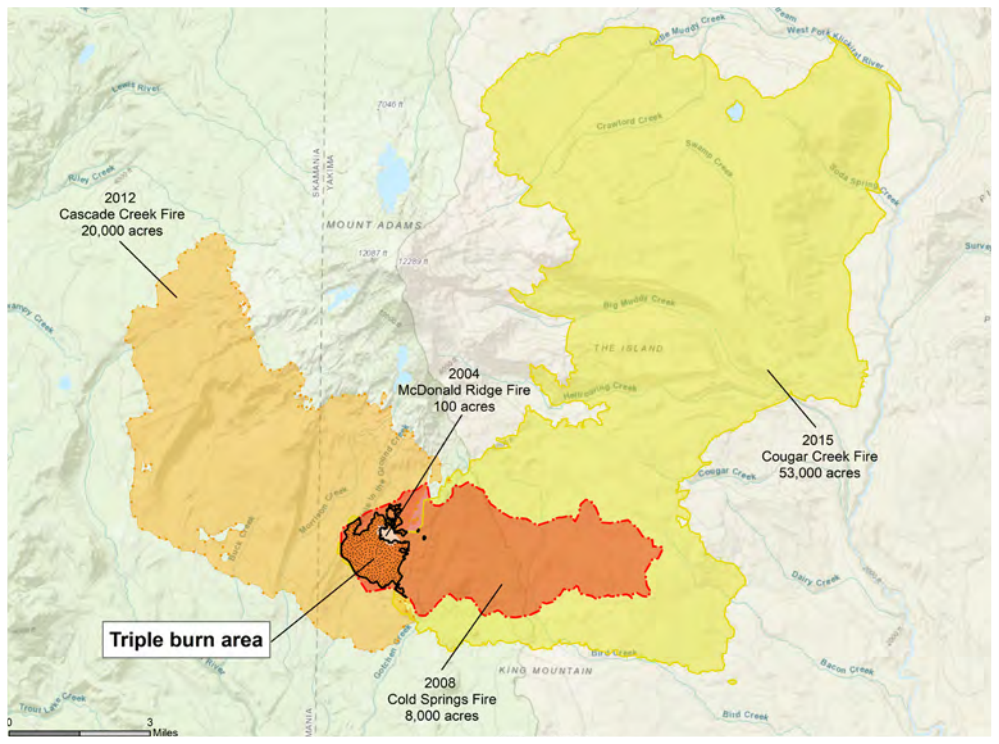
Different forest types have different fire histories and trajectories. The western hemlock, Pacific silver fir, and mountain hemlock zones (encompassing most of the GPNF and loosely fitting under the category of "westside forests") have a fire regime that is notably different from



Map of vegitation zones from Reilly and Spies 2015



Vegetation zones from Hudec et al. 2019



Recurrent wildfires near Mount Adams

In a ten-year span, the south slopes of Mount Adams experienced multiple high-severity fires, resulting in a triple burn area encompassing 82,152 acres. Successive reburns like this, which are exacerbated by climate change, pose significant challenges for ecological resilience, impacting tree regeneration and potentially leading to shifts in vegetation types.

the grand fir zone and the dry forests found farther east and south. In the westside forests, major fires generally swept through at intervals over 200 years, although ranges vary greatly and certain subtypes have experienced fire intervals closer to 50 years.[25] Fires in these areas are often large (>1,000 acres and sometimes even >10,000 acres) with extensive high-severity patches (>70% mortality).[25,31]

Fires in the mixed-conifer forests (largely the grand fir zone), were generally more frequent. Dry subtypes in the grand fir zone may have fire return intervals between 9 and 25 years, but other subtypes and classification methods point to intervals over 100 years.[25] Fires in these areas are often low-severity, with tree mortality under 25%.[32] These more frequent fires would often sweep through the understory and kill off the smaller trees and shrubs in a mosaic fashion. Certain areas (such ridgelines and south slopes) would experience more frequent fire with lower severities, and other areas (valleys and north slopes) would experience lower fire frequencies yet higher severities.[33] Variability is a defining characteristic of these forests, and differences in slope degree, aspect, elevation, plant composition, and soil moisture all affect fire dynamics.[18]

In addition to forest types and on-the-ground conditions, weather plays a large role in determining the onset and dynamics of wildfires. The relationship between low precipitation and widespread fire activity in the western United States is apparent in fire histories.[34,35] For instance, during periods of sustained drought in the early part of the 20th century, the GPNF and surrounding forest lands experienced a series of large fires with footprints and impacts that can be seen today.[36–38]

Wildfire projections

While wildfires play a natural role in patterns of forest ecology in the Pacific Northwest, climate change creates a longer fire season and conditions where fires are likely to burn at frequencies and severities that are different from their historic patterns.[26,32,39] For instance, on the south slopes of Mount Adams, fires have swept through forest stands three and even four times during a ten-year period—a frequency that is far outside the historical pattern.[33] Three of the larger fires in this footprint (Cold Springs Fire of 2008, Cascade Creek Fire of 2012, and Cougar Creek Fire of 2015) burned a combined total of 82,152 acres.[25] Reburns are likely to increase with climate change, especially in drier sites, and this has significant implications for ecological resilience as multiple burns can create compound disturbance effects on tree regeneration and prompt shifts to non-forest vegetation types.[26]

The mountain hemlock and grand fir zones are at particular risk from heightened fire activity. Fires are also expected to increase in low-elevation westside forest areas, such as the western hemlock zone. However, an increase in fire activity from 20th century levels in these westside forests

could be expected even without climate change due to the fire deficit documented for these forests over large parts of the last century.[32]

One important difference between the past and present is the current scarcity of old-growth forests on the landscape. When large and high-severity wildfires reach into the small remaining patches of old-growth in the region, the result can be a loss of important and relatively scarce habitat. Western hemlock forests, for instance, evolved with high severity fire, but the current lack of old-growth changes how we view disturbances like wildfire and where we may want to take steps to protect rare old-growth stands, such as through the creation of road-based fire breaks or other experimental techniques that may buffer existing old-growth from high severity fire.

In the mixed-conifer forests on the south side of Mount Adams, fire suppression has resulted in dense stands of small and medium-sized grand fir and other ladder fuels and thicker layers of duff (needles and other small tree material) on the forest floor.[40] This results in a scenario where fires can be expected to be larger and more severe than they would have been historically. Unlike large ponderosa pine, larch, and Douglas-fir, which can persist through frequent, low-intensity fires, grand fir is less tolerant of fire due in large part to its thinner bark. Also, the densely aggregated young and mid-age grand fir trees act as ladder fuels, allowing fires to reach the crowns of larger trees. Higher grand fir densities also increase competition for moisture and exacerbate the impacts of drought, disease, and insect outbreaks.[41] It is not only the greater density of trees that impacts resilience, it is the fact that grand fir, in particular, cannot control their stomatal openings and therefore do not downgrade their water uptake and transpiration in periods of drought. In addition to impacts from grand firs, the uncharacteristically thick layers of duff around the base of trees can increase the residence time of fires, resulting in higher fire severities and increased mortality.

Historical patterns allow a better understanding of these ecosystems and the role fire has played in their evolution, but the current dynamics are not the same as they were prior to fire exclusion, industrial forestry, and climate change. Forest resilience in the era of climate change requires navigating these increasingly complex relationships.

Forest management before, during, and after wildfire

The Forest Service's response to managing a forest before, during, and after wildfire depends largely on the guidance already in a Forest Plan. Discussed in detail in Chapter 4, Forest Plans dictate where the Forest Service should actively suppress a fire, when they can allow the fire to burn naturally, what steps should be taken to decrease fire risk and severity, and under what circumstances salvage logging can and cannot occur.

Recently, there has been an increased focus from Congress on wildfire, with additional spending for the Forest Service to carry out treatments to reduce fire risks. Many people, including some in Congress, are seeing the fires of the recent summers and wondering if there is a solution through increased logging. In the majority of the areas in which we focus—the moist conifer forests on the west side of the Cascade Crest—logging would likely have minimal and/or very short-term impact on wildfire spread and severity.[23,42,43] One important management strategy in moist forests is retaining the amount of old-growth forests

Interactions between fire and other disturbances, such as drought and insect outbreaks, are likely to be the primary drivers of ecosystem change in a warming climate. Reburns are also likely to occur more frequently with warming and drought, with potential effects on tree regeneration and species composition. Hotter, drier sites may be particularly at risk for regeneration failures.

Halofsky et al. 2020 [26]

on the landscape and protecting mature forests that will be tomorrow's old-growth. In dry and mixed-conifer forests, on the other hand, fuel treatments such as mechanical thinning and prescribed fire can be strategically employed to mitigate future wildfire intensity and spread and to promote overall ecosystem health and resilience.[33,44,45]

Following a wildfire event, a common assumption is that immediate actions, such as salvage logging or replanting, are needed to restore the "fire-damaged" landscape.[46] In general, these types of activities are unnecessary and, in the case of salvage logging, can be particularly damaging. Salvage logging can lead to high levels of sedimentation in streams, an introduction of invasive plants, severe soil impacts, disruption of post-fire habitats, and the impairment of the natural revegetation process.[46–50] Also, trees killed or damaged by wildfire can serve important roles for wildlife; the ecological services they previously provided in a pre-fire forest do not disappear, they simply change.[51]

In Oregon, the Biscuit Fire in 2002 burned over 500,000 acres and included the whole footprint of the 93,000-acre Silver Fire that burned 15 years earlier. After the Silver Fire, some of the area was allowed to regenerate naturally and other areas were salvage logged and replanted. Researchers were able to compare these two different areas and measure how they fared through another fire. Compared to stands that were left alone, fire severity was 16–61% higher in areas that were logged and planted after the first fire.[52] There are situations, though, where selective thinning of small diameter trees after a fire in the mixed-conifer forests could possibly reduce future reburn potential.[53] These are rare scenarios, and soil impacts remain a significant issue, so careful planning and a narrowly targeted application would be key tenets of such an approach.

Post-fire area on the south slopes of Mount Adams

Regarding revegetation of burned areas, while it is often ecologically sound to allow a post-fire landscape to recover with minimal human intervention, the current combination of environmental stressors (e.g., fire suppression, previous timber harvest, a hotter and drier climate, and the presence of invasive vegetation) has resulted in some landscapes lacking the resilience, soil health, and seeds banks that would normally aid in successful regeneration.[54] In the portions of this chapter focused on restoration recommendations, we discuss strategies to aid in recovery after successive burns.

An overview of species-specific climate change impacts

The plants and animals of the southern Washington Cascades will respond to climate change in a variety of ways and over varying timeframes. Some impacts, such as those brought on directly by increasing temperatures and changing weather patterns, will sometimes be more readily apparent than other types of impacts, which could occur through shifts of prey, predators, or competitors. Here we will discuss a snapshot of species-specific climate impacts that are potentially relevant for conservation planning.

The fate of certain bird species such as marbled murrelets (*Brachyramphus marmoratus*), northern goshawks (*Accipiter gentilis*), and northern spotted owls (*Strix occidentalis caurina*) will be closely linked to the health and connectivity of old forests, as they provide valuable habitat features, such as large horizontal limbs, hollow snags, and wide trunks for nesting cavities. Compared to younger forests, mature forests are relatively resilient, but increased drought and fires are still likely to decrease habitat abundance and quality.

Preferring old Douglas-fir and hemlock forests with large branches as horizontal nesting features with ferns and lichens, marbled murrelets have and may continue to be impacted by a loss of nesting habitat from wildfires.[55] In addition to fire impacts, dry summers may reduce fern and lichen growth, thereby degrading the quality of nesting platforms.[56] Northern goshawks, which also nest

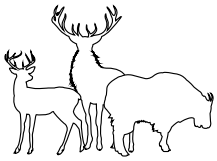
in dense patches of old forest, may be impacted by shifting prey distributions.[57,58] For northern spotted owls, patterns observed during a 15-year study suggest that an increase in summer droughts will negatively impact annual survival and population growth.[59] Carroll (2010) found winter precipitation to be an important variable for predicting northern spotted owl abundance and distribution; changes in this cycle can potentially impact populations.[60] Any discussion of northern spotted owl resilience would be incomplete without mention of the range expansion of the barred owl (*Strix varia*), a critically impactful competitor. Wildlife managers are currently navigating barred owl management strategies (e.g., killing barred owls to save northern spotted owls).[61] This approach may prove to be helpful for northern spotted owls, but it brings with it an array of complications and concerns.

Mountain goat caught on a wildlife camera during a CFC wildlife survey

Bald eagles (*Haliaeetus leucocephalus*), with a diet dependent on healthy fish populations, may be affected by decreasing fish abundance in certain waterways.[62] According to the Audubon Society's climate model, bald eagles may have as little as 26% of their current summer range remaining by 2080 (climate.audubon.org/all-species). Even so, Rubenstein et al. (2019) note that bald eagles are also highly adaptive and are "capable of tracking salmon as they spawn in rivers across the Pacific Northwest," which is a trait that will help them adapt to climate impacts.[63]

The Audubon Society, as part of their "Survival by Degrees" report, has identified a number of other bird species in the southern Washington Cascades that may be at risk from future climate impacts such as increased temperatures, wildfires, and altered precipitation patterns. These include Vaux's swift (*Chaetura vauxi*), northern pygmy owl (*Glaucidium gnoma*), red-breasted sapsucker (*Sphyrapicus ruber*), and Hammond's flycatcher (*Empidonax hammondii*).[64]

Terrestrial amphibians, like Van Dyke's salamander (*Plethodon vandykei*) and the western red-backed salamander (*Plethodon vehiculum*) that inhabit rock outcroppings, depend on wet microclimates to keep their skin moist, and they have minimal tolerance for dry, warm conditions.[65] Drought and temperature increases can be expected to impact these amphibian species.



Mountain goats (*Oreamnos americanus*) are found in the high-elevation lands around Mount Adams, Mount St. Helens, Goat Rocks Wilderness, Mount Rainier, and in travel corridors between. They are most typically found in rocky terrain where their natural ability to climb makes them difficult prey for predators such as bears, wolverines, and wolves. Mountain goats are dependent on grasses, low-growing shrubs, and mosses for sustenance. Because of their size and the typically low levels of nutrients in alpine and subalpine plants, mountain goats can also be found ingesting soil and making pilgrimages to known mineral licks to get the essential nutrients they need. Mountain goat populations in the Washington Cascades have declined over the past 50 years. While not currently an endangered species, their populations are expected to face stressors as alpine and subalpine habitats transform. They will likely suffer from a decrease in late-season forage in rocky outcrops due to dry and hot summers.[25] An encroaching tree line is also expected to reduce grazing areas and the amount of accessible food.

The reduction of snowpack is expected to significantly impact the wolverine (*Gulo gulo*), which relies on snow for denning and caching prey.[66-68] Wolverines have specific adaptations to snow, such as enlarged feet and fur that insulates them from the cold. Reproductive dens of wolverines are limited to areas that retain snow during the spring.[68] In 2010, the wolverine was listed as a "candidate" species under the ESA. In 2014, a proposed rule to list

the wolverine as "threatened" was withdrawn by the U.S. Fish and Wildlife Service, but that decision was widely questioned and eventually disputed by a federal court. The proposed rule was reconsidered as ordered by the court, yet U.S. Fish and Wildlife Service chose to withdraw the rule again. Conservation groups challenged the agency's decision in federal court, and in 2022, the court sided with the conservation groups and restored the proposed rule, providing some protections for wolverines under the ESA. The U.S. Fish and Wildlife Service is currently considering whether to list wolverines as "threatened" for the third time.[69] With shrinking habitat areas, oftentimes limited to narrow elevation bands, protecting wolverine habitat will require identifying habitat, mapping corridors, and enacting policies to limit influences known to negatively impact wolverine survival and reproduction, such as snowmobile activity near den sites.[70]

The American pika (*Ochotona princeps*) is a charismatic relative of the rabbit, adapted to rocky terrain and cold weather. American pikas are typically found living between the cracks and crevices of talus fields (slopes with loose and medium-sized rocks) often near or above treeline where snow is common in winter and spring. Well-shaded dens and thick snow packs create cooler microclimates that shelter pikas from warm summer temperatures. As a diurnal species, they are active during the day, foraging close to the talus and storing vegetation in haypiles during the summer to supply themselves with food stocks over the winter months.[71] Plant health and availability around talus slopes could be restricted by increasing summer drought. If climate change causes an increase in freezing rain in certain areas, this can encase plants in ice and affect foraging. Earlier snowmelt can reduce snow packs that pikas sometimes depend on for shelter, temperature regulation, and food storage. For pika populations living at elevations between 8,000–14,000 feet, they do not have the luxury of being able to extend their range upward in elevation as they already exist near the upper limits of peaks.[72] Some pika populations live in lower elevations, though, and there is evidence that pikas may be able to persist through potential future changes to high elevation habitats.[73] There are instances of pika retreating to the cool crevices of the talus slopes to evade peak temperatures and foraging during the nighttime if daytime activity is restricted.[75] In the GPNF and the Columbia River Gorge, Cascade Forest Conservancy volunteers and other field survey teams have found pikas living in a variety of elevation bands, including low-elevation sites. Such observations provide hope that pika populations can adapt to a changing climate, but their trajectory remains unclear.

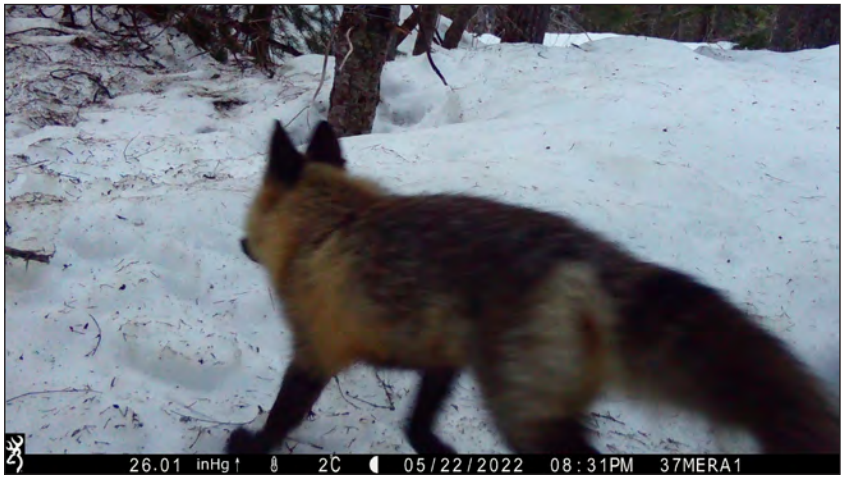
A busy pika gathers leaves and grasses to bulk up its food cache pile for winter

The Cascade red fox (*Vulpes vulpes cascadensis*), an already rare species, is well-adapted to cold but could suffer from a lack of suitable connectivity and habitat quality due to warming temperatures and reduced snowpack. In the mountainous Cascade Range, the sparse distribution of their preferred alpine and subalpine meadow habitat causes them to be limited to small, isolated populations.[75] In a warmer climate, certain alpine habitats may decrease or disappear, and high elevation meadows will likely become drier and degraded. Additionally, prey abundance and stressors from new competitors like non-native foxes (*e.g., Vulpes vulpes*) and coyotes (*Canis latrans*) could reduce success of prey caching, limit den sites, and over-expend dispersal costs.[75,76]

The hoary marmot (*Marmota caligata*) has a highly specific preferred habitat of rocky outcrops next to wet meadows just above the treeline. They hibernate for eight months and rely on availability of favored plant species during their active period. A warming climate and seasonal fluctuations in precipitation and snow cover duration could create a phenotypic mismatch wherein they emerge from hibernation earlier due to warmer temperatures, but the vegetation they rely on for survival and reproduction success is still dormant.[77] Changes in alpine vegetation could also increase competition and populations of predators as it becomes more favorable for new species.[78]

Some animals that benefit from early seral habitats and which are wide-ranging, such as deer, elk, and bear, may experience an increase in habitat availability from fires and losses in forest cover, but drought impacts may negatively affect their forage.[79-81] The black-backed woodpecker (*Picoides arcticus*), a fan of post-fire habitats, may respond positively to the likely increases in wildfires.

Cascade red fox photographed by wildlife camera in 2020



Cascade red fox photographed by wildlife camera in 2022

Male Columbian black-tailed deer photographed in 2021

Meadow habitats

Topography influences meadow locations, and elevation influences types of vegetation that occur in the meadows, as it relates to growing season length, climate, soil development, and glacial history. Wet meadows are most common on the GPNF and are particularly prominent in alpine and subalpine vegetation zones. Wet meadows are saturated with water for much, if not all, of the growing season. Moist meadows may be flooded soon after snowmelt but may not stay saturated as the water table lowers. Dry meadows may experience intermittent flooding but are well drained and have a deeper water table than wet or moist meadows.

Hudec et al. 2019 [25]

Meadow habitats are vital components of a healthy Pacific Northwest ecosystem. They house unique configurations of plants and animals that are not found in the surrounding forested landscapes. Threatened and rare species, such as pale blue-eyed grass (*Sisyrinchium sarmentosum*) and the mardon skipper butterfly (*Polites mardon*), rely on meadows. The abundance of invertebrates supply food for birds, amphibians, and reptiles. Meadows support a wide array of butterflies, including skippers, checkerspots, fritillaries, sulphers, blues, and swallowtails.[25] Birds such as chipping sparrow (*Spizella passerina*), hermit thrush (*Catharus guttatus*), yellow-rumped warbler (*Setophaga coronata*), and Townsend's warbler (*Setophaga townsendi*) nest at the edges between meadows and conifer forests. A variety of mammals, such as bear, deer, elk, and squirrels also regularly use meadow habitat for forage.[25] Connected meadow habitats help ensure genetic diversity for transitory species, such as the Cascade red fox.

In some meadow habitats, perennial flowering plants have already been replaced by low-lying shrubs and sedges that are better equipped for warmer and drier weather.[82] This decline of floral plants could have severe implications for pollinators, as well as wildlife that depend on nutrients and habitats specific to a meadow environment. Further endangering plant diversity, warmer temperatures will likely bring threats from invasive species, such as Scotch broom and reed canarygrass, which can withstand longer periods of drought.[83]

Meadow restoration—consisting of cutting back small conifers that are encroaching on current meadow systems—can ameliorate some loss of habitat and competition for moisture. In addition, seeding and planting of native meadow species can help boost biodiversity and aid in the establishment of new meadows.

Alpine and subalpine ecosystems

The picturesque scenes of the snow-capped volcanoes that tower above our region draw visitors from far and wide. They are also home to a number of rare species, such as the elusive wolverine and Cascade red fox. These unique habitats also support a variety of plants, many of which cling close to the ground to absorb the heat and avoid the harsh winds.

The subalpine and alpine regions in the southern Washington Cascades can be found at elevations from about 7,000 to 14,410 feet at the peak of Mt. Rainier. The cold climate, rocky soil, heavy winds, and swaths of year-round ice and snow create a unique area that suits a particular suite of species. Timberline marks the transition from the dense conifer forests below to the alpine uplands dominated by low-lying plants and uniquely-adapted wildlife species. A healthy buildup of snow and ice over the winter ensures snowmelt through the summer months, and this snowmelt is an integral part of the region's hydrological cycle, especially for glacial-fed river systems.

Subalpine and alpine ecosystems are considered some of the most threatened in our region. In the face of even mild to moderate warming from climate change, we can expect to see a recession of glaciers and a reduction of snowpacks. We can also expect to see the treeline encroach on upland habitat in certain areas, including subalpine meadows.[84-86] A shift in the timing of flowering has the potential to cause direct mortality for certain species and to disrupt various species relationships.[87] Animals, like the wolverine, that depend on snow and ice for shelter, foraging, and food storage are likely to be severely impacted by climate change. Connectivity between alpine habitats is low due to the wide distances between areas, which can hinder dispersal and movement for species facing climate pressures in certain locations.

Conservation and restoration strategies for alpine systems are limited due to the inability to change snow and rainfall dynamics. Because of this, protection of alpine systems requires strategies to reduce the severity of climate change, such as through carbon storage and forest preservation. Data collection, though, is an important strategy to help managers gauge localized impacts and tailor resilience-building efforts.

ADVOCACY AND POLICY CONSIDERATIONS ON **FEDERAL LANDS**

This section outlines strategies related to policies and projects on federal lands. Forest management strategies relating to Forest Plans are outlined in Chapter 4.

National level: retain valuable aspects of the NEPA process and other federal programs

In the last several years, Congress and presidential administrations have been active on forest management issues. The Forest Service released and began implementing the Wildfire Crisis Strategy in 2021 to increase fuels reduction treatments. Additionally, Congress has been providing new funding for forest management, primarily for addressing wildfire risk. Congress has also enacted public lands packages, like the Great American Outdoors Act, that provides much-needed funding to our underfunded and understaffed land management agencies. This has funded several shovel-ready projects on the GPNF, many of which are ecologically-tuned restoration projects that had otherwise lacked funds.

More recently, the Infrastructure Act invested massive amounts of federal money into climate change mitigation and adaptation.[88] The bill includes several types of funding mechanisms to assist in restoring ecosystems and increasing resilience. It is important that this funding is directed at high priority projects, such as those identified through this guidebook.

The National Environmental Policy Act (NEPA) process is a systematic approach to environmental decision-making in the United States, requiring federal agencies to assess the environmental effects of their proposed actions and engage with the public prior to making decisions. There has been recent focus on weakening NEPA regulations and requirements, including provisions in funding bills aimed at decreasing planning durations, efforts to decrease the emphasis of cumulative impacts, and yet-to-be-seen changes that will be coming from the Council on Environmental Quality.

Also, the categorical exclusion (CE) for salvage logging was greatly expanded by the Trump Administration (from 250 acres to 3,000 acres), but a court recently sided with the environmental community challenging this change. CEs allow certain management projects to bypass the NEPA analysis process and most of the associated public input. CEs are usually for non-controversial projects that are limited in size and have well-understood impacts. Expanding the salvage CE could have had enormous negative implications for how the Forest Service addresses salvage logging after wildfire.

Regional level: retain valuable aspects of the NWFP and increase protections for certain forest habitats

As we move to the regional level, we look to the NWFP, the guiding plan that dictates the limits of timber harvest activities in the Pacific Northwest. For nearly three decades, the management of Pacific Northwest national forests under the NWFP saw minor alterations, such as amendments to guidelines and local revisions, but the original land allocations remained mostly unaltered. However, a potential change to the NWFP is in the works. We delve into Forest Plan recommendations in Chapter 4, where we outline specific strategies that can be employed at the regional and local levels to improve climate resilience through Forest Plan amendments or revisions.

Local level: public involvement with timber harvest planning

One way to ensure mature forests are left intact and habitat protections are prioritized on federal lands is by getting involved in the process of timber harvest planning. With most forest management efforts on federal land, the Forest Service must follow NEPA, which requires federal agencies to consider public input and environmental impacts when making decisions.

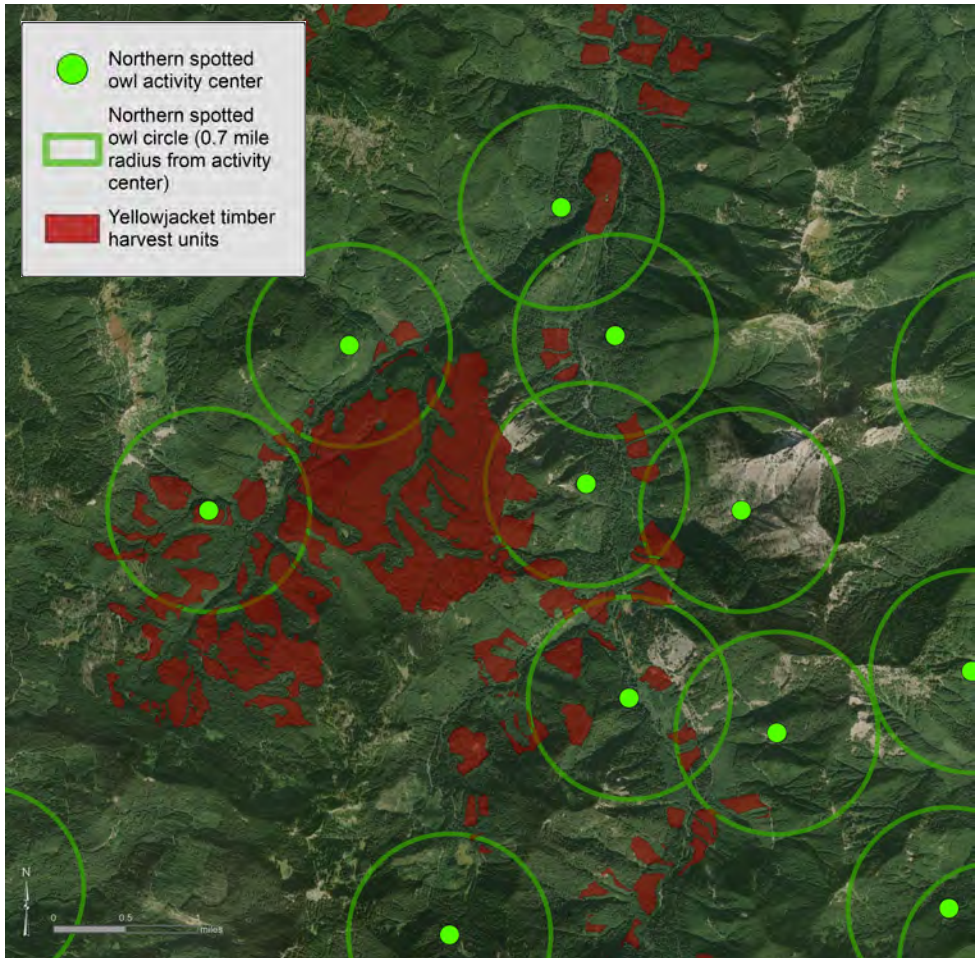
The Forest Service carries out vegetation management planning with a district-level team where a variety of different specialists (such as botanists, wildlife biologists, silviculturists, hydrologists, and others) come together to plan where logging should occur in a certain planning area, how many trees and what types of trees would be removed, where roads would be built or re-opened, which roads would be closed, and what steps will be taken to protect

or enhance habitat. The specialists bring various ecologically-driven perspectives into these planning processes, but with timber harvest being the foundation upon which these plans are built, extraction of trees has often been the dominant factor driving which areas are logged and which are protected. After months to years of preparation and analysis, a plan is eventually finalized, a decision is formalized, and the work is carried out by a contracted logger.

We engage with timber planning on federal lands in two ways: 1) submitting official comment letters to the agency to point out any legal and scientific deficiencies found in a proposal and to provide feedback from our on-the-ground investigations; and 2) participating in forest collaboratives, which are stakeholder groups that meet regularly to discuss timber harvest proposals and provide input to the Forest Service planning team. In the Upper Wind federal timber sale, for example, through our multi-year engagement in the process, we prevented forest stands that were over 120 years old from being logged to create early seral habitat (i.e., removal of most trees from a unit to create a condition that is analogous to a post-disturbance/post-fire setting). Writing official comment letters and participating in forest collaboratives allow us to be site-specific and to advocate for the protection of particular forest stands and habitat features. Comment letters and collaborative deliberation are independent but related efforts.

For most timber projects, there are two opportunities to engage in the public comment process: 1) the initial scoping phase where the agency is looking for early feedback on a basic and generalized plan, and 2) after the draft environmental assessment (EA) is released. The EA

A volunteer collecting information to ensure protection of old forest habitats



Map showing the overlap of northern spotted owl circles and timber harvest units in the Yellowjacket planning area on the GPNF

is more refined than the scoping notice and includes site-specific information about timber prescriptions and road construction.

The public comment process discussed above is not just available for organizations. Community members can submit comments as well. The federal agency fields all input and takes this information into account when finalizing their management decisions for a particular area.

Members of the public can also join their local forest collaborative. Collaboratives are open to the public and are meant to contain a wide variety of perspectives on forest management, including input from conservation groups, loggers, county representatives, and concerned citizens. In general, the goal of the collaborative is to discuss potential forest management activities early in the planning process (members receive forest management information before it is released on agency websites) and to ultimately work toward finding consensus or areas of agreement around federal forest management projects.

There are several issues of concern that we frequently encounter in timber sale planning processes and which are important to keep in mind when hoping to influence land management plans. One of these issues is mechanically-created early seral habitat. Early seral is a habitat type that is early in the successional stages and is characterized by very few trees and many shrubs and other small plant species. Certain wildlife species rely on early seral habitat. Historically, this type of habitat was created through disturbances like wildfire or, in smaller patches, from insects, disease, or windthrow. Due to a century of fire suppression, creation of monoculture plantation stands, and other anthropogenic factors, there is less early seral habitat on the landscape than would have been seen in previous eras. While this might suggest a need to create more early seral habitat, there is more to the story. Most notably, the wider spread and greater intensity of wildfires are already rapidly increasing the amount of early seral habitat in the region. As an example, during the planning for the Upper Wind timber sale, the Big Hollow Fire swept through the GPNF and burned approximately 25,000 acres. There may have been a lack of this habitat in and near the planning area before this fire, but afterwards, that was not the case. We can expect to see this pattern repeated elsewhere as the size and intensities of wildfires increase with rising levels of drought and a longer fire season. Because of this, it is unnecessary and unwise to mechanically create large swaths of early successional habitat, especially by logging mature forests, as these forests are our future old-growth. In addition, it is not clear whether timber harvest is an effective tool for creating early seral habitat. This type of treatment may cause more harm than good, considering the impacts from heavy machinery on soil compaction, understory plants, current habitat features, and the introduction of invasive species.

It is often necessary to advocate for timber plans that adequately protect species like northern spotted owls and fishers. When reviewing timber sale layouts, we pay special attention to known northern spotted owl nest sites to ensure they receive adequate buffers from harvest and to reduce the intensity of logging in adjacent areas. Generally, northern spotted owls thrive in forests with canopy cover levels over 70%, so we aim to ensure that logging levels

A field trip with members of the South Gifford Pinchot Collaborative

remain above this threshold in key areas.[31,89,90] Other mature forest species also benefit from similar canopy coverage levels, and maintaining this minimum canopy threshold in key locations can also have the added benefit of helping retain cool and moist microclimates.

We also address impacts to aquatic ecosystems in our timber sale comments. This is explained in greater detail in Chapter 3.

For comments to accurately reflect the details of timber harvest plans and for collaborative processes to be successful, strong communication, transparency, and data sharing from the Forest Service is needed. This helps ensure meaningful community involvement and public participation in the decision-making process, which is critical for community buy-in and social license. Forest Service teams in the southern Washington Cascades model this effectively but this is not the case in all parts of the western United States.

Support Tribal involvement in land management

For generations, local Indigenous communities have actively managed these forest habitats. A key element to promoting future resilience should involve a collaborative approach that integrates Traditional Ecological Knowledge and Tribal practices into the management of federal lands. This can be done in a number of ways, but generally this means supporting co-management mechanisms and other programs meant to enhance coordination with Tribes in the ecological management of national forests.[91] For example, the Tulalip Tribes have used "memorandums of agreement" to collaborate on management of the Mt. Baker-Snoqualmie National Forest for many years. This collaboration has included watershed enhancement, huckleberry enhancement, and wildlife reintroduction work. The Cowlitz Indian Tribe works on a number of projects on the Gifford Pinchot National Forest, including advocating for targeted forest thinning to enhance the growth of huckleberry and working in the Pinchot Partners, the forest collaborative in the Cowlitz Valley Ranger District.

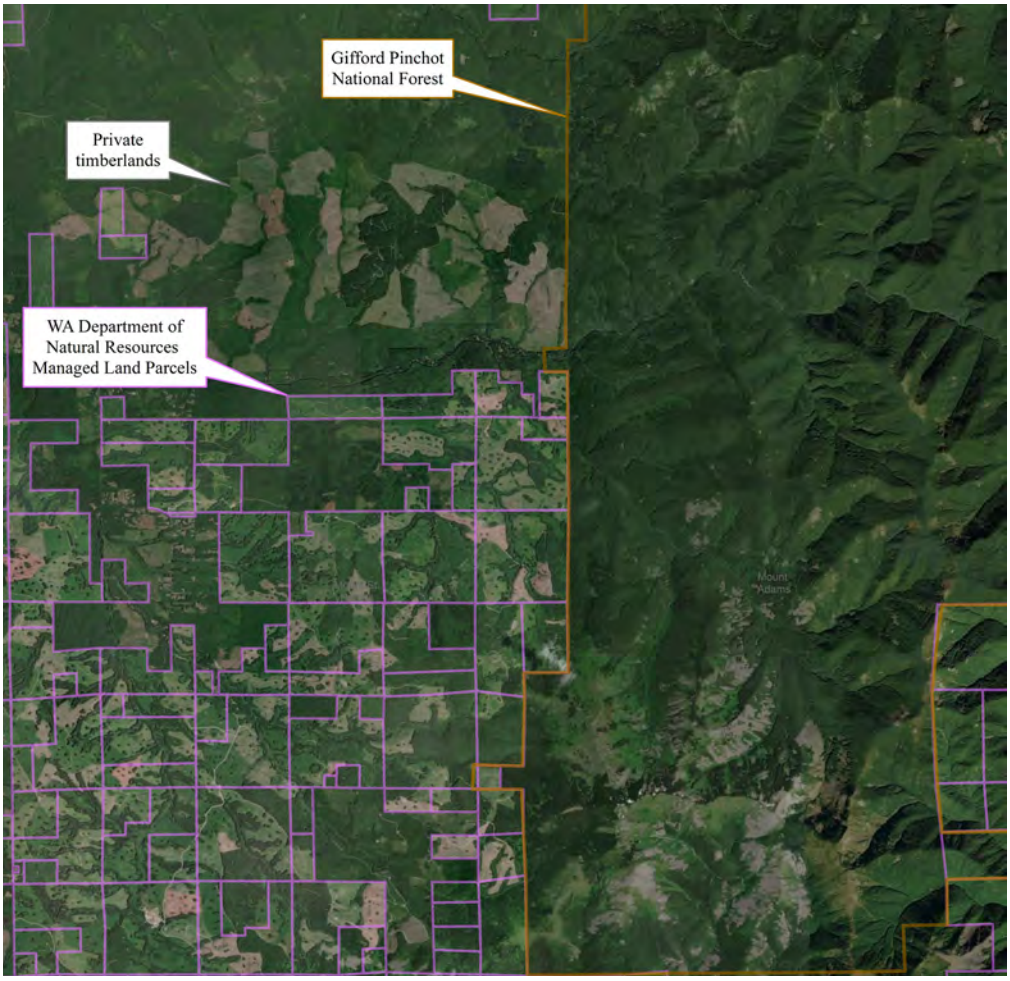
CFC volunteers performing huckleberry surveys at a berry field restoration site

Also, a federal program called the Good Neighbor Authority creates avenues for Tribes, counties, and states to carry out timber harvest and restoration work on federal lands. This enables Indigenous communities to steward and gain income from on-the-ground projects. This authority helps projects move forward more quickly and over larger areas by allowing multiple entities to carry out work on federal lands.

Other mechanisms include the Tribal Forest Protection Act, which has been used to advance collaboration with the Forest Service for managing lands adjacent to Tribal lands. The 2018 Farm Bill added the ability to carry out demonstration projects using this contracting authority. The Tulalip Tribes in 2020 entered into a Tribal Forest Protection Act contract focused on beaver relocation and monitoring efforts using the new demonstration project authority.

The Forest Service also has a special authority that enables Tribes to bypass certain regulatory hurdles and receive natural materials, such as trees, without having to compensate the federal government.[92] This authority can be utilized to advance more mutually-beneficial restoration projects. In the southern Washington Cascades, we helped facilitate the use of this authority by sourcing trees from the Columbia River Gorge National Scenic Area and delivering these for instream restoration work being carried out by the Cowlitz Indian Tribe.

The Forest Service has indicated they are focused on enhancing co-stewardship of national forests and grasslands in a recent action plan titled Strengthening Tribal Consultations and Nation-to-Nation Relationships.[93] We recommend that these plans, authorities, and opportunities be used to advance Tribal co-management and mutually-beneficial projects to improve climate resilience on federal lands.



Map showing forest cover in three different types of land ownership: state, federal, and private lands

ADVOCACY AND POLICY CONSIDERATIONS ON **STATE LANDS**

Climate resilience cannot be achieved by only focusing on federal lands. The management of the roughly two million acres of state forest lands is largely tilted toward extraction, with less emphasis on habitat needs and the role that these forests can play in mitigating climate change through carbon storage.

Washington State Trust Lands

The state of Washington owns several types of forested lands (state trust lands, state forest lands, community forests, natural resource conservation areas, natural area preserves, and wildlife areas). Much of the forest lands are called trust lands. There are two different types of trust lands: 1) those that were granted to the state by the federal government, and 2) others that were forfeited to the counties by private owners and turned over to the state for management. For trust lands, the state has a legal duty to provide a continuous flow of revenue to trust beneficiaries over time. These beneficiaries include counties, public schools, state universities, and prisons, to name a few. The trust responsibilities complicate the management of much of the state's forest lands, as environmental protection and conservation goals on trust lands must be balanced against the state's responsibilities to beneficiaries. It's unfortunate that some county and state public services are tied to logging, but that is the current arrangement through which we must address these issues. In addition to timber harvest, though, the state can employ other activities or methods to produce income for beneficiaries, including leasing land for agriculture, leasing communication sites, mining and mineral leases, wind farms and other types of energy production, rights of way, forest products like biomass, and, currently in a limited capacity, carbon storage.

There is some indication that management of the trust lands is evolving to a small degree. In 2022, the Washington Supreme Court deliberated on the question of whether trust responsibilities only apply to those who receive direct income (certain counties, schools, etc) or

whether the state must manage on behalf of all citizens.[94] The Court determined that the agency must manage on behalf of all citizens, not just the direct beneficiaries. The case has not yet solicited any direct changes in forest management, but it may eventually impact how Washington Department of Natural Resources (DNR) can make management decisions in the future regarding their trust lands.

Staying involved in timber sales on state lands

One way to advocate for healthy and resilient ecosystems on state lands is to be involved in state timber sales. Similar to federal lands, the state has a public involvement process under the State Environmental Policy Act (SEPA) where citizens and groups can provide feedback on harvest plans. Anyone from the community can provide feedback on harvest plans on state lands by reviewing the SEPA materials online and commenting before the deadline. DNR will review any comments received and will consider those comments before finalizing their decision. Like with federal timber sales, reviewing and commenting on state timber sales allows the public to be involved on a site-specific level and to help ensure all laws are being followed and that a site's ecological characteristics are more fully considered when finalizing harvest plans.

We regularly monitor several issues, including road-building, aquatic habitat and water quality impacts, protection of older forests and large trees, and potential impacts to species like salmon and the northern spotted owl. On state lands, protections for old-growth-dependent species are measured and considered through a Habitat Conservation Plan under the Endangered Species Act. Under this plan, there are areas of designated high-quality northern spotted owl habitat and a requirement to maintain a percentage (50% per watershed) of that habitat. There are varying perspectives on how to apply this percentage and some conservation groups recommend that future projections of habitat loss (e.g., from wildfire or drought) be considered when determining whether the 50% per watershed requirement will be met after timber sales. With the consideration that we can justifiably expect an increase in the rate of habitat loss in the coming decades, it would be appropriate to maintain a higher percentage of habitat for northern spotted owls to ensure 50% per watershed actually exists in the future.

When reviewing state sales, we pay particular attention to the habitat classification and the age of the stand to ensure state lands are meeting their requirements to support species – this sometimes involves advocating that a higher percentage of habitat be conserved in a certain sale area. We also pay close attention to riparian management zones around streams and rivers (see Chapter 3). In response to the current lack of protections for headwater streams, we frequently advocate for the state to provide greater safeguards for these stream reaches due to the known impacts of logging along waterways.

Preserves for ecological values

The state has one land management tool that can help move ecologically-important lands in trust ownership to other types of public ownership. This tool is called the **Trust Land Transfer Program**, and it is funded by the state legislature. This transfer, in turn, requires the purchase of replacement lands for the trust. In the past, during the legislative budget process, particular parcels would be nominated for transfer, and the legislature would make final determinations on which parcels to transfer. Overall, though, use of this program has not been very consistent or transparent. There are, however, efforts underway to revitalize the program—a recommendation that came out of the 2021 Trust Lands Performance Assessment.[95] DNR introduced bills in the 2023 legislative session to implement some of the needed reforms.[96] Passing these bills is only the beginning of making these programs more consistent and transparent.

One type of public ownership that trust lands can be, and have been, transferred to is the network of natural areas intended to preserve vital populations of important species and ecosystems in existence over the long-term. These areas (**Natural Area Preserves** and **Natural Resource Conservation Areas**) are managed by the DNR in the Natural Heritage Program. Natural Area Preserves are areas that "protect the best remaining examples of many ecological communities including rare plant and animal habitat." [97] Natural Resource Conservation Areas are areas that "protect outstanding examples of native ecosystems, habitat for endangered, threatened and sensitive plants and animals, and scenic landscapes." [97] The Trust Land Transfer Program, although worthwhile, has fallen short in efforts to ensure species and ecosystems important to the state will survive in the face of climate impacts, especially considering the high degree of impact and development on the private lands that surround most of DNR's properties. In a 2022 report to the legislature, the state acknowledged that a majority of the species and ecosystems listed as a priority for the natural preserve system are still not adequately represented in preserves, i.e., their population numbers are too low in these areas.[98]

If the Trust Lands Transfer Program is revitalized into a more functional program in a future session, this tool could be used to move priority conservation areas identified on page 34 into a more protected status, e.g., the Natural Area

Preserves and Natural Resource Conservation Areas. In summary, we recommend that DNR use the updated and revitalized transfer tool to protect key habitats in southwest Washington and ensure the Natural Heritage Program goals are achieved.

Efforts to set aside trust land for carbon storage

While still attending to the beneficiary needs, DNR has recently taken small steps to address carbon storage by creating a Carbon Project. This effort set out to identify 10,000 acres for conservation in order to preserve forest carbon and to bring in funding through credits for carbon storage as an ecosystem service. This is a step in the right direction and serves as a foundation upon which to modernize the state's management of forest carbon. Currently, though, these efforts are being challenged in court by some of the trust beneficiaries. If the Carbon Project survives litigation or if future efforts are brought forward, expansion of that program beyond the initial 10,000 acres should focus on protecting the priority areas identified below.

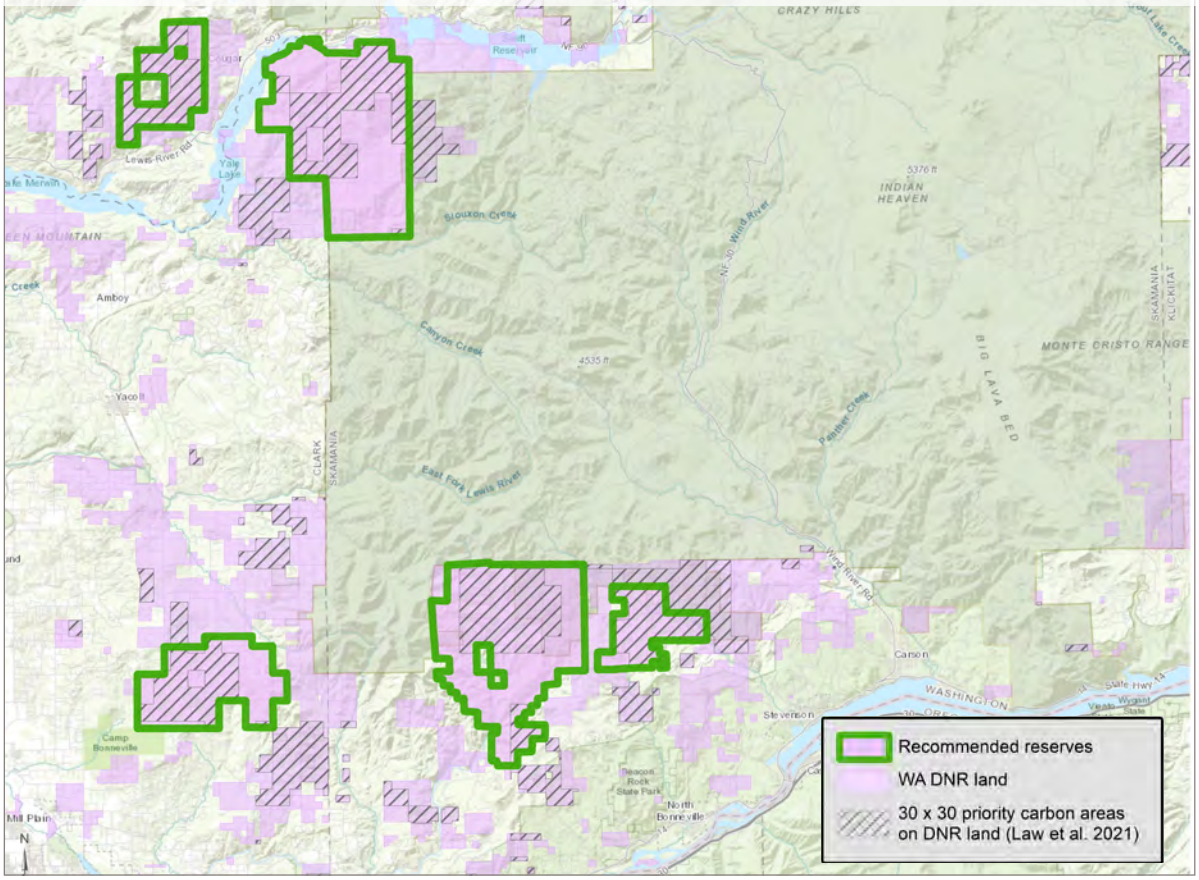
Relatedly, recent efforts in legislative sessions have focused on expanding DNR's authority to participate in carbon markets and sell carbon credits and offsets. Currently it is unclear what the limitations of this expanded authority will be, if an expansion happens at all.

Regardless, these bills, which were at the request of DNR, are an indication of the state's desire to manage certain forest parcels as carbon storage areas. We designed our recommended areas of protection (in the map below) to align with both carbon storage goals and habitat needs.

State forest areas recommended for long-term protection

Here we identify five areas on DNR land where we recommend a comprehensive analysis and consideration for future protection from logging using either the Trust Land Transfer Program or a future carbon storage project.

These areas were identified by overlaying three datasets in order to highlight areas that would bring multiple benefits, including protection of mature forest habitat, connectivity, and carbon storage. The layers we used were: 1) a recently completed scientific analysis showing priority areas for carbon storage (Law et al. 2021), 2) a forest age layer, and 3) our previously completed connectivity model.

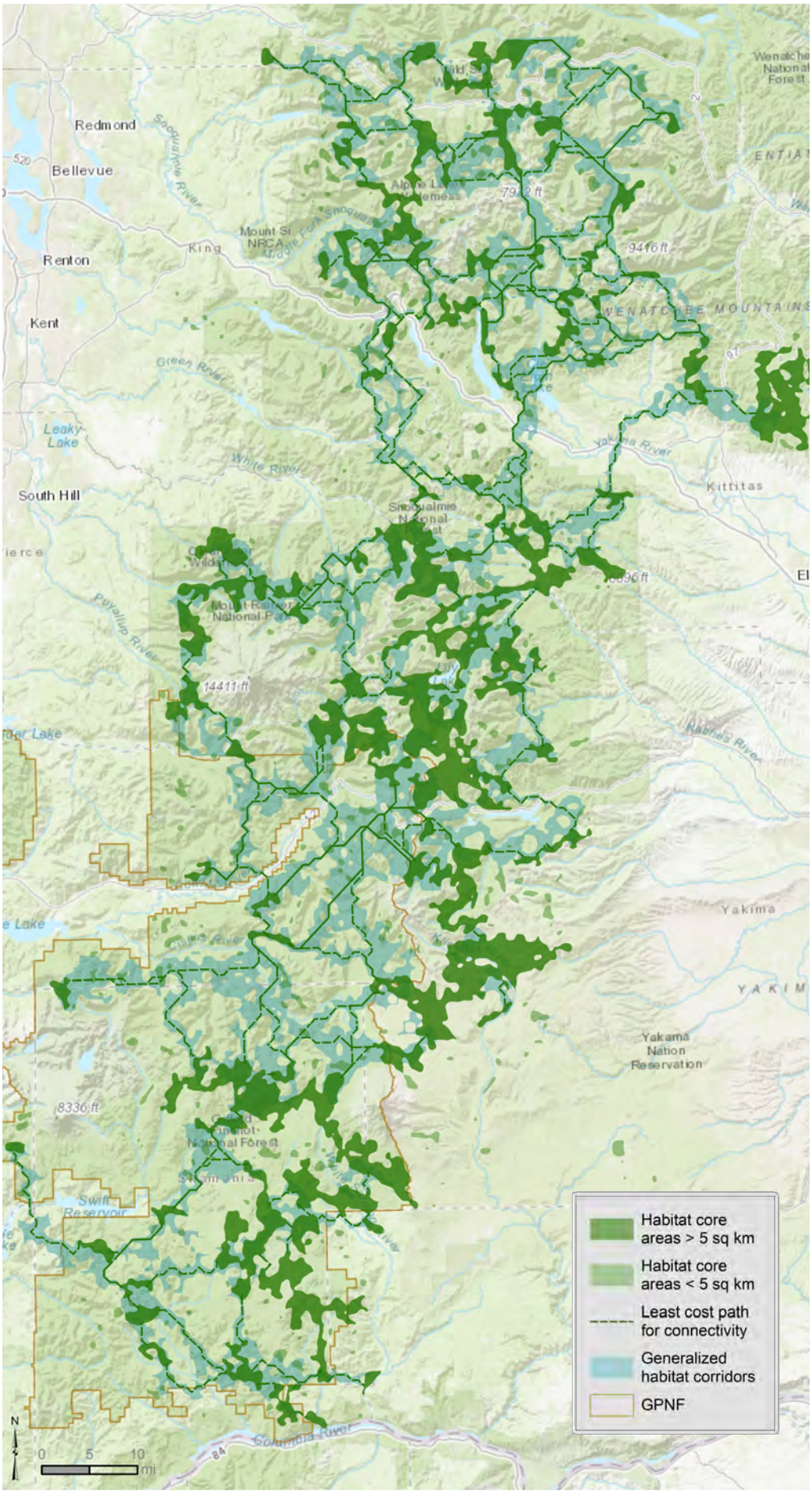


Connectivity

Connectivity is a key component to consider when developing strategies to conserve species and habitats. It represents the critical arteries that sustain ecosystems. Robust connectivity throughout the landscape enables wildlife populations to be more resilient to climate impacts by allowing movement to alternate habitat areas and decreasing the degree to which disturbances in a specific habitat patch will jeopardize the overall viability of a population. For example, if a certain area is dramatically affected by wildfire or drought, the availability of nearby suitable habitats, linked by corridors of viable dispersal habitat, becomes critical in preventing population extirpation.

In developing conservation strategies for species, we must consider a landscape perspective of connectivity that anticipates potential shifts in habitat patterns and dispersal needs. Refugia areas must correlate to the dispersal and resource needs at particular times in the life cycle of plants and animals.[99,100] It is also important to prioritize areas with high conservation value (such as old-growth forests or other rare habitats) or areas with relatively high inherent resilience (such as mature or old-growth forests).[101] By conserving these areas and the areas of connectivity in-between, we can support the movement, resilience, and long-term survival of species.

In 2017, Cascade Forest Conservancy carried out a connectivity analysis to assist in conservation planning for old forest habitats. This analysis identified core habitat areas (referred to as "habitat core areas" or HCAs) and potential connectivity corridors. The analysis parameters set for this analysis were broad and were intended to encompass habitat needs for a suite of species that depend on old forest habitats, such as fishers, martens, and northern spotted owls. We used this connectivity model to help refine our Forest Plan-related conservation strategies outlined in Chapter 4.



Walking among the pines in a mixed-conifer forest near Mt. Adams where prescribed fire is planned

RESTORATION
RECOMMENDATIONS

In this section we outline restoration strategies for forest ecosystems. Interwoven within these restoration strategies is an understanding of the fundamental significance of biodiversity, as it provides a box of tools to mitigate threats from climate change. Another crucial theme weaving together these strategies is an implicit understanding of the value of gathering on-the-ground information. Community members play a pivotal role in monitoring ecological changes over time and collecting data that can inform adaptive management efforts, species recovery initiatives, and the classification of threatened or endangered species at both federal and state levels. By developing a comprehensive understanding of local wildlife populations, such as pikas and rare carnivores, policymakers can target specific policy changes and reintroduction endeavors to ensure long-term survival of at-risk populations.

Increasing resilience through strategic restoration of mixed-conifer forests

There are actions we can take to help improve the resilience of certain forest areas. Our recommendations for fire risk reduction in forest ecosystems specifically focus on the drier mixed-conifer forests on the south side of Mount Adams, as thinning for fire risk reduction in moist, westside forests is not well supported by the literature.[23,42,43]

In the mixed-conifer forests, where we see uncharacteristically large influxes of grand fir amongst the ponderosa pines and Douglas-firs and where thick layers of duff increase the potential for tree mortality, restoration thinning and prescribed fire can reduce fuel loads, improve resilience, and set these landscapes on a trajectory that is more analogous to their historic conditions and more likely to persist amidst future changes. The consequences of logging and active management (e.g., prescribed fire and skid trails) can bring impacts of their own, though, such as loss of certain habitat features, the introduction of invasive plants, and soil compaction. Because of this, careful planning and thorough consideration of near-term impacts need to be integrated into management plans.

To ensure that management efforts sufficiently balance both short-term and long-term resilience, it is important that the following measures are taken:

- Conduct pre-treatment surveys to protect rare plants and sensitive wildlife;
- Maintain intact forest patches within treatment units to promote fine-scale heterogeneity;
- Preserve higher tree densities in valley bottoms and north slopes as these areas naturally have higher stem densities and cooler microclimates;

- Leave streamside (riparian) areas undisturbed to protect waterways;
- Avoid regeneration harvest (clearcut) and gaps larger than ¼ acre to retain carbon and limit habitat fragmentation;
- Focus thinning on small diameter trees, with particular focus on grand fir;
- Retain large trees, such as Douglas-firs and ponderosa pines over 30" in diameter, due to their value for wildlife, soils, and carbon storage; and
- Ensure strategic use of prescribed fire to increase efficacy of restoration.

Prescribed burning has been underutilized in the recent past due to limited burn windows and procedural hurdles. The omission of this crucial step hinders the full potential of restoration thinning. The Forest Service, the state, and local communities approach the use of fire as a management tool with varying levels of caution. The Forest Service, for example, exercises prudence due to limited resources, limited opportunities with desirable weather and fuel conditions, and instances of escaped burns in other areas. Local communities express concerns about impacts on air quality as well as the potential risk of escape. Addressing this issue requires increased collaboration and communication between agencies and local communities regarding prescribed fire, associated risks, and the time frames within which burning is allowed.

Furthermore, it is essential to continue monitoring restoration actions and their effects on forest conditions and future wildfire patterns. By doing so, we can gather valuable local evidence to determine the best practices and inform adaptive management strategies.

Post-fire restoration

There are certain instances where post-fire restoration can make a difference in accelerating revegetation. When conditions for natural recovery are limited due to successive burns, size and severity of the fire, or pre-fire conditions that will hinder recovery, actively facilitating the establishment of diverse native plant species can be beneficial to a post-fire landscape. This type of restoration can protect soils from erosion and compaction, minimize encroachment of invasive plants, provide resources to a variety of pollinators and other wildlife, and speed up the re-establishment of other ecological functions. Depending on budgets and the size of the landscape, sowing seeds via helicopters, drones, hikers, and even dogs can allow for dispersal with minimal additional soil disturbance. Attention should be paid to maintaining the genetic diversity of the local plant communities; as such, the collection of seeds from multiple locations within close proximity to the burned area is recommended. An alternate strategy, and one within the realm of assisted migration, is selecting seeds from an area where plants have been experiencing conditions similar to what the future conditions are predicted to be at the restoration site.

CFC volunteers and staff working with a botany expert from the Forest Service to restore fire-impacted forests

Assisted migration

Future climate conditions will change which plants can thrive in certain areas.[102-104] This has led researchers to explore adaptation strategies such as assisted migration, which involves humans physically relocating plants to a location beyond their historical distribution.[105] Assisted migration is not a new concept, Indigenous cultures practiced this when planting culturally-important plants, and forest managers replant forest stands with particular species for lumber and other uses.[106] Regardless, assisted migration is a controversial topic. It offers the potential to reduce some of the adverse effects of climate change, but opponents argue there is significant risk of the practice having unintended consequences by disrupting natural ecological and genetic processes or introducing invasive species, especially if using plants from far-off locations.[107,108]

A recent synthesis by Twardek et al (2023) collated the results from various assisted migration studies and concluded that there is a paucity of data paucity of data to support assisted migration as a climate adaptation strategy. The GPNF is participating in an assisted migration and silviculture study with the Pacific Northwest Research Station. The Experimental Network for Assisted Migration and Establishment Silviculture (ENAMES) is a long-term study being conducted at ~25 sites from California to Washington, including a 16-acre plot of Douglas-fir seedlings planted in 2021 on the GPNF. The seeds were

chosen from lower elevation areas and moved to cooler, higher elevations within their general habitat range.[109] As years pass, the results of this study will offer insight into the value and utility of this practice.

Increasing our understanding of local wildlife to help sustain populations

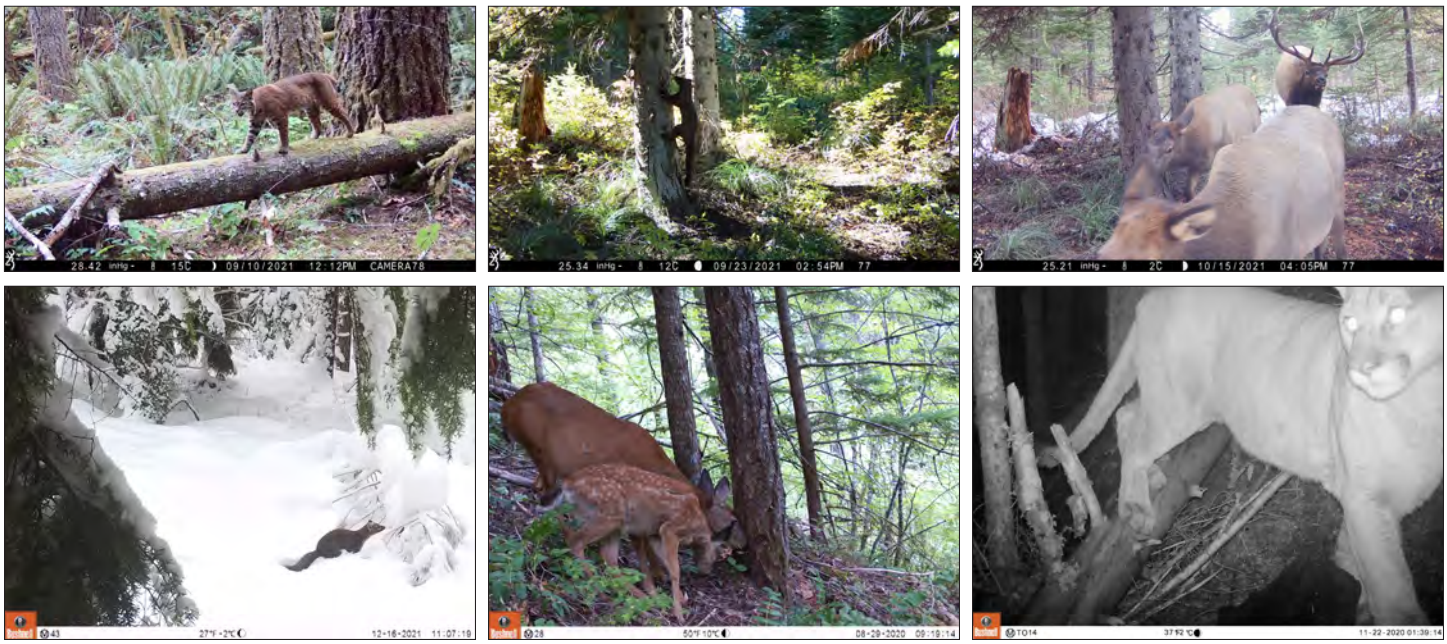
On-the-ground research on wildlife distributions, trends, and behavior can help us in designing effective conservation strategies.

Some species, like pikas, can be monitored through surveys carried out by conservation professionals or volunteers out in the field. On-the-ground surveys, both opportunistic and systematic, are crucial for American pika research as they provide direct observations of their presence in specific elevation bands and habitat zones. Opportunistic surveys involve individuals reporting random pika sightings encountered during recreational activities. Systematic surveys involve surveyors visiting sites with known pika presence to assess whether pika populations have sustained at those locations. This hands-on approach allows us to collect valuable data that contribute to a comprehensive understanding of the pika's distribution. This helps us understand how they have been impacted by current temperature patterns and how they might be impacted by future changes, such as changing habitat zones along elevation gradients.

Wildlife camera surveys offer another approach to monitoring at-risk and recovering wildlife populations, allowing more fine-tuned conservation and climate adaptation planning. This is especially valuable for monitoring rare and elusive species. This work involves the use of remotely-triggered cameras that capture photos when animals pass in front of the camera. Studies can be set up to use either baited or non-baited stations.

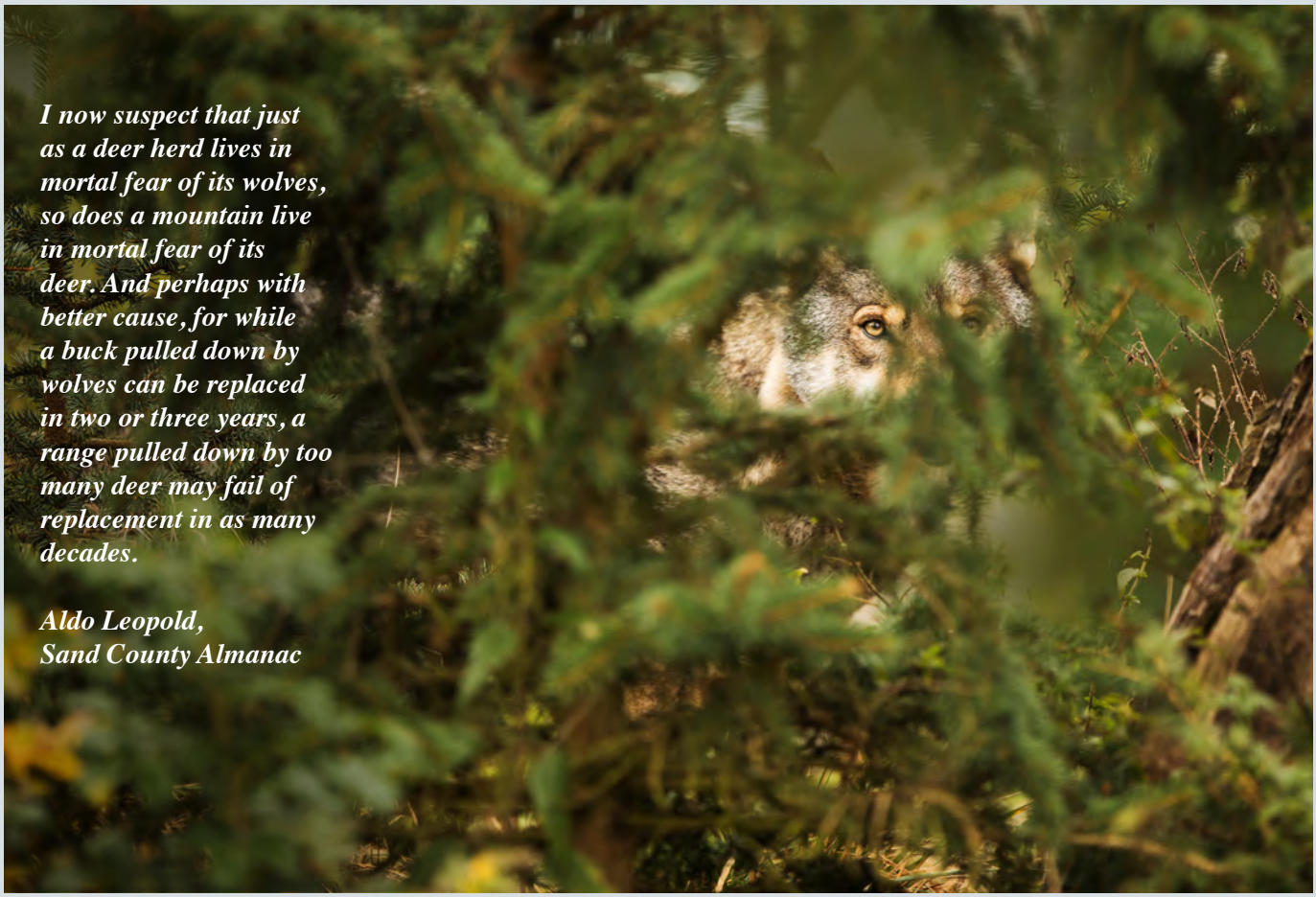
Camera traps can track the movement patterns of elusive carnivores across different seasons, offering insights into their breeding, feeding, and movement patterns. This information can be useful for adjusting timber harvest plans to minimize disruption to key habitats. Additionally, these cameras can aid in determining the success of reintroduction programs by monitoring the acclimation of species to new environments and their interactions with existing wildlife. Over time, the collected data helps in shaping effective policy decisions and management strategies aimed at enhancing the resilience of these species to climate change and habitat alteration.

Moreover, wildlife surveys can play a significant role in community science initiatives. By engaging local communities in camera setup and field monitoring efforts, these projects foster a deeper connection between people and the natural world, encouraging a more inclusive approach to wildlife conservation. This collaboration not only broadens the scope of data collection but also promotes awareness and support for conservation efforts among the general public.



Photos from CFC's wildlife survey project carried out in partnership with Oregon State University. This project aimed to monitor the success of fisher reintroduction and capture on-the-ground information on species assemblages in survey areas across the GPNF. Species pictured clockwise from top left include bobcat, fisher, elk, marten, deer, and mountain lion.

The return of wolves



The return of wolves to the southern Washington Cascades—which will most likely be realized through dispersal from nearby packs—can enhance the health of ecosystems. Wolves were nearly eradicated across the continental U.S. by the early part of the 20th century. The gray wolf was listed as endangered under the ESA when it was passed in 1973 and was also listed as endangered by the state of Washington in 1980. The species briefly lost its federally-protected status in January 2021, but protections were restored in February of the following year. As wolf populations recover in the northeastern parts of Washington, the ESA status will likely shift accordingly.

Wolves are a keystone species that play a vital role in bringing balance to ecosystems. For example, the now-famous 1995 reintroduction of wolves to Yellowstone National Park led to a surprising number of positive impacts for ecosystems in the region. Without their primary predator, elk had overgrazed much of the park. The riparian and aquatic areas suffered and the loss of vegetation negatively impacted a variety of wildlife species, including beavers. After wolves returned, there was a strong rebound in ecosystem health.

Here is southwest Washington, we can see the impacts that a century of elk and deer populations living without their main predator have had on riparian and aquatic systems. Wolves have already begun to return to this area but it will take many years before packs grow and we are able to observe ecological impacts. As this recovery progresses, we can expect their return to play a role in building climate resilience.

The wolf, perhaps more than any other animal in North America, elicits strong feelings and spurs passionate debates. To some ranchers and others, wolves represent an unwelcome danger or a threat to rural livestock. And, although there are effective coexistence strategies and compensation policies that ranchers and agencies can employ, fear and distrust can end up dominating the conversation. As we monitor the return of wolves to the southern Washington Cascades, it is essential that we work to support multi-stakeholder collaboration and advance coexistence efforts.

Wildlife overpass in Banff, Canada. Image sourced from Canadian Geographic (2022)

Example of a culvert that blocks fish passage and doesn't facilitate movement for terrestrial wildlife. Photo courtesy of Washington Department of Fish and Wildlife

An aquatic organism passage (AOP) culvert that facilitates movement for fish and other species such as frogs, salamanders, small mammals, insects, and microorganisms

Increase the number of wildlife crossings over and under roadways

It is critical that we direct attention and funding to increasing the number of wildlife crossings over and under roadways. In many cases, such as areas with high rates of elk or deer collisions, costs for this work are often offset by savings gained from fewer car-animal collisions which are expensive for agencies and individuals. In other areas, culvert upgrades can present a prime opportunity to modify the construction design and create underpasses that service both the migratory needs of aquatic species and permeability for terrestrial species.[110,111] Washington Department of Transportation, the Forest Service, and other agencies are all working in different ways to advance wildlife connectivity over and under roadways. As road restoration is carried out and as funding comes online to address needed culvert upgrades or long-overdue wildlife overpasses, it is important that we direct attention to efforts that benefit a multitude of species.

In addition to funding for salmon-related culvert improvement projects, there are infrastructure funding routes through which to create new wildlife crossings. For instance, the Wildlife Crossings Pilot Program is a federally funded initiative aimed at reducing wildlife collisions through competitive grants. Also, the Bipartisan Infrastructure Law recently allocated $350 million to be spent between 2022 and 2026.

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CHAPTER 3:
AQUATIC ECOSYSTEMS

CHAPTER 3 **EXECUTIVE SUMMARY**

The waterways of the southern Washington Cascades contain vital habitat for a wide array of aquatic species. Increasing water temperatures, propelled by rising air temperatures and depleting snowpacks, are causing thermal stress to species, disrupting migratory patterns and impacting the physiological health of several anadromous species. These impacts are compounded by alterations in streamflow patterns, such as diminished summer flows and increased high flows in winter and spring, which will exacerbate habitat fragmentation, intensify competition, and increase mortality rates for fish. The extent and severity of current and expected impacts underscores the pressing need for accelerated conservation and restoration strategies to improve future conditions of aquatic habitats and their dependent species.

Specific strategies include:

- **Outstanding Resource Waters (ORW) designation:** The ORW designation under the Clean Water Act provides an extra layer of protection to unique, ecologically-important, and high-quality waters. We have identified high priority sections of three waterways—Upper Lewis River, Wind River, and Washougal River—that are potential future candidates for ORW consideration.

- **Wild and Scenic designation:** The National Wild and Scenic Rivers System was set up to protect the free-flowing nature of select river systems. Through a multi-step selection process considering past designation efforts, current risks, and amount of protection gained, we created two tiers of recommendations. Our Tier 1 recommendations include sections of: Clear Fork Cowlitz River, Cispus River, Yellowjacket Creek, Lewis River, and Wind River—all of which, except Yellowjacket Creek, are waterways that have already been formally recommended by the Forest Service for Wild and Scenic designation. Tier 2 includes sections of: Quartz Creek, Smith Creek, Siouxon Creek, Muddy River, and Clear Creek—which includes waterways that have been identified as eligible but not yet formally deemed suitable. Public support and community engagement will play crucial roles in elevating priority waterways through to designation.

- **Expand no-cut buffers for headwater streams on state and private lands:** We recommend a no-cut buffer of at least 75 feet on headwater streams to protect water quality and the health of imperiled aquatic systems.

- **Involvement in federal timber sales:** By actively participating in timber sale planning processes, the public can help mitigate degradation of aquatic habitats by advocating for increased no-cut buffers, reduced use of ground-based logging machinery near waterways, and harvest prescriptions that retain higher canopy cover percentages in critical areas.

- **Remove passage barriers and address habitat fragmentation:** Dams and under-sized culverts present passage barriers that reduce the distribution and quality of habitat for fish and put many species at risk. Dam removal is critical for improving the vitality of native fish species. Culvert upgrades are discussed alongside road survey recommendations in Chapter 2 where we highlight connectivity work that can benefit both terrestrial and aquatic species.

- **Road surveys to prioritize road restoration and reduction opportunities:** Conducting on-the-ground surveys of roads to prioritize them for closure or restoration can help the Forest Service address negative impacts from forest roads, such as habitat fragmentation and sedimentation issues.

- **Support and improve the Legacy Roads and Trails program:** The strategic use and continued funding of the Legacy Roads and Trails program can aid in addressing water quality problems stemming from the backlog of maintenance needs on road systems on national forest lands. This program would benefit from increased transparency and public involvement in project prioritization.

- **Enhanced monitoring for pollutants and plant and wildlife species:** Addressing the lack of monitoring of pollutants, temperature, sediment, and species distributions necessitates an increase in focus and funding for state-level monitoring programs.

- **Supporting beaver co-existence and carrying out beaver reintroduction:** We recommend strategic reintroduction of beavers to suitable river and wetland habitats, combined with community education and engagement to foster human-beaver coexistence. Surveys for instream restoration suitability can be tailored to capture information for future reintroduction potential.

- **Implementing low-tech, process-based restoration in low-gradient waterways:** In addition to engineered logjams and other large instream restoration projects, we recommend the use of low-tech, process-based restoration, such as beaver dam analogs (BDAs) and post-assisted log structures (PALS). This type of restoration is meant to mimic natural fluvial processes, slow flows, spread water laterally across the landscape, reconnect floodplains and side-channels, and create refugia for imperiled salmon, steelhead, and various amphibian species. Considering factors such as slope, floodplain width, land ownership, access, and the presence of at-risk species, we identified 26 sites in the southern Washington Cascades that are priority candidates for survey and potential implementation.

- **Strategic reed canarygrass treatment:** Strategic efforts to combat invasive reed canarygrass must involve collaborations focused on early detection and rapid response as well as continued attention in previously treated areas to keep regrowth at bay.

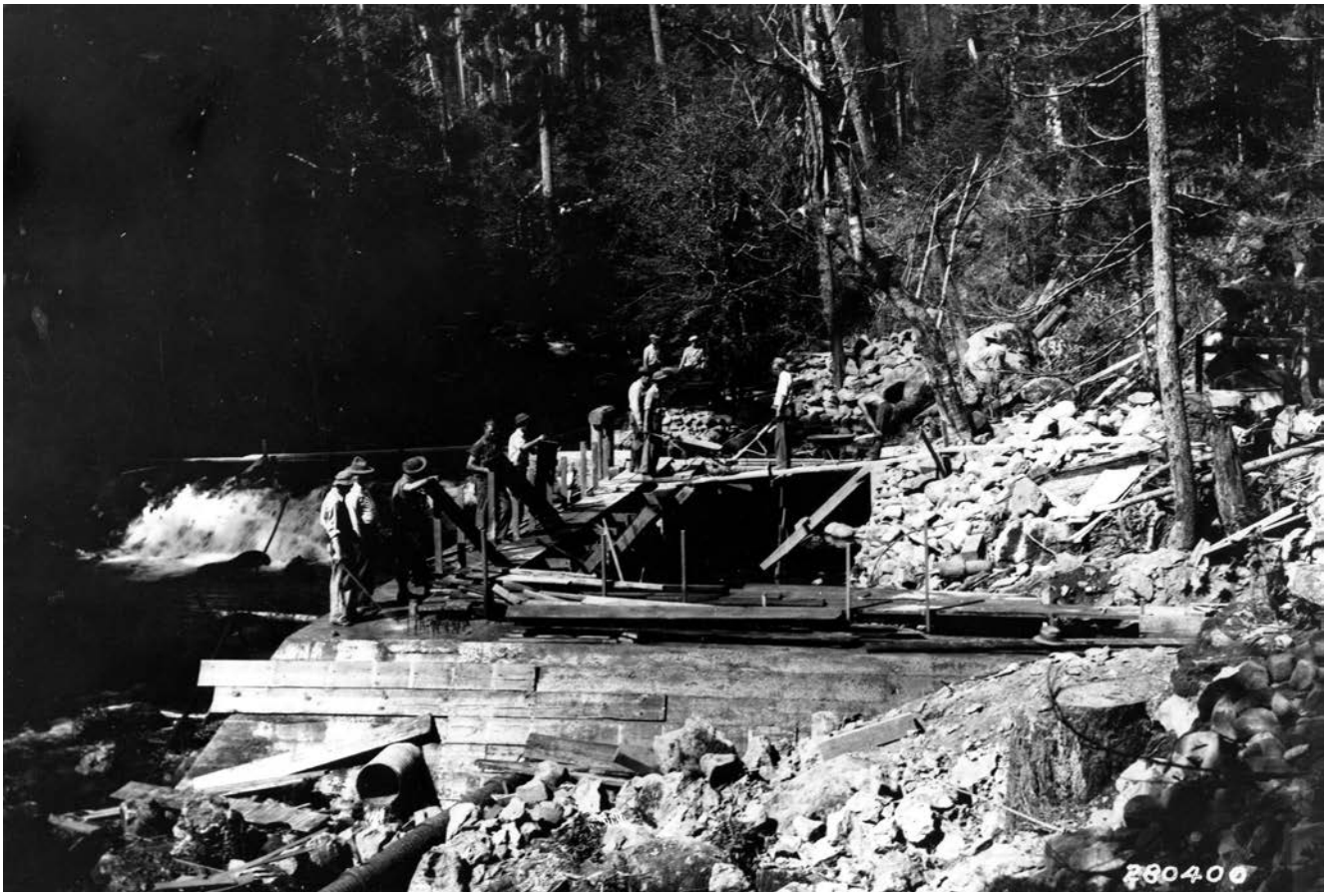
- **Volunteer engagement:** Community volunteers play a pivotal role in helping us capture important on-the-ground information and carry out hands-on restoration projects for a wide array of conservation initiatives.

Aquatic Ecosystems

Rising temperatures and altered streamflow patterns will affect many aquatic systems in the southern Washington Cascades. In the next section, we delve into expected climate impacts for aquatic systems, with a particular focus on anadromous fish species, such as coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead (*Oncorhynchus mykiss*). We also outline policy and restoration recommendations to protect critical habitats and improve resilience for aquatic ecosystems and species.

Historical framework

The Lower Columbia River and the streams flowing into it from the forests of the southern Washington Cascades once hosted runs of a million or more anadromous fish, but these runs now average closer to 30,000 annually.[1] Indigenous communities have a deep connection to the aquatic systems of the region. For thousands of years, they depended on fish for sustenance and have stewarded the aquatic resources of the region to maintain healthy populations of different species. Many spiritual traditions revolve around the harvest of salmon, smelt, lamprey, and others. As explorers, trappers, and settlers expanded into these lands, fish populations began to suffer. The health and resilience of aquatic systems was further degraded by dam building, timber extraction near waterways, draining of wetlands, land and road development, channel manipulation, and the removal of instream wood to facilitate the downstream transportation of timber to mills. As a consequence, many waterways now exist in a fragile state, rendering them even more vulnerable to severe impacts from climate change. In addition to passage barriers and a lack of instream wood, riparian trees, and overall aquatic habitat heterogeneity, many rivers and streams are incised and isolated from their floodplains, a situation which accelerates water transport and flushes juvenile fish out of the cooler, headwater reaches before they complete their freshwater life cycle. Anadromous fish, due to their long migrations, varied life stages, and their reliance on both ocean and freshwater systems, are in a particularly precarious position and face a number of compounding threats.



Members of the Civilian Conservation Corps building a dam on Trout Creek in 1933

Meadow Creek flowing through Lone Butte Meadows

AQUATIC ECOSYSTEMS, SPECIES, AND **EXPECTED IMPACTS**

Temperature and stream flow

The combination of increasing air temperatures and decreases in snowpack is predicted to warm water and impact aquatic and riparian habitats.[2,3] August stream temperatures (a metric used for comparing differences in peak temperatures) are expected to warm approximately 0.4 to 0.5 °F (0.2 to 0.3 °C) per decade, with a 2.3 °F (1.3 °C) increase between 2000 and 2040 and a 4 °F (2.2 °C) increase between 2000 and 2080.[1] Moreover, many fish are already living close to the upper range of their thermal tolerance.[4] According to the Washington State Department of Ecology, the Gifford Pinchot National Forest (GPNF) has 30 streams (and over 88 miles) that are currently temperature-impaired.[1]

High water temperatures can impact summer upstream migrations, forcing salmon and steelhead to delay or stop their upward migration in an effort to seek cold water refugia and avoid thermal stress.[1] It can also impact egg incubation, spawning, rearing, cardiorespiratory activity, and swimming performance.[1,3,5]

Altered streamflow patterns

Altered streamflow patterns—from changes in the amount of snow and timing of snowmelt and rain—are also expected to impair the function of aquatic ecosystems and decrease the quantity and quality of aquatic habitat.[6] In the Columbia Basin, we can expect to have less snow, earlier snowmelt, less rain in summer, and more rain in winter and spring.[7] Snowmelt-dominated watersheds are expected to shift to mixed rain-snow, mixed rain-snow watersheds are expected to become mostly rain-dominated, and rain-dominated watersheds may experience an increase in winter precipitation.[8,9] The reduction in snow levels and

Washout on route 504 near Mount St. Helens. Photo courtsey of Nickolett Uhler and KGW

shift from snowfall to rainfall will be most pronounced in mid-elevation areas.[7] Increased rain in the winter and spring months is expected to result in higher peak flows during these seasons.

In the southern Washington Cascades, the frequency of days with high winter flows may rise from 11 days in the 1980s to 13 in the 2040s or 14 in the 2080s, and peak flows (the highest flow in a given year) may be 9.6 to 17.3% higher during the same comparison period.[1] These increases will be higher in the mountainous terrain of the GPNF. A rise in high flows can cause an increase in sediment and can scour riverbeds, destroy redds (spawning areas for fish), and lead to higher levels of mortality for newly-emerged alevins, fry, and parr, particularly for winter and spring spawning species.[8] High flows also increase channel incision, disconnecting creeks and rivers from their floodplains, side-channels, wetlands, and other refugia.

Salmon moving upstream to spawn

Summer flows may decrease by 40 to 65% as a result of extended dry periods, decreased snowpack, and earlier runoff.[1] This has a direct impact on many species. Coho salmon, for instance, are expected to experience a parallel reduction in habitat (40 to 65%) over the next several decades.[1] Reduced summer flows—especially in simplified river systems lacking suitable water storage

capacities—create barriers for migrating fish, increase competition in smaller habitat areas, and cause young fish to be stranded in small isolated pools that dry up before the rains return.[8] These impacts are exacerbated by roads and culverts, which further fragment habitat.

Impacts from wildfires, dams, and changes in the marine environment

High intensity forest fires, although a natural part of a watershed's evolution, can cause added strain on aquatic systems. They can create pulses of sediment in streams and can reduce riparian shade. Burnt soil is unable to absorb rainwater and instead causes water to flow downslope and gather other sediment, with this material ultimately ending up in stream systems, burying redds and impacting levels of dissolved oxygen in the water.

Climate-related changes in the marine environment also impact salmonids. Some of the primary changes in the marine environment affecting salmonids are 1) changes in ocean temperature, current, and upwelling patterns; 2) persistent and large anoxic "dead" zones; 3) reduced abundance and distribution of forage fish, invertebrates, jellyfish, and planktons; and 4) ocean acidification that impacts the growth and survival of important salmonid food sources, such as krill and amphipods.

The multitude of overlapping impacts paints a dire picture for salmon and steelhead. While reductions in populations are almost certain, these species have historically been known for their phenotypic plasticity and resilience, and anadromous species may adapt and move to new suitable habitats as long as there is a wide array of options.[1] Passage barriers (dams and large waterfalls) will preclude this option along some waterways, but as energy sectors are diversifying and awareness about the substantial impact of dams on aquatic health increases, we may see at least some of the impact of dams reduced through time.

Hudec et al. (2019) highlight the adaptation potential of anadromous fish:

> "Where barriers do not impede movements, species may adapt by shifting their distributions in space or time to track suitable habitats or to recolonize previously disturbed habitats from nearby refugia if a diversity of landscape conditions exist (Reeves et al. 1995, Sedell et al. 1990). Many of the species considered here also have diverse life histories, which may change based on how climate change affects metabolic rates, water temperature, stream productivity, and habitat connectivity. Development of adaptive responses associated with phenology may also bolster population resilience in ways that allow species to persist in dynamic environments subject to long-term climate trends (Crozier et al. 2008, Kovach et al. 2012)."

Streamflow is projected to increase at all locations in winter and spring. Summer streamflow is, on average, projected to decrease owing predominantly to an earlier shift in snowmelt onset accompanied by a reduction in summer precipitation and increases in evaporation due to higher temperatures.

Chegwidden et al. 2019

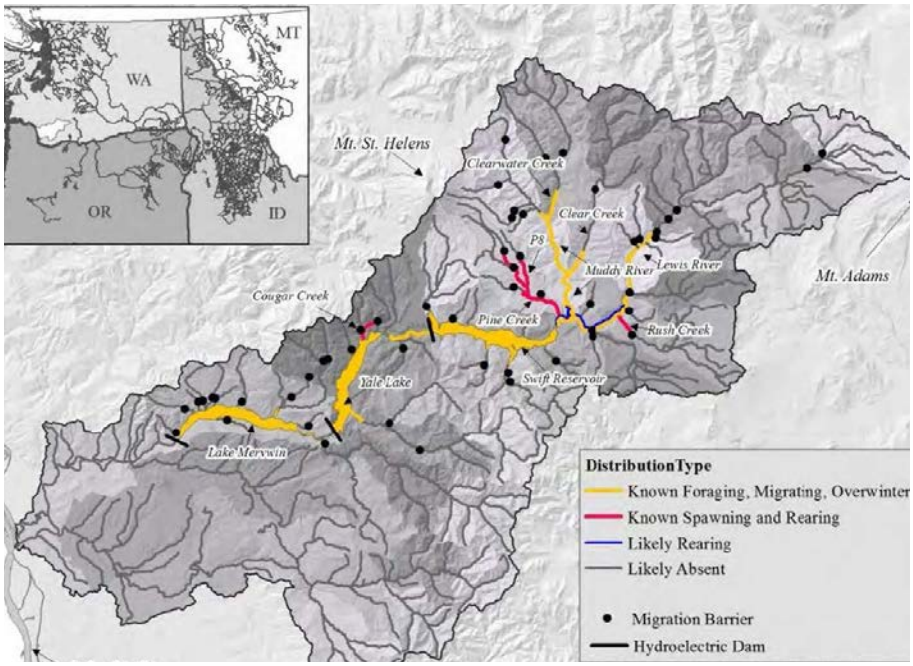
Other species-spesific impacts

Cutthroat trout (*Oncorhynchus clarkii*) are less sensitive than salmonids to rising water temperatures, but low summer flows can severely impact the species.[10,11] Low summer flows can impact foraging and cause stranding, reductions in genetic diversity, and direct mortality as pools dry up.[12,13]

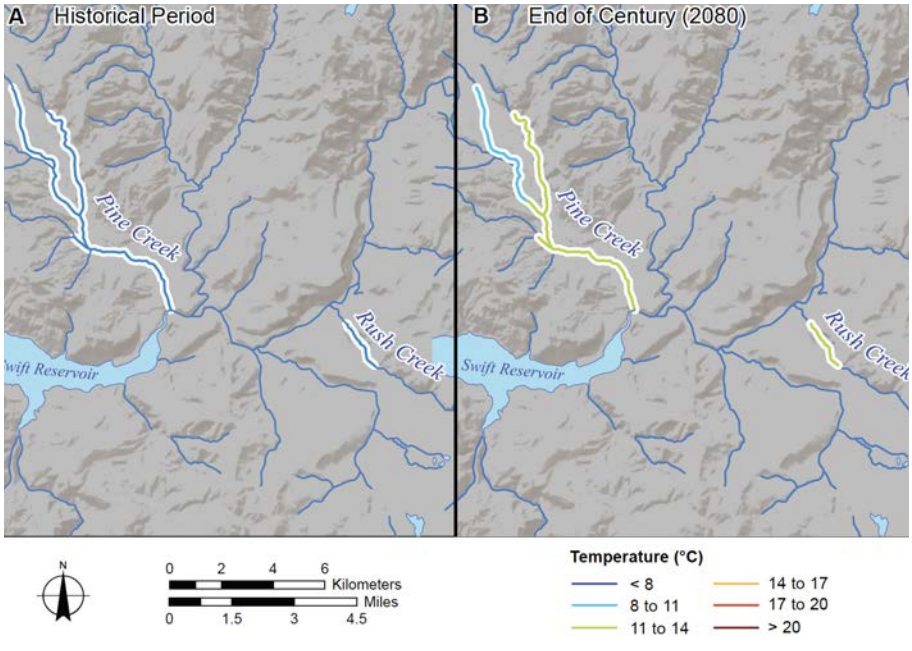
Bull trout (*Salvelinus confluentus*) are expected to be severely impacted by warming water temperatures.[14] They rely on cool water for spawning (with average summer water temperatures less than 52 °F or 11 °C). They are "one of the most thermally sensitive coldwater species in western North America." [15,16] Bull trout habitat is expected to shrink, with thermal bottlenecks limiting access to cooler upstream habitats. Bull trout are relatively rare, but there are two known natal streams in the GPNF, Pine Creek and Rush Creek, that contain a combined total of approximately 12.4 miles (20 km) of habitat.[1] Spawning and juvenile rearing also occur in Cougar Creek, which feeds into Yale Reservoir.[17] Stream temperature increases in portions of these creeks are expected to significantly shrink the amount of area suitable for spawning and rearing.[1]

Pacific lamprey (*Entosphenus tridentatus*) play a vital ecological role and are important to many Indigenous groups. As an anadromous species, it navigates between freshwater and the ocean, facing similar threats as salmon, including passage barriers, lack of suitable habitat, and climate impacts associated with extremes in both low and high flows.

Our region is home to a variety of aquatic and terrestrial amphibians that rely on particular habitat types and seasonal cycles due to their intricate life stages. The northwestern salamander (*Ambystoma gracile*) and Cope's giant salamander



Map from Hudson et al. (2019) showing bull trout distribution in the Lewis River subbasin using field data from 1979 to 2016



Map from Hudec et al. (2019) showing "[s]ummer temperatures (°C) in two streams (outlined in white) that support spawning and rearing by bull trout in Gifford Pinchot National Forest in: (A) the 1980s, and (B) the 2080s, based on NorWeST and the A1B emission scenario. Stream reaches shown in green may become too warm for spawning and rearing in the future."

(*Dicamptodon copei*), which utilize both in-channel and riparian habitat, may be impacted by low summer flows and increased temperatures, which can disrupt their development cycle.[18] The Cascade torrent salamander (*Rhyacotriton cascadae*) is likely sensitive to climate change due to 1) its reliance on specific microhabitats, such as cool, forested streams and low-flow habitats for egg deposition; 2) sensitivity to temperature variations; 3) limited dispersal ability; and 4) vulnerability to altered water availability and sedimentation resulting from changes in precipitation, snowpack, and stream discharge.[19] Ponded meadows provide breeding habitat for species like the northern red-legged frog (*Rana aurora*) and western toad (*Anaxyrus boreas*).[20] Drought, invasive plants, and altered hydrologic patterns can impact the health and viability of these habitats.

CFC volunteer measures a western red-backed salamander

Northern red-legged frog

ADVOCACY AND LEGAL PROTECTIONS FOR **WATERWAYS**

There are several avenues to protect aquatic ecosystems and improve resilience in the Gifford Pinchot National Forest and surrounding state and private lands. The first step is to curtail further degradation and lay the foundation for future improvements. Legal requirements within the Clean Water Act, the federal and state endangered species acts, the Northwest Forest Plan, Washington State's Forest and Fish Law, and other policies and regulations present opportunities to protect aquatic systems and increase climate resilience.

The Clean Water Act

The original goal of the Clean Water Act (CWA) was to totally eliminate pollutants entering waterways over time. In practice, the CWA is generally used to prevent the "discharge of pollutants without a permit." The CWA was the impetus for a water quality program now in place that requires states to identify waters that are not meeting quality standards and to create plans to improve and clean them up. Waters that are not meeting standards are placed on the impaired waters list, the 303(d) list, and are effectively in the queue to receive a targeted clean-up plan, the primary of which is called a Total Maximum Daily Load (TMDL). The GPNF and surrounding state and private lands have several waterways listed as impaired yet lacking a clean-up plan. Getting these impaired waters onto a clean-up plan, such as a TMDL, is one powerful way to improve aquatic habitats. Unfortunately, there is currently insufficient staffing and funding to keep up with demand.

Utilizing this process to improve waterways will require submitting official comments and coordinating with the Department of Ecology to increase funding and to include more previously-identified priority waterways on the work plan for the state.

Outstanding Resource Waters

The Clean Water Act also enables states to designate unique, ecologically-important, and/or high-quality waters as Outstanding Resource Waters (ORW). This state-level designation provides an extra layer of protection to waterways to ensure these values are protected. An ORW protection prevents new sources of pollution, such as from mining or excessive riparian logging, except in very limited circumstances like emergencies. New activities proposed in the ORW area would need to prove they would not impact water quality, and if the new activity could not prove a lack of impacts, that activity would not be allowed.

To be designated as an Outstanding Resource Waters a waterway must meet at least one of the following criteria:

a. "The water is in a relatively pristine condition (largely absent human sources of degradation) or possesses exceptional water quality, and also occurs in federal and state parks, monuments, preserves, wildlife refuges, wilderness areas, marine sanctuaries, estuarine research reserves, or wild and scenic rivers;

b. The water has unique aquatic habitat types that by conventional water quality parameters (such as dissolved oxygen, temperature, or sediment) are not considered high quality, but that are unique and regionally rare examples of their kind;

c. The water has both high water quality and regionally unique recreational value;

d. The water is of exceptional statewide ecological significance; or

e. The water has cold water thermal refuges critical to the long-term protection of aquatic species. For this type of outstanding resource water, the nondegradation protection would apply only to temperature and dissolved oxygen." [21]

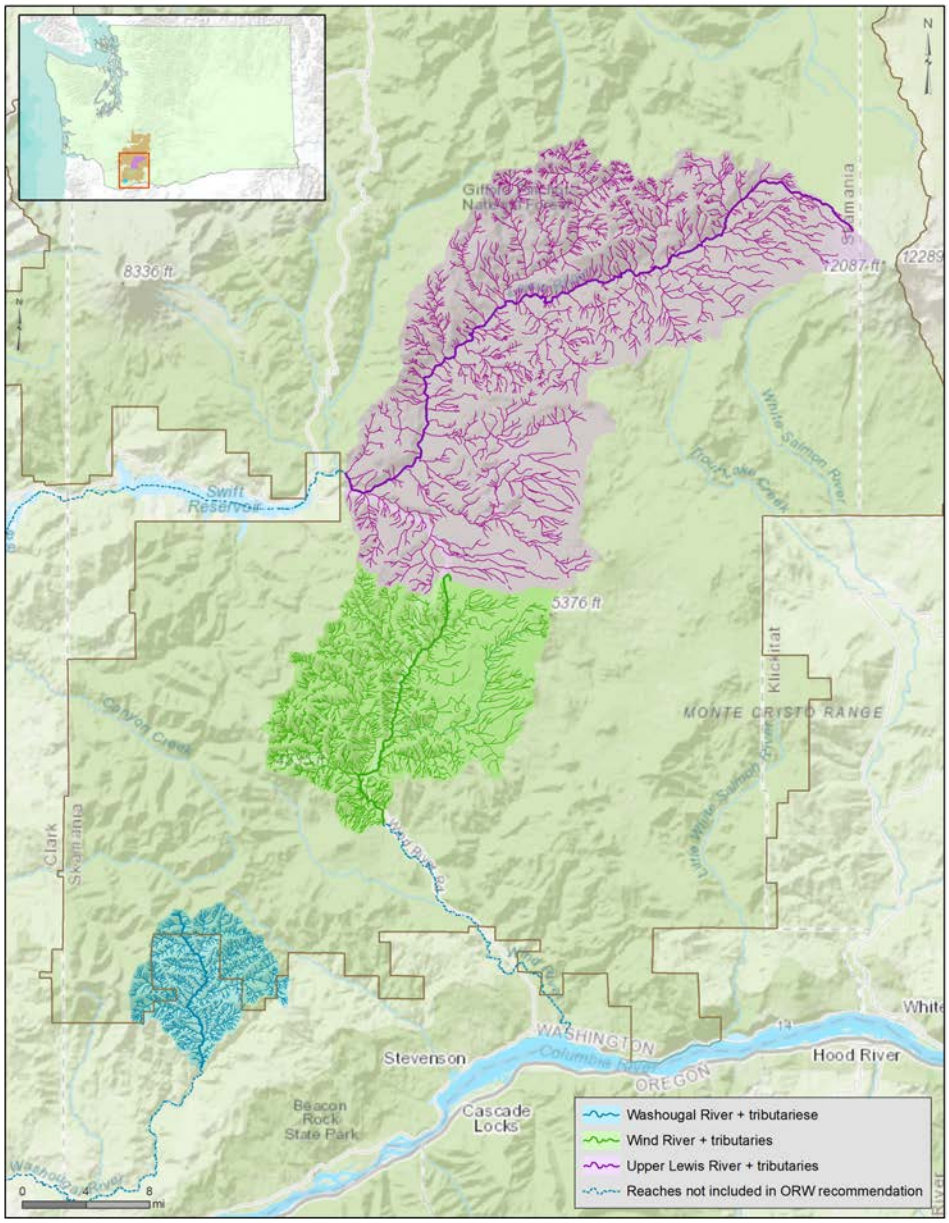
Recommendations for new Outstanding Resource Waters

A historic first: The Green River, Napeequa River, and Cascade River are Outstanding Resource Waters

The upper portions of the Green River were among the first three waterways to be designated as Outstanding Resource Waters in Washington state

The Green River flows from headwaters near the slope of Mount St. Helens into the North Fork Toutle River, later joining the Cowlitz and Columbia Rivers. It is a designated genebank for wild steelhead and is beloved by backcountry hikers, cyclists, foragers, horseback riders, and anglers. It has also been considered one of Washington's most-threatened waterways, due to recurring attempts by mining corporations to prospect for gold, copper, and other minerals in the area.

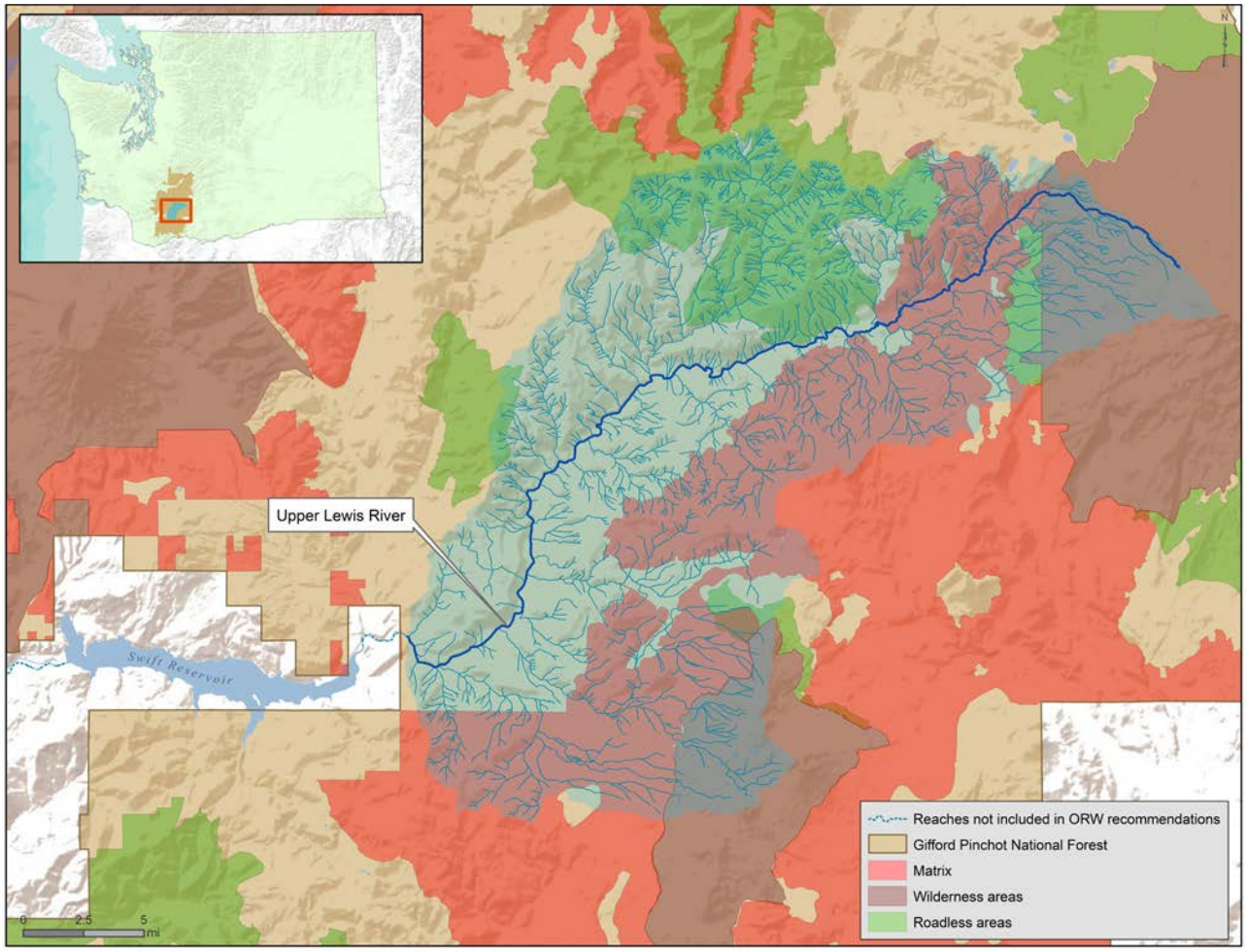
On December 18, 2023, portions of the Green River, Napeequa River, and Cascade River were designated as Washington state's first Outstanding Resource Waters, granting them new protections under the Clean Water Act.



Recommended waterways for future Outstanding Resource Waters consideration

In this section, we identify three waterways (Upper Lewis River, Wind River, and Washougal River) in the southern Washington Cascades that are suitable candidates for ORW consideration. These recommendations are an initial step to help prioritize local efforts, acknowledging that pursuing an ORW designation requires extensive collaboration, stakeholder buy-in, and a long-term campaign involving multiple groups.

To create this list, we prioritized waterways that are primarily on public lands that are 1) in relatively good ecological condition, 2) home to threatened aquatic species, and 3) at-risk, i.e., they are located in areas where we could expect future impacts from logging, development, or degradation. We also took into account the state requirements for ORW designation. Although meeting just one of the criteria is sufficient for a waterway to be considered for ORW status, we have chosen waterways that fulfill multiple criteria to ensure a more compelling case for designation. To investigate suitability, we referenced documentation and spatial data from the WA Department of Ecology, Environmental Protection Agency (EPA), Lower Columbia Fish Recovery Board, Forest Service, WA Department of Natural Resources, county data repositories, and watershed action plans, with particular attention paid to Department of Ecology's Current Water Quality Assessment, the GPNF Land and Resource Management Plan, Lower Columbia Fish Recovery Board's SalmonPORT, and the Washington State Scenic River Assessment.[22–26]



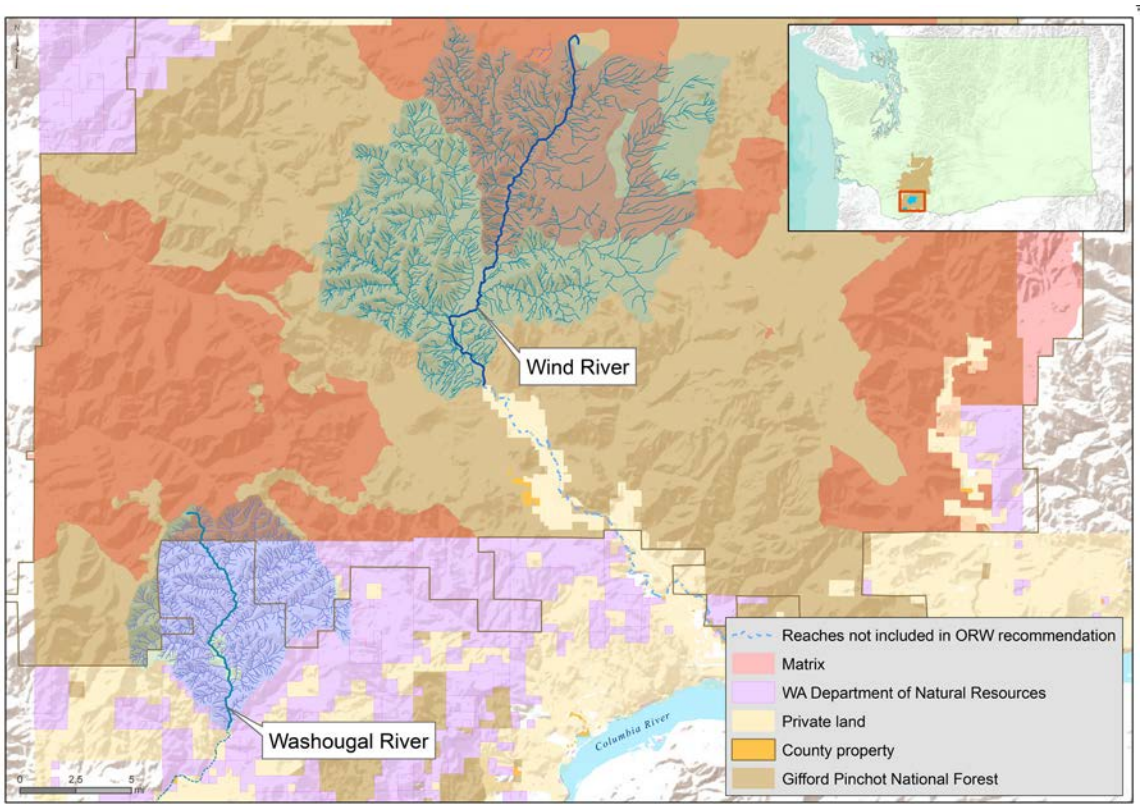
Map of the Upper Lewis River watershed highlighting reaches of the mainstem and tributaries that could be protected through the ORW process

Recommendation 1: Upper Lewis River

The Upper Lewis River flows from its source in the Mount Adams Wilderness through stretches of old-growth, past massive rocky cliffs, and into Swift Reservoir. This area is a popular recreation destination for its scenic beauty, fishing opportunities, hiking trails, and renowned waterfalls. There are also prehistoric villages along the river that are listed in the state's Register of Historic Places. The river contains valuable habitat for coho, steelhead, and bull trout and has been identified by the EPA as one of twelve primary thermal refuges for the Columbia River. This stretch of the Lewis River is almost entirely in the GPNF.

The Upper Lewis River meets three ORW criteria: 1) relatively pristine condition, with much of it in Wilderness and Late-Successional Reserves, 2) high water quality and regionally-unique recreational value, and 3) exceptional statewide ecological significance. Aligning with this finding, Pew Charitable Trusts commissioned a third-party analysis in 2021 to examine and highlight priority waterways in Washington for ORW designation.[27] This watershed, referred to therein as "Headwaters Lewis River," ranked 8 of 20, highlighting its relative importance in a state-wide list of priority waterways.

A waterfall on the Upper Lewis River



Wind River and Washougal River mainstem reaches and tributaries that could be protected through the ORW process

Recommendation 2: Wind River

Wind River was designated as a wild steelhead gene bank by the Washington Department of Fish and Wildlife in 1980 due to its status as a stronghold for summer-run steelhead.[28] The river is undammed and has been identified by the EPA as one of twelve primary thermal refuges for the Columbia River. The Wind River watershed does have an improvement plan for temperature due to some areas exceeding the temperature standard, but it is not exceeding any other water quality standards and otherwise has high water quality. Its diverse riparian corridor provides vital habitat for a wide variety of species, both aquatic and terrestrial. Moreover, the Wind River corridor boasts a distinctive landscape, characterized by deep, cliff-lined gorges, thermal mineral springs, and other geologic and scenic attributes. Additionally, the river and its riparian areas serve as a popular destination for various recreational activities, such as fishing, hiking, boating, and cross-country skiing. The recommended reach originates in Matrix lands of the GPNF and then flows through a stretch of Late-Successional Reserves to the boundary of the national forest.

The Wind River meets three of the ORW criteria: 1) high water quality and regionally-unique recreational value, 2) exceptional statewide ecological significance, and 3) cold water thermal refugia.

Recommendation 3: Washougal River

This upper section of the Washougal River originates within Matrix lands of the GPNF and runs through state lands before passing through a small aggregation of private lands. There are scenic falls on the upper mainstem and varied recreational destinations throughout the watershed, including whitewater kayaking.[29] The Washougal River is undammed and has been identified by the EPA as a thermal refugia for the Columbia River. None of the reaches we are considering for nomination are listed on the 303(d) impaired waters list.

The Washougal River meets three of the ORW criteria: 1) high water quality and regionally-unique recreational value, 2) exceptional statewide ecological significance, and 3) cold water thermal refugia. A small number of private landowners own properties on the lower portion of the recommended reach; therefore, designating the entire mapped area would require outreach and coordination with these stakeholders.

CFC staff and volunteer conducting lamprey surveys in the Wind River

The Washougal River

Wild and Scenic designation

The National Wild and Scenic Rivers System was created by Congress in 1968 to protect the free-flowing nature of some of the country's river systems, particularly those that retained a primitive character. This effort was a response to the prolific alteration of waterways across the U.S., including damming for hydropower and redirection of water for agriculture use.

The act encompasses three different designations:

1. Wild rivers: free from impoundments, remaining primitive, and inaccessible by road
2. Scenic rivers: free of impoundments, largely primitive, and partially accessible by road
3. Recreational rivers: accessible by road, with possible developments along the shoreline, and with potential past impairments

A key element of the designation process involves determining Outstanding Resource Values (ORVs) for any river being considered. The managing agency, generally the Forest Service, must then create a plan aimed at protecting those identified ORVs.

Notably, while safeguarding waterways, the Wild and Scenic Rivers Act acknowledges the potential for appropriate use and development. It encourages a balance between protection and utilization. The legislation encourages a management approach that transcends political boundaries and actively involves public participation in shaping protection goals.

As of 2022, the National Wild and Scenic Rivers System, implemented under this act, protects 13,467 miles of 228 rivers across 41 states and the Commonwealth of Puerto Rico.[30] Remarkably, this coverage accounts for less than one-half of one percent of the nation's rivers.

Although Congress has the final say in designating most Wild and Scenic Rivers, the Forest Service or other federal agencies can nominate rivers or sections of rivers for this designation. If the Forest Service determines a river or section is "eligible" and/or "suitable" for a designation then the agency has to apply interim protections to ensure the resource values of that river are protected until Congress decides whether or not to officially designate the waterway under the Wild and Scenic Rivers Act. These interim protections are limited and easier to overturn than official designation.

There is also a pathway for designation through the state. If a state designates a river through its own Wild and Scenic program, the Governor can then make a request to the Secretary of Interior that the river be included in the national system. The Secretary will determine whether the river meets the criteria, and after notice to relevant federal agencies and the public, as well as ample opportunity for public comment, the Secretary will make a final determination on whether to include the river in the national system.

Before Congress can vote on adding particular rivers to the Wild and Scenic Rivers System, both a determination of eligibility and suitability must be done. Eligibility is a determination that the river segments are free-flowing and includes a consideration of whether the waterway and the adjacent land area have at least one ORV. Suitability, in turn, looks to determine whether an eligible river should be included in the Wild and Scenic Rivers System and considers factors such as existing land uses along the studied segment(s), whether the ORVs would actually be protected through the designation, and whether there are other important uses that weigh against designating the segment(s).

Rivers that are deemed eligible and/or suitable receive protection against water resource projects (including water supply dams, diversions, and flood control work) and hydroelectric projects, as well as protection measures related to impacts from transportation infrastructure, utilities, recreation development, motorized travel, vegetation management, and domestic livestock grazing. When and if rivers move from an eligible stage to suitable, wherein it is formally recommended to Congress for protection, the waterway gains a higher level of protection.

Once a river is designated, a management plan is crafted, including resource inventories, monitoring, and task force development. Its classification (wild, scenic, or recreational) will dictate the extent of protection afforded to the waterway. Wild designations offer the most protection. For example, wild designation offers a quarter mile mineral withdrawal, which prohibits mining on either side of the waterways banks. For scenic and recreation designations, mining would still be allowed, but the mining activities would have to be carefully evaluated to ensure there is no pollution and no unnecessary impairment of the scenic or recreational values. Scenic designation offers the second highest level of protection, and recreational designation offers the lowest level of protection.

Many rivers on the GPNF were studied in the 1990s for possible inclusion in the National Wild and Scenic Rivers System. In total, 14 were found eligible and four were found suitable and formally recommended to Congress

by the Forest Service for inclusion in the Wild and Scenic Rivers System. However, these were never formally designated by Congress. The four that were found suitable and recommended for inclusion are the Cispus River, Muddy Fork Cowlitz River, Clear Fork Cowlitz River, and North Fork Lewis River (sometimes called Upper Lewis River or Headwaters Lewis River). The following 14 waterways were found to be eligible but have yet to receive a suitability determination. These are: Lewis River, Clear Creek, Green River, Ohanapecosh River, Quartz Creek, Siouxon Creek, Smith Creek/Muddy River, Toutle River, White Salmon River, Yellowjacket Creek, Cowlitz River, East Fork Lewis River, and Wind River.

Public support can and has influenced the Wild and Scenic designation process in the past. Several waterways which were found eligible in the 1990 study were not initially proposed for study by the Forest Service and were only studied and included after members of the public submitted them for consideration. Some of the waterways submitted and eventually found eligible due to public submission include Clear Creek, Quartz Creek, Siouxon Creek, Yellowjacket Creek, Ohanapecosh River, and White Salmon River.

Recommendations for new Wild and Scenic designations

In this section, we identify a set of waterways that we recommend be prioritized for Wild and Scenic consideration. Similar to ORW designations, pursuing Wild and Scenic status is a multi-group effort requiring group buy-in, and in this case, a congressional campaign. We view these recommendations as an initial step to better understand which waterways in the southern Washington Cascades would be suitable candidates for future Wild and Scenic discussions.

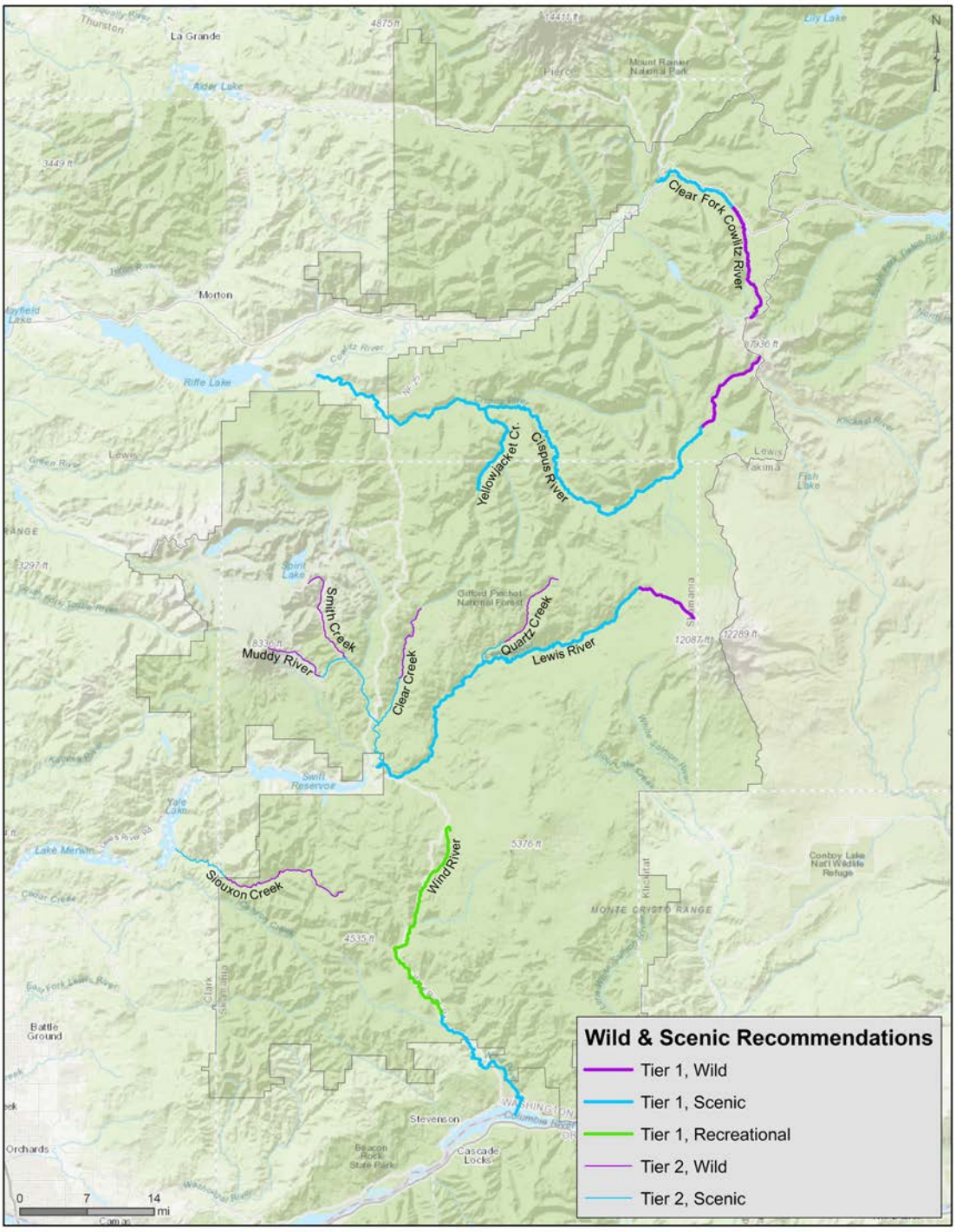
Our recommendations include waterways that have already been found to be eligible by the Forest Service. We then considered other factors to refine our recommendations and to create a two-tiered ranking of priority. These factors included: importance for anadromous fish species, land allocation as it relates to suitability for designation, land allocation as it relates to logging and development risks, and recreational value.

Tier 1 Recommendations
Clear Fork Cowlitz
Cispus River
Upper Lewis River
Yellowjacket Creek
Wind River

Tier 2 Recommendations
Quartz Creek
Smith Creek
Siouxon Creek
Muddy River
Clear Creek

Our Tier 1 recommendations are waterways that, in most cases, have been formally recommended by the Forest Service for inclusion in the Wild and Scenic System, with the exception being Yellowjacket Creek, which was found eligible but not recommended. Our Tier 2 recommendations include waterways that have been

Tower Rock towering over the Cispus River



identified as eligible for Wild and Scenic designation but were not yet deemed suitable by the Forest Service. These Tier 2 waterways could rise in priority if substantial community support emerges for the designation of a particular waterway.

We refined the previous 1990 Forest Service list, utilizing new information on factors such as fish, risk, recreation, impact of designation, and likelihood of success. For instance, Muddy Fork Cowlitz River was found suitable but not included in either tier because it falls almost entirely within wilderness or national park boundaries and therefore already has high levels of protection. Yellowjacket Creek, on the other hand, was found eligible but not yet deemed suitable, and was included in our top tier because of risks associated with its placement within Matrix lands and potential impacts from mining. The remaining waterways previously found eligible but not included in our Tier 2 list were discounted for reasons such as: a low risk of logging, development, or pollution; a minimal increase in protection level from what already exists; or a large overlap with private land, where designation success would be lower and where there would be fewer viable enforcement mechanisms.

No-cut buffers for headwater streams on state and private lands

The Forest and Fish Rules dictate timber harvest regulations and stipulations on state and private lands, and they offer a framework for protection of waterways and riparian zones. In comparison to federal lands, these rules generally provide less protective measures for riparian areas.

Currently, with some exceptions, headwater streams receive little protection from logging. Type Np waters, a class of headwater streams, are perennial streams reaches that are not currently fish habitat or they are intermittent reaches that are downstream of a perennial section. Type Ns waters, another class of headwater streams, are seasonal, intermittent, currently non-habitat streams reaches that are connected by a surface channel to a downstream perennial stream. What does exist is a limit on heavy equipment within 30 feet of the stream, which is an insufficient width to protect the stream from serious negative impacts. Moreover, logging of riparian trees is often allowed all the way up to the waterway in these headwater streams. At this point, we know the severity of the damage that is caused by logging activity near streams. The loss of stream shade causes higher water temperatures in downstream reaches and the increase in sedimentation negatively impacts downstream habitats. We should be adjusting our management methods to better protect aquatic habitats and drinking water.

Because of this, we recommend a no-cut buffer of at least 75 feet on all headwater streams, especially perennial ones, to protect water quality and the health of imperiled aquatic systems.

We are working to address these deficiencies through timber sale comments, and we will also be working within the Adaptive Management Program (part of the Forest and Fish Rules) to discuss this issue and determine whether the rules put in place many years ago are sufficient to retain habitat values and maintain water quality standards under the Clean Water Act.

Staying involved in federal timber sales

Opportunities to improve aquatic habitats or curtail degradation will often arise during the federal timber sale planning process. Logging prescriptions can be adjusted to improve protections for particular waterways, such as increasing no-cut buffers. Also, public support for restoration work can be demonstrated, which improves the chances that this type of work is integrated into upcoming management plans.

During the timber sale planning process, the agency will plan on-the-ground activities under the guidance of various land management allocations such as Late-Successional Reserves, Matrix, Congressionally Withdrawn Areas (such as Wilderness), Riparian Reserves, and others. For this section, we will focus on Riparian Reserves, which is a federal land management designation intended to offer heightened protections for areas around waterways. This usually includes wetland areas, the adjacent floodplain of a waterway, and lands directly upslope from creeks, rivers, and wetlands. Riparian Reserves do not prevent logging outright, but typically there is a no-cut buffer delineated within subsections of these areas and there is an overriding management direction guiding the agency to focus timber management toward harvest actions that, at a minimum, will not negatively impact the nearby aquatic system. But, there are widely varied interpretations of these harvest guidelines.

When ecologically-harmful logging activities are proposed within these areas, the Riparian Reserve designation offers a mechanism for outside entities, such as non-profits or community members, to advocate for more protective measures. On-the ground surveys and investigations of spatial data can help elucidate areas where heightened protection should be advanced through comment letters and/or direct dialogue with the Forest Service. This can include requests for larger no-cut buffers, reductions in the use of ground-based logging machinery near the waterway, and harvest prescriptions that retain higher canopy cover percentages or employ a fell-and-leave strategy rather than extracting trees.

CFC staff and volunteers collecting data along a stream in a timber sale stand

Road surveys

On-the-ground surveys of roads can help in prioritizing roads for closure or restoration, the latter of which can consist of culvert upgrades or the installation of aquatic organism passage structures. Information gleaned from surveys can be shared directly with the Forest Service and can influence future management efforts.

While many national forest roads are needed for timber harvest or to access established recreation sites, others may be less necessary and may be suitable candidates for closure or seasonal closure due to their potential negative impacts on terrestrial or aquatic habitats. Roads can fragment habitats, increase sediment issues in aquatic systems (from erosion or malfunctioning culverts), and increase the introduction and spread of invasive species.[31–35] High road densities have also been shown to negatively impact a variety of terrestrial wildlife species.[34,36]

The funding allocated to the GPNF is insufficient to effectively manage the existing road network and keep up with the maintenance needs required to fix washouts, address road failures, control encroaching vegetation, minimize erosion, and keep culverts open and functioning. The Forest Service acknowledged this in its 2015 Travel Analysis Plan and slowly works to address this issue by implementing road restoration and reduction efforts during timber harvest projects.[37] Unfortunately, these efforts address only a fraction of the vast need, and by being limited to timber sale areas, needs in other parts of the national forest often remain unaddressed.

In Chapter 4, we outline two priority areas where we recommend a dedicated investigation of road restoration and closure potential.

Retain and improve the Legacy Roads and Trails program

The Legacy Roads and Trails (LRT) program began in 2008 as a targeted temporary funding program to address the serious water quality problems stemming from the backlog of maintenance needs on the road systems on national forest lands. In 2021, the Infrastructure Law made this program permanent and authorized $250 million for fiscal years 2022-2026. While this creates opportunities for habitat improvement locally, there has been a lack of clarity on how the Forest Service prioritizes LRT projects and how the public can be involved in advancing publicly-driven recommendations. We recommend that the regional office of the Forest Service establishes a process for annually ranking and selecting LRT projects and including opportunities for public input in this process. We also advocate for the continued funding and strategic use of the LRT program.

Monitoring for pollutants, sediment, temperature, and species

A key component to protecting water quality is ensuring there is sufficient monitoring of pollutants, sediment, temperature, and species distributions. Both federal and state agencies have monitoring responsibilities under various laws, but they are chronically underfunded and

A CFC volunteer conducts erosion assessment along a forest road to address excess sedimentation concerns

understaffed and often unable to adequately meet these requirements. For instance, a tributary flowing into the Green River just upstream from the Green River Horse Camp had previously been found to have high levels of copper, potentially from old mines in the area.[38] This information was collected in 2001, yet there has been no update of the data since. Without access to updated on-the-ground information, conservation and restoration efforts may overlook important needs and areas of degradation.

Conservation groups and other entities can play a role in these efforts by communicating with the WA Department of Ecology and the Forest Service and advocating for increased attention to known issues and funding for monitoring programs. Frequently, lack of attention to a particular problem is related to staffing and funding issues. Stakeholders can advocate through the state legislatures' biennial budgetary process to ensure Ecology has sufficient funding for monitoring. If areas with particular monitoring needs remain unaddressed after communication with Ecology and the Forest Service, concerns can be elevated to EPA Region 10, the entity responsible for administering the Clean Water Act and which offers federal oversight of Washington State's Department of Ecology's water quality program.

RESTORATION RECOMMENDATIONS FOR AQUATIC SYSTEMS

There is a great deal of work taking place across the region to recover threatened aquatic species and improve the resilience of riverine ecosystems. Partner groups such as Lower Columbia Fish Enhancement Group, Underwood Conservation District, Yakama Nation, Cowlitz Indian Tribe, and the Forest Service represent a handful of the entities that are carrying out large wood placement on rivers and creeks across the southern Washington Cascades. Lower Columbia Fish Enhancement Group, for instance, has been chipping away at a years-long effort to restore habitat along the South Fork Toutle River. This work has consisted of a variety of restoration approaches, ranging from large engineered logjams to smaller, low-tech projects along tributaries. The Cowlitz Indian Tribe has been working for the past several years on improving habitat for salmon at the confluence of Yellowjacket Creek and Cispus River. Through this effort, the Tribe has built a series of large logjams that have already begun creating new habitat and significantly expanding aquatic complexity in the area. Partner groups have also played vital roles in removing dams that have been blocking fish passage for decades. Dam removal is one of the most important steps that can be taken to improve the health and resilience of anadromous fish populations.

An engineered logjam on the Cispus River

Thanks to region-wide entities like Lower Columbia Fish Recovery Board coordinating project priorities and federal- and state-level funding enabling millions of dollars' worth of work to move forward each year, we can expect to see many new projects come online over the next several years to address habitat degradation and resilience needs.

In this section, our aim is to delve into restoration recommendations that are tuned to the work of groups like CFC, with a focus on low-tech, process-based restoration and other efforts that can be employed widely and that can directly benefit from the help of community volunteers.

Beaver recovery

Beavers have been helping shape aquatic and riparian landscapes throughout the Pacific Northwest since they first arrived in the area 7 to 7.3 million years ago.[39] Before European colonization, beaver populations in the United States were estimated to be between 60 and 400 million.[40] The subsequent period of intensive trapping nearly extirpated beavers from the Pacific Northwest, but their numbers have rebounded in some areas, with estimates ranging from 6 to 12 million.[41] Despite their partial recovery, beaver populations are a fraction of what they once were, and they are still absent from many headwater systems.[41,42] Recolonization in upper headwater systems is often difficult to achieve because beaver colonies can be hindered by stretches of unsuitable habitat, culverts, and waterfalls, all of which were previously passable when downstream populations were abundant, healthy,

and forcing upward dispersal. Recolonization in lowland systems is generally easier as beaver colonies have access to more contiguous suitable habitats and can more easily disperse to find a mate when they leave their home.

Beavers actively modify stream channels and floodplains by building dams and digging channels. The sediment and wood structure that is retained behind a beaver dam can raise the stream bed, expanding riparian areas laterally and creating larger areas of saturation.[43–45] Beavers can help forge new side-channels and reconnect relic wetland areas. With increased pooling and water storage above ground, it can increase hyporheic exchange—the movement of water between the surface and the water that moves underground. With increased moisture and a lateral spreading of water, beaver-impacted riparian areas can become more resistant to fires, drought, and channel incision from high flow events.[46–48]

Fairfax and Whittle (2020) compared the greenness of vegetation in riparian areas that were beaver-dammed before, during, and after a wildfire. Stream reaches with no beavers saw a loss of 51% of the riparian vegetation, while reaches with beavers had a reduction of 19%.[48] The results suggest that the presence of beavers can help keep the soil moist and vegetation green and fire resistant even in a period of drought.

Other research has shown that beaver dams can capture the influx of sediment and contaminants that are present after a fire.[49] Burned landscapes are typically less able to hold moisture due to changes in soil composition and vegetation; consequently, the runoff will send fine sediments and pyrogenic contaminants into the streams below, negatively impacting the aquatic community. A beaver dam or similar instream feature can retain these sediments, reducing degradation of downstream habitat and water quality.[49]

For several years now, Cascade Forest Conservancy has been releasing beavers into headwater systems in the GPNF. The beavers are sourced from urban or near-urban areas where they are causing problems for landowners, such as flooding or damage to trees. Our release sites were identified through a spatial analysis we carried out in 2018. This spatial analysis was followed by on-the-ground surveys to collect more refined data on habitat viability.

As beavers have been absent from most headwater systems for many decades, channel structure in many places has become too simplified and incised to support their return without foundational changes to floodplain function. Also, survival may be limited in some areas by a lack of forage (favored hardwoods such as cottonwood or willow) or deep pools to allow beavers an escape from predators. Due to these factors, much of our future beaver recovery efforts will be focused on improving beaver habitat through instream restoration and riparian planting, especially in areas near and above current beaver populations where this work can attract beavers into the higher reaches of waterways. In the next section, we highlight areas where on-the-ground surveys can be carried out to gauge suitability for low-tech, process-based restoration. These surveys serve the dual function of also capturing information for beaver reintroduction suitability.

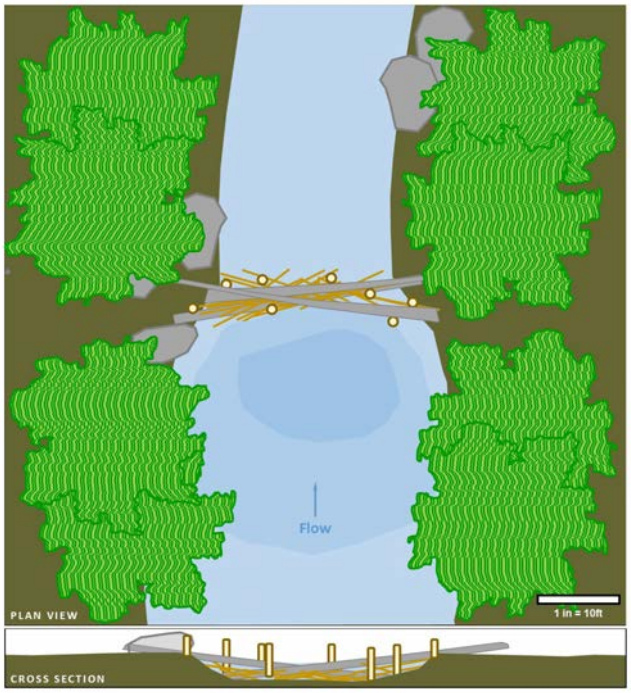
Releasing beavers to areas of historic occupancy and current suitability is a potential restoration strategy, but it must be accompanied by a thorough consideration of co-existence opportunities at the source site. In other words, are there methods or devices that can be employed to allow "nuisance" beavers to remain where they are found so that they can continue to persist and expand without relocation? In some cases, this will not be possible, but in others we have found success by educating landowners on ways to mitigate the issues that beavers are causing, such as devices that limit a beaver's ability to plug a culvert. In most cases, even after relocation, other beavers will occupy the source site and continue to cause issues for these landowners who are residing in areas where beavers used to live. In Appendix A, we list resources for landowners and organizations hoping to advance co-existence strategies for beavers.

On the policy side of things, there has been a recent initiative to create and implement a statewide beaver ecosystem management plan in Washington. This move reflects a commitment to recognizing and harnessing the vital role beavers play in maintaining ecosystem health and biodiversity. By defining beavers as a keystone species, the plan would prioritize providing resources and services to address human-beaver conflicts, emphasizing outreach, education, coexistence, relocation, and, only as a last resort, lethal removal services. We see this as a positive step forward in beaver conservation and recovery efforts in Washington and will be participating in the legal efforts to ensure beavers are protected.

Low-tech, process-based restoration

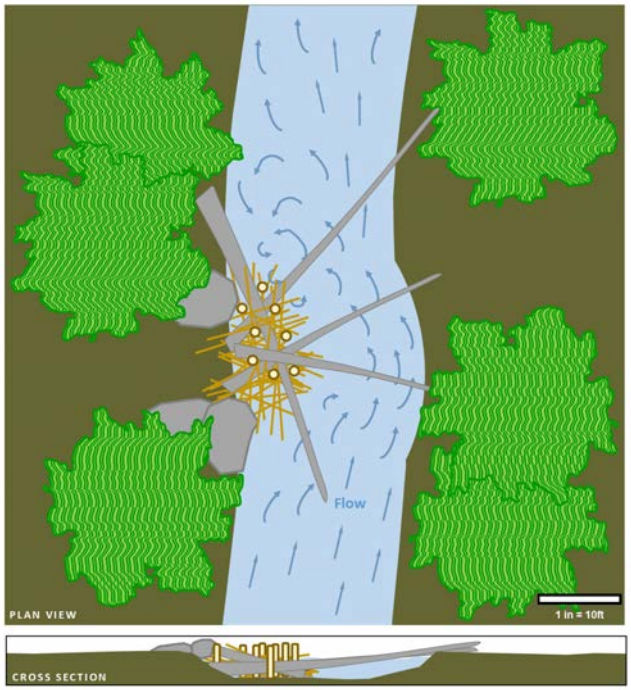
In this section, we will discuss low-tech, process-based restoration (LTPBR). This type of restoration can consist of handbuilt beaver dam analogs (BDAs), post-assisted log structures (PALS), individually placed large logs, or strategically-felled riparian trees (with riparian felling work, it is important to ensure that sufficient canopy cover is retained). Some structures are channel spanning (creating pools above the structures); some are flow

Four types of instream structures for low-tech, processed-based restoration



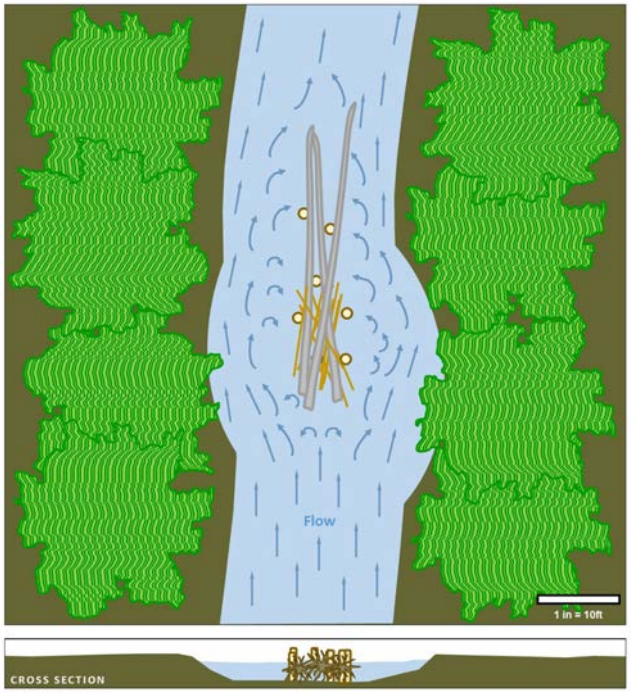
Beaver Dam Analog

Captures sediment, slows stream flow, and creates a pool



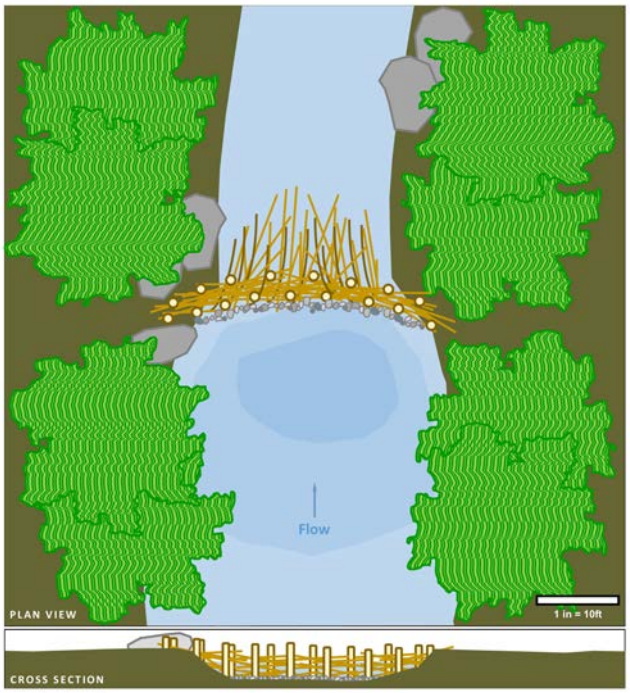
Channel Process Structure

Impedes flow on one side of the stream, creating hydraulic diversity that erodes banks and stores sediment



Flow Splitting Structure

Splits flow into multiple channels and increases aquatic complexity



Channel Spanning Structure

Captures sediments, slows stream flow, and creates a pool

Beaver dam analogs installed by CFC and volunteers along Stump Creek

splitting (these are smaller and positioned in the middle of the streambank to encourage new side-channels and channel complexity); and others are positioned on one side of the waterway to both direct flows to the opposite bank and create pooling. BDAs are generally similar to channel-spanning structures yet are intended for lower gradient reaches and areas where the substrate allows the installation of posts.

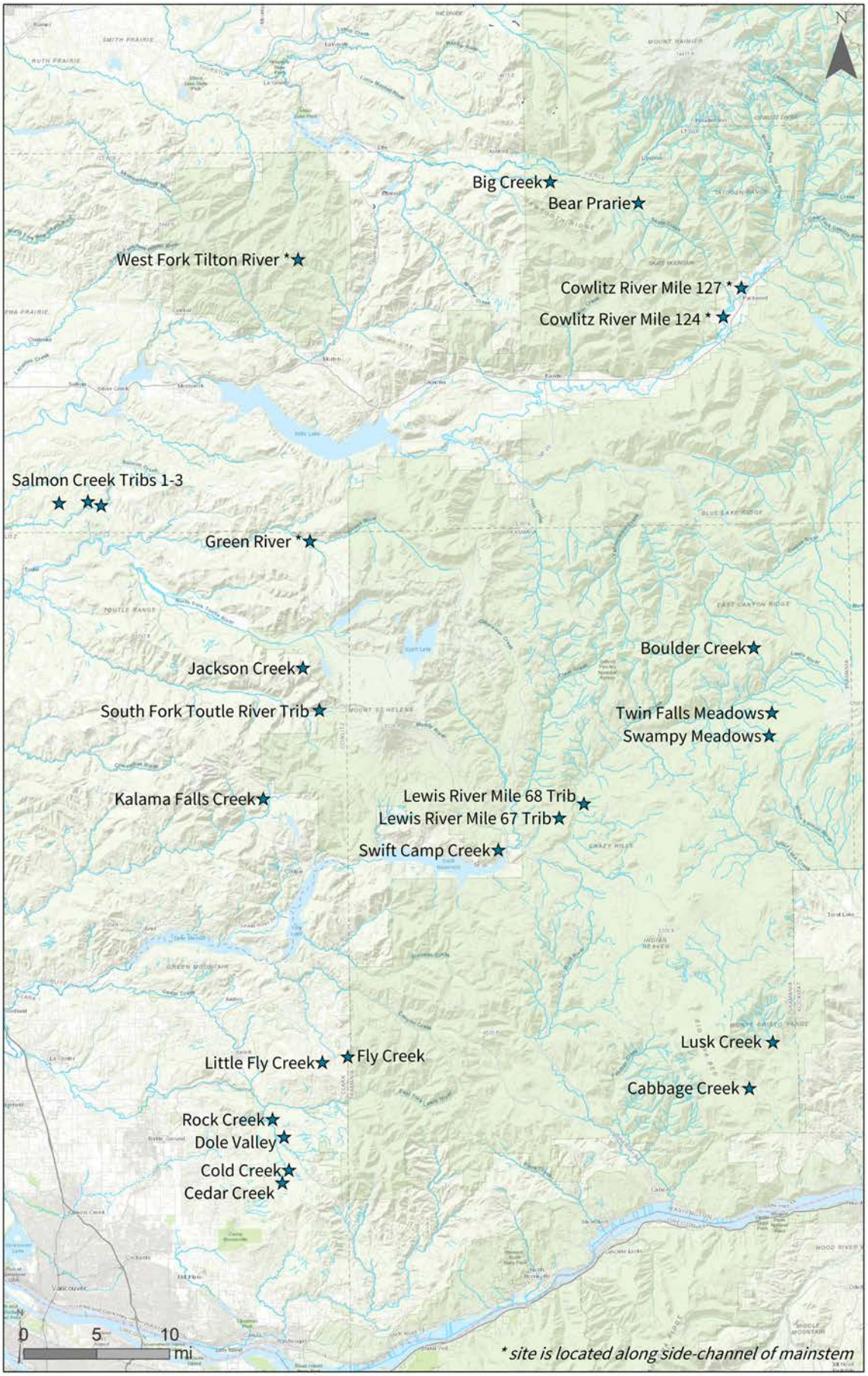
LTPBR creates new microhabitats within a stream channel and also serves as structure to slow flows and spread water laterally across the landscape (out of incised channels). This re-engages floodplains and side-channels that can persist longer into the dry season, creating refugia and access to rich foraging grounds for a variety of aquatic and terrestrial species. As these structures change the flow, they create new habitats and flow patterns, furthering the cycle of change and re-establishing aquatic complexity. As new channels are forged, the change begets future changes and increased floodplain connectivity. This work can also help reduce water temperature, as water is redirected into newly connected riparian floodplains that provide more shade (from vegetated riparian areas) and as groundwater exchange increases connection between the above-ground water and the cool waters that flow below. All these factors interact to improve habitat quantity, quality, connectivity, and complexity for salmon and many other species. While climate change threatens aquatic systems in multiple ways, instream wood is able to respond in-kind. This work also complements beaver recovery by creating new beaver real estate ("beaverhoods") and attracting beavers to new or formerly occupied habitats.

In this next section, we highlight 26 potential LTPBR sites in and around the GPNF. We selected these sites based on the following factors:

- Fish presence and habitat uplift potential: Will this work improve or expand habitat for at-risk species?
- Slope: Is it flat enough to be suitable for low-tech, non-engineered restoration?
- Land ownership: Is landowner support likely?
- Access: Can restoration materials such as logs, wood posts, and post-pounders be reasonably imported to the site?

For areas on federal land, we gave preferential consideration to areas where we know the Forest Service will soon be focusing their planning efforts and associated funding and permitting.

We know the on-the-ground dynamics of some of these areas better than others. This list is a first step in highlighting potential future project areas, with the requisite next step being thorough on-the-ground investigation and refined prioritization.



Potential LTPBR sites in southwest Washington

Considerations for resident trout species

Most current-day instream restoration efforts are focused on recovering habitat for salmon and other anadromous fish due to the multitude of risks faced by these species, but a pinpointed assessment of vulnerability of resident rainbow or cutthroat trout in certain areas will be a valuable step for ensuring at-risk populations are set on a path toward recovery. When instream restoration projects targeting resident species are implemented above barriers that prevent the passage for anadromous fish (such as work carried out above waterfalls), downstream species can still reap benefits through the attenuation of high and low flows. Such upland initiatives can also benefit amphibians dependent on damp riparian environments, as well as birds that prey on these resident trout.

Strategic treatment of reed canarygrass

Reed canarygrass (RCG) poses a significant threat to riparian habitats and biodiversity, spreading rapidly and outcompeting native vegetation species. Moreover, it exacerbates drought issues by absorbing substantial amounts of water from waterways and wetlands. The negative impact on water storage, biodiversity, and tree abundance affects a wide array of species, including fish, amphibians, and beavers. Tackling an RCG infestation is a time-consuming process, requiring diligent monitoring and follow-up. Therefore, it becomes crucial to strategically target locations where eradicating RCG will have the most substantial positive impact on habitat and resilience.

While chemical treatment is often a part of the restoration process, we must also emphasize native revegetation, which can aid in the process of outcompeting and shading out RCG, reducing the need for repeated treatments. Regular monitoring of priority wetland locations is vital, and we recommend the employment of an early detection, rapid response methodology to keep future infestations at bay before they become entrenched.

Volunteers can play a pivotal role in this conservation effort, surveying wetlands to identify areas where RCG is starting to take hold. They can also assist in monitoring previously treated areas, promptly identifying and reporting any resurgence of RCG. By engaging the community, we can build a collective effort to protect our waterways and wetlands from the encroachment of this particularly pernicious invasive plant.

Reed canarygrass at Woods Creek Watchable Wildlife Area

A call to action from Wheaton et al. 2019: select passages from the Low-Tech Process-Based Restoration of Riverscape Design Manual

A channel spanning structure constructed at Stump Creek

"Scaling restoration to match the scope of degradation will require a re-imagination of what's possible and an expansion of the restoration toolbox to include low-tech process-based approaches that get more people off the sidelines and into riverscapes restoration. In the American West alone, it is estimated that conservatively between 50,000 to 100,000 miles of perennially flowing riverscapes are degraded (USEPA, 2016), depending on definitions of degradation, choice of indicators of stream health, or the bar we set for stream recovery. The impairments to riverscapes are well understood and documented (Allan, 2004; Montgomery and Wohl, 2003), but the sobering scope of this degradation is often not emphasized enough. The grand challenge is what to do about it. As practitioners, scientists, landowners, and resource managers, do we standby, continue to observe and accept this degradation? Or do we re-imagine what these riverscapes could be and invest in re-establishing sustainable and resilient riverscapes and, in turn, the communities and ecosystems that depend on these riverscapes?"

***

"Current stream restoration practice costs an average of $65,000 to $450,000 per mile (median: $270K per mile), and the median length of restoration projects is < 0.5 mile (Bair, 2004; Bernhardt et al., 2007). These are respectable per project monetary investments, but the size of the projects is far too small to reverse over 200 years of riverscape degradation, land use impacts, and systematic structural starvation – in short, the scale of restoration does not match the scale of degradation. We need to make restoration investments that are smarter, and 'partner' with the natural processes to let the system do much of the work required to restore riverscapes (Restoration Principle 7). This approach is far more likely to lead to self-sustaining riverscapes (Restoration Principle 10). This requires a process-based perspective and an honest look at the bigger picture. We cannot afford to continue to disproportionately overspend on small projects (i.e., spatial extent of < 2 miles of riverscapes), ignore the scope of the problem (i.e., 50-100,000 miles of degradation), or expect measurable increases in populations of imperiled fish and wildlife – our approach needs to change."

***

"The overarching goal of low-tech restoration is to improve the health of as many miles of riverscapes as possible and to promote and maintain the full range of self-sustaining riverscape processes."

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"The restoration approach (i.e., low -tech process-based restoration) described in this manual is intended to be implemented primarily in wadeable streams. Approximately 90% of the perennial streams and rivers in the United States are considered wadeable (EPA, 2006). The importance of wadeable streams, also often referred to as low-order or headwater streams, has been well-documented. Wadeable streams contribute to the biodiversity of river networks (Meyer et al., 2007), are important carbon-storage zones (Beckman and Wohl, 2014), contribute allochthonous inputs (nutrients, litter, etc.) to lower, larger depositional rivers (Bellmore and Baxter, 2014), and are important controls on water quality and quantity (Alexander et al., 2007)."[50]

Appendix A: Beaver Co-existence Resources

https://coexistwithbeavers.org/

https://awionline.org/content/coexisting-beavers

https://www.oregonzoo.org/news/2022/01/living-beavers-tips-and-tools-coexistence

https://www.beaversolutions.com/

https://www.beaverinstitute.org/

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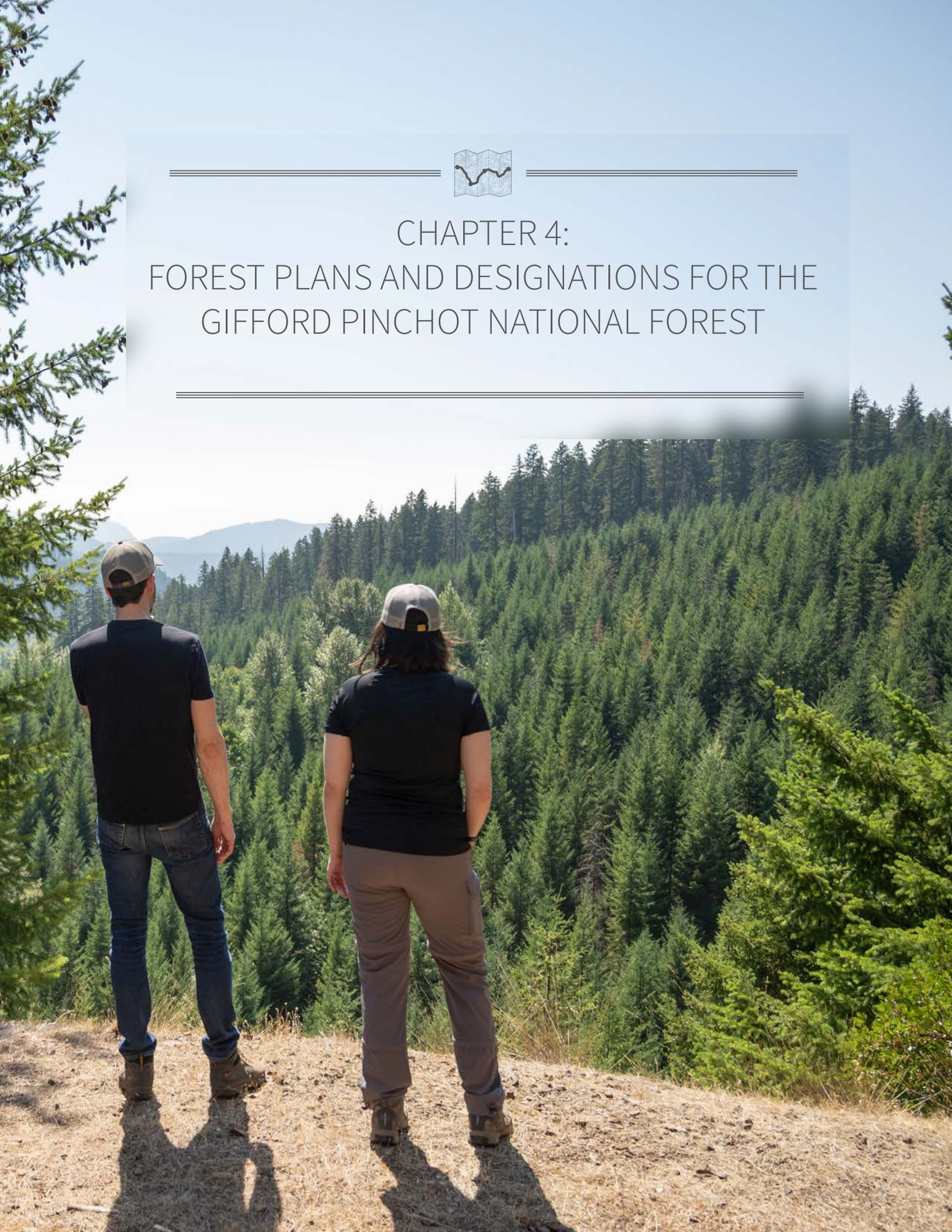
CHAPTER 4:
FOREST PLANS AND DESIGNATIONS FOR THE GIFFORD PINCHOT NATIONAL FOREST



CHAPTER 4 **EXECUTIVE SUMMARY**

Mature and old-growth forests on federal lands play a crucial role in improving climate resilience, enhancing carbon storage, and providing vital habitats for a diverse array of plants and animals. Unfortunately, the existing federal standards often fall short in adequately protecting these invaluable forest ecosystems. In this section, we establish a framework of conservation possibilities through Forest Plan updates and present a set of strategies to protect key areas, particularly older forests and high-quality habitats that face threats from logging and road construction. These recommendations align with the 2012 Planning Rule's focus on ecological integrity, use of best available science, and robust public involvement, aiming to ensure that the ecosystems within the Gifford Pinchot National Forest (GPNF) and other national forests in the Pacific Northwest remain healthy and resilient.

- **Update LSR objectives to include carbon storage and guidance regarding restoration in dry and mixed-conifer forests:** We suggest revising the management objectives for LSRs to emphasize carbon storage in order to enable project-by-project examinations of carbon storage values and associated tree retention. LSR objectives should also include new directives for restoration treatments in dry and mixed-conifer forests to allow targeted thinning and burning in areas where these actions can build resilience.

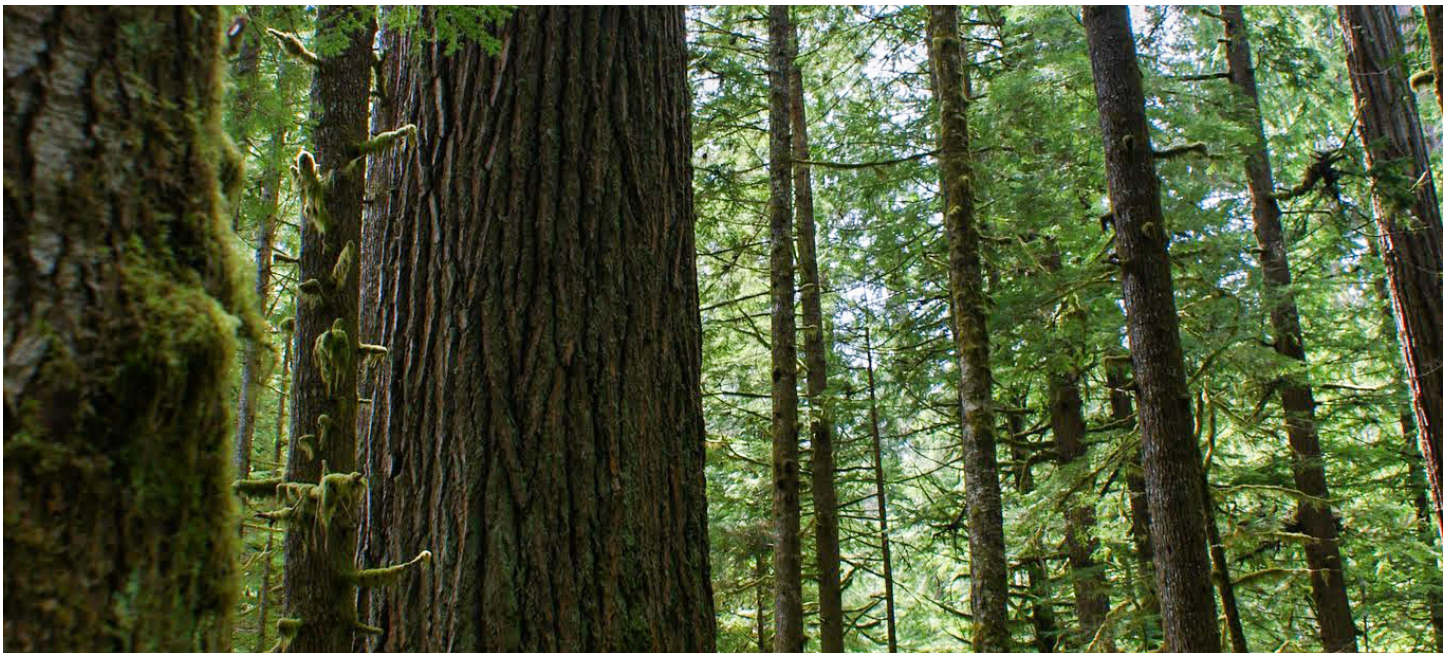
- **Rethinking reserves: select areas for a transfer from Matrix to Late-Successional Reserve (LSR) land use allocation:** We recommend the reclassification of select Matrix lands to LSR allocation to protect older forests that are currently located in Matrix areas where timber harvest is a dominant management objective. Using a hierarchical spatial analysis process that prioritized mature, westside forests with high connectivity potential and high carbon storage value, we identified 77,818 acres for conservation. The proposed alteration does not prohibit logging but concentrates on maintaining and enhancing old-growth characteristics in priority locations. This process was designed for the GPNF but can be replicated in other national forests in the Pacific Northwest.

- **Protect all trees established before 1920 in moist forests:** Due to the role that old and large trees play in creating habitats for wildlife, fostering biodiversity, and increasing stand-level resilience, Forest Plan updates should explicitly outline the protection of all trees in moist forests established before 1920 regardless of land allocation.

- **Preservation of the Survey and Manage program:** The Survey and Manage program has been an important tool for helping us understand and protect biodiversity, and it should remain strong and intact through any changes to the Northwest Forest Plan. This program is pivotal for designing management actions that ensure the protection of rare species identified during pre-management surveys.

- **Pragmatic and effective application of the Species of Conservation Concern program:** The Species of Conservation Concern (SCC) program helps land managers support biodiversity and species health through ecosystem management. It is important that species specialists, such as botanists and wildlife biologists, are engaged in creating and maintaining the SCC lists and that species on these lists have adequate ecosystem management plan components that are specific to their needs.

- **Creation of new Special Areas and other management designations:** We identify four specific areas in the GPNF that warrant consideration for Special Area status, Management Area status, or other designations that can be integrated into Northwest Forest Plan or local Forest Plan updates. These areas each have their own particular management approach and range from road reduction to conservation of connectivity and protection of old-growth. Proposed names for these areas are: Lost Creek Cedar Refugia, Clear Creek Road Reduction Area, Crab Creek Road Reduction Area, and the Steamboat Climate Resilience and Mitigation Area. The management approach for these newly designated areas would be outlined during planning and deliberation to align with specific conservation goals and objectives.



A forest stand in the Gifford Pinchot National Forest

FOREST PLANS AND DESIGNATIONS ON FEDERAL LANDS

History of Forest Plans

Federal lands set aside as national forests are managed by guiding documents called Forest Plans (or Land and Resource Management Plans). These plans are required under the National Forest Management Act (NFMA) of 1976, which requires the Forest Service to develop a Forest Plan for each unit of the national forest system and for plans to be maintained, amended, and revised as needed.

Forest Plans provide management direction and ensure the continuing activity of multiple uses (outdoor recreation, grazing, timber production, wilderness character, and wildlife, fish, and watershed health), while providing a sustained yield of various forest products and services.[1] Although a Forest Plan sets logging goals, identifies suitable areas for timber production, and determines which methods of timber harvest are appropriate, "it does not itself authorize the cutting of any trees." [2] Forest Plans are essentially the zoning ordinances of the national forest, determining which areas are suitable for specific activities. Forest Plans set specific standards and guidelines for future decisions and projects.

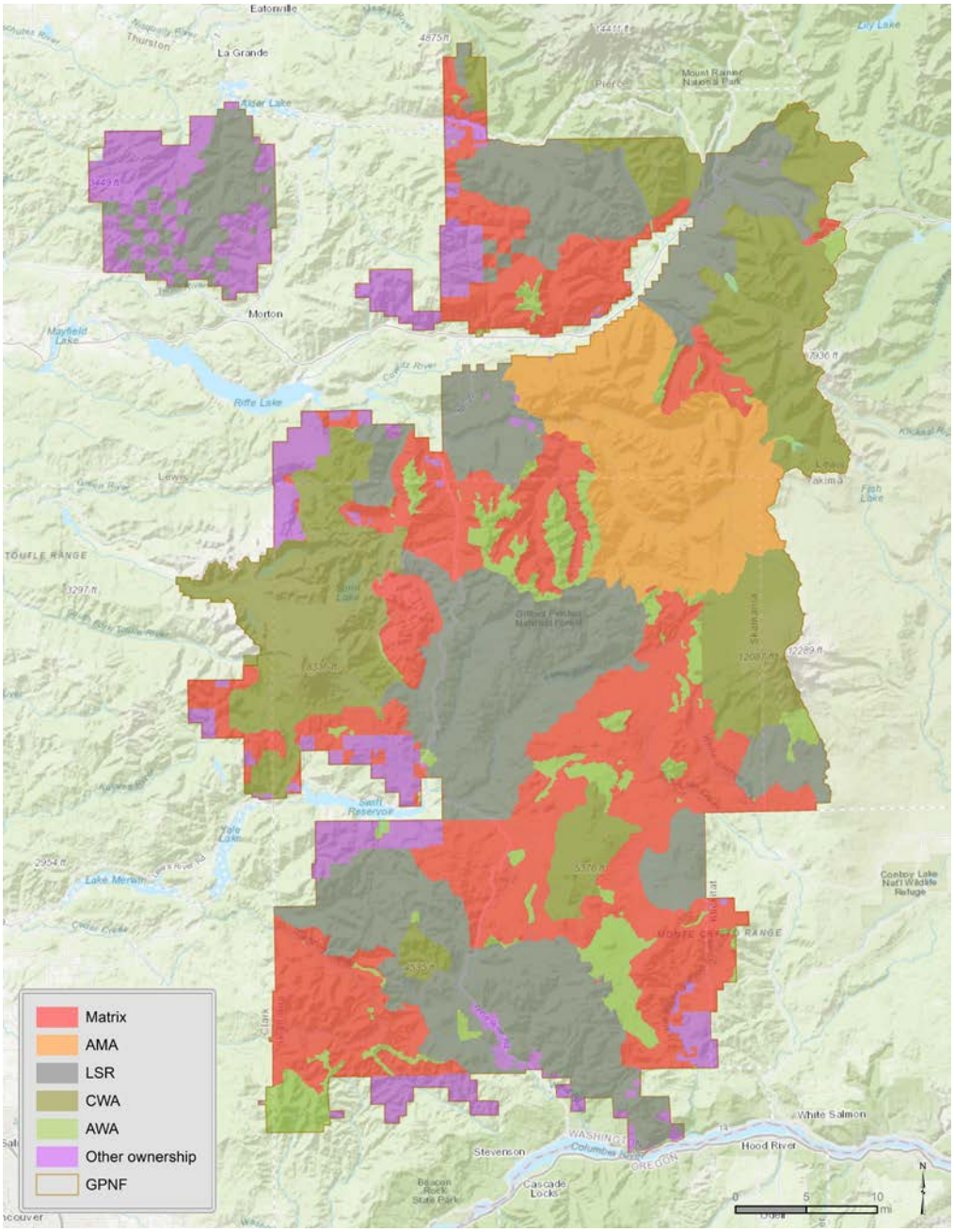
The requirement to create Forest Plans was a reaction to the increased amount of timber harvest occurring on national forests and an attempt to refocus the agency on its multi-use mandate. Before the NFMA was passed, timber harvest was the primary focus, and all other uses were considered secondary. Unfortunately, this approach largely continued even after Forest Plans were initially adopted, which meant objectives such as protecting vulnerable species took a back seat to timber production. By largely disregarding species conservation needs, the agency failed to consider what actions were needed to maintain species viability as required by relatively new requirements such as the 1973 Endangered Species Act and NFMA regulations adopted in 1979 and 1982.

After several courts rejected the agency's approach for conserving species like the northern spotted owl, the agency set a new goal to develop a scientifically-credible conservation strategy. This ultimately led to the Northwest Forest Plan.

Forest Plans

In the Pacific Northwest, within the range of the northern spotted owl, national forests operate under the Northwest Forest Plan (NWFP), which outlines management guidance for all Forest Service and Bureau of Land Management lands. In addition to the NWFP, each national forest has its own unique forest plan, which for the GPNF is called the Gifford Pinchot Land and Resource Management Plan (Gifford Pinchot LRMP).

The NWFP was one of the first land management plans to put into practice the concept of a scientifically-credible conservation strategy for plant and animal species using



Land use allocations on the Gifford Pinchot National Forest (GPNF) showing Matrix, Adaptive Management Areas (AMA), Late-Successional Reserves (LSR), Congressionally Withdrawn Areas (CWA), Administratively Withdrawn Areas (AWA), and other ownership, the latter of which commonly consists of privately-owned timberlands

a system of reserves. Of particular importance to this guidebook are the areas designated by the NWFP as Matrix and Late-Successional Reserves (LSRs). Matrix lands are areas where timber harvest is a primary objective and where fewer protections for habitats and species exist. LSRs are meant to safeguard late-successional forest ecosystems, particularly as habitat for species like the northern spotted owl. LSRs are to be managed in a way that maintains or accelerates old-growth forest characteristics.

Other relevant land allocations include: A) Adaptive Management Areas where experimental land management and harvest strategies may be tested, B) Congressionally or Administratively Withdrawn Areas such as Wilderness or Botanical Special Areas which will be discussed later in the chapter, and C) Riparian Reserves, which surround waterways and are meant to focus management therein on improving or retaining riparian function.

Local Forest Plans, like the Gifford Pinchot LRMP, apply a more detailed and localized lens through which managers plan on-the-ground management activities.

Forest Plan updates

After the adoption of the NWFP, various presidential administrations noted the need for updates to forest planning. New planning rules were proposed, but updated regulations were not finalized and adopted until 2012. The 2012 Planning Rule established an overarching goal of ecological sustainability, an emphasis on adaptive management (the process of monitoring strategies for effectiveness and making changes when necessary), and only required the Forest Service to forecast future conditions to a few decades rather than ten decades or more, which was the previous requirement.[3]

The process laid out in the 2012 Planning Rule includes distinct phases for Forest Plan updates: assessment, plan development, implementation, and monitoring. When changing Forest Plans, the Forest Service may either complete a **revision** where the agency reviews and updates a whole Forest Plan (NWFP or a local plan), or they may carry out a more narrowly-targeted update through an **amendment**. The revision process is more complex than an amendment and requires Forest Service staff to carry out an assessment and evaluate the current condition or status of an array of management factors including: terrestrial and aquatic ecosystems, air and soil quality, carbon stocks, disturbance regimes, invasive species, threatened and endangered species, proposed and candidate species, species of conservation concern, cultural and historic resources, economic conditions, infrastructure, recreation, access patterns, currently designated areas (i.e. Congressionally and Administratively Withdrawn Areas), the potential need and opportunity for additional designated areas, and other factors. For more targeted amendments, an assessment is not required but can be completed to support the need for change.

In 2022, the Forest Service started a process to update and likely amend the NWFP. This process started with the formation of an advisory committee to provide advice and recommendations for a modernization of the NWFP. The committee is composed of scientists, Tribal representatives, and other stakeholders who will consider issues of sustainability, climate change adaptation, wildfire resilience, and protection of late-successional forests.[4] Although not part of this committee's work, local Forest Plans may be updated at some point in the near future as well. In addition, the federal government issued Executive Order 14072, which called for a nation-wide inventory of all mature and old-growth forests on federal lands, an assessment of threats to these forests, and the development of policies to address these threats. And, in 2023, the Forest Service published a notice of intent to amend all Forest Plans across the country to conserve and steward old-growth conditions.

National forest lands in southwest Washington

PROTECTING FOREST HABITATS ON **FEDERAL LANDS**

Below, we outline a series of strategies that can help ensure the region retains important older forests and intact habitats and is set on a course to be more resilient to climate change. These strategies can be integrated into larger NWFP updates or put forward as a set of standalone updates for local Forest Plans. This entails working with the Forest Service, the advisory committee, and partners in advancing these recommendations for the southern Washington Cascades and helping apply these strategies to other national forests in the Pacific Northwest.

Changes to either plan would be done under the 2012 Planning Rule and other agency guidance including manuals, handbooks, secretarial memoranda, guidebooks, and notices.[5,6] Although the agency must initiate and complete the planning process, the rationale for change to the plan can come from "other documentation" from "any source" including groups such as CFC and documents like this guidebook.[6,7] The strategies suggested in this section fit well within the 2012 Planning Rule's need to ensure ecological integrity, use of best available science, and robust public involvement. And, further, these strategies will help the agency keep the GPNF's ecosystems healthy while also helping the agency meet the Rule's requirement to keep land management plans up-to-date and responsive to changing conditions.

Our strategies include: 1) transfer a select subset of Matrix areas to LSR allocation, 2) update LSR objectives to include carbon storage and restoration guidance for dry and mixed-conifer forests, 3) protect all trees established before 1920, 4) protect biodiversity through the Survey and Manage Program, 5) ensure the Species of Conservation Concern Program is effectively addressing the health and resilience of species, and, 6) protect or enhance the ecological function of specific areas through new designations, such as Special Area designation or other management designations. For each strategy, we underscore how management would shift and provide guidance on implementation.

In Chapter 2, we outline other strategies related to federal forest management that are likely best pursued through means outside of Forest Plan updates, such as recommendations involving NEPA and others regarding Tribal involvement in land management decisions.

Strategy 1: Transfer a select subset of Matrix areas to LSR allocation

Matrix lands are those areas where timber harvest is a primary management objective. In Matrix, it is common to see treatments called "heavy thinning" or "regeneration harvest." Heavy thinning refers to a logging plan where the canopy cover is reduced significantly, sometimes down to 40%. Regeneration harvest refers to a technique intended to "restart" the growth cycle of a forest stand by removing most trees throughout the majority of a cutting unit. The application of these logging prescriptions in old forests is anathema to the broadly agreed-upon goals of protecting rare old forests, preserving habitat for species that rely on them, and responsibly managing the carbon storage capabilities of Pacific Northwest coniferous forests.

Unfortunately, there are large amounts of old forests currently located on Matrix lands. Using forest age estimates from 2017 data, Matrix on the GPNF contains approximately 169,884 acres under 100 years of age, 160,031 acres 100 to 200 years of age, and 72,857 acres over 200 years in age.

Unlike forests in LSRs and Inventoried Roadless Areas, which have adequate baseline levels of protection, old forests on Matrix lands lack important safeguards. Therefore, prioritized older forests and connectivity areas currently located on Matrix lands for conservation.

Prioritizing locations

To move all mature and old-growth forests currently in Matrix to LSR would be impractical, so we narrowed down the locations using a spatial analysis process in ArcGIS to identify priority conservation locations containing:

- Older forest stands—using thresholds of 100 years and 200 years in different stages of the analysis;
- High connectivity potential—using priority areas identified in our previously completed connectivity model with results that included habitat core areas

(HCAs) where there is a high density of mature forests and connectivity corridors where movement between HCAs is expected to be least encumbered by areas of non-forest or otherwise low habitat quality; and

- High carbon storage potential—using estimates of carbon storage values by Law et al. 2021[8]

By focusing on areas where there was a density of overlapping values, we were able to focus on multi-value, high-priority areas that are at-risk from logging and ideal candidates for conservation.

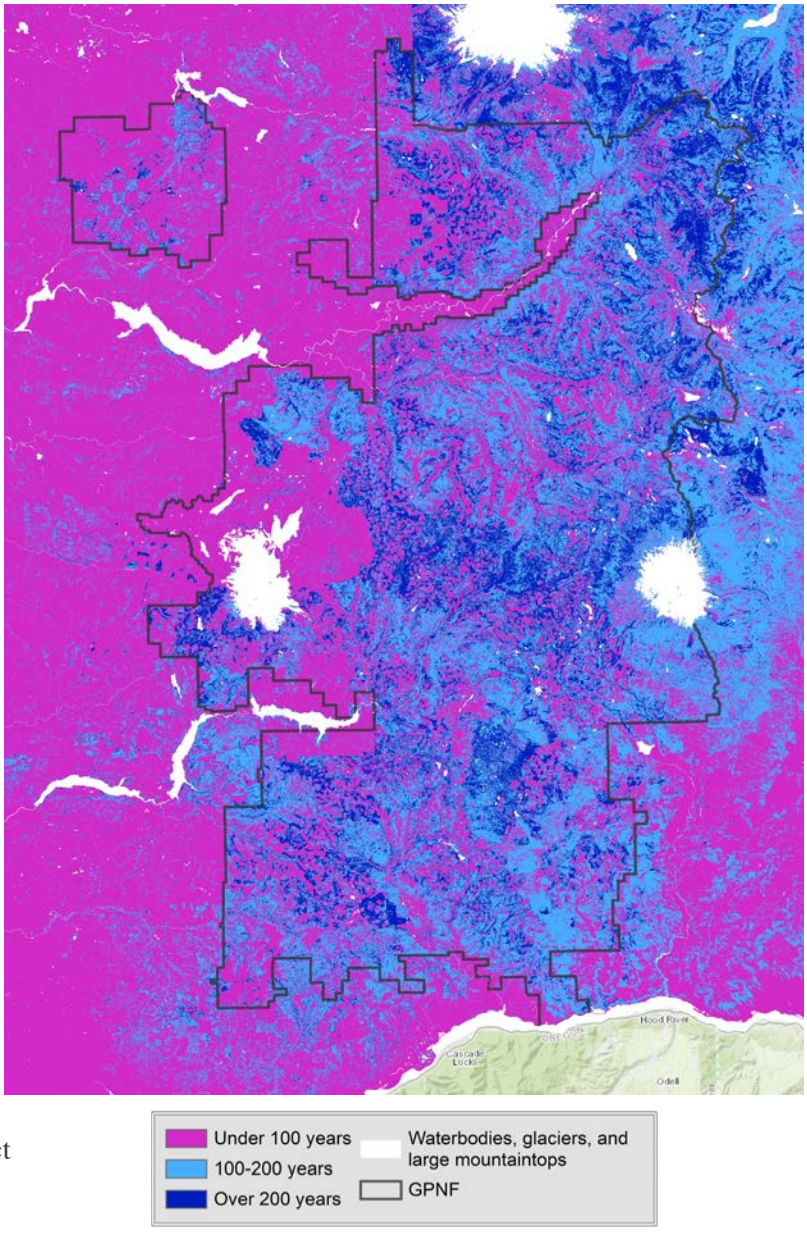
The spatial analysis process is outlined on page 84.

The process identified 77,818 acres for a Matrix to LSR transfer, including 23,747 acres over 200 years old (31% of the total conservation area), 34,427 acres 100–200 years old (44%), and 19,645 acres under 100 years old (25%). Most of the proposed conservation area (75%) consists of forests over 100 years old. The areas assessed to be younger than 100 years in age (comprising 25% of the total) were incorporated at various stages in the process, either: A) initially, as a spatial cell in an HCA or connectivity corridor, B) subsequently, when the layer containing carbon information was applied, or C) in the concluding steps when finalizing the polygon to encompass adjacent priority areas rich in carbon or old-growth.

Our focus is on the GPNF but our analysis methods can be applied to other national forests in the Pacific Northwest that are managed under the NWFP.

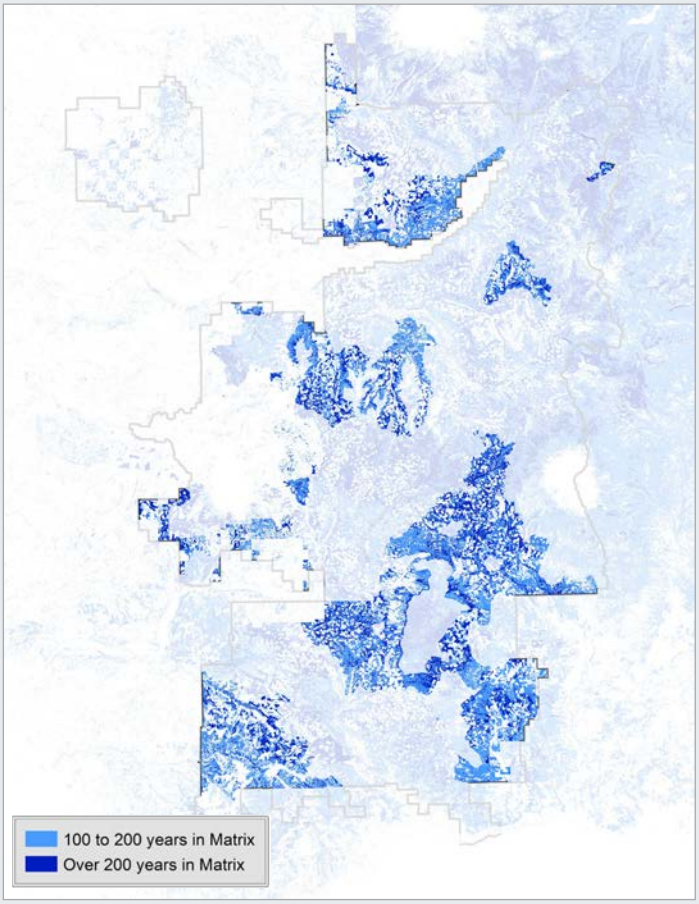
It is important to acknowledge that, as a society, we still use wood as a resource for building materials and paper and that this resource and harvest economy is critically important for many communities in the region. An LSR designation does not preclude logging but merely decreases the intensity of logging in certain areas and ensures that management objectives are largely focused on maintaining and enhancing old-growth characteristics. Instead of logging old forests, we recommend focusing timber harvest on thinning monoculture plantation stands and carrying out restoration thinning and prescribed burning in dry and mixed-conifer forests. In addition, as outlined in chapters 2 and 5 within discussions of forest management on state and private land, economic impacts can be further offset by advancing efforts to diversify the resource economy, such as through easements, carbon markets, new wood product certifications highlighting extended harvest durations, and governmental programs that are intended to help advance a smoother transition to a more diverse, resilient, and climate-smart economy. And, while more difficult to quantify than regional income numbers presented by mills and large timber companies, it is important to fully consider the economic potential for local contractors who are carrying out restoration work for roads, rivers, and forests. This economic input is often overlooked when considering region-wide economic reviews and projections.

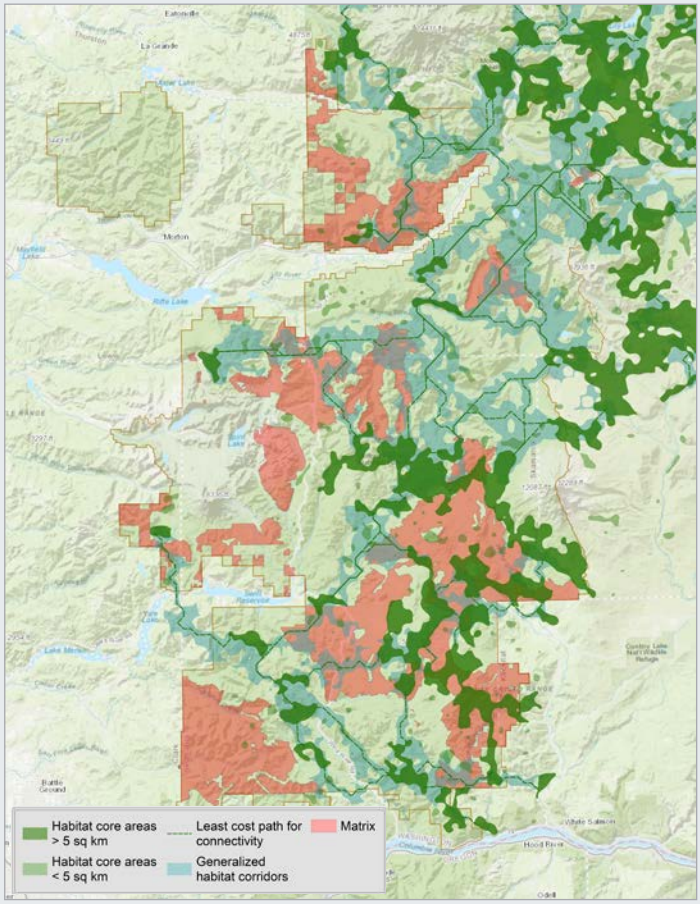
In summary, this recommended change to the Northwest Forest Plan or local Forest Plan would help align forest management goals with current on-the-ground realities regarding climate change, the overall scarcity of old forests on the landscape, and the state and distributions of rare species. The final map on page 85 shows our recommended areas for a switch from Matrix to LSR.



MAPPING **PRIORITY AREAS** FOR PROTECTION

ArcGIS was used to identify mature and old-growth forest areas within Matrix that were modeled as either habitat core areas (HCAs) or connectivity pathways between these HCAs.



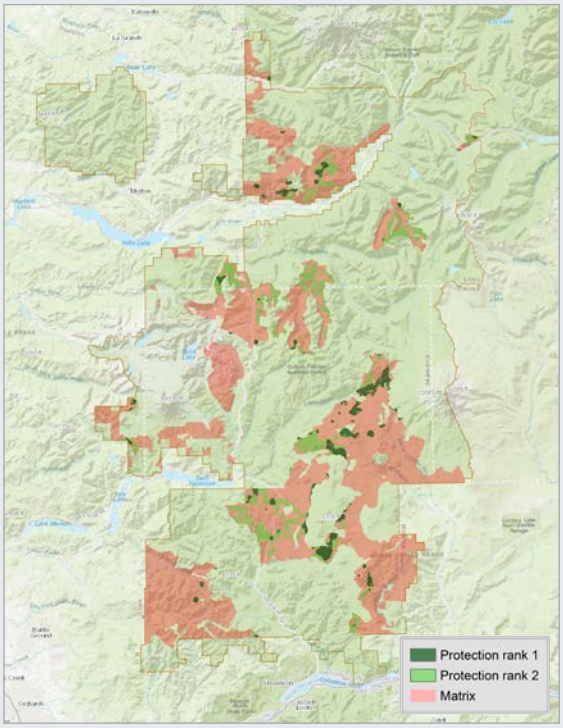


ORGANIZING THE DATA

Each cell was assigned a value based on the following: designation as Matrix (4 points), presence of forests >100 years in age (3 points), presence of an HCA (2 points), and presence of a connectivity corridor (1 point).

The assigned values of each cell were summed, resulting in the combined values in the table shown here.

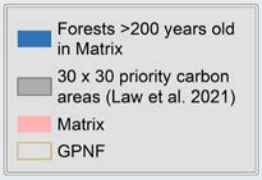
Combined Value	Protection Ranking
9-10	Protection rank 1
8	Protection rank 2
1-7	Excluded

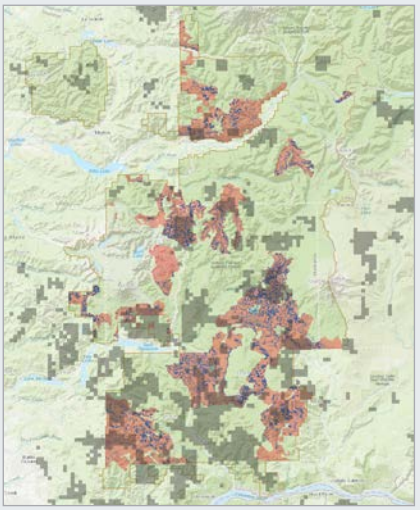


REFINING OUR RECOMMENDATIONS

The ranking and reclassification of raster layers resulted in a large number of relatively disjunct areas that would not translate well to management boundaries.

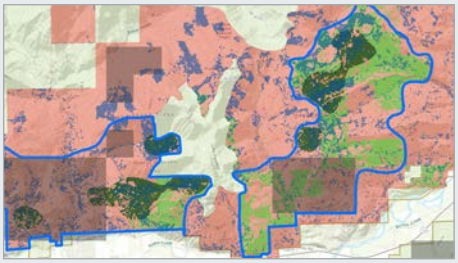
To help refine the final recommendations and to bring two new variables into consideration, we overlaid: 1) a carbon storage layer from Law et al. 2021 (showing priority areas for conserving carbon), and 2) a layer showing old-growth forests over 200 years old. We also overlaid recent timber harvest areas and removed these areas from consideration as future harvest is less likely to occur there again in the near future.

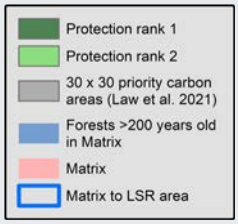


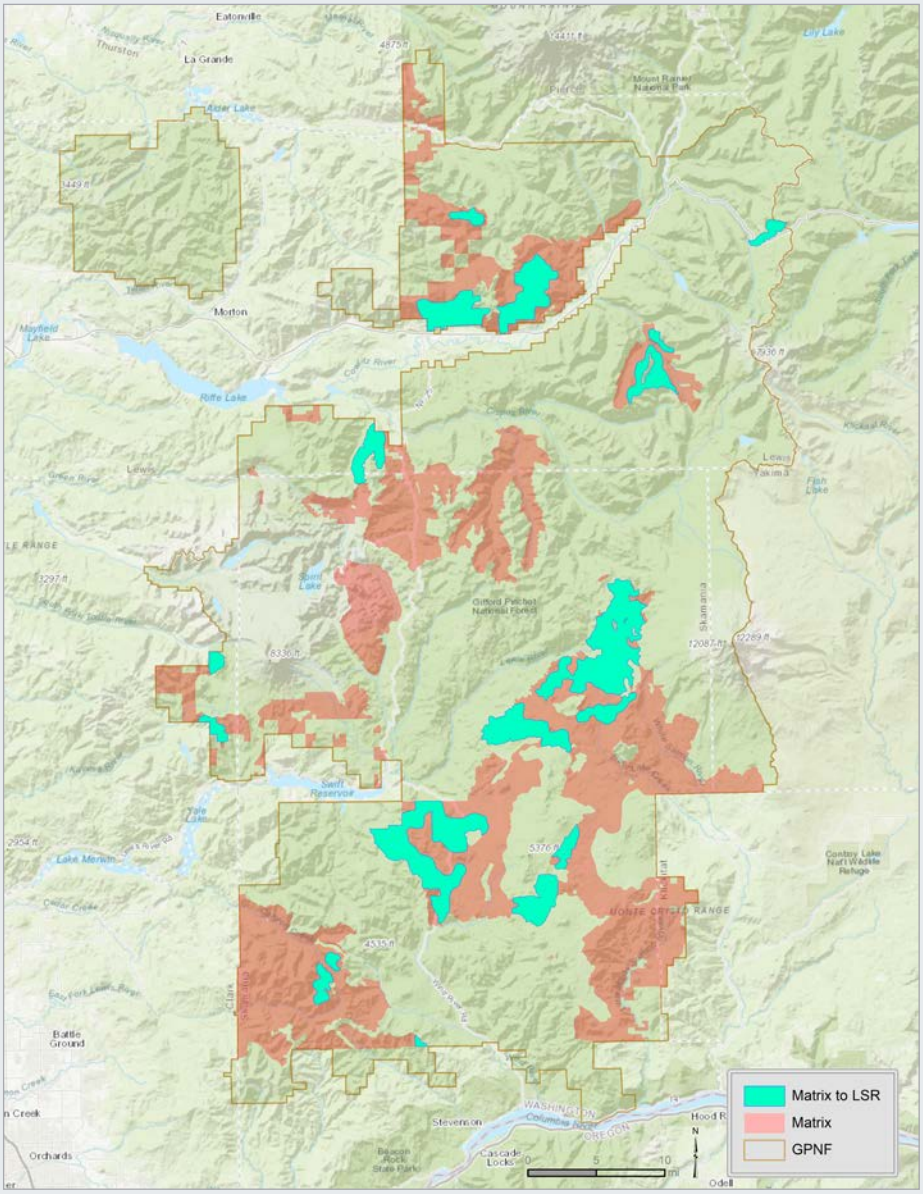


FINALIZING OUR RECOMMENDATIONS

To finalize the boundaries, we prioritized regions with an aggregation of protection rank 1, incorporating adjacent areas of: protection rank 2, priority carbon areas, and forests over 200 years old. This step, while qualitative, refined the data-driven prioritization with practical judgement regarding the proximity and densities of the various inputs. It ensured that designated conservation areas were not only viable in size for management but also encompassed ecologically important zones adjacent to initial clusters.







Recommended areas for a transfer from Matrix to LSR. Part of this area overlaps the proposed Steamboat Climate Resilience and Mitigation Area; implementation of both approaches in these areas of overlap would create redundancy, and the Climate Resilience and Mitigation Area designation would take precedence in this case.

Strategy 2: Update LSR objectives

Management objectives for LSRs should be updated to include carbon storage as one of the primary objectives across all LSRs in Pacific Northwest forests. In addition, LSRs in dry and mixed-conifer forests should more clearly include management directives that allow for targeted restoration thinning and prescribed burning to align these forests with their historical conditions and to bolster their future resilience to drought, insects, disease, and wildfire.

Currently, two of the primary objectives for LSRs are to retain old-growth characteristics in stands that are already at or near an old-growth state and, in younger areas, to accelerate forest stands toward an old-growth state. The latter is done by thinning, sometimes taking the canopy cover down to coverages as low as 40%. Thinning can sometimes help the larger trees reach maturity quicker, but there are negative impacts of this type of logging, including impacts to wildlife habitats, soils, and mycorrhizal communities (underground networks of fungus) as well as the introduction of invasive species. And, logging almost always works contrary to the goal of carbon storage and sequestration, even acknowledging that some carbon is retained in wood products.[9-13]

Our objective with the first part of this strategy is to ensure carbon storage becomes one of the primary management objectives for LSRs in moist, westside forests. Although there are a variety of management objectives in LSR, the two primary objectives under this new scenario would be: 1) retaining old-growth stands and characteristics, and 2) increasing carbon storage. This objective and management shift should, in most cases, be interpreted to mean less intensive thinning. For instance, if a current canopy cover target in certain LSR stands is 40%, the integration of carbon dynamics as a management consideration would result in this target number being higher in future prescriptions, helping retain more old trees in the stand and increasing carbon storage.

This type of management change, however, is not appropriate for dry and mixed-conifer forests where more intensive thinning, combined with prescribed fire, can reduce risks associated with wildfires, insects, disease, and drought stress. This brings us to our second recommendation regarding management direction for LSRs.

Current LSR guidelines and associated planning requirements are sometimes interpreted to suggest that thinning of medium and large grand firs or significantly reducing canopy cover levels to create a more open environment are not permissible management actions in dry and mixed-conifer forests. Therefore, the Forest Service has oftentimes not utilized what flexibility it has in these areas. Because of this, we believe it is important that guidance documents more clearly outline these exceptions for management in dry and mixed-conifer forests.

Some timber harvest activities are still permitted in LSRs

Restoration thinning and prescribed burning in specific areas should be paired with the preservation of large pine, cedar, Douglas-fir, and larch trees, as well as retention of strategically-placed dense forest patches across a third or more of the landscape. These large trees are 1) more resilient than grand fir, 2) much rarer on the landscape, and 3) less likely than grand fir to exacerbate drought stress during the dry season—as grand fir cannot control their stomatal openings like many other species, which means they cannot reduce their water uptake and transpiration in periods of drought.

These LSR recommendations align with federal directives, like the 2012 Planning Rule and the 2022 Executive Order focused on protecting old-growth. Integrating this strategy into upcoming NWFP revisions or amendments is a logical next step.

Option 1: Update of the NWFP

We recommend updating management goals for LSRs through the amendment process of the NWFP. Climate change and LSRs are topics that will be addressed by the agency and the federal advisory committee, and a change that enhances climate resilience and decreases the loss of carbon is a fitting consideration for efforts to modernize the NWFP.

Option 2: Update GPNF's LSR Assessment

As a secondary approach, we can advance this strategy by working with the GPNF to evaluate opportunities to incorporate these changes into the local LSR Assessment, an internal document used by the GPNF to determine what types of prescriptions are allowed within LSRs. An LSR Assessment can be updated by the GPNF through a process that is local to the Forest and less intensive than updating the NWFP or Gifford Pinchot LRMP. This is because a change to an LSR Assessment does not require adherence to the 2012 Planning Rule. Although updating the LSR Assessment is simpler, updates would be limited in scope (i.e., changes would only be local with less potential for regional change). Also, they must function within existing management direction and guidance within the NWFP, which could actually preclude the ability to retain more trees in a stand since the NWFP goal of accelerating tree growth might be interpreted to conflict with carbon goals. As it relates to management guidance for dry and mixed-conifer forests, however, this local option would likely suffice in helping advance restoration thinning and prescribed burning.

Strategy 3: Protect all trees established before 1920

In this strategy, we discuss a Forest Plan recommendation for moist forest zones that involves the retention of all trees established before 1920. This echoes recommendations outlined by Johnson et al. (2023) in *Making of the Northwest Forest Plan*.[14] The difference between this strategy and the one previously outlined (select areas for a Matrix to LSR transfer) is that the previous recommendation involves protection of contiguous forest stands that may encompass a mix of forest ages whereas this recommendation targets the protection of individual trees without stated retention of surrounding forest areas. This combination approach allows both targeted protection of older trees and larger-scale protections of contiguous habitat patches.

This strategy can be written into Forest Plan updates. The tenets would then be integrated into harvest prescriptions, which could include approaches employing selective thinning of smaller trees or variable density thinning whereby certain structural elements—such as large trees, high priority tree species, standing dead snags, or any other desired features—are retained (possibly in clumps) and incorporated into the future heterogeneity of the larger area.[14]

This strategy is especially relevant for management guidelines in Matrix and Adaptive Management Areas, since management guidelines for LSRs already discourage cutting trees over 80 years unless it is advancing old-growth characteristics or resilience in dry or mixed-conifer forests.

While a stand origin threshold of 1920 may suggest we support logging of trees that are in the 80 to 100-year range, this is generally not the case. From an ecological perspective, when looking at moist, westside forests (which make up the bulk of the GPNF), it is optimal to retain older trees as much as possible, especially those which are starting to gain attributes allowing them to serve increasingly important habitat roles.

Management in dry and mixed-conifer forests, on the other hand, may require more site-specific flexibility, so while retention of old and large trees is also extremely important in these forests, we do not outline specific limits for these zones.

LAND DESIGNATIONS

CONGRESSIONAL DESIGNATIONS		
Establishing Authority	**Size Limitation**	**Examples/Categories**
Congress by law*	None as a group	Wilderness; Wild and Scenic Rivers; National Recreation Areas; National Monuments; National Scenic Areas; National Scenic Research Areas; National Management Emphasis Areas; National Scenic and Historic Trails; National Heritage Areas
Process for Designation	**Interaction with Forest Plan**	**How vunerable to overturning?**
Law - Usually done with individual bills. There are several existing categories of designation that require an inventory and recommendation process from the agency to Congress.	Any specific management direction should be incorporated into the Forest Plan or a Comprehensive Management Plan should be created if required by the creating law.***	These are generally hard to overturn since it would require another Act of Congress.

SPECIAL AREA		
Establishing Authority	**Size Limitation**	**Examples/Categories**
Forest Service/USDA	None, but designated official changes at 100,000 acres**	Scenic Areas; Geological Areas; Botanical Areas; Zoological Areas; Paleontological Areas; Historical Areas; Recreational Areas
Process for Designation	**Interaction with Forest Plan**	**How vunerable to overturning?**
Administratively Designated - An analysis should be done that shows the "need and desirability" for the Special Area, usually done as part of the forest planning process either for amendment or revision. If Regional Forester can designate the area they may do so cocurrently when adopting an amendment or revision of a Forest Plan. Regional Forester may designate under 100,000 acres; Sec. of Ag. may designate over 100,000 acres.**	Regardless of whether designation occurs during the forest planning process or outside of it, amendment to the Forest Plan should be done to incorporate management direction into the plan for the new Special Area. When designation is recommended through the planning process, inclusion of management direction can be done cocurrently with the recommendation or through an amendment later.	Can be overturned in the same manner as they are created, including through either an amendment or revision of the Forest Plan if an analysis shows and makes a recommendation that the Special Area should be recinded. If the Regional Forester could have designated the area, then adoption of the amendment or revision of the Forest Plan with the recommendation to recind would remove the designation.

MANAGEMENT AREA		
Establishing Authority	**Size Limitation**	**Examples/Categories**
Forest Service	None	No set categories. These are very specific to particular Forest needs.
Process for Designation	**Interaction with Forest Plan**	**How vunerable to overturning?**
Administratively Adopted - Responsible Official may identify the area as a management area or as a geographic area in the land management plan if the land area does not otherwise qualify for designation adminstratively or congressionally.	The need for a management area should be identified in the forest planning process. If management areas are identified, management direction should be created and adopted for the area through the forest planning process.	Can be overturned in the same manner as they are created, through analysis in the forest planning process showing that the management area no longer needs focused management direction.

* National Monuments can also be established by the President

** If substantial improvements are planned for the Special Area then Regional Forester can designate areas up to 160 acres and anything over that must be done by the Sec. of Agriculture

*** For example, the Mount St. Helens National Volcanic Monument has a Comprehensive Management Plan that was required by the establishing law

Looking up toward Mount St. Helens

A fisher is a mid-sized carnivore that was extirpated from the Gifford National Forest due to trapping and habitat loss prior to recent reintroduction efforts. Photo by Michael Sulis.

Strategy 4: Protect biodiversity through the Survey and Manage Program

As changes to Forest Plans are considered at the regional and local levels, it is imperative that the Survey and Manage Program remains fully intact. Survey and Manage consists of a set of standards and guidelines, encompassing field surveys, associated reporting, and project adjustments, all of which are mandatory before initiating particular management action. The goal is to design management actions in a way that safeguards rare species identified during these survey processes. The Survey and Manage list comprises "rare and little known species thought to be associated with late-successional and old-growth forests (including mosses, liverworts, fungi, lichens, vascular plants, slugs, snails, salamanders, and red tree voles)."[15] The Survey and Manage process is a pivotal tool for protecting biodiversity and enabling effective adaptive management (i.e., continual improvement of management practices through scientific learning and new information), which holds particular significance in the face of climate change. It provides crucial information on the locations of rare species and data on population patterns and species trajectories, and it allows us to tailor management strategies to protect these species effectively.

An amendment in 2001 introduced several changes to the Survey and Manage Program, creating exceptions to the survey requirement for specific project types: 1) thinning in forest stands younger than 80 years of age, 2) culvert replacement/removal, 3) riparian and stream improvement projects, and 4) hazardous fuels treatments which apply prescribed fire. While these changes sensibly provide exceptions to the survey requirement, there have been other proposed shifts that would erode the strength and purpose of this program. It is crucial to ensure that no other exceptions are employed to circumvent this vital program.

Strategy 5: Ensure the Species of Conservation Concern Program is effectively protecting listed species

When considering updates to local and regional Forest Plans, it is important to design the Species of Conservation Concern (SCC) Program with comprehensive input from on-the-ground staff, including botanists and wildlife biologists, and to ensure that Forest Plan components are sufficiently structured to advance the long-term health and resilience of SCC species.

The SCC Program is a requirement from the 2012 Planning Rule; it is an updated method for conserving known species for which there is "substantial concern over the species' ability to persist over the long-term in the plan area," which is different from the Survey and Manage Program, which protects species where little is known regarding their presence or where protection measures are needed to ensure their "persistence" at a site.[15] The 2012 Planning Rule requires ecosystem integrity be maintained or restored. The rule assumes that most species will be adequately protected if their ecosystem is protected. For those species that are not adequately protected through ecosystem protection or state or federal listings, such as the Endangered Species Act, the Regional Forester is tasked with identifying species for the SCC list. The agency is then required to enhance habitat protection to ensure health and resilience of the species.

For this program to successfully protect biodiversity, it is essential that botany and wildlife experts with the Forest Service are engaged with creating and managing the SCC lists and developing plan components to ensure there is sufficient on-the-ground experience and suitable application in the design of Forest Plans.

Strategy 6: Protecting forest habitats through new designations

Below, we identify four priority conservation areas within the GPNF that warrant more ecologically-tailored management. We recommend these areas receive new designations, primarily as Special Areas in the local Forest Plan. We also discuss designation options for new Management Areas and another option that would be enacted through an update of the NWFP. The management approach for each is outlined below and would ultimately be determined by the specific goals and objectives outlined during planning, deliberation, and designation.

We identified these areas using methodologies similar to those outlined previously for the Matrix to LSR shift yet with a stronger focus on old-growth forests (rather than mature forests) and an incorporation of other variables such as 1) proximity to current roadless and Wilderness areas, 2) road locations and densities, 3) results from a previously completed road impacts analysis, and 4) locations of recreation facilities, trails, and potential future recreation needs. The process was less hierarchical and more qualitative and conditional upon this broad set of factors.

Before we discuss these recommendations, we will examine existing designations and their influence on management.

Designated Areas

Designated Areas are defined in regulations as "[a]n area or feature identified and managed to maintain its unique special character or purpose."[16] Both Congress and administrative agencies like the Forest Service have the authority to create land designations of different types and scales. Designated Areas all have their own management objectives and goals that can override the general prescriptions and management direction in Forest Plans.

Areas designated by Congress

Congress can establish new Designated Areas that protect or enhance specific conservation and recreation values by law. Examples of areas created by law include Wilderness, National Recreation Areas, National Monuments, National Scenic Areas, National Scenic Research Areas, and National Management Emphasis Areas (defined in the text box on page 101. The specific management objectives for each area are determined by the law which established a particular area. For example, the management objectives of Mount St. Helens National Volcanic Monument are "to protect the geologic, ecologic, and cultural resources, in accordance with the provisions of this act allowing geological forces and ecological succession to continue substantially unimpeded." [17]

Once a law designating an area is enacted by Congress, the management objectives and goals are incorporated into the Forest Plan at the local level in the form of guidelines that will ensure the area is managed as the law dictates. Other uses that do not directly conflict with the primary management objectives are allowed. Uses that would conflict with objectives are generally prohibited. For example, the Mount St. Helens Monument heavily restricts timber management in the establishing law, and therefore, timber harvest is only implemented in very narrow circumstances, such as the removal of hazard trees.

In this guidebook, we do not suggest Wilderness as a means of habitat protection. Instead, we recommend protection methods that 1) present fewer roadblocks, 2) are easier to adopt, 3) don't rely on an inherent assumption that humans never inhabited the area, 4) can be managed with more flexibility, and 5) will allow us to focus on areas most at-risk and those that may not meet Wilderness standards. In short, new Wilderness designation would have a low likelihood of success compared to our proposed methods and would limit our geographic focus to areas that, in some cases, are already well protected, such as Inventoried Roadless Areas.

Areas designated administratively

Special Areas: The Forest Service can designate Special Areas to protect and/or study sensitive species and habitats. They can be designated at the regional level by the Region 6 Forester or through the U.S. Department of Agriculture by the Secretary of Agriculture. The objective of this authority is stated in the Forest Service Manual as: to "protect the special values and attributes of the area (that is, scenic, cultural, historic, wilderness, wildlife, or other values) that contribute to public enjoyment" and "[m]anage for any other resource values present in the area, in a manner that does not impair the public recreation values or the special attributes of the area."[18]

If an area meets one of the Special Area categories then it may be designated through the forest planning process, such as through a targeted amendment to the Gifford Pinchot LRMP or a more comprehensive revision. On the GPNF, current Special Areas include (among others) Smith Butte Research Natural Area, Shark Rock Unusual Interest Area, Mount St. Helens Geothermal Area, Sister Rocks Natural Research Area, Cedar Flats National Research Area, and Wind River Experimental Forest.

The size and condition of Administratively Designated Areas determine which agency official must make the designation. For example, if an area is proposed for recreation and needs "development and substantial improvements"[19] then the Regional Forester can only approve a Special Area of 160 acres or less. The Secretary of Agriculture designates areas above that size. If an area will be maintained substantially in its current or natural condition, the Regional Forester can designate a Special Area up to 100,000 acres, and the Secretary of Agriculture designates those over 100,000 acres.

Old-growth western redcedars. Photo by Darryl Lloyd

The designation of Special Areas aligns well with the goal of building resilience as the rules for management of these areas are determined by the original reason for their designation. In other words, if an area is designated because it was identified as valuable climate refugia for a certain species or group of species, management would focus on conserving that trait, enabling managers to manage adaptively in the face of uncertainty and allowing restoration efforts that are supported by observed changes and current literature. The Forest Service echoes this in their documentation on Special Areas: "One of the goals of the program is to preserve a wide spectrum of pristine areas. We want to preserve and maintain genetic diversity. Within these areas, we want to protect against serious environmental disruptions."[20]

Management Areas: If specific guidance is needed for a certain area, but the area does not meet any of the Special Area criteria, the Forest Service can identify it as a "management area or as a geographic area to apply specific plan components in the land management plan."[6] Similar to Special Areas, a Management Area designated in a Forest Plan, with its associated management guidelines, allows the Forest Service to manage for specific desired conditions or features – such as climate resilience.

Old-growth western redcedars along Lost Creek

PLACE 1: LOST CREEK CEDAR REFUGIA

Lost Creek Cedar Refugia is a 305-acre area in the Little White Salmon watershed where ancient forests straddle Lost Creek and the boundary of the GPNF and the Columbia River Gorge Scenic Area. This area is home to some of the largest trees in the GPNF and a thriving understory teeming with botanical diversity. The area was threatened by a timber sale 25 years ago, but local citizens and stewards appealed and stopped the sale. As Matrix lands, this area remains at-risk from logging and should be set aside as a habitat reserve.

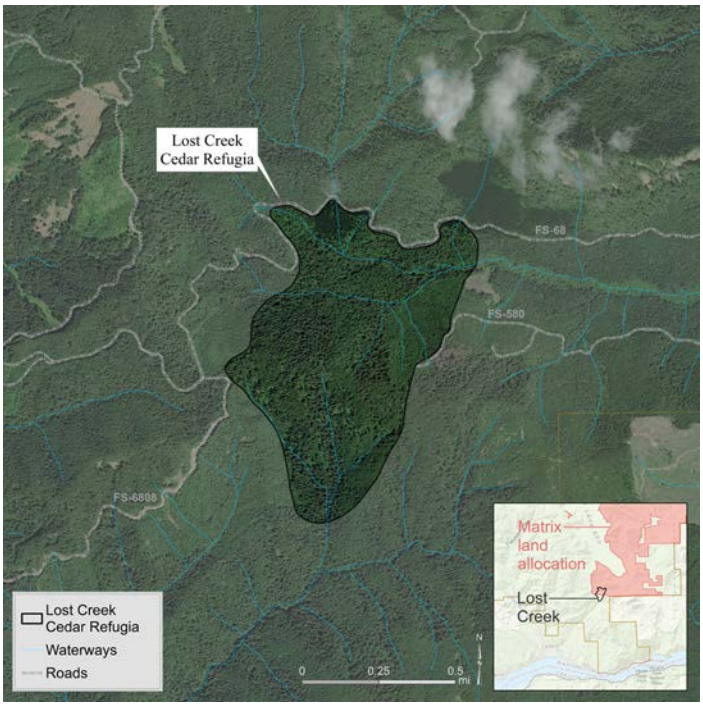
We are proposing to enhance forest protection in this area (through a full restriction of logging) utilizing one of two routes.

Option 1: Special Area Designation

Our primary designation recommendation for this area is to designate it as a Botanical Special Area or Research Natural Area in the Gifford Pinchot Land and Resource Management Plan for its rare ecological integrity. Both of these designations fit under the category of Special Areas. We will pursue this by working with the GPNF to create an "analysis of the need and desirability" showing the need for this Special Area in the Gifford Pinchot LRMP, whereby the Regional Forester could designate the Lost Creek Cedar Refugia as a new Special Area.[18]

Option 2: Management Area Designation

If the GPNF determines that the Lost Creek Cedar Refugia does not meet the requirements for a Special Area then the area could alternatively be protected as a Management Area. Designating the area as a Management Area could focus management on preserving it as a habitat reserve. This change in management direction could be done through a revision or amendment of the Gifford Pinchot LRMP.



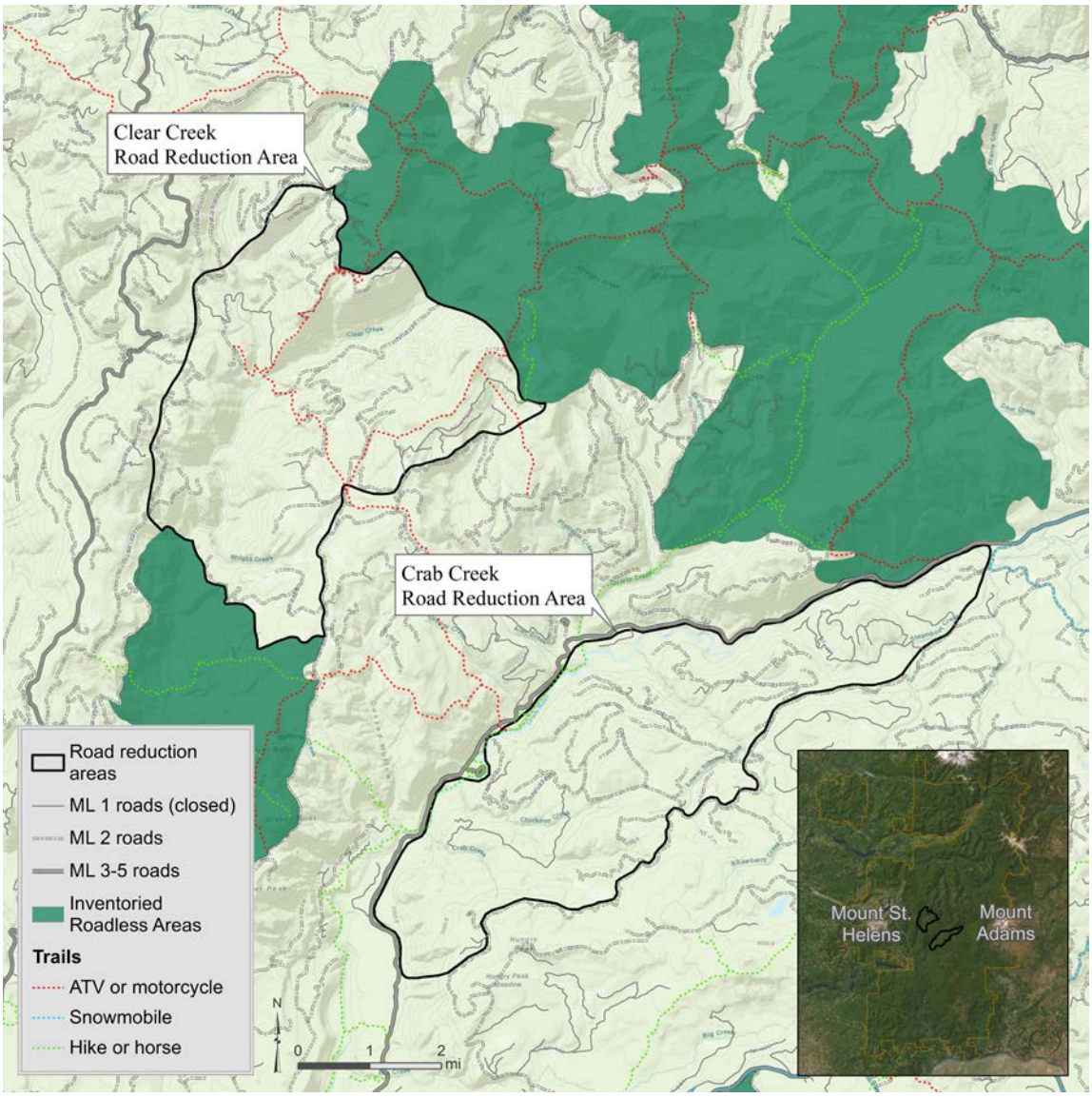
The proposed Lost Creek Cedar Refugia Special Area

PLACES 2 AND 3: CLEAR CREEK AND CRAB CREEK ROAD REDUCTION AREAS

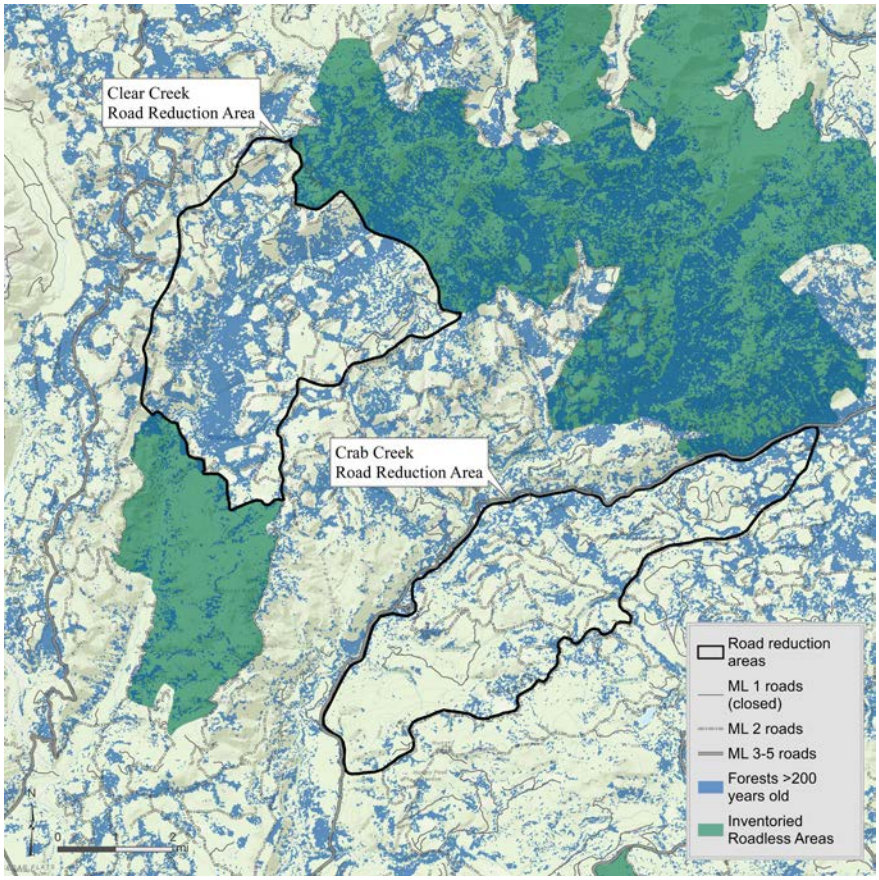
There are more roads in the GPNF than can be properly maintained, especially considering the projected increase in high flow events from climate change. In addition, forest roads can have a significant impact on terrestrial and aquatic ecosystems. Roads increase sediment in waterways, block fish passage, introduce invasive plants, and disrupt habitat use for a variety of land-roaming species.[21–24]

The GPNF carried out a travel management planning process in 2015, but the identification of road reduction opportunities was minimal, and the effort was tilted strongly toward road retention, with the idea that fine-tuned planning for targeted road reduction would occur during future timber harvest planning efforts. Because of this and the rarity of other planning efforts focused on roads issues, there is little to no opportunity to address road closure needs outside of timber sales. Even during timber sale planning, road reduction often remains overlooked and under-utilized.

In 2017, the GPNF did finalize one standalone roads assessment, the Upper Lewis River Roads Project, where the agency identified specific road restoration and reduction needs, with the intention to carry out on-the-ground implementation over the following several years. To assist in this project, CFC, along with teams of volunteers, collected on-the-ground information about road conditions and culverts and helped identify priority road segments for closure. A similar process can be carried out in the areas identified here.



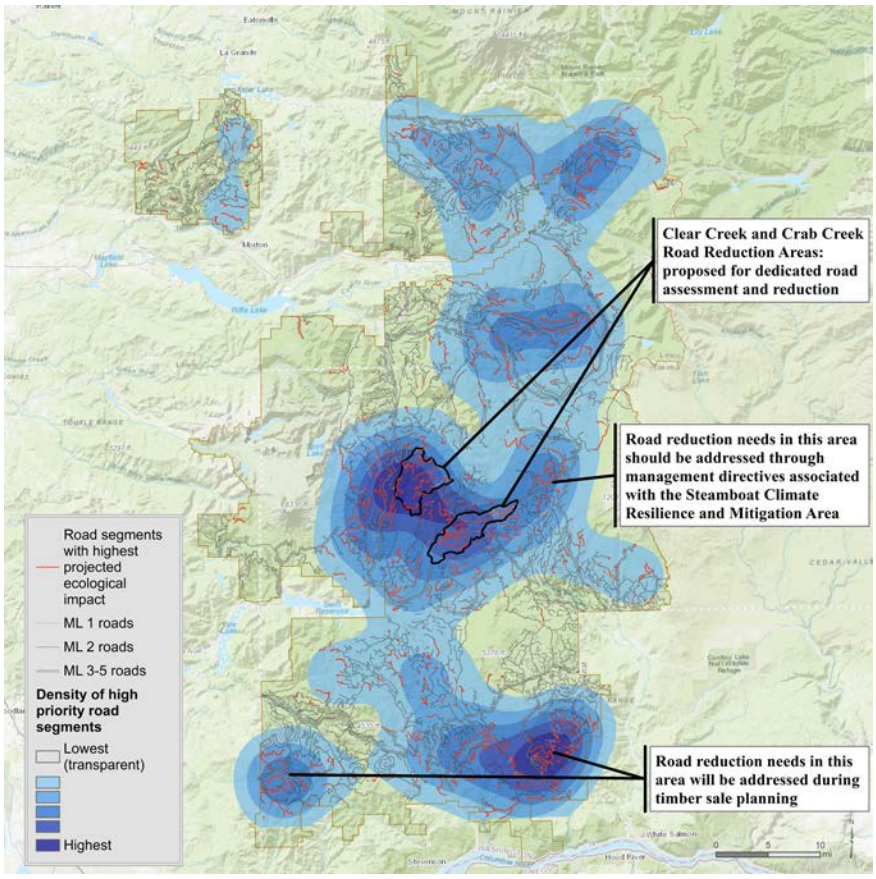
Through spatial analysis and investigation into potential management and policy solutions, we have identified two priority areas where we recommend management directives be tailored to 1) study the road network, 2) reduce road mileage and associated impacts, 3) increase habitat quality and connectivity, and 4) improve backcountry recreation opportunities. An additional goal for the Clear Creek Road Reduction Area is to connect two existing roadless areas and create one of the largest contiguous roadless areas in the southern Washington Cascades.



These two particular areas were selected for a variety of reasons.

First, these areas do not contain major thoroughfares or critical access routes that would make it difficult to advance their roadless character.

Second, they contain high densities of roads projected to bring negative ecological impacts. The map to the right was created using a base model that estimated road impacts by considering factors such as number of stream crossings, likelihood of a road segment creating sedimentation issues in aquatic systems (due to soil and topography dynamics), proximity to critical terrestrial habitats, and a variety of other measures. We then narrowed it down further by focusing on the highest impact roads (top quartile) and removing roads designated as maintenance levels 3, 4, and 5 (well-used and/or regularly maintained roads) as well as those labeled with two digits (e.g., FS-32) as these are likely well-used and needed on the landscape for a variety of purposes. Using this refined selection of road segments, we then ran a density tool to locate areas where these were densely aggregated. Running this density analysis allowed us to identify general project areas where a collection of roads could be assessed and considered as a group, similar to the process carried out for the Upper Lewis River Roads Project.



Third, these road reduction areas are nearby other roadless areas and this work

can therefore help in creating larger contiguous zones of un-roaded forest habitats, offering connectivity benefits for wildlife. The Clear Creek Road Reduction Area, in particular, encompasses a large expanse of old-growth forests and also sits between two existing Inventoried Roadless Areas, the Dark Divide and Spencer Ridge Roadless Areas. If significant closure of roads in this area was able to be accomplished, it would create one of the largest roadless areas in the region. Even partial road reduction would enhance the wildness of the area and improve habitats. Habitat models created by the Washington Wildlife Habitat Connectivity Working Group and Halsey et al. (2015) suggest that these areas are important as core habitat areas and/or connectivity pathways for a variety of species including fisher, marten, black bear, mountain goat, elk, flying squirrel, and western toad.[25,26] Field investigations can be integrated into management directives and can help in prioritizing reduction strategies and refining management objectives.

Option 1: Management Area Designation

Our top recommendation for advancing the roadless nature of these areas is to designate them as Management Areas through a revision or amendment of the Gifford Pinchot LRMP.

Management Area determinations are flexible and can allow for specific management objectives, such as road reduction, habitat protection and improvement, or recreation enhancement. In this case, Management Area designation would allow the agency to direct attention and resources toward A) assessing roads for closure and B) decommissioning road segments found to be suitable candidates for closure. This would, in turn, reduce long-term costs associated with forest-wide road maintenance, improve habitat and connectivity for terrestrial and aquatic wildlife, and improve backcountry recreation opportunities.

Option 2: Recreational Special Area Designation

Alternatively, designation as a Recreational Special Area could also be suitable and would allow more flexibility for enhancing backcountry recreation in this area. Similar to a Management Area, this type of designation would be enacted through a revision or amendment of the Gifford Pinchot LRMP. A Recreational Special Area is "a unit of land that has been administratively designated for particular recreation opportunities or activities such as hiking, rock hounding, recreational mining, photography, or other special activity." [18] These areas already contain recreation opportunities that fit this description, but more so, this option presents an opportunity to enhance these features. Recreation specialists would be needed to refine recreation locations and carry out requisite planning actions such as identification of low-impact camping locations, trail routes, and road-to-trail opportunities. As populations in cities and communities around the region continue to grow rapidly, we see a need to increase opportunities for low-impact recreation.

Option 3: District-level Management Project

A third approach to advance road reduction is through the creation of a standalone management project initiated and carried out by the district office(s). This effort would be similar to the Upper Lewis River Roads Project carried out by the GPNF in 2017 and would be done through the standard NEPA process, including assessment, scoping and environmental analysis (with associated public input), and a final decision.

A multistory forest stand near Clear Creek

What is the 2001 Roadless Rule? Can it be used to advance road reduction in these areas?

In 2001, the Forest Service adopted the 2001 Roadless Rule. This effort was implemented to protect the unique characteristics of un-roaded areas. The Inventoried Roadless Areas (IRAs) were identified by the Forest Service in either the Roadless Area Review and Evaluation II (RARE II) done in the late 1970s or other large scale assessments done for each national forest and grassland.[27] Instead of defining a minimum size or other set characteristics through which to determine eligibility, the Rule intentionally limited IRAs to include only those areas identified through the 2001 rulemaking process and which were mapped in the Rule's Final Environmental Impact Statement.[28] IRAs carry strong protections from logging and road development due to the national value they offer for habitat, recreation, and biodiversity.

While it might seem prudent to consider the Crab Creek and Clear Creek areas as new IRAs, there are two primary reasons that we recommend alternate approaches. First, these areas likely do not meet the pre-designation standards required for an IRA, since there are roads currently in place. Second, there is no set process for designating new IRAs. The process that originally created the IRAs was specific to the 2001 rulemaking process and could not be readily replicated in a present-day context. If a similar process were to be considered, it would require involvement of the Secretary of Agriculture which would create unnecessary complications.

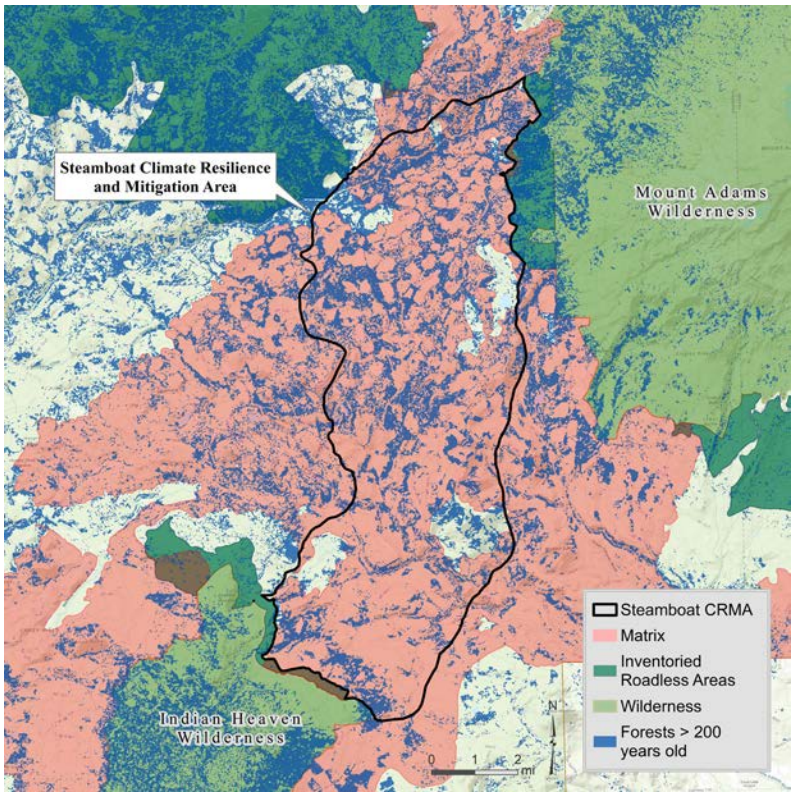
PLACE 4: STEAMBOAT CLIMATE RESILIENCE AND MITIGATION AREA

We recommend establishing a new protected area focused on carbon storage, connectivity, and climate resilience, where disturbance from logging and new road development would be limited and where management would be specifically tailored to advancing resilience for species and habitats. This recommendation focuses on using a new Forest Plan designation to reduce logging intensity, with 70% set as a minimum canopy cover threshold except in narrowly-targeted cases such as the treatment of root rot or the creation of fire breaks.

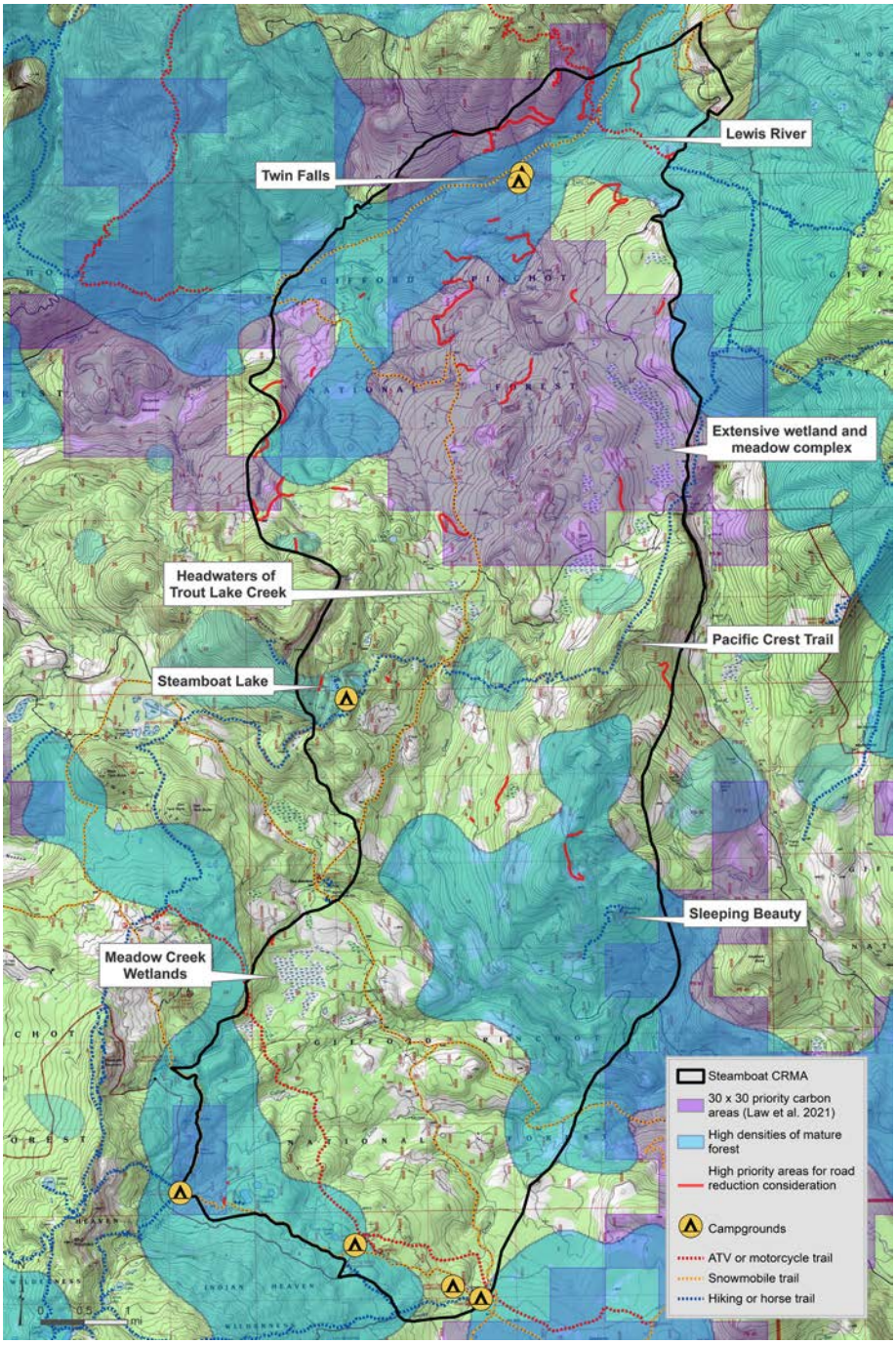
The proposed Steamboat Climate Resilience and Mitigation Area (CRMA) would connect Mount Adams Wilderness and Indian Heaven Wilderness. It encompasses Steamboat Lake, patches of old-growth forest, an abundance of wetlands and meadows, and many popular recreation sites and trails, including the Pacific Crest Trail.

In the CRMA, like a Wilderness area, habitat conservation is a primary objective along with recreation. But, management of a CRMA differs from Wilderness in a variety of ways: 1) roads are allowed; 2) aquatic, riparian, and road restoration is encouraged; and 3) light thinning of monoculture plantation stands originating between 1945 and 2015 is allowed. In addition, there is a distinct push to monitor and advance climate resilience to better understand the role of large multi-use areas in an era of climate change.

In the Steamboat CRMA, roads allow access to recreation areas and, in some situations, could be useful as fire breaks to protect patches of old-growth (note: more research is needed regarding the efficacy of roads as fire breaks in varying fire severity scenarios). As with most areas in our national forests, there are many old and unneeded roads that are causing ecological damage. So, with the goal of maintaining ecosystem health and enhancing climate resilience, this designation would advance processes to identify some roads for closure and others for upgrades (such as culvert replacements to increase fish passage and decrease the chance of road failure from high streamflow events).



A forest stand bordering a meadow in the Steamboat area



Option 1: Climate Resilience and Mitigation Area (CRMA) in the NWFP

This method employs a campaign advocating for the inclusion of climate resilience reserves—to be titled Climate Resilience and Mitigation Areas (CRMAs)—in the update of the NWFP. The Steamboat CRMA would be the pilot case showcasing the process and potential for such a designation in other national forests operating under the Northwest Forest Plan. As we move forward with advancing protection for this area, we will pursue opportunities to work with partner groups and apply our methods to locations in other areas.

Option 2: Special Area Designation

This method involves establishing the Steamboat CRMA as a Special Area (recreational or scenic) through the Gifford Pinchot LRMP.

As outlined for the road reduction areas, recreational areas are "designated for particular recreation opportunities or activities such as hiking, rock-hounding, recreational mining, photography, or other special activity."[18] There are many recreational opportunities present in this area, such as the Pacific Crest Trail, Cultus Creek Campground, Langfield Falls, Steamboat Lake, Swampy Meadows, and many more. There is also the potential to enhance

backcountry recreation through infrastructure updates, trail construction, and strategic road closures in areas where there are unneeded roads, such as the heavily-roaded slopes near the headwaters of Trout Lake Creek and the north section of the Steamboat CRMA, which ranked high in our analysis of projected road impacts on ecological systems.

The scenic values of this area are abundant and diverse (meadows, old-growth forests, lakes, and rock outcroppings) and could potentially justify Scenic Special Area designation. The regulations define a Scenic Special Area as "a unit of land with outstanding natural beauty that requires special management to preserve this beauty." [18]

If logging impacts are reduced, roads are studied and decreased in select areas, and infrastructure is enhanced to support Scenic Area goals, the natural beauty of this area can justifiably be improved through a designation of this sort.

For either option, we would pursue Special Area designation by working with the GPNF to create an "analysis of the need and desirability"showing the need for this Special Area in the Forest Plan which could then be used by the Regional Forester to designate the Steamboat CRMA as a newly designated Special Area. [18]

Looking out at Mount Adams and the Steamboat Climate Resilience and Mitigation Area

Appendix B: Congressional Designations

Wilderness: is defined in its enabling act as an "area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions." (Wilderness Act of 1964) Additional Wilderness areas may be added by a process that includes inventory and recommendation to Congress. All new Wilderness areas are adopted through Congress.

Wild and Scenic Rivers: are select rivers that "possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values" and "shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." (Public Law 90-542; 16 U.S.C. 1271 et seq.)

National Recreation Areas: "Areas that have outstanding combinations of outdoor recreation opportunities, aesthetic attractions, and proximity to potential users. They may also have cultural, historical, archaeological, pastoral, Wilderness, scientific, wildlife, and other values contributing to public enjoyment." (Forest Service Manual Ch 2370)

National Monuments: "Areas of unique ecological, geologic, historical, prehistorical, cultural, and scientific interest." (Forest Service Manual Ch 2370)

National Scenic Areas: "Areas that contain outstanding scenic characteristics, recreational values, and geologic, ecologic, and cultural resources." (Forest Service Manual Ch 2370)

National Scenic Research Areas: "Areas that contain outstanding scenic values for research, scientific, and recreational purposes." (Forest Service Manual Ch 2370)

National Management Emphasis Areas: "[A]reas that contain unique or outstanding physical features and that contain specific physical, cultural, or political characteristics receiving specific emphasis in the legislation." (Forest Service Manual Ch 2370)

National Scenic and Historic Trails: These trails are intended to provide for expanding outdoor recreational needs. Scenic trails are those with "outdoor recreation potential" and for "the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass." Historic trails are those "which follow as closely as possible and practicable the original trails or routes of travel of national historic significance." (The National Trails System Act, 16 USC 1241-1251)

National Heritage Areas: These are areas that are nationally important with historic, cultural, and natural resource significance. These areas are mostly lived-in landscapes and usually involve collaboration with local communities and include a component of sustaining economic vitality of the designated area. (https://www.nps.gov/subjects/heritageareas/index.htm)

Appendix C: Administrative Designations

Research Natural Areas: The Forest Service "shall establish a series of research natural areas, sufficient in number and size to illustrate adequately or typify for research or educational purposes, the important forest and range types in each forest region, as well as other plant communities that have special or unique characteristics of scientific interest and importance."

Botanical Special Areas: Botanical Special Areas can be designated to secure important plant communities. Designation for these areas is similar to that for RNAs, yet is focused on preserving certain botanical species or communities. Management of these areas comes with a distinct set of rules; these rules and their flexibility vary with the type of species or communities.

Scenic Special Areas: Scenic Special Areas are used to protect outstanding natural beauty. The focus is to tailor management toward the preservation of this outstanding natural beauty.

Geological Special Areas: These areas contain "outstanding formations or unique geological features of the earth's development." Some examples include caves, cliffs, and fossil areas.

Zoological Special Areas: These areas are intended to protect important animals or communities. These can be significant "because of their occurrence, habitat, location, life history, ecology, rarity, or other features."

Paleontological Special Areas: "A paleontological area is a unit of land that contains fossils of plants and animals, shellfish, early vertebrates, coal swamp forests, early reptiles, dinosaurs, and other prehistoric plants and animals."

Historical Special Areas: "A historical area is a unit of land possessing a significant site or a concentration of sites, buildings, structures, or objects united historically or prehistorically by plan or physical development. Memorial areas are included in this definition."

Recreational Special Areas: A recreational area is a unit of land that has been administratively designated to protect or enhance recreation opportunities or activities such as "hiking, rock hounding, recreational mining, photography, or other special activity."

Inventoried Roadless Areas: In 2001 the Forest Service and USDA adopted a rule that provided protections for inventoried roadless areas against timber harvest and roadbuilding. There is no existing process in regulations or law to add more areas to the inventoried roadless area category.

*Designation information sourced from 36 C.F.R. § 251.23 (2023) and Forest Service Manual 2372.05

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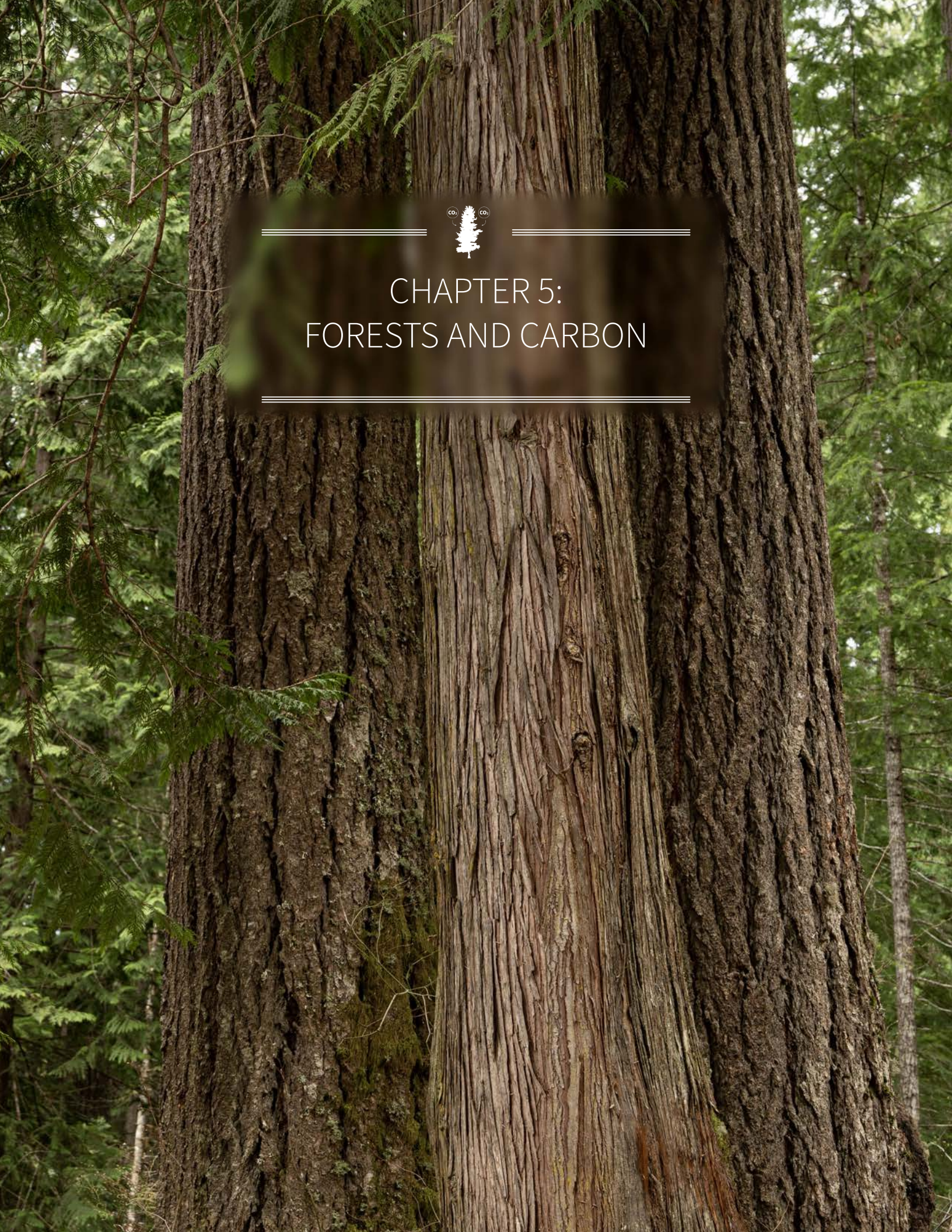


CHAPTER 5:
FORESTS AND CARBON

CHAPTER 5 **EXECUTIVE SUMMARY**

Pacific Northwest forests are vital carbon storage reserves, instrumental in mitigating the impacts of climate change. Extending harvest durations (from a range of 35–60 years to 80–100 years) serves as a critical strategy in enhancing carbon storage capabilities. This method entails a shift toward multi-faceted forest management portfolios, focusing on a holistic balance between timber harvest and ecological functionality. There are an array of economic benefits for landowners and others involved in the timber business, but there are also significant challenges. We discuss the opportunities and challenges in this section.

Our specific strategies include:

- **Increase incentives for private landowners**: Increasing incentives for private landowners to lengthen their rotations is paramount. This can be achieved by enhancing a landowner's ability to diversify their revenue streams through ecosystem services and advancing federal programs to ease the financial burden during the transition to longer rotations. Embracing "ecological forest management" can reduce management costs, buffer against market volatility, increase the volume of timber extracted from a particular plot of land, and elevate overall income by tapping into diverse economic potentials, such as carbon credits and conservation easements, all while improving ecological conditions and carbon storage capacities.

- **Propel the advancement of certifications and mill updates**: Encouraging the adoption of new certifications like "Long Rotation-Certified" wood can raise awareness of the value of wood from extended harvest durations and help increase economic incentives along the supply chain. Leveraging sustainable procurement clauses for federal infrastructure projects can stimulate the use of homegrown, long rotation timber, promoting local economies, ecosystems, and carbon storage. Grant programs like the Wood Innovations Program and technical assistance grants from the Farm Bill can aid mills in the transition to longer harvest durations.

- **Investigate opportunities to improve the functionality and use of habitat conservation plans and safe harbor agreements**: Investigating opportunities to improve the functionality of habitat conservation plans (HCPs) and safe harbor agreements (SHAs) can help identify opportunities for reducing risks to landowners related to the Endangered Species Act.

Forests and Carbon

There are many misconceptions about the interplay of carbon and forests. There are a number of reasons for this, including new findings being regularly uncovered as scientists delve deeper into this topic and the fact that there are widely varied interpretations or misapplications of the research.[1] The timber industry, in particular, has been fairly successful in framing logging, even short-rotation industrial logging, as a net positive for reducing atmospheric carbon. They highlight the role of wood products in storing carbon and cite studies about the rapid growth rate of young trees. While we can understand the motivation in portraying the data in this way, it is important we get the facts straight. If we were managing solely for carbon storage, the research is clear that we would not log our forests.[2–6] But, seeing as we all use wood products and knowing that the timber industry is an important economic driver and a livelihood for many people, we know that's not a reasonable scenario. So, is there a way to balance these competing needs: the need to harvest wood and the need to optimize carbon storage to reduce climate impacts? The short answer is yes, but as you may have guessed, it's a complex topic with trade-offs.

Let's start with the basics.

Forests store carbon by pulling the most prominent greenhouse gas, CO2, from the atmosphere through the process of photosynthesis and then converting it into glucose, which is used for growth and other functions. Carbon is then stored in all parts of the tree as well as the soil. In fact, soil and downed logs account for much of the carbon stored in old-growth forests, which makes understanding the forest as a system, rather than a collection of trees, all the more important.[7]

Forests in the Pacific Northwest store more carbon than most forest systems, and a growing body of literature suggests that mature and old-growth forests are uniquely valuable as global carbon banks.[8–11] Data from the Intergovernmental Panel on Climate Change show that temperate forests, like those in the Cascades, sequester an average of 68 tons of carbon per acre every year in their soil and plant life.[9] Mature conifer forests account for some of North America's highest annual carbon storage, and in a 2023 research article, the Gifford Pinchot National Forest was found to have the highest carbon density of all 154 national forests.[12]

Due to this, no-cut reserves are a great solution for some of our federal lands, such as those that are already nearing old-growth status and other areas which may be appropriate candidates for heightened protection. But, this is not feasible for some of our federally-managed forest areas nor for the many acres of private and state forest lands in southwest Washington. So, how can we increase carbon storage while also generating timber for houses, paper, and other products? The short answer: extending the time between harvests.

This approach for addressing global climate storage is often considered alongside a suite of strategies called natural climate solutions (NCS). Some of the other NCS approaches include reforestation, avoided forest conversion (to buildings, pavement, or farms), fire management, avoided grassland conversion, improved manure management, integrating legumes in pastures, tidal wetland restoration, peatland restoration, seagrass restoration, and avoided seagrass loss.[13]

Focusing on the state of Washington, extending harvest rotations on industrial forestlands in the wet, western forests could account for the state's largest NCS contribution to mitigating climate change. Results from Robertson et al. (2021) highlight that natural climate solutions can play an important role in helping the state of Washington achieve its net zero goal by 2050, with most of the gains achieved by extending timber harvest rotations from 45 to 75 years.[14] Other significant reduction pathways include avoided conversion of forests and changes in farming practices, although even the highest among these represents a quarter or less of the reductions that can be seen with extended timber harvest rotations. Reductions in "Lewis County alone are greater than the highest aggregated reductions from all other pathways in any single county."[14] When looking at all forest-based strategies together (including riparian reforestation and post-wildfire planting, avoided forest conversion, and extended timber harvest), they represent over 80% of the natural climate solution potential in Washington State.[14]

Short rotation logging (harvesting a plot of trees every 35 to 60 years) is at odds with the goal of increasing carbon storage, yet this is the type of logging that occurs throughout most of the industrial timberlands of the Pacific Northwest.[10,11,15,16] Corporate mergers and acquisitions in the timber industry in the 1980s and 1990s closely linked the compensation of CEOs with short-term profits and a quick return on timberland investments. We went from cutting trees at a "biological rotation age" (around 80-100 years for Douglas-fir) to what's called the "financial rotation age." [17,18]

The good news is that transitioning from short harvest rotations to longer rotations can produce multiple benefits, including more timber volume per acre (even when

counting two harvests with a shorter rotation cycle), increased carbon storage, less herbicide and fertilizer use, longer durations of favorable habitat conditions for forest wildlife, and fewer impacts to soil health, mycorrhizal communities, aquatic habitats, and water quality.[19–25]

According to modeling done by Northwest Natural Resource Group (NNRG), doubling the rotation age (from 40 to 80 years) can increase timber production by 52% and can keep an average of 53% more carbon out of the atmosphere.[20] Commercial thinning on this 80-year rotation produces 82,000 board feet compared to 54,000 board feet from two 40-year rotations, and they found that the longer rotation sequesters 319 tons of CO2 per acre, with the shorter rotation sequestering only 209 tons (both scenarios considered carbon stored in wood products, landfills, and forests).[20]

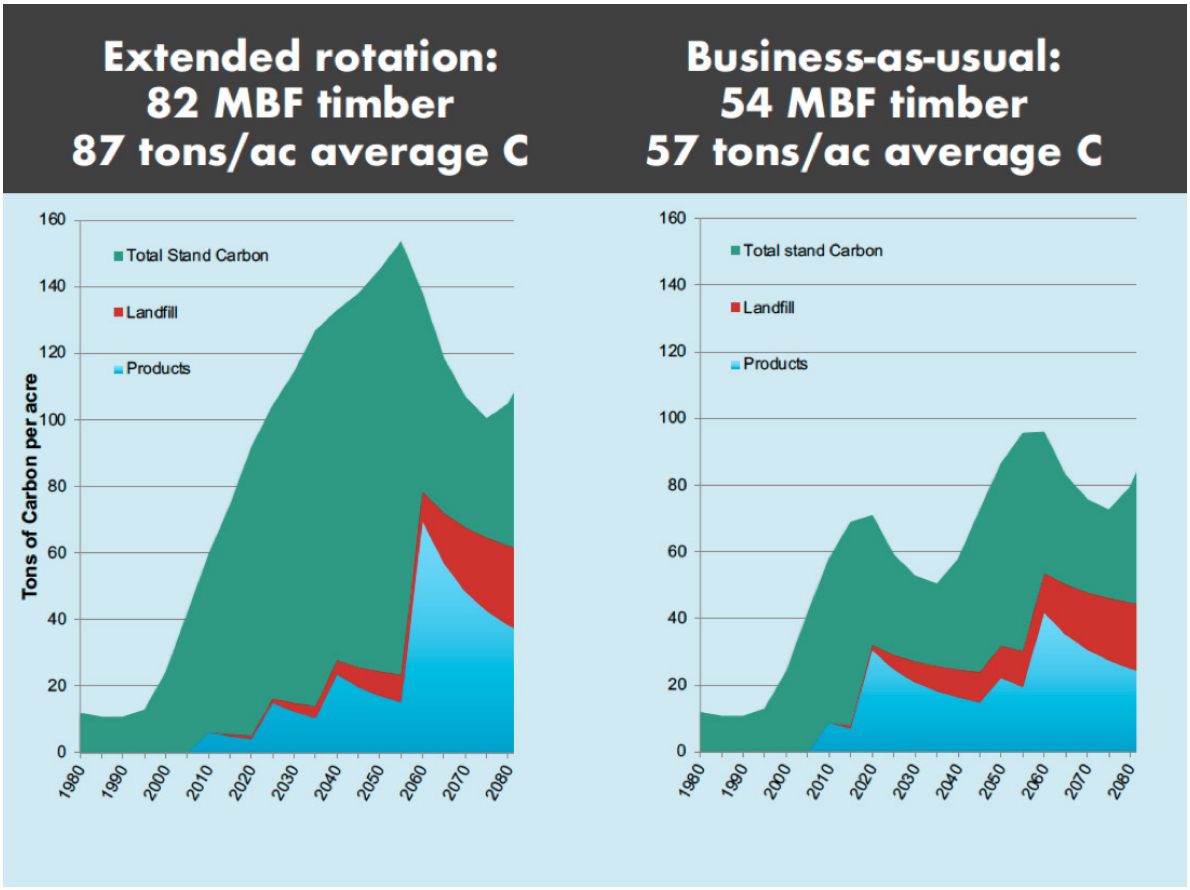
But, there are risks and trade-offs to consider, and while they may be surmountable and temporary, a transition will not be easy.

The hurdles

A transition to longer durations would create a supply gap during which time there would be a reduction in cash flow. If not enacted in combination with necessary economic mitigations (explained below), extending rotations could cause a 20 to 30 year supply shortage that could threaten jobs and raise lumber prices.

Another complicating factor is the fact that some mills are unable to accept large diameter trees as their facilities have been tuned to process smaller trees. The processing of smaller trees best suits automation, which can lower labor costs by up to two-thirds. The recent rise in engineered wood product technology has also created more markets for smaller diameter trees.

Another hurdle associated with increasing harvest durations involves conservation groups and conservation policies. Some timber companies fear that if they allow a forest stand to grow to an older age, a species like a



Graph from Northwest Natural Resource Group showing how the doubling of the rotation age increases timber production by 52 percent over an 80-year time period. Over a 100-year period, the longer rotation keeps 53 percent more carbon, on average, out of the atmosphere.

northern spotted owl may inhabit the stand and impact their ability to harvest the plot (and up to 70-acres around it). So, from a forester's perspective, there is less risk when cutting this stand before it becomes enticing to a protected species like a northern spotted owl.

There are ways to address these hurdles and they involve community members, decision-makers, conservation groups, and all three entities involved in the business of timber harvest and wood production: landowners, contractors, and mill owners. We will outline a variety of approaches here in this chapter. A combination of several strategies is likely required.

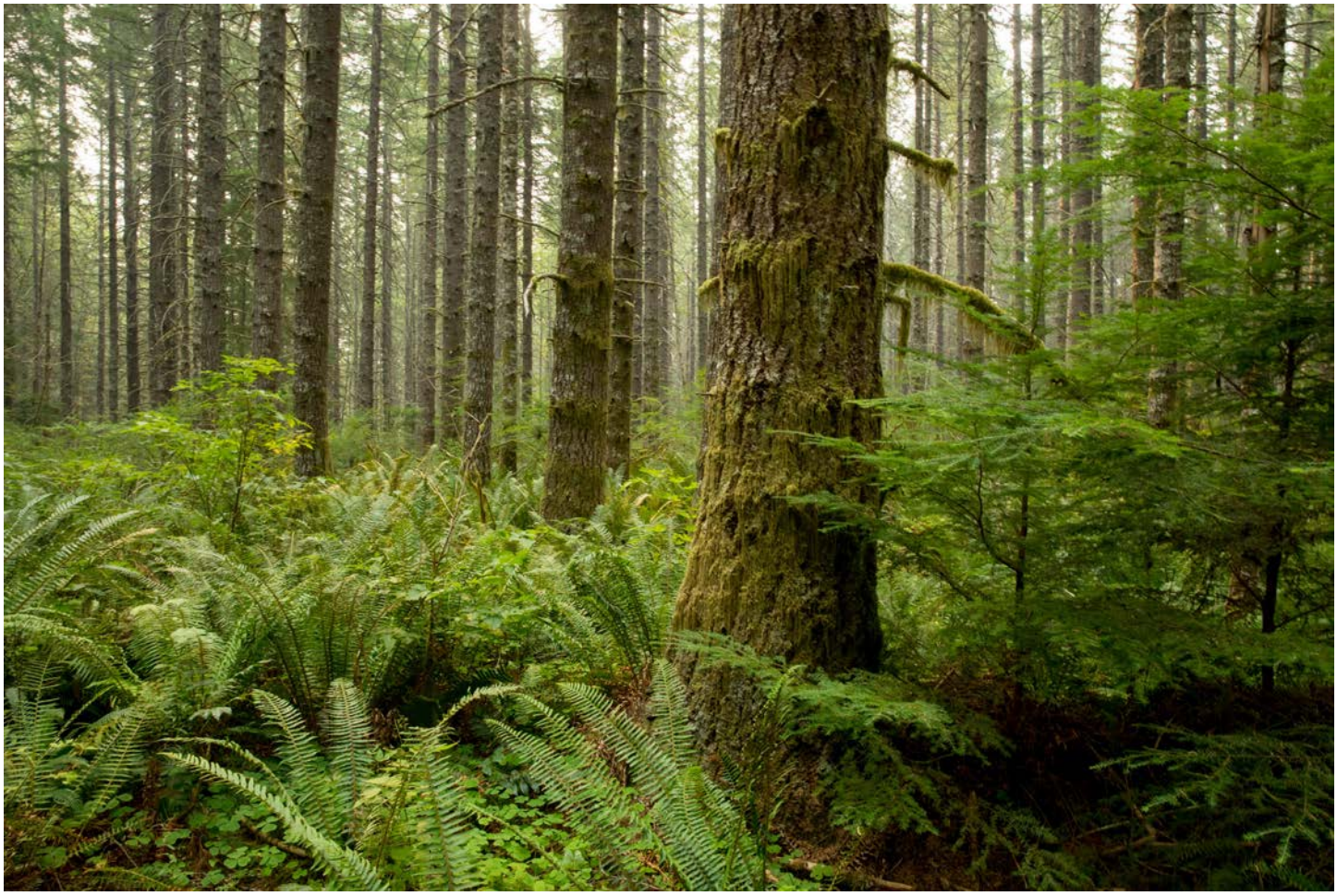
Pathways for landowners

First, we must increase incentives for private landowners to lengthen their rotations. This can be accomplished through 1) supporting and enhancing the ability for landowners to diversify their revenue streams (e.g., ecosystem services from a plot of forested land) and 2) advancing federal programs to ease the financial burden of the transition to longer rotations. Managing a plot of land under what is sometimes called ecological forest management (EFM), which is often part of an "ecological investment strategy," can reduce management costs, decrease market volatility, and increase overall income by diversifying income potentials, all while improving on-the-ground ecological conditions and increasing carbon storage.[18] Timber markets in the Pacific Northwest are more volatile than those in some other regions of the country, but a move from commodity grade wood (small logs) to higher value wood (large logs) can mitigate volatility due to the larger margins and a longer growth timeframe.[18] EFM requires forest managers to consider ecosystem services and ecosystem functionality alongside timber harvest calculations. This generally means longer rotations (80 to 100 years) and associated protection or enhancement of biodiversity and habitat features. This approach often involves thinning a forest stand two or three times over an 80- to 100-year period. Thinning can be done with ground-based machinery—harvesting the timber and then selling it—or can be carried out through a fell-and-leave strategy with no ground-based machinery. Periodic thinning can bring in funding and can sometimes accelerate growth, but thinning is not always necessary for

Figure from Binkley et al. (2006) showing two timber harvest scenarios: In addition to timber, the scenario also includes "an assumed sale of a conservation easement for $20 million in Year 3, the use of $10 million of New Market Tax Credits to offset the acquisition cost, and the sale of carbon credits for $5/tonne of CO2-e every five years based on the excess accumulation of carbon in the forest inventory above that which would occur in the industrial regime." IRR = internal rate of return. NMTC = New Markets Tax Credits.

growing large trees or realizing the higher income potential from longer rotations.

In addition to the end result being larger trees which bring in more income than the larger number of smaller ones, a significant part of the shorter-term income potential with EFM comes from ecosystem services, such as selling carbon credits, creating conservation easements, or creating forest reserves for certain durations of time. The carbon market is a complex and ever-changing realm with many opportunities for mitigating carbon loss yet many risks associated with misuse, including scenarios where people who had no previous intention of logging would still reap benefits from carbon income. Regardless, income from carbon storage offers promise for diversifying income streams and valuing the unique carbon storage capabilities of Pacific Northwest forests. Conservation easements, which protect forests from conversion to agriculture or development, are another tool in the toolbox. Landowners can place certain forest areas in an easement and obtain money for this through a number of possible programs, including the Forest Legacy Program, USDA Climate Smart Commodities Program, Healthy Forest Reserve Program, Coastal Estuarine Land Conservation Program, State Acres for Wildlife Enhancement Initiative, and the Land and Water Conservation Fund, with each functioning in different ways and in different parts of the region. This is just a snapshot of programs currently in operation. In the future, new programs can and will likely be created to expand this list. According to the Sightline Institute, minor modifications to the Forest Legacy Program and Healthy Forest Reserve Program—in addition to an adequate appropriations bill in Congress to scale these programs—would make a significant impact on the amount of forestland put under extended rotation in the Pacific Northwest.[26]



The Winston Creek area, which is managed by Port Blakely on an extended harvest duration

Pathways and economic incentives for private landowners that can facilitate changes to longer harvest durations

The **Forest Legacy Program** is administered by the USDA and encourages the protection of privately owned forest lands through conservation easements or land purchases.

www.fs.usda.gov/managing-land/private-land/forest-legacy

The **Healthy Forest Reserve Program** allows landowners to acquire funds for carbon storage over a contractual length of time, thereby offering an incentive to delay harvest. This particular program, though, would require ongoing payment (rather than a lump sum) so doesn't offer a long-term solution and could be misused by landowners who weren't previously planning to harvest their trees. Therefore, careful attention and adjustments to program rules might be required.

www.nrcs.usda.gov/programs-initiatives/hfrp-healthy-forests-reserve-program

From 2002 to 2019, the **Coastal and Estuarine Land Conservation Program** protected over 110,000 acres through funds to state and local governments to purchase threatened coastal and estuarine lands or obtain conservation easements, including over 16,000 acres protected as in-kind matching contributions.

www.coast.noaa.gov/czm/landconservation/

The **Land and Water Conservation Fund** provides matching grants to state governments for the acquisition and development of public parks and other outdoor recreation sites. Agencies can also partner with landowners to support voluntary conservation on private lands.

www.doi.gov/lwcf

The **State Acres for Wildlife Enhancement Initiative**, a state and federal partnership, offers cooperating landowners "rental payments, establishment and maintenance cost-share and incentive payments in return for entering a contract to provide specific wildlife habitat."

www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/archived-fact-sheets/state_acres_wildlife_enhancement_init_jul2015.pdf

Although not directly related to forest conservation, there are analogous examples in other sectors that could be replicated to ease other financial burdens related to extending harvest durations. The Dairy Margin Protection Program, for instance, provides financial assistance to farmers when the difference between the price of milk and feed costs falls below a certain level. This program was authorized through the 2014 Farm Bill. There are also a number of Environmental Quality Incentive Program initiatives, enacted at the federal level, that provide financial assistance for landowners in their efforts to improve air, water, soil, and habitat quality.

Mills, certifications, exports, and imports

As landowners begin to grow trees on a longer rotation, it's important there is an equally evolving market and processing avenues for these larger trees. Fortunately, there are growing markets, as well as market potential, for larger trees and their unique value in producing higher quality and higher strength wood for building materials and as instream wood in aquatic restoration projects.

First, as basic economic theory suggests, if mills have more large wood to process from nearby timberlands, and demand for this type of wood increases, there will be increased market incentive to adapt.

Second, there are grant programs that can help with updating mills, enabling them to handle larger trees. One example is the Wood Innovations Program which "may be used to establish, reopen, retrofit, expand, or improve a sawmill or other wood-processing facility."[27] There are also technical assistance grants, such as those found in the Farm Bill.

Similar to the role that FSC (Forest Stewardship Council) certification has played in increasing our awareness of the sustainability of certain wood products, this same type of certification concept (e.g., "Long Rotation-Certified"

wood) could be adopted for longer rotation timber (this idea was coined by the Sightline Institute).[28] Conservation groups can play a role in helping bring awareness to this issue and pushing these changes to the forefront.

Executive orders, such as EO 14057 (Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability), have included sustainable procurement clauses requiring the use of certain homegrown products. These types of initiatives can require that federal projects use wood from long rotation timber. This is a large market that would make a significant difference in reducing carbon loss while also helping the long-term resilience of local economies and ecosystems.

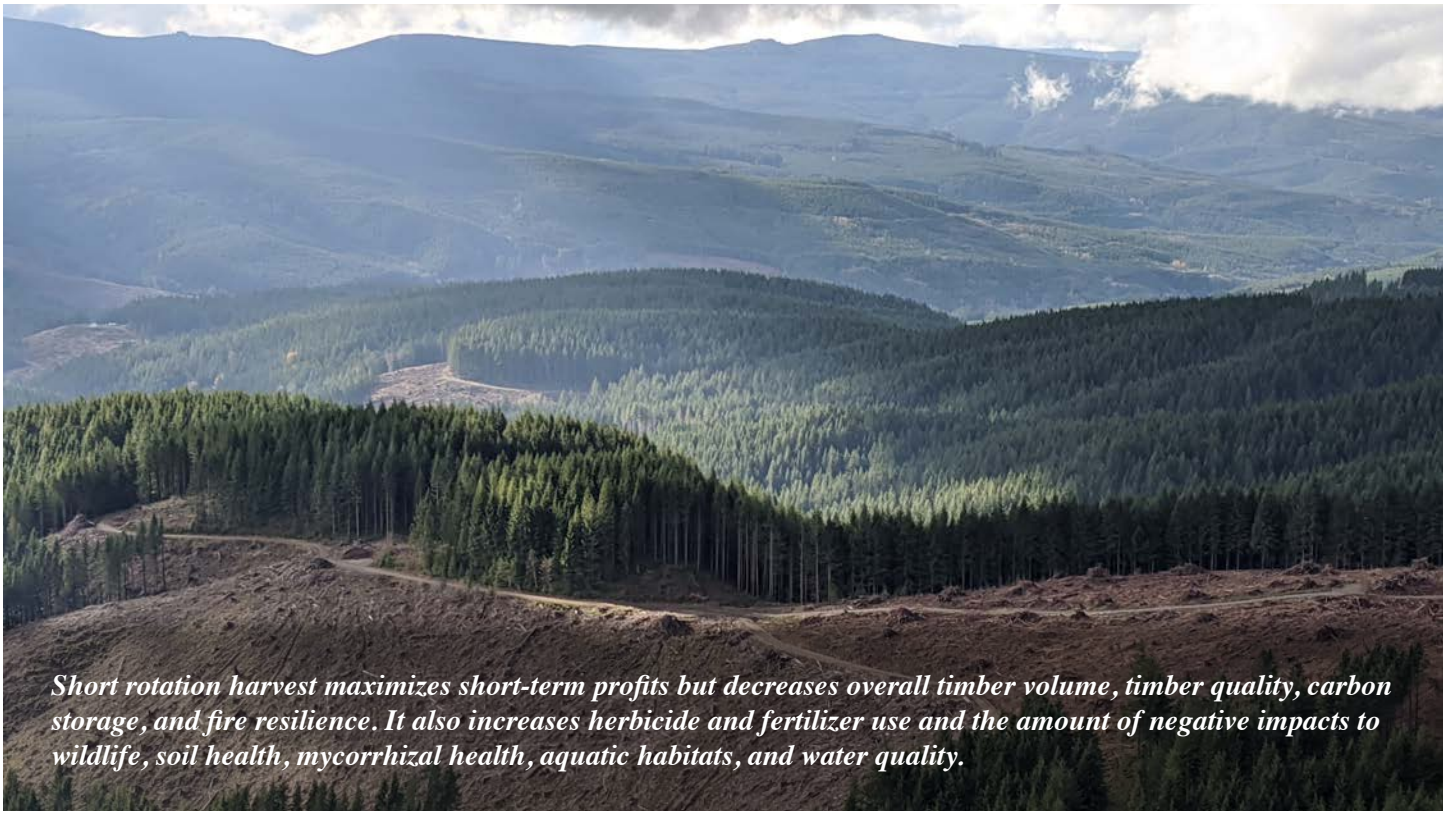
Germane to this topic is the fact that a sizable portion of the wood we use actually comes from other countries, as well as the fact that we export large amounts of the wood from our timberlands each year. According to analyses done in 2019 by the National Home Builders Association, we import around 14.5 billion board feet per year (30.8% of our consumption).[29] And, between 2016 and 2020, we exported an annual average of 1.4 billion board feet.[30] From a climate change perspective, this scenario is not optimal. Federal and state governments can play a role in regulating this unsustainable situation and incentivizing solutions for the betterment of humanity, ecosystems, and local economies.

Northern spotted owls, habitat conservation plans, and safe harbor agreements

The presence or potential presence of listed species in and around timber units can impact a landowner's interest in extending harvest durations. These species might include northern spotted owl, marbled murrelet, or federally-listed anadromous fish. As trees become older and larger, such as through extended harvest duration, the likelihood or perceived likelihood of this scenario increases. Because of

Twenty five years of institutional investment in timberland has not only provided reasonably good historical information on risk and returns, but has also highlighted some of the environmental problems related to private-equity ownership of timberland. While not always the case, a typical practice is to acquire a property, increase harvest levels, perhaps add debt (which may create pressure to accelerate harvests still further), sell the property in smaller parcels, and exit upon the termination of a fixed-term fund in 10-15 years. This investment strategy may leave an ecologically simplified forest with a lower volume of older trees. Average annual timber supply as measured by the forest's mean annual increment is lower than would be the case with longer rotations, so, all else equal, such forests will be less capable of sustaining rural communities and traditional land uses over the long term.

Binkley et al. 2006



Short rotation harvest maximizes short-term profits but decreases overall timber volume, timber quality, carbon storage, and fire resilience. It also increases herbicide and fertilizer use and the amount of negative impacts to wildlife, soil health, mycorrhizal health, aquatic habitats, and water quality.

this, it is important for conservation groups, landowners, and policy-makers work together and provide assurances that a landowner's willingness to extend harvest durations doesn't preclude their future ability to harvest the trees.

There are existing tools for private landowners that help provide flexibility regarding harvest limitations and certainty around compliance with the ESA. Two of these tools are called safe harbor agreements (SHAs) and habitat conservation plans (HCPs).

SHAs are binding agreements between a landowner and the wildlife agency. These stipulate that as long as the landowner abides by the conditions of the agreement (which could include longer harvest rotations, Special Set-Aside Areas, a snag conservation and development program, and new nest site provisions), additional management restrictions for protecting endangered species will be waived for the length of the agreement, usually for 60 years.[31] The types of species and management practices written into the plan will depend on the location and will be specified in the agreement. SHAs apply to property owners whose land *could* contribute to the recovery of endangered species. Some of these properties do not currently have endangered species but could if managed in certain ways. Some timber companies in the Pacific Northwest, such as Port Blakely, have already used SHAs to move from a 45-year to a 60-year harvest rotation.[32]

If the landowner already *has* habitat where an endangered species is located, an HCP can be set up between a landowner and the federal wildlife agency. The HCP enables the landowner to harvest according to agreed-upon mitigation measures to protect listed species. This frees the property owner from liability for any harm to individuals of that species, as long as the agreement is followed.

Although these agreements offer a certain level of certainty and assurance for private landowners to extend harvest durations, they can present drawbacks such as high costs and time-consuming processes. Additionally, they have the potential to impede the recovery of listed species due to the establishment of lengthy 60-year agreements that might prove to have insufficient conservation measures to mitigate lasting impacts on species of conservation concern. For example, conservation efforts could falter if it turns out they are not based on the best current science and not mandating sufficient canopy cover in designated conservation areas that are supposed to help ensure the species is recovering. They are also quite difficult to update if conditions change. These tools, while not perfect, may still be helpful in addressing some of the disincentives for longer rotations.

In summary, forests play a crucial role in carbon storage. A transition to longer harvest durations comes with challenges and trade-offs, but with the right incentives, market developments, and conservation policies, it is possible to increase carbon storage in forests while meeting the demand for wood products and supporting local economies.

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