Summary of Climate Change Effects in the Columbia River Gorge National Scenic Area

A report provided to the Columbia River Gorge Commission in support of Gorge 2020

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Executive Summary

The Gorge Commission and the Forest Service are in the process of reviewing and revising the Columbia River National Scenic Area Management Plan (hereafter referred to simply as the Management Plan). The Commission has been vocal from the start of this process, in examining what has changed in the last ten years, that climate change is a critical concern to be addressed in the Plan. This report, drawing on a range of sources, is provided in response to the Commission's requests for information about how climate change will affect the National Scenic Area.

This report describes the climate change effects most relevant to the National Scenic Area and, where possible, identifies likely implications for the resources enumerated in the National Scenic Area Act and covered by the Management Plan.

Projected changes to annual average temperature and precipitation patterns will likely affect each of the resource categories described in the Management Plan: Scenic, Natural, Cultural, and Recreation. These changes in temperature and precipitation patterns will affect vegetation, ecological processes, and habitats; they will likely increase the frequency and severity of certain natural hazards such as floods, wildfire, and landslides; and they may exacerbate current management challenges. Fortunately, the National Scenic Area's compact urban development framework, the rigorous land use planning controls in the Management Plan, and the preponderance of intact natural lands all serve to create a landscape that is in many ways resilient to the effects of climate change. The Management Plan's goals, objectives, policies, and guidelines further provide a robust framework for adaptation to climate change impacts. The Management Plan provides a strong foundation upon which to build.

The report draws on a range of sources: summaries of current scientific consensus on climate change as represented in international and national assessments, regional and state-level climate vulnerability assessments, relevant adaptation frameworks, local and statewide climate action plans, treaty tribe action plans, and social scientific research. Based on review of these sources, the report summarizes climate change impacts and offers insights about how the Commission might consider these ideas moving forward.

Introduction

This report addresses the current and projected impacts of climate change on the Columbia River Gorge National Scenic Area. Its purpose is to support the Columbia River Gorge Commission (hereafter simply "Commission") in the Gorge 2020 process by synthesizing relevant literature on climate impacts and adaption approaches occurring elsewhere in the region. The report describes the climate change impacts most relevant to the National Scenic Area and, where possible, identifies likely implications for the resources enumerated in the National Scenic Area Act and covered by the Management Plan.

In a sense, climate change simply adds a new dimension of long-term change to those already anticipated by the Management Plan – changes like population growth, economic and technological shifts, and new forms of recreation. The National Scenic Area Act itself, along with the Management Plan's land use designations and resource protection measures, provides a framework for adapting to climate change because it clearly articulates the resources of value. In this respect, the Gorge begins the task of adapting to climate change from a uniquely strong position.

Nevertheless, given the likely magnitude and ubiquity of climate change impacts, Commission members, staff, and stakeholders recognize the need to put a climate "lens" on the Management Plan, asking if there are gaps or barriers in the current plan that require updating to address climate impacts or adaptation efforts. In viewing the Management Plan through a climate "lens", we can consider the likely resource impacts, including the ways in which climate change effects may exacerbate existing stressors and human development pressures. Then, we can identify the mechanisms already in place, such as minimum parcel sizes, resource protection buffers, and mitigation measures that support adaptation to climate change. We can also evaluate where and how these mechanisms may need to be monitored or revised. These steps provide focus on how the Management Plan can be adaptive to a changing climate, and continue to protect and enhance scenic, cultural, natural, and recreational resources, and support economic vitality.

This report provides background and context to inform such an evaluation by summarizing likely climate change impacts and linking them explicitly to National Scenic Area resources. It summarizes climate trends and likely impacts, discusses relevant plans and planning frameworks, and indicates approaches the Commission might take in response, both within the Management Plan update and beyond.

Background

Since its inception, the Columbia River Gorge Commission has worked with the U.S. Forest Service to protect and enhance the Gorge's resources. It adopted the first Management Plan in 1991 and revised it in 2004. In reviewing the current plan, the Commissioners recognized the need to specifically address climate change.

In 2016, the Commission initiated a formal process to update the National Scenic Area Management Plan. As part of this process, called Gorge 2020, the Commission set out to explicitly address climate change impacts and identify adaptation measures. Unrelated to the Gorge2020 effort but occurring concurrently, the Columbia River Gorge National Scenic Area unit of the U.S. Forest Service initiated a climate vulnerability assessment in partnership with the Mount Hood and Willamette National Forests. These two distinct processes, along with other applicable information, can mutually inform the National Scenic Area's approach to climate adaptation.

In February 2018, Commissioners hosted a panel of climate change experts including climate scientists affiliated with Oregon State University and the University of Washington, representatives of both Oregon's and Washington's Governors, and a representative from the Columbia River Intertribal Fish Commission. These experts provided the Commission with a current picture of climate work in the region, an overview of climate science and impacts associated with climate change, examples of how that climate science can be integrated into management strategies, and shared policies proposed or adopted to address climate change and its associated impacts in Oregon and Washington's respective legislatures. The panel emphasized how policy choices made now may affect the trajectory of climate change, and how important it is for government agencies to address climate change now. Several agencies are addressing climate change by conducting vulnerability assessments, creating adaptation plans, implementing those plans, and evaluating climate adaptation actions in an adaptive management framework.

At the global scale since the February 2018 panel, several major reports have been published on the effects of climate change. The Intergovernmental Panel on Climate Change (IPCC), a United Nations body tasked with assessing the climate change science, produces periodic syntheses of climate science to inform the United Nations Framework Convention on Climate Change (UNFCCC), the main international treaty on climate change. In 2018, the IPCC issued a report on the impacts of global warming above 1.5 °C and the emissions pathways needed to stay below this level. This report followed from the 2015 Paris Agreement, in which nations pledged to hold "the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change". The parties to the Paris Agreement tasked the IPCC with further research to quantify the benefits of a 1.5 °C target compared to the agreed upon 2 °C target.

The 2018 IPCC report concluded that the world faces substantial risks in exceeding 1.5 °C, including potentially long lasting or irreversible impacts, such as the loss of some ecosystems.[1] Under current emission trends, the 1.5 °C point is likely to be reached between 2030 and 2052.[2] The report identified key "Reasons for Concern" covering a range of social, ecological, and economic issues.

The report was significant for several reasons. First, it highlighted the severity and potential irreversibility of likely impacts to natural systems on which humans depend, and it made clear that these

[1] IPCC, 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. In Press.

[2] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

most serious potential implications are likely to occur with the current lifetime of many people. Second, it made clear that the 2 °C target agreed to in Paris is not enough to avert these impacts.

Following close upon the IPCC report, the U.S. Global Change Research Program (USGCRP) released Volume II of the Fourth National Climate Assessment. The first volume was released in 2017 and surveyed the state of climate science. Volume II addressed "the human welfare, societal, and environmental elements of climate change and variability for 10 regions and 18 national topics, with particular attention paid to observed and projected risks, impacts, consideration of risk reduction, and implications under different mitigation pathways."[3] The report went beyond previous assessments in the level of detail it devoted to impacts at the regional and local scale, facilitated in part by improvements in the detection and attribution of extreme weather events to climate change. It drew explicit connections between the changing climate and the likelihood, severity, and costs of extreme events such as hurricanes, wildfires, and droughts.

The report also addressed "to a much greater degree than previous National Climate Assessments… broader and more systematic quantification of climate change impacts in economic terms."[4] While far from complete, this analysis suggests that economic harms of climate change – and benefits of mitigation – are substantial, though the extent of the effects will vary based on location.

[3] USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018; page 1.
[4] https://nca2018.globalchange.gov/chapter/1/

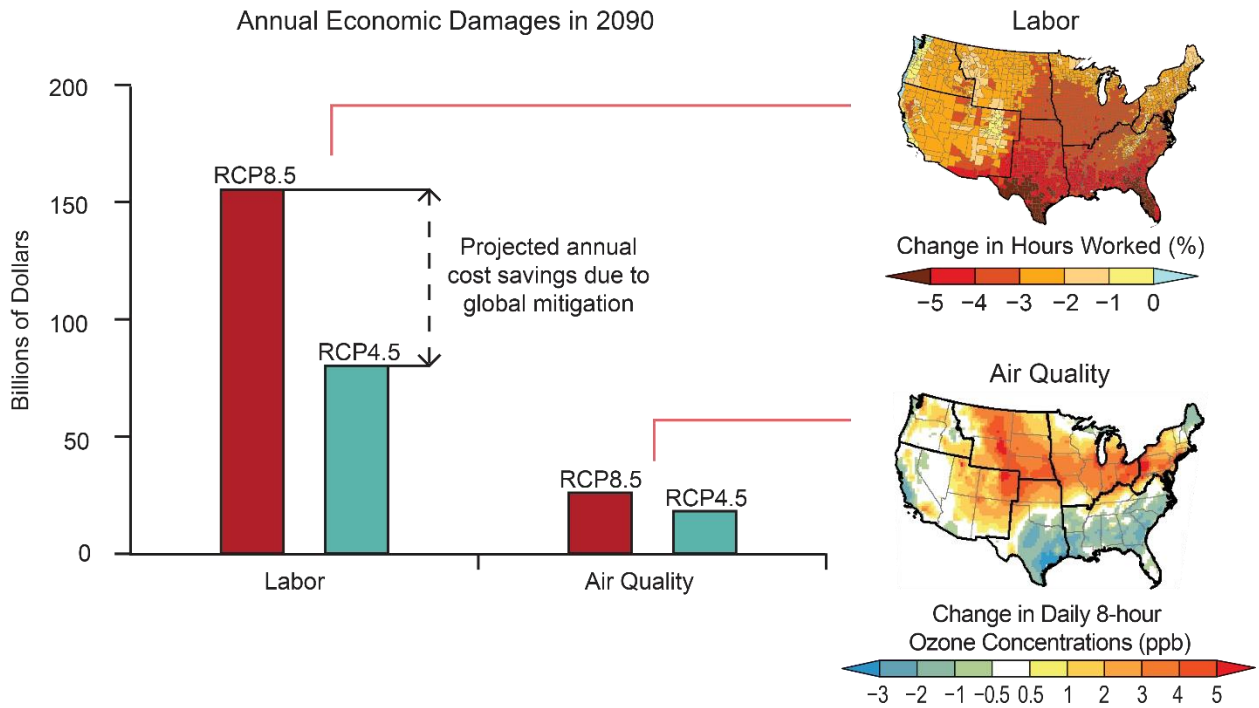

Figure 1: New Economic Impact Studies, Fourth National Climate Assessment. Annual economic impact estimates are shown for labor and air quality. The bar graph on the left shows national annual damages in 2090 (in billions of 2015 dollars) for a higher scenario (RCP8.5) and lower scenario (RCP4.5); the difference between the height of the RCP8.5 and RCP4.5 bars for a given category represents an estimate of the economic benefit to the United States from global mitigation action. For these two categories, damage estimates do not consider costs or benefits of new adaptation actions to reduce impacts, and they do not include Alaska, Hawaii and U.S.-Affiliated Pacific Islands, or the U.S. Caribbean. The maps on the right show regional variation in annual impacts projected under the higher scenario (RCP8.5) in 2090. The map on the top shows the percent change in hours worked in high-risk industries as compared to the period 2003–2007. The hours lost result in economic damages: for example, $28 billion per year in the Southern Great Plains. The map on the bottom is the change in summer-average maximum daily 8-hour ozone concentrations (ppb) at ground-level as compared to the period 1995–2005. These changes in ozone concentrations result in premature deaths: for example, an additional 910 premature deaths each year in the Midwest. Source: EPA, 2017. Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment. U.S. Environmental Protection Agency, EPA 430-R-17-001.

For example as Figure 1 summarizes, there are substantial differences between the costs associated with a higher emissions scenario (RCP8.5) and one likely to keep the global average temperature below 1.5 °C (RCP4.5). The cost of economic damages to the labor are anticipated to save over 60 billion dollars annually due to global mitigation measures under the lower emission scenario and the higher emissions scenario. This is from a reduction in hours worked, which is articulated by county in Figure 1. These changes in hours worked may be most significant in the Midwest through the southern states, and the gorge may experience less total change locally.

In sum, the IPCC Special Report: Global Warming of 1.5 °C and Volume II of the Fourth National Climate Assessment reflect the increasing focus on the urgency of needed action to avoid potentially irreversible impacts.

As experts have developed additional tools and focused on more granular accounting of climate impacts, policy makers have increased the scope of scale of proposed responses. While federal action has stalled, both Oregon and Washington have proposed ambitious climate policies. As the Commission heard at the February 2018 panel, Washington State is investing significantly in clean energy.

Additionally, in May of 2019 Governor Jay Inslee signed a package of legislation including a mandate to transition the state to a clean electricity supply by 2045.[5] At the same time, Ballot Measure 1631, a proposed fee on carbon, was defeated after record-breaking campaign spending by a coalition of fossil fuel producers. In Oregon, the "cap and invest" system proposed in 2017 resurfaced in the 2019 legislative session as House Bill 2020 which would have created the second economy-wide cap and trade system in the United States. The bill remained in committee upon the adjournment of the 2019 legislative session, though state leaders have indicated their intention to keep moving on broad-based climate regulation.[6]

These developments reflect an increasing awareness that predicted climate change impacts are occurring sooner and with greater force than expected only a short time ago. As the National Climate Assessment and other recent reports make clear, this is not only a problem for future generations – it's a challenge right now. As the Commission considers climate change impacts to the National Scenic Area, it's worth recognizing these impacts, though still of uncertain timing and magnitude, may occur more rapidly and more severely than was apparent even 18 months ago at the panel presentation.[7]

Climate Impacts to National Scenic Area Resources

National and state-level climate assessments describe complex and mutually interdependent changes to the Pacific Northwest's climate, driven by large-scale changes to the global climate system. It is difficult to scale down many of the effects to the National Scenic Area with any degree of specificity. The key changes most relevant to this report are:

- Increased average temperatures (with 21st-century warming rates greater than those observed last century);
- Warming across all seasons;
- Greater concentration of precipitation in winter months with more extreme events; and

[5] https://app.leg.wa.gov/billsummary?BillNumber=5116&Initiative=false&Year=2019; accessed on June 16, 2019.
[6] Ted Sickinger, "Oregon Gov. Kate Brown says she's 'not backing down' on climate change agenda," *The Oregonian,* July 2, 2019. Accessed on August 1, 2019 at https://www.oregonlive.com/politics/2019/07/gov-brown-vows-ongoing-push-for-climate-change-policy.html.
[7] See in particular the IPCC Special Report's discussion of the 2016 Cancun Agreement, in which parties to the UNFCCC recognized "the need to consider 'strengthening the long-term global goal on the basis of the best available scientific knowledge…to a global average temperature rise of 1.5°C'." and the resulting "Structured Expert Dialogue" that prompted a shift to 1.5 degrees as an appropriate limit for global temperature rise. From FAQ 1.1: "Why are we talking about 1.5°C?" Allen, M.R., O.P. Dube, W. Solecki, F. Aragón-Durand, W. Cramer, S. Humphreys, M. Kainuma, J. Kala, N. Mahowald, Y. Mulugetta, R. Perez, M. Wairiu, and K. Zickfeld, 2018: Framing and Context. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

- Hydrologic shifts, including changed timing of stream flows, reduced snowpack, and reduced soil moisture.[8]

Chapter 24 of the recent Fourth National Climate Assessment, Volume II which focused on the Pacific Northwest summarizes climate impacts with a simple analogy. The future of the Pacific Northwest, it notes, will look a lot like 2015. The conditions experienced in 2015 may become the "new normal" later this century. Exactly when depends on future emissions. Under the current trajectory, we will reach this new normal by mid-century under a higher emission scenario or late century under the lower emission scenario.

Table 1. The Future of the Pacific Northwest may look a lot like 2015

2015: The Future for the Pacific Northwest?

In 2015:

- Average temperatures were 3.4°F above normal;
- Winter temperatures were 6.2°F above normal;
- Snowpack was the lowest on record, with Oregon and Washington 89% and 70% below average respectively;
- Below-normal precipitation in winter, spring, and summer; and
- Ocean heat wave raised nearshore water temperatures across the region.

Impacts included:

- Drought declarations in 24 counties, with widespread irrigation shortages and agricultural losses totaling nearly $1.5 billion across Oregon and Washington;
- Limited snow- and water-based recreation opportunities entailing significant economic harm;
- Drinking water quality concerns;
- Hydropower shortages;
- Fish die-offs and fisheries closed due to the largest algal bloom ever recorded on the West Coast; and
- Severe wildfire season in history, with 1.6m acres burned across the region.[9]

[8] Climate Impacts Group, 2009. *The Washington Climate Change Impacts Assessment,* M. McGuire Elsner, J. Littell, and L Whitely Binder (eds). Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington. *Available at:* *http://www.cses.washington.edu/db/pdf/wacciareport681.pdf*

[9] Adapted from Box 24.7, Fourth National Climate Assessment, Volume II, Chapter 24 page 1066.

These climate impacts already affect the National Scenic Area's resources in myriad ways. Figure 2 highlights the impacts most relevant to the Commission's mandate and role. In this summary diagram, the red wedges represent key temperature impacts; the blue wedges represent key hydrologic impacts; the green wedges represent vegetation impacts; and the tan wedges represent key risks arising from other types of impacts.

Figure 2: Principal impacts to National Scenic Area resources

The diagram overlays principal climate impacts and risks identified in regional and local assessments to the resources identified in the National Scenic Area Management Plan.[10] It is not intended to be comprehensive. Rather, it serves as an overview and tool for linking the most relevant impacts to the four resource categories defined by the National Scenic Area Act and covered in the Management Plan: Scenic, Natural, Cultural, and Recreation. The subsequent sections of this report attempt to link these impacts to the specific resource categories.

Impacts to some resources are harder to define or quantify than others. This limitation stems from several factors. First, climate models have significant limitations at the scale of the National Scenic Area. Temperature and precipitation projections derive from global climate models that have been statistically "downscaled" to the Pacific Northwest and combined with a fine-scale regional climate model that accounts for the effects of topography such as mountains. The fine-scale regional model utilizes 25km cells. In a place like the Columbia Gorge, with abrupt elevation changes and an abundance of microclimates, projections at this scale necessarily mask local variations. Likewise, impacts to some resources occur at scales greater than the National Scenic Area. Anadromous salmon populations, for example, may suffer negative impacts of increased stream temperatures in National Scenic Area streams, but the main drivers of salmon decline extend across a much larger area.

Second, the actual location and timing of these impacts are important. For example, had a wildfire the size and extent of the Eagle Creek fire occurred farther from Interstate 84, it may have occasioned much less economic hardship. Likewise, the effects on future vegetation shifts may vary significantly depending on disturbances, location, and micro-climates.

[10] Fourth National Climate Assessment Vol. II (2018), the *Washington Climate Change Impacts Assessment* (2009), the *Third Oregon Climate Assessment Report* (2017), and the *Fourth Oregon Climate Assessment Report: State of climate science: 2019* (2019).

Third, the magnitude of future impacts depends on future greenhouse gas emissions. The rate of change may determine the degree and severity of impacts. The interactions of policy decisions, emissions trajectories, and the impact of resilience actions are complex and difficult to predict.[11]

Finally, and perhaps most importantly, many National Scenic Area resources are fundamentally difficult to measure. The National Scenic Area is unique – and uniquely valuable – because it explicitly aims to protect a range of aesthetic, ecological, and experiential features that collectively represent a cultural landscape. It is therefore difficult to judge when, if, and how a discreet natural event, even one as dramatic as the Eagle Creek fire, might affect the National Scenic Area's resources.

Scenic Resources

Figure 2 above summarizes the principal climate impacts on National Scenic Area resources. This section considers these impacts specific to scenic resources as identified in the Management Plan. The scenic resources in National Scenic Area are protected and enhanced through the policies and guidelines in the Management Plan for the overall scenic provisions, Key Viewing Areas, Landscape Settings, Scenic Travel Corridors and signs.

Many of the landscape settings are defined by the vegetation types that are a dominating feature of the setting. Landscape settings in the western Gorge contain coniferous forest types that are a defining characteristic of the landscape. In the eastern Gorge, forests that transition to woodlands, shrublands and grasslands play a defining role in the landscape setting used to protect and enhance the scenic resources. As climactic conditions change, these vegetation types may experience continued mortality from invasive pests and pathogens due to the additional stress. More frequent and extensive forest fires could also serve as a catalyst for shifts in vegetation types and vegetation biomes.[12]

Because these impacts are projected to occur throughout the various vegetation types and biomes, public and private land managers may look to manage forested areas more actively to reduce hazards and actively prepare landscapes for future disturbances and vegetation shifts. In some cases, these actions can return the landscape to historic conditions.

The need to mitigate from disturbances may require additional measures to reduce the visibility of existing structures where and if vegetation is managed. New structures may also be required to take measures to ensure compliance with scenic guidelines that previously would have been screened by vegetation. Developments within those settings where structures are permitted would require careful attention to siting that may be even more visible with reductions in forest density. This could impact forested rural communities that rely on heavily forested vegetation for screening.

Many of the impacts noted may affect the Key Viewing Areas and scenic travel corridors, which provide vantages over landscape characteristics of the National Scenic Area. Landscape settings were developed to be dynamic to the natural forces of time and change. However, areas that are currently prescribed to a higher scenic standard (not visually evident) may have more difficulty meeting the guidelines as

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[11] *Fourth National Climate Assessment*, Chapter 17: "Sector Interactions, Multiple Stressors, and Complex Systems," pages 641-42.

[12] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 28-30.

disturbance events like wildfires, landslides, or disease outbreaks, change topographic visibility or limit the screening from areas previously covered in dense and continuous vegetation.

Changed seasonal timing of flows will visibly alter some popular streams. Mean summer flows are predicted to decrease in many western Gorge streams by 30-40 percent, and flood events to increase by 20-30 percent in some of these as well. (Eastern Gorge streams, already more highly seasonal, are projected to experience less change.)[13]

As shown in Figure 1, higher summer temperatures and more frequent wildfire will likely impact air quality and visibility. They are likely to contribute to more days with poor air quality and visibility. Finally, the impacts of climate change on other regions will likely spur additional in-migration to the Pacific Northwest generally and the Columbia Gorge in particular.[14] This added development pressure will further compound impacts to the overall scenic character, rural setting, outstanding scenic views and sites, and waterways.

Cultural Resources

Within the National Scenic Area, the Management Plan explicitly identifies three types of cultural resources: archaeological resources, historic buildings and structures, and traditional cultural properties. While this research did not identify any analyses of climate-related risks to archaeological resources and historic buildings and structures within the National Scenic Area, some indirect impacts may be projected. The Management Plan requires that cultural resources are protected and enhanced, and so many of these indirect impacts may be the result of natural actions or unpermitted activities. Climate change will increase these resources' exposure to extreme weather events and natural hazards, in particular larger and more frequent floods, wildfires, and landslides. The magnitude of impact is difficult to predict, in part because many of the National Scenic Area's cultural resources are living plants and animals, moving from year to year, or are located below the surface.

Increased winter flooding and landslides potentially threaten archaeological resources, many of which are located along the Columbia River and key tributaries. These are the places where, as the Columbia River Inter-Tribal Fish Commission notes, Indians "gathered food, hunted, fished, and lived in small and large villages, worshipped in special places, and carefully buried their dead. Because of this, it is a region

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[13] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 12-13.

[14] The drivers of migration are complex and climate change is only one factor. However, the consensus of demographers and planners in the region is that the "push" factor of climate change in other regions may tend to compound the "pull" factor of the Pacific Northwest's existing advantages in terms of climate and economic opportunity – especially in large metro areas and their surroundings. See Whitely Binder, L.C. and J. Jurjevich. 2016. The Winds of Change? Exploring Climate Change-driven Migration and Related Impacts in the Pacific Northwest: Symposium Summary. June 24, 2016, Portland, Oregon: Portland State University Population Research Center (Portland, Oregon) and the University of Washington Climate Impacts Group (Seattle, Washington). See also: Saperstein, Alison. (2015) The Puget Sound Region: What We Know and How We Could Learn More. Prepared for the University of Washington Climate Impacts Group. https://cig.uw.edu/wp-content/uploads/sites/2/2015/10/Climate-Migration-Saperstein-Final-Aug-3-2015.pdf.

rich with culturally and historically sensitive areas and artifacts."[15] It is difficult to estimate the exposure of these sites to climate hazards, as many remain confidential or undiscovered. Nevertheless, the concentration of such sites along the Columbia River and tributaries heightens their likelihood of disturbance from high flow events or landslides.

Risks to historic buildings and structures are more apparent. The Management Plan defines these as "standing buildings and structures that are at least 50 years old, including log cabins, barns, highways, and wagon trails."[16] While such features exist throughout the National Scenic Area, they are clustered around roads and near the Columbia River and key tributaries. As with archeological sites, they are exposed to increases in magnitude and extremity of natural hazards amplified by climate change. As discussed below, landslides and rock fall are likely to increase as a result of increased disturbance events. These may augment existing natural threats to historic resources such as the Historic Columbia River Highway.[17]

As with so many climate change related hazards, the Eagle Creek fire provides a relevant example. The Forest Service's BAER (Burned Area Emergency Response Summary) identified a range of cultural resources within the burned area including "[tribal] task-specific activity areas and camps such as lithic scatters, fishing stations, vision quest sites, historic trails, wagon roads and highways, railroad logging features and artifacts, fish hatcheries, historic structures, and Forest Service recreation and administrative sites." All these resources suffered some level of damage from the fire. Last, but not least, Multnomah Falls Lodge – listed on the National Register of Historic Places – narrowly escaped destruction.[18] Wildfires, landslides and rock fall, shifting water levels, and flood damage to riparian areas all directly threaten the National Scenic Area's cultural resources. As these climate impacts increase over the coming decades, public and private land managers may invest in more ambitious hazard mitigation and preservation to limit the loss of some cultural resources.

Perhaps even more important than the archeological artifacts and structures at risk from climate change-driven extreme weather and hydrologic events are the traditional cultural properties that face long-term challenges compounded by climate change. The Management Plan defines these as "objects and places associated with beliefs and practices of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community. Traditional cultural properties may include a location used by past and present generations of Native Americans for ceremonial purposes or an area where a community has traditionally conducted culturally important economic or artistic activities."[19]

While traditional cultural "properties" are not solely associated with Native Americans, tribal cultural resources are especially significant in this analysis. The National Scenic Area Act requires that its

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[15] "Archaeological Protection." Columbia River Inter-Tribal Fish Commission, https://www.critfc.org/tribal-treaty-fishing-rights/fisheries-enforcement/archaeological-protection/. Accessed on August 1, 2019.
[16] Management Plan, I-2-1.
[17] National Park Service Technical Preservation Services, "The Historic Columbia River Gorge: Rehabilitating a Rural Designed Landscape." Cultural Landscape Currents, Case Study #2. Accessed at https://www.nps.gov/tps/how-to-preserve/currents/columbia/existing.htm on August 5, 2019.
[18] U.S. Forest Service. Columbia River Gorge National Scenic Area Burned Area Emergency Response Summary, Eagle Creek Fire. October 10, 2017.
[19] Management Plan, I-2-1.

implementation does not affect the rights of the four Columbia River Treaty Tribes– Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, and Confederated Tribes and Bands of the Yakama Nation. Many key tribal cultural resources are also natural resources, which from a tribal perspective are deeply intertwined and are already at risk from climate change (discussed in the following section).[20]

Fortunately, tribes whose current and historic territories include the National Scenic Area have proactively worked to identify these impacts and begin planning for adaptation. The Columbia River Inter-Tribal Fish Commission (CRITFC) recently surveyed members of the Yakama, Umatilla, Nez Perce, and Warm Springs tribes regarding their understanding of climate change impacts. Findings included concern that "climate change will result in significant adverse impacts to tribal food security, cultural continuity, sovereignty, economic opportunities, ecosystem balance, human health, and environmental justice…" and that climate change is "…compounding the adverse effects of other ecosystem stressors including dams, increased land development for urban, agriculture, forestry, and other uses, and associated pollution."[21]

These findings, beyond illustrating the complexity of climate impacts to tribes, provide two important insights for the Management Plan's treatment of cultural resources. First, climate change impacts to what the plan considers "traditional cultural properties" directly affect tribal identity and even tribal sovereignty as reserved through the Treaties of 1855 with the four Columbia River Treaty Tribes. This was recently affirmed in the culverts case in Washington State in which the U.S Court of Appeals for the Ninth Circuit confirmed that the treaties include a right to habitat suitable for treaty-reserved fishing.[22] The U.S. Supreme Court affirmed that decision.[23] By extension, the treaties also include a right to habitat suitable for treaty-reserved hunting and gathering. Second, these impacts are inseparable from the other impacts that the Management Plan seeks to manage across protected resource categories.

First Foods, a term used by some to describe water and culturally significant plants and animals, are a critical dimension of the nexus between climate impacts and tribal cultural resources. In its climate change vulnerability assessment, the Confederated Tribes of the Umatilla Indian Reservation articulates this connection. The assessment evaluates climate impacts relative to Tamánwit, or "natural law," which

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[20] See for example, Stults. M., Petersen, S., Bell, J., Baule, W., Nasser, E., Gibbons, E., Fougerat., M., 2016. Climate Change Vulnerability Assessment and Adaptation Plan: 1854 Ceded Territory Including the Bois Forte, Fond du Lac, and Grand Portage Reservations. Duluth, MN: 1854 Ceded Territory. "To the Ojibwe, natural resources are cultural resources. There is no separation between how the bands manage and interact with a resource and how their culture endures: one is dependent on the other. Climate change, however, is threatening the very viability of many natural resources important to the Ojibwe." Quoted from Tribal Climate Adaptation Guidebook Writing Team (Meghan Dalton, Samantha Chisholm Hatfield, and Alexander "Sascha" Petersen). *Tribal Climate Adaptation Guidebook* (Corvallis, OR: Oregon State University, 2018), page 62. Conversely, the Yakama Nation utilizes five broad resource categories: land, air, water, natural, and cultural resources. *Climate Adaptation Plan for the Territories of the Yakama Nation,* page 11.

[21] Akana, *Climate Change Needs Assessment Survey.* Prepared for the Columbia River Inter-Tribal Fish Commission. 2017. Page 1.

[22] 853 F.3d 946 (9th Cir. 2017).

[23] 138 S. Ct. 2832 (2018) (affirmed by an equally divided court).

summarizes the Umatilla world view.[24] This is a multifaceted and holistic understanding of culture and nature that, among other things, identifies First Foods as integral pillars of the natural and human order. They not only nourish people, they also reflect fundamental physical and spiritual reality.

The Umatilla assessment identifies thirteen Key Items of Concern regarding climate impacts, of which five – water, chinook salmon, elk, cous, and huckleberry – are First Foods. Utilizing the same framework as the IPCC, the assessment considers the *sensitivity* to climate change and the *adaptive capacity* of each Key Item of Concern. The most vulnerable resource identified in the analysis is Chinook salmon. The assessment notes: "Chinook salmon… is in a class all to itself at the top due to its critical cultural importance as a First Food, and the magnitude and timing of impacts of climate change. The CTUIR has already observed impacts to the existing salmon population and there are thresholds beyond which the species is unlikely to adapt (critical stream temperature and flow thresholds)."[25]

The importance of First Foods as cultural resources cannot be overstated. Beyond providing important substance, cultural cohesion, and economic opportunities, First Foods are also fundamental to tribal sovereignty.

Climate change may impact tribal cultural resources in ways that parallel impacts to recreation and natural resources. For example, in its climate adaptation plan the Yakama Nation emphasizes the effects from increased flooding and wildfire. Increased frequency and intensity of wildfires may alter the seasonal water cycle, affecting culturally important species and potentially inhibiting access to culturally important sites. It further notes that "ceremonial and ancestral use of key areas may be significantly curtailed due to a lack of water during the summer and autumn months."[26] Impacts to what the Management Plan might consider natural and recreational resources are also impacts to cultural resources.

Natural Resources

Part of what makes the National Scenic Area special is its diversity of landscape, climate, and habitats, a string of contrasts connected by the thread of the Columbia River. This diversity of natural resources also suggests a diversity of effects and risks associated with climate change.

Virtually all the natural resources addressed in the Management Plan may experience climate change impacts. The principal dimensions of impact include:

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[24] Tamánwit merits a slightly fuller definition. The following is excerpted from Armand Minthorn, *As Days Go By* (Cited in Confederated Tribes of the Umatilla Indian Reservation, *Comprehensive Plan*. 2010):

[25] Confederated Tribes of the Umatilla Indian Reservation, 2015. Climate Change Vulnerability Assessment. Nasser, E., Petersen, S., Mills, P. (eds). Page 32.

[26] Yakama Nation. Climate Adaptation Plan for the Territories of the Yakama Nation. 2016. Page 11.

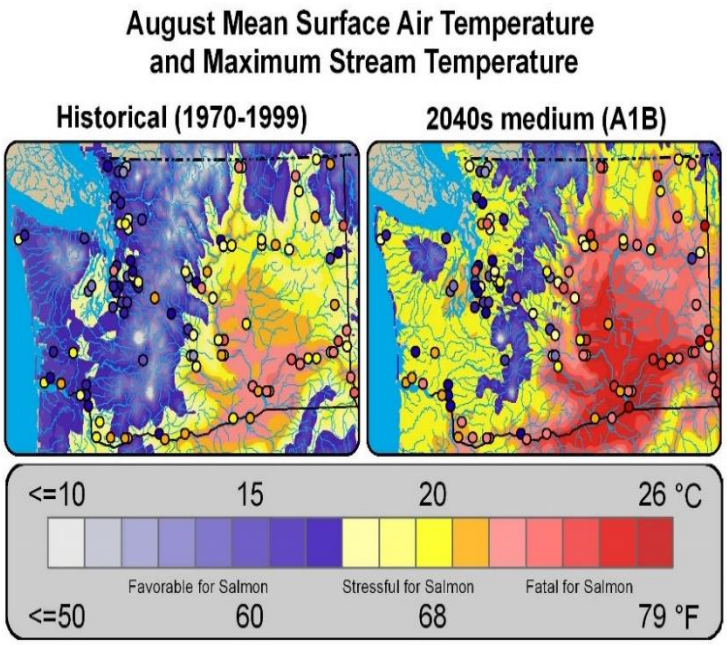

Figure 3: August mean surface air temperature (colored patches) and maximum stream temperature (dots) for 1970-1999 (left) and the 2040s (right, based on a "moderate" emission scenario). From the Washington Climate Change Impacts Assessment, Executive Summary, page 43.

- Changes in the timing, quantity and quality of water may drive changes to habitats, influencing the distribution and viability of native species.
- A warmer overall climate and prolonged summer drought can make native species more vulnerable to pests and pathogens.
- Nonnative and invasive species may increase their range in response to increased disturbance and warmer temperatures.
- Increases in wildfire and disturbance frequency and severity in addition to increased extreme weather events may accelerate processes of ecosystem change.

Changing temperature and precipitation patterns can affect a variety of species relationships, including the timing and availability of food sources and species migrations. The complexity of these interactions makes it likely that not all changes are readily foreseeable.

This research did not locate an analysis specific to National Scenic Area wetlands. However, it is likely that warmer air temperatures and diminished seasonal stream flows may stress and add natural pressures that could degrade or reduce the extent of wetlands, particularly surface water-dependent wetlands[27].

As noted above, streams across the National Scenic Area may experience some shift in hydrology toward winter flows. Stream systems that are currently snow dependent or mixed (rain and snow) may experience bigger shifts, with more pronounced winter flooding from rain-on-snow events. This could threaten the spawning rearing habitat of native salmonids. Higher summer temperatures and reduced summer flows would degrade fish habitats across the region. Effects would vary by species. Those dependent on very cold water (e.g. bull trout) may be most severely stressed.[28] Salmon, as Figure 3

[27] Moskal, M. 2017. Final Report: Can we conserve wetlands under a changing climate? Mapping wetland hydrology across an ecoregion and developing climate adaptation recommendations. Northwest Climate Science Center.

[28] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 22-23.

illustrates, also face long odds.[29] Warmer water temperatures and reduced water quality would favor nonnative invasive species.

Increased temperatures and diminished summer flows may lead to more frequent and harmful algal blooms, affecting the limited number of ponds and lakes in the National Scenic Area. Riparian areas may experience greater disturbance from high and low flows and increased flooding in some areas. Streambeds newly exposed by lower summer flows and riparian areas disturbed by floods may be more vulnerable to invasive plants.

Wildlife and wildlife habitats may shift in response to changed temperatures, moisture availability, loss of snowpack, disturbance events and more insect outbreaks among other factors. Species interactions, e.g. the timing of food sources with migratory species, may also shift, in some cases furthering threatening species already at risk. Climate change-driven shifts in the distribution of habitats may likely compound the effects of encroaching development and habitat fragmentation to stress wildlife populations.[30]

Sensitivity to climate impacts and the adaptive capacity of wildlife depends on many factors, including the focal habitat type and the species' ability to move. Wildlife populations that depend on already limited habitat areas, heavily fragmented habitats, and habitats already on the edge of available climate parameters may be most affected. The Columbia River Gorge pika are an example of one species with a limited range, microclimate requirements, and fragmented habitats.

Natural areas and SMA Priority Habitats may experience similar impacts, with relatively rare habitat types such as aspen stands, prairies, steppe habitat and old growth conifer forests likely to face increased pressure.[31] A more systematic assessment of impacts to the forty-five identified natural areas, while desirable, is beyond the scope of this report.[32]

This research did not locate any analysis of climate impacts on rare plants or soil productivity in the National Scenic Area, but the projected reductions in soil moisture availability suggest productivity may be constrained on many sites without irrigation. As the Eagle Creek fire demonstrated, increased wildfires can decrease soil's ability to retain moisture, diminishing productivity and increasing landslide risk.[33]

It is important to note that the National Scenic Area has a reasonably high potential for most of its flora, fauna, and habitats to be resilient in the fact of climate change. Thanks to the land use regulations put in place by the National Scenic Act, habitat fragmentation from development is less pronounced than in many other parts of the Pacific Northwest. In addition to new infrastructure, potential for habitat

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[29] Climate Impacts Group, 2009. *The Washington Climate Change Impacts Assessment,* M. McGuire Elsner, J. Littell, and L Whitely Binder (eds). Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington, page 13.

[30] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 43.

[31] See, for example, Yakama Nation. *Climate Adaptation Plan for the Territories of the Yakama Nation*. 2016. Page 35.

[32] Management Plan, I-3-49-50.

[33] U.S. Forest Service. *Columbia River Gorge National Scenic Area Burned Area Emergency Response Summary, Eagle Creek Fire.* October 10, 2017.

conversion under the Management Plan exists where forested lands are taken out of timber production and where new agricultural practices are established.

The land use regulations, combined with a highly diverse topography, creates many possibilities for the area's habitats, especially those areas closest to the Cascade Crest, to shift in response to climate change.[34] As with most climate change impacts, however, the rate of change matters; accelerating climate change later in the century may overwhelm the ability of National Scenic Area habits to adapt.

The National Scenic Area's compact diversity is part of what makes it a natural treasure. As the Management Plan notes, "The diverse climate of the Gorge fosters nearly 1,000 native species of wildflowers, including many species that are listed as endangered, threatened, or sensitive. Sixteen species do not occur outside the Gorge region."[35] Some of these species may have a hard time persisting in the face of increased temperatures and changed hydrologic regimes.

A certain amount of change is inevitable. The Management Plan acknowledges the dynamic landscape and provides means through open space and natural areas, buffer zones, and site-specific management plan requirements to accommodate change while protecting and enhancing the resources. These tools already built into the Management Plan can also help to foster resilience to climate change, especially if applied in tandem with the strategic habitat protections designed to support highly resilient places.[36]

Recreational Resources

A report on the conditions of scenic, natural, economic, cultural and recreation resources in the Columbia River Gorge National Scenic Area Columbia, the *State of the Gorge 2009* report posed the question: "how can we all share in the experience, without loving the Gorge to death?"[37] Climate change adds a sharper point to this question, affecting the timing, location, and resource intensity of many recreation activities.

Hiking and walking are near the top of recreational activities in the National Scenic Area, with a participation rate in excess of 70 percent. Popular trails and trailheads already experience perceived and actual crowding, creating "hot spots" of resource degradation.[38] Climate change-driven increases in natural hazards may likely compound these impacts by limiting recreational access to areas affected by natural hazards. County, state, and federal recreation providers are already overstretched and under-

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[34] Map 8.4: Terrestrial Landscape Resilience Density, in Buttrick, S., K. Popper, M. Schindel, B. McRae, B. Unnasch, A. Jones, and J. Platt. 2015. *Conserving Nature's Stage: Identifying Resilient Terrestrial Landscapes in the Pacific Northwest.* The Nature Conservancy, Portland Oregon. 104 pp. Available online at: http://nature.ly/resilienceNW March 3, 2015

[35] Management Plan, I-3-1.

[36] See Buttrick, S et al.

[37] Vital Signs Indicators – State of the Gorge 2009: A report on the conditions of scenic, natural, economic, cultural and recreation resources in the Columbia River Gorge National Scenic Area Columbia River Gorge Commission & USDA Forest Service - Columbia River Gorge National Scenic Area, 2009, page 58.

[38] R. Burns, T. Chuprinko, S. Shrestha. 2012. Columbia River Gorge Meta-Analysis: A Spatial and Temporal Examination of Outdoor Recreation. Cited in Columbia River Gorge National Scenic Area Interagency Recreation Strategy Team, "Columbia River Gorge National Scenic Area Interagency Recreation Team Recreation Report and Recommended Interim Strategies." November 2014. Page 22.

resourced, adding to the challenge of meeting rising recreation demand while protecting resources.[39] Hazard-related closures would require additional visitor management and closure enforcement, further stretching management resources.

Climate impacts may likely affect access to water-based activities directly, through changes to water quantity and quality, and indirectly, through potential impacts from natural hazards. The impacts to fish species noted above also diminishes opportunities to participate in traditional sport fisheries.[40] Contrary to the national decline in fishing participation, this activity is growing in popularity the National Scenic Area.[41] Demand for water-based recreation, such as whitewater rafting, is also growing.[42] Yet some popular rivers, such as the Klickitat, may likely experience reductions in functional access for boating usage as spring runoff accelerates and the appropriate conditions for boating and fishing occur during a more limited window. However, these types of impacts would likely vary significantly across the National Scenic Area.

In line with the previous section's assessment of climate impacts to wildlife and wildlife habitats, climate change is likely to affect the timing and availability of wildlife and wildflower viewing. Accelerated spring runoff may shift the wildflower season earlier and may shorten it in areas more exposed to drought stress such as the eastern Gorge. Broad-scale climate impacts on wildlife viewing opportunities are difficult to predict.

Some sightseeing, picnicking, and camping opportunities may be degraded by constrained water supplies, extreme heat events, and hydrologic shifts. As the Eagle Creek Fire indicated, recreation managers face difficult decisions when natural hazards such as floods and wildfires – projected to be more intense and frequent in a warming climate – prompt the closure of popular recreation sites. The wide availability of public lands provides, in theory, an "adaptive capacity" in that visitors can seek out different sites for the same experience[43] and make visitation decisions based largely on activity type rather than specific places.[44] The Management Plan already highlights the need for disbursing use – a need likely to be exacerbated by increased closures.[45] There is a practical limit to disbursal, however. Iconic sites such as Multnomah Falls, and Oneonta Gorge may experience high user demand irrespective of alternatives.

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[39] Columbia River Gorge National Scenic Area Interagency Recreation Strategy Team, "Columbia River Gorge National Scenic Area Interagency Recreation Team Recreation Report and Recommended Interim Strategies." November 2014. Pages 23-24.
[40] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 43.
[41] Columbia River Gorge National Scenic Area Interagency Recreation Strategy Team, "Columbia River Gorge National Scenic Area Interagency Recreation Team Recreation Report and Recommended Interim Strategies." November 2014. Page 21.
[42] Kathi Jaworski, "Columbia Gorge Tourism Studio Baseline Assessment, January 2016." Travel Oregon, 2016, page 14.
[43] Columbia River Gorge National Scenic Area, Mount Hood National Forest, & Willamette National Forest Adaptation Partnership, Vulnerability Assessment Summaries, 40-45.
[44] Robert C. Burns, "Columbia River Gorge Vital Signs Indicators Resident and Visitor Study." Submitted to Columbia River Gorge Commission, June 30, 2011. Page 23.
[45] Management Plan, I-4-2.

Important scenic and recreation travel corridors are also likely to experience more frequent closures due to key hazards such as wildfires, floods, and landslides which could increase in frequency and severity. The Eagle Creek Fire not only disrupted local recreational users but also affected use of the Pacific Crest Trail, an iconic corridor. It also forced a long closure of the Historic Columbia River Highway. Future disruption of this sort may be more common.

As scenic and recreation travel corridors, roads are also at risk. Roads may experience increased rain on snow events, with increased magnitude and frequency of peak flows, increasing flood and washout risks. This could be a reason for the increased number of emergency response actions that have occurred for road maintenance and repair over the past several years.

The National Scenic Area's key east-west corridors Washington State Route 14 and Interstate 84 are also exposed to climate impacts. The Washington Department of Transportation has assessed State Route 14 as highly vulnerable throughout Skamania County due its proximity to the Columbia River.[46] In Oregon, landslide hazards affect much of Interstate 84. As the Oregon Department of Transportation notes, "One of the biggest drivers of landslides is groundwater…With an already elevated groundwater level in the winter months, as is the case in many areas in western Oregon, it may take smaller rainfall events to trigger more landslide movement. Increased rainfall means that the normal slides ODOT deals with may get worse (increase in size, rate, and movement magnitude), but there may also be an increase in incidence of new slides around the state."[47]

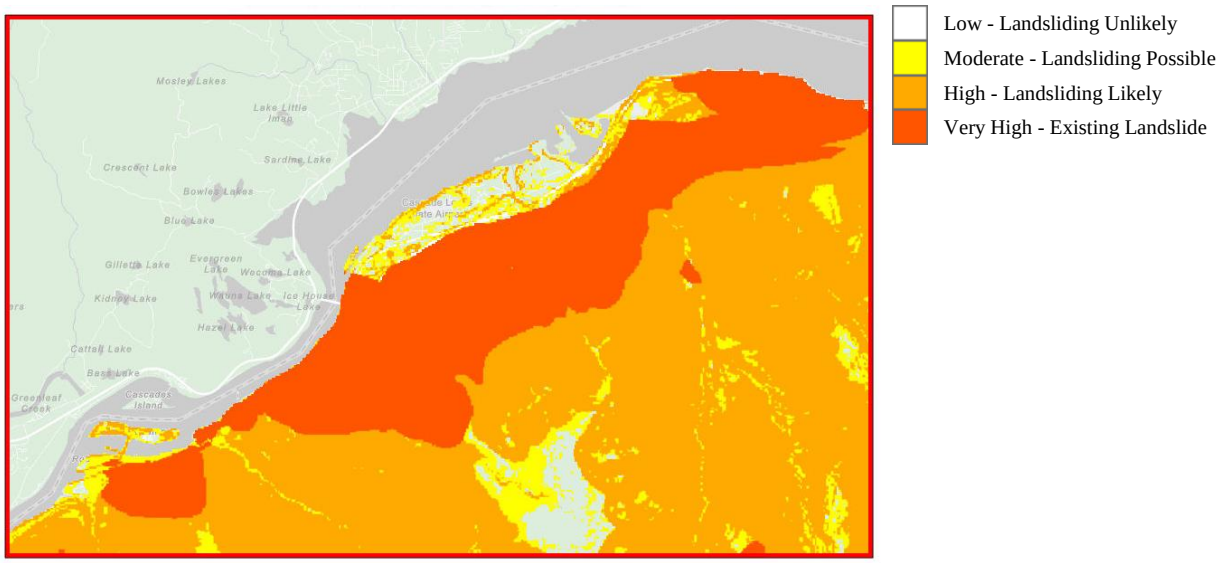

Figure 4. Landslide hazard near Cascade Locks, Oregon

The National Scenic Area's interpretive facilities likewise present both a vulnerability and an asset. This research was unable to uncover any substantive means of analyzing specific risks to interpretive sites. The hazards outlined elsewhere in this section to infrastructure may affect interpretive facilities as well.

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[46] Washington State Department of Transportation. "Climate Impacts Vulnerability Assessment Report." Prepared by the Washington State Department of Transportation for submittal to the Federal Highway Administration in fulfillment of the matching grant of Surface Transportation Research, Development, and Deployment funds as obligated by the FHWA-Washington Division, FHWA program code 4L30. November 2011. Page 68.
[47] Oregon Department of Transportation, *Climate Change Adaptation Strategy Report*. 2012. Page 31.

At the same time, facilities such as the Gorge Discovery Center are well positioned to document and educate residents and visitors about climate impacts. They can serve to situate climate change in the overall story of the Columbia Gorge, a landscape defined by the powers of natural forces, and engage the public in a thoughtful dialogue around the difficult questions of how to protect Gorge's resources while adapting to inevitable change.

Overall, a recurring theme regarding climate change and recreation in the National Scenic Area is that while some impacts can be readily predicted, others cannot. Seasonal, long term, or even permanent closures may result from natural hazards amplified by increased heat, extreme weather events, and changes to hydrologic regimes. When and where such closures happen, and what strain they put on the system overall, may be hard to forecast. One consequence of increased closures or other constraints on recreational access is a potential mismatch between the distribution of recreational opportunities and demand for them. An example may be the location and distribution of the Management Plan's Recreation Intensity Classes may need to be revisited when and if visitation patterns shift in response to these constraints.

Impacts to the National Scenic Area Economy

This research has not discovered any economic impact analysis of climate change specific to the National Scenic Area. As such, the impacts discussed here are inferred from the general conclusions of national and state assessments, in particular Volume II of the Fourth National Climate Assessment, which focused heavily on socioeconomic impacts.

Many of the key economic impacts identified in these assessments are relevant to the National Scenic Area. The agricultural sector, which is a foundational element of the National Scenic Area economy, may have already started experiencing these changes. Shifts in the timing of precipitation, in particular the extended summer drought, may tend to increase the extent and intensity of irrigation needs, adding costs and uncertainty to irrigation-dependent operations. Some of the Gorge's specialty crops, such as tree fruits, have already experienced a mismatch in timing flowering and the availability of pollinators.[48] Higher summer temperatures can sunburn or scald certain crops, lowering quality. Livestock likewise experience additional heat stress, and in some locations reduced quality forage, resulting in lower weights. While many of these challenges can be addressed through additional infrastructure investments, shifting crops to warmer climate adapted species and changing management practices, the economic costs of adaptation may have a potential to be significant.

The forestry sector faces similar challenges. Increased wildfire, extended summer droughts, elevated summer temperatures, reduced winter snowpack and a greater overall variability in precipitation timing may all stress tree species and reduce yield for forest practices.[49] These impacts may be less pronounced in the National Scenic Area compared to areas with a greater dependence on forest industry, however the National Scenic Area is home to industries that rely on timber produced outside of the Gorge where

[48] Houston, L., S. Capalbo, C. Seavert, M. Dalton, D. Bryla, and R. Sagili, 2018: Specialty fruit production in the Pacific Northwest: Adaptation strategies for a changing climate. Climatic Change, 146 (1-2), 159-171. http://dx.doi.org/10.1007/s10584-017-1951-y. Cited in USGCRP, Fourth National Climate Assessment, page 24.
[49] Latta, G., H. Temesgen, D. Adams, and T. Barrett, 2010: Analysis of potential impacts of climate change on forests of the United States Pacific Northwest. Forest Ecology and Management, 259 (4), 720-729. http://dx.doi.org/10.1016/j.foreco.2009.09.003.

decreased timber productivity and/or elevated management costs are likely to be felt in the local economy.

The other obvious area of climate impacts on the regional economy relates to outdoor recreation and scenic tourism, pillars of the National Scenic Area's economy. These losses will not be absolute; outdoor recreation may shift rather than simply disappear. Yet the shift may be disruptive and cause short to medium term economic harm; moreover, the outdoor recreation activities that replace a highly economically productive activity may have a less significant economic benefit. The overall impact of these shifts is hard to predict and depends in part of the adaptive actions of local businesses and governments.

Extreme weather events, wildfires, landslides, and similar disruptions may also have an economic impact. The closure of Interstate 84 during the Eagle Creek wildfire disrupted tourism, recreation, commercial transportation, along with nearly every other aspect of economic life in the Gorge. These impacts were especially felt in communities such as Cascade Locks, according to *the economic impacts task force* convened by Govern Kate Brown in October 2017. Landslides, rock fall, and flood damage, as discussed above in relation to recreation resources, not only harm economic activity, they also necessitate costly investments in repairing public infrastructure. Likewise, the public health impacts of higher summer temperatures (e.g. increased incidence of heat illnesses), reduced air quality from wildfires (e.g. elevated asthma rates) may result in lost economic productivity and increased health care costs. These impacts to the human and physical capital of the National Scenic Area may impose costs that are not documented to have been forecast or adequately anticipated in local or state budgets.

At the risk of oversimplifying a complex set of relationships, the overall economic impact of climate change in the National Scenic Area may be to necessitate higher levels of investment, innovation, and adaptability in the region's economy. In the long term many of these changes may, if well planned and executed, foster a more diverse, resilient, and robust economy. Climate change may not fundamentally change the National Scenic Area's principal attractions; however, it may accelerate the rate of change in the local economy and impose short to medium term costs that may prove substantial.

Addressing Climate Change through Resilience

All the impacts and risks identified in this report extend beyond the National Scenic Area. They also touch on resources and issues that have traditionally fallen outside the focus of the Management Plan and its implementers, the Columbia River Gorge Commission, the U.S. Forest Service, and the five counties that have adopted National Scenic Area ordinances. The sheer multiplicity of climate impacts, many of which are interdependent, makes it a problem that will challenge individual agencies, jurisdictions, or organizations to strategically and meaningfully respond.

Recognizing this challenge, a new field of climate resilience has arisen. Drawing on elements of natural resource hazard planning, climate science, and social science, it is rapidly developing as a field of practice. Numerous approaches and frameworks have emerged, suiting the needs and goals of different audiences. What they have in common is a focus on bringing an understanding of climate science, in particular a rigorous understanding of climate change impacts, together with collaborative and community-led planning. The goal of climate resilience as a practice is to systematically identify, prioritize, and implement actions that can minimize or mitigate the most important climate impacts and promote a locality's ability to adapt to these impacts.

The word "resilience," merits further definition. The U.S. Climate Resilience Toolkit defines resilience as the "capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption."[50] In the context of the National Scenic Area, a definition used in the *Tribal Climate Adaptation Guidebook* is also relevant: "Resilience is the capacity of a community to withstand, survive, and thrive by applying adaptation actions that maintain and adhere to essential cultural functions, identities, and structures while co-existing with and managing for changing conditions.[51]

Resilience is a useful concept for the National Scenic Area for two reasons. First, as the *Tribal Climate Adaptation Guidebook* definition cited above suggests, resilience helps a place adapt to change in ways that maintain its essential character. Building a massive seawall may be an effective adaptation action in the face of sea level rise but does not promote resilience if it cuts a community off from accessing a resource that defines the community. Second, because the National Scenic Area exists to protect a suite of natural, cultural, scenic and recreation resources, meaningful adaptation entails actions across many domains: land use planning, natural resource management, natural hazards management, economic development, and so forth.

Of the many resilience frameworks, the U.S. Climate Resilience Toolkit is one of the most useful. The "Steps to Resilience" framework provides a streamlined method for systematically assessing vulnerabilities and adaptive capacity, evaluating and planning for action, and implementing plans.

The National Scenic Area is well positioned to utilize a resilience planning approach of this sort because the area of interest is clearly defined, and Management Plan provides a foundation for establishing parameters of acceptable change. Moreover, a set of metrics already exists, in concept at least, with the Vital Signs Indicators.

Several entities across the National Scenic Area landscape have already undertaken resilience planning efforts. For example, the Yakama Nation have undertaken a multi-phase process that parallels the Steps to Resilience approach. The *Climate Adaptation Plan for the Territories of the Yakama Nation*, published in 2016, implements Step 1. It summarizes likely climate changes across the Yakama Nation's ceded lands and reservation and identifies impacts across nine categories: Health and Public Safety, Tribal Infrastructure, Lands and Agriculture, Forestry, Water and Wetlands, Fisheries, Shrub-Steppe and Rangelands, Wildlife and Vegetation, and Toxics. For each category, the plan identifies potential actions and further research needs. Two additional planning phases – a vulnerability assessment and an implementation plan – may address Steps 2 through 5.

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[50] U.S. Climate Resilience Toolkit. https://toolkit.climate.gov/content/glossary/. Accessed on August 17, 2019.
[51] Cited from: The Kresge Foundation and Island Press, *Bounce Forward: Urban Resilience in the Era of Climate Change, A Strategy Paper from Island Press and The Kresge Foundation* (Washington, DC: Island Press, 2015).

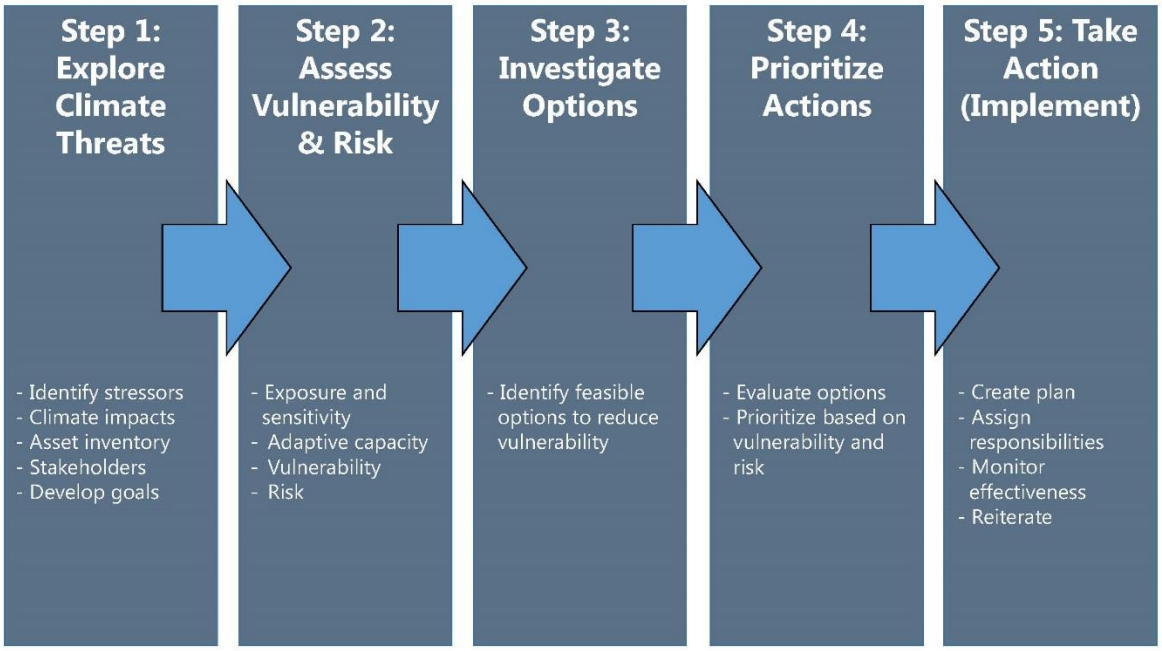

Figure 5. U.S. Climate Resilience Toolkit Steps to Resilience. Adapted from Hutchins et al, 2016

Within and adjacent to the National Scenic Area, Multnomah County and the City of Portland have created a climate resilience plan that, while broader in scope and scale, follows a similar approach.[52] The city-county effort synthesizes climate science to identify impacts most likely to affect city and county services. It considers these impacts across three broad categories – Human Systems, Natural Systems, and Infrastructure and the Built Environment – to assess vulnerabilities across five key climate risks:

- Increased temperatures (both day and night) and frequency of high-heat days
- Increased incidence of drought
- Increased wildfire frequency and intensity
- Increased incidence and magnitude of damaging floods
- Increased incidence of landslides

The plan then identifies objectives to build resilience to these risks (Figure 6).[53] It includes an explicit focus on equity dimensions of climate resilience, asking how climate risks and responses disproportionately affect especially vulnerable communities: those with concentrations of renters, individuals with lower educational attainment, households with reduced income, and people of color. Collectively these documents accomplish Steps 1 through 4 of the U.S. Climate Resilience Toolkit Steps to Resilience framework. The county and city have created a multi-bureau/department climate preparation coordination team to drive implementation, report on progress, and amend the strategy as needed.

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[52] City of Portland, Multnomah County, *Climate Change Preparation Strategy: Preparing for Local Impacts in Portland and Multnomah County* (2014) and *Climate Change Preparation Strategy: Risk and Vulnerabilities Assessment* (2014).

[53] City of Portland, Multnomah County. *Climate Change Preparation Strategy: Preparing for Local Impacts in Portland and Multnomah County*, 2014. Page 16.

These two examples serve to illustrate what entities of differing size and capacity have already accomplished in understanding climate impacts and planning for resilience. They are not alone. Other entities in the National Scenic Area have undertaken elements of climate resilience planning. The Oregon and Washington Departments of Transportation have assessed transportation networks' vulnerability to climate change and created adaptation plans; in Washington's case, the plan specifically identifies assets of concern in the National Scenic Area. Hood River County has created an energy plan focused both on mitigating greenhouse gas emissions by reducing the county's fossil fuel consumption and on building resilience by increasing local renewable energy production.[54] The U.S. Forest Service is completing climate change vulnerability assessments for four National Forest units, including the National Scenic Area.[55]

HOTTER, DRIER SUMMERS WITH INCREASED INCIDENCE OF HIGH-HEAT DAYS	
1	Decrease the urban heat island effect, especially in areas with populations most vulnerable to heat.
2	Minimize health issues caused by extreme heat days, especially for populations most vulnerable to heat.
3	Increase the resilience of Portland's water supply to drier summers.
4	Increase the resilience of natural systems to adapt to increased temperatures and drier summers.
5	Manage the risk of wildfires as a result of drier summers.
WARMER WINTERS WITH THE POTENTIAL FOR MORE INTENSE RAIN EVENTS	
6	Increase the resilience of the natural and built environment to more intense rain event and associated flooding.
7	Manage the increased risk of disease due to changes in vector populations.
8	Manage the increased risk of landslides due to changing precipitation patterns.
BUILDING CAPACITY TO PREPARE FOR AND RESPOND TO CLIMATE CHANGE	
9	Strengthen emergency management capacity to respond to weather-related emergencies.
10	Institutionalize climate change preparation planning and best practices.
11	Improve the capacity of the community, especially populations most vulnerable to climate change risks, to understand, prepare for and respond to climate impacts.
12	Improve monitoring, evaluate effectiveness of climate change preparation actions and advance new research to support climate change preparation efforts.

Figure 6: Portland-Multnomah County Key Climate Risks and Responses

However, it is not clear how, or if, these disparate planning and implementation efforts add up to a comprehensive resilience approach for the entire landscape. Approaches such as that undertaken by Portland and Multnomah County touch on only a portion of the landscape and rely on funding mechanisms that compete with immediate needs for basic services. The Yakama Nation approach leans heavily on leveraging partnerships with federal and state agencies, many of which have overlapping plans lacking appropriate implementation funding. Agencies like the Oregon and Washington Departments of Transportation, which have climate adaptation plans and specific, prioritized adaptation projects, are not fully coordinated with other agencies and entities needed to build resilience across the entire suite of resources of concern to the Management Plan. Additional coordination, led by an entity with a more holistic view of the National Scenic Area, could potentially help focus efforts and make the case for investment.

[54] Hood River County Energy Plan Steering Committee, *Hood River County Energy Plan.* 2018.,
[55] Hudec et al. *Climate Change Vulnerability and Adaptation in Southwest Washington*.

The Commission's Role

As this report has noted, the National Scenic Area faces a multitude of climate impacts. Some are potentially dramatic and can have compounding effects as climatic conditions shift. Yet few if any of these impacts are fundamentally new. Rather, they mostly exacerbate existing management challenges.

That said, climate change adds a new dimension to the Commission's mandate. Neither the National Scenic Area Act nor the Management Plan attempts to preserve the Columbia River Gorge unchanged. The Act and Management Plan create a framework to support necessary growth and change with the goal of protecting the identified resources. As this report has suggested, climate change is likely to affect the resources themselves independent of future land use regulations or planning decisions.

Given the interconnected nature of climate change impacts, a climate-informed understanding of National Scenic Area resources may touch on more issues than those explicitly addressed in the Management Plan, most of which focus on land use. The Commission is therefore challenged to articulate in more detail a vision for a climate-adapted National Scenic Area. With such a vision defined and detailed, the Commission can then identify its roles in creating that landscape – understanding that many other entities have critical roles as well.

The resilience framework described above provides a useful start. It creates a structured process by which to assess vulnerabilities and identify and prioritize response actions. It can also help the Commission identify achievable climate-related outcomes and avoidable climate-related risks around which to define limits of acceptable change.

In this author's opinion, the Commission could convene the appropriate partners and create a climate resilience plan that would stand separately from the Management Plan.

Over time, specific insights from climate adaptation actions may likely inform changes to specific guidelines and policies. For now, however, the priority should be to map out a resilience strategy, grounded in the protected resources that can leverage maximum cooperation and coordination among all National Scenic Area stakeholders. This strategy is timely considering the accelerating policy environment and the fact that while many entities have in the National Scenic Area have begun planning for resilience, implementation is at a very early stage. It is not too late for the Commission to help integrate ongoing efforts.

Conclusion

Climate change has been characterized as a "wicked" problem due to its physical, economic and social complexity, its ethical dimensions, its mutually interdependent impacts, and the unpredictable interaction of human with natural systems it causes.[56] Climate change drives systems-level changes with consequences on National Scenic Area resources that are fundamentally hard to predict. A changing climate drives shifts in vegetation, water, and weather that, while empirically measurable with

[56] See, for example, Toman, Mike. "A 'Wicked Problem:' Controlling Climate Change." Policy Research Talk. The World Bank. September 23, 2014. http://pubdocs.worldbank.org/en/887581482181502910/PRT-Presentation-Mike-Toman-climate-change-092314.pdf. Accessed on June 16, 2019.

increasing accuracy, take on their true significance only through their interplay with the social, political, and economic systems underpinning Gorge communities.

This interconnectedness ultimately makes climate change a fundamentally unique challenge for the National Scenic Area. While the Management Plan can and should address climate impacts in discrete terms, the Commission cannot expect to build real climate resilience through the Management Plan. A systemic challenge demands a systemic approach, of which the Management Plan is only a single element.

In defining the resources to be protected and establishing land use measures to protect these resources, the National Scenic Area Act and Management Plan provided elements that may help the Columbia River Gorge respond to climate change far better than many other regions. These tools alone may not be sufficient to prevent the National Scenic Area's resources from suffering negative impacts of a changing climate, but they do provide a powerful vehicle to organize and focus resilience efforts. In carrying out its mandate to protect and enhance the National Scenic Area's resources, the Commission is simultaneously supporting resilience across the landscape. In doing so, it supports the communities, partner agencies, and local governments also committed to successful climate adaptation.

The National Scenic Area has strong inherent potential for resilience in a changed climate, thanks to its intrinsic landscape diversity and to the protections and planning entailed in the National Scenic Area designation. It thus begins from an enviable position. The challenge, however, is that a maximally resilient National Scenic Area may require coordinated action across the suite of stakeholders mentioned above. This is often the case in resilience planning, but especially so in the case of the National Scenic Area. It requires stakeholders to not only build resilience into their own approaches, but proactively look for ways to align their efforts across sectors.

The Commission is well suited to facilitate this alignment as it has a stake in seeing a robust resilience response across the landscape. It has compelling reasons to take a broader view of the challenge and seek to forge new partnerships to address climate change comprehensively. The long-term task of achieving the National Scenic Area Act's aims may require doing so.

All that is certain is that the National Scenic Area we know today may be very different in the future as a result of climate change. It demands that we adapt our expectations of the landscape to account for the projected changes, but also hone our abilities and tools to minimize the impacts and risks.