HOH INDIAN TRIBE
NATURAL RESOURCES DEPARTMENT

2025

CLIMATE CHANGE VULNERABILITY ASSESSMENT

DOCUMENTING THE PAST AND PREPARING FOR THE FUTURE

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Disclaimer

Much of this assessment is based on interviews. Interviewees shared their experiences, knowing they would be quoted for this assessment. However, the quotes should not be removed from this document and used by any entities outside of the Hoh Tribe unless explicit permission is granted by the interviewees. Additionally, interviewees may remove their quotes and knowledge at any time as they see fit.

"Our vision is to ensure our future as a strong, sovereign nation by continuing to preserve and instill our inherent cultural and spiritual traditions and values."

Hoh Indian Tribe, 2022 - 2024 Strategic Plan

INTRODUCTION

The Hoh people were created along the Hoh River by K'wati, the shape-shifting Changer. Since that time, the Hoh Indian Tribe's home and territory has been the western side of the Olympic Peninsula in the temperate rainforest near glacially-fed rivers and the roaring Pacific Ocean. The Hoh Tribe is spiritually and culturally connected with this land and has stewarded their rich resources for generations.

Climate change is a pressing threat to the Hoh way of life. It is changing environmental conditions and impacting animals and plants that Tribal members depend on for food, livelihoods, cultural traditions, and spiritual practices. Treaty rights, like fishing, hunting, and gathering, are central to the Tribe's sovereignty and revolve around natural resources. Infrastructure, cultural resources, and human health are at risk from winter floods, summer low flows, worsening air quality, and heat waves, among other concerns. Climate change is an environmental justice issue; the Hoh Tribe has contributed little to this global problem and is now disproportionately affected by the impacts.

While there have been broad assessments that included portions of the Hoh usual and accustomed area (U&A) or focused on combined coastal Treaty Tribe concerns, there has not yet been a report produced solely by the Hoh Tribe. Seeing this gap, this is the Tribe's first climate change assessment, focused on their specific experiences, concerns, and needs. The goal of this document is to share the changes Tribal members are experiencing, the future changes the Tribe can expect, and the impacts on ecosystems, species, and well-being. It was created through interviews with Tribal members and a synthesis of scientific literature and reports. This assessment and the future work it can support are a commitment to facing climate challenges, creating a positive future for current and future generations of Hoh Tribal members, and supporting Hoh Tribal sovereignty.

This assessment has five main sections:

1: Background: A brief history of the Hoh Tribe's connections to natural resources.

2: Changing Climate Conditions: A summary of changing climate conditions and future climate projections. While we cannot predict exactly what the future will look like, knowing the range of expected changes is essential to understanding risks, defining priorities, and taking action.

3: Well-being and Climate Change: A sample of quotes from Tribal members that give insight into how climate change could affect their way of life, as well as actions that could strengthen well-being.

4: Ecosystems and Climate Change: This section covers four ecosystems within the U&A: Marine, Forest, Wetland, and River and Riparian. For each, the main climate impacts are shared and highlighted species are covered in-depth.

5: Concerns, Desires, and Hopes: A summary of the general concerns, desires, and hopes shared by Tribal members in interviews. These move beyond specific impacts and can help guide future planning and adaptation efforts.

This assessment is intended to be accessible, providing a high-level view of these topics. For more information, please refer to the list of appendices.

"Given close relationships with the natural world stemming from deep spiritual and cultural connections and subsistence lifeways, Indigenous peoples are on the frontlines of those experiencing and adapting to climate change. Indigenous peoples possess incredible resiliency and innovation, borne from Indigenous knowledges, worldviews, and countless generations of connection to place (Ford et al., 2020).

At the same time, climate change impacts for many Tribal communities are already severe (such as shifts in/loss of key cultural species and land loss due to erosion, flooding, and permafrost thaw), and the challenges they face responding to impacts are daunting (such as lack of funding and technical resources and legacies from colonialism and discrimination). The time to act is now, and the way to act is together: in community, taking care of one another and all our relations."

The Status of Tribes and Climate Change report, 2021

This photo scan was shared by Vivian Lee. It shows old-time Hoh smelt fishers on the beach with their dip nets.

HOH INDIAN TRIBE BACKGROUND

This section provides the briefest of histories to ground the reader in the Hoh Tribe's connection to and management of resources since time immemorial.

The Hoh people were created by transformation along the Hoh River at the Time of Beginnings. K'wati, the shape shifting Changer, arrived at the river and found the upside-down people walking on their hands and fumbling with their dipnets. He righted them and blessed the community with abundant smelt (Hoh Tribe, 2024). Since that time, the Hoh people have been interconnected with the Hoh watershed. They traveled extensively along the rivers, in the surrounding mountains, and into the ocean, as do Hoh Tribal members today. There were at least seven permanent village sites with longhouses along the river. Many other areas were used seasonally for hunting and fishing. Tribal members would launch ocean-going canoes from the beach near the Hoh River mouth and go fishing, hunting, and traveling along the coast, including trips to Destruction Island and Tatoosh Island. Natural resources from the ocean to the tidelands, from the river to the wetlands and mountain foothills, were abundant. They provided everything people needed, including food, fishing gear, medicine, and clothing. A spiritual connection with the natural world was and continues to be an important part of Hoh cultural practices and identity (CGC, 2019).

The first recorded contacts with colonizers were interactions between the Hoh people and Europeans and Russians arriving by ship (CGC, 2019). During treaty time in 1855, the Hoh Tribe and the Quileute Tribe were identified as one tribe. The Quileute and Quinault, together with the Hoh Tribe, were parties to the Treaty of Olympia, negotiated on July 1, 1855 at a village at the mouth of the Quinault River, now known as Taholah (United States v. Washington, 384 F. Supp. 312,359, 1974; Treaty of Olympia, 12 Stat. 971). The Treaty of Olympia was signed by Governor Stevens on January 25, 1856, ratified by the United States Senate on March 8, 1859, and proclaimed by the President on April 11, 1859 (Treaty of Olympia, 12 Stat. 971).

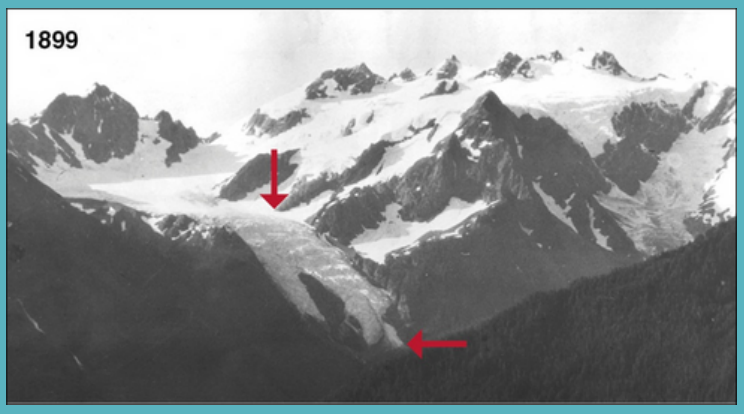
After signing and ratification of this Treaty, the US government tried to force the Hoh people onto the Quinault Reservation, but they refused to leave their homelands. The Hoh Indian Reservation was established, in response, by executive order in 1893 on the south side of the river, despite requests that it span both sides (Powell, n.d.).

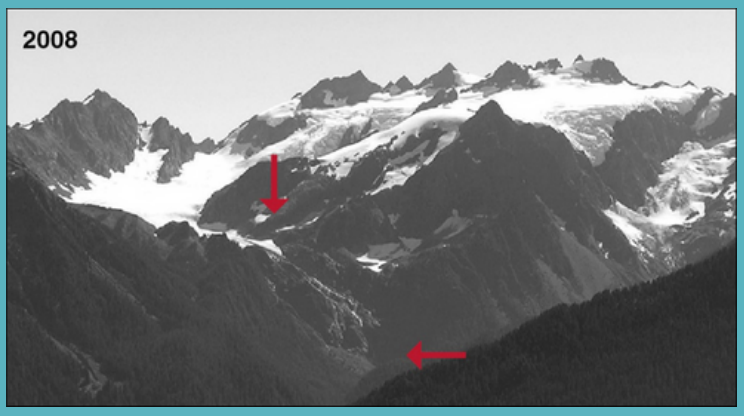
Through the Treaty, the Hoh Tribe reserved their hunting, fishing, and gathering rights in their usual and accustomed areas (U&A) in perpetuity, along with other rights as a sovereign nation. The Stevens Treaties have since been litigated many times in court. One of the seminal cases that reaffirmed the Tribe's treaty rights is United States v. Washington or the Boldt decision, as it's commonly referred to. The first ruling in the Boldt decision was in 1974; there have been over 75 sub-proceedings since. The Boldt decision affirmed that the Tribes who were party to the Stevens Treaties have rights to half of the fish catch in Washington and are co-managers of the fisheries, including shellfish. Sub-proceedings have also affirmed the Tribe's right to hunt and gather in all "open and unclaimed lands". Because of their inherent sovereignty and these decisions in Treaty litigations, the Hoh Tribe is currently an active co-manager of the natural resources in their U&A (Dorsay, 2024; UW Gallagher Law Library, 2024).

Coastal erosion has removed some of the original reservation land base, but the Tribe has expanded by getting land back from Olympic National Park and purchasing new lots. The majority of the reservation and Tribal infrastructure is within both the river floodplain and the Pacific Ocean tsunami zone. Because of this, the Tribe has experienced a variety of flood disasters throughout the years. To keep current and future generations safe, the Tribe is relocating to a site outside of the tsunami zone called the Hoh Highlands. The U&A is much larger than the ceded reservation lands and extends into the ocean. It contains several rivers, including the 56 miles of the Hoh River which is home to four species of wild salmon and steelhead (Hoh Tribe, n.d.). The Hoh Tribe has always managed natural resources in their U&A from historical cultural burning of prairies to today's careful cedar harvesting. Currently, the Tribe's Natural Resources Department (NRD) is responsible for management. NRD staff run the Chalaat Creek hatchery, co-manage fish populations with the state of Washington, maintain forest inventories, manage cultural programs, monitor freshwater quality, and test for harmful algal bloom conditions, in addition to other tasks. All operations are overseen by the Hoh Tribal Business Committee, the governing body elected by the General Council.

"I'd love to have things back the way they were in the environment so my cupboards would be full. It's healthier too."

Marie Riebe





Photos courtesy of Mike Larrabee, Physical Science Technician with the National Park Service NCCN Inventory and Monitoring Program

GLACIER LOSS

"The years that I went upriver with my grandfather [Charles Sailto Sr.], we went all the way up to the top where the snow and glacier was. He took pictures of that...I went up with our biologist and I go 'Where are the glaciers?' They moved up, melted about 10, 15 miles or more. We've been observing them. They're moving maybe about 2 to 3 feet a year, melting that much. That has changed quite a bit."

Walter Ward

Above are photos of the Blue Glacier, one of the glaciers that feeds the Hoh River. In both photos, the red arrows are in the same spot, showing just how much the glacier retreated over 109 years. Warming temperatures and reduced winter snow are causing glaciers to melt. With less glacial melt, future summer river flows will be lower.

CHANGING CLIMATE CONDITIONS IN THE HOH U&A

AN INTRODUCTION

Climate change is the shift in average weather patterns over long time periods, like decades. We have evidence these patterns are changing now, both from people's experiences, as this report shows, and from climate records around the world. Climate change is overwhelmingly caused by the high levels of greenhouse gases in our atmosphere. These are produced by burning fossil fuels, like coal, oil, and gas, for energy. Secondary contributors include processes like deforestation and soil degradation due to agriculture (Marvel et al., 2023). As more greenhouse gases enter the atmosphere, they trap increasingly more heat. The magnitude of the changes and the risks they pose increase with every bit of warming that occurs. This presents an opportunity; the choices the world makes today determine our future. Every reduction that can be made and every emission that can be cut will reduce the risks that future generations experience (Jay et al., 2023).

Climate changes across the world are not uniform. The following section covers eight major changes Tribal members are experiencing and how these will shift in the future. For more detailed information, including an in-depth look at flooding and an overview of different representative concentration pathways (RCPs), please refer to Appendices 1 and 2.

Each of the future predictions shared here are under RCP 8.5, a scenario in which greenhouse gas emissions aren't reduced. See Appendix 1 for more information on RCPs.

WARMER AIR TEMPERATURES

Observed changes: Tribal members have noticed both warmer winters and summers, but the reservation stays cooler than other areas because of its proximity to the ocean. People deal with summer heat by using air conditioners, fans, swimming, taking drives with the windows down, and carefully managing their home temperatures via shades and open windows.

Predicted changes: Annual average temperatures in the U&A will be 7 – 8.5°F warmer. Depending where you are in U&A, there could be 1 – 23 more days per year above 86°F by the end of the century (Krosby et al., 2018).

Impacts: Rising temperatures drive most of the other changes shown here, disrupting ecosystems, weather patterns, and human health.

CHANGING RAIN

Observed changes: Some Tribal members believe rain has stayed the same, while others have noticed drier summers, noting that they've had to mow their lawn less frequently.

Predicted changes: Winter rain will increase, while summer rain will decrease. Intense atmospheric river events and winter storms will become more likely. The risk of drought in the summer increases by 32-47% by 2070 (Raymond & Rogers, 2022).

Impacts: Increased winter rains will cause more flooding, which could change the river path and harm fish redds and infrastructure, including roads. More extreme winter storms can harm human health through power outages and disaster events. Low summer rain will stress animals and plants and could cause water shortages for Tribal members. Drought could also increase the risk of wildfire and cause health problems due to smoke, although this risk is not yet well understood in the rainforest.

DECREASED SNOWPACK & DISAPPEARING GLACIERS

Observed changes: Tribal members say it snows both less frequently and smaller amounts on the reservation than when they were young. They've also noticed the snow line on the mountains rising throughout the years.

Predicted changes: Snowpack in the Olympic mountains will decrease and the glaciers could fully melt by 2070 (Fountain et al., 2022).

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Impacts: Less snowpack and glacial melt, in combination with less summer rain, could lead to drought, increased wildfires, stressed plants, and lower river flows that are difficult for fish to live in due to high temperatures and low dissolved oxygen concentrations. Low flows can also physically limit migration and reduce suitable spawning habitat.

CHANGING RIVER FLOWS

Observed changes: The Hoh River is known for its cold water but some Tribal members say they've noticed it warming. Flows are incredibly variable, with low seasons that prevent fish from moving upstream and high seasons where flooding is a common occurrence. The river is wider and shallower than it used to be when some Tribal members were young.

Predicted changes: Because of less glacier melt and rain, summer low flow season will be longer and lower; by 2040, flows in the Hoh River main stem will be 20 - 30% lower and by 2080, they could be 41-58% lower. Winter flows will increase; by 2080, the average winter flow could be 45% higher. The river will get warmer with August temperatures at the upper end of what salmon can tolerate (Adams & Zimmerman, 2023).

Impacts: Floods that could change the course of the river and damage infrastructure will increase, as will as times when the river isn't safe to navigate. High flows also scour redds and spawning gravels. Lower summer flows will be challenging for fish and fisherman, as well as the hatchery.

"Especially getting towards summertime, they're really not a creek. They're like a trickle...There were times that we did do surveys on that creek but we couldn't because it was so low. We weren't going to see anything anyway."

Chief Daki Fisher

SEA LEVEL RISE & EROSION

Observed changes: Tribal members have seen coastal erosion dramatically change their beach. High water and coastal erosion forced members out of the old village site on the beach in the 1970s.

Predicted changes: Relative sea level will rise around 2.1 ft by the end of the century (Krosby et al., 2018). Rising sea level and total water levels are predicted to increase coastal erosion.

Impacts: Coastal erosion will shrink the footprint of the reservation; this causes harm as the land and cultural resources are affected. Erosion could also reduce habitat for species living on the beaches, like razor clams. High total water events can cause coastal flooding in low-lying areas. Outside of the reservation, ports and other coastal infrastructure that Tribal members use could be threatened by rising sea levels.

A WARMING OCEAN

Observed changes: One Tribal member has noticed that their hands get less cold while processing smelt than they used to. Another has pulled up dead crabs in pots and attributes that to hypoxic areas (parts of the ocean with too little oxygen to support life).

Predicted changes: Oceans have warmed around the world and this is predicted to continue. It's difficult to predict temperatures in the marine U&A because there are many processes happening at the same time, like upwelling and wind patterns. However, it's predicted that the U&A waters could warm by 1°C by 2050 (Miller et al., 2013).

Impacts: A warmer ocean could cause water circulation and regional weather patterns to change. It could slow the growth of some phytoplankton, algae at the base of the food chain. It will lead other phytoplankton to grow rapidly, causing harmful algal blooms and hypoxic areas. These can kill marine life and make shellfish dangerous to eat if the bloom produce toxins.

A MORE ACIDIC OCEAN

Observed changes: Surface pH, or the measurement of acidity in the ocean, shows that there has been a 30% increase in acidity (Miller et al., 2013).

Predicted changes: By 2100, a 150-200% increase in acidity is predicted. Aragonite and calcite concentrations, the carbonate ions that many animals use to build shells, are predicted to decrease (Siedlecki et al., 2021).

Impacts: More acidic waters make it difficult for some creatures, like oysters and mussels, to grow their shells. When creatures lower on the food chain struggle, these impacts ripple throughout the entire ocean. There will be other impacts of an acidic ocean that we don't yet know; for example, scientists recently learned that salmon don't smell as well in more acidic waters (Williams et al., 2018). This affects First Foods and those whose livelihoods depend on the ocean.

SHIFTING PLANTS & ANIMALS

Observed changes: Tribal members have seen some new species, including the occasional California squid. Many species have disappeared, like flounder and certain tidal creatures.

Predicted changes: The prevailing idea is that species who are able to will generally shift northward, up in elevation, and to deeper depths in the ocean to find habitat similar in temperature to their original range. Cedar is one species whose shift is predicted and is highly concerning.

Impacts: This could impact all First Foods and natural resources that Tribal members are connected with and depend on.

COULD 2015 PROVIDE CLUES ABOUT THE FUTURE?

Climate change preparation is all about understanding what the future might look like based on the level of greenhouse gases in the atmosphere. Sometimes we can look to the past to understand the future.

2015 was Washington's warmest year on record, so far, with average temperatures being 4.8°F warmer than pre-industrial times (UW Climate Impacts Group, n.d.). These temperatures are similar to what we expect in the future. Depending on the emission scenario, by 2050, average temperatures are predicted to be 1 - 7.5°F higher than the historical record. By 2100, average temperatures could be 2 - 13.5°F higher (Frankson et al., 2022). This will have ripple effects on the ecosystem including decreasing snowpack, increasing wildfires, and warmer ocean temperatures:

In 2015, snowpack across WA state was 70% below the normal amount (normal is considered the 1970-1999 average) (Snover et al., 2019). On the Olympic Peninsula, the maximum snow depth at the NPS weather station near Hurricane Ridge was 25 in. The average maximum depth is 104 in (Baccus, 2018). Summer river flows in the Olympic Peninsula were some of the lowest ever recorded (Petersen et al., 2015).

Across WA, 2015 was the biggest wildfire year on record in terms of acres burned; in eastern WA, over 1 million acres (about the area of Rhode Island) burned compared to the 10-year annual average of 470,000 (WA DNR, 2022). A lightning strike ignited the Paradise Fire in the Queets Valley wilderness which burned from May until November on the Olympic Peninsula (NPS, 2024).

There was a large bloom of *Pseudo-nitzschia*, an algae, which caused the largest recorded outbreak of domoic acid, a neurotoxin, along the west coast of North America. This caused many fishery closures, including Tribal razor clam and Dungeness crab harvests. The harmful algal bloom was caused by sea surface temperatures that were 2.5°C warmer than the average (McCabe et al., 2016). With climate change, waters will regularly become this warm by 2100.

Photos above are: "Olympic Mountains from Hurricane Ridge" by Paul Cooper, "Washington Wildland Fires" by WA DNR, and "285_razor_clam_odfw" by OR DFW. All are licensed under CC BY 2.0.

Verla Gomez teaching youth how to create beach mobiles during the 2024 Hoh Watershed Adventure Camp. Photo by Kelly Rosales.

WELL-BEING AND CLIMATE CHANGE

Everything is interwoven; the plants, animals, and landscapes that characterize the Hoh U&A cannot be separated from Tribal members' health and well-being. Because climate change has potential to damage natural resources and processes, it has potential to damage the Hoh way of life. However, opportunities accompany this challenge. Decisions to protect and enhance natural resources could improve well-being. The Hoh Tribe has adapted to change throughout the generations. They will continue to adapt, guided by their cultural values.

This section shares some perspectives from Tribal members on the impacts of environmental change. For more, see Appendix 3.

IDENTITY

" [The ocean is] where I belong...It's just me and a crew doing...what us as people were meant to do anyway. We live on a coast for a reason. So we're coastal fishermen. That's always just been a drive of mine."

Joe Hudson

IMPORTANCE OF CULTURAL PRACTICES

"Throughout the different years, we've been having different people in our canoes, different nationalities. We're leaving from Hoh River, we're going to La Push or we're going to Neah Bay. I'm going to ask each one of you guys 'What do you see with your own eyes out here?' We're sitting in the canoe out in the ocean, one to two miles offshore. 'Yeah, lots of water, we're in the Pacific Ocean.' So each one of you are seeing what our forefathers saw out here. It's all wildlife, Mother Nature. So you're seeing what they saw, different day, different year, seeing the same stuff. Whether you're on the left side of the canoe or the right side of the canoe when you're paddling, you're feeling what they did every day of their lives because they were fishermen, hunters and gatherers, all of our families on the coast."

Chief Howeeshata, Dave Hudson

WELL-BEING AND CLIMATE CHANGE

Photo by Kim Bray

EMOTIONAL IMPACT OF COASTAL EROSION

"We used to be able to have a road on the right side when you get to the beach to go on to the river. When the river and the king tides came, and the storms, they just wiped everything away. The Army Corps had to come in and dig big holes and put big rocks. When I saw it, I cried...I'm like 'Wow. This is our ancient village. This is our home. We can't drive down there.' It was really shocking, and I cried. But now we will open the other side...so we have river access because that's our elders, our fishermen, our kids... We all go down there. That's a very sacred place for us."

Hoh Tribal Member

INFRINGEMENT ON TREATY RIGHTS

"They're even trying to get us off of the beach from clamming because they think that we're only supposed to have a limit when they have no clue what kind of Native we are, Hoh River or Quileute or Quinault. They don't know, but they're ready to take our buckets and we lift our shovels and say 'Come and try it, Mister. We're calling your supervisor when we get to the car and you're going to get transferred because of what you just did. You're trying to prevent me from doing what I do to survive. This is our culture, not yours. It's not part of the park. Your park is right there at the end of that line. This ocean does not belong to the park. But it belongs to us.'"

Vivian Lee

SPECIES SHIFTS AND KNOWLEDGE SHARING

"Like 23 years ago, I brought them out to the beach, 4 kids, 5 kids. I brought lunch and drinks for them and chips. I'm bringing them to the tide pools and there's nothing in there. I'm showing them that there's supposed to be stuff in this tide pool, but there's no starfish, no mussels, no boots. We don't get to see those little snails. "

Vivian Lee

ECONOMIC IMPACTS

"There was just so much fish back in the day there. Nowadays, man, there aren't any seasons to make a living off of."

Richard Sheriff

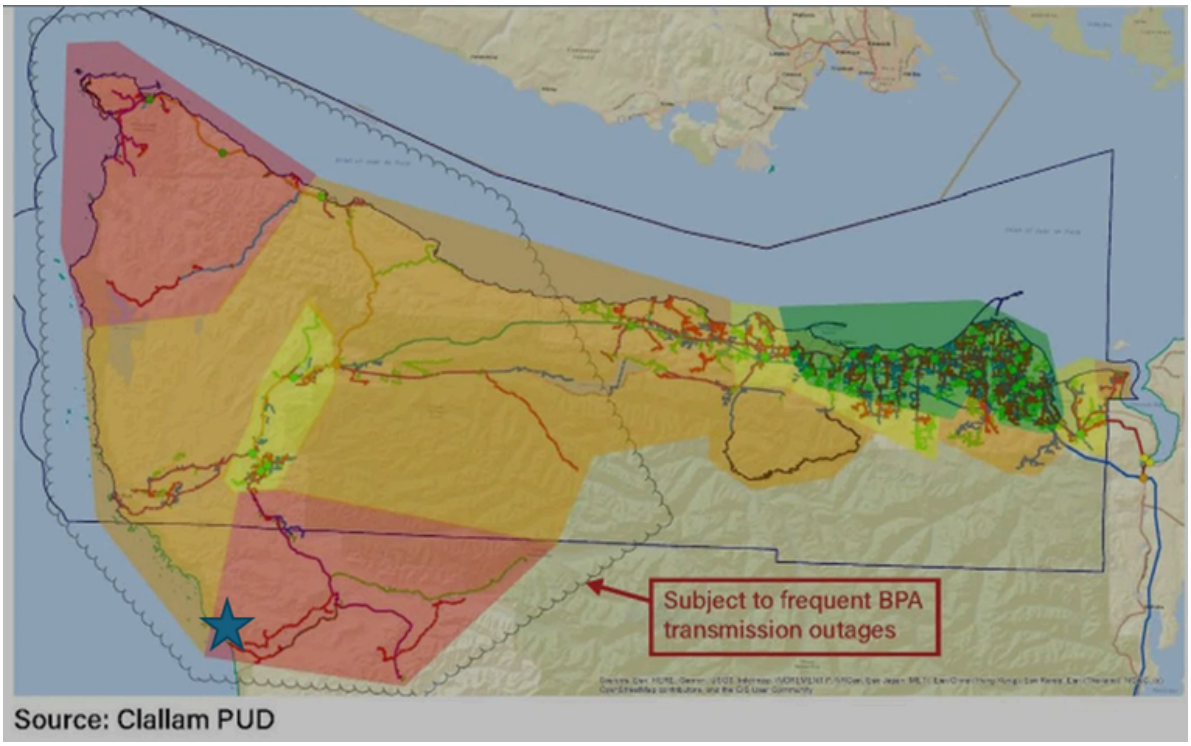
Drumming and singing at the old village site during the 2024 Hoh Watershed Adventure Camp. Starting from the left side of the circle, people pictured are Brenda Lee, Mya Fisher, Sonja Hudson, Ruby Sheriff, Vivian Lee, Chief Howeeshata Dave Hudson, Gene Sampson, and Jay Powell. Photo by Kelly Rosales

ACTIONS TO STRENGTHEN WELL-BEING

The Hoh Tribe currently has many programs underway to strengthen well-being and build climate resilience. To support those and offer additional ideas about actions the Tribe could pursue, here are a few ideas for Tribal staff, government, and members to explore. The stars (*) indicate ideas offered by Tribal members in the climate change interviews.

- Protect, conserve, and restore all natural resources and ecosystems within the U&A, including the most vulnerable like fish habitat, wetlands, riparian buffers, and tidal zones*
- Increase Tribal co-management / management and ensure that the Tribe is appropriately consulted on all decisions that might affect cultural and treaty resources*
- Maintain and create strict ordinances and protections against pollution of all kinds*
- Host potlatches, drum circles, and cultural events with the whole community*
- Retrofit and build new infrastructure with climate change in mind, including roads, housing, and utilities
- Research and employ water saving techniques to ensure Tribal members have enough water in times of drought
- Fund and support robust emergency management programs
- Support and increase ongoing cultural programming, including opportunities for youth*
- Continue strong participation in the Tribal Canoe Journey, a tradition started by Chief Howeeshata, Dave Hudson, with others
- Expand economic opportunities for the Tribe
- Continue to use and teach sustainable harvesting practices*
- Advocate for global reduction of carbon emissions in coalition with other Indigenous groups
- Increase natural resources monitoring and protection efforts*
- Pursue energy sovereignty while protecting the Hoh way of life and resources
- Increase land back, expanding the area that the Tribe can steward*

IN-DEPTH: ENERGY RESILIENCY ON THE HOH INDIAN RESERVATION



Source: Map originally from Clallam PUD but taken from a NODC presentation

The reservation, roughly represented by the blue star on the map, is in an area subject to frequent energy outages.

Climate change mitigation requires stopping fossil fuel use. However, energy is essential for human health so building renewable sources that don't harm Tribal cultural and natural resources is a necessity. Because energy is a central topic in climate change conversations, here is a brief look into energy resiliency on the Hoh Indian Reservation.

Currently, all the energy used on the Hoh Indian Reservation arrives from a single transmission line owned by the Bonneville Power Administration (BPA, n.d.). This line curves around the Hood Canal and brings energy north along the east side of the Olympic Peninsula. Just east of Beaver, smaller transmission lines bend south through Forks and carry energy to the reservation. The energy lines are alternatively owned by BPA and Clallam Public Utility District (PUD). **Because this electricity comes from a singular source, it has multiple vulnerabilities; outages anywhere along the line can affect the reservation.** Winter storms and trees often take out lines and, when they do, the amount of time it takes to restore power depends on how fast a crew can get there. Currently, BPA doesn't allow other companies to work on their lines and they don't station employees on the peninsula. If the storms cause other problems, like landslides or a Hood Canal Bridge closure, the response time is further delayed, lengthening the power outage. In the case of a major earthquake, the entire peninsula could be out of power for nearly a year (K. Affeld & L. Lesser, personal communication, April 26, 2024).

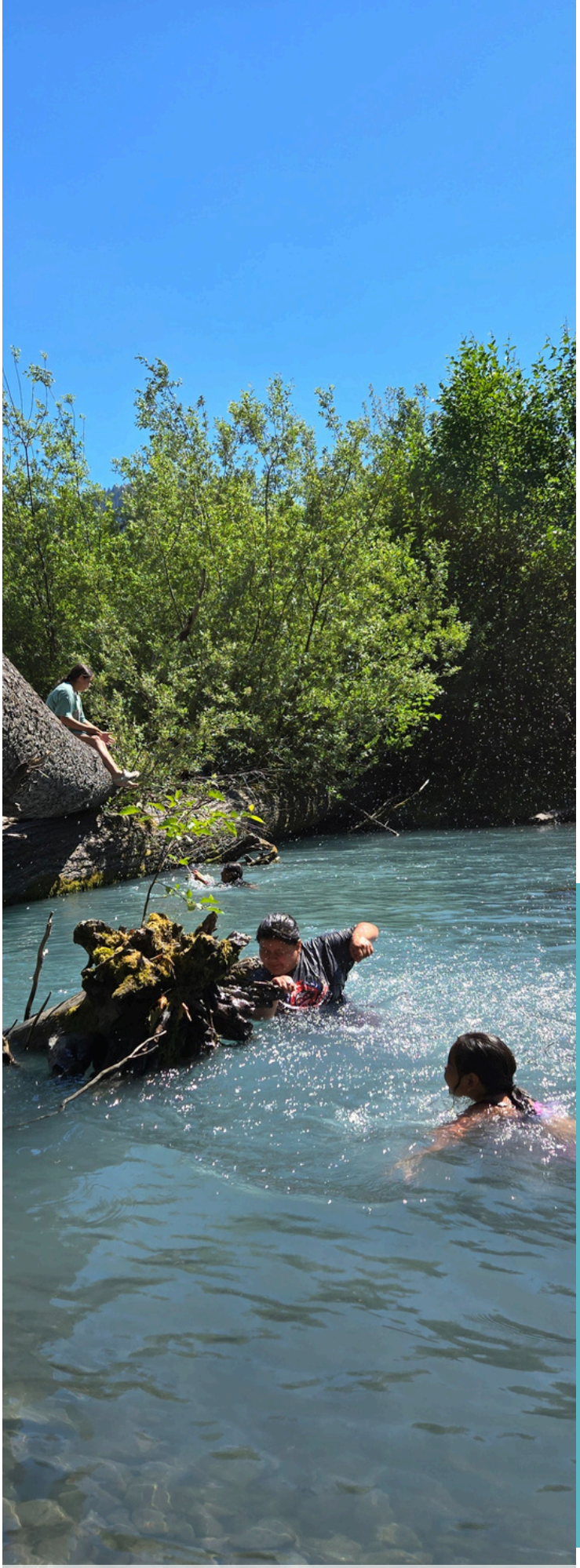
In the long term, there are additional risks to energy security. Energy demand is predicted to increase as populations grow, extreme weather prompts higher usage, and electric vehicle ownership increases. The existing infrastructure can't handle a large increase in energy load so updates to the grid are needed. Finally, 84% of BPA's energy production is hydroelectric, coming from 31 dams on the Columbia River and its tributaries (NODC, 2022, US Army Corps of Engineers et al., 2003). Energy production will be challenged by declining snowpacks and lower summer flows, as well as increasing summer demands from users who want to stay cool (BPA, 2021).

Having increased local power production and more energy sovereignty could be a compelling solution for the Hoh Tribe. While it would mean maintaining infrastructure, it would allow the Hoh to have power sources they support and energy production they have control over. Additionally, local energy production could be more reliable during times it's highly needed, like storms, cold snaps, and heat waves. It could also lead to additional economic opportunities, like selling energy credits. Electricity is necessary for Tribal operations that are directly connected with health and well-being, like running the Chalaat creek hatchery and operating both the water supply system and wastewater treatment plant.

Local energy solutions can include microgrids, solar production with storage, diesel generators, biomass generators, microhydro, or small scale onshore wind with smaller turbine blades that can be transported along Highway 101. Microgrids are a self-contained electricity system that can be connected to the main grid but can also isolate from it when outages occur, producing energy on its own. A combination of these could be utilized to allow the Hoh Tribe to be more energy independent.

Microgrid success story

In 2017, the Blue Lake Rancheria Tribe in California installed a $6.3 million dollar microgrid consisting of a 0.5MW solar system with a 950kW battery storage system. This system can provide energy for six buildings, including government offices and an American Red Cross shelter. In 2020, when the utility company Pacific Gas & Electric had to shut off power to 2 million people in northern California, the Tribe's microgrid was able to continue operating. They became an essential emergency responder, serving more than 10,000 people during the day-long outage. They hosted eight critically ill patients in their functioning hotel rooms, provided a space for the local newspaper to continue publishing, and had the only open gas station and mini mart in the region (Wilson, 2020).



Youth swimming in the Upper Hoh River during a summer heat wave. Photo by Kelly Rosales

HOH ECOSYSTEMS & CLIMATE CHANGE

This section covers how climate change is expected to impact the Hoh Tribe's natural resources. For the purposes of this assessment, the U&A is divided into four ecosystems (Marine, Forest, Wetlands, and River and Riparian) but that division only exists on paper. These ecosystems and their processes are interconnected and cannot be separated from each other. The same is true about humans; Tribal members and their well-being cannot be separated from these ecosystems.

Each section has a summary of the climate changes most likely to affect it. This is followed by a closer look at 1 - 3 highlighted species and their characteristics that make them resilient or vulnerable to climate change. For more information on each ecosystem and the highlighted species, see Appendix 4. To see how species vulnerability scores were calculated, see Appendix 6.

[Talking about school cedar bark harvesting activities]: ***"[The chaperones] showed us where, but now you have to get it at the right time because it gets sticky or hard and you can't pull it off the tree as much or it splits when you try to pull it... It's like the right time, right place. It's like you have to go right after a hot weekend, the first hot weekend, and then grab it, but if you keep waiting and waiting, it's going to be too soft, not good. If you go too early, it's just going to split it in half."***

Ruby Sheriff

Photo by Hannah Tennent

MARINE: OCEAN & TIDAL

Projected climate stressors to the ecosystem:

- **Ocean acidification:** Acidic waters with fewer carbonate ions will make it harder for some creatures to survive, impacting the entire food chain, including salmon.
- **Warming sea surface temperatures:** Warmer temperatures will stress species and make it harder for them to survive, having ripple effects on the food chain.
- **Rising sea levels and increasing total water levels:** This can cause greater coastal erosion and flooding events. Species who depend on sandy beaches or have narrow habitats along the beach could be negatively affected.
- **Increased marine heatwaves, hypoxic events, and harmful algal blooms:** These kill sea creatures and can create blooms of toxins that shut down fisheries and gathering due to serious risks to human health.

"We were having a tsunami warning there. Gee, smelts hit the beach. So we're all down there getting all the smelts there. We had state patrol, Coast Guard, park rangers all trying to get us off the beach. 'There's a tidal wave coming.' We don't care about the waves there, we want our fish. There's 15 trucks that went down there. We were loading those 15 trucks up with fish. Everyone there, getting them, using their coats, whatever they can find to put the fish in their trucks and they're trying to hurry up and get us off the beach. We're just... we're all worried about the smelts, getting the smelts. Tidal wave will come, will come. We'll be with it, we'll be with it. But we're getting our fish."

Brenda Lee

tó·piks (smelt)

Surf Smelt / *Hypomesus pretiosus*

Uses	Past Conditions	Current Conditions
Smelt are integral. K'wati gifted smelt uniquely to the Hoh Tribe. The smelt are sold, traded, and eaten in a variety of forms. Some consider smelt a medicine. Fishing for smelt is a treaty right. Smelt are a food source for marine mammals, sea birds, and other fish, including salmon.	Coastal beaches from the Quinault River to the Quillayute River have long been spawning grounds for abundant smelt. People remember catching 100 lbs of smelt in one thrust, dipnets too heavy to lift. When the smelt would hit, people used to call north and south, letting everyone know the smelt had arrived.	Smelt still spawn in the area but some Tribal members report it's much less than it used to be, that the fish are smaller, and that they don't arrive in schools. Some Tribal members say that fish in recent years have been a decent size. It's common now to only be able to fill a few coolers, as opposed to being able to fill a truck with totes of smelt. Smelt amounts fluctuate yearly.

Potential climate stressors	Compounding challenges	Beneficial actions
• Narrowing of beach spawning habitat due to coastal squeeze • Lack of prey due to ocean acidification and shifting upwelling • Warmer ocean waters	• Natural fluctuations in population size	• Conduct research on coastal smelt • Have communal gatherings focused on smelt • Assess beach habitat and protect spawning grounds

(more information and quotes in Appendix 4)

yàʔlí·ḵala

Pacific razor clams / *Siliqua patula*

Uses	Past Conditions	Current Conditions
Razor clams are an important traditional food. They also have commercial value and can be used in regalia and cultural items. Clamming is a treaty right. They are also important food for Dungeness crab, marine fish, and sea otters.	Razor clams have always been harvested by Hoh Tribal members.	Tribal members share that the clams at Kalaloch are smaller and less abundant that they used to be. The shells are also soft and break easily.

Potential climate stressors	Compounding challenges	Beneficial actions
• Ocean acidification • Warming waters • Beach erosion due to rising total water levels	• Nuclear Inclusion X (NIX) • Microplastics in clams presenting a danger to human health • Harmful algal blooms and marine toxins • Otter predation	• Continue HAB monitoring • Monitor and study razor clams, as well as beach erosion • Have communal gatherings focused on razor clams • Research beach erosion solution options

"The clams got real small at Kalaloch and south of there all the way to the primitive part. My sister and I go down that way...we can eat them, but it's just like you have to pick out the big ones that you do find and you put the little ones back so they can grow."

Vivian Lee

(more information and quotes in Appendix 4)

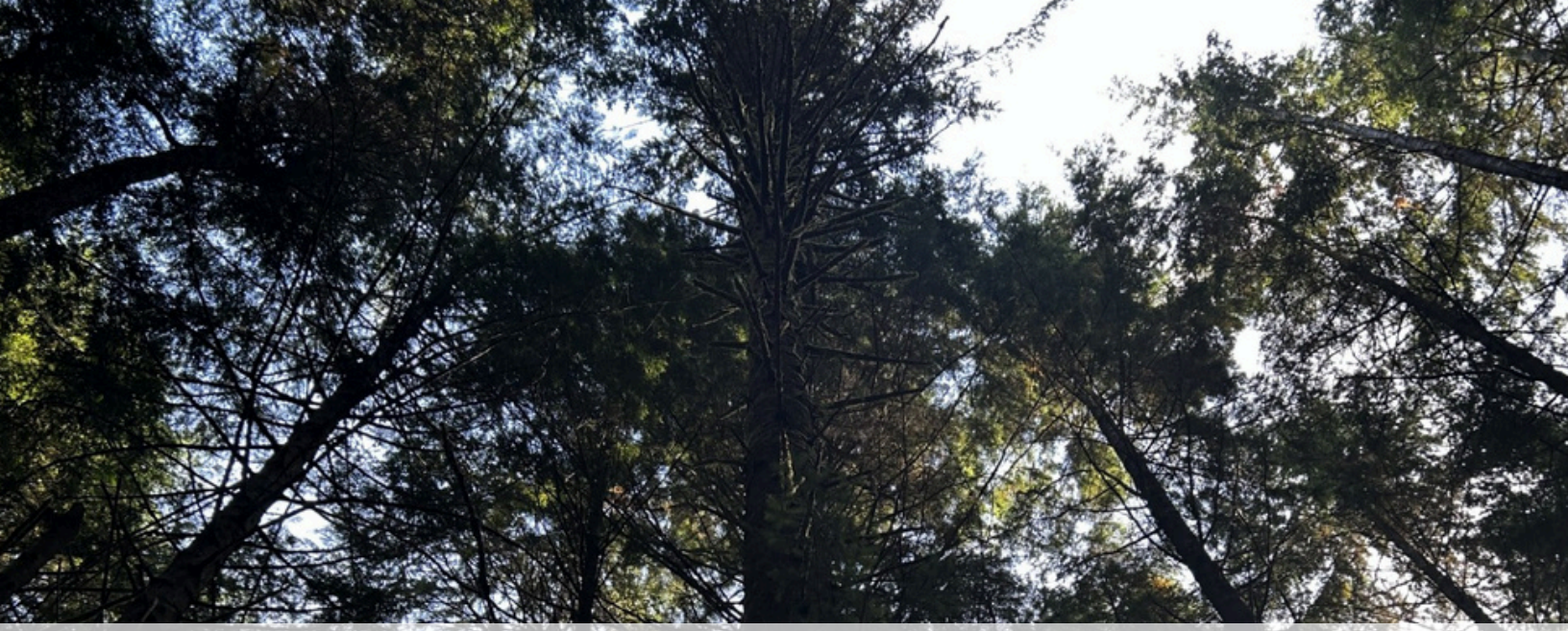


Photo by Hannah Tennent

FORESTS

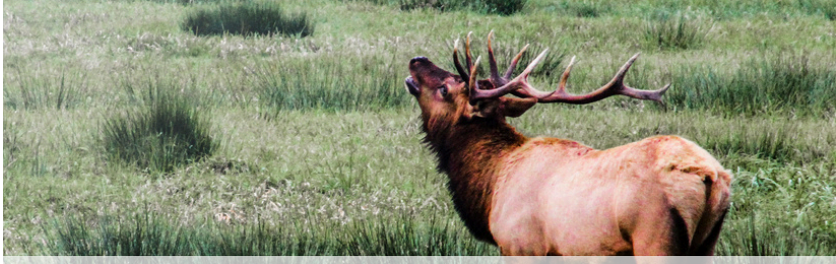
Projected climate stressors to the ecosystem:

- **Warmer air temperatures:** Both plants and animals are adapted to the current conditions in the forests. If temperatures increase more rapidly than species can adjust, it could stress them or even make the ecosystem uninhabitable.
- **Changing water availability through shifting precipitation patterns and declining snowpack:** Longer summer dry seasons will challenge species adjusted to abundant moisture.
- **Potential for increased wildfire:** Large wildfires are rare on the Olympic Peninsula compared to eastern WA. However, risk factors for fire, like longer dry seasons, are increasing. Large wildfires could alter forest composition as new species move in after burns.
- **Insects and tree diseases may thrive in warmer temperatures with longer growing seasons:** For example, the spruce weevil, which prevents Sitka spruce from growing tall, becomes active after winter when temperatures become warm enough for them (The Oregon Climate Change Research Institute, 2016).
- **Expanding invasive species range:** Invasive species may be able to move into new areas or expand their reach as native species struggle with changing conditions.

kí·kił

Roosevelt elk / *Cervus canadensis roosevelti*

LESS VULNERABLE



Uses	Past Conditions	Current Conditions
Elk are a food source. Hunting is a treaty right. They are integral to cultural practices, from different societies to regalia. Elk are also essential to the ecosystem; they are food for mountain lions. When elk die of natural causes, their carcasses provide food for hundreds of organisms.	Abundant before settlers arrived. Since settling, populations have fluctuated depending on hunting pressure, logging, development, and protection.	Many interviewees said elk are healthy and abundant. Some said they've noticed smaller herds and elk with smaller antlers. Elk hoof disease is not yet prevalent like in other parts of WA.

Potential climate stressors	Compounding challenges	Beneficial actions
• Spread of less nutritious invasive plant species • Drought	• Elk hoof disease • Chronic wasting disease • Development leading to habitat loss	• Preserve and restore habitat • Monitor and remove invasive species • Monitor for diseases • Engage youth and others in hunting

"I went into the hunting scene and, oh man, what a life it is that's out there."

Boe Horejsi

(more information and quotes in Appendix 4)

Oval-leafed huckleberry / oval-leafed blueberry / *Vaccinium ovalifolium*

MODERATELY VULNERABLE

"Oval-Leaf Huckleberry" by Peter Pearsall is licensed under CC BY 2.0

Uses	Past Conditions	Current Conditions
An important food source for people and animals. Berries and jam are sometimes sold or traded. Gathering is a treaty right.	There are many varieties of berries around the U&A. Tribal members have harvested across the Peninsula and as far as Mt. Adams for generations. People had abundant canned berries to eat throughout the year.	There are mixed experiences with berry timing. Some people report that the season has shifted earlier, with some berries freezing after budding out and huckleberries ripening in late July and early August now as opposed to August and September. Others have noticed that berry seasons are later than they used to be and that there are fewer blue huckleberries.

Potential climate stressors	Compounding challenges	Beneficial actions
• Habitat shift due to rain and temperature conditions • Wildfire		• Monitor and study huckleberry. Not much is known about their range or response to climate change. • Maintain and restore bog and wetland habitats • Determine if a program supporting huckleberry through seeding efforts or assisted migration would be appropriate • Host communal gatherings around huckleberry

(more information and quotes in Appendix 4)

cha?á·łowa

Salmonberry / *Rubus spectabilis*

LESS VULNERABLE

Uses	Past Conditions	Current Conditions
Both the berries and the salmonberry sprouts are an important food source. Berries and jam are sometimes sold or traded. Gathering is a treaty right.	Salmonberries have been abundant and something people have always eaten. Some salmonberry areas were managed with fire because the fruit yield would increase two years after being burned (Zouhar, 2019).	Many interviewees said they notice fewer berry bushes and smaller harvests. An exception to this is abundant salmonberries in logged areas. One interviewee said that the salmonberry sprouts are bitter tasting now.

Potential climate stressors	Compounding challenges	Beneficial actions
• Habitat shift due to rain and temperature conditions • Competition with non-native plants		• Monitor and study salmonberry. Not much is known about their range or response to climate change. • Maintain and restore riparian salmonberry habitat • Consider a return to fire as a management practice • Maintain and revitalize vigorous invasive species management

(more information and quotes in Appendix 4)

WETLANDS

Projected climate stressors to the ecosystem:

- **Decreased snow melt, decreased summer rain, and increased temperature:** Many of the bogs along the Pacific Coast depend on rain as their water source, as opposed to groundwater (Rocchio et al., 2014). Because of decreasing rain predicted in summers, as well as general warming, wetlands will likely become drier. Models predict that wetlands in western WA will dry out earlier in the summer than they currently do and wetlands that already dry out could be lost (Lee et al., 2015). These changes will cause plant species in wetlands to change, including those that are culturally important like camas and beargrass. Drying wetlands will also release their stored carbon into the atmosphere, contributing to climate change.

BACKGROUND

Wetlands are considered essential to Hoh people as excellent areas to hunt and find medicinal plants (Powell, 2002). Wetlands support an immense amount of life. By area, they are only 2% of Washington's landscape but over 66% of vertebrate animals use them. Forty-five percent of endangered, threatened, or sensitive plants live in wetlands (Rocchio et al., 2014). Certain wetlands themselves can also be rare, like the Crowberry Bog in the Hoh watershed. It is the only documented raised bog in the western contiguous United States and has been storing peat, or decomposing plant material, for over 15,000 years (Rocchio, 2019, Munguía, 2021). This ability to store peat, a type of carbon, makes preserving wetlands essential to slowing climate change. If wetlands are damaged, their carbon is released, adding to greenhouse gas concentrations. Unfortunately, wetlands can be easily destroyed by logging and development. A recent U.S. Supreme Court decision in Sackett v. Environmental Protection Agency loosened regulations around wetlands, making them more vulnerable. The Hoh watershed also has many cryptic wetlands, or forested wetlands that are invisible to satellite imaging, that are excellent carbon storage and valuable habitat (Mesa, 2024).

Indian Tea / Labrador Tea
Rhododendron groenlandicum

MODERATELY VULNERABLE

Uses	Past Conditions	Current Conditions
This is a traditional food with high cultural importance and medicinal properties. It provides habitat for birds, as well as food for insects, bees, and elk. Gathering is a treaty right.	Indian tea has been gathered since time immemorial in bogs on the Hoh U&A. Quileute and Hoh people practiced burning to maintain the prairies.	People have not observed any increase or decrease in the amount of tea. The best time to harvest is the fall, starting in September. Some members share that this timing has shifted later in the year.

Potential climate stressors	Compounding challenges	Beneficial actions
• Drying and warming wetland habitat	• Damaging harvest methods • Decreasing habitat due to forest encroachment or development	• Preserve and maintain wetland and prairie habitats • Host communal harvesting events • Monitor Indian tea as little information is known about how it might respond to climate change • Map wetlands in the Hoh U&A for management and protection • Consider returning to controlled burning as a management method

(more information and quotes in Appendix 4)

Photo by Kim Bray

RIVER AND RIPARIAN

Projected climate stressors to the ecosystem:

- **Lower summer flows:** The Hoh River will see lower flows in summer due to less summer rain and declining glacial and snowpack melt. Low flows can block fish migration.
- **Warming temperatures:** A consequence of lower flows is warmer rivers. This creates challenging environments with lower dissolved oxygen concentrations for fish and other life.
- **Higher winter flows:** Increased winter rain will cause higher flows which can cause floods, scour habitats, and change the course of the river.

"You have see it to believe it. I could tell you where the river was compared to where it's at now and it's unrecognizable. It used to rub right up against a schoolhouse that was across the river about right there on the other side. Now it's 300 yards away from there, from where that schoolhouse is. Just since the '90s. It was a major channel over there at one time. Now it's just filled in with sand. And it'll probably be back over there in 30 more years. Just the way the river flows. Who knows?"

Joe Hudson

hà·dí·ḵʷa (salmon, general)
ʔá·p̓ita (salmon, fish, general)

Pacific Salmonids

EXTREMELY VULNERABLE

To keep the report short, all Pacific salmon are combined. Impacts to different species will depend on their biological needs and seasonal timing of their life cycles, among other issues.

<table>
<tr><th>Uses</th><th>Past Conditions</th><th>Current Conditions</th></tr>
<tr><td>Salmonids are a keystone species ecologically, economically, and culturally. Fishing is a treaty right.</td><td rowspan="2">The saying goes that salmon were so thick, you could walk across the river on their backs. Interviewees recalled fishing seven days a week when they were younger. They regularly caught 25 – 50lb spring salmon. Canoes would be so full of fish that they were difficult to paddle back to shore without tipping over.</td><td rowspan="4">Compared to other rivers in the US, the Hoh has a healthy wild salmon run. However, Tribal members have witnessed declines over the generations.

Some people say fish are smaller and are moving to new areas to find quality habitat conditions. Fall fisheries have occasionally opened late due to low water levels. Other seasons have closed early because of low catch numbers or below average numbers of redds.</td></tr>
<tr><td>Potential climate stressors</td></tr>
<tr><td>• Both river and ocean temperatures becoming too warm
• River levels becoming too low in the summer
• Winter storms scouring redds
• Lack of prey in the ocean due to acidification</td><td>Compounding challenges

• Pollutants, including oil spills and emerging contaminants of concern, like 6PPD-Q
• Transportation infrastructure that blocks fish passage, like under-sized culverts
• Degraded streams due to sediment and invasive species
• Habitat degradation due to legacy logging impacts
• Overfishing</td></tr>
<tr><td colspan="3">Beneficial actions</td></tr>
<tr><td colspan="2">• Preserve existing habitat and implement restoration projects that expand habitat
• Increase groundwater connection through woody debris installation
• Continue to buy land along the river to preserve large buffers and increase Tribal access</td><td>• Reduce stressors like urbanization, pollution, and erosion
• Continue monitoring
• Remove fish passage barriers
• Carefully manage hatcheries to reduce risk to wild salmon
• Connect youth with fishing opportunities</td></tr>
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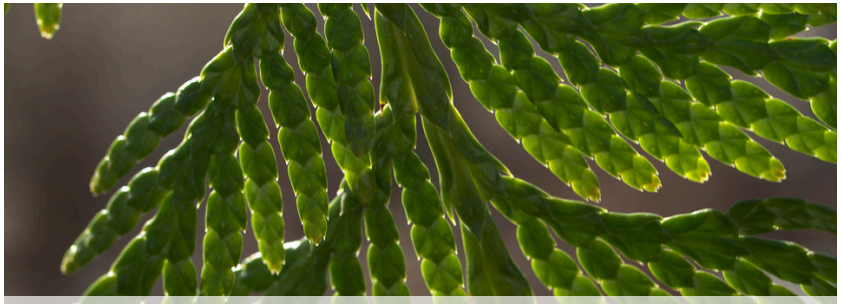
t̓sá·pis / t̓saʔá·pis

Western redcedar / *Thuja plicata*

HIGHLY VULNERABLE



Uses	Past Conditions	Current Conditions
Redcedar is a cultural keystone species. It is used to make many different items, including canoes, drums, carvings, regalia, gifts, and baskets. Different size cedar is useful; for example, cedars with large diameters are needed for dug out canoes. Cedar items are often traded or sold as an income source. Gathering cedar is a treaty right. Cedars are massive trees central to the ecosystem, providing important habitat and shade for rivers.	Redcedar has been abundant in the Hoh U&A. Logging of all species has been extensive in the U&A and the Olympic Peninsula (Van Pelt, J., 2007).	Interviewees noted that forests seem to be healthy, although there isn't much old growth around as there used to be; even the trees that wash up on the beach are smaller than what people remember when they were young. Cedar is still accessible for gathering but some people are seeing a shift in the best time to gather it. There have been fewer observations of redcedar dieback along the coast than in Puget Sound and central WA (Goodrich et al., 2023).

Potential climate stressors	Compounding challenges	Beneficial actions
• Drought • Wildfire	• Illegal cedar harvest and sale, including boughs, wood, and bark	• Continue communal cedar gathering • Monitor redcedar to understand any changes in population • Protect existing cedar trees, particularly in high soil moisture areas, and allow stands to grow large • Consider planting cedar in areas with high soil moisture content

(more information and quotes in Appendix 4)

IN OUR WORDS: SPECIES LOSS AND SHIFT

The decline of fish:

“We need something big to change because they are gone [referring to a fall king salmon replica in the Natural Resources office that likely weighed 35 – 50lbs and is longer than 3 ft]. I haven't seen one of them since the ‘80s. That's a big old toad there. They were regularly like that in our nets.”

Joe Hudson

Fluctuating razor clams:

“I wish we’d get the monster ones down there like in Taholah…One year, I was with my uncle…We're all in a circle talking and one guy was tapping his foot and the clam hole chirped up… So we all moved away from him there and that clam he dug out, it came out like that [shows the size of about a 12-inch clam].

He got full off of that one clam and he said that we used to have those down here. We don't any more. Only have the medium size or the little ones.”

Brenda Lee

Shifting seasons:

“I do know it's a different time with gathering the cedar because we used to go towards the end of April, beginning of May and now it's towards the end of May, beginning of June. We have to wait for the sap to quit running or else our bark, when we peel it, is pitchy. Nobody wants pitchy bark, especially me.”

Marie Riebe

“Well now, because everything's changing, it's so weird. Usually the huckleberries and stuff came in August, September and now they're early, they're fast. They come fast now like early August, late July… It’s just so weird because I never saw blackberries grow with salmonberries.”

Ruby Sheriff

CONCERNS

This list summarizes the concerns that surfaced in interviews. Some are directly related to climate change while others are more general environmental concerns but it's all listed because everything is connected. Many overlap, even though they are categorized. These are not ranked in any manner and some represent multiple people's concerns while others might only represent one person's.

Harm to species and ecosystems

- Declining species, including smaller clams at Kalaloch, declining fish, and the spread of elk hoof disease. People expressed concerns from economic, cultural, ecological, and subsistence viewpoints.
- An unhealthy ocean, including warming waters, hypoxia events, ocean acidification, and pollution
- Overfishing due to sport fishers, state management of fish, and international management
- Overhunting of elk due to an abundance of seasons provided by state managers
- New development causing harm. Specific impacts mentioned included:
  - Decreasing habitat for elk
  - Warming river waters caused by removing trees and making buffer zones too small
  - Redds becoming damaged by winter floods, sedimentation, and an accelerated river caused by riverbank armoring and road construction
  - New development without sufficient science to show there won't be damage, like moving too fast on offshore wind
- Pollution negatively affecting species and drinking water, including damage to natural springs
- Logging cycles that are too short and trees not getting big enough to provide healthy habitat for birds and other animals
- Incorrect commercial harvesting that damages ecosystems. Examples include:
  - Salal and beargrass being overharvested and in a way that doesn't ensure continued productivity
  - Legacy impacts of bottom trawling in the ocean
- Human produced sound in the ocean harming whales

Risk to human health and Tribal infrastructure

- Insufficient water supply for people and the hatchery during the summer
- Erosion of the reservation area, including the beach, the road, and historical homes
- Tsunamis
- Flooding risks, both from the river and the ocean
- Poor air quality due to both wildfire smoke and pollution

Infringement on treaty rights and cultural traditions

- Locked gates preventing access to the U&A (covered in Appendix 3)
- Infringement on exercising treaty rights, like people trying to enforce limits or prevent Hoh Tribal members from being in certain areas
- A lack of gathering spaces, like a longhouse, leading to cultural loss and people spending less time together

DESIRES AND HOPES

This list summarizes the desires that surfaced in interviews. Some are directly related to climate change while others are more general but it's all listed because everything is connected. Many overlap, even though they are categorized. These are not ranked in any manner and some represent multiple people's hopes while others might only represent one person's.

A healthy environment with abundant wildlife populations, including tidal life, fish, and plants. There were a variety of solutions and actions proposed including:

- Habitat restoration along the river to increase shaded areas
- Improvements to the Chalaat hatchery, which is generally viewed positively:
  - More hatcheries on creeks and rivers with year-round flow, like the South Fork
  - Stocking with additional fish from the Cook Creek hatchery
  - An expansion of the Chalaat hatchery including increased broodstocking and producing coho
  - Releasing fish further upriver where the water is colder
- More scientific information and monitoring, as well as staff members. There was a request for more communication that isn't online between staff and the community. A Tribal member shared how they felt valued when the Natural Resources Department asked for help in decision making.
- Continued focus on removing noxious weeds
- More green energy use instead of fossil fuels

Protecting human health and infrastructure

- Protection of the current land base and preventing erosion of the beach
- An increase in First Foods, including salmon, clams and berries, so that pantries are full
- Having abundant educational opportunities for youth, as well as career opportunities, like internships. Having Native role models and Native representation at schools and in the workplace.

Protecting Treaty rights and ensuring cultural continuance

- Increasing access to the U&A
- Land back within the U&A
- Ensuring protection of treaty rights and maximum harvest allowances for Tribal members. One Tribal member wanted more fishing days. Another expressed support for closing the river to fishing for awhile to let the resources rebound.
- Having stable cultural programs and providing resources to elders
- Widespread teaching and sharing of cultural traditions and knowledge, both within families and through programs for the wider Tribal community
- Continued participation and involvement with the Tribal Canoe Journey
- Protection of Hoh Tribal cultural artifacts and restoration of others, like the beach house

Things people are hopeful about

- Young people in leadership and stepping up as cultural role models
- Ongoing cultural programs and reconnecting with the language
- Expansion of economic opportunities in the marine U&A
- Careful management of fish

Gratitude

This project benefited from following in the footsteps of others. Being able to follow their methods and receive inspiration from their work was invaluable. Here are some of the reports and plans that greatly influenced this assessment. A full list of referenced publications follows.

Aanji-bimaadiziimagak o'ow aki, a 2023 assessment written by the GLIFWC Climate Change Team. *(The species charts and some interview questions are directly from their work.)*

Climate Adaptation Plan for the Territories of the Yakama Nation Version 1, a 2016 assessment written by the Yakama Nation, Cascadia Consulting Group, SAH Ecologia LLC, and University of Washington Climate Impacts Group.

Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes, a 2016 assessment written for the Quinault Indian Nation, Hoh Indian Tribe, and Quileute Tribe by The Oregon Climate Change Research Institute.

Climate Vulnerability Assessment and Adaptation Plan, a 2013 assessment written by the Jamestown S'kallam Tribe.

Author positionality statement

My name is Hannah Tennent. I am a white American who was raised in New Mexico and has lived in Seattle, Washington on the land of the Coast Salish people for the past ten years. I graduated from University of Washington's School of Marine and Environmental Affairs in June 2023. This climate change assessment was the focus of my 2023 - 2024 Hershman Fellowship, a program run by WA Sea Grant. Because my position as a non-Native fellow working for the Natural Resources Department could influence this work, I tried to ground ideas in interview comments and topics addressed in Tribal climate resources.

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APPENDIX 1: REPRESENTATIVE CONCENTRATION PATHWAY SCENARIOS

Climate models use sets of equations to represent the processes that make up the Earth's climate. Models are tested through "hindcasting" or putting in variables from the past, like greenhouse gas levels, and seeing if the outcome matches historical recorded conditions. Scientists are confident that models accurately represent earth systems, but each model differs and they all contain some level of uncertainty because Earth's complexity is inherently difficult to replicate. Because of this, ranges of predictions are shared in this report whenever possible. When one scenario is used, it's often RCP 8.5, the scenario in which no climate mitigation is done (see below). This was chosen so as not to underestimate the risks.

Different climate scenarios allow us to prepare for varying futures based on the level of greenhouse gases in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) is recognized as an authority on climate change and they've issued several scenario types throughout the years. The first were published in 1992 and then refined in 2000. One of those scenarios is referenced in this report: A1B. In this scenario, the world has more efficient fossil fuel technology and, in 2050, both population and emissions peak (IPCC Working Group III, 2000). This report primarily uses the scenarios from the 5th IPCC Report called Representative Concentration Pathways (RCPs). These are defined by how many greenhouses gases are in the atmosphere by the year 2100 (IPCC, 2014):

RCP Scenario	**Level of mitigation**	**Greenhouse gas concentration in atmosphere by 2100 (ppm)**
RCP 2.6	Very strict. Greenhouse gases peak around 2020 and then decline to 0 by 2100. The world has passed this scenario.	430 - 480
In 2023, the global average greenhouse gas concentration was 419 ppm (Lindsey, 2024).		
RCP 4.5	Some mitigation. Greenhouse gases peak around 2040. This scenario is still possible but would require immense and immediate mobilization.	580 - 720
RCP 6.0 (similar to A1B)	Some mitigation. Greenhouse gases peak around 2080.	720 - 1000
RCP 8.5	No mitigation. Greenhouse gases continue to rise.	> 1000

APPENDIX 2: CHANGING CLIMATE CONDITIONS IN THE HOH U&A, EXPANDED

Warmer air temperatures

The increasing greenhouse gases that cause climate change are like a warm blanket in the atmosphere; they keep heat in. As humans keep producing greenhouse gases, this blanket gets thicker, and the Earth gets warmer. **Average air temperatures have risen and are predicted to keep rising. This is the underlying cause of most of the changing climate conditions covered in this appendix.**

- **Observed changes:** Tribal members say that winters feel warmer than they used to and that summers are getting hotter. Some noted that the air temperature difference between the reservation and Forks is noticeable, with Forks being warmer, and they are grateful to live near the ocean where the air is cooler. One Tribal member shared that they recently bought their first air conditioner.
- **Predicted changes: Temperatures will continue to change seasonally, but, overall, the trend will be towards warmer temperatures.** From 1971-2000, the average annual temperature in the Hoh watershed was 46.3°F (7.9°C). It's predicted to rise to 50.8°F (10.4°C) under the RCP 4.5 scenario or to 54.1°F (12.2°C) under RCP 8.5 by the end of the 21st century. At the end of the 20th century, there were 0.2 days per year

with temperatures over 86°F (30°C). By the end of the 21st century, that could rise to 1 - 23 days depending on the location in the U&A and on the level of carbon emissions. In the Olympic Mountains that feed the Hoh River, freeze-free days, or days with a minimum temperature above 32°F (0°C), will increase, reducing snowfall (Krosby et al., 2018).

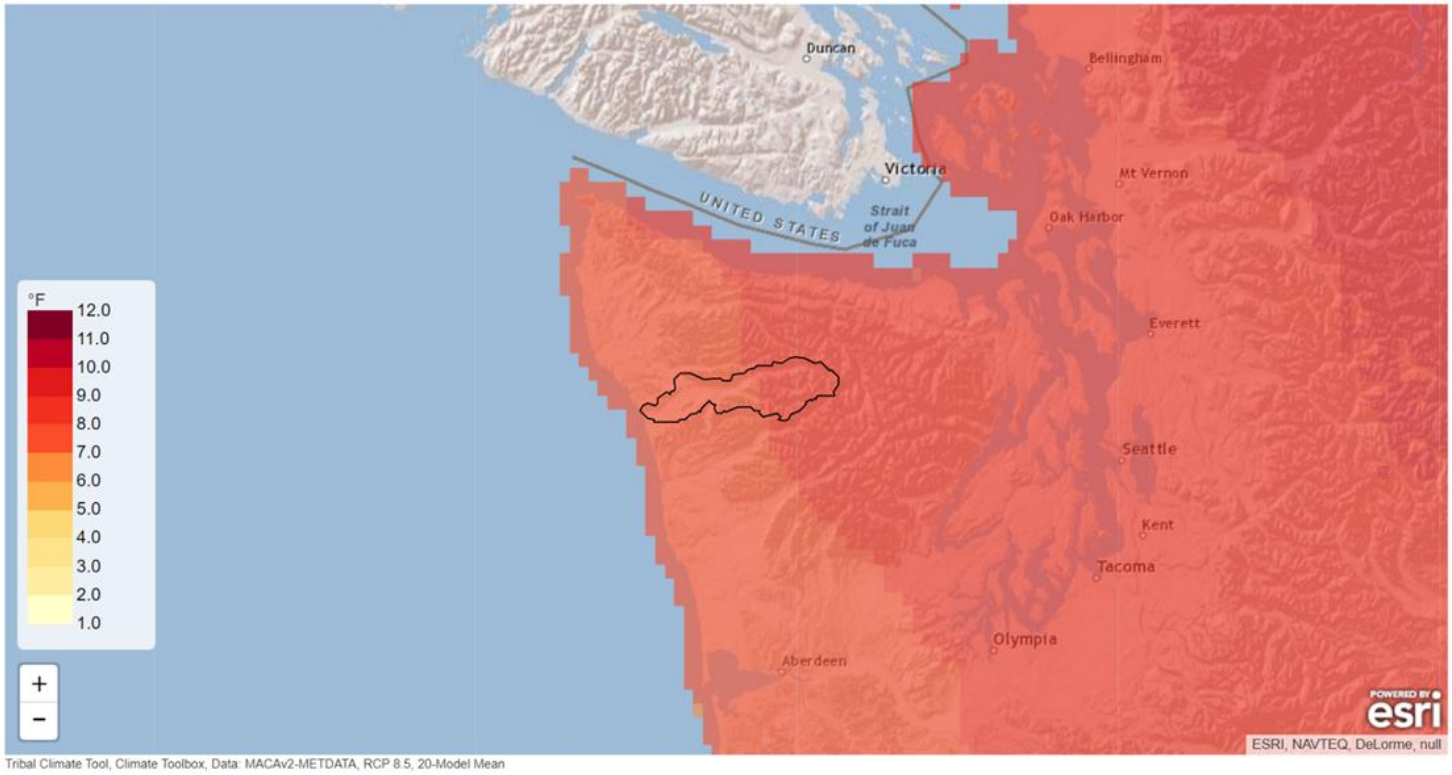


Figure 1. Projected Change in Annual Average Daily Temperature 2070-2099 vs. 1971-2000 under a Higher Emissions Scenario, RCP 8.5. This image shows the Olympic Peninsula with the Hoh watershed, a portion of the Hoh U&A, outlined in black. Under a high emissions scenario, average annual temperatures along the western side will rise by 7-8°F while the eastern side will rise >8°F (Krosby et al., 2018).

Changing rain

Abundant rain is a part of what defines the Hoh Tribe's ecosystems and creates the familiar landscape. The Lower Hoh River sees an average of 102 to 142 inches of precipitation per year (WA DNR, 1999). In the future, the pattern of when and how much rain arrives will change. **Summer rain levels will decrease, while winter rain will increase.**

- **Observed changes:** Some Tribal members aren't experiencing a shift in rain patterns, noting that the alternating wet and dry seasons that have always existed are continuing. Others have observed drier summers. Historically, summer fog levels have been relatively high, and this helps offset some of the moisture stress (Spies et al., 2018).

"For example, we used to always have to mow our lawn every week, otherwise it would get too long. Every week we had to mow the lawn. And now this last year, I think we mowed it maybe three times. I'm pretty sure it was just three times instead of every week. Even Philip [Riebe] goes 'Man, I can't believe we're not mowing the lawn.' I said 'I know. It doesn't need it.'"

Marie Riebe

- **Predicted changes:**

Winter	Summer
 **More rain is predicted to fall during the winter.** From 1971-2000, the Hoh watershed received an average of 115 in of rain in the winter. From 2070-2099 under RCP 8.5, the watershed could expect anywhere from 125-129 in during the winter (Krosby et al., 2018). **Increased intensity:** Heavy rainfall events, often called atmospheric rivers, are expected to become more intense across western Washington after 2050 because warmer air can hold more water (Mauger, 2019).	 **Less rain will fall in summer.** Right now, the watershed sees 34 in from April to September. Models estimate that the watershed will have a few inches less fall in the summer, around 32 in by 2070 under RCP 8.5 (Krosby et al., 2018). Late summer precipitation from mid-July to mid-September could decline by 1 – 12% (Raymond & Rogers, 2022). **Drought:** Drought is legally defined in WA as summer precipitation below 75% of normal summer precipitation. Under RCP 8.5, the chance of summer drought happening increases as time goes on, up to a 32 – 47% chance by 2070 (Raymond & Rogers, 2022).

Snow

Increasing temperatures have changed winter on the reservation. Many Tribal members have observed less snow during winters in their lifetime:

"That field down there, when they first opened it, the snow used to get up there, four or five feet high. We used to all go over, make a maze in that field. We'd play tag and everything on that field when we were all younger. Now you can't even get two inches of snow…You can get it up the road but not here. So that's how much it really changed."

Walter Ward

Ruby: ***"We haven't been having a lot of snow, like it will be snowing and then it'll be here for a couple of days, like a day, three days and then it's melted and gone. It's just bogus because I love the snow."***

Interviewer: ***"Do you feel like it snowed more when you were younger?"***

Ruby: ***"Oh yeah, because my sister used to bring us to the beach, and we'd go down that big hill down there... We had to go early in the morning when nobody drove in it because we only get a couple inches of snow and not a couple feet of snow."***

Ruby Sheriff

"I don't know if it was just a shorter time period, but it seemed like we had more snow days... throughout the whole school year. It wasn't just one week straight. It might have been different times of the year I thought but it was too crazy. We had more snow when I was younger, but maybe it was just that I couldn't keep track of time or something like that. Whether it was one a week, but it seemed like it was different times of the year."

Richard Sheriff

Melting and disappearing glaciers

The thin glaciers on the Olympic Mountains are particularly susceptible to temperature shifts. They exist at a relatively low elevation where a slight air temperature change can transform snow to rain. At Hurricane Ridge (5,242 ft) on the northeastern side of the National Park, the average winter temperature is 29°F (Baccus, personal communication, 2024). **Because of warming temperatures, glaciers are a fraction of what they once were, and they are predicted to disappear by 2070 if carbon emissions are not curbed.**

"The years that I went upriver with my grandfather [Charles Sailto Sr], we went all the way up to the top where the snow and glacier was. He took pictures of that. When I first went up, it was pretty much this way. I went up with our biologist and I go 'Where are the glaciers?' They moved up, melted about 10, 15 miles or more. We've been observing them. They're moving maybe about 2 to 3 feet a year, melting that much. That has changed quite a bit."

Walter Ward

- **Observed changes:** Historically, snow fell on the Olympic Mountains in winter where it contributed to glacier growth and formed snowfields. With temperature shifts, much of that snow is now falling as rain. Then, as warmer summers arrive, melting of the dwindling snowpack and shrinking glaciers starts earlier and continues steadily through the summer. One Hoh Tribal member shared that they've seen the snow line shift upward throughout their life. This observation matches the monitoring record; there has been a

downward trend in snowpack levels in the Olympics since 1949 (Baccus, personal communication, 2023). In 2015, the area of glacial ice and snowfields in the Olympic Peninsula was only half of what it was in 1900 (Fountain et al., 2022). From 1980 – 2009, temperature rise reduced the Hoh Glacier's thickness by 15% (Riedel et al., 2015).

Blue Glacier Loss 1899 - 2008

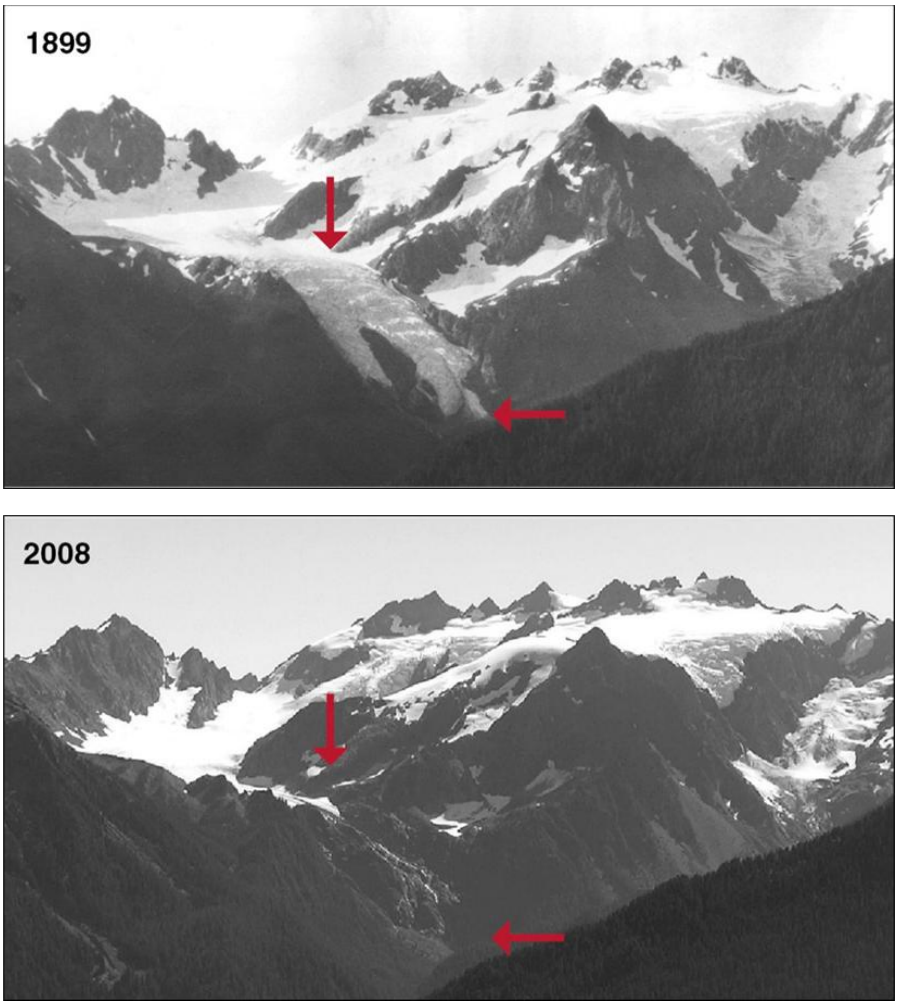


Figure 2: Blue Glacier Loss. The red arrows are in the same spot on each photo, showing the dramatic loss of Blue Glacier, one of the glaciers feeding into the Hoh River (Photos provided by Mike Larrabee, Physical Science Technician with the National Park Service NCCN Inventory and Monitoring Program).

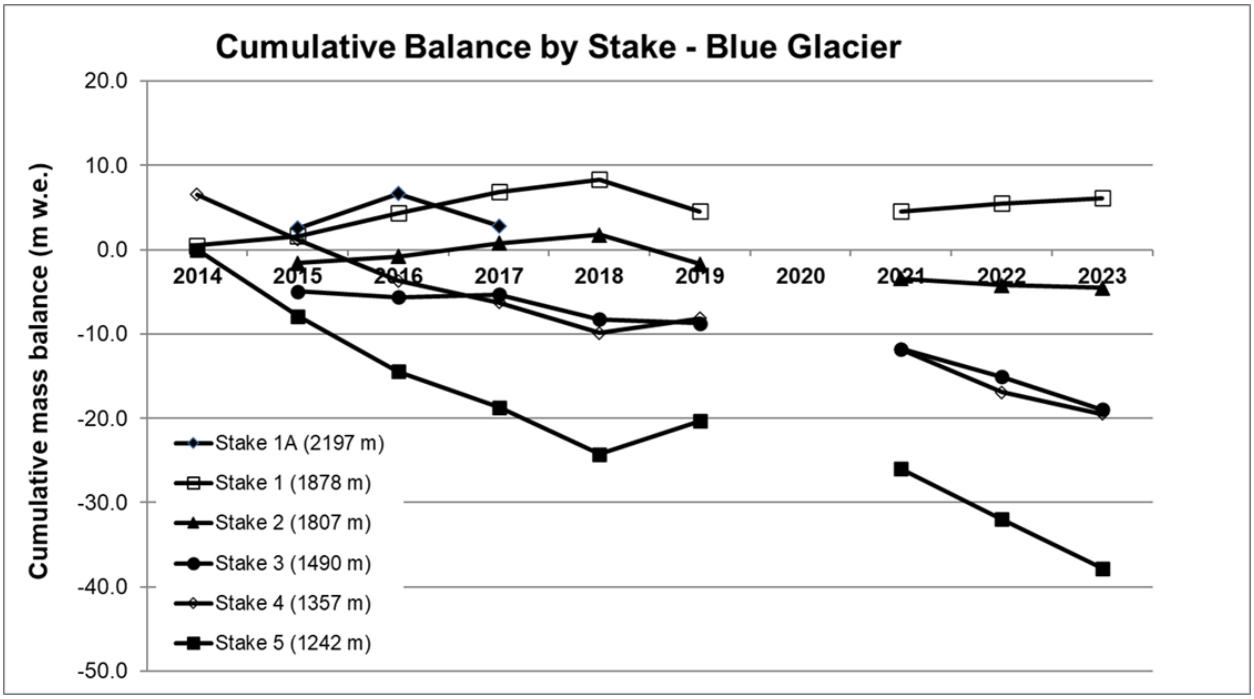


Figure 3. Cumulative Balance by Stake – Blue Glacier. This graph shows the cumulative balance of the glacier, or how much ice it has and whether it is gaining mass, remaining the same, or losing mass. By taking accurate measurements of the stakes, scientists can calculate how much mass the glacier has gained or lost in any given year. The stakes are at different elevations along the glacier. In more recent years, the lower elevation stakes in areas with warmer temperatures have increasingly lost more mass. The change is more pronounced in the lower elevation stakes, but most of the higher elevation locations are losing mass too, except Stake 1. (Graph provided by Mike Larrabee, Physical Science Technician with the National Park Service NCCN Inventory and Monitoring Program)

- **Predicted changes:**
    - **Glacial disappearance:** Glaciers are predicted to fully disappear from the Olympic Mountains by 2070 if carbon emissions continue unabated, the future represented by RCP 8.5. If emissions are quickly mitigated, under the RCP 4.5 future, glaciers will be around a few square km and exist only on Mt. Olympus (Fountain et al., 2022).

Rivers and streams with warmer temperatures and shifting flows

The streams and rivers in the U&A are predicted to be warmer, with higher winter flows and lower summer flows. The mainstem of the Hoh River is predicted to have an average August temperature of 16 – 20°C, the upper end of the temperature range in which salmon can survive (Adams & Zimmerman, 2023).

- **Observed changes:**
    - **Water temperatures:** The Hoh River is known for having cold water, but temperatures in streams are rising; currently 14 waterbodies have high water temperatures unsuitable for their designated salmonid habitat (NWIFC, 2020).

- **Flows:** Since 1960, the 7-day minimum recorded flow on the Hoh River has been highly variable but the overall trend is decreasing. The minimum flows range from 260 cubic feet per second (cfs) – 1000 cfs. In years where it was below 300 cfs, Tribal staff members observed Chinook salmon unable to move upstream (Golder Associates Inc., 2005).
- **Changing shape of the river:** Tribal members shared how the river is wider and shallower now than it used to be when they were younger. The river and its tributaries are likely widening, in part, due to effects of historical logging. Before riparian buffer zones were established as the best practice, the old growth trees were removed right up the edge of the streams. The alder stands and other trees that grew up in their absence aren't large enough to prevent the banks from eroding during high flows, allowing the channels to widen. Additionally, when the small trees now along the river fall in, they are washed downstream. Unlike old growth trees, they don't create hard points in the river and build islands that add structure. The wider channels, along with a lack of large woody debris to create deep pools and less canopy cover, contribute to the rising stream temperatures.

Interviewer: ***"You were saying the creeks change. It sounds like with high water they could split or change spots. Were there any other ways that the creeks were changing?"***

Daki: ***"Especially getting towards summertime, they're really not a creek. They're like a trickle…There were times that we did do surveys on that creek, but we couldn't because it was so low. We weren't going to see anything anyway."***

Chief Daki Fisher

- **Projected changes:**
  - **Lower summer flows:** The receding glaciers are one of the primary culprits behind lower summer flows. Between 9 - 15.4% of the total summer flow in the Hoh River currently comes from glacial ice and snow melt. However, the glacial contribution can increase to as much as 18- 30% of the flow in August, with 1/3 of that coming from melting glacial ice alone (Riedel et al., 2015). Summer flows are in for severe reductions due to this disappearing glacial contribution and less rain. By 2040, the Hoh River mainstem could see flows that are reduced by 20 – 30% in the summer, while smaller tributaries will see reductions of less than 10% (The Oregon Climate Change Research Institute, 2016). By 2080, under a high emissions scenario, the average summer flow in the mainstem could be 41 - 58% lower and the duration of low streamflow will get longer (Adams & Zimmerman, 2023; Raymond & Rogers, 2022).
  - **Higher winter flows:** Winter flows will grow with increased rain, as will spring flows with earlier snowmelt. Mean winter increases of 0 – 10% are predicted in streams and tributaries. These small changes accumulate in the Hoh River which could see the winter average flow increase by 45% (Adams & Zimmerman, 2023). More 100-year magnitude floods are expected (Miller et al., 2013).
  - **Warmer temperatures:** While water temperatures aren't predicted to rise as much as in other watersheds along the coast due to glacial melt and snow input, the Hoh U&A will see warming waters that are harmful to fish. Under RCP 8.5, the headwaters are anticipated to stay below 12°C (53°F) in the summer but the mainstem of the Hoh is predicted to have August average temperatures between 16-20°C (60-68°F), at the upper end of the salmonids' range (Adams &

Zimmerman, 2023). Because that's a prediction of the average, there will be days where portions of the river have temperatures above what salmonids can tolerate.

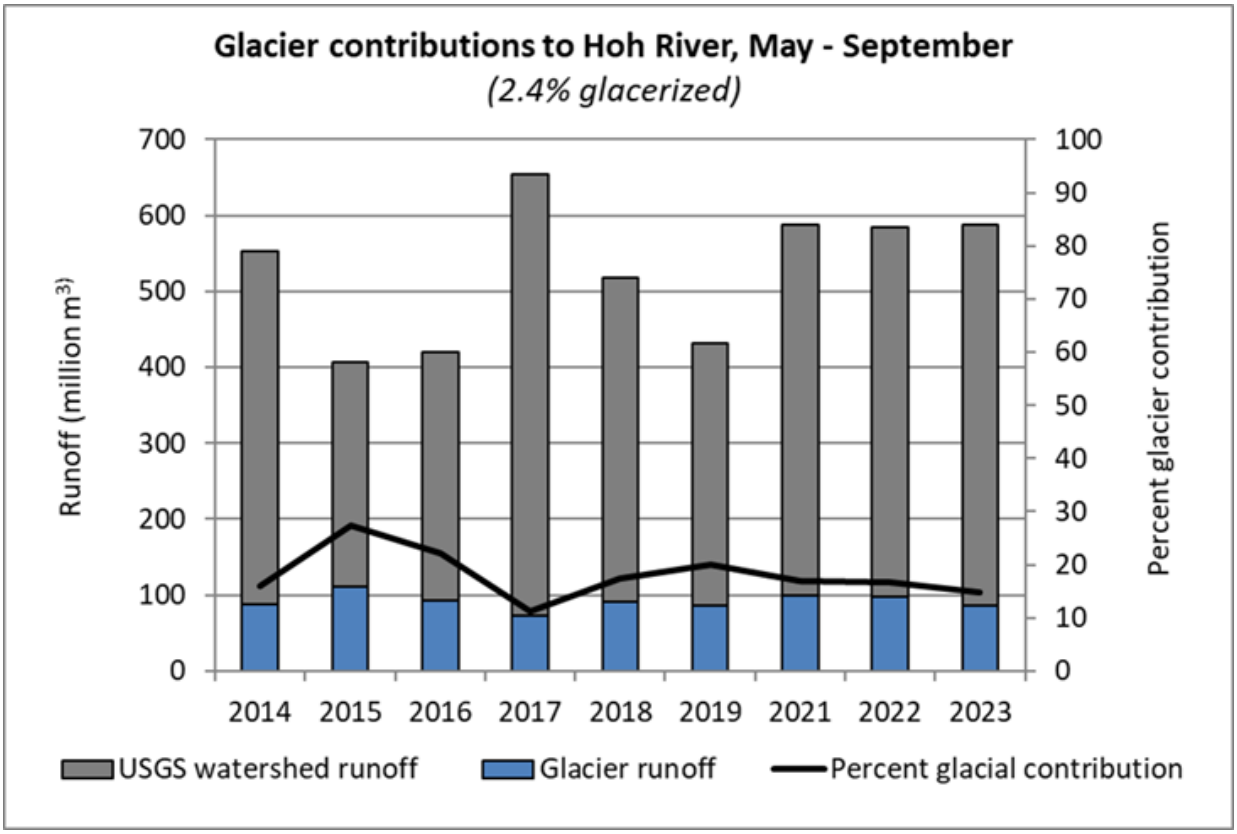


Figure 4. Glacier contributions to Hoh River, May – September. This graph shows how much water in the Hoh River has come from glacial melt or runoff from the watershed in various years from 2014. In warmer years, like 2015, glacial melt has increased and is a higher percentage of the overall flow. (Graph provided by Mike Larrabee, Physical Science Technician with the National Park Service NCCN Inventory and Monitoring Program).

Flooding risks

Floods have long been a part of life on the Hoh Indian Reservation. People moved from their homes at the beach to homes further inland due, in part, to the ocean flooding. When a braid of the Hoh River was further south than it currently is, flooding of the baseball field and Tribal offices was common. Some of the housing close to creeks sees regular floods whose impacts range in severity, from lifting the boats in people's yards to causing toilets to back up and turn into mini geysers. Floods have forced the Tribe to replace water wells and sewer systems, and they've had to declare disasters over 20 times (Bridgeview Consulting, 2022). Outside of the reservation, flooding can affect critical infrastructure, like when high waters washed out the Bogachiel Bridge in 1979 making Highway 101 impassable to the north. WSDOT has ranked the section of highway from the reservation north to milepost 185, south of Forks, as having high vulnerability to climate change due to extreme weather events, sedimentation from glaciers, and rising rivers and creeks (WSDOT, 2011).

Flooding in the Hoh U&A, from both the rivers and the ocean, will increase due to increasing winter precipitation, sea level rise, and higher extreme total water level events. Frequency and severity are likely to increase with water entering new areas than previous flood patterns. Floods are a wide-reaching and expensive climate change impact. They can cause unsafe housing conditions, deaths, property and infrastructure damage, harm to salmon habitat, and road closures that can cut off emergency response routes. The Hoh Highlands development is the primary mitigation strategy as it will place infrastructure out of both the tsunami zone and the river's 100-year floodplain (Bridgeview Consulting, 2022). However, important cultural resources and locations will remain in the floodplain even after infrastructure is moved. Because of the risks posed to cultural resources and surrounding infrastructure, like Highway 101, **flood preparation and response should be considered an essential part of climate change adaptation.**

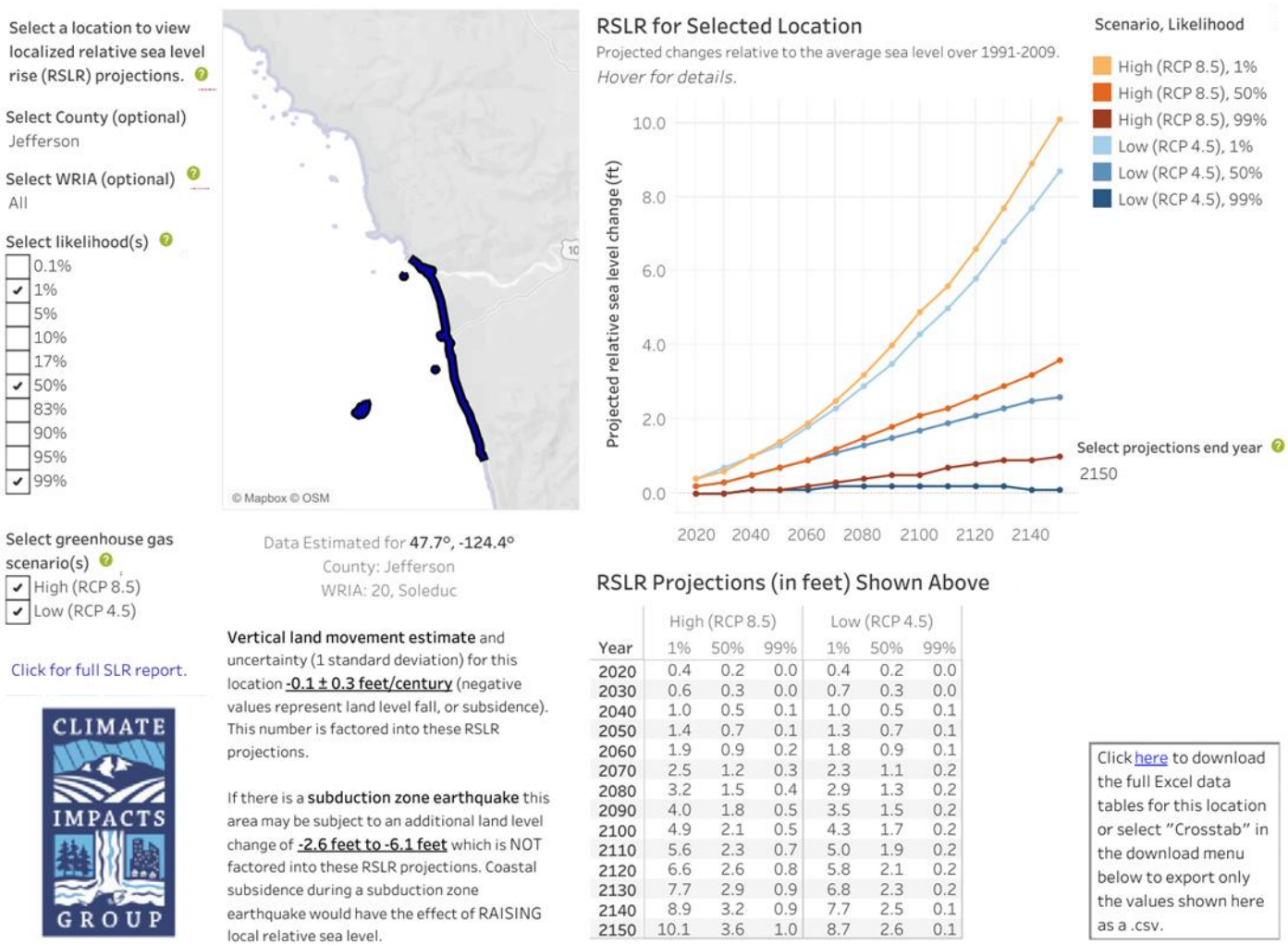
Figure 5. Flood risk along the Hoh River. This map shows areas that are at risk from flooding. The coast is a FEMA 1% V zone or a coastal area that has a 1% chance of flooding each year. These are also referred to as 100-year floods and are large floods. The orange area along the river is a FEMA A Zone, or a river area with a 1% change of being inundated by a large flood every year. A flood of this size would cover Lower Hoh Road and infrastructure on the western side of the reservation. It also gets quite close to the middle of Lower Hoh Road and Highway 101. The Highlands area, roughly located by the star on the map, is out of the flood zone. (Map from NOAA Coastal Flood Exposure Mapper, https://coast.noaa.gov/floodexposure/#-10575352,4439107,5z).

Sea level rise

Sea level has been rising around the globe at an average of 0.17 in per year for the last decade (2013-2022) (May et al., 2023). This is due to warmer temperatures causing large ice sheets on land to melt and expansion of the seawater itself as it warms. **Sea level will continue to rise along the U&A coastline but predicting an exact amount is complicated because the land is rising due to plate tectonic activity** (Miller et al., 2013).

- **Observed changes:** Tribal members have seen the ocean dramatically change their beach and reservation area; this is covered in the coastal erosion section below. One Tribal member shared how they've seen the ocean drop and how the waves coming into the mouth of certain rivers are much larger than they used to be.
- **Predicted changes:** In the shorter term (2040-2059), under both RCP 4.5 and 8.5, some sea level rise in the U&A is predicted – around .6 -.8 ft higher than sea level from 1991-2009. As time goes on, there is a greater rise. From 2090-2109, under RCP 4.5, the rise along the reservation is around 1.6 ft, with areas north of the reservation, around La Push, seeing less, around 1.4 ft. With RCP 8.5, this increases with the beach near the reservation seeing 2.1 - 2.2 ft (Krosby et al., 2018). Over time and with greater amounts of greenhouse gas emissions, the level of sea rise increases. This rise is buffered a bit, compared to other places around the world, because the northwest coast of the peninsula is also rising.

One risk of sea level rise is groundwater rise or the lifting of the water table due to seawater pushing further inland. Rising groundwater can damage underground infrastructure and increase flooding (California Coastal Commission, 2024). Whether or not groundwater rise is a threat for the Hoh Tribe has not yet been studied.



	High (RCP 8.5)			Low (RCP 4.5)		
Year	1%	50%	99%	1%	50%	99%
2020	0.4	0.2	0.0	0.4	0.2	0.0
2030	0.6	0.3	0.0	0.7	0.3	0.0
2040	1.0	0.5	0.1	1.0	0.5	0.1
2050	1.4	0.7	0.1	1.3	0.7	0.1
2060	1.9	0.9	0.2	1.8	0.9	0.1
2070	2.5	1.2	0.3	2.3	1.1	0.2
2080	3.2	1.5	0.4	2.9	1.3	0.2
2090	4.0	1.8	0.5	3.5	1.5	0.2
2100	4.9	2.1	0.5	4.3	1.7	0.2
2110	5.6	2.3	0.7	5.0	1.9	0.2
2120	6.6	2.6	0.8	5.8	2.1	0.2
2130	7.7	2.9	0.9	6.8	2.3	0.2
2140	8.9	3.2	0.9	7.7	2.5	0.1
2150	10.1	3.6	1.0	8.7	2.6	0.1

Figure 6. Range of Relative Sea Level Rise (RSLR) Projections along the Hoh Reservation beachfront and a portion of the U&A. This visualization shows the full range of sea level rise projections for the portion of the coast along and south of the Hoh Indian Reservation, shown in the map on the left. The 1%, 50%, and 99% percentages represent the likelihood that sea level rise will meet or exceed a certain measurement. It is very likely, 99% likelihood, that sea level rise will be 0.5 ft by the end of the 21st century under a high RCP scenario. There is a 50% likelihood the rise will be around 1.8-2.1 ft at the end of the century under RCP 8.5. Regardless of the scenario, sea levels rise with time (Lavin et al., 2019).

Increased coastal erosion

Higher total water levels could increase coastal erosion as sea levels rise.

- **Observed changes:** Coastal erosion has severely changed the shape of the Hoh Indian Reservation. The original 640 acres of the reservation land base was reduced to 443 acres by 2009 due to erosion both from the ocean and the Hoh River (Testimony of Chairman Walter Ward on the Hoh Indian Tribe Safe Homelands Act, 2009). Because of this, some families have lost fishing grounds along the river and a canoe landing was washed away. Tribal members shared that they used to have a long beach they could drive on but now it's much smaller. In addition, coastal erosion and high waters were part of what forced the Tribal members living in the homes right on the beach to move in the early 1970s.
- **Predicted changes:** A risk that accompanies rising sea levels is extreme total water levels, or times when different processes occur simultaneously, producing unusually high levels of water. These processes can be storm surges, high tides, seasonal water levels, and wave run-up (The Oregon Climate Change Research Institute, 2016). Specific estimates of where extreme total water level events might reach are unknown because there are few observations of historical events and the coast is a complex area, making modeling expensive (Miller et al., 2019). Sea level rise will increase the reach of these extreme total water level events, causing greater erosion of the beach and coastal bluffs.

A warming ocean

Sea surface temperature is steadily rising and will continue as the ocean absorbs most of the greenhouse gases. Marine heatwaves will become more frequent and more intense.

- **Observed changes:** Much of the heat emitted by humans has sunk into the ocean. This has caused ocean waters to warm (The Oregon Climate Change Research Institute, 2016). One Tribal member reported noticing this and many shared that it's a large concern. Global sea surface temperatures have been steadily rising since the mid 1900s. However, temperature patterns in the Hoh marine U&A are difficult to track. There are many drivers that affect water temperature, including El Niño-Southern Oscillations, wind patterns, and upwelling. Studies done in the Olympic National Marine Sanctuary, which overlaps with the Hoh marine U&A, reflect this variability; some have found increasing temperatures while others didn't come to any conclusion because they found the data lacking or too irregular (Miller et al., 2013).

Hoh Tribal Member: ***"I noticed that the water is really warm when the smelts are coming in. The last couple of summers…the water has been really warm. You can definitely feel the water being warm."***

Interviewer: ***"Is it the ocean water?"***

Hoh Tribal Member: ***"Mm-hmm [affirmative]. I'm like 'Wow, that's really warm.' Because usually our hands will get cold when we're cleaning and packing them."***

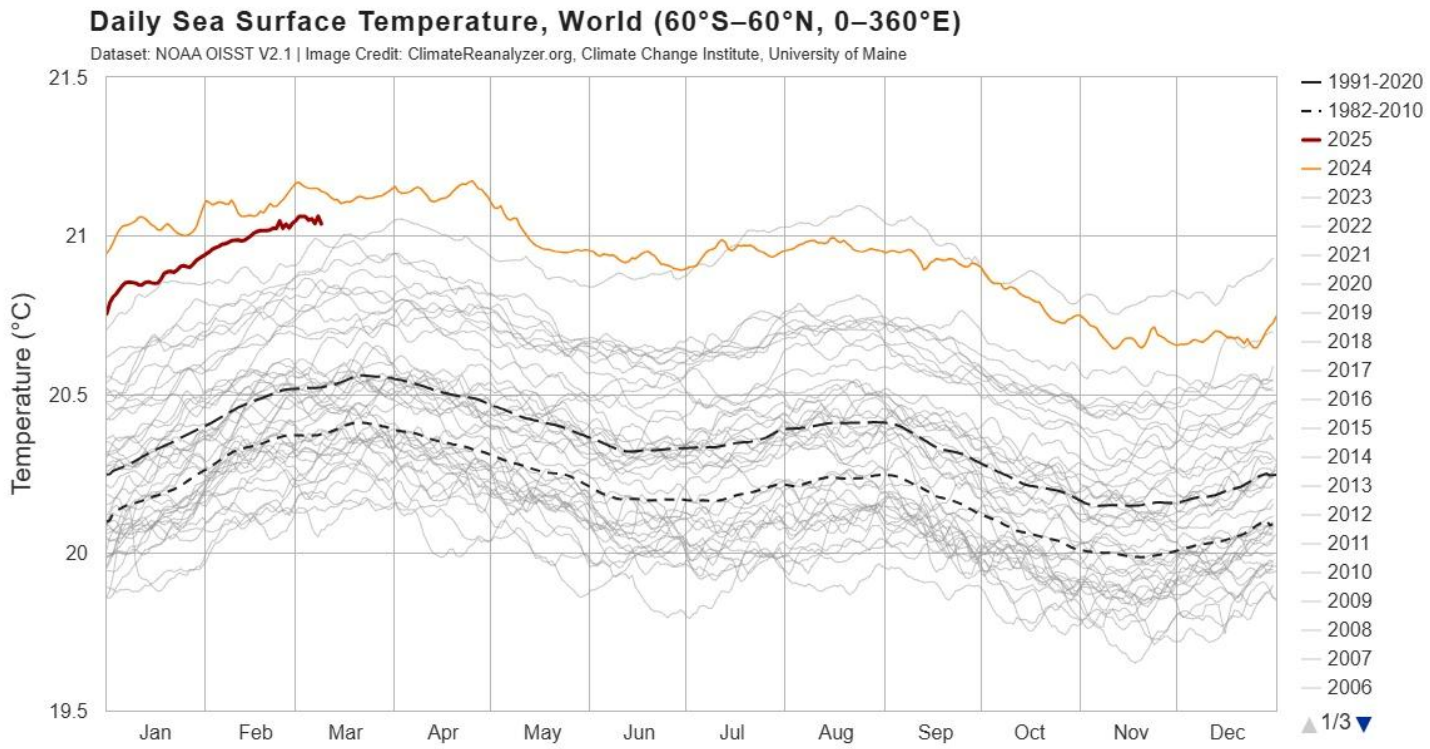


Figure 7. Global Daily Sea Surface Temperature Measurements. The ocean temperatures shown here come from the NOAA Optimum Interpolation SST (OISST) version 2.1 dataset. This dataset splits the world into small grids, takes sea surface temperatures from satellites, ships, and buoys, and then estimates what the temperatures are for the grid squares that don't have measurements. In this graph, the daily sea surface temperature of all the grids is averaged together. From 1981 – 2025, the ocean has been getting warmer, on average, and 2024 and 2025 have been incredibly warm years (Climate Reanalyzer, n.d.).

- **Predicted changes:**
  - **Increasing temperatures:** Globally, oceans are certain to warm but the amount depends on the level of greenhouse gas emissions. Models using different emissions scenarios predict a range between 1.5°C - 2.6°C by 2100. Overall, downscaled climate models predict that the coastal Olympic waters could warm up by 1°C by 2050. This could have a variety of effects including

changing water circulation patterns, altered regional weather patterns, and shifts in the amount of phytoplankton algae at the base of the food chain (Miller et al., 2013).

- **More frequent and intense marine heatwaves:** Marine heatwaves are periods where the water temperatures are higher than the standard seasonal variation for at least five days, although they can last for over a year. They fuel algal blooms and harm marine life, with repercussions reverberating around the food web. The infamous 2014-2016 "blob" was a marine heatwave that caused species to travel north for hundreds of miles, aided in the growth of large harmful algal blooms, stranded sea lions, and killed many seabirds and whales. Marine heatwaves have intensified in recent decades due to increasing greenhouse gases and they are projected to increase in frequency, intensity, and size as greenhouse gas levels rise (Wrubel et al., 2025).
- **Increasing hypoxia:** Hoh Tribal crabbers have found limp, dead crabs in their pots and wondered if it was caused by hypoxia, or low concentrations of dissolved oxygen that can stress or even kill marine organisms. Ocean circulation is one factor that controls hypoxic events because currents from around the globe contain different levels of dissolved oxygen. Additionally, high levels of bacteria associated with large phytoplankton blooms can further deplete waters of oxygen as the bacteria breathe (Miller et al., 2013). Because warm water holds less oxygen than cold water and because ocean mixing is predicted to decline, the Hoh marine U&A is likely to see more hypoxic events that will harm marine life.
- **Harmful algal blooms:** While harmful algal blooms (HABs) are a natural phenomenon, they have increased in recent decades. This has been linked to rising temperatures because the phytoplankton species that cause the blooms can grow more quickly and for longer periods of time in warmer water (Gobler et al., 2017). More HABs are predicted which will prevent Tribal members from eating and harvesting shellfish.

A more acidic ocean

The ocean takes up most of the carbon dioxide (CO_2) in the atmosphere. Once it's in the sea water, a chemical reaction called ocean acidification occurs which decreases pH levels and lowers the amount of carbonate ions in the water. **Ocean acidification is predicted to increase in the Hoh marine U&A.**

- **Observed changes:** Global surface ocean pH has fallen from 8.2 to 8.1, which, because the pH scale is logarithmic, is a 30% increase in acidity (Miller et al., 2013). The Olympic Coast is considered particularly vulnerable to acidification because so much upwelling is occurring. The deep ocean waters that rise to the surface are already low in pH and high in CO_2 due to biological activity. When these mix with surface waters that are absorbing atmospheric CO_2, it can worsen acidification (WSG, 2014).
- **Predicted changes:** Global surface ocean pH is expected to continue falling to around 7.8-7.9 by 2100 which would be a 150-200% increase in acidity from pre-industrial levels (Miller et al., 2013). pH levels in the Hoh marine U&A are also predicted to fall, although the level depends on the model. Aragonite and calcite concentrations, the carbonate ions that many animals use to build shells, are predicted to decrease from the surface to the bottom waters (Siedlecki et al., 2021).

Wildfires and worsening air quality

Wildfire is a natural and necessary part of ecosystems, but climate change is causing the number of fires and their intensity to increase. Annual instances of wildfires are predicted to rise around the Western United States due to decreasing summer rain and drier plants. **Risk factors for wildfire on the Olympic Peninsula, like less summer rain and smaller snowpacks, will increase but it's difficult to predict how much more wildfire Tribal members might experience in the U&A. Smoke from wildfires near and far will continue to be a health hazard.**

- **Observed changes:** The air on the reservation and in the surrounding area has gotten smoky from wildfires, but Tribal members share that it's primarily from Canadian or Californian wildfires. For some people with asthma, this has limited the amount of time they can spend outdoors. Tribal members also report that fires in the area are increasing.
- **Predicted changes:** Historically, Hoh and Quileute peoples used fire as a tool to manage certain landscapes. These would have been smaller burns than naturally occurring wildfires. Natural wildfires on the Olympic Peninsula were rare but had high severity. Climate records like tree rings, charcoal in lake sediments, and modern recorded fire history show that wildfire increases with higher temperatures, low precipitation, low snowpack, and drought. Because these are conditions we expect to see in the future, wildfires are likely to increase in both frequency and size (Ho et al., 2023). Because there is so little information on historical wildfires, it is difficult to make specific predictions about the future based on data aside from the risk factors (Morgan et al., 2019). Wetter conditions on the Olympic Peninsula do make the Hoh U&A less vulnerable than drier parts of the state.

One factor that increases wildfire risk is the infrastructure needed to respond. While the chance of wildfire might be low, the current lack of a Hoh fire department and the long response time of outside agencies increase the risk posed by fires on the reservation and surrounding lands. The Tribe has fought structure fires with hoses and watched buildings burn down due to a lack of structural fire response (Bridgeview Consulting, 2022). Additionally, infrastructure on the reservation and in nearby towns where Tribal members live, work, and visit, like Forks, is in the wildland urban interface. It's comingled and adjacent to forests, making that infrastructure susceptible to burning if a fire came through (see Figure 8 below). Finally, as wildfire will continue to increase across the western US and Canada, smoke remains a health hazard, particularly for youth, elders, and those with chronic health conditions.

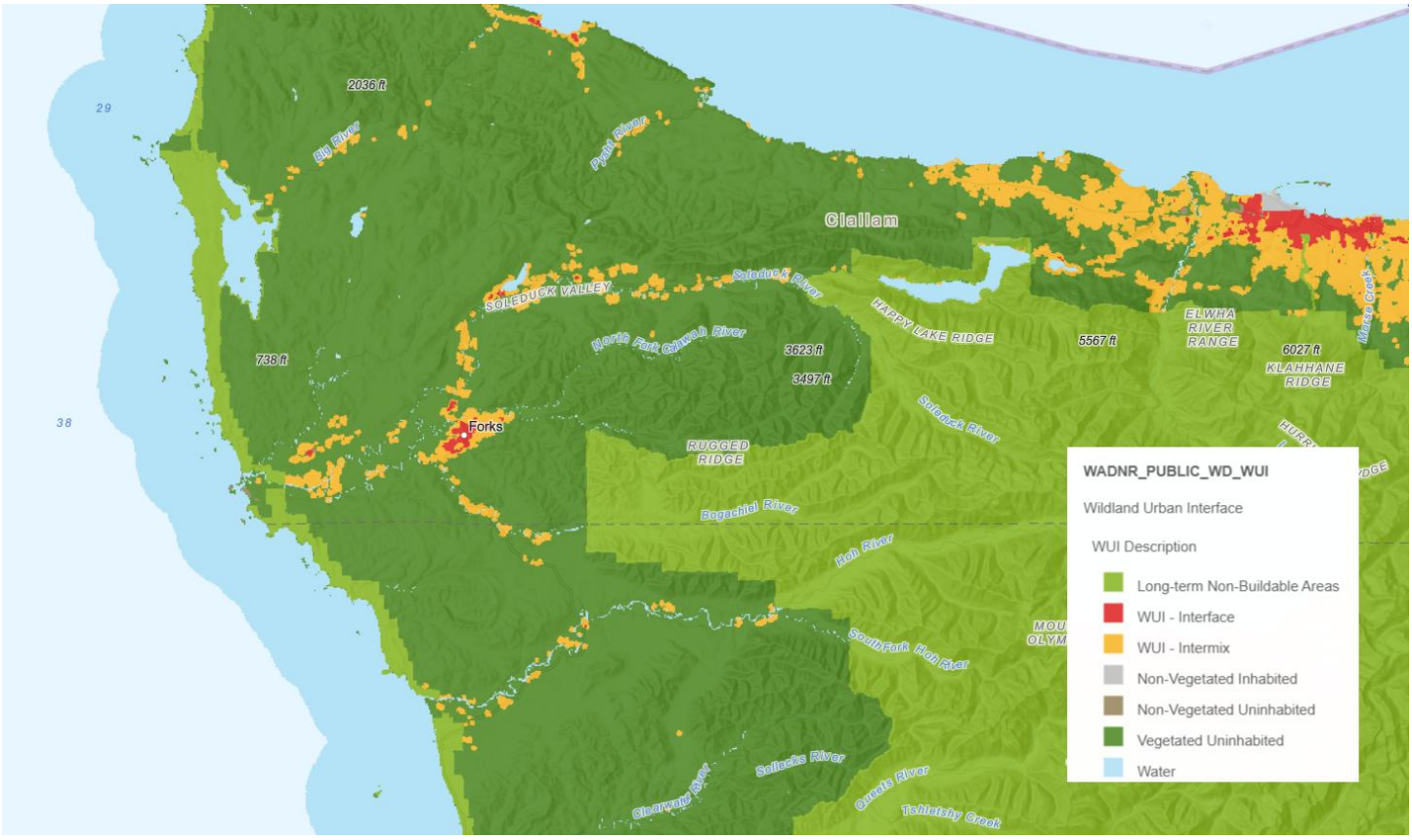


Figure 8. Wildland Urban Interface on the west side of the Olympic Peninsula. This map shows the high levels of wildland urban interface (WUI) in areas where Tribal members live and work, including the Hoh Indian Reservation, Forks, La Push, and Port Angeles. It's not possible to fully predict wildfire risk just by location but infrastructure located in the interface is vulnerable (WA Department of Natural Resources, 2019).

Shifting plant and animal ranges

Many species are adapting to climate change by moving their range and finding new habitats that can better serve their needs. **Animals and plants native to the Hoh U&A may move out of it and new species could arrive.**

- **Observed changes:** Hoh and other Tribal fishermen in the area have seen new fish species off the coast, including the occasional California squid. Many Tribal members report that they haven't seen any new species. However, many have noticed species loss. They don't see flounder at the mouth of the river anymore and tidal life, like urchin, starfish, and slippers (or chitons), have disappeared from some areas. While the cause isn't currently known, documenting what changes have happened could lead to greater understanding of the future.
- **Predicted changes:** The general understanding has been that species will shift northward, up in elevation, and to deeper depths in the ocean to find habitat similar in temperature to their original range. Some species are shifting counterintuitively, towards warmer temperatures. Many factors, including precipitation patterns and available habitat, could be complicating how species are moving (Rubenstein et al., 2023). We can expect species in the U&A to shift but specific predictions will be unique to each species, their habitat, and their needs.

Rosetta Leitka and Cecilia Ashue (second and third from left, in red and white shirts respectively) teach youth how to weave cedar headbands during the 2024 Hoh Watershed Adventure Camp. Photo shared by Kelly Rosales.

APPENDIX 3: HOH WELL-BEING AND CLIMATE CHANGE, EXPANDED

In 2019, Dr. Melissa Poe, social scientist, and WA Sea Grant's Assistant Director for Outreach, and Bernard Afterbuffalo Jr., Hoh Tribal Councilmember and Natural Resources staff member, interviewed Hoh Tribal members about well-being for the research project "The Olympic Coast as a Sentinel: An Integrated Social-Ecological Regional Vulnerability Assessment to Ocean Acidification". Eight components that define Hoh Tribal health and well-being emerged from these interviews. They provide a rich portrait of what's needed by Tribal members for a good life. Appendix 3 contains information on how climate change might impact each of these well-being components, including many quotes from Tribal members.

The information from that project is protected by a data agreement. Because of this, Appendix 3 will only be shared freely with Hoh Tribal members, staff, and leadership. If you fall outside of these groups but are interested in reading it, please email the Hoh Tribe Natural Resources Director and share the nature of your request.

Photo by Hannah Tennent

APPENDIX 4: HOH ECOSYSTEMS AND CLIMATE CHANGE, EXPANDED

Appendix 4 is a comprehensive look into climate impacts to ecosystems in the Hoh U&A. It contains projected impacts, species change charts, more information on the species vulnerability assessments, and experiences from Tribal members. Because this appendix discusses Tribal resources in detail, it's freely available only to Hoh Tribal members, staff, and leadership. If you fall outside of these groups but are interested in reading it, please email the Hoh Tribe Natural Resources Director and share the nature of your request.

APPENDIX 5: ASSESSMENT METHODOLOGY

This assessment is based on thirteen interviews of Hoh Tribal members (youth, adults, and elders) and a synthesis of current climate research. Therefore, it does not include all Tribal members' knowledge and opinions, nor can it predict both how science and climate conditions will evolve in the future. It is a foundation for climate adaptation work that will change as new experiences, understandings, and priorities emerge.

Interviews

Interviews were conducted in person from November 2023 to March 2024 either in Tribal offices or in participants' homes. They lasted one to three hours. Kelly Rosales, Tribal Historic Preservation Officer, and Hannah Tennent, WA Sea Grant Hershman Fellow, led each interview. Interviews were semi-structured, and each one was recorded. While each interview took its own path, the outline of the questions used is available in Appendix 7. All interviews followed the principle of free, prior, and informed consent. Interviewees are welcome to retract their consent at any point and have quotes removed from this assessment if they see fit. Interview participants received an honorarium to thank them for their time and honor the expertise they shared.

The interview transcripts were returned to all interviewees for review and all requested revisions and edits were made. After edits were finalized, the interviews were qualitatively analyzed using Atlas.TI.

Well-being and climate change

The Hoh well-being indicators are from "The Olympic Coast as a Sentinel: An Integrated Social-Ecological Vulnerability Assessment to Ocean Acidification." The Hoh Tribal interviews were led by Dr. Melissa Poe and Bernard Afterbuffalo Jr. The effects that climate change could have on the indicators were synthesized from interviews and literature solely by me, Hannah Tennent.

Climate Change Vulnerability Assessment

The climate change predictions were compiled from climate tools and scientific literature. Interviewees discussed many important species, all of which are included in the species change charts. There wasn't enough time to do in-depth research into each species so eight that were spoken about frequently and hold significance were chosen for vulnerability assessments. Six of the species were assessed with NatureServe's Climate Change Vulnerability Index (CCVI) tool, version 3.02. This is an Excel based tool that determines vulnerability scores based on species' attributes and climate models. Information from both interviews and literature was used to create these scores.

However, the NatureServe CCVI tool is currently designed to only address terrestrial species. For the highlighted marine species in this assessment, razor clams and smelt, I used the sensitivity characteristics defined by NOAA in their 2015 "Methodology for Assessing the Vulnerability of

Marine Fish and Shellfish Species to a Changing Climate." This methodology requires having a group of experts rate each category to determine a vulnerability score. Because I didn't have a group of experts and because there are still many data gaps with these species, I did not generate a score. However, the qualitative assessment provides information about how each important species might be vulnerable to changing ocean conditions.

Because the assessment was done without a team, I discussed many of the topics with experts in the field, both in the Hoh Natural Resources department and outside. Thank you again to everyone who talked about this work with me.

APPENDIX 6: NATURESERVE CCVI AND MARINE SPECIES VULNERABILITY SCORES

These charts show the rationale for each species' score.

Marine species using NOAA methodology

Species	ťó·piks (smelt) / Surf smelt or day smelt / *Hypomesus pretiosus*
Factors that affect sensitivity:	
Species range within the U&A:	Smelt have always been in the Hoh U&A. Day smelt have arrived on the Hoh beaches for generations, although the specific location varies.
Stock size/status: To determine if the stock's resilience is compromised due to low abundance	**Unknown -** Hoh Tribal members have experienced large decreases in the numbers of smelt throughout the decades. There are no current stock assessments for surf smelt. However, it's common for forage fish to have large fluctuations in population and these aren't well understood (Jacobsen & Essington, 2018).
Other stressors: Examples include habitat degradation, pollution levels, parasites, harmful algal bloom	**Unknown** – Other stressors for smelt have not been identified.

exposure, and invasive species.	
Population growth rate: Estimate the productivity of a stock	**Unknown** – I did not find information on smelt population growth rate.
Complexity in reproductive strategy: Identify reproductive strategies that may be disrupted by climate change	**Low -** Smelt spawning requires that large populations be in the same place together. The species is generally considered a large aggregate species, although not much is known about their behavior outside of spawning. There aren't other known complexities.
Spawning cycle: Identify spawning strategies that are sensitive to changes	**Moderate - There are spawning events throughout the year.** Forage fish spawning has been found along the Hoh U&A coast from February – September (Langness et al., 2015). Both day and night smelt have been observed arriving at the beach from April – October, with most arriving in the summer.
Early life history survival and settlement requirements: Determine the relative importance of early life history requirements for a stock	**High sensitivity due to beach requirements and sensitivity to climate change -** Surf smelt spawn on beaches where their eggs adhere to the gravel. Some sea level rise is predicted in the Hoh U&A and this could erode the beach, narrowing surf smelt spawning habitat. In addition to sea level rise, beach development can reduce available habitat and vegetation that keeps the beach shaded. Even if habitat is available, air temperatures can harm eggs. Warmer and drier beach conditions have been shown to lead to higher levels of smelt egg mortality (WDFW, 2015).
Sensitivity to ocean acidification: Determine the stock's relationship to "sensitive taxa"	**Moderate -** Ocean acidification will negatively affect some types of phytoplankton while others will do well. The balance and composition of species will change (Dutkiewicz et al., 2015). It's unknown how smelt will respond to this shift.
Habitat specificity: Determine the relative dependence a stock has on habitat and the abundance of the habitat	**Low sensitivity -** When not spawning, not much is known about smelt habitat except that they school and live in the open ocean. They can range from California to Alaska but it's unknown how far each population might travel (Harbo, 2022). Unlike coral reefs or salt marshes, pelagic habitats are considered to have low sensitivity.
Prey specificity: Determine if the stock is a prey generalist or a prey specialist	**Moderate -** Surf smelt eat plankton, a classification that covers many different organisms. Because there are many types, smelt can shift what they eat based on what's available. One study found that coastal Washington smelt ate different prey in years when sea surface temperatures were warm and cool. In 2000, an average temperature year, the smelt stomachs they surveyed primarily had decapods. In 2011, a cool year, their prey was primarily copepods, phytoplankton, amphipods, and pteropods. In 2016, a warm year, they primarily ate gelatinous zooplankton, a food with lower energy content compared to the types eaten in

	2000 and 2011 (Brodeur et al., 2019). Many of the species that smelt eat are negatively impacted by ocean acidification.
Sensitivity to temperature: Known temperature of occurrence or distribution as a proxy for sensitivity to temperature	**High–Very High Sensitivity -** While I couldn't find information on smelt temperature tolerances, they are only found in one ocean province, as defined by the NOAA methodology. This makes them have high – very high sensitivity to temperature changes.
Adult mobility: Determine the ability of the stock to move if their current location becomes unsuitable	**Unknown** – There are many populations of smelt in Washington waters but not a lot is known about their movements. There isn't evidence that they travel long distances (WDFW, 2015).
Dispersal of early life stages: Estimate the ability of the stock to colonize new habitats	**Low - moderate** –After hatching, smelt larvae drift around for a few weeks. However, the amount of time they can drift will likely shorten in warmer waters. During this larval stage, the fish depend on energy reserves before they can forage for food. Under lab conditions, these reserves get smaller as the water gets warmer (Russell et al., 2022).
Predicted impact of land use changes resulting from human responses:	In urban areas, like the Puget Sound, shoreline armoring has diminished smelt habitat, but that threat is less likely along the coast of the Hoh U&A because there is less infrastructure immediately adjacent to the coast (WDFW, n.d.). Other adjustments to the beach, like removing vegetation or dumping dredge material, could negatively harm the spawning grounds. Additionally, ocean production of energy, whether it's wind, tidal, or wave, has the potential to affect smelt but there is not enough research yet to know what the effect is.

Species	yàʔlíɬkala / Razor clams / *Siliqua patula*
Factors that affect sensitivity:	
Species range within the U&A:	Razor clams live in sandy beaches along the Hoh U&A. Kalaloch Beach is one traditional gathering spot.
Stock size/status: To determine if the stock's resilience is compromised due to low abundance	**Unknown -** Stocks around WA state fluctuate. I was not able to find a B_{MSY} number, which this assessment wants.
Other stressors: Examples include habitat degradation, pollution levels, parasites, harmful algal bloom exposure, and invasive species.	**Nuclear Inclusion X (NIX):** NIX is a bacteria that is associated with razor clam die-off. The bacteria gets into the clam's cells and prevent their gills from working normally. While the cause of the low population of small razor clams at Kalaloch isn't entirely known, NIX is one hypothesized culprit. NIX concentrations at Kalaloch are 10 – 1,000 times higher than clams from other sample locations (Goldfarb, 2023).

	Microplastics: A study examining microplastics in razor clams found that Kalaloch beach had the highest microplastic content out of the clams they sampled along the Olympic Coast. These can have potential negative effects on the clam's bodily processes, like respiration, reproduction and feeding. People who eat clams can reduce the amount of microplastic they eat by thoroughly cleaning the clams; cleaned clams in the study had 50% fewer microplastics (Baechler et al., 2020). **Harmful algal blooms -** Harmful algal blooms (HABs) produce high levels of biotoxins. When razor clams eat phytoplankton from a HAB, those toxins can accumulate in their bodies. While this appears not to harm the clams themselves, if humans eat the clams, they can experience a variety of negative symptoms like memory loss, stroke-like symptoms, and even death (WDFW, 2023). **Otters** - People have observed rafts of otters coming over from Destruction Island to eat the clams at Kalaloch. They hypothesize that heavy otter predation is the reason for suppressed clam populations at Kalaloch.
Population growth rate: Estimate the productivity of a stock	**Unknown** – I couldn't find information on razor clam population growth rate.
Complexity in reproductive strategy: Identify reproductive strategies that may be disrupted by climate change	**Low** – Spawning initiation does depend on a specific temperature threshold, around 13°C (Hiebert, 2015). The timing of spawning has potential to shift as sea surface temperatures rise. However, the rest of the razor clam reproductive strategy is relatively simple, making it less vulnerable.
Spawning cycle: Identify spawning strategies that are sensitive to changes	**Moderate** – In Washington, spawning only takes place in the late spring or early summer when water temperature reaches a certain threshold (Hiebert, 2015). Less frequent spawning events make the species more vulnerable to climate change. However, they are broadcast spawners which is a prolific strategy.
Early life history survival and settlement requirements: Determine the relative importance of early life history requirements for a stock	**Moderate** – Larval requirements are not well studied. It is assumed that razor clams have similar development to other bivalves. The embryonic phase of many bivalves, before they become larvae, does depend on temperature (Alcantar et al., 2023). If the same is true for razor clams, warming waters could cause changes in development.
Sensitivity to ocean acidification: Determine the	**Very High** – Razor clams are a bivalve mollusk. The NOAA methodology uses a scientific paper (Kroeker et al., 2013) that ranks the impacts of ocean acidification on different types of

stock's relationship to "sensitive taxa"	marine species. Mollusks are highly vulnerable. Additionally, razor clams were ranked as some of most vulnerable species in a 2018 assessment done by Olympic National Park (Jones et al., 2018). Tribal members are noticing that the clam shells are thinner which could be due to ocean acidification.
Habitat specificity: Determine the relative dependence a stock has on habitat and the abundance of the habitat	**Low** – Razor clams depend on flat, sandy beaches (Hiebert, 2015). While not all beaches in the Hoh U&A meet these criteria, it is a common abiotic habitat.
Prey specificity: Determine if the stock is a prey generalist or a prey specialist	**Moderate** – Razor clams are filter feeders, sucking in diatoms, other algae, and phytoplankton. This is a large variety of food sources, but these species are vulnerable to ocean acidification.
Sensitivity to temperature: Known temperature of occurrence or distribution as a proxy for sensitivity to temperature	**Very High** - While I couldn't find information on razor clam temperature tolerances, they are only found in one ocean province, as defined by the NOAA methodology, and they don't go to deep depths, as they live in the sand.
Adult mobility: Determine the ability of the stock to move if their current location becomes unsuitable	**High** – Adults have little mobility. They can move vertically, digging into the sand. This is beneficial for changing surf conditions. However, they cannot move laterally and cannot shift into new habitat if theirs becomes degraded (The Oregon Climate Change Research Institute, 2016).
Dispersal of early life stages: Estimate the ability of the stock to colonize new habitats	**Moderate** – The larvae are free swimming for up to 8 weeks, which is a decent amount of time for wide dispersal per the NOAA methodology. They can disperse tens of kilometers (McCaffery et al., 2018).
Predicted impact of land use changes resulting from human responses:	**Low risk** - Some of the razor clam habitat that is within the Hoh U&A is also within Olympic National Park, protecting it from development.

River and terrestrial species using NatureServe CCVI methodology

Universal Assessment Criteria for NatureServe species	
Geographic Area Assessed:	Approximation of Hoh usual and accustomed area (U&A)
Time period:	Near term: 2040 – 2069. This is the time period NatureServe suggests using and what their resources use.
Emissions scenario:	A1B. This is what the tool was built with. A1B represents a world with rapid growth, the global population peaking around 2050, and a balance between fossil fuel intensive technologies and non-fossil fuel energy sources (IPCC, 2000). It has carbon emissions at 600 ppmv by 2100 (IPCC, n.d.). RCP 6.0 is a similar representative pathway used today (UW Climate Impacts Group, 2013). Both are middle-of-the-road estimates.

Temperature Severity:	Annual temperature within the Hoh U&A is predicted to rise between 3.4 - 3.7°F from 2040-2069 under emissions A1B (Young et al., 2016).
Hamon AET:PET Moisture Metric:	The moisture metric for the Hoh U&A is all between –0.096 - -0.074 (Young et al., 2016). NatureServe uses this metric, as opposed to estimates of precipitation, because moisture availability is more relevant to a plant or animal's ability to survive (GLIFWC Climate Change Team, 2023).
Rankings: These are the options to rank how each aspect increases vulnerability	• GI = Greatly increase • I = Increase • SI = Somewhat increase • N = Neutral • U = Unknown

Species	ƙí·kił / Roosevelt Elk / *Cervus canadensis roosevelti*
Score	**Less Vulnerable**
Species range within the U&A:	Throughout the entire U&A
Migratory exposure:	Not applicable – Roosevelt elk aren't neotropical, migratory species
Exposure to sea level rise:	**Neutral –** Although sea level rise is expected along the Hoh U&A coastline, it is a tiny part of the elk's range and not where they spend most of their time.
Natural barriers:	**Neutral – Somewhat increase** - Elk may be slightly impaired by natural barriers if they attempt to shift their habitat range. Elk are highly mobile, with some already moving around the Olympic Peninsula from lowland areas to over the Olympic Mountains as they see fit (McCaffery et al., 2018). Moving off the peninsula may be difficult due to the Strait of Juan de Fuca in the north and significant urban development to the east. However, it's also a possibility that elk living in northern CA and OR could move northward into the Hoh U&A. The NatureServe index allows for multiple values, so this was ranked both N & SI to account for the range of possibilities.
Anthropogenic barriers:	**Neutral -** There are currently no large anthropogenic barriers to this species. Examples are dams for fish, impenetrable fencing, and large urban areas. The urban area east of the peninsula is mentioned in the ranking above.
Predicted impact of land use changes resulting from human responses:	**Neutral -** This category is about land actions taken to mitigate climate change, like wind farms and solar arrays. A fair amount of elk habitat is already protected by being in Olympic National Park and the remaining land is not currently desirable for other technologies, like solar farms.

Dispersal and movements:	**Neutral -** Elk are highly mobile.
Historical thermal niche:	**Increase** – Nearly half of their range sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37-47°F. Compared to much of the rest of the United States, this a mild climate with a small thermal niche which makes these elk more vulnerable.
Physiological thermal niche:	**Neutral -** Elk are not restricted to any cool or cold environments, like frost pockets, north-facing slopes, or the highest elevation zones. Additionally, they can move to find cool areas that meet their needs.
Historical hydrological niche:	**Neutral -** Elk experience high levels of rain variation. As calculated by the NatureServe data, elk can experience precipitation variation of >20 in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Neutral -** Because they are so mobile, elk can move to find the wet areas they need. While they need water, they don't depend on a specific wetland habitat that is highly vulnerable to loss.
Dependence on a specific disturbance regime likely to be impacted by climate change:	**Neutral -** Fire could have a mixed effect on elk populations. They like to stay near areas with trees and cover so if an extreme fire eliminated trees, elk would be negatively impacted. However, if the fire cleared out underbrush and forage plants increased afterwards, elk could be positively affected (McCaffery et al., 2018, Jenkins & Starkey, 1984). It would also depend on how much of their range was burned. Because they are so mobile, they could travel to an unaffected area.
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral -** While some elk in the Hoh U&A follow snow melt to find spring plants, many remain in snow free habitat throughout the year.
Restriction to uncommon geological features or derivatives:	**Neutral -** Elk are not restricted to a particular geological or landscape feature.
Dependence on other species to generate habitat:	**Neutral -** Elk habitat requirements do not have species-specific processes, like relying on a burrow created by another animal.
Dietary versatility (animals only):	**Neutral -** Elk eat a variety of grasses, sedges, ferns, trees, and other plants depending on the season. Their diet is not highly specific.
Dependence on other species for propagule dispersal:	**Neutral -** Elk do not depend on any other species for reproduction or offspring movement.
Sensitivity to pathogens or natural enemies:	**Unknown –** One of the current pathogens most destructive to elk is Treponema-Associated Hoof Disease, also known as hoof disease. Highly infectious, it causes elk to have deformed hooves, which then affects their ability to walk, and they die at higher rates than healthy elk. Interviewees said they hadn't seen any hoof disease in the U&A and WDFW reports only 3 sightings in the U&A since 2012

	(WDFW, 2024). Chronic wasting disease is also a threat to elk. Tribal members have also not seen this affecting elk in the U&A yet. Additionally, wolves are one of the main predators of elk, aside from humans. Wolves have been extirpated from the Olympic Peninsula.
Sensitivity to competition from native or non-native species:	**Neutral -** Elk are not highly sensitive to competitors. They do share habitats with other herbivores, like deer, but it is unlikely that deer will be so positively affected by climate change that they then harm elk.
Forms part of an interspecific interaction not covered by C4a-f:	**Neutral -** Elk do not require any specific interspecies interactions.
Measured genetic variation:	**Unknown -** Elk genetic variation on the Olympic Peninsula is unknown.
Occurrence of bottlenecks in recent evolutionary history:	**Neutral -** While the amount of habitat loss in the last 500 years for Roosevelt elk on the peninsula is unknown, it is estimated that elk populations were around 1800-2000 individuals at their lowest (Jenkins & Happe, 2018). This doesn't qualify as a bottleneck under NatureServe CCVI guidelines.
Phenological response to changing seasonal temperature or precipitation dynamics:	**Unknown -** There does not seem to be any evidence, from either interviews or research, that elk have failed to shift the timing of their practices with the seasons. Interviewees talked about the rut occurring with cooling temperatures in the fall but didn't note that this was significantly changing or that elk were failing to go into rut.
Documented response to recent climate change:	**Unknown -** Herds have shifted locations in response to drought but not outside of their range (Jenkins & Happe, 2018). From interviews and published research, there aren't other documented responses to climate change.
Modeled future (2050) change in range or population size:	**Unknown -** No models found in the literature.
Overlap of modeled future (2050) range with current range:	**Unknown -** No models found in the literature.
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** No models found in the literature.

Species	Oval-leafed Huckleberry / *Vaccinium ovalifolium*
Score	**Moderately Vulnerable**
Species range within the U&A:	Huckleberry is common in forested areas around the U&A.
Migratory exposure:	N/A

Exposure to sea level rise:	**Neutral** – Berry habitat area is not susceptible to sea level rise.
Natural barriers:	**Neutral -** There are not significant natural barriers.
Anthropogenic barriers:	**Neutral** – There are not significant anthropogenic barriers.
Predicted impact of land use changes resulting from human responses:	**Neutral -** It is unlikely that there would be climate-change inspired land use development that would affect huckleberries.
Dispersal and movements:	**Neutral -** Berries are eaten by birds and mammals who can then distribute them more than 1km away from the original plant (Tirmenstein, 1990).
Historical thermal niche:	**Increase -** Nearly half of the Hoh U&A sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37-47°F. Compared to much of the rest of the United States, this a mild climate with a narrow thermal niche.
Physiological thermal niche:	**Neutral -** Huckleberry is not restricted to relatively cool or cold environments.
Historical hydrological niche:	**Neutral -** As calculated by the NatureServe data, the Hoh U&A experiences large precipitation variation, >20in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Somewhat Increase -** Huckleberry can grow in a variety of sites but it is primarily found in moist areas (Tirmenstein, 1990).
Dependence on a specific disturbance regime likely to be impacted by climate change:	**Somewhat Increase -** Depending on the type of fire and how wet the soil is, huckleberry doesn't respond well to fire. Berry production can be halted anywhere from 5 – 20 years after fires (Tirmenstein, 1990).
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral -** Huckleberry is not dependent on ice or snow cover habitats.
Restriction to uncommon geological features or derivatives:	**Somewhat Increase -** Huckleberries require acidic soils with a pH of 4.0 -5.0. They also thrive in soil that is low in nitrogen. This is a specific preference that slightly increases their vulnerability.
Dependence on other species to generate habitat:	**Neutral -** Huckleberry does not depend on another species to create its habitat.
Pollinator versatility (plants only):	**Somewhat Increase -** Huckleberries depend on long tongued native bees for pollination, a relatively narrow range of pollinators (Tirmenstein, 1990).
Dependence on other species for propagule dispersal:	**Neutral -** See dispersal information.
Sensitivity to pathogens or natural enemies:	**Unknown -** Huckleberry is sensitive to a wide variety of pathogens. I did not find detailed observations or research about how certain

	pathogens that affect huckleberry might change with climate change.
Sensitivity to competition from native or non-native species:	**Unknown –** Competitors are unknown.
Forms part of an interspecific interaction not covered by C4a-f:	**Neutral -** Does not require any interspecific interactions.
Measured genetic variation:	**Unknown -** No information available about genetic variation.
Occurrence of bottlenecks in recent evolutionary history:	**Unknown -** No information available about bottlenecks.
Reproductive system:	**Neutral** - Huckleberry can both vegetatively reproduce and reproduce via pollination.
Phenological response to changing seasonal temperature or precipitation dynamics:	**Neutral** – Interviewees have noticed phenological shifts in timing so the huckleberry is adapting in response.
Documented response to recent climate change:	**Unknown -** No information available
Modeled future (2050) change in range or population size:	**Unknown -** No information available. There are models for similar species (*Vaccinium membranaceum* or thin leaf huckleberry) but no models for this specific species.
Overlap of modeled future (2050) range with current range:	**Unknown -** No information available
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** No information available

Species	chaʔá·łowa / Salmonberry / *Rubus spectabilis*
Score	**Less Vulnerable**
Species range within the U&A:	Salmonberry is found throughout the entire U&A.
Migratory exposure:	N/A
Exposure to sea level rise:	**Neutral** – Berry habitat area is not susceptible to sea level rise.
Natural barriers:	**Neutral** – There are not significant natural barriers.
Anthropogenic barriers:	**Neutral** – There are not significant anthropogenic barriers.
Predicted impact of land use changes resulting from human responses:	**Neutral** – It is unlikely that there would be climate-change inspired land use development that would affect salmonberries.

Dispersal and movements:	**Neutral** – Berries are eaten by birds and mammals who can then distribute them more than 1km away from the original plant (Zouhar, 2019).
Historical thermal niche:	**Increase -** Nearly half of the Hoh U&A sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37 - 47°F. Compared to much of the rest of the United States, this a mild climate with a narrow thermal niche.
Physiological thermal niche:	**Neutral** – Salmonberry is not restricted to relatively cool or cold environments.
Historical hydrological niche:	**Neutral** – As calculated by the NatureServe data, the Hoh U&A experiences large precipitation variation, >20in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Somewhat Increase -** Salmonberry prefers to grow in moist soil. It is a facultative wetland plant that can often be found on streambanks (Zouhar, 2019).
Dependence on a specific disturbance regime likely to be impacted by climate change:	**Neutral** – Although frequent fires would be damaging overall to the ecosystem, salmonberries are fairly resistant to fire (Zouhar, 2019).
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral** – Salmonberry is not dependent on ice or snow cover habitats.
Restriction to uncommon geological features or derivatives:	**Neutral** – Salmonberry prefers nitrogen rich soil but can survive in many different types.
Dependence on other species to generate habitat:	**Neutral** – Salmonberry does not depend on another species to create its habitat.
Pollinator versatility (plants only):	**Neutral** – Salmonberry is pollinated by multiple species, including insects, beetles, and hummingbirds (Zouhar, 2019).
Dependence on other species for propagule dispersal:	**Neutral** – See dispersal information.
Sensitivity to pathogens or natural enemies:	**Unknown -** Salmonberry is sensitive to a wide variety of pathogens, including powdery mildew. I did not find detailed observations or research about how certain pathogens that affect salmonberry might change with climate change.
Sensitivity to competition from native or non-native species:	**Somewhat Increase -** Knotweed, a known problem along the Hoh River, likes to grow in the same moist riparian areas as salmonberry. Knotweed is predicted to do well under climate change conditions so it could pose a threat to salmonberry.
Forms part of an interspecific interaction not covered by C4a-f:	**Neutral** – Does not require any interspecific interactions.

Measured genetic variation:	**Unknown -** No information available about genetic variation.
Occurrence of bottlenecks in recent evolutionary history:	**Unknown -** No information available about bottlenecks.
Reproductive system:	**Neutral** – Salmonberry can both vegetatively reproduce and reproduce via pollination.
Phenological response to changing seasonal temperature or precipitation dynamics:	**Unknown -** Interviewees have noticed a change in harvests but it's difficult to attribute these shifts to a phenological change.
Documented response to recent climate change:	**Unknown -** No information available
Modeled future (2050) change in range or population size:	**Unknown -** No information available
Overlap of modeled future (2050) range with current range:	**Unknown -** No information available
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** No information available

Species	Indian Tea or Labrador Tea / *Rhododendron groenlandicum*
Score	**Moderately Vulnerable**
Species range within the U&A:	Found in bogs and wet areas in the Hoh U&A.
Migratory exposure:	N/A
Exposure to sea level rise:	**Neutral** – Indian tea grows in wet areas in low to middle elevations. Few of these environments are in the area where sea level rise is expected (Gucker, 2006).
Natural barriers:	**Somewhat Increase -** Indian tea is found in unique environments, open bogs, and prairies. These are surrounded by forest, a less ideal habitat. Having their seeds distributed in the correct environment could be difficult for this species.
Anthropogenic barriers:	**Neutral** – There are not major anthropogenic barriers for this species.
Predicted impact of land use changes resulting from human responses:	**Neutral** – It is unlikely that there would be climate-change inspired land use development in the areas where Indian tea grows, although regular development is a risk.
Dispersal and movements:	**Neutral** – Seeds are dispersed by wind and are generally effective. It may be difficult for the seeds to disperse through forests, but this is addressed in the natural barriers section (Campbell et al., 2003).

Historical thermal niche:	**Increase -** Nearly half of the Hoh U&A sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37-47°F. Compared to much of the rest of the United States, this a mild climate with a narrow thermal niche.
Physiological thermal niche:	**Somewhat Increase -** Indian tea prefers to grow in cool climates; much of the plant's range is much further north than WA (Gucker, 2006).
Historical hydrological niche:	**Neutral** – As calculated by the NatureServe data, the Hoh U&A experiences large precipitation variation, >20in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Increase** - Indian tea depends on wet, boggy areas to grow. Most coastal bogs are fed by rain, as opposed to groundwater (Rocchio et al., 2014). Soil moisture is predicted to decrease slightly by 2050 under a moderate emissions scenario, as is summer rain and snowmelt (Krosby et al., 2018). This will contribute to the drying of bogs which is predicted in climate models (Lee et al., 2015). "Greatly Increase" was not chosen because the full extent of where Indian tea grows in the Hoh U&A isn't known.
Dependence on a specific disturbance regime likely to be impacted by climate change:	**Neutral** – Indian tea is fairly fire resistant and was even managed with fire by tribes to increase leaf growth (Anderson, 2011). It has been found on disturbed sites and in sites after floods, although it is not one of the first plants to return (Gucker, 2006).
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral** – Indian tea does not depend on ice or snow cover habitats.
Restriction to uncommon geological features or derivatives:	**Unknown -** While Indian tea is restricted to wetland habitats, there isn't much research about how the plants found in Western WA are or aren't restricted to certain soils. Indian tea grows in a variety of soil conditions throughout its entire range.
Dependence on other species to generate habitat:	**Neutral** – While Indian tea requires a specific environment, it's not an environment created by only a few species. Browsing by ungulates is hypothesized to be helpful in maintaining these open bogs, but it's unknown exactly how large of a role they play (Anderson, 2009).
Pollinator versatility (plants only)	**Neutral** – Indian tea has a large variety of pollinators (Gucker, 2006).
Dependence on other species for propagule dispersal:	**Neutral** – Seeds are dispersed by wind (Gucker, 2006).
Sensitivity to pathogens or natural enemies:	**Unknown -** Spruce needle rust can negatively affect Indian tea in Canada. However, I couldn't find evidence of this affecting the tea in the Hoh U&A. Also, spruce needle rust needs cool weather to form spores on the tea so it might not expand with climate change (Hennon, 2001).

Sensitivity to competition from native or non-native species:	**Unknown -** I couldn't find evidence of any plants that compete with Labrador tea.
Forms part of an interspecific interaction not covered by C4a-f:	**Neutral** – It does not have any interspecific interactions not already covered.
Measured genetic variation:	**Unknown -** Genetic variation has not been measured.
Occurrence of bottlenecks in recent evolutionary history:	**Unknown -** There isn't information about genetic bottlenecks.
Reproductive system (plants only; use only if C5a and C5b are "unknown")	**Neutral** – Indian tea can reproduce both asexually and sexually with cross-pollination occurring.
Phenological response to changing seasonal temperature or precipitation dynamics:	**Neutral** – Interviewees have not observed any shift in phenological timing.
Documented response to recent climate change:	**Unknown -** No information available
Modeled future (2050) change in range or population size:	**Unknown -** No information available on the Washington range. Studies have been done looking at the Canadian extent of Indian tea but not yet in Washington.
Overlap of modeled future (2050) range with current range:	**Unknown -** No information available
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** No information available

Species	hà·dí·ƛ̓ʷa (salmon – general) / ʔá·p̓ita (salmon, fish – general) / Pacific Salmonids (Winter and Summer Steelhead, Spring and Fall Chinook, Fall Coho, and Chum Salmon)
Score	**Extremely Vulnerable**
Species range within the U&A:	Both in freshwater rivers and streams in the U&A, as well as migrating into and through the ocean U&A.
Migratory exposure:	**N/A -** These fish do migrate to the ocean but the NatureServe CCVI has this section to address animals who migrate to Central and South America.
Exposure to sea level rise:	**Neutral -** <10% of their range occurs in the coastal zone that will be subject to sea level rise. Sea level rise in the open ocean will not affect salmonids while the effects on coastal habitats are not yet predicted with high confidence. Sea level rise has the potential to

	inundate and degrade coastal habitat, like eelgrass beds (Adams & Zimmerman, 2023).
Natural barriers:	**Greatly Increase** – If the mainstems of rivers are too warm for fish, they will be blocked from reaching all the habitat behind it. The Hoh River mainstem is projected to have August mean temperatures of 16-20°C (60-68°F) by 2080 in a moderate emission model (Adams & Zimmerman, 2023). We are already seeing these temperatures on occasional days – interviewees have remarked on the warmth of the water and a thermal flight observed temperatures up to 17.4°C in the mainstem of the Hoh in 2023 (Diabat & Miwa, 2023).
Anthropogenic barriers:	**Somewhat Increase -** There are many culverts in the Hoh U&A that aren't suitable for fish passage (Coast Salmon Partnership, 2024).
Predicted impact of land use changes resulting from human responses:	**Neutral –** There are different types of marine renewable energy and carbon dioxide removal technologies that could be installed in the river or ocean U&A. It is currently unknown how those might affect salmonid species or where development would be likely to occur given Tribal management and land protection by Olympic National Park and the Olympic Coast National Marine Sanctuary.
Dispersal and movements:	**Somewhat Increase -** Fish are highly mobile but, if water levels are too low, they cannot move through them. Interviewees talked about seeing fish piled up in deep holes when they couldn't move upstream.
Historical thermal niche:	**Increase -** Nearly half the Hoh U&A sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37-47°F. This factor measures broad regional patterns, as opposed to water temperatures, but NatureServe recommends addressing it the same way for aquatic and terrestrial species.
Physiological thermal niche:	**Greatly Increase** - >90% of their range is restricted to cool or cold environments that could be lost or reduced. The optimal range for salmon and steelhead is 12-16°C (53°F -61°F) but the suitable range extends to 20°C (68°F) (Adams & Zimmerman, 2023). Springers or spring chinook have the lowest tolerance for warm temperatures; their range is 3-13°C (37 °F - 55°F) (Bjornn & Reiser, 1991) Models also predict that salmonids will continue to decline as sea surface temperature rises (Crozier et al., 2021).
Historical hydrological niche:	**Neutral -** As calculated by the NatureServe data, the Hoh U&A experiences large precipitation variation, >20in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Somewhat Increase -** The hydrologic regime in the Hoh U&A will change as less snow falls in winter and melt occurs earlier. Particularly for spring chinook, the timing of the spring snow melt is important. Under the NatureServe guidelines, salmonids live in an aquatic habitat that is "highly vulnerable to loss or reduction with climate change."

Dependence on a specific disturbance regime likely to be impacted by climate change:	**Somewhat Increase -** More rain in winter will mean higher peak flows that could scour eggs.
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral -** Little dependence on ice or snow-cover habitats. The cold water melting from the glacier is crucial to fish but that has already been addressed in the thermal niche section.
Restriction to uncommon geological features or derivatives:	**Neutral -** Salmonids are not restricted to one geological type or area.
Dependence on other species to generate habitat:	**Neutral -** Salmonids do not depend on other species to create their habitat. They are central in creating habitat, as their carcasses provide essential nutrients when they return from the ocean, but they do not depend on others for creating their own habitat.
Dietary versatility (animals only):	**Somewhat Increase -** Salmonids do have dietary versatility, eating other fish, insects, amphipods, and zooplankton, among other items. However, a lot of their diet in the ocean is likely to be negatively affected by ocean acidification. Even if prey exists, salmonids might have a more difficult time finding it; coho salmon lose their sense of smell in more acidic waters (Williams et al., 2018).
Dependence on other species for propagule dispersal:	**Neutral -** Salmonids don't depend on other species to move between any of their life stages.
Sensitivity to pathogens or natural enemies:	**Unknown -** Warmer waters have been ideal environments for outbreak of fish disease in many parts of the world but not much is known yet about disease and Pacific salmonids (Bass et al., 2023).
Sensitivity to competition from native or non-native species:	**Unknown -** I did not find specific information about salmon competitors and climate change.
Forms part of an interspecific interaction not covered by C4a-f:	**Neutral -** Salmonids do not require an interspecies interaction.
Measured genetic variation:	**Unknown -** I did not find specific information about genetic variation in salmon in the Hoh U&A, aside from comparisons between wild salmon and hatchery-origin salmon.
Occurrence of bottlenecks in recent evolutionary history:	**Neutral -** I did not find evidence of bottlenecks.
Phenological response to changing seasonal temperature or precipitation dynamics:	**Neutral -** It is uncertain whether it is in response to climate change or other variables, but interviewees have shared that seasons are shifting or that they see fish waiting for the right conditions. Fish do not arrive at the same time every year.
Documented response to recent climate change:	**Unknown –** Tribal members report changes since they were young and from what they've heard from their parents and previous generation but it's difficult to attribute causes to these changes.

	There are many factors involved. It's unknown how much might be climate change vs how much is habitat loss, fishing, historical logging practices, etc.
Modeled future (2050) change in range or population size:	**Unknown -** No models found in the literature.
Overlap of modeled future (2050) range with current range:	**Unknown -** No models found in the literature.
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** No models found in the literature.

Species	ťsá·pis / ťsaťá·pis / Western Redcedar / *Thuja plicata*
Score	**Highly vulnerable**
Species range within the U&A:	Throughout the entire U&A. The U&A is in the latitudinal center of the full Western redcedar range from northern CA to Southeast Alaska (USDA, n.d.).
Migratory exposure:	N/A
Exposure to sea level rise:	**Neutral -** <10% of range occurs in the area subject to sea level rise
Natural barriers:	**Neutral -** There are not major natural barriers that prevent redcedar from shifting its range northwards. If the range of redcedar shifted out of the Hoh U&A, that would be locally devastating, but, for the sake of this assessment, the species could exist somewhere else. Additionally, western redcedar is limited by cold so with warming temperatures, the range may be able to shift up in elevation.
Anthropogenic barriers:	**Neutral -** There are no anthropogenic barriers for the whole western redcedar's range.
Predicted impact of land use changes resulting from human responses:	**Neutral -** It is unlikely that there would be significant land use changes due to climate mitigation infrastructure. Restoration and planting new trees for carbon sequestration could be beneficial for redcedar trees.
Dispersal and movements:	**Increase -** Redcedar seeds are moved by the wind. Dissemination is really only adequate within 100 m and the maximum dispersal distance is less than 1 km (The Oregon Climate Change Research Institute, 2016; USDA, n.d.). Because of this limited dispersal distance, large mountains, rivers, and urban areas can be barriers.
Historical thermal niche:	**Increase -** Nearly half of the Hoh U&A sees annual temperature variations between 18 - 37°F, while the other half, which includes more of the river valleys, sees swings of 37-47°F. Compared to much of the rest of the United States, this a mild climate with a narrow thermal niche.

Physiological thermal niche:	**Neutral -** While the western redcedars on the Peninsula are accustomed to a maritime climate, their range covers a variety of temperatures, making them a generalist with fairly high temperature tolerance (USDA, n.d.).
Historical hydrological niche:	**Neutral -** As calculated by the NatureServe data, the Hoh U&A experiences large precipitation variation, >20in in different parts of the Hoh U&A.
Physiological hydrological niche:	**Increase -** Although western redcedar can grow in a variety of moisture conditions, it is most productive in wet areas (Antos et al., 2016). Estimates of drought tolerance range from very low to moderate (Devine et al., 2012; Goodrich et al., 2023). Western redcedar has a shallow root system in wet soils and no tap root which make it ill-equipped to access deeper water sources in times of drought.
Dependence on a specific disturbance regime likely to be impacted by climate change:	**Somewhat Increase -** Western redcedar is more severely damaged by fire than other coastal trees (USDA, n.d.). Fires have been rare historically on the Olympic Peninsula but are predicted to increase. Redcedar is slow growing and it isn't able to establish itself as quickly as other successional species after a fire.
Dependence on ice, ice-edge, or snow cover habitats:	**Neutral -** Redcedar is not dependent on ice or snow cover habitats.
Restriction to uncommon geological features or derivatives:	**Neutral -** Redcedar can grow in a wide variety of soil types, including those with poor nutrients (USDA, n.d.).
Dependence on other species to generate habitat:	**Neutral -** Redcedar does not depend on any other species to create its habitat.
Pollinator versatility (plants only):	**Neutral -** Pollen is carried to the seed cones via wind, so the trees are not dependent on other species for pollination.
Dependence on other species for propagule dispersal:	**Neutral -** Seeds are wind-dispersed.
Sensitivity to pathogens or natural enemies:	**Neutral -** Redcedar is relatively resistant to insects and diseases (Goodrich et al., 2023). Some insects that damage redcedar, like the western cedar bark beetle (*Phloeosinus punctatus)* and the redcedar wood borer (*Trachykele blondeli)* attack weakened trees. As more trees weaken due to climate change, insect damage could be more widespread but there isn't evidence of this yet (Minore, 1983).
Sensitivity to competition from native or non-native species:	**Neutral -** Western redcedar is often in forests with Douglas-fir and western hemlock. These trees are also predicted to struggle under future climate conditions.

Forms part of an interspecific interaction not covered by C4a-f:	**Neutral -** Cedar does not require an interspecific interaction for habitat or reproduction.
Measured genetic variation:	**Somewhat Increase -** Genetic variation among Western redcedar is low compared to other tree species. Scientists believe the last glaciation confined the trees to the southern end of their range and limited the gene pool (Antos et al., 2016).
Occurrence of bottlenecks in recent evolutionary history:	N/A because we know about genetic variation
Reproductive system (plants only; use only if C5a and C5b are "unknown")	N/A because we know about genetic variation
Phenological response to changing seasonal temperature or precipitation dynamics:	**Unknown -** Interviewees talked about cedar bark harvesting timing changing to be later in the year and after the first hot weather. This could be attributed to climate change or it could be due to other factors, and there isn't evidence of other phenological shifts.
Documented response to recent climate change:	**Unknown -** Western redcedar has been dying back in OR, WA, and Canada with no clear cause, like insect damage or disease. Scientists believe this is due to drought and heat, but it hasn't been observed to kill 10 – 30% of the distribution that NatureServe wants to document it for this category. Additionally, most of the dieback in WA has so far been observed in the urban corridor near Puget Sound and in eastern WA.
Modeled future (2050) change in range or population size:	**Increase -** Models show western redcedar moving to the northeast by 2060 under emissions scenario A1B. It shows cedar entirely disappearing from the Hoh U&A, except for the most eastern edges in the Olympic Mountains (Crookston, 2009).
Overlap of modeled future (2050) range with current range:	**Unknown -** Skipping this category to avoid overcounting.
Occurrence of protected areas in modeled future (2050) distribution:	**Unknown -** Leaving this as unknown since, in 2060, nearly all redcedar moves out of the U&A.

APPENDIX 7: INTERVIEW QUESTIONS AND CONSENT FORM

Semi-structured Interview Guide

(inspired by the interview guide used in the Olympic Coast as Sentinel Project and the GLIFWC Assessment)

Interview goals:

- Learn about the ways you use and value natural resources & relatives (elk, fish, plants, clams, etc) and your memories of what those natural resources were like when you were young across the whole U&A and what they are like today.

Interview process:

- Go over interview procedure, length, and honorarium.
- Go over how transcripts, quotes, and the assessment will be used.
- If no questions or concerns, and people still want to participate, sign consent form.

Interview Questions *(These are only a few examples – you can answer as few or as many you'd like to).*

1. Personal History
    a. Have long have you lived here?
        i. Where were you born? Did you grow up here?
    b. Can you tell me a little bit about your family?
2. Hunting, fishing, and harvesting
    a. What do you hunt/fish/harvest for?
        i. What seasons does that take place in?
    b. How long have you been hunting/fishing/harvesting?
        i. How did you learn?
    c. What was the hunting/fishing/harvesting like when you were younger?
        i. Health/abundance?
    d. What is it like today?
        i. Can you do the same seasons? Same health/abundance?
    e. What cues do you look for to understand if the harvest will be good or not (such as environmental or other)?
    f. Are there any indicators, meaning other things you look for to know when it is time to harvest or stop harvesting certain things/beings (such as when certain plants bloom)?
3. Changes
    a. Have you noticed any changes in the environment in the areas you are most familiar with? (plants, animals, land, water air – abundance, health) over time?

i. Do any of these changes concern you?
ii. If there is not a concern, is there something to be learned from these differences?

b. Is there anything in particular happening (such as human activity) that is having either a positive or negative impact on the items you harvest?
c. When you think back about stories your elders told you, have you noticed any changes in when things were harvested vs. now? Any other changes?
d. Are there new species? Ones that have disappeared?
e. Have you experienced any environmental hazards, like flooding, wildfires, coastal erosion, etc?

4. Future
    a. What are your priorities for resource protection or conservation for the next generation?
    b. What would a future healthy ecosystem look like?
5. **Anything else I didn't ask about that we should talk about?**

THANK YOU!

Consent Form: Climate Change Interviews for Hoh Tribal Natural Resources Department

I, _____, voluntarily agree to participate in this interview.

I understand:

- That my interview will be used to inform a Climate Change Assessment for the Hoh Tribe Natural Resources Department (NRD).
- That this interview will be recorded and I will be provided with a transcript at a later date.
- That I can withdraw or refuse to answer any question at any time.
- That the transcript and audio recording will be stored in the Hoh Natural Resources Department office. Current and future NRD staff will have access to the transcripts.
- The transcripts will also be part of an archive curated by the Hoh Tribe Historic Preservation Officer who will allow access as they see fit.
- The Climate Change Assessment will be shared with the Hoh Business Committee.

- Entire interview transcripts won't be shared with anyone outside of the NRD or outside of the archive project unless the Hoh Business Committee approves it.
- If I have concerns, questions, or want to edit my interview later, I can contact Kelly Rosales, the Hoh Tribe Historic Preservation Officer, and Hannah Tennent, WA Sea Grant Hershman Fellow.

Quote preferences

Direct quotes from interviewees might be used in the assessment and in outward facing materials, like presentations and written statements. These quotes can be attributed to you or they can be anonymous.

☐ I am okay with direct quotes being used and I would like to have my name attached.

☐ I am okay with direct quotes being used but I don't want my name attached. Keep it anonymous.

☐ Don't use any direct quotes from my interview.

Signature of interviewee:

_____

Date: _____

I, Hannah Tennent, WA Sea Grant Hershman Fellow, will abide by the interviewee's preferences. I won't share the interview transcripts with anyone outside of the Natural Resource Staff unless approved by the Business Committee.

Signature of Hershman Fellow: _____

Date: _____