Clallam County Climate Vulnerability Assessment

FUNDED BY WASHINGTON'S CLIMATE COMMITMENT ACT

The Clallam County Vulnerability Assessment is supported with funding from Washington's Climate Commitment Act. The CCA supports Washington's climate action efforts by putting cap-and-invest dollars to work reducing climate pollution, creating jobs, and improving public health. Information about the CCA is available at www.climate.wa.gov.

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Executive Summary

The Climate Vulnerability Assessment (CVA) is a foundational component of Clallam County's Climate Element (CE) for the 2025 Comprehensive Plan update. This document provides a comprehensive overview of current and projected climate risks affecting the County's land, infrastructure, and residents, serving as a critical resource for climate resilience and adaptation planning. As a companion to the County's Multi-Jurisdiction Hazard Mitigation Plan (MJHMP), the CVA expands on identified hazards and aligns with key sectors and focus areas of the Comprehensive Plan. The purpose is to guide the development of CE measures to enhance climate resilience and integrate climate considerations into future planning and development.

Climate Impacts

Clallam County has already experienced climate impacts and will continue to be affected by climate hazards. Without ambitious greenhouse GHG reduction measures across the region and globe, Clallam County is expected to experience the following climate impacts.

- Coastal flooding from higher sea levels.
- Reduced snowpack, resulting in less water availability for streams during the late summer months, affecting salmon habitat, water quality, and streamflow.
- Increased riverine flooding from increased winter precipitation, along with more precipitation falling as rain rather than snow.
- Ocean acidification, which adversely affects marine life and fisheries.
- Increased risk of drought, leading to greater wildfire risk and severity.
- Higher annual average temperatures, with higher temperature increases during the summer months.

Assessing Vulnerability

The CVA focuses on key climate risks and hazards affecting Clallam County's assets and sectors aligned with the Comprehensive Plan as well as critical public health and services to vulnerable populations. The risk assessment examines climate risks in terms of exposure and sensitivity and assesses the ability of a sector to respond by examining the adaptive capacity. **Exposure** refers to the extent a system encounters climate hazards, **sensitivity** assesses the system's likelihood of being affected, and **adaptive capacity** reflects the system's ability to cope with or adjust to climate impacts.

The CVA analysis draws on extensive research from Tribal, municipal, county, state, federal, academic, and peer-reviewed sources, supplemented by input from the County's Hazard Mitigation and Climate Resilience Steering Committee via the MJHMP planning process. This collaborative planning process included two community surveys and public workshops to address climate and hazard risks and inform resilience policies.

Key Findings

Key findings for each sector are included here, with an overall climate vulnerability ranking. Further details are in the Climate Vulnerability Assessment Findings section.

COMMUNITY HEALTH AND WELLBEING

Climate impacts pose significant risks to health and community well-being in Clallam County, with extreme heat, wildfire smoke, and severe weather events likely to increase heat-related illnesses, air quality issues, and infrastructure damage. Vulnerable populations, including the elderly, Tribal communities, and low-income residents, face heightened risks, underscoring the need to strengthen emergency response, public health services, and community resilience.

Table 1. Community Health and Well-being Climate Vulnerability Ranking

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Public Health	Mod - High	Low - Mod	Mod - High
Emergency Management	High	Moderate	Mod - High
Community Resources	Mod - High	Moderate	Moderate

NATURAL ENVIRONMENT AND WATER RESOURCES

Clallam County's natural environment and water resources face growing threats from climate impacts, including hotter temperatures, decreased summer rainfall, and more intense precipitation events. These changes pose risks to aquatic species like salmon and shellfish, increase the vulnerability of trails and open spaces to flooding and landslides, and jeopardize freshwater supplies through reduced storage, saltwater intrusion, and higher demand.

Table 2. Natural Environment and Water Resources Climate Vulnerability Ranking

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Ecosystems and Critical Areas	Mod - High	Mod - High	Moderate
Parks, Trails, and Open Space	Low	Mod - High	Low
Water Supply	Mod - High	Moderate	Moderate

ECONOMIC DEVELOPMENT AND LAND USE

Clallam County's economy, rooted in natural resource industries and tourism, faces moderate vulnerability to climate impacts due to its dependence on natural resources and limited supply chain routes. Many workers in climate-impacted jobs, for example, fisheries and forestry, face physical health risks as well as risks from economic impacts of climate change.

Table 3. Economic Development and Land Use Climate Ranking

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Local Industries and Businesses	Mod - High	Moderate	Moderate
Land Use and Resource Lands	Low - Mod	Moderate	Moderate

BUILT INFRASTRUCTURE

Clallam County's aging and undersized infrastructure faces significant climate risks, including flooding, sea level rise, and extreme heat, which threaten roadways, housing, stormwater systems, and energy networks. Key vulnerabilities include highways at risk of inundation, aging housing stock exposed to wildfire hazards, outdated stormwater systems, and energy infrastructure struggling to withstand climate impacts like summer drought and reduced streamflow (which affects hydropower), intense storms, wildfire threats, and extended heat events.

Table 4. Built Infrastructure Climate Vulnerability Ranking

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Transportation	Mod - High	Moderate	Moderate
Housing	High	Low - Mod	High
Water Systems	Mod - High	Mod - High	Mod - High
Energy	High	Moderate	Mod - High

Next Steps

The results of the CVA will be used to inform policy development for the County's Climate Element as part of the Comprehensive Plan update.

Introduction

Clallam County, like many areas in the Pacific Northwest, is already feeling the effects of climate change. These include warmer temperatures year-round, heavier and more frequent rainstorms, less snow in winter, summer droughts, and flooding along rivers and coastlines. These issues are expected to worsen unless global greenhouse gas emissions are significantly reduced, and the County takes steps to adapt to these anticipated climate impacts.

Climate change impacts the County in various ways. Infrastructure such as roads, bridges, and utility systems face increased stress from extreme weather events. Natural resources, including forests, water supplies, and local ecosystems, are at risk of degradation, which can also harm the County's economy. Additionally, people's health and well-being are directly affected by extreme weather, which can lead to illness, injuries, or even fatalities.

Recent events highlight the reality of these challenges. Severe flooding occurred during winter storms in 2018 (Hawkins, 2018) and 2021 (Clallam County Sheriff's Office, 2021)), and the 2021 heat dome caused two deaths in Clallam County (Washington State Department of Health). In 2022, wildfires on the Makah Reservation forced evacuations, emphasizing the growing risk of extreme events (KOMO News Staff, 2022). These examples demonstrate how climate hazards are already affecting the region.

To address these challenges, Clallam County is updating two key plans that relate to advancing climate resilience across the county. One major effort is the creation of a Climate Element (CE) as part of the County's 2025 Comprehensive Plan update. This new section will include strategies to improve climate resilience, as required by Washington's House Bill 1181. At the same time, the County is updating its Multi-Jurisdictional Hazard Mitigation Plan (MJHMP), which was last revised in 2019. This plan outlines steps to reduce risks from natural disasters such as earthquakes, drought, and wildfires. Findings from the Climate Vulnerability Assessment (CVA) will be integrated into these plans to address overlapping hazards more effectively.

Coordinating climate planning efforts helps the County address "compounding impacts," where multiple hazards—such as wildfires and power outages—occur simultaneously, resulting in greater damage and more complex recovery efforts. For instance, wildfires can increase air pollution (PM2.5), and when combined with a heat wave and power outages, can create hazardous health conditions. Similarly, rising sea levels and stronger storms exacerbate coastal flooding during naturally high "king tides," as seen in Sequim in 2024 (Figure 1). King tides, or extremely high tides, are natural events, but their effects are amplified by climate-related factors like sea level rise and more intense storms. These combined events, such as the high tides and winter storms of December 2018 that impacted residential areas in Sequim, underscore the growing concern about cascading impacts and the need for coordinated planning to mitigate them (Figure 2).

Figure 1. Aerial image of 3 Crabs Road, looking East during a King Tide event in December 2024. Photo by John Gussman.

Figure 2. Flooding near 3 Crabs Road near Dungeness and Sequim during a high tide and storm event in 2018 (Hawkins, 2018).

Through these efforts, Clallam County aims to prepare for the challenges of a changing climate, reduce risks to its communities, and strengthen its resilience to future hazards.

Report Goals and Structure

The CVA is a critical effort to inform Clallam County's Climate Element (CE) for the 2025 Comprehensive Plan update providing an overview of current and future climate risks and hazards that are already affecting the County's land, infrastructure, and residents. It is intended as an accompanying document to the CE for the County's Comprehensive Plan update and the County's Multi-Jurisdiction Hazard Mitigation Plan (MJHMP), expanding from hazards identified in the MJHMP to key sectors and focus areas aligned with the Comprehensive Plan. The CVA has several key objectives that guide its role in shaping the County's approach to climate resilience and adaptation:

1. **Shape the CE measures to enhance climate resilience:** The CVA identifies areas where Clallam County is most vulnerable to climate impacts, guiding targeted CE measures that improve the adaptive capacity of key sectors such as public health and community wellbeing, natural environment and water resources, economic development and land use, and built infrastructure.
2. **Inform future planning and development:** As Clallam County plans for growth, the CVA helps integrate climate considerations into land and resource use, housing, and infrastructure.
3. **Strengthen the Multi-jurisdiction Hazard Mitigation Plan (MJHMP) update:** The CVA provides additional data on climate hazards and risks across sectors that goes beyond the County's 2024 MJHMP and FEMA requirements and achieves state requirements for the CE update.

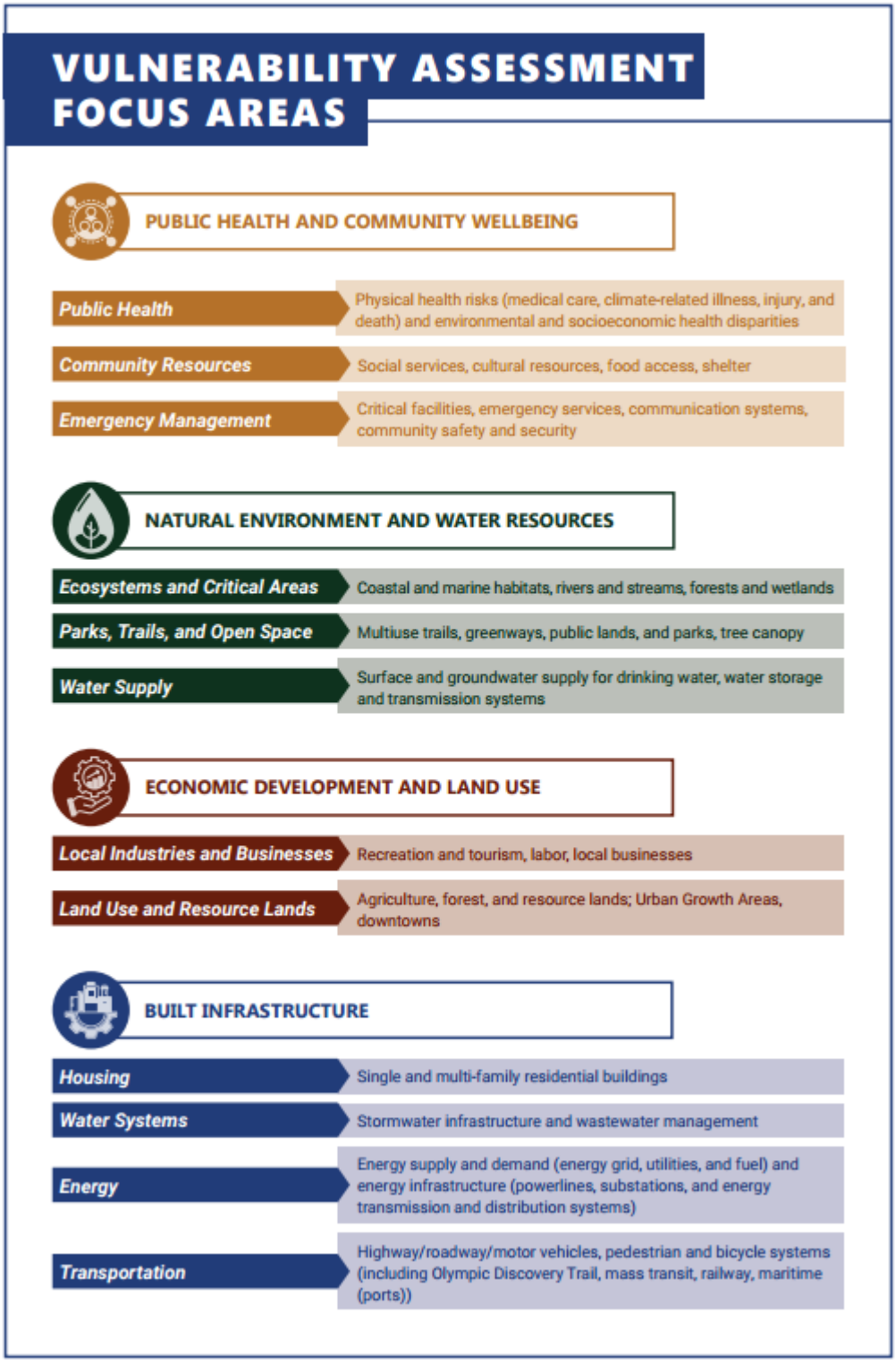
How to Read this Document

This document provides a comprehensive analysis of climate vulnerability in Clallam County. In addition, we discuss the adaptive capacity within each sector and subsector to highlight existing strengths and areas to bolster.

Here's what you'll find in each section of the focus areas:

Summary of Risks and Adaptive Capacity	This section outlines the exposure and sensitivity of Clallam County to various climate hazards, as well as the capacity to adapt to these risks. It highlights key vulnerabilities, considerations of socially vulnerable communities, and strengths in the County's ability to respond to climate impacts.
Evaluation of Vulnerability	This is a description and vulnerability ranking of the identified sector to climate risks considering the exposure, sensitivity, and adaptive capacity. It provides insights into areas, communities, and sectors that are most at risk from climate change.

The CVA analyzes climate vulnerability across four focus areas that are aligned with core areas in the County's Comprehensive Plan:



Methodology

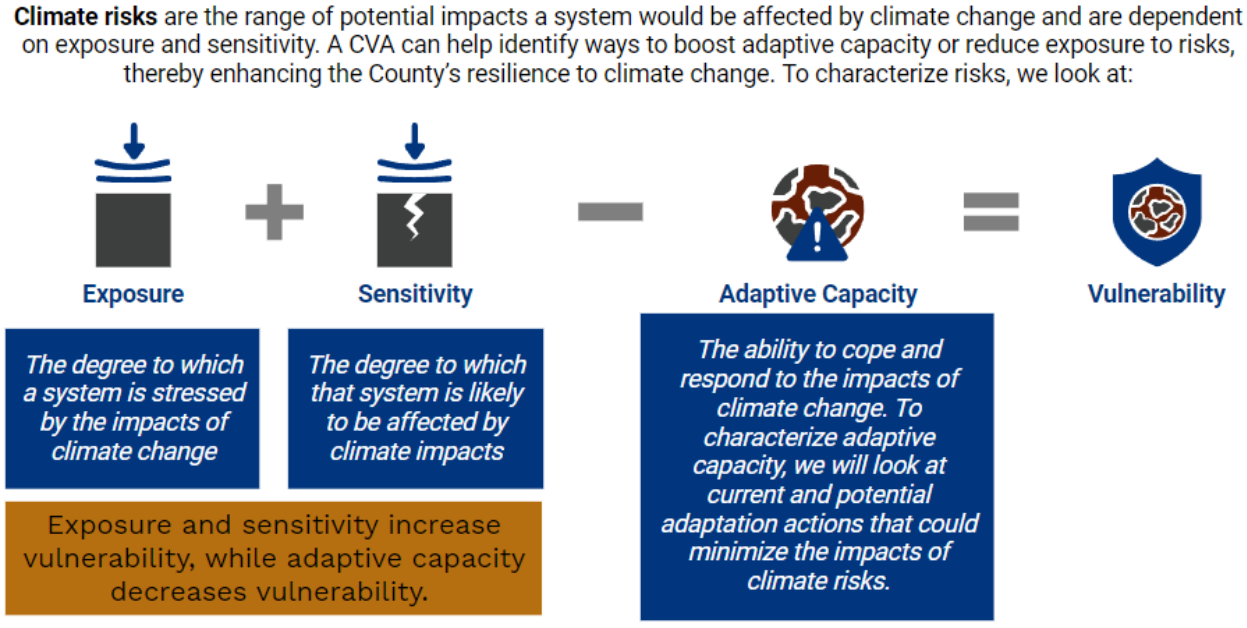
The focus of this CVA is on key climate risks and hazards on assets that Clallam County directly owns or operates, sectors that are within the purview of the Comprehensive Plan or are important for public health and safety, and assets that provide an important service for vulnerable populations.

This CVA leverages a wide body of research available from Tribal, municipal, county, state, federal, and academic and peer-reviewed sources (See References and Appendix A: Documents Reviewed for more specifics on documents and resources used). In addition, the CVA is a part of a larger planning process driven by the County's Hazard Mitigation and Climate Resilience (HMCR) Steering Committee made up of county, city, Tribal, federal, state and other local entities informing the development of the MJHMP and CE. The planning process included two community-wide surveys on hazards and climate impacts and two public workshops on climate and hazard risks and resilience policies.

Climate Vulnerability Framework

Climate vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as a combination of climate risks (combination of exposure to climate impacts and sensitivity to those impacts) and the adaptive capacity (or level of preparedness to adapt to climate change (Figure 3) (Chu, 2023).

Figure 3. Assessing Climate Vulnerability



Vulnerability Risk Assessment

Each of the four sectors was assigned a vulnerability score based on a scale that evaluates climate risk and adaptive capacity. This provides a general overview of the County's climate

vulnerability, ranging from low to high, as shown in Table 5. Climate risk and adaptive capacity scoring matrix. **Climate risk** scores for each subsector were determined using the results of the climate impacts analysis (Appendix C), document review, alignment with the MJHMP, and input from the planning process. Subsectors' level of exposure to climate impacts, such as asset location with respect to coastal flooding, sea level rise, and wildfire risks, and community and asset sensitivity were used to evaluate climate risk. For instance, older residents are more sensitive to extreme heat, and individuals with certain health conditions are more affected by smoke from frequent and severe wildfires.

Adaptive capacity measures the ability to mitigate damage, cope with, or adjust to climate change. This capacity can be evaluated at the individual, sector, or community level, reflecting preparedness to address specific climate risks. It also depends on the County's leadership, staffing, resources, and partnerships. For example, a high adaptive capacity is indicated when the County has conducted significant research, established clear policies, and mobilized resources and stakeholders to implement priority actions. Conversely, if plans are in place but actions are largely unimplemented, this suggests a moderate adaptive capacity.

The overall vulnerability score for each sector combines the climate risk and adaptive capacity scores to provide a broad understanding of vulnerability to climate change impacts, ranging from low to high. A "high vulnerability" rating signifies both a high level of climate risk and a low level of adaptive capacity. Whereas a "low vulnerability" rating indicates a low level of climate risk and a high level of adaptive capacity. It is important to note that this county-wide assessment is not intended to evaluate specific infrastructure or assets. Individual facilities and communities may have vulnerabilities that differ from the sector-level findings.

Table 5. Climate risk and adaptive capacity scoring matrix

Climate Risk	Adaptive Capacity	Vulnerability
Low *Low exposure and sensitivity to climate impacts*	**High** *Robust plans in place with staffing and resources for implementation. Actions are being taken to address the issues, and those actions already have an impact.*	**Low** *Low climate risk and high adaptive capacity for a sector means low overall climate vulnerability.*
Moderate *Moderate exposure and sensitivity to climate impacts.*	**Moderate** *Plans and resources are in place that address climate issues but may not account for future climate impacts. There is staff capacity and resources available to address climate impacts in this sector.*	**Moderate** *Moderate climate risk with some capacity to address those risks classifies a sector as low to moderate overall climate vulnerability.*
High *High exposure and sensitivity to climate impacts.*	**Low** *The sector may not have a plan and lacks resources or has limited redundancy. The*	**High** *High climate risk with low ability to adapt to those risks means high climate*

	County may have a plan and some staff, but limited resources to implement actions to increase resiliency.	*vulnerability and an opportunity to focus climate resilience strategies.*

Alignment with Hazard Mitigation Plan

We aligned our CVA with the County's MJHMP risk assessment process. The MJHMP is organized by hazard and looks five years backward and five years forward, per FEMA requirement. The CVA utilizes climate projections farther into the future and is organized by sectors that consider community resources and assets beyond the focus of critical assets and populations in the MJHMP (e.g., Agriculture and Economic Development).

We utilized the MJHMP hazard ranking scores that were determined by the HMCR Steering Committee (Table 6) to help assess climate risk for the CVA.

Table 6. Hazard Rankings & Correlates

Climate impact	HMP Correlate Hazard	HMP Hazard Ranking
Drought	Drought	High
Extreme Heat	Severe Weather - Extreme Heat	High
Extreme Precipitation & Storms	Severe Weather - Winter Storm (rain, ice, snow, cold temperature)	Medium
Flooding	Flooding	Medium
Landslides	Landslides	Medium
Sea Level Rise	Sea Level Rise	Medium
Wildfire	Wildfire	High
Wildfire Smoke	Wildfire (including wildfire smoke)	High

Climate Trends and Projections

Since 1895, Clallam County's average annual temperature has increased by 1.4°F (NOAA National Centers for Environmental information, 2024). By the end of the century, average summer maximum temperatures are projected to rise by 9°F from the historical baseline of 68.4°F (Abatzoglou and Brown, 2012). This warming trend will bring significant consequences, including altered precipitation patterns, increased wildfire risks, and higher rates of heat-related illnesses. Heatwaves and heat dome events are also expected to become more frequent and intense (North Olympic Development Council, 2022).

Expected Climate Impacts

Without strong greenhouse gas (GHG) reduction measures, Clallam County is likely to face the following climate impacts:

- **Coastal Flooding:** Rising sea levels will increase the frequency and severity of coastal flooding.
- **Reduced Snowpack:** Less snow in winter will decrease water availability during late summer, impacting fish and animal habitats, water quality, and streamflow.
- **Increased Riverine Flooding:** Heavier winter precipitation and more rain (instead of snow) will lead to greater flooding along rivers.
- **Ocean Acidification:** Marine life and fisheries will be adversely affected by more acidic ocean conditions.
- **Drought and Wildfire Risk:** Longer and more severe droughts will increase the frequency and intensity of wildfires.
- **Rising Temperatures:** Annual average temperatures will continue to climb, melting glaciers and leading to hotter summers and more frequent days with extreme heat.

These impacts are summarized in Figure 4 and explored in detail in Appendix C: Climate Impacts Summary.

Climate Variability and Scenarios

The climate in the Pacific Northwest region, including Clallam County, is influenced by natural variability such as the El Niño, La Niña, and Pacific Decadal Oscillation which are long term variations in the sea surface temperature. These cycles can impact the County's climate on a yearly basis. For instance, during an El Niño year, the region tends to experience warmer and drier winters, while in a La Niña year, winters are typically cooler and wetter. Natural processes, such as the El Niño-Southern Oscillation and the Pacific Decadal Oscillation, also influence climate variability over shorter timeframes. However, the rate of human-induced climate change far outpaces natural variability (Perlwitz, 2017).

Climate change refers to the long-term alteration of environmental conditions and weather patterns caused by human activities, particularly greenhouse gases. The rise in atmospheric greenhouse gases has already caused significant climate changes. Future climate conditions are

projected using scenarios that consider factors such as land use, population growth, technological advancements, and emission levels.

This CVA primarily uses the Representative Concentration Pathway (RCP) 8.5 scenario, which represents a "business-as-usual" trajectory where emissions continue at current rates. RCP 8.5 is the highest emissions scenario and projects global warming of about 4.3°C (7.7°F) by 2100 relative to pre-industrial temperatures.

Understanding climate projections helps Clallam County prepare for and adapt to the challenges of a changing climate.

Figure 4. Climate Impacts Summary for Clallam County

Climate Impacts and Social Vulnerability

"Climate impacts are not distributed equally. Who is at risk is a factor of both who is most exposed, and who has the ability to respond, adapt, and decide."

(Washington State Department of Commerce, 2024)

Climate impacts exacerbate social inequities, placing the greatest burdens on Clallam County's most socially vulnerable groups. These groups, often referred to as "frontline communities," are likely to experience the first and worst effects of climate impacts. In Clallam County, vulnerable groups include:

- Senior residents (65 years and older)
- Mobile home residents
- Residents with chronic health conditions
- Low-income households
- Tribal communities
- Transient and Seasonal Visitors
- Climate-Impacted Workers

Clallam County's census tracts show varying levels of social vulnerability, according to both the Center for Disease Control Social Vulnerability Index (CDC SVI)[1] and Washington Department of Health, Environmental Health Disparities Map[2]. According to the CDC SVI, census tracts in the western area of the county, and around Sequim and Port Angeles, have a high level of social vulnerability primarily due to age, income, health, and housing factors (Figure 5). In other words, those parts of the county have higher rates of senior residents, low-income households, chronic health conditions, and people living in mobile homes.

Likewise, the Environmental Health Disparities map shows the highest scores, illustrating higher social vulnerability, in the western region of the county, Sequim, and Port Angeles (Figure 6). This map shows pollution measures such as diesel emissions and ozone, as well as proximity to hazardous waste sites. In addition, it displays measures like poverty and cardiovascular disease.

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[1] This report references the CDC Social Vulnerability Index (SVI), which states that "Social vulnerability refers to the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss. ATSDR's Social Vulnerability Index uses U.S. census variables at tract level to help local officials identify communities that may need support in preparing for hazards or recovering from disaster." See more at CDC Social Vulnerability Index (SVI) | Data | Centers for Disease Control and Prevention

[2] This report uses the Washington Environmental Health Disparities Map, which is an interactive mapping tool comparing communities across the state for environmental health disparities.

The tool ranks key data categories from 1-10, with 1 being the lowest occurrence of environmental health disparities (light purple color) and 10 being the highest (darkest purple color). There are 19 indicators, divided into four themes: Environmental Exposures, Environmental Effects, Socioeconomic Factors, and Sensitive Populations. See more at Information by Location | Washington Tracking Network (WTN)

Figure 5. Map of Social Vulnerability Index from the Center for Disease Control. Areas in dark purple have higher rates of socially vulnerable residents.

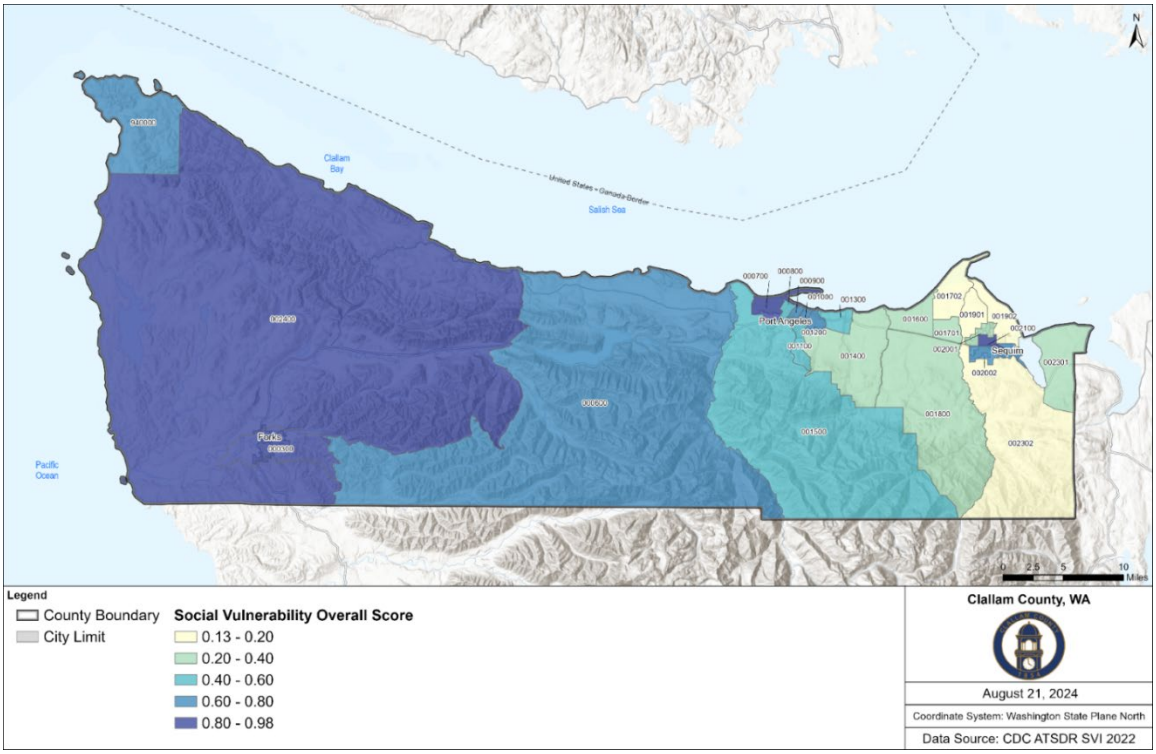
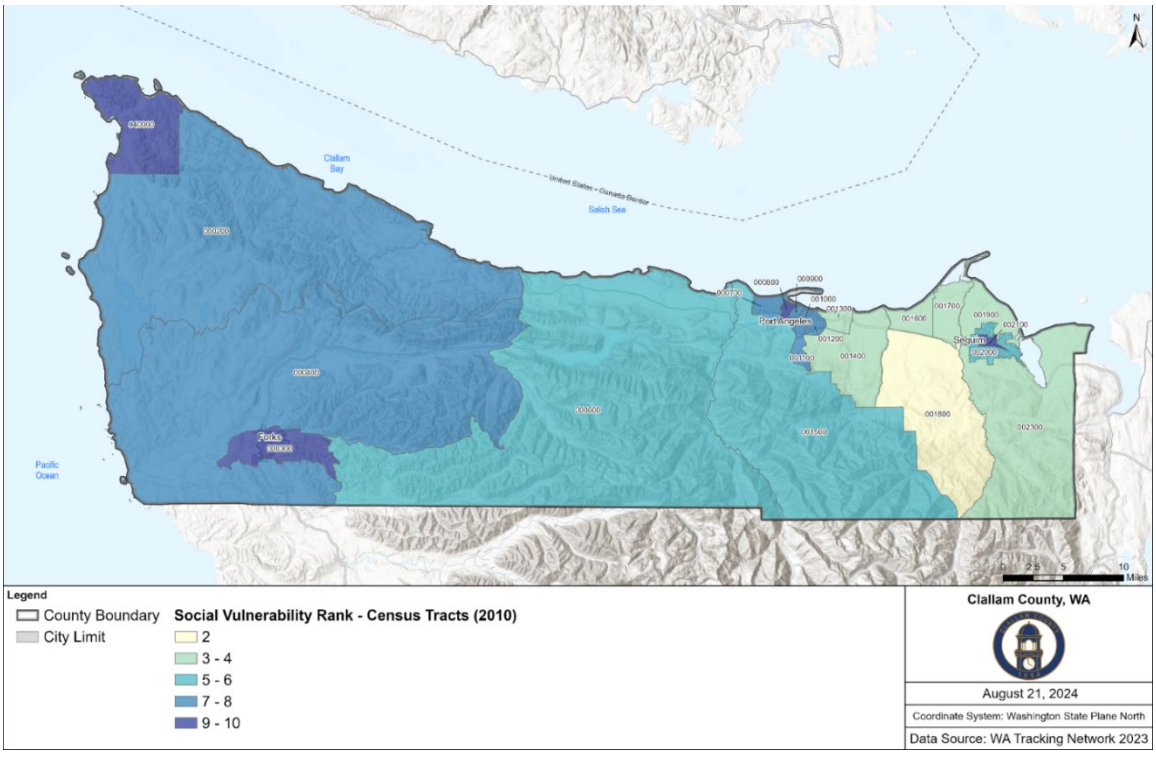


Figure 6. Washington Environmental Health Disparities Map. Areas in dark purple indicate where there are more environmental health disparities.



Vulnerable Groups in Clallam County

An overview of climate impacts and sensitivities for vulnerable groups is described below.

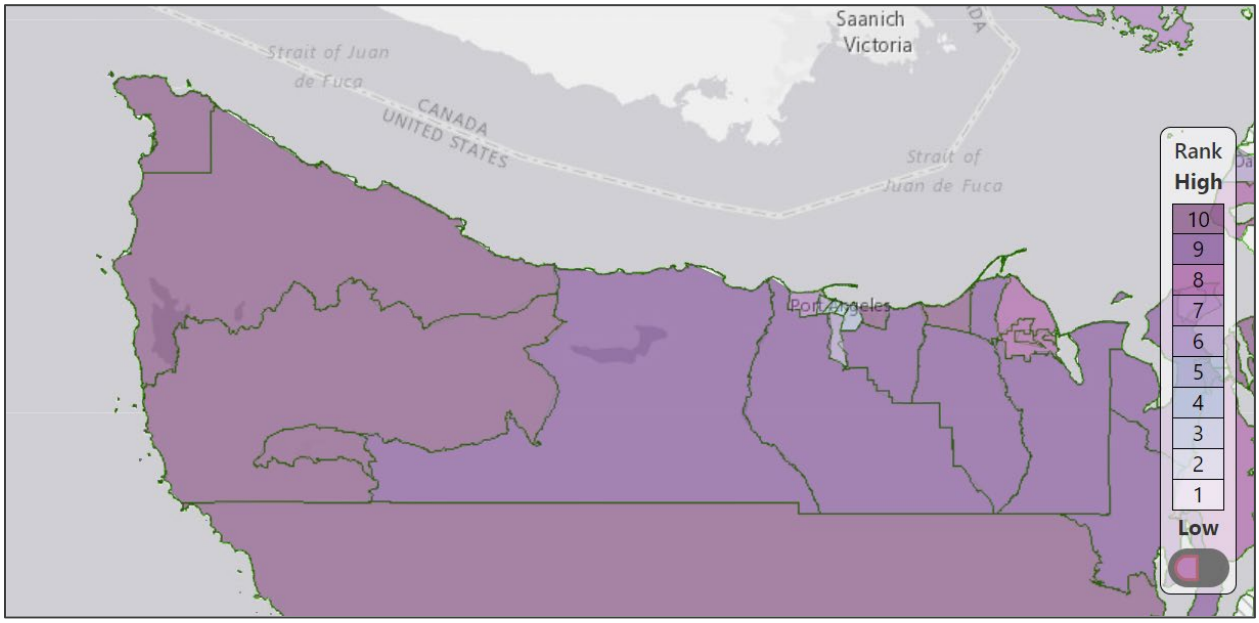
SENIORS

Clallam County has a significantly older population compared to the state average, with seniors comprising 30.7% of the population, compared to 17.1% statewide. Seniors face heightened risks due to mobility issues, health concerns, and limited access to transportation and technology. This makes them more vulnerable to heatwaves, air pollution, and extreme weather events. Many also have disabilities, such as cognitive impairment or vision and hearing challenges, which complicate emergency response and recovery efforts (Environmental Protection Agency).

MOBILE HOME RESIDENTS

Mobile homes, particularly older units, are more vulnerable to flooding and other extreme weather events. In areas like Western Clallam County and Forks there is a high concentration of mobile homes as illustrated in Figure 7 (HMP 2024, CDC). For example, over 30% of residents in Southwest Clallam County live in mobile homes (Northwest Clean Energy Atlas). These homes are more common among low-income households, with residents that can lack the financial resources to prepare for or recover from climate impacts. For example, Sequim has 13 mobile home parks, with residents on fixed incomes expressing concerns about rising housing costs, which further strain their ability to prepare for climate events (Nash, Council extends manufactured home moratorium again, 2024).

Figure 7. Population living in manufactured or mobile homes (Washington Environmental Health Disparities). Note this map uses data from the U.S. census which counts people with seasonal homes or who have transitory living arrangements (such as RV parks) at the residence where they live and sleep most of the time. If they have no usual residence, they're counted at their location on Census Day.



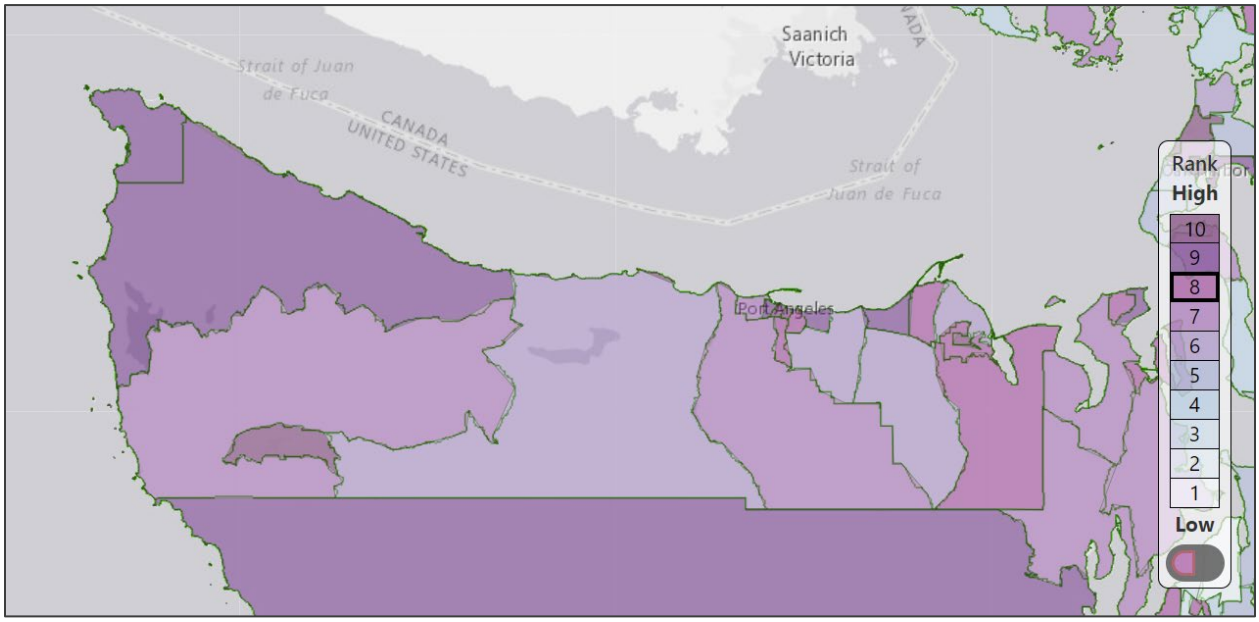
RESIDENTS WITH CHRONIC HEALTH CONDITIONS

Individuals with conditions such as cardiovascular disease or asthma are more sensitive to climate-related hazards like extreme heat, flooding, and wildfire smoke. Areas with high rates of chronic illness, such as Forks, southern Port Angeles, and Sequim, also show high levels of uninsured residents and lower life expectancy, increasing vulnerability to environmental hazards (Washington State Department of Health).

LOW-INCOME HOUSEHOLDS

Low-income households, especially those below 150% of the poverty line, often lack resources to prepare for or recover from climate impacts like flooding, extreme heat, and wildfire smoke. Clallam County's median household income is about 30% lower than the state average, and many residents lack homeowners' or renters' insurance, making recovery from disasters more challenging (Clallam County, 2024). Areas like Western Clallam County, Forks, northern Sequim, and the Makah Reservation show significant overlap between poverty, disability, and aging populations, increasing their vulnerability to climate change impacts (Figure 8).

Figure 8. Median household income (Washington Environmental Health Disparities)



TRIBAL COMMUNITIES

Tribal communities, including the Quileute, Makah, Lower Elwha Klallam, and Jamestown S'Klallam Tribes, face unique climate challenges due to their reliance on natural resources and treaty-protected lands. For example, flooding could isolate the Makah Reservation in Neah Bay by cutting off the only road out (Hazard Mitigation & Climate Resilience Planning Workshop, 2024). Climate change threatens ecosystems and resources central to Tribal health, culture, and livelihoods, intensifying existing social and economic difficulties (Clallam County, 2024).

TRANSIENT AND SEASONAL VISITORS

Tourists and seasonal visitors are considered vulnerable because they often lack local knowledge of evacuation routes and may be unprepared for natural hazards. During peak summer months, the influx of visitors can strain local resources, emergency services, and healthcare systems, complicating disaster response efforts for residents and visitors alike (Clallam County, 2024).

CLIMATE-IMPACTED WORKERS

Outdoor workers, such as those in logging and construction—two key industries in Clallam County—face heightened risks from extreme heat and wildfire smoke. Prolonged exposure to air pollutants and extreme temperatures can lead to health issues, reduced productivity, and economic instability. Extreme heat is linked to spikes in workplace injuries and illness (University of Washington, 2024). Access to adaptive measures like shade, air conditioning, and workplace protections is critical to safeguarding these workers.

Climate Vulnerability Assessment Findings

The following sections provide an assessment of overall climate vulnerability score, key takeaways and an overview of key climate risks and adaptive capacity within Clallam County.

Public Health and Community Wellbeing

In Clallam County, climate change threatens key services that support residents' health and community well-being. Extreme heat can cause heat stress, especially in older adults, while severe weather events may disrupt emergency and health services by overloading communication infrastructure and damaging already limited transportation routes. Strengthening emergency response, public health services, food access, and social cohesion will boost community resilience before, during, and after such events.

The Public Health sector evaluates climate risk (exposure and sensitivity) and adaptive capacity impacting the County's Public Health, Emergency Management, and Community Resources sub-sectors to determine overall vulnerability.

Table 7. Vulnerability Scores for Public Health and Community Well-Being

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Public Health	Mod – High	Low - Moderate	Moderate - High
Emergency Management	High	Moderate	Moderate - High
Community Resources	Moderate – High	Moderate	Moderate

PUBLIC HEALTH

Climate Risk	Adaptive Capacity	Vulnerability
Moderate – High	Low - Moderate	Moderate - High
Clallam County faces "moderate-high" public health risks from extreme heat, wildfire smoke, and flooding, disproportionately impacting vulnerable populations like older adults, Tribal communities, and low-income residents.	Clallam County's adaptive capacity is ranked "low-moderate" due to limited healthcare resources, lack of a coordinated countywide disaster response plan, and reliance on external facilities for trauma care.	Limited resources, healthcare access, and aging infrastructure heighten these risks, while increasing extreme events strain public health systems and community well-being.

EMERGENCY MANAGEMENT

Climate Risk	Adaptive Capacity	Vulnerability
High	Moderate	Moderate - High

Emergency management climate risks in Clallam County are ranked high due to the county's vulnerability to flooding, wildfires, and disruptions to critical infrastructure, which can isolate residents, strain emergency services, and limit access to essential resources during major climate events.	Adaptive capacity in Clallam County is ranked moderate due to having some community-wide planning efforts underway but ongoing needs and challenges with implementation, particularly with funding.	Overall vulnerability in Clallam County is moderate to high due to the combination of significant climate risks, such as flooding, wildfires, and extreme weather events, and the challenges in emergency management and adaptive capacity, including limited healthcare infrastructure, dependence on isolated transportation routes, and stretched local resources.

COMMUNITY RESOURCES

Climate Risk	Adaptive Capacity	Vulnerability
Moderate – High	Moderate	Moderate
Community resources in Clallam County are ranked moderate-high due to the vulnerability of essential services like food access, healthcare, and transportation, which are increasingly threatened by climate impacts such as flooding, extreme heat, and disruptions to traditional food sources, disproportionately affecting low-income, elderly, and Tribal communities.	Community resources' adaptive capacity in Clallam County is ranked moderate due to various plans and programs, such as the Climate Action Plan and Tribal resilience initiatives, which aim to enhance community well-being, food systems, transportation, and emergency management, though challenges remain in remote areas and limited resources.	Overall vulnerability for community resources in Clallam County is ranked moderate due to climate-related challenges like food insecurity, limited transportation options, and disruptions from extreme weather, despite the presence of adaptive plans and community support programs.

KEY TAKEAWAYS

- Extreme heat, wildfire smoke, and extreme precipitation present moderately high health risks in Clallam County, likely leading to increased heat-related illnesses, decreased air quality, injury, and distress.
- Critical facilities and emergency services face moderate exposure to climate impacts such as flooding and landslides, with very high risk to communities given limited evacuation routes and damaged critical infrastructure.
- Vulnerable groups in the County will be particularly sensitive to climate impacts and related sensitivities such as food insecurity and loss of cultural foods, especially those with pre-existing health conditions, the elderly, residents without health insurance, outdoor workers, Tribal communities, and individuals with low income.

Public Health

The effects of climate change are and will continue to adversely affect physical, mental, and community health in Clallam County. In the Pacific Northwest, the incidence of illnesses and death during extreme heat events and wildfire smoke days is increasing, and climate change is stressing health systems (US Global Change Research Program, n.d.). Climate-related health risks disproportionately affect socially vulnerable populations, including the elderly, residents without health insurance, outdoor workers, Tribal communities, and individuals with low income.

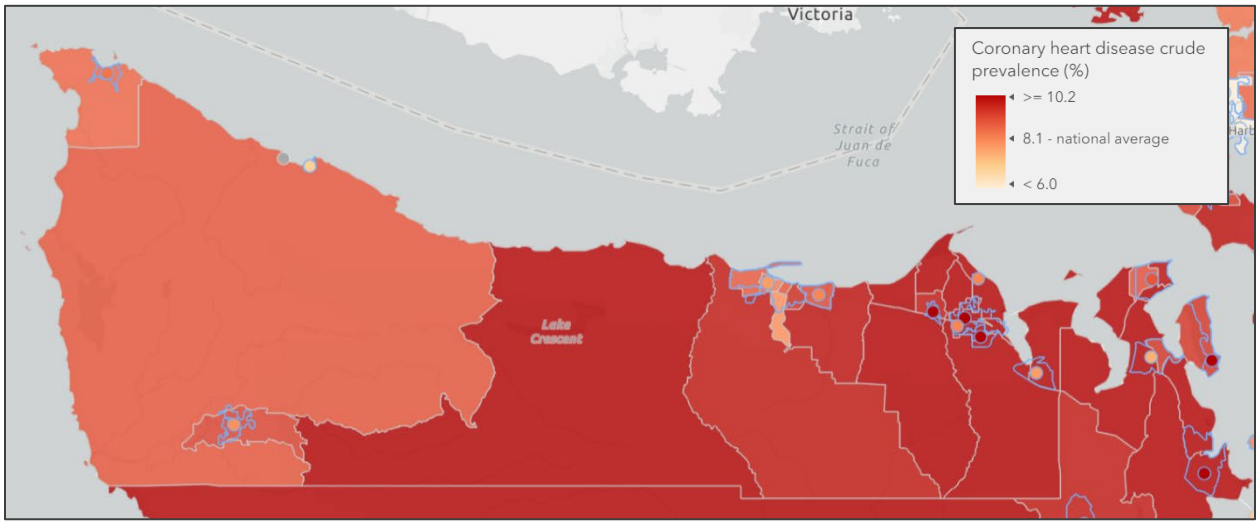
CLIMATE RISK

Climate impacts such as extreme heat, wildfire and wildfire smoke, and extreme precipitation pose risk to public health in the County. As one example, extreme heat events are already happening and are likely to increase rates of heat related illnesses, death, and emergency room visits in the County (North Olympic Development Council, 2015). While all residents will experience physical health impacts to some extent, some community members will be more sensitive to these impacts. Tribal community health is already facing stress due to an aging population, higher rates of type 2 diabetes, and shifting natural resources (discusses in later parts of this report)—a trend expected to continue (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).

The 2021 heat dome in the Pacific Northwest broke 128 temperature records across Washington and officially caused 126 heat-related deaths. However, the actual toll was higher—441 more people died during this period than expected, excluding COVID-19 deaths. These "excess deaths" include cases where heat indirectly contributed, such as through kidney failure or heart attacks. This event also marked the deadliest weather disaster in Washington's history (University of Washington, Climate Impacts Groups, 2023).

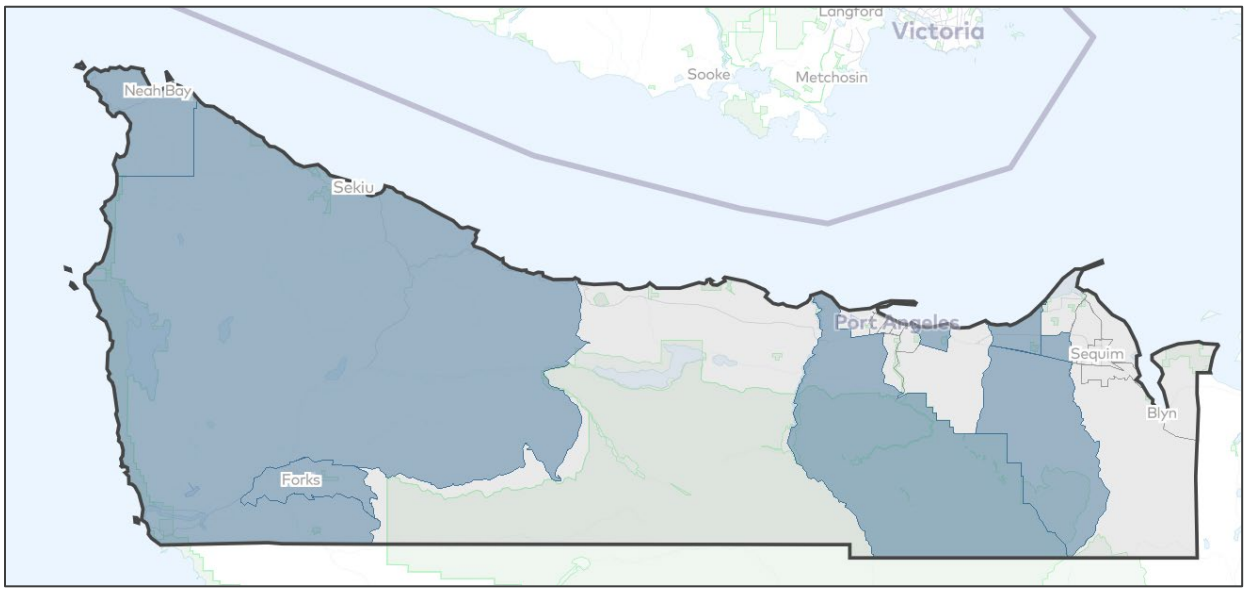
In Clallam County, vulnerable groups like older adults, especially Tribal elders, and those with chronic health conditions are especially sensitive to extreme heat. They also may be less able to cross levees and be less mobile during flooding events (Hazard Mitigation & Climate Resilience Planning Workshop, 2024). As of 2022, over 30% of residents in the County were over 65 years of age and several communities were above the national average for rates of heart disease, including the tract that encompasses Lake Crescent and the eastern region of Clallam, most notably the City of Sequim and surrounding areas (Washington State Department of Health). As shown in Figure 9, the estimated prevalence of coronary heart disease among adults aged 18 years and older was over 10% in many of these areas in 2022, above the national average of 8.1% (Center for Disease Control, 2022).

Figure 9. Prevalence of coronary heart disease (Center for Disease Control, 2022)



Residents who live in older housing or mobile homes are also more sensitive to extreme heat and are more likely to be without access to air conditioning or cooling (North Olympic Development Council, 2015). Mobile homes, especially those in areas with coastal and/or riverine flood risk, may be more exposed to flood risk. In the County, 11.3% of housing units are mobile homes, higher than the US average of 5.2%. Certain areas in Clallam County have significantly higher percentage of housing units that are mobile homes compared to the County and US average, including the City of Forks at 30.4%, the tract south of Port Angeles at 31.9%, and the tract southwest of Sequim at 32.1% (Figure 10) (Headwaters Economics, 2024).

Figure 10. Housing units that are mobile homes—blue highlight indicates percentage above 18% (Headwaters Economics)



As temperatures rise and water availability shifts in the County, the risk and extent of wildfire damage and periods of smoke from regional fires will increase, further impacting public health and wellbeing of residents. Wildfire smoke is a significant hazard in Clallam County, consisting of fine particles (PM2.5) and harmful gases from burning trees, plants, buildings, and other

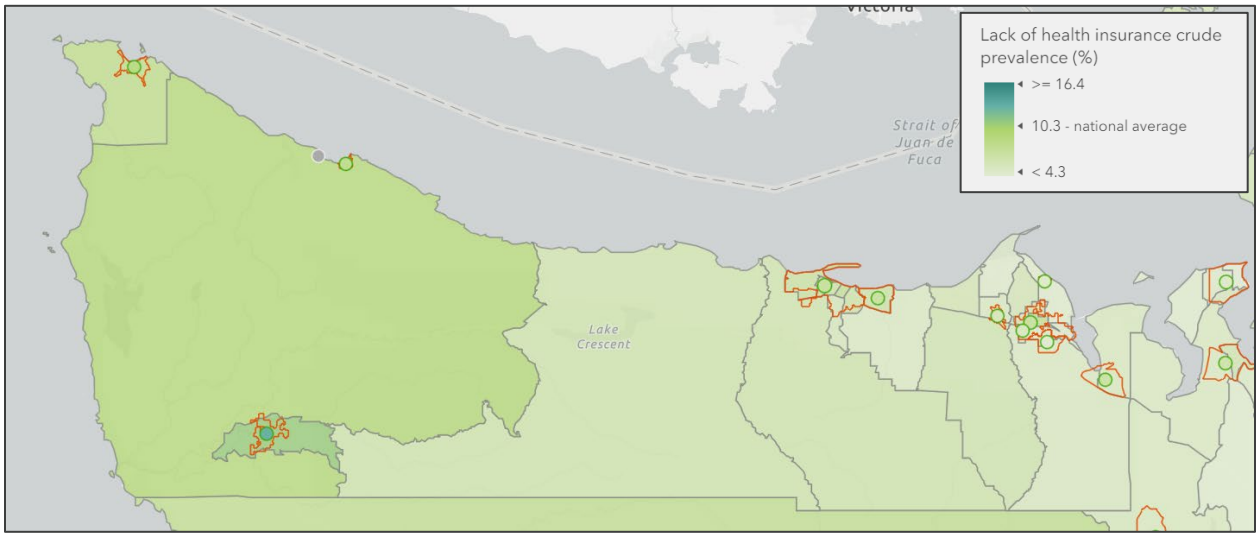
materials (Clallam County, 2019). Inhaling PM2.5 can lead to respiratory and cardiovascular problems, ranging from mild irritation to serious health issues, including heart failure and even death. The regions of the county most likely to be at risk for wildfire (urban-wildland interface) include unincorporated areas of the County (North Olympic Development Council, 2015).

Figure 11. Wildland Fire "Six Pack" Area 2024 (Clallam Fire 2)

Groups sensitive to wildfire and wildfire smoke in the County include those with pre-existing health conditions, the elderly, residents without health insurance, outdoor workers, Tribal communities, and individuals with low income. While the Jamestown Health Clinic notes that respiratory illnesses are not among the top reasons Tribal Citizens visit the clinic, some cases of chronic respiratory issues do exist. The main factors contributing to these illnesses include smoking, genetic predisposition, side effects from medications, allergies, and indoor air quality issues, with the potential to exacerbate the health effects of air pollution and smoke for the community (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).

Health impacts are particularly problematic for people who lack health insurance or easy access to medical facilities, because they may not receive timely treatment, if any at all. The City of Forks has an estimated prevalence of lack of health insurance among adults aged 18-64 years of 13%, higher than the national average of 10.3% (Figure 12). These residents are less likely to regularly see a doctor for preexisting conditions or receive care for injuries or illnesses caused by wildfire or heat events (Center for Disease Control, 2022).

Figure 12. Residents with lack of health insurance (PLACES 2022)



In addition to heat and wildfire smoke effects on the physical health of residents, extreme weather events such as floods and landslides may lead to accidents and injuries from damage to homes or disruption of essential services, as well as mental and socioeconomic distress from displacement or financial hardship during or after a disaster. During storms, wastewater and sewer breaks may occur near damaged potable water lines, which can contaminate drinking water supplies (Clallam County, 2019). This contamination may lead to authorities issuing boil water notices to protect public health. Additionally, people relying on electric-based health support systems, such as those requiring oxygen or dialysis, are particularly vulnerable during power outages from extreme weather, putting their health at serious risk (Makah Tribe, 2023).

ADAPTIVE CAPACITY

Clallam County Health and Human Services (HHS) provides programs and services to help protect and improve the health of the County, cities, and Tribal nations. HHS leads the response to public health threats, providing vital programs for disaster response and recovery, including food safety, water quality, immunizations, communicable disease control, and support services for families, developmental disabilities, behavioral health, and homelessness (Clallam County, 2022). However, community members noted a need for communication resources across jurisdictions for disaster response, as well as back up communication methods if the County's emergency number is blocked or impeded in any way.

The **Olympic Medical Center** and **Forks Community Hospital** are the primary hospitals in the county, offering physicians' clinics, home health and hospice care, outpatient diagnostics, and rehabilitation services. Although they provide limited emergency room facilities, neither is a certified trauma center. Another important Tribal health resource is Jamestown S'Klallam Healing Clinic (Figure 13).

Figure 13. Jamestown S'Klallam Healing Clinic (https://jamestowntribe.org/portfolio-items/jamestown-healing-clinic/)

While both hospitals have their own disaster plans to coordinate resources during climate impacts and other emergencies, there is not a community-wide coordinated plan, and many communities are dependent on traveling to the I-5 corridor to access any type of secondary health care. In the case of road blockages or damage on Highway 101 or other major roads, these communities will be completely cut off from accessing care (Clallam County, 2022). Any necessary trauma care would likely require a helicopter medical evacuation out of the county (Hazard Mitigation & Climate Resilience Planning Workshop, 2024). Other healthcare facilities in the county whose services support the community's adaptive capacity include:

- Volunteers in Medicine of the Olympics
- Dungeness Valley Health and Wellness Clinic
- Sequim Free Clinic
- North Olympic Healthcare Network
- Peninsula Behavior Health
- Elwha Health Clinic
- Forks Community Hospital
- Makah Tribe's Sophie Trettevick Indian Health Center
- Makah Wellness Center
- Jamestown S'Klallam Healing Clinic
- Jamestown Family Health Clinic

Emergency Management

Clallam County has five operational emergency management areas, as well as comprehensive emergency support functions assigned to primary and support agencies to manage emergency prevention, protection, mitigation, response, and recovery (Clallam County, 2022). Each jurisdiction has an emergency management department, mitigation planning team, governmental departments and partners to support the hazard mitigation program (Clallam County, 2024).

CLIMATE RISK

Clallam County has unique emergency management challenges due to climate impacts like flooding and wildfire, requiring innovative planning and resource sharing. Isolation and reliance on Highway 101, with bridges like the Elwha River Bridge, limits resource availability and mutual aid access, with "just-in-time" inventory demanding daily supplies (Figure 14). In a major regional event like a massive storm, Clallam County is a lower priority than larger population centers. Supply chain disruptions from destroyed infrastructure, such as for food, water, and medical supplies, could require residents to be self-sufficient for at least 30 days (Clallam County, 2022).

Figure 14. US 101 Elwha River Bridge (Washington State Department of Transportation, 2021)

Local services are in some cases already stretched thin. For example, Clallam Fire District 3 responded to over 9,000 calls in 2024, a new record (Nash, 2025). The Port Angeles Fire Department has seen an average 5.09% annual increase in calls for two decades, and the Chief expects they'll see future increases, with increased visitors to the Olympic National Park, an aging population, the continued opioid crisis, and other factors. All local Fire Districts report that their numbers of calls are higher than in the past (Hazard Mitigation and Climate Resilience Planning Workshop, 2024).

Additionally, critical and emergency management facilities and infrastructure, such as hospitals, fire stations, and roads, provide essential services, especially during extreme events. Climate change will impact access to these facilities through inland or coastal flooding, road closures, increased traffic, and energy outages. Strained emergency services and disruptions to these services can lead to greater health risks and stress on both health systems and the social safety net.

Critical Infrastructure and Flood Zones

Increased flooding and landslide risk in the County can lead to loss of life, homes, and infrastructure, as well as impacts to transportation corridors, impeding access to critical services such as hospitals, schools, and utility facilities (North Olympic Development Council, 2022). Flood zones of the Sol Duc River and Bogachiel River and at the mouth of the Hoko and Pysht Rivers will affect transportation routes in the County (Clallam County, 2024). This may increase flooding along Highways 112, 113, 117, and 101, blocking key evacuation routes and leaving socially vulnerable populations, especially those with limited mobility, at greater risk. The 2021 atmospheric rivers demonstrated how landslides and flooding can disrupt transportation routes, leading to potential injury, death, and isolation from critical emergency services.

Significant flood events occurred in Clallam County over the 2021-2022 winter season and again in late fall of 2022, resulting in flooding, landslides, downed trees, washed out roads, and power outages. Major highways were closed, including the Elwa River Bridge and a major landslide impacted State Route 112 near Clallam Bay. In an intense storm event in a November 2021, US Coast Guard helicopter extracted almost a dozen residents from their wet homes after they were isolated from the fast rising river in the vicinity of Three Rivers (Clallam County Sheriff's Office, 2021). The Board of Clallam County Commissioners declared a state of emergency in November 2021 and a federal disaster declaration was made in January 2022. Severe storms recurred the following fall, with the Governor declaring an emergency proclamation on in December 2022 and a federal disaster declaration following (Clallam County, 2024).

Below photo from Clallam County Sherrif's Office on November 17, 2021.

Twenty critical facilities in the County are mapped within the FEMA flood zone, and several non-mapped facilities exist on low-bank oceanfront sites and are also vulnerable to flooding (MJHMP 2024). This infrastructure includes buildings supporting public health, utility services, maritime industries, government, and community safety. For example, flooding of Van Riper's Marina and Westport Shipyard could cause a high release of hazardous materials, leading to negative health impacts of local residents through drowning, injury, or disease (Clallam County, 2024).

Wildfire Risk

Wildfire risks affect the cities of Port Angeles, Sequim, and Forks, which have significant wildland-urban interface areas. Port Angeles and Sequim are bordered by wildland areas and Olympic National Park, while Forks is surrounded by commercial forests, making it especially vulnerable.

Makah Tribe Flood Vulnerability Highlight

On the Makah reservation, the Wa'atch and Tsoo-Yess Rivers are at risk of riverine floods that may threaten homes, roads, and bridges. High tides impacted by storm surges, swells, wind waves and high westerly winds can cause riverine flooding by backing up streamflow (Makah Tribe, 2023). Elders are a particularly vulnerable segment of the population during storm events and may have health issues that become increasingly urgent when combined with a degraded transportation system. These include decreased access to medications, advanced medical equipment and services, and family members (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).

Many older structures in Clallam County were built before modern fire codes, heightening urban fire risks and potential emergencies (Clallam County, 2024). The most recent wildfire in Clallam County occurred in June 2023, near Joyce Access Road off Highway 101, with 85 acres burned before emergency personnel could extinguish the fire (Clallam County, 2024).

Makah Tribe Wildfire Vulnerability Highlight

Tribal reservations are also at risk of wildfire, including the majority of the Makah Tribe's infrastructure. The Makak Reservation is located on Neah Bay, isolated from the rest of the state (Figure 15). A significant wildfire could damage the Tribe's 67 mapped government facilities, 577 housing units, and other infrastructure. Many homes house multigenerational families, so damage to residences would lead to severe social hardship, particularly given high unemployment rates (Makah Tribe, 2023). Highway 112 serves as both the Tribe's main supply route and its sole reliable emergency evacuation road, with logging roads from Shi Shi to Lake Ozette as potential bypasses, though likely much slower (Makah Tribe). Power is supplied through a single power line along Highway 112, which is vulnerable to fire. Destruction of this line would leave the Tribe without power for an extended period of time (Makah Tribe, 2023).

Figure 15. Neah Bay, location of the Makah Reservation (Neah Bay, 2005)

ADAPTIVE CAPACITY

Clallam County actively participates in local and regional emergency response exercises and maintains a comprehensive emergency health communications system. This ensures that residents across Clallam, Kitsap, and Jefferson Counties have 24/7 access to a public health duty officer. In an extreme weather or climate event like flooding or wildfire, Clallam County HHS is responsible for reducing health risks through vaccinations and medications, investigating and controlling communicable diseases, providing urgent health information to local providers, communicating vital health advice to the public, assisting in hazardous material incidents, and helping monitor the safety of air, food, and water supplies. The County also has mutual aid agreements with local Tribes to enhance collaborative response efforts (Clallam County, 2022).

In 2016, the City of Sequim adopted a resolution to enhance resilience and climate change mitigation through several key actions. This resolution improves the City's adaptive capacity by requiring that infrastructure climate resilience and climate mitigation be integrated into all Master Plans, Capital Improvement Programs, land use and development plans, and Emergency Management and Hazard Mitigation Plans during regular updates. The City will build partnerships with local and regional stakeholders to track emerging climate issues and educate staff and residents on adaptation and resilience. It will also set measurable objectives for mitigation and preparedness, ensure annual budgets support these goals, and report progress to the Council every two years.

There are a few supportive plans that strengthen the county's adaptive capacity. The County's 2024 MJHMP improves the County's adaptive capacity and understanding of climate impacts on emergency management by including newly profiled hazards and updated hazard profiles, the inclusion of an analysis of socially vulnerable populations, and the inclusion of climate change considerations. Additionally, the County's adaptive capacity is further supported by the Community Wildfire Protection Plan and established goals to: Identify safe evacuation routes and improve knowledge of landslide hazards; Develop an emergency water distribution plan; Create Community Resilience Centers across the county; Develop food storage facility that includes locally produced and culturally relevant food; and Create an emergency power management plan While there is some progress in implementation of these goals, such as resilience centers through the Clallam Resilience Project (CRP), many goals are still in the planning stage and will require additional coordinated effort and funding to implement.

Community Resources

Community services and amenities are both vulnerable to climate change and essential for building community resilience. In Clallam County, climate impacts such as stronger storms, resulting floods, and heatwaves can disrupt access to services like food, especially for those with limited mobility or resources. Prolonged events, such as the 2021 Heat Dome or 2022 King Tide floods, may further prohibit residents' ability to access these essential services in Clallam County, especially for those who are cost burdened, have existing health issues, or are experiencing food insecurity and loss of cultural foods.

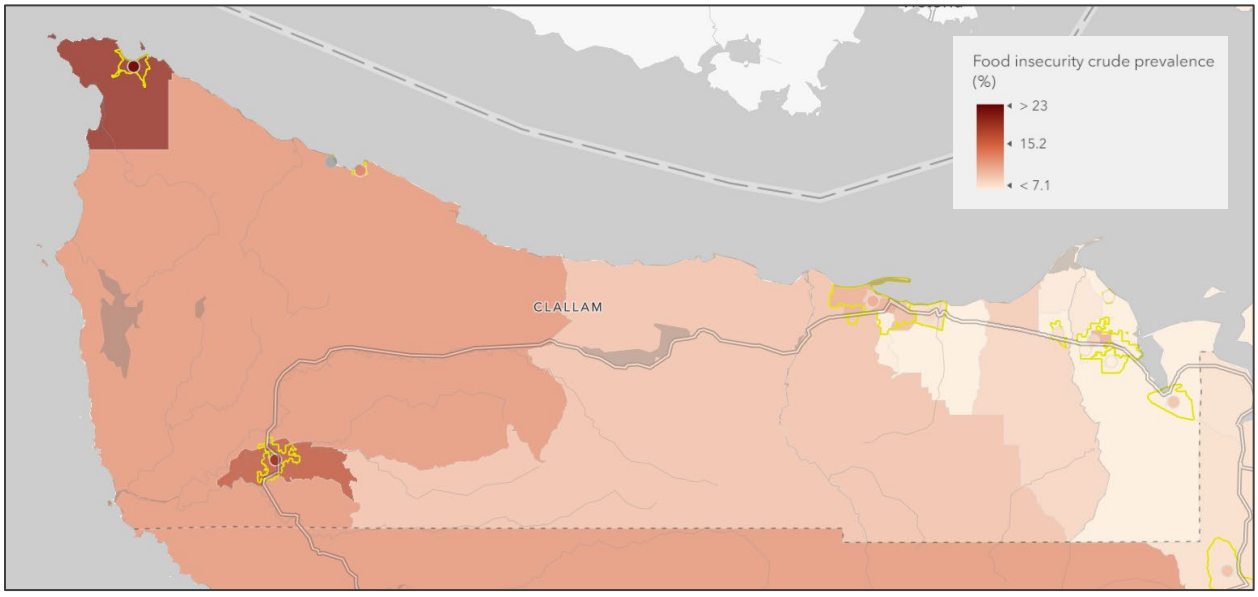
Some local community centers are already serving as cooling centers. For example, the casino, with two generators, has been an "informal cooling center" that people go to during extended heat waves (Hazard Mitigation and Climate Resilience Planning Workshop, 2024).

CLIMATE RISK

Food Security and Cultural Resources

Food insecurity describes a lack of access to enough food for an active, healthy life, and is associated with several adverse social and health outcomes. Food security means having the resources to obtain food, including affordable prices and proximity to food amenities and retail outlets. In Clallam County, 14% of residents are considered food insecure, higher than the state rate of 11.5% (Feeding America, 2022). The western region of the County has higher rates of food insecurity, including the Makah reservation (22.5% in 2022) and the City of Forks (18.9% in 2022) (Figure 16) (PLACES).

Figure 16. Estimated prevalence of food insecurity in the past 12 months among adults aged >=18 years (PLACES)



Increased flooding and extreme weather may disrupt roadways and limit access to food, especially for those without personal vehicles or with mobility challenges. Coastal flooding can also hinder access to subsistence food sources like clams and fish, affecting residents who rely on harvesting and gathering. Increasing droughts and extreme heat events in the Northwest may

also disrupt agriculture and worsen food insecurity, leading to financial and psychological distress for affected communities (US Global Change Research Program, n.d.).

Any large-scale change to the quality and quantity of a traditional food such as salmon will have impacts that affect the people who depend on traditional food for cultural and nutritional nourishment. Depending on magnitude of change to salmon populations, Tribal members could experience impacts to commercial fishing, diet, active lifestyles, and cultural wellness. The complex threats facing salmon in the north Pacific are an immediate risk to Tribal community health and wellness (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).

Tribal Access to Cultural Foods and Activities

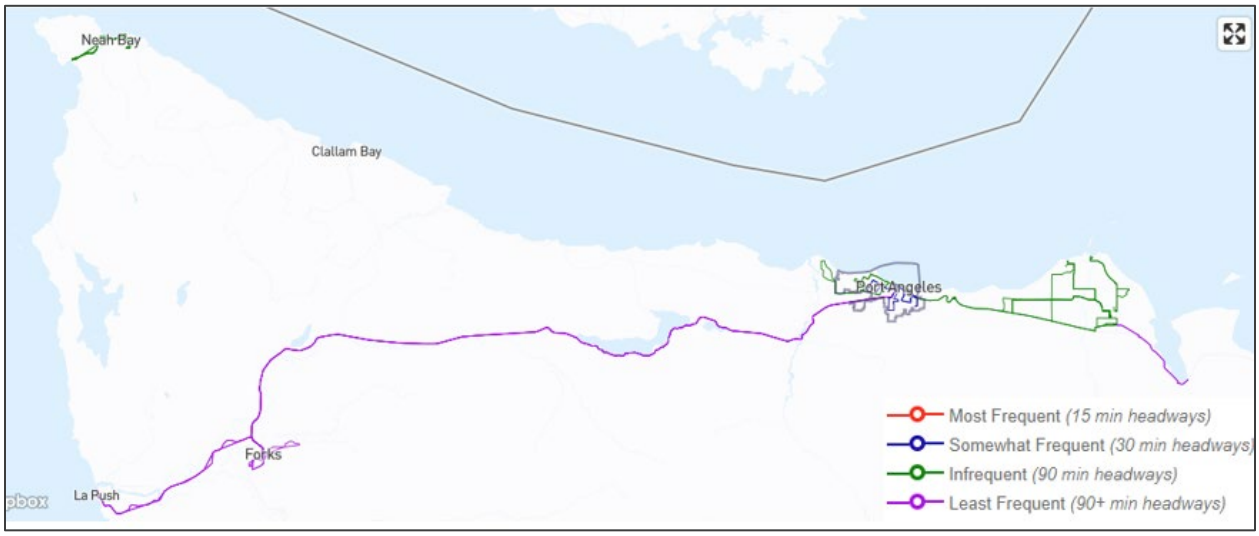
Climate change is further disrupting Tribal communities' access to traditional foods, exacerbating the legacy of settler colonialism and increasing reliance on processed foods, which is linked to higher rates of diabetes, heart disease, and obesity. The marine environment is vital culturally, economically, and ecologically to local Tribes and native people. Climate change drivers like ocean acidification, rising sea temperatures, altered hydrology, storm patterns, sea level rise, coastal upwelling, hypoxia, and harmful algal blooms threaten this environment (24 - Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes). These changes are expected to disrupt cultural and ceremonial activities and food sources, impacting mental, cultural, and physical well-being, and hindering the transmission of intergenerational teachings essential to Indigenous health and healing (NCA5 Northwest).

Figure 17. Salmon preparation at Makah Indian Reservation (Olympic Peninsula Community Museum, 2010)

Community Mobility and Transit Access

Transit access can promote climate and health equity through better access to medical care, food, essential services, jobs, and social connections. A social vulnerability in Clallam County is that Clallam Transit does not reach remote areas of the county such as Neah Bay, and there is an overall lack of transit frequency throughout the county (North Olympic Development Council, 2022) (Figure 18). Some current transit stops are hard to access for residents, e.g., in western Port Angeles, and some stops are near steep roads or have no shoulder (North Olympic Development Council, 2022). However, Clallam Transit ridership is increasing, with paratransit ridership up 26% in January 2024 compared with the same month last year, and ridership on the interlink micro transit service in Forks and Sequim 125% higher (Peninsula Daily News, 2024).

Figure 18. Transit Frequencies throughout the County (Washington Transit Access Map).



Nearly all Clallam social and economic activity is dependent on the quality and maintenance of road infrastructure, so climate impacts such as flooding or extreme weather can impede already limited essential transit and mobility services, especially for those without access to a personal vehicle (Clallam County, 2024).

ADAPTIVE CAPACITY

The County has several plans and programs aimed at building adaptive capacity to support community resource needs in the face of natural hazards and climate impacts. The **Clallam County Climate Action Plan** includes actions aimed at investing in and supporting local food systems and increasing resiliency against climate-related supply chain issues. The **Port Angeles Climate Resiliency Plan** aims to ensure that resident have a safe and affordable place to live; Build capacity to better meet the community's needs; Invest in relationships and partnerships to increase trust and cohesion for City Council, stakeholders, and the broader community; and Promote goals that improve climate migration preparation, climate outreach and education, and climate resilience. Additionally, the Makah Tribe completed a **Climate Adaptation and Resilience Plan** supported by the U.S. Department of Energy, Office of Indian Energy Policy and Programs in 2021, and the Jamestown S'Klallam tribe has a number of health and wellness programs with the common aim of "Preserving, Restoring and Sustaining our Indian Heritage and Community Continuity." These social programs include elder gatherings, youth after school programs, summer culture camps, youth empowerment, and Tribal artistry workshops.

Tribal Emergency Management Adaptive Capacity

Tribes in the community aim to educate Tribal members about exposure to hazards and ways to increase their ability to prepare, respond, recover and mitigate the impacts of hazard events.

For example, the Makah Tribe Hazard Mitigation Plan includes actions to improve the resilience and continuity of operations of identified critical facilities on the Reservation and develop and improve emergency warning response and communication systems and evacuation procedures. Additionally, the Makah Tribe Reservation water system can provide limited water for fire suppression, and mutual aid agreements are in place to provide additional help when local resources are overwhelmed. This makes the likelihood of a single structure fire spreading to involve the wildland quite low. Although the Tribe is not a FIREWISE community, it has completed a Community Wildfire Protection Plan and updates it each year (Makah Tribe, 2023).

Additionally, while **Clallam Transit** faces challenges with fixed-route services in remote areas, vanpools may offer some additional services to these communities (Clallam County, 2024). Additional transportation options, such as Greyhound bus services and The Dungeness Line, provide alternative connections between Port Angeles, Sequim, and Discovery Bay with twice-daily service. Moreover, in the event of an extreme incident requiring evacuation, Clallam Transit and Clallam County School District buses are available to assist residents, though are limited by driver and staff availability and road conditions.

Figure 19. Clallam Transit Routes 14 on US 101

In addition to these plans and services, several organizations support community well-being and adaptive capacity in the County, including:

The Clallam Resilience Project	• A consortium of over 50 organizations working together to foster resiliency for the residents, organizations, community and systems in the County
The Olympic Peninsula Community Action Program	• A non-profit community organization with dozens of programs including weatherization, community centers, employment and training, and housing.
Housing Resources (Port Angeles Housing Resource Center, Sequim Housing Resource Center, Forks Housing Resource Center, Peninsula Housing Authority)	• Provides free housing services for people who are homeless or at risk of becoming homeless
TAFY The Answer for Youth	• Provides assistance for youth and young families, food bank, free clothes closet, blankets, tents and other survival products).
Port Angeles Food Bank	• Provides food assistance monthly for families, homeless clients, senior citizens and special needs individuals, and support for students on free and reduced lunch.
Sequim Food Bank	• Provides food assistance for Sequim area residents living within the school district boundaries.
Farmers Markets (Port Angeles and Sequim Farmers Market)	• Supports local food access ansd security efforts.

These plans, organizations, and services support social cohesion and the communities' adaptive capacity to prepare for, cope with, and be resilient to climate change. Social cohesion boosts a community's ability to adapt to climate change because connected communities with readily available social services tend to cooperate more effectively, increasing their resilience during and after climate disasters and impacts (Cherng, 2019).

Natural Environment and Water Resources

Clallam County's unique natural environment and water resource systems are increasingly threatened by climate change. Altered weather patterns can render conditions unsuitable for species that have adapted to the region's climate and ecosystems. Additionally, Clallam's world-class bike and pedestrian trails may face significant impacts, including flooding and landslides. More intense precipitation events can lead to reduced water storage and compromised water quality.

The following risk assessment for the Natural Environment and Water Resources sector evaluates climate risk (exposure and sensitivity) and adaptive capacity impacting the County's Ecosystems and Critical Areas, Parks, Trails and Open Space, and Water Supply sub-sectors to determine overall vulnerability.

Table 8. Vulnerability Scores for Natural Environment and Water Resources Sector

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Ecosystems and Critical Areas	Moderate	Moderate - High	Moderate

Parks, Trails, and Open Space	Low	Moderate - High	Low
Water Supply	Moderate - High	Moderate	Moderate

ECOSYSTEMS AND CRITICAL AREAS

Climate Risk	Adaptive Capacity	Vulnerability
Moderate	Moderate - High	Moderate
Climate risk for ecosystems and critical areas in Clallam County is ranked moderate due to the range of climate impacts on habitats, such as declining snowpack, drought, flooding, and rising sea levels, which threaten species like salmon and other wildlife, despite their resilience in some protected areas.	Adaptive capacity for ecosystems and critical areas in Clallam County is ranked moderate to high due to natural environmental advantages, ongoing restoration efforts, and proactive management practices that enhance ecosystem resilience, particularly for salmon and marine habitats.	Vulnerability to ecosystems and critical infrastructure in Clallam County is moderate due to the county's diverse ecosystems facing climate impacts like rising temperatures, drought, and flooding, while ongoing restoration efforts and natural resilience provide some protection.

PARKS, TRAILS, AND OPEN SPACE

Climate Risk	Adaptive Capacity	Vulnerability
Low	Moderate - High	Low
Climate risk to parks, trails, and open space in Clallam County is low due to relatively low exposure to direct climate impacts compared to other sectors, though specific areas face risks from flooding, wildfires, and erosion.	Adaptive capacity is moderate to high as the county has implemented strategies like tree planting, native plant landscaping, and land protection programs to increase resilience, and cities have invested in safeguarding parks and open spaces.	Overall vulnerability is low because the county has strong planning initiatives, and the resilience benefits of parks and open spaces mitigate some climate impacts, offering both environmental and community advantages.

WATER SUPPLY

Climate Risk	Adaptive Capacity	Vulnerability
Moderate - High	Moderate	Moderate
Climate risk to water supply in Clallam County is moderate to high due to the increasing likelihood of drought, reduced snowpack,	Adaptive capacity for water supply is moderate, with efforts such as water conservation, stormwater retention, and infrastructure	Overall vulnerability is moderate because, while the county has implemented proactive water management and

and risks of saltwater intrusion, which threaten the availability and quality of water resources.	improvements aimed at mitigating climate impacts, but challenges remain, particularly in drought-prone areas.	conservation strategies, ongoing climate changes and limited water resources in some areas still pose significant risks.

KEY TAKEAWAYS

- Hotter temperatures and decreased summer rainfall threaten the health of streams and oceans, leading to moderate climate risk for key species such as salmon, shellfish, and other aquatic life.
- Coastal and riverine flooding poses low-moderate risk to parks and open spaces, particularly low-lying areas. Segments of trails, such as the Port Angeles to Sequim section of the Olympic Discovery Trail, however, are especially vulnerable to inundation.
- Local water supplies will experience moderately high risk from climate impacts due to shifts from snow to rain in county watersheds. Increased demand and saltwater intrusion further jeopardize the sustainability of freshwater resources.

Ecosystems and Critical Areas

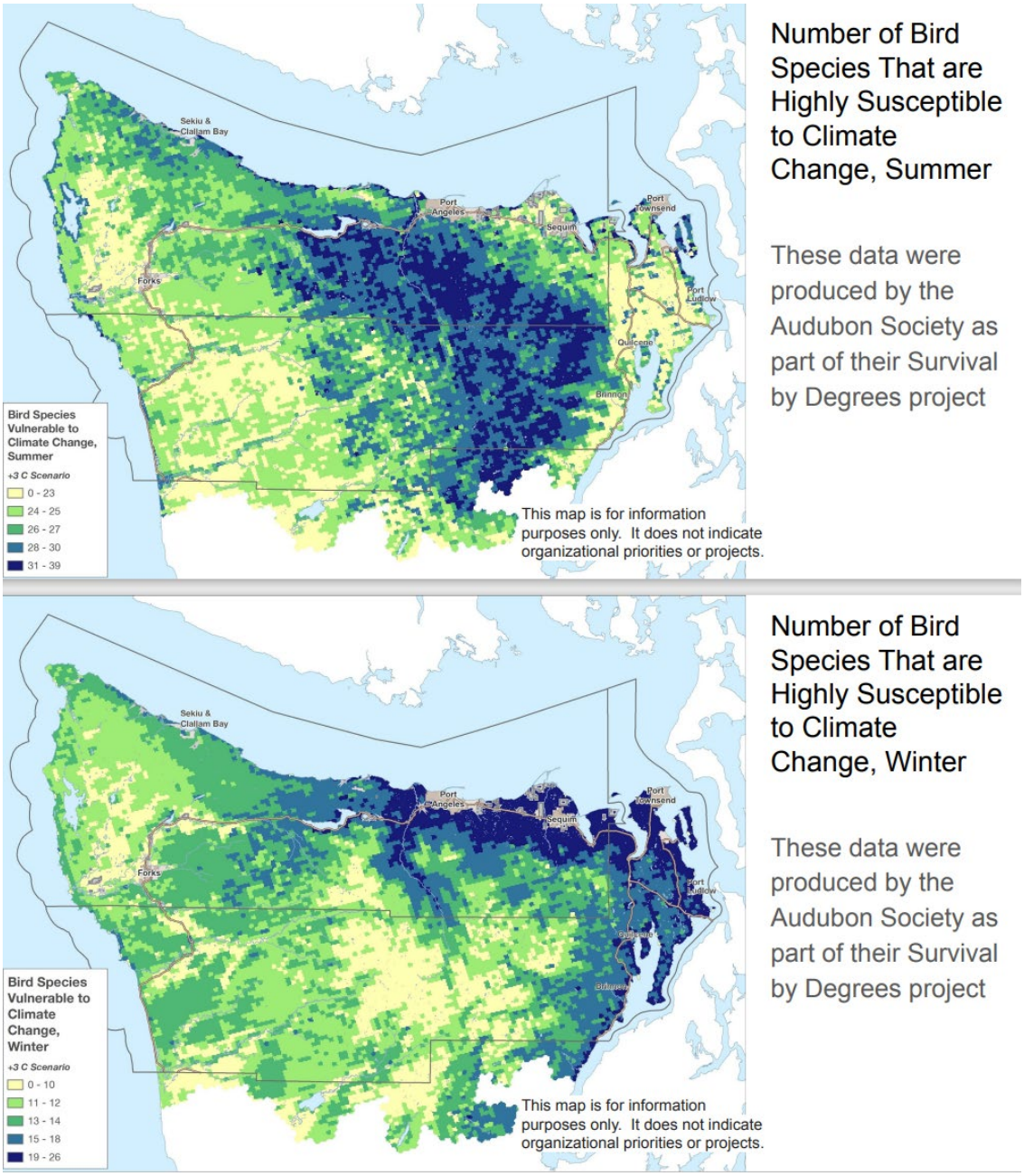
Clallam County's ecosystems range from coastal and marine areas, including estuaries and kelp forests, to freshwater systems like the Elwha and Dungeness Rivers, which are crucial for salmon. The Quillayute River system is the largest river system in Clallam County. Much of the basin is low-mid elevation, relying on snowpack and continual inputs of precipitation to maintain river flows. The county also features temperate rainforests and mixed coniferous forests, providing habitats for diverse wildlife. While much of the county's area is composed of Olympic National Park land, the section is focused on land solely within Clallam County jurisdiction.

CLIMATE RISKS

Clallam County's diverse ecosystems and critical areas are increasingly vulnerable to various climate impacts, including declining snowpack, drought, prolonged heatwaves, destructive flooding, and rising sea levels (Port Angeles, 2022). From 1900 to 2015, the Olympic Mountains experienced a glacier loss of approximately 0.59 km per year. If warming trends continue, glaciers in the area are expected to nearly disappear by 2070 (Fountain et al., 2015). This loss will profoundly affect Clallam County's glacial-fed streams and cold-water fish species, such as bull trout, that depend on these habitats (Riedel, J.L. et al., 2015).

Birds and animals will be impacted. The maps below show areas of the County with high concentration of birds that are susceptible to climate impacts in summer and winter (Figure 20). A higher number of bird populations are expected to be impacted in the western region of the county in both the summer and winter months. Summer impacts on bird species anticipated in higher elevation areas and winter impacts on bird species occurring along the coast.

Figure 20. Areas in dark blue show where high concentrations of bird species are vulnerable to climate impacts (Climate Resilience Alliance, n.d.).



Climate impacts like low summer river flows, heat events, and flooding will affect land and freshwater ecosystems. There may be negative impacts to stream health and water quality, posing threats to salmon populations (Krueger, 2017). There will likely be increased competition for water resources between in-stream flows and other ecosystem needs, while also reducing the water supply for residents, agriculture, and industrial purpose (Petersen, 2015). Olympic Peninsula tree species, such as Western Red Cedar and Western Hemlock, are sensitive to prolonged heat and to water supply limitations at lower elevation. Hotter and drier summers will likely lead to drought conditions that favor drought-tolerant species in forests and other natural areas. Moreover, species and ecosystems are already sensitive to the effects of intensive fishing,

logging, dam and levee construction and removal, and land conversion for agricultural, residential, and industrial uses (Petersen, 2015).

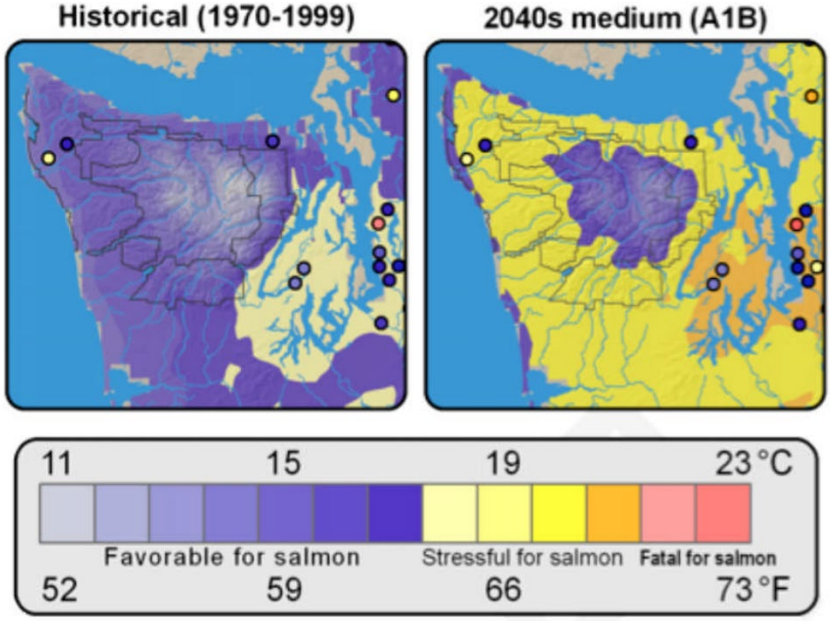
Ocean ecosystems will also be affected. Rising temperatures in the Salish sea may also result in upwelling of acidic waters, which would severely affect crabs, shellfish and other species (NOAA, 2023). With approximately 800 miles of marine and freshwater shorelines (Clallam County, 2011), warmer water temperatures will lead to more frequent harmful algal blooms (HABs), resulting in reduced water quality, negatively affecting salmon and shellfish (see Economic Development and Land Use section), with juvenile salmon particularly vulnerable due to the rising temperatures and hypoxia brought on from HABs (Petersen, 2015).

People who recreate outdoors will be impacted by increasing heat, flooding, and wildfire events as well. Popular natural areas for boating and hiking may face major changes and may be closed after extreme events, limiting cultural and recreational access, and reducing people's enjoyment and mental health benefits from experiencing nature.

ADAPTIVE CAPACITY

Despite the challenges posed by climate change, Clallam County's ecosystems and critical areas demonstrate some current efforts to build adaptive capacity. For example, due to their geography and natural environmental conditions, some – though not all - watersheds in the county will continue to have river water temperatures that are cooler and more favorable for salmon despite warmer air temperatures (North Olympic Development Council, 2015). This is shown in Figure 21 (North Olympic Development Council, 2015). Wild fish populations in local watersheds may maintain robust genetic diversity. While many species face habitat loss, their overall risk remains low relative to other areas (Krueger, 2017). The Olympic Mountains contribute to this resilience, with their wetter conditions and reduced susceptibility to wildfires compared to other regions of the state (Krueger, 2017).

Figure 21. Historic and future air (shading) and stream (dots) temperature throughout the Olympics (North Olympic Development Council, 2015).



On the County's western coast, relatively undisturbed environments provide quality marine habitat, safeguarded from development and anthropogenic disturbances due to their remote location (NOAA, 2022). In addition to these natural advantages, Clallam County has taken proactive measures to monitor and analyze climate change impacts at salmon stream restoration sites (North Olympic Development Council, 2015) and set goals for conserving its environmental attributes and critical areas (Clallam County, 2023).

Salmon well-being is vital to Clallam County, and is addressed in multiple sectors and subsectors of this SVA, including this one, the food security subsector, and the economic development subsector. As each discussion notes, the well-being of salmon are interlined with community and environmental well-being. Meanwhile, salmon are sensitive to climate change impacts like rising stream temperatures. While the region has some innate adaptive capacity and there are some important efforts to protect and enhance salmon habitat, salmon remain at risk overall in the County.

Figure 22. Image of salmon jumping (North Olympic Salmon Coalition)

Furthermore, the ecosystems in Clallam County have benefited from adaptation and management practices implemented within the Olympic National Forest. These initiatives include restoration and revegetation plans that prioritize native plants, manage invasive species, and conduct occasional prescribed burns (Halofsky, 2011). Such practices enhance the adaptive capacity of the surrounding ecosystems by emphasizing native species and reducing wildfire threats.

Parks, Trails, and Open Space

Clallam County's parks, trails, and open spaces offer a diverse array of outdoor recreational opportunities, ranging from coastal beaches to forested areas. The county is home to several well-maintained parks, including the popular Dungeness Recreation Area. Clallam County also features nearly 65 miles of existing, separate trail as part of the Olympic Discovery Trail, which connects communities along the northern Olympic Peninsula, providing both recreational and community/local transportation routes for walking, biking, and horseback riding. The future goal is a 135-mile separated trail (including 15 miles in Jefferson County). The county's open spaces support wildlife habitats and offer residents and visitors places for hiking, picnicking, and enjoying the region's natural landscapes.

CLIMATE RISKS

The County's extensive trail network is exposed to a variety of impacts; for example, the 25-mile-long Discovery Trail Dungeness River/RR Bridge Park is at risk of landslides, flood, extreme weather, and erosion concerns (Clallam County, 2019). Several parks located throughout the county are at risk of wildfires and weather (Makah Tribe, 2023). Additionally, many of the parks are exposed to inundation from river or coastal flooding and sea level rise (Clallam County, 2019). One example of flooding of a County Park is shown in Figure 23.

Figure 23. In Fall of 2021, heavy storms led to flooding of Lake Pleasant County Park, near Forks (Jablonski, 2021)

Parks and Open space in the County are exposed to drought, which may lead to the degradation of urban parks and landscaping, degradation of fishery habitat, and tree canopy mortality. This may lead to drier vegetation and greater wildfire risk, especially in the Wildland Urban Interface (WUI), where most of Clallam's parks and open space exist. Parks and open space in the eastern portion of the County have historically received lower amounts of rainfall, increasing risk of drought and wildfire (Clallam County, 2024). The most exposed WUI parks and open spaces generally surround the three cities of Port Angeles, Sequim, and Forks.

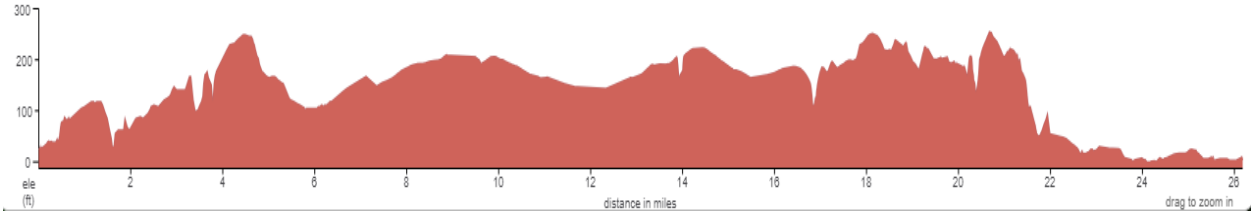
Additionally, the county expects climate change-driven increases in extreme precipitation, increasing the frequency, extent, intensity, and geographic distribution of floods (see 0Appendix C: Climate Impacts Summary), affecting parks and open spaces through inundation and landslide risk (Clallam County, 2024). Open space and recreational areas of concern for floods and landslides are areas along major rivers including the Quillayute River, along the Port Angeles marine bluff, the Olympic Discovery Trail, Johnson Creek, and Bell Creek (Clallam County GIS, 2023).

In 2015, the Railroad Bridge along the Olympic Discovery Trail was damaged and closed due to flooding (McDaniel, 2015).

Figure 24. Extreme flooding along the Dungeness River in February 2015 damaged the Olympic Discovery Trail's Railroad Bridge (McDaniel, 2015).

The Olympic Discovery Trail, the county's longest trail, crosses several rivers that are prone to flooding. Since 70% of the trail follows a converted railway, its elevation is low in many areas, with some segments nearly at sea level between Port Angeles and Sequim (Figure 25). Moreover, while most of the trail is paved, older segments made of chip-seal, gravel, or dirt are less durable than asphalt, making them particularly vulnerable to flooding.

Figure 25: Elevation Profile of the Blyn to Port Angeles segment of the Olympic Discovery Trail (Peninsula Trails Coalition, 2024).



ADAPTIVE CAPACITY

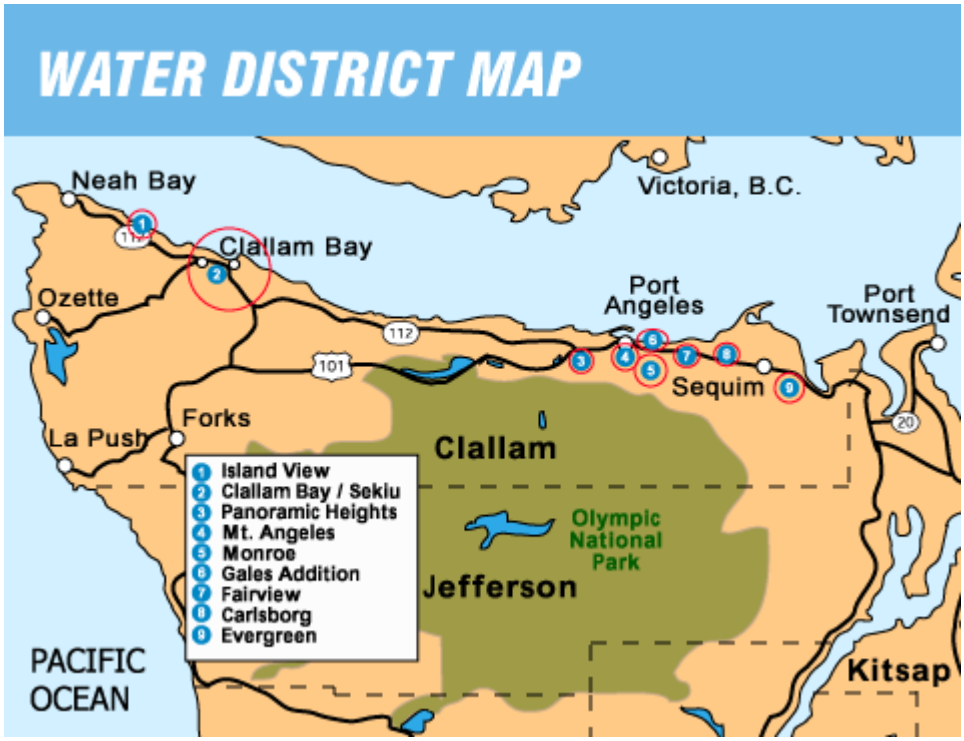
Parks and open spaces in Clallam County offer numerous resilience benefits, such as filtering runoff during rainstorms and mitigating the urban heat island effect in cities (Gill, Handley, Ernnos, & Pauleit, 2007), and act as defensible spaces, reducing fire danger (Makah Tribe, 2023). Clallam County benefits from initiatives like the Conversion Forestry Ordinance (Clallam County, 2023) that protect these valuable spaces. Additionally, cities like Port Angeles have invested in plans and initiatives to safeguard urban tree canopy, parks, and open spaces (Port Angeles, 2022). The County is poised to expand its trail network, with the future goal of the Olympic Discovery Trail to consist of 135 miles of paved, separated trail, including fifteen miles of trail in Jefferson County.

The county has a Parks and Recreation Master Plan and Parks and Recreation Advisory Board and is currently updating the Master Plan to guide the County's strategic park planning and management efforts through 2037. The 2023 Climate Action Plan includes actions to increase tree planting and native plant landscaping in public open spaces and have relatively short (1 to 2 years) implementation timeframes (Clallam County, 2023).

Water Supply

Most of the County's water supply is served by the Clallam Public Utility District (PUD), though there are other smaller water purveyors as well (e.g. community water systems like Black Diamond Water District, Sunland, and others). The PUD manages nine districts (Figure 26; Clallam County PUD, 2017). Water primarily comes from groundwater wells and surface water sources, such as Morse Creek and Olsen Creek (Clallam County PUD, 2017). The Makah Tribe utilizes the Educket Dam Reservoir and the Wa'atch River to supply residents with water (Makah Tribe, 2023). Water reservoirs, along with gravity mains and pump stations, are used to distribute water to surrounding communities across the county.

Figure 26. Some of the water systems of Clallam County PUD (Clallam County PUD, 2017). Not all systems are included on this map (e.g. Dry Creek neighborhood and Crescent Water association).



CLIMATE RISKS

Clallam County faces significant challenges regarding water availability. In the Olympic Mountains, where snowfall has historically sustained glaciers, the transition from snow to rain in "transient" hydrologic basins will impact the water supply (Petersen, 2015). This shift is particularly concerning for mountainous regions in the Pacific Northwest, such as the Olympics, where snowpack has historically provided 70% of annual streamflow (Mote et al., 2008). Projected temperature increases will increase the likelihood that precipitation will fall as rain instead of snow, reducing water storage in the snowpack (Frankson, et al. , 2022). By mid-century, there is a 64% chance that the April 1st snowpack, an important measure for tracking water supply, will fall below 75% of average in Clallam County. This increases to 79% by end of century and is an indicator of high likelihood of drought in the region (Climate Impacts Group, 2022). The loss of glaciers reduced snowpack, and earlier snowmelt due to rising temperatures will further decrease water availability during the summer months.

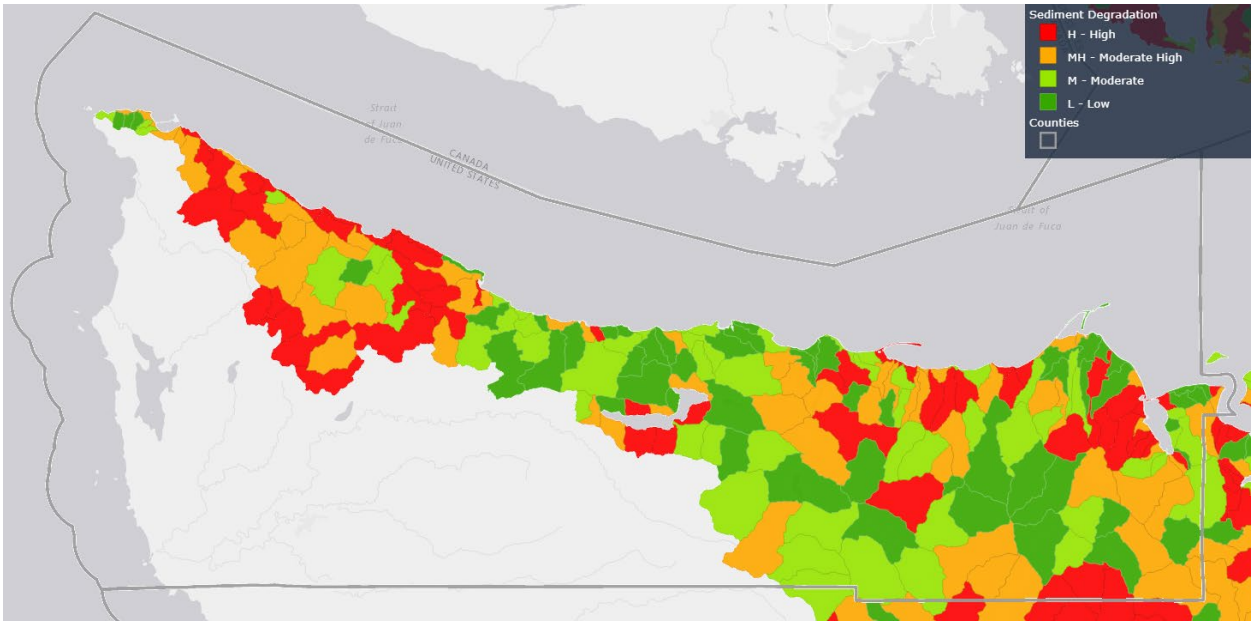
While these impacts will be felt throughout the county, the northeast region, is especially vulnerable, as it resides in the Olympic Rain Shadow (Clallam County, 2019). The wells and aquifers serving the city of Sequim face risk. Areas dependent on aquifers, such as the Quileute and Makah Tribe reservations, are also at risk. Saltwater intrusion, exacerbated by rising sea levels, poses a significant threat to regions like Port Angeles and Jamestown Beach (North Olympic Development Council, 2022).

While Clallam County does not typically experience periods of extended drought, recent years have seen more Washington Department of Ecology-declared droughts impacting the North

Olympic Peninsula, eight declarations since 2001 (Makah Tribe, 2023). The Makah Reservation faces significant challenges with its water supply, which is limited in terms of the quantity for fire suppression and can struggle to supply residents with water during consecutive dry years (Makah Tribe, 2023). Similarly, the Jamestown Beach water supply is sensitive to climate impacts like changing precipitation and drought (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023). During the 2015 drought, the region had to initiate water restrictions (North Olympic Development Council, 2022). And, following a storm and landslide, people had their water temporarily turned off as one participant shared during the community workshop (Climate Vulnerablity and Hazard Mitigtation Community Workshop, 2024); (Peninsula Daily News, 2021).

Drinking water quality in Clallam County faces additional risks due to watersheds with high potential to transport excess phosphorus that can fuel algal blooms and transport sediment into aquatic ecosystems, which could further degrade water quality (Figure 27).

Figure 27. Sediment degradation within Clallam County. Watersheds with elevated levels of sediment degradation will result in lower water quality in streams and less capacity in reservoirs (Washington State Department of Ecology, n.d.).



Increased sediment in waterways reduces storage volume in reservoirs and elevates the need for filtration and treatment. More frequent extreme precipitation events driven by climate change can lead to higher sediment levels in rivers and streams ***(Environmental Protection Agency, 2024)***, further jeopardizing Clallam County's water supply and its quality.

The Makah Reservation has seen water quality impacts on water sources as far back as 1980, when several wells were abandoned in Neah Bay due to inferior water quality (Dion, Walters, & Nelson, 1980).

ADAPTIVE CAPACITY

The groundwater supply of Clallam Bay/Sekiu is currently unaffected by snowpack, which may reduce the impact of snowpack changes on groundwater recharge in that area. However, prolonged droughts and extreme precipitation events could still alter the groundwater table.

Agriculture in the region benefits from water management practices, for example enhancing irrigation efficiency and planning the future Dungeness Off-Channel Reservoir Project, which aims to capture high river flows and store the water in a reservoir for summer irrigation, alleviating pressure on water resources during dry seasons (Clallam Conservation District, 2015). The city of Sequim employs a diverse range of water resources, including reclaimed water, groundwater recharge capabilities, and water conservation measures (City of Sequim, 2016).

To further enhance water management, the Clallam County Action Plan includes conservation-initiatives such as incentivizing regulated rainwater harvesting, enforcing regulations for water-efficient appliances, improving stormwater retention, developing infrastructure for reclaimed water systems, and collaborating with Clallam PUD to expand water conservation efforts across residential, commercial, and agricultural sectors (Clallam County, 2023). PUD's proactive approach is reflected in their 2017 water system plan (Clallam County PUD, 2017), which outlines critical actions that have been implemented to ensure water quality and sustainability, including:

- **Disinfection and Contaminant Treatment**: Ensuring all wells are treated to maintain high water quality.
- **Monitoring Water Consumption**: Tracking usage from groundwater and surface sources to inform resource management.
- **Protection Programs:** Developing strategies to identify and mitigate potential contamination sources.
- **Efficiency Measures**: Implementing mandates to promote water conservation among users.

Port Angeles' 2018 water system plan additionally demonstrates a commitment to maintaining a reliable supply for the city's population and a decline in water usage indicates successful conservation efforts among residents (Port Angeles, 2017). However, some community leaders have questioned whether limitations on new wells should be considered.

The Jamestown S'Klallam Tribe has taken significant measures to increase the adaptive capacity and resilience of the water supply within the Reservation. These efforts include supporting water conservation initiatives and collaboratively planning for sustainable future water supply. Over the past 30 years, efforts have resulted in a nearly 50% reduction in irrigation withdrawals, significantly enhancing water availability and resilience within the watershed (Jamestown S'Klallam Tribe, 2020).

Economic Development and Land Use

Clallam County has scenic as well as productive working and natural landscapes. Fisheries, farming, and forestry are foundational industries of the regional economy. The County's mild climate, National Parks, and recreation areas also draw tourists from around the world. Many of the economic opportunities are based in or near towns including Sequim, Port Angeles, and Forks, as well as on reservations.

The following risk assessment for the Economic Development and Land Use sector evaluates climate risk (exposure and sensitivity) and adaptive capacity impacting the County's Local Industries and Businesses (including Fisheries, Commercial Districts/Businesses, and Tribes) and Land Use and Resource (Agriculture, Forestlands and Developed Areas including Wildland Urban Interface lands) sub-sectors to determine overall vulnerability.

Table 10. Vulnerability Scores for Economic Development and Land Use Sector

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Local Industries and Businesses	Moderate - High	Moderate	Moderate
Land Use and Resource Lands	Low - Moderate	Moderate	Moderate

LOCAL INDUSTRIES AND BUSINESSES

Climate Risk	Adaptive Capacity	Vulnerability
Moderate - High	Moderate	Moderate
Climate risk to local industries and businesses in Clallam County is moderate to high due to the vulnerabilities of key sectors like fisheries, tourism, and critical infrastructure to climate impacts such as ocean acidification, rising sea levels, flooding, higher stream temperatures, and disruptions in transportation.	Adaptive capacity for local industries is moderate, as businesses have access to support services but face challenges in securing the financial resources needed for comprehensive resilience measures.	Overall vulnerability is moderate because, while some industries are taking steps toward adaptation, the ongoing risks from climate change, particularly to fisheries and tourism, remain significant and challenging to fully address.

LAND USE AND RESOURCE LANDS

Climate Risk	Adaptive Capacity	Vulnerability
Low - Moderate	Moderate	Moderate
Climate risk to land use and resource lands in Clallam County is low to moderate,	Adaptive capacity for land use and resource lands is moderate, as there are	Overall vulnerability is moderate because, while some land uses have

as agricultural and forest lands face impacts from drought, pests, and wildfire, but many parts of the region are relatively climate resilient.	opportunities for farmers and landowners to implement sustainable practices, though economic and development pressures could limit full adaptation.	resilience potential, ongoing challenges like water availability, economic viability, and development threats could still undermine long-term sustainability.

KEY TAKEAWAYS

- The County's dependence on natural resources and tourism, as well as its unique location with limited transportation and supply chain routes into and out of the Peninsula, make the sector moderately vulnerable to climate and related economic impacts. Many workers in climate-impacted jobs face physical health risks, as well as economic impacts from climate change.
- Residents in the County, especially on reservations, have fewer economic opportunities, lower median wages, and higher poverty and unemployment rates, increasing social vulnerability to the impacts of ocean acidification on fisheries and extended smoke events on tourism.
- State and Tribal leadership, the management of forest and farmlands, and land use decisions provide moderate low to moderate adaptive capacity towards climate impacts for the County in terms of economic development and land use.

Local Industries and Businesses

Fisheries

CLIMATE RISKS

Commercial, recreational and subsistence fishing are extremely important to the economy of Clallam County and to the livelihood of local residents. One study estimates that commercial fish landings (the combination of groundfish, salmon and shellfish) total about $3.72 million annually in Clallam County (Trust for Public Land, 2021). Nearshore ecosystems provide significant ecosystem services (calculated to be worth tens of millions of dollars of services annually) to the region and more broadly as well, including carbon storage and sequestration, creation of habitat, and forage fish (Earth Economics, 2013). Fishing, crabbing, and related activities are also important culturally and recreationally (especially to Tribes, discussed elsewhere in this report), beyond their economic and environmental benefits.

Climate impacts such as ocean acidification and rising water temperatures present threats to local marine ecosystems and fisheries (U.S. Fish and Wildlife Service, 2023). Ocean acidification is a climate risk across the Pacific Northwest, with hatcheries closest to the Pacific Ocean and its associated upwelling of acidic ocean waters the most vulnerable. NOAA and University of Washington scientists note that shellfish important to Clallam County, including oysters, clams, mussels, and Dungeness Crab, are particularly impacted (North Olympic Development Council, 2022). Local leaders report major concern for shellfish and crab populations (Climate Vulnerablity and Hazard Mitigtation Community Workshop, 2024).

Climate impacts also intersect with and compound other environmental issues, like the rise in invasive green crabs which can outcompete local species. Another big issue in the region is algal

blooms or red tides, which can harm shellfish and prompt the closure of public beaches and the harvest of clams, oysters, mussels, scallops, and other species of mollusks. Higher water temperatures combined with increased stormwater runoff of nutrients- both likely in the future- can result in more frequent and intense algal blooms. There have also been recent cases of elevated biotoxin levels (Fisher, 2022).In recent years, many beaches and commercial growing areas have been closed or 'downgraded' by the Washington State Department of Health due to contamination (Clallam County Environmental Health).

Rivers and streams in the County- like Bogachiel, Dungeness, Elwha, Sol Duc and Salt Creek- have historically had some of the most productive Pacific salmon runs in the world. But salmon stocks have declined significantly in the past century due to practices like logging and damming. The Wild Salmon Center reports that most wild steelhead populations on the Olympic Peninsula are in long-term decline, and some are even near their lowest on record (Wild Salmon Center, 2017). Olympic National Park has closed the Queets, Salmon and Quinault Rivers to sport fishing earlier than usual some years, due to low forecasted returns (Olympic National Park, 2023). These closures impact sport anglers and fishing guides. There are some bright spots, including an increase in Coho salmon on the Elwha River after dam removal, though Chinook numbers are struggling (Washington Policy Center, 2023).

Salmon hatcheries (Tribal, state, federal, and private) have already been trying to cope with climate impacts like varied precipitation and extreme weather events, lower snowpack, and hotter temperatures, which cause low average river flow, high water temperatures, and more intense flooding events with diminished water quality. Juvenile salmon are especially at risk (North Olympic Development Council, 2022).

With decreasing catch and landing rates anticipated and fishing becoming more challenging, the average age of commercial fishers is increasing (5th National Climate Assessment). Fishery losses and closures can also affect fishing-adjacent industries, such as hospitality.

ADAPTIVE CAPACITY

Several rivers in the County (e.g., Dungeness River), have dikes and levees which are detrimental to salmon habitat. One of the biggest interventions in the recent past in Clallam County is the Elwha Dam removal, where annual salmon runs have rebounded some but not as quickly as hoped and moratorium on fishing remain in effect (National Park Service, 2022). On the Olympic Peninsula in Northwest Washington, the Lower Dungeness River Floodplain Restoration project aims to remove historic levees and dikes and restore habitat and natural river processes (Aspect, 2021). Jamestown S'Klallam Tribe has been purposefully installing logjams and restoring smaller creeks in the area for a long time, as well, helping to slow the river down and create shaded areas for fish and animals (Jamestown S'Klallam Tribe).

The County does not have direct influence over ocean fisheries management. While there have been efforts to evolve more sustainable fisheries, many of the impacts including ocean acidification are beyond local influence.

Commercial districts, local businesses, and tourism

CLIMATE RISKS

Many pieces of critical economic infrastructure- like marinas, banks, grocery stores, and other retail services- in Clallam County are located on low bank oceanfront sites or within floodplains, which may expose them to risk from flooding sand sea level rise. Areas of downtown Port Angeles flood during major winter storm events, like in 2020 outside the Shore Aquatic Center (North Olympic Development Council, 2022).

With Highway 101 being the only transportation route into and out of the Peninsula, Clallam County industries and businesses are uniquely vulnerable to supply chain disruptions. Closures of Hwy 101 due to flooding and landslides are likely to interrupt deliveries, potentially negatively impacting businesses and employers ranging from tourist businesses to grocery stores and marinas.

Tourism is a major part of the economy of the County. with its proximity to national parks, ocean, and more. One recent study estimated direct visitor spending on lodging, food, recreation, retail, and transportation was $284.4 million in 2023 (Olympic Peninsula Tourism Commission, 2024). Tourism generated nearly $25 million in state and local taxes, and 1,874 direct employment, or over 5% of county's employment in 2023 as well.

While tourism brings some economic benefits, the influx of people also has some negative impacts, like over-use of certain areas like Hurricane Ridge and air pollution from traffic. Not all visitors spend much money locally. Climate impacts like flooding and extended wildfire and smoke events can negatively impact tourism dependent businesses like hotels and recreational fishing outfitters.

ADAPTIVE CAPACITY

Existing businesses have access to general business support from the Clallam Economic Development Council and the Small Business Development Center with a branch in Port Angeles. The latter, in coordination with the state network, offers business resilience toolkit and disaster assistance. However, Clallam County local businesses face a range of practical and financial challenges after extreme events, like access to credit and flood insurance and navigating procedural and regulatory hurdles. Building owners may not have money to invest in needed building retrofits for better energy efficiency and indoor air quality. They also may struggle to survive if they face repeated closures due to flooding, smoke, or other climate events.

In past events, there have been efforts to distribute state funds and other support to help small businesses after disasters. For example, the Northwest Disaster Grants Program distributed $10 million in grants to businesses in the Quileute Tribe and Clallam County, to cover the costs of layoffs, inventory loss, facility damage, fixed expense needs, loss of revenue due to closure, and out-of-pocket costs related to severe winter storms and flooding in 2021-2022 (My Clallam County, 2023). But it is not clear that there will be resources like that for escalating future events.

Marinas are vulnerable to storms and sea level rise. They could be useful places for receiving supplies in the event of road closures, but this is not yet a developed practice, and the marinas would need infrastructure upgrades to be able to handle this.

Tribal Businesses and Livelihoods

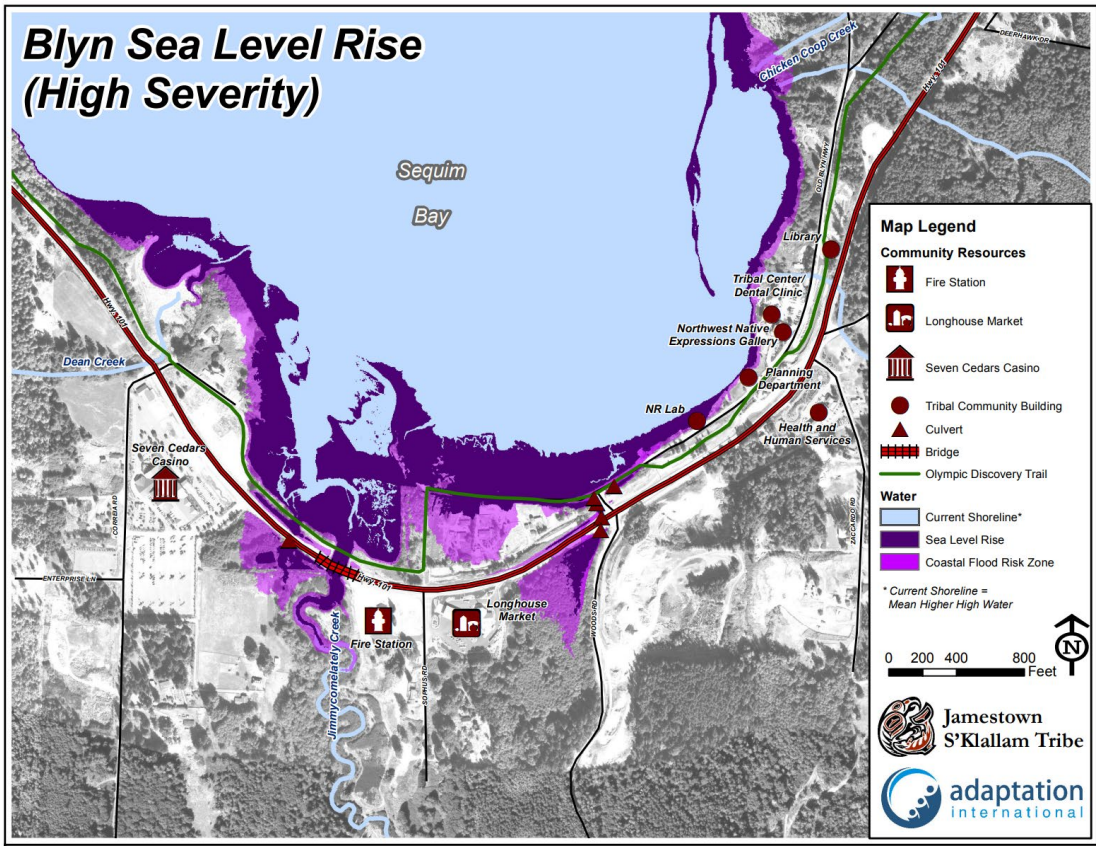
CLIMATE RISKS

Economic opportunities on reservations in Clallam County are limited and typically dependent on tourism (including casinos) and natural resources. Unemployment hovers around 50% on the Makah Reservation (Makah Tribe, 2023). Assessments of the impacts of sea level rise on Tribal industries vary by Tribal location.

Tribes are already experiencing the negative impacts of climate change to their businesses and livelihoods. The Quileute Tribe has gotten cut off for days due to the flooding of the Bogachiel River, which closes Highway 101 between LaPush and Forks and inhibits visitation to the Tribal resort and restaurant.

Flooding could impact roadways and affect business at the Jamestown S'Klallam Tribe Casino and Longhouse market (Figure 29). The casino and longhouse are near potential flooding areas but not at direct risk itself (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023). Major impacts to these businesses, or to transportation routes to access them, would harm employees as well as the Tribe and local governments.

Figure 28. Map Showing Potential Sea Level Rise and Coastal Flood Impacts on the Longhouse Market (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).



Tribes are also first and worst impacted by the fishery (including shellfish) declines described earlier. Fishing is economically important for native livelihoods, comprising about 50% of the

Neah Bay economy and being the main occupation for two thirds of Makah households (Makah Tribe Hazard Mitigation Plan). Nearly all Makah households rely on fishing, shellfish (including Dungeness crab), and hunting resources for a portion of their diet.

Tribes already account for over half of federal fishery loss requests in the Northwest (5th National Climate Assessment). In recent years, the Makah National Fish Hatchery has sustained massive floods at a scale and frequency not seen before, damaging infrastructure and moving large amounts of sediment and gravel (Chang, 2023). The Jamestown S'Klallam tribe has already moved some of its commercial fishing operations to Kona, Hawaii, due to increasing PH levels for clams and oysters (Community workshop). One Tribal leader in the region says, "Tribes aren't able to harvest oysters like they once did… We just don't get the natural shellfish recruitment like we used to." (Northwest Treaty Tribes, 2017)

Further declines, especially of Pacific salmon and Dungeness Crab, will have additional consequences for Tribal communities reliant on fish and shellfish for economic as well as subsistence, cultural, and spiritual practices and community health and identity.

ADAPTIVE CAPACITY

Tribal members face structural barriers to securing equipment, insurance, loans and equipment and to thrive in competitive market systems in the era of climate change (Quileute Tribe Climate Plan). However, many Tribes are utilizing Indigenous approaches and Tribal–federal partnerships to increase the resilience of their commercial and subsistence fisheries.

The Quileute Tribe has been trying for years to relocate critical facilities and services to higher ground, and completed Phase 1, Tribal School relocation, in 2022 (Quilete Tribe).

Tribes are also leading the County in their development and use of community-based climate resilience action plans and actions that incorporate traditional knowledge. As one example, the Jamestown S'Klallam Tribe and others are trying to offset changing stream conditions, including warming stream temperatures, by inputting large woody debris into rivers and streams and managing invasive species. It will take even further effort to further restore fish populations in rivers and it may be difficult to offset the effects of warming temperatures. The Jamestown S'Klallam Tribe also relocated its fishery lab on Sequim Bay to higher ground. In addition, tribes like the Makah and Quileute are attempting to ensure government planning for fish conservation does not inequitably limit Tribal treaty fishing compared to non-treaty fishing.

Land Use and Resource Lands

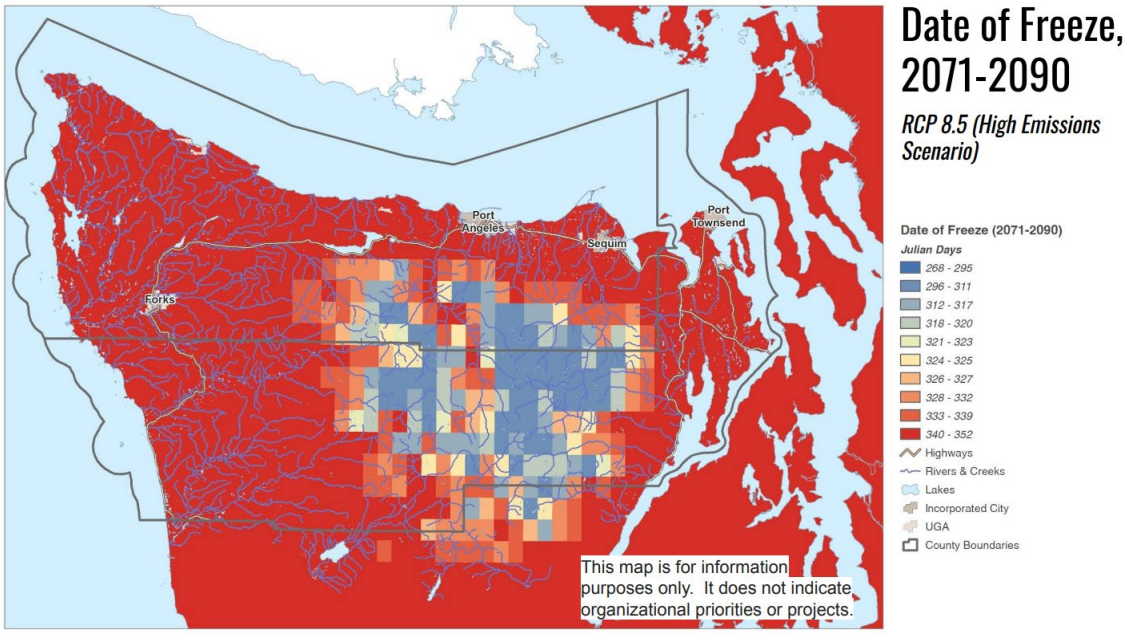
Agricultural Lands

CLIMATE RISKS

Agriculture is a big part of Clallam County's economy, with 514 farms (31-acre average) and $17 million in the market value of products sold, with a lot of fruit and vegetable and forage/grain production (United States Department of Agriculture, 2022). The Dungeness Valley region has some of the most productive agricultural soils in the region. Climate change may have mixed impacts for farming. On the one hand, longer growing seasons due to later and fewer freeze days may enable farmers to grow more. Figure 30 shows the likely date of freeze in the latter part of this century as much later than it is currently. However, due to increased summer drought,

reductions in summer/fall water availability from decreases in snowpack, increases in mean winter precipitation (which can increase root rot), and changes and increases in pests and disease are all greater risks to farmers, with impacts varying by crop.

Figure 29. Most of Clallam County will experience a very late date of freeze in the years 2071-2090 as shown in red below, compared to historical records (Climate Resilience Alliance, n.d.)



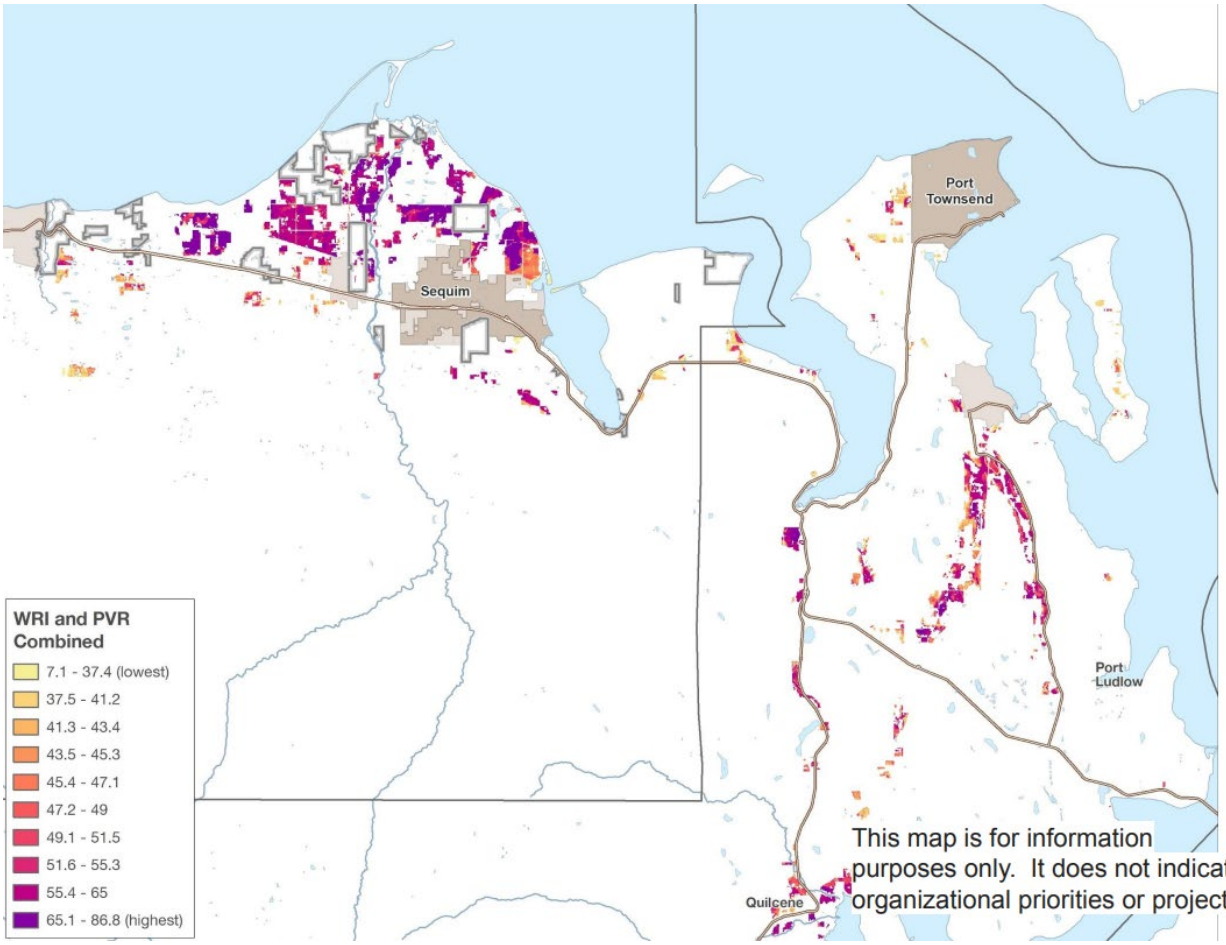
Water availability is a continuing source of tension in areas with water rights restrictions, where lower availability leads to increased competition between users. Water rights for commercial agriculture on the North Olympic Peninsula rarely include groundwater use, leading farmers to use other water sources for irrigation (North Olympic Development Council, 2015). Climate change may exacerbate these tensions.

ADAPTIVE CAPACITY

Agricultural lands in Clallam County have some strengths in terms of adaptive capacity. The North Olympic Land Trust categorizes much of the farmland near and around Sequim as relatively climate resilient, due to its high water retention index (WRI) and positive assessment of its productivity, versatility, and resilience (PVR) (Figure 31). Well managed farms could contribute to carbon sequestration as well as local food security, and contribute positively to the area's adaptive capacity (Climate Resilience Alliance, n.d.). Farmers could reduce their use of water by growing less water-intensive crops and by altering their land management and growing practices, especially with support from local Extension offices, Conservation Districts, and consumers.

In terms of positive actions, the County manages a Conservation Futures program, which uses a property tax levy to "maintain, preserve, conserve and otherwise continue in existence adequate open space lands for the production of food, fiber, and forest crops, and to assure the use and enjoyment of natural resources and scenic beauty for the economic and social well-being of the County and its citizens" (Clallam County, n.d.). As of 2025, the Program has completed three projects, preserving nearly 82 acres of farmland. The Climate Action Plan proposes support and expansion of the program.

Figure 30. Map showing Climate Resilient Farmland in the Darkest Pinks and Purples. (Climate Resilience Alliance, n.d.)



In addition to climate impacts, farmland in Clallam County also faces development pressure. Much of the zoned farmland in the County is already subdivided into 5 acre lots, which increases their risk of being turned into residential development (Climate Resilience Alliance, n.d.). Channeling future residential development into buildable lands within the boundaries of Forks, Port Angeles, and Sequim, rather than onto farmland, would help conserve farmland for farming.

Another major challenge that farmers face is the challenging economics of farming. Most farms in the County make less than $2,500 annually, and the average net cash farm income is negative (United States Department of Agriculture, 2022). If the economic challenges are not addressed, farms will struggle to adapt to changing climate conditions and their ability to contribute to carbon sequestration and local food security.

Forest Lands

CLIMATE RISKS

While commercial forestry has declined from its historic prominence, it remains a vital force in the local economy. Working Forests estimates there are over 430,000 acres of working forest land (managed by private industries and by the Department of Natural Resources) in Clallam County, with 791 direct jobs (1,705 total jobs), $111 million in total related wages and nearly $8 million in taxes and fees returned to state agencies (Working Forests, n.d.).

Climate change poses risks to the local forestry economy. Warmer temperatures and increased drought stress will likely affect "traditional" tree species and decrease forest growth and lower productivity as well as increase fire risk and susceptibility to insects and disease (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023). The forestry sector in Clallam County has already been affected by a dieback in Western Red Cedar, an economically and culturally important tree. The Washington State Department of Natural Resources notes that this dieback may be linked to changing climate conditions, including increasing average temperatures and drought stress (Washington Department of Natural Resources, 2022). Additionally, logging practices in steep terrain may exacerbate erosion and landslide risk associated with increased extreme precipitation events.

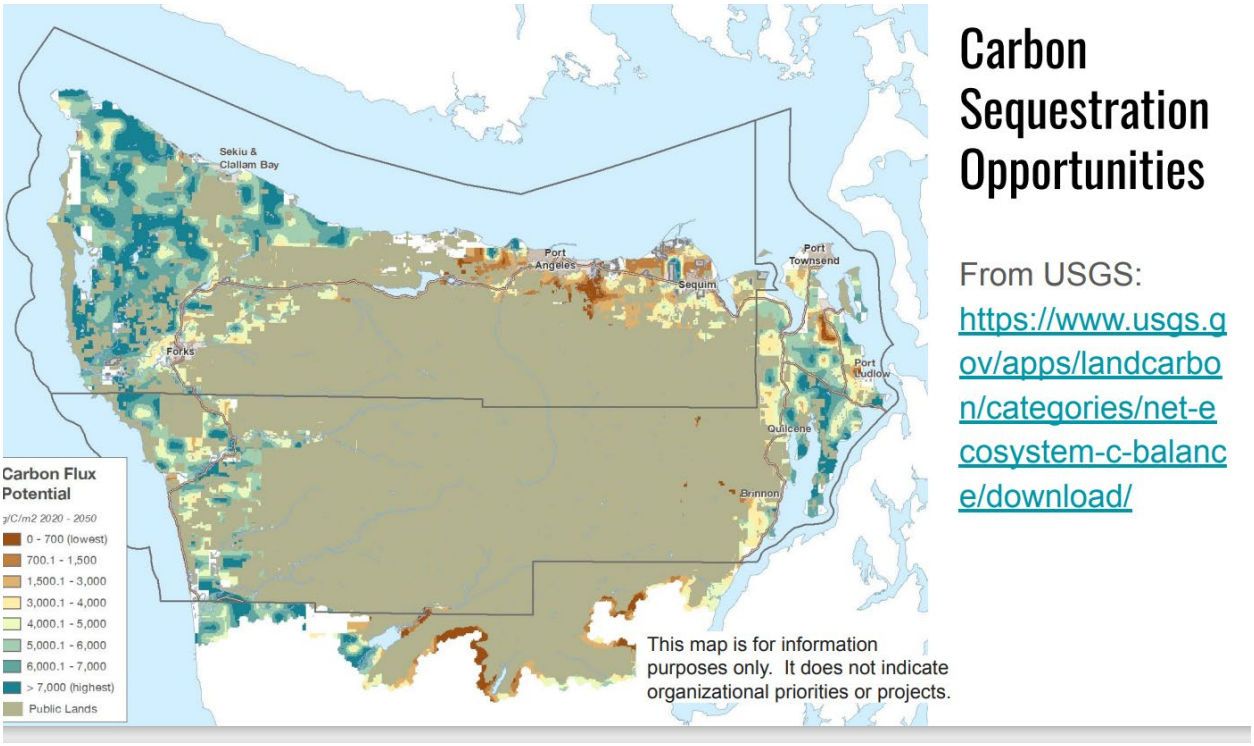
ADAPTIVE CAPACITY

There is moderate to high potential for adaptation in the forestry sector, but there is no guarantee that the capacity will be fulfilled. Hopefully leadership, policy, and economic incentives will provide sufficient motivation. Washington State Department of Natural Resources emphasizes the need for adaptive management including prescribed burns, removing invasive species and thinning, to help restore forests to a more natural, reliant and healthy condition. Clallam County has little authority over the management of forest lands.

Climate impacts to forestry could lead to economic depression in Clallam County, resulting in migration away from these communities (5th National Climate Assessment). However, industries and private landowners may be motivated to make new adaptation choices that foster climate resilience and technologies like cross-laminated timber may provide economic opportunity for locals.

Forests represent another area of potential adaptive capacity in terms of their carbon sequestration opportunities. The North Olympic Land Trust suggests that much of the forestland in the western half of the County has high carbon flux potential (Figure 31). In addition to the environmental benefits of carbon sequestration, the lands could also be a potential source of payments for ecosystem services in the future, if such programs are implemented.

Figure 31. Carbon sequestration opportunities on forestlands in the Olympic Peninsula. (Climate Resilience Alliance, n.d.)

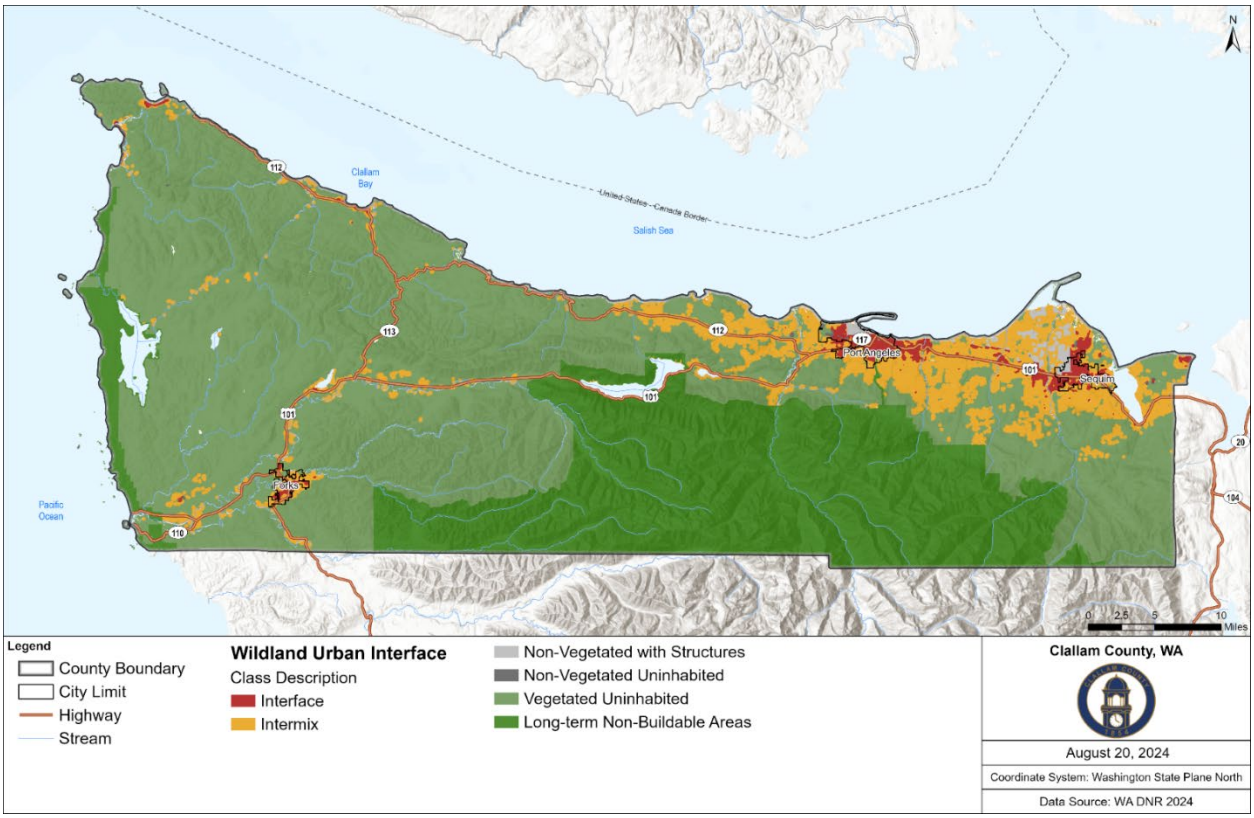


Developed Areas including Wildland Urban Interface Areas

CLIMATE RISKS

Wildfire poses some risks to developed parts of the County, as described in detail in the County Wildfire Protection Plan (CWPP) and MJHMP. The cities of Port Angeles and Sequim are bordered to the south by wildland forest areas and are close to Olympic National Park. The City of Forks is surrounded by commercial forests and may be particularly susceptible to wildland urban interface fires. The CWPP estimates nearly 150,000 acres of land– including about 13,000 homes - in the wildland urban interface (WUI). Figure 32shows the location of WUI lands, generally surrounding Port Angeles, Sequim, and Forks. Pockets of wildland urban intermix can be found around major transportation corridors in Clallam County, including Highways 101, 112, 113 and 110. In addition, the City of Forks is surrounded by commercial forests, putting it at unique risk. Many older structures throughout the County were constructed before modern fire codes and fire-resistant building materials, which could exacerbate their risk (Callam County's 2024 Hazard Mitigation Plan). Narrow access roads, which are typical in these areas, interfere with fire response.

Figure 32. Map of Wildland Urban Interface in Clallam County. Areas in red depict areas where high concentrations of structures and wildland meet or intermingle- notably, outside of Sequim, Port Angeles, Forks, as well as in Clallam Bay and Neah Bay (Washington State Department of Natural Resource, n.d.).



ADAPTIVE CAPACITY

Developed areas in Clallam County need to both build their adaptive capacity to changing climate, and likely also need to accommodate population growth. The County is currently attractive to retirees and other new residents, and may be more so in the future, with its relatively abundant water resources and milder summers compared to other parts of the country (Climate Resilience Alliance, n.d.). Where this population growth is channeled and how it is managed will impact the adaptive capacity of individual residences and the county. In Clallam County, land use planning often encourages large, detached, single-family homes with big yards. These homes take more energy to heat or cool, and the separation from other destinations generally results in greater automobile usage (Clallam County Climate Action Plan).

A threat to adaptive capacity is the increasing construction of residences in wildland-urban interfaces. It would be prudent to restrict development in these areas. Existing individual property owners can lower their risks via fire-resistant building construction and the use of fire mitigation practices and defensible space. The Firewise USA map does not show any active Firewise communities in Clallam County as of 2025. In Sequim, planners are discussing how to encourage homeowners to work together in clusters to defend their properties from flooding and fire, but this has not yet become a common practice.

The County reports not having funds to do any major property buy-back of properties in high-risk areas. New development may best be channeled into already developed areas, like near the downtowns of Forks, Port Angeles and Sequim. Local planners report that constraining

development in flood and fire-prone areas is not popular with homeowners, so more education is needed.

Clallam County is already spending thousands of dollars annually on flood preventive controls and dikes, but more investments will likely be needed in the future. In Port Angeles, with anticipated increased flooding downtown, the Port has made improvements to the two marinas at each end of downtown, with higher pilings and walkway access, in anticipation of rising sea levels. More such investments in high-risk areas are needed.

Built Infrastructure

Clallam County's built infrastructure systems, many of which are ageing and relatively undersized relative to the population growth in recent decades, are impacted by climate change in a variety of ways. Flooding can inundate roadways and housing developments, and sea level rise can lead to overflows of stormwater systems, and higher temperatures could strain the energy system. The built infrastructure sector includes the following subsectors.

- **Transportation**: Roads, highways, bridges, and transit systems.
- **Housing:** Stock, age, and condition of housing.
- **Energy**: Generation, transmissions and distribution lines, and renewable energy.
- **Water systems:** Water distribution, wastewater treatment, and stormwater systems (Water supply is referenced in the natural environment and water resources section.)

The following risk assessment for the Built Infrastructure sector evaluates climate risk (exposure and sensitivity) and adaptive capacity impacting the County's Transportation, Housing, Water Systems, and Energy sub-sectors to determine overall vulnerability.

Table 9. Vulnerability Scores for Built Infrastructure Sector

Sector	Climate Risk	Adaptive Capacity	Vulnerability
Transportation	Moderate - High	Moderate	Moderate
Housing	High	Low - Moderate	High
Water Systems	Moderate	Moderate - High	Moderate
Energy	High	Moderate	Moderate - High

TRANSPORTATION

Climate Risk	Adaptive Capacity	Vulnerability
Moderate - High	Moderate	Moderate
Climate risk to transportation is moderate to high due to the vulnerability of key roadways to flooding, sea level rise, landslides, and extreme precipitation events.	Adaptive capacity is moderate, with ongoing efforts by WSDOT and Clallam Transit to assess vulnerabilities and improve infrastructure resilience through projects like culvert replacements.	Overall vulnerability is moderate, considering the limited redundancy in transportation routes and the potential for disruptions, especially in more remote areas.

HOUSING

Climate Risk	Adaptive Capacity	Vulnerability
High	Low - Moderate	High

Climate risk to housing is high due to threats such as wildfires, flooding, and coastal inundation, which directly impact a significant portion of homes in Clallam County, particularly in low-lying and rural areas.	Adaptive capacity is low to moderate, as while some mitigation efforts are in place, the widespread lack of preparedness and the vulnerability of older and mobile homes limit resilience.	Overall vulnerability is high, given the large number of homes at risk from multiple climate hazards and the limited capacity for homeowners to protect their properties from these threats.

WATER SYSTEMS

Climate Risk	Adaptive Capacity	Vulnerability
Moderate	Moderate - High	Moderate
Climate risk to water systems is moderate due to the vulnerability of infrastructure to flooding and stormwater surges, especially in areas relying on coastal or flood-prone systems.	Adaptive capacity is moderate to high, with proactive measures such as system evaluations, infrastructure strengthening projects, and community workshops to enhance resilience.	Overall vulnerability is moderate, as water systems face localized risks that are being addressed but continue to require significant adaptation to cope with increasing climate impacts.

ENERGY

Climate Risk	Adaptive Capacity	Vulnerability
High	Moderate	Moderate - High
Climate risk to energy is high due to the combined threats of wildfires, extreme weather events, and the potential for reduced hydropower generation due to climate-induced droughts and low precipitation.	Adaptive capacity is moderate, with efforts like the Bonneville Power Administration's climate vulnerability assessment and wildfire mitigation plans in place to strengthen resilience.	Overall vulnerability is moderate to high, reflecting the system's susceptibility to power outages and the increasing stress on energy infrastructure from climate change-driven challenges.

KEY TAKEAWAYS

- Flooding and sea level rise pose moderately high risks to several routes across the county including Highways 112, 110 and 101.
- The County's housing stock is aging and highly sensitive to climate risks, with nearly half of the housing in Clallam County in vegetated areas that may have some fire risk and housing in low lying coastal areas exposed to coastal flooding.
- Stormwater infrastructure systems are running beyond their capacity and outdated culverts are inadequately serving urban areas, such as Port Angles and Sequim.

- The County's energy system faces high risk from climate impacts with concerns that energy distribution and transmission infrastructure will not be able to meet future demands, especially in remote areas and/or during extreme weather events.

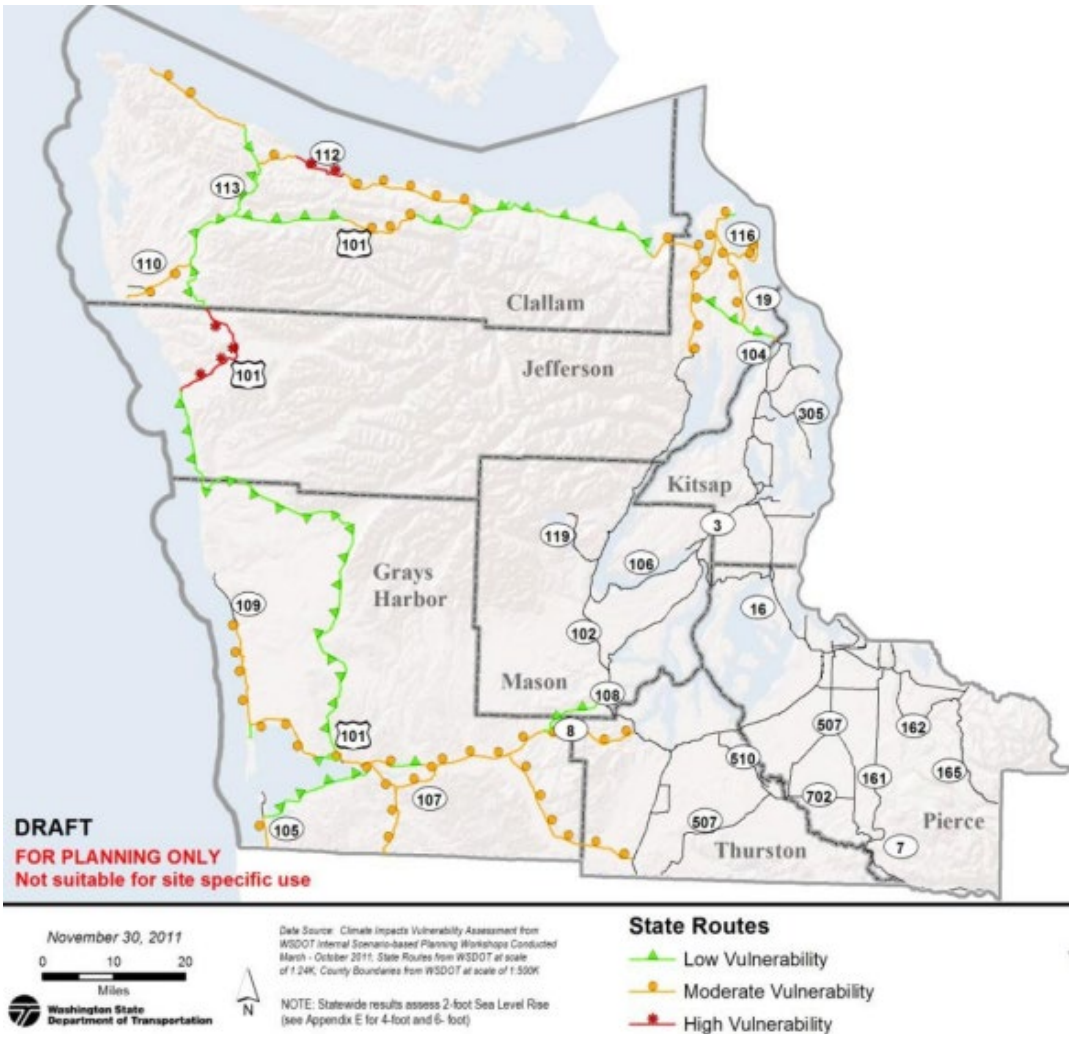
Transportation

Due to its remote geography, Clallam County relies on a unique transportation system to serve its residents across larger cities and more rural areas. U.S. Highway 101 serves as the main arterial, running east to west, while state routes and local roads connect communities, neighborhoods, and agricultural lands to Highway 101. Clallam Transit provides fixed route buses, shuttles, and paratransit services that connect residents to major towns and other key locations, as well as offering connections to nearby Jefferson and Kitsap County transit systems.

CLIMATE RISKS

Clallam County's transportation system is already experiencing the impacts of climate change, as described earlier. For example, Highway 112 has been affected by landslides near Sekiu and Clallam Bay, which have closed the highway, and flooding from the Pysht River (Makah Tribe, 2023). Many times, the Makah Tribe has been cut off from the rest of the Peninsula due to closed roads. Additionally, parts of Highways 112, 110, and 101 will likely be impacted by 4 to 6 feet of sea level rise or coastal flooding in the future (Figure 33).

Figure 33. WSDOT Climate Vulnerability Assessment for the Olympic Region. Several state routes within Clallam County have moderate to high vulnerability to impacts such as flooding, extreme precipitation, unstable soils, and several sea level rise scenarios (Washington State Department of Transportation, 2011) .



Roads serving urban areas such as Canyon Edge Drive in Port Angeles are also prone to flooding during heavy rain events (Port Angeles, 2022). Highway 101 near Forks also floods (Figure 34). Several state routes within Clallam County have moderate to high vulnerability to impacts such as flooding, extreme precipitation, unstable soils, and several sea level rise scenarios (Washington State Department of Transportation, 2011). As climate change continues to progress, Clallam County's transportation corridors are expected to face more frequent landslides, increased coastal erosion, and more severe flooding (North Olympic Development Council, 2022).

Figure 34. Flooding along Highway 101 near Forks (Washington State Department of Transportation, 2021)

The sensitivity of the Clallam County transportation network is heightened due to its limited redundancy (North Olympic Development Council, 2022). This is particularly evident in the more remote western parts of the county, such as the Makah Reservation, where the end of a 150-mile supply chain is constricted at multiple points and where Highway 112 is the single road connecting the reservation with the rest of the county (Makah Tribe, 2023). LaPush, on the Quileute Reservation, gets cut off due to flooding as well.

Additionally, as the backbone of Clallam's transportation network, Highway 101 could be shut down for up to 24 hours during an extreme storm (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023).

November 2021: Heavy storms led to flooding and several closures along Highway 101, and State Route 112, blocking access to Neah Bay, Clallam Bay, and Sekiu (Jablonski, 2021). A US Coast Guard helicopter evacuated residents who were trapped in their wet homes and unable to leave their homes, along Erickson Road, due to flooding of the Bogachiel River (Clallam County Sheriff's Office, 2021)

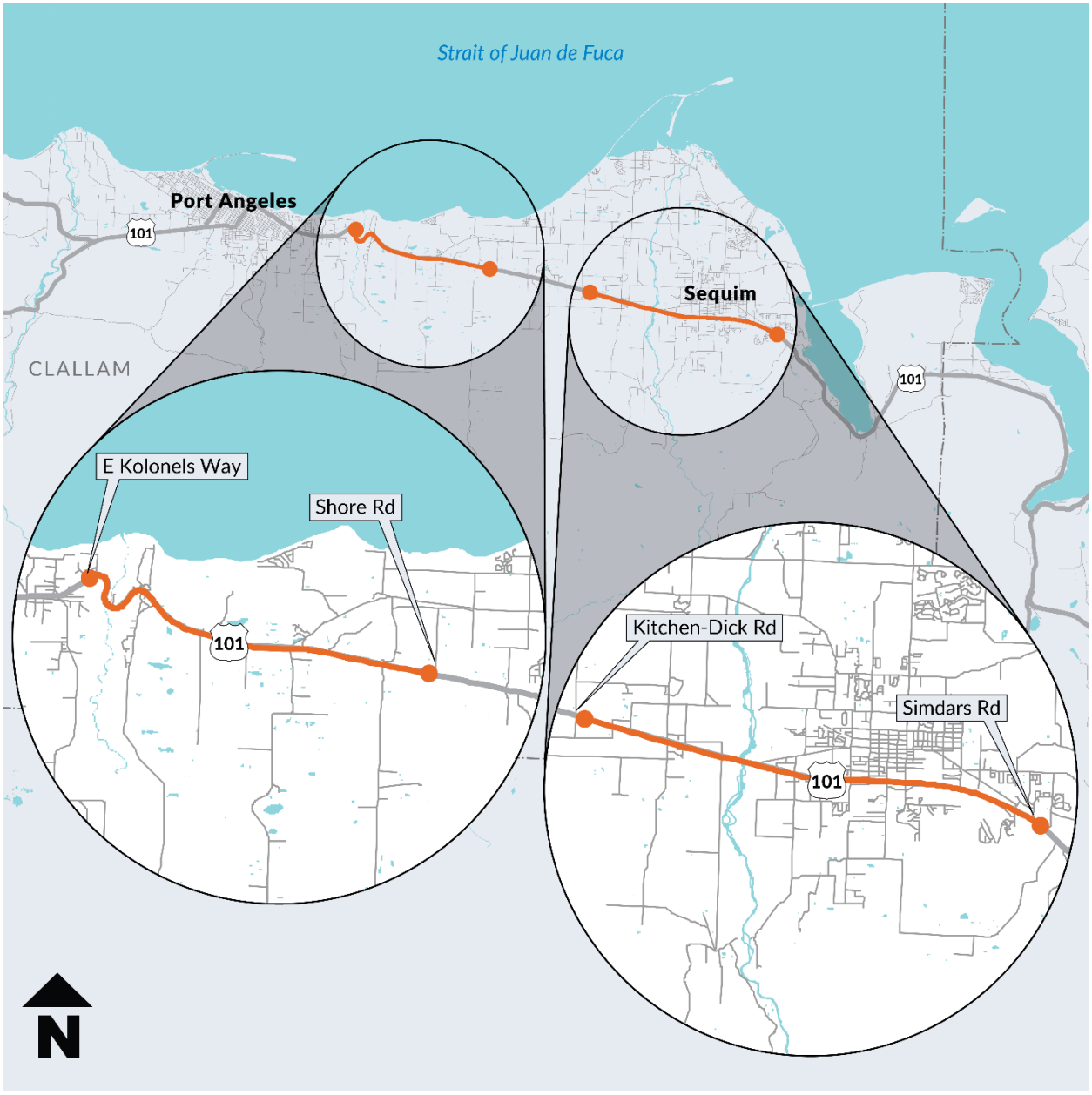
ADAPTIVE CAPACITY

Efforts have been taken to reduce the vulnerability of Clallam County's transportation network to climate impacts like flooding, sea level rise, and storms. Agencies like the Washington Department of Transportation (WSDOT) have conducted climate vulnerability assessments for state highways and transportation systems. WSDOT is also exploring options to relocate sections

of Highway 101 from coastal erosion zones (North Olympic Development Council, 2015). Clallam Transit operates over 100 vehicles and has developed a plan to phase out older vehicles within their fleet, replacing them with newer, more reliable models (Clallam Transit, 2023).

Clallam County will benefit from transportation-related climate adaptation through several WSDOT projects within its boundaries. The Highway 101 repaving project includes redesigning two segments between Sequim and Port Angeles to comply with Washington state's Complete Streets legislation (Figure 35; Washington State Department of Transportation, 2023).. This initiative, currently in the design phase, aims to enhance multi-modal transportation options, such as biking, walking, and transit, while also increasing the longevity and resilience of these segments (Washington State Department of Transportation, 2023). The County will also experience reduced flooding risk from the fish passage barrier removal projects near Blyn and Sequim, where outdated culverts under Highway 101 are being replaced (Washington State Department of Transportation, 2021).

Figure 35. Planned repaving of two segments along Highway 101 between Port Angeles and Sequim (Washington State Department of Transportation, 2023).



Water Systems

Clallam County's water, wastewater, and stormwater systems are essential components of its infrastructure, supporting public health, environmental quality, and community resilience. Water systems are owned and operated by Clallam PUD which oversees water districts across the county (Clallam County Public Utility District, 2023).

CLIMATE RISKS

The County water supply includes water districts and private systems, many of which are vulnerable to climate impacts like flooding, wildfires, and landslides (Clallam County, 2019).

Urban sprawl has extended water infrastructure into rural areas, with 17 water systems (defined as any well or water system serving more than two residences) located within the wildland-urban interface (Clallam County, 2019). Flooding and sea level rise further threaten drinking water systems, such as in Port Angeles, where drinking water is transported in a concrete pipeline along the shoreline, and in Jamestown, where water distribution systems face flood risks (Clallam County, 2019).

Wastewater systems are also at risk, with tanks in coastal flood zones like those on the Jamestown S'Klallam Reservation (Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan, 2023) and the Sekiu sewage treatment plant in Clallam Bay particularly vulnerable to sea level rise and flooding (Halofsky, 2011). Additionally, many stormwater systems are operating at capacity, with groundwater flooding and inadequate culverts causing issues in Sequim (North Olympic Development Council, 2022). See Figure 36.

In 2021, an intense winter storm over exceeded the capacity of Sequim stormwater infrastructure, leading to flooding on 7th and 5th avenues (Nash, Sequim Experiences Flooding, 2021).

Figure 36. Flooding along South Seventh Avenue occurred in December 2021 due to heavy rains, blocked storm drains, and flooded stormwater ponds (Nash, Sequim Experiences Flooding, 2021).

In Port Angeles, the Hill Street/Marine Drive system is frequently inundated, and its efficiency is expected to decline as high tide lines rise, potentially overwhelming stormwater outfalls (North Olympic Development Council, 2015).

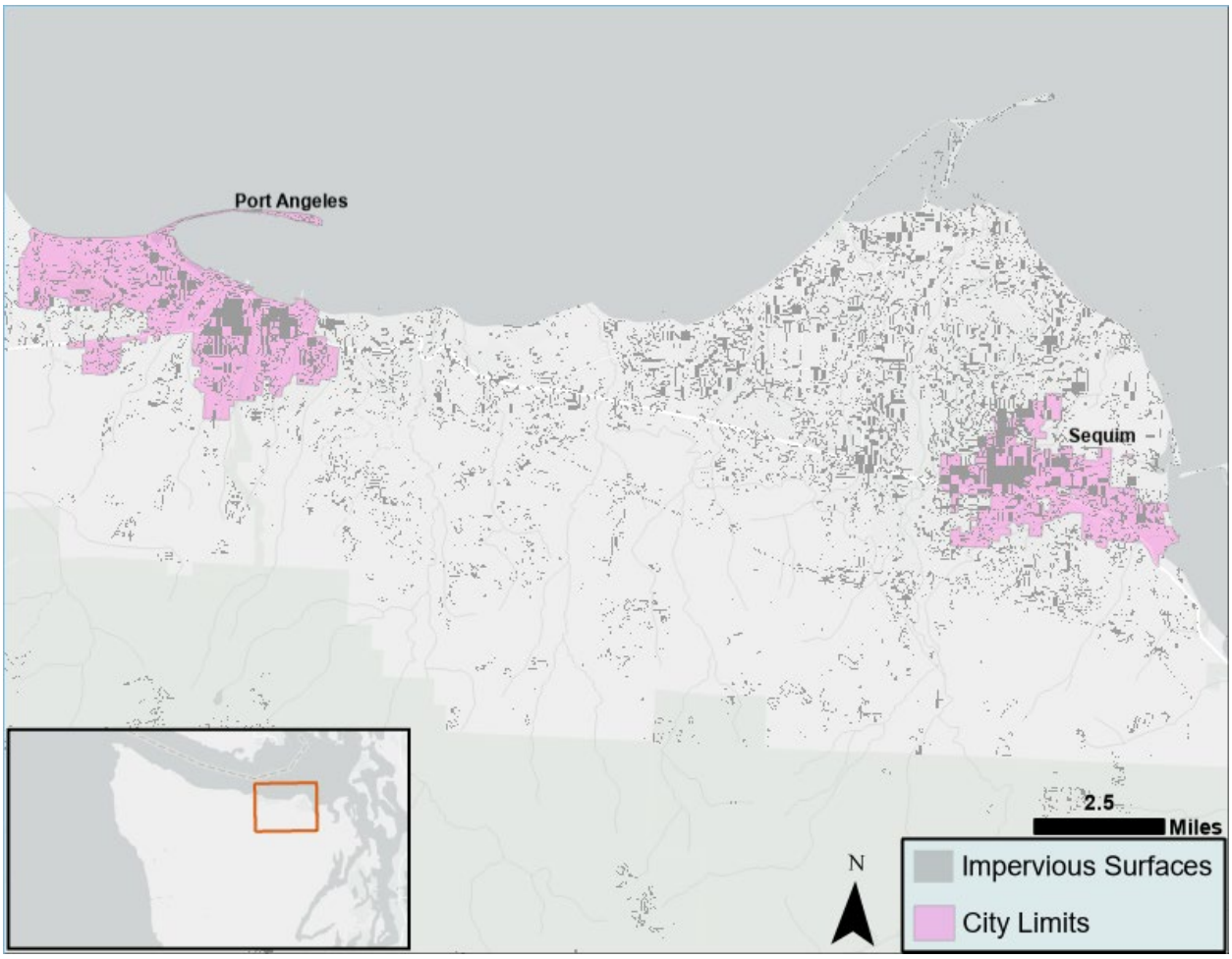
The sensitivity of water systems to climate change is partly due to low redundancy across the peninsula (North Olympic Development Council, 2015). Many systems rely on electrical pump stations; thus, a power outage could halt water and wastewater services (Clallam County, 2019). This issue affects areas like the Makah Reservation and Neah Bay, including Bullman Beach,

where water systems are increasingly vulnerable due to changing winter precipitation patterns (Clallam County, 2019). Bullman Beach Water System, which has been out of compliance with state health requirements, is anticipated to be updated with a water treatment plan in 2025 (Clallam County Public Works).

In November 2021, during a severe storm, an electrical and communication failure at the Hoko Pump Station prompted Clallam PUD to ask Clallam Bay and Sekiu water customers to reduce their water usage (Fisher, Flooding brings active rescue operations, road closures, suspended bus services, 2021).

Septic systems face additional vulnerabilities from groundwater table changes and sea level rise, and enforcing updates is challenging because many systems are on private lands (North Olympic Development Council, 2015). Stormwater systems in urbanized areas like Port Angeles and Sequim are more vulnerable due to impervious surfaces, like buildings, and roads, preventing water from naturally infiltrating the ground (Figure 37). This leads to excess stormwater runoff, which can overwhelm drainage systems, increasing the risk of localized flooding, particularly during heavy rain events (Washington State University).

Figure 37. Impervious surfaces overlaid onto Port Angeles and Sequim City Limits. The map indicates the high density of impervious surfaces in urban areas, leading to increased surface runoff. Data accessed from Washington State Geospatial Data Portal (United States Geological Service, 2023).



ADAPTIVE CAPACITY

Effective stormwater and sewer management in the region is crucial for mitigating the impacts of heavy precipitation and flooding (North Olympic Development Council, 2015). To address this, the NODC has held workshops with community members to identify the strengths, weaknesses, vulnerabilities, and adaptation and resilience measures of stormwater and sewer infrastructure, intending that future climate change-driven decisions reflect local conditions. Additionally, several jurisdictions in Clallam County have taken proactive measures to enhance their water systems' resilience to climate change. For instance, Port Angeles' 2017 water system plan evaluated the infrastructure and found minimal need for replacing distribution components, indicating a robust and resilient system (Port Angeles, 2017). Similarly, Sequim has conducted assessments of its storm flow patterns during wet and dry seasons, leading to several stormwater infrastructure strengthening projects being adopted by the city council (Sequim-Area Surface Water Flow Monitoring, 2015).

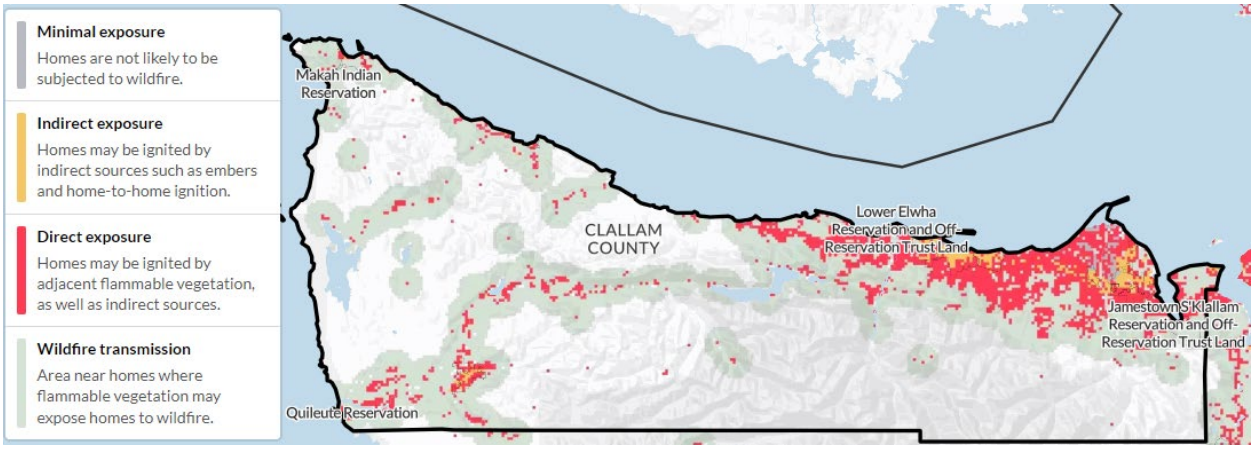
Housing

According to the US Census there are over 38,000 households within Clallam County. Its housing infrastructure reflects the County's diverse geography and population distribution. In populated areas such as Port Angeles and Sequim, housing units are usually more concentrated and include more multifamily housing, while in the rural areas of the County, single-family homes are more prevalent and spread out.

CLIMATE RISKS

Clallam County's housing infrastructure faces multiple climate change-related threats. Windstorms have already caused damage to homes and county buildings (Clallam County, 2024). As temperatures rise and precipitation patterns shift, the risk of wildfire is projected to grow. Currently, 45% of buildings in the county (23,639 buildings) face direct exposure to wildfire, meaning they could be ignited by nearby flammable vegetation (Wildfire Risk to Communities, 2024). Additionally, 43% of homes face moderate risk to wildfire, such as ignition from embers or from fire spreading between homes (Wildfire Risk to Communities, 2024). Figure 38 indicates which areas have minimal, indirect, and direct exposures, as well as areas near wildfire transmission.

Figure 38. Wildfire risk to households across Clallam County. Several homes on the outskirts of urban areas have increased direct exposure to flammable vegetation (Wildfire Risk to Communities, 2024).



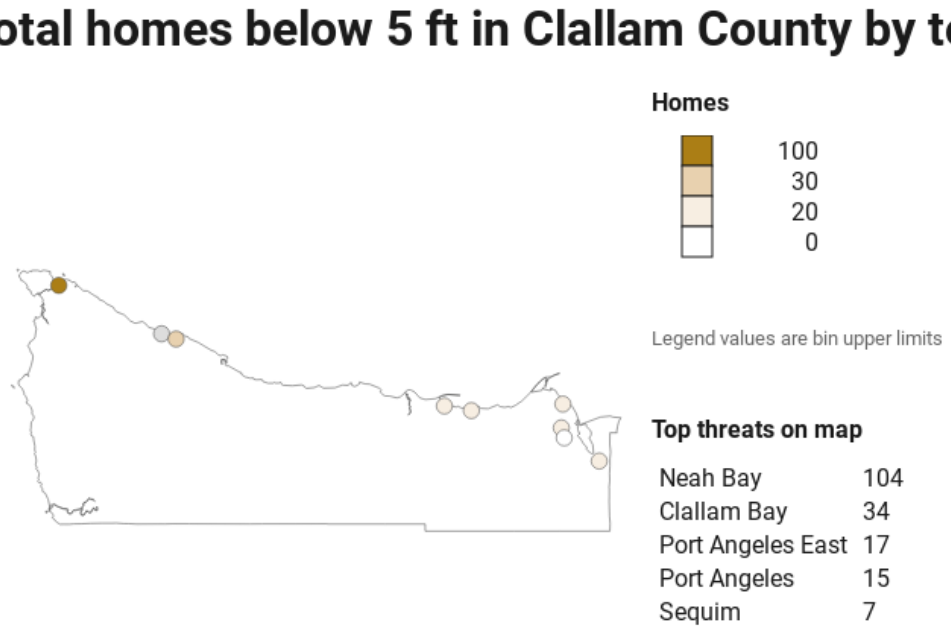
Flooding also poses a significant threat, with 22% of all properties in Clallam County are vulnerable to inland flood events (Headwaters Economics, 2024). Coastal inundation further endangers the county's housing stock, particularly on low-bank oceanfront sites or within floodplains along the Olympic Peninsula (North Olympic Development Council, 2022). A secondary impact from flooding that is a risk, especially for homes with basements, is mold, which can have serious health consequences (Climate Vulnerablity and Hazard Mitigtation Community Workshop, 2024). See Figure 39 and Figure 40 for photos of houses near Dungeness and Sequim at risk of flooding during recent King Tide and storm events.

Figure 39. Aerial image of 3 Crabs Road, looking West during a King Tide in December 2024. Photo by John Gussman.

Figure 40. Coastal flooding near 3 Crabs Road near Dungeness and Sequim Flooding in Sequim during a high tide and storm even in 2018 (Hawkins, 2018).

With a 5-foot rise in sea level, a future 1% annual storm could expose 481 homes in Clallam County to coastal inundation, putting approximately $69 million worth of property at risk (Surging Seas Risk Finder, n.d.). A large majority of these low-elevation homes occur in Neah Bay and other urban areas, such as along 3 Crabs Road in Sequim (Figure 41; Surging Seas Risk Finder).

Figure 41. Homes at risk to 5 ft of Sea Level Rise in Clallam County urban areas (Surging Seas Risk Finder, n.d.).



Urban sprawl is a significant factor driving climate sensitivity within Clallam County, as it further pushes housing developments into more remote and rural areas. Between 1970 and 1990, the population of the three cities in Clallam County grew by only 4,600 people, while unincorporated areas saw an increase of over 17,000 (Clallam County, 2009). In recent years, the total number of

housing units in unincorporated Clallam County has continued to increase at a rate similar to that of incorporated areas, including cities and towns (Table 12).

Table 10. Housing units by Clallam County jurisdictions and year (Clallam County Coordinated Entry Annual Report, 2023).

Jurisdiction	2021 Postcensal Estimate of Total Housing Units	2022 Postcensal Estimate of Total Housing Units	Percent Change from 2021-2022	2023 Postcensal Estimate of Total Housing Units	Percent Change from 2022-2023
Clallam County	38,228	38,384	0.41	38,608	0.58
Unincorporated Clallam County	22,750	22,804	0.24	22,948	0.63
Incorporated Clallam County	15,478	15,580	0.66	15,660	0.51
Forks	1,406	1,418	0.85	1,433	1.06
Port Angeles	9,630	9,661	0.32	9,782	1.25
Sequim	4,442	4,501	1.33	4,547	1.02

This trend indicates that expansion is occurring in areas potentially more prone to climate impacts, such as flooding and wildfires.

In addition to urban sprawl, Clallam County's housing stock faces other vulnerabilities. The median year built for housing units across Clallam County is 1981 (Headwaters Economics, 2024), with 20% of housing units being built before 1960 (Table 13).

Table 11. Housing units by year built (U.S. Census Bureau, 2022).

Year built	Housing units	Percentage
2020 or later	181	0.5%
2010 to 2019	2,360	6%
2000 to 2009	5,748	15%
1990 to 1999	6,551	17%
1980 to 1989	4,527	12%
1970 to 1979	8,530	22%
1960 to 1969	2,662	7%
1950 to 1959	2,471	7%

1940 to 1949	2,027	5%
1939 or earlier	2,937	8%

Across census tracts in the County, the percentage of housing stock built before 1960 ranges from 0% to 71%, with an average of 18% for all tracts. This not only serves as an indicator for the presence of lead paint, but older housing is typically more sensitive to climate change (Adamkiewicz, 2009). Another key concern is the lack of air conditioning in many homes, which diminishes the resilience of the housing stock to extreme heat events (North Olympic Development Council, 2022). The County also has an unusually high percentage of mobile homes, comprising over 12% of housing units (Headwaters Economics, 2024). These manufactured home communities are particularly susceptible to hazards and displacements, placing a substantial portion of the county's households at higher risk, as manufactured homes are lighter and less sturdy than conventional homes, and are more likely to be located in flood zones (Howard & Flavelle, 2024).

ADAPTIVE CAPACITY

Planning, mitigation, and relocation efforts by Clallam County and Tribal governments contribute to the adaptive capacity of built infrastructure. For example, Clallam County is currently updating its Wildfire Protection Plan to improve wildfire prevention and fuel-reduction efforts. While fire is an increasing risk to homes and structures in the County, currently there are no Firewise communities, and many residents are unaware of the importance of defensible space to their homes because historically fire risk has been low (Clallam County, 2009).

Considering household level hazard preparedness, the public survey for the MJHMP found that over half of the 557 respondents (53%) indicated they had taken actions to protect their homes and/or business from the impacts of hazards. Overall, respondents described taking steps to protect their home and business with insurance, home fortification, emergency supplies, landscaping, community preparedness, and self-sufficiency. When considering level of preparedness in case of emergency, the public survey for the MJHMP found that 57% of the respondents have a 30-day supply of food and water in their home in case of emergency, which includes climate related emergencies (e.g., shelter in place during following road closures). Of those who indicated that they had not taken actions to protect their homes and/or business from hazards, 37% indicated the reason is lack of storage space for emergency supplies, 36% shared they have limited funds to purchase emergency supplies, and 23% said they had not considered emergency supply needs.

Some individual homeowners, in response to chronic bluff recession, have elected to relocate their homes further inland as well (Washington Sea Grant, 2016). The costs can be significant, including the cost of moving the house, building a new foundation and installing a new septic system. Figure 42 shows an example of some homes, where moving inland would reduce risk.

Figure 42. Homes at risks of receding bluffs (Parks, 2015)

Energy

With approximately 145 miles of transmission lines, nearly 2,000 miles of distribution lines (Table 14) and 24 substations, Clallam PUD serves nearly 30,000 customers across both populated and rural areas of Clallam County (Clallam County PUD, 2024).

Table 12. Clallam PUD Equipment make-up (Clallam County PUD, 2024).

Line type	Miles of line	Voltage
Overhead Distribution	687	25kV and 12.47kV
Overhead Transmission	110	69kV and 115kV
Underground Distribution	1,157	25kV and 12.47kV
Underground Transmission	0	N/A

Approximately 75% of PUD's accounts are residential, while 24% are for commercial and industrial use. Agricultural use accounts for the remaining 1% (Clallam County PUD, 2024). 85% of Clallam PUD's utility fuel mix is sourced from hydropower (Department of Commerce, 2022).

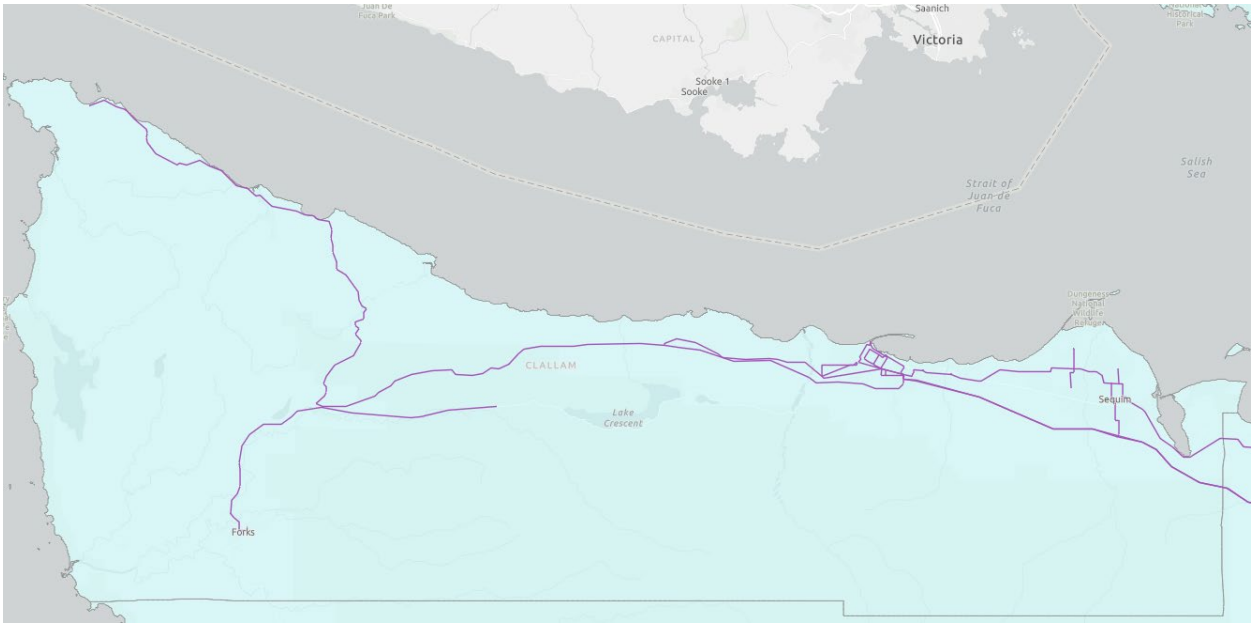
CLIMATE RISKS

Clallam PUD's energy transmission and distribution system are vulnerable to various climate impacts. Windstorms with sustained winds of 30 mph or gusts of 45 mph, as well as snow and

ice storms, have been known to cause power outages (Clallam County, 2022). While communities in the Olympic foothills are particularly susceptible to winter storm-related outages, the entire system faces additional threats. The county's reliance on hydropower makes it vulnerable to drought and low precipitation, which can significantly reduce energy generation capacity (Clallam County, 2023). Furthermore, the grid is likely to experience added stress from increased demand due to extreme heat (North Olympic Development Council, 2022). Wildfire threats add further concerns, as approximately 2% of the PUD's service area consists of wildland-urban interface land, while another 12% is classified as wildland-urban intermix. Both areas are at a higher risk for wildfires (Clallam County PUD, 2024).

Given its rural setting and limited redundant transmission lines (Energy Information Administration, 2021; Figure 43), Clallam County faces unique challenges in meeting energy needs. As development continues and heatwaves and storms become more frequent, the risk of utility failures grows, particularly for remote communities like the Makah Tribe, (Makah Tribe, 2023). Moreover, between 2021 and 2022, hydropower generation in the Pacific Northwest is affected by climate drivers like precipitation and snowpack and recently dropped to a 22-year low, indicating that many of the hydroelectric plants supplying Clallam PUD are already experiencing climate change-related challenges (US Energy Information Administration, 2024).

Figure 43. Transmission lines throughout Clallam (Energy Information Administration, 2021).



The community survey for the MJHMP highlights the urgency of energy concerns, with 72% of the 619 survey respondents reporting that they experience power outages either once or multiple times per year (Clallam County, 2024), underscoring the community's priority for improved electrical grid resilience. Addressing these vulnerabilities is crucial to ensuring reliable power access for all communities, especially those most dependent on consistent electricity.

ADAPTIVE CAPACITY

The Bonneville Power Association (BPA), which supplies Clallam County's energy, has conducted a climate vulnerability assessment and resilience plan to anticipate and mitigate the risks that climate change poses to their system (Bonneville Power Administration, 2022).This proactive

approach enhances the adaptive capacity of Clallam County's energy supply. BPA also made the decision to join the Western Resource Adequacy Program (WRAP), a collaborative effort among utilities and energy providers in the Western U.S. to pool resources and share energy across borders. By participating in WRAP, BPA is required to ensure that it has sufficient energy resources to meet forecasted demand during periods of extreme weather, such as heatwaves or cold snaps. Currently, WRAP is in its non-binding operational phase, where participants are testing their capacity to meet these requirements (Sexton, 2022).

Power facilities within the county are generally protected from wildland-urban interface fires by defensible space. Clallam PUD developed a wildfire mitigation plan and a vegetation management plan that outline the use of vegetation management crews to clear areas around infrastructure, thereby reducing the risk of wildfires and service outages caused by tree debris (Clallam County PUD, 2024). Beyond wildfire prevention, crews will also identify and remove hazardous trees that could fall, preventing outages and damage to assets (Clallam County PUD, 2023). Clallam PUD enhances energy resilience ny participating in conversations about road or community relocation to plan for maintenance and substation planning needs and building more roundabouts and solar power lights, which reduces dependency on electric stoplights. Lastly, while extreme heat is expected to increase demand on the grid, Clallam's current low rate of air conditioning in homes could help manage summer energy demand (North Olympic Development Council, 2022). However, the lack of air conditioning is also a risk to public health and may not be viable, especially for vulnerable communities, as temperatures continue to increase.

Clallam County PUD was awarded $648,274 in state grants to develop a solar-powered microgrid at the Sequim Substation, designed to operate independently during power outages caused by severe weather or natural disasters. The project will increase energy resilience of the grid and the region's adaptive capacity. Construction is expected to begin in 2025 and to be completed by the end of the year (Clallam County PUD, 2024).

Clallam PUD offers some programs intended to support residents, including low-income residents who are most vulnerable to rising energy costs, in making their homes more energy efficient (See https://clallampud.net/residential/). These include weatherization incentives and loans and appliance and fixture rebates. Lower Elwha Klallam Tribe (LEKT) Housing has gotten grants to install heat pumps in Tribe Elders' homes. To build long-term resilience, Clallam County will need more energy efficiency measures and renewable energy production, including solar panels and solar generators, and electric grid expansion to accommodate that growth.

Conclusion

The CVA for Clallam County highlights the urgent need for targeted climate resilience measures across various sectors, including public health, infrastructure, natural resources, and economic development. The County faces a range of climate hazards, including rising sea levels, more frequent and intense storms, droughts, and higher temperatures. Vulnerable populations, such as the elderly, low-income residents, and Tribal communities, are particularly at risk. To address these challenges, the CVA informs the development of the County's Climate Element for the 2025 Comprehensive Plan update, ensuring that climate adaptation and resilience strategies are incorporated into future planning. This assessment serves as a crucial resource for guiding the County's efforts to mitigate climate impacts and build a more resilient future for its communities.

References

University of Washington. (2024). *Protecting Outdoor Workers From Climate Change Impacts Through Interdisciplinary Collaboration.* Retrieved from Occupational Safety and Health Continuing Education: https://oshce.uw.edu/news/2024-05-14/new-nwcohs-publication-protecting-outdoor-workers-climate-change-impacts-through

Adamkiewicz, G. e. (2009). *Moving environmental justice indoors: understanding structural influences on residential exposure patterns in low-income communities.* Retrieved from 10.2105/AJPH.2011.300119

Aspect. (2021). *20+ Years in the Making: Levee Sparks Dungeness River Restoration.* Retrieved from https://www.aspectconsulting.com/blog/2021/11/18/levee-dungeness-river-restoration

Bonneville Power Administration. (2022). *BPA Sustainability Highlights.* Retrieved from https://www.bpa.gov/-/media/Aep/environmental-initiatives/sustainability/sustainability-highlights.pdf

Center for Disease Control. (2022). *PLACES: Local Data for Better Health*. Retrieved from https://www.cdc.gov/places/index.html#:~:text=PLACES%20provides%20health%20data%20for%20small%20areas%20across,and%20assist%20them%20in%20planning%20public%20health%20interventions.

Chang, L. (2023). *Olympic Peninsula Fish Hatcheries Adapt to a Changing Climate.* Retrieved from https://www.fws.gov/story/2023-05/olympic-peninsula-fish-hatcheries-adapt-changing-climat

Chegwidden, O. S., et al. (2017). *Hydrologic Response of the Columbia River System to Climate Change.* Retrieved from doi:10.5281/zenodo.854763

Cherng, S. (2019). Social cohesion and passive adaptation in relation to climate change and disease. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959378018309270?via%3Dihub

Chu, E. e. (2023). Ch. 12. Built environment, urban systems, and cities. In A. e. Crimmins, *Fifth National Climate Assessment.* Washington, DC, USA.: U.S. Global Change Research Program.

City of Sequim. (2016). *Sustainability and Resiliency Plan.* Retrieved from https://sequimwa.gov/DocumentCenter/View/11956/Att-4-R2016-16-Sustainability-and-Resiliency?bidId=

Clallam Conservation District. (2015). *Irrigation Water Management*. Retrieved from Clallam Conservation District: https://clallamcd.org/irrigationwatermngt

Clallam County. (2009). *Clallam County Community Wildfire Protection Plan.* Retrieved from https://www.dnr.wa.gov/publications/rp_burn_cwpp_clallamco.pdf

Clallam County. (2009). *Clallam County Comprehensive Plan Growth Management & Urban Growth Area.* Retrieved from https://clallam.county.codes/CCC/31.02.220

Clallam County. (2011). *Clallam County Shoreline Master Program Update*. Retrieved from https://www.clallamcountywa.gov/DocumentCenter/View/6763/Clallam-County-Final-Revised-SMP-Update-Public-Participation-Strategy-PDF

Clallam County. (2019). *Clallam County Multipurpose Map*. Retrieved from https://clallam-county-portal-clallam.hub.arcgis.com/apps/23bbb33c10b24b4c8706e89ae98f7add/explore

Clallam County. (2019). *Hazard Mitigation Plan.*

Clallam County. (2022). *Comprehensive Emergency Management Plan.*

Clallam County. (2023). *Cliamte Action Plan.* Retrieved from https://www.clallamcountywa.gov/DocumentCenter/View/14569/Clallam-County-Final-2023-Climate-Action-Plan

Clallam County. (2024). *Multi Jurisdiction Hazard Mitigation Plan.*

Clallam County. (n.d.). *Conservation Futures*. Retrieved from https://www.clallamcountywa.gov/724/Conservation-Futures-Program-Advisory-Bo

Clallam County Environmental Health. (n.d.). *Biotoxin Monitoring & Notification.* Retrieved from https://www.clallamcountywa.gov/533/Biotoxin-Monitoring-Notification

Clallam County GIS. (2023). *Clallam County Multipurpose* . Retrieved from https://clallam-county-portal-clallam.hub.arcgis.com/

Clallam County Parks, Fair & Facilities Department. (2024). *Parks Survey Results.* Clallam County. Retrieved from https://www.clallamcountywa.gov/DocumentCenter/View/16055/Parks-Survey-Results---March-2024

Clallam County Public Utility District. (2023). *Water & Wastewater*. Retrieved from Clallam County PUD: https://clallampud.net/water-wastewater/

Clallam County Public Works. (n.d.). Retrieved from Bullman Beach Water System: https://www.clallamcountywa.gov/DocumentCenter/View/14432/Purlic-Works---Bullman-Beach-Water-System

Clallam County PUD. (2017). Water System Plan Update. Retrieved from https://clallampud.net/wp-content/uploads/2019/12/Clallam-PUD-Water-System-Plan.pdf

Clallam County PUD. (2023). *Vegetation Management Plan.* Public Utility District #1 of Clallam County. Retrieved from https://clallampud.net/wp-content/uploads/2021/06/District-Wildffire-Mitigations-Vegetation-Mgmt-Protection-OM-6-21-21.pdf

Clallam County PUD. (2024). *Clallam County PUD #1 Wildland Fire Mitigation Plan.* Retrieved from https://clallampud.net/wp-content/uploads/2024/09/Clallam-PUD-WFMP-2024-9-12-24-att-DRAFT.pdf

Clallam County PUD. (2024, September 24). Clallam County PUD Awarded Over $648,000 in Clean Energy Grants. Retrieved from Clallam County Public Utility District: https://clallampud.net/clallam-county-pud-awarded-over-648000-in-clean-energy-grants/

Clallam County PUD. (2024). *Clallam County PUD Awarded Over $648,000 in Clean Energy Grants*. Retrieved from Clallam County Public Utility District: https://clallampud.net/clallam-county-pud-awarded-over-648000-in-clean-energy-grants/

Clallam County Sheriff's Office. (2021, November 17). ***11/17/21 - ROAD, WEATHER AND EMERGENCY MANAGEMENT UPDATE***. Retrieved from Facebook: https://www.facebook.com/photo/?fbid=4959132074097950&set=a.1680355495308974

Clallam County- Thumbnail History. (2005). Retrieved from HistoryLink: https://www.historylink.org/file/7576

Clallam Transit. (2023). *Transit Development Plan 2023-2028*. Retrieved from https://irp.cdn-website.com/0eaf265e/files/uploaded/Clallam%20Transit%202023%20-%202028%20TDP.pdf

Clarke, H., Cirulis, B., & Borchers-Arriagada, N. (2023). *Health costs of wildfire smoke to rise under climate change.* Clim Atmos Sci.

Climate Impacts Group. (2022). *Climate Impacts Group Tribal Climate Tool*. Retrieved from https://cig.uw.edu/resources/tribal-vulnerability-assessment-resources/tribal-climate-tool/

Climate Impacts Group. (2022). *Climate Mapping for a Resilient Washington*. Retrieved from https://cig.uw.edu/resources/analysis-tools/climate-mapping-for-a-resilient-washington/

Climate Resilience Alliance. (n.d.). *Building a Resilient Peninsula Through Local Conservation*. Retrieved from https://storymaps.arcgis.com/stories/8016d7ae28474981890266b23bf5bf3a

Climate Vulnerablity and Hazard Mitigtation Community Workshop. (2024, August). Climate Vulnerablity and Hazard Mitigtation Community Workshop. Hosted by Clallam County and Cascadia Consulting.

County, S. H. (2023). *Clallam County Coordinated Entry Annual Report*. Retrieved from https://www.clallamcountywa.gov/DocumentCenter/View/15363/Serenity-House-2023-Annual-Report---Clallam-County-PDF

Department of Commerce. (2022). *Washington State Electric Utility Fuel Mix Disclosure Report with Utility Fuel Mix Summary*. Retrieved from https://deptofcommerce.app.box.com/s/l9sqx4bcfnko3omrpk4tv8n0vbzcvsdz/file/1673766736695

Dion, N., Walters, K. L., & Nelson, L. (1980). *Water resources of the Makah Indian Reservation, Washington*. U.S. Geological Survey. doi:10.3133/wri8015

Earth Economics. (2013). *Nature's Value in Clallam County: Policy Implications of the Economic Benefits of Feeder Bluffs*. Retrieved from https://wdfw.wa.gov/sites/default/files/2019-03/ee_clallam_county_report_2013.pdf#:~:text=Earth%20Economics%20provides%20robust,

Energy Information Administration. (2021). *U.S. Energy Atlas*. Retrieved from https://atlas.eia.gov/?_gl=1*1smba8h*_ga*NzE5MzkyMzc1LjE3MjY4NjA0NTc.*_ga_NB85F8V3TS*MTcyOTgwOTQ2OC41LjAuMTcyOTgwOTQ2OC4wLjAuMA..

Environmental Protection Agency. (2024). *Air Data - Multiyear Tile Plot*. Retrieved from AirNow Data: https://www.epa.gov/outdoor-air-quality-data/air-data-multiyear-tile-plot

Environmental Protection Agency. (2024). *Climate Adaptation and Erosion & Sedimentation.* Retrieved from https://www.epa.gov/arc-x/climate-adaptation-and-erosion-sedimentation

Environmental Protection Agency. (n.d.). *Climate Change and the Health of Older Adults.* Retrieved from https://www.epa.gov/climateimpacts/climate-change-and-health-older-adults

Feeding America. (2022). *Food Insecurity among the Overall Population in Clallam County*. Retrieved from https://map.feedingamerica.org/county/2022/overall/washington/county/clallam

Fisher, P. (2021). Flooding brings active rescue operations, road closures, suspended bus services. *Radio Pacific Inc*.

Fisher, P. (2022, July 7). *As biotoxins close local shellfish harvesting, we do some digging.* Retrieved from Radio Pacific, Inc,: https://www.myclallamcounty.com/2022/07/07/as-biotoxins-close-local-shellfish-harvesting-we-do-some-digging/

Frankson, et al. . (2022). *Washington State Climate Summary*. Retrieved from https://statesummaries.ncics.org/chapter/wa/

Gill, S., Handley, J., Ernnos, A., & Pauleit, S. (2007). *Adapting Cities for Climate Change: The Role of the Green Infrastructure.* Alexandrine Press. doi:https://doi.org/10.2148/benv.33.1.115

Halofsky, J. e. (2011). *Adapting to climate change at Olympic National Forest and Olympic National Park.* Retrieved from https://research.fs.usda.gov/treesearch/38702#

Hawkins, E. (2018, December 18). *High tides, storm surge cause flooding around 3 Crabs.* Retrieved from Sequim Gazette: https://www.sequimgazette.com/news/high-tides-storm-surge-cause-flooding-around-3-crabs/

Hazard Mitigation & Climate Resilience Planning Workshop. (2024).

Headwaters Economics. (2024). *A Profile of Wildfire RisK.* Economic Profile System (EPS). Retrieved from https://headwaterseconomics.org/eps

Headwaters Economics. (2024). *Neighborhoods at Risk*. Retrieved from https://nar.headwaterseconomics.org/

Hegewisch, K., & Abatzoglou, J. (n.d.). *Future Time Series' web tool*. Retrieved 12 19, 2024, from Climate Toolbox: https://climatetoolbox.org/

Hegewisch, K., & Abatzoglou, J. (n.d.). *Future Time Series' web tool.* Cliamte Toolbox. Retrieved 2024, from Climate Toolbox.

Hohl, P. (2024). *Clallam Public Utility District Extends NISC Mapping For Added Value.* ESRI. Retrieved from https://www.esri.com/en-us/industries/blog/articles/clallam-public-utility-district-extends-nisc-mapping-for-added-value/

Howard, H., & Flavelle, C. (2024). How Climate Disasters Are Making Mobile Homes a Huge Risk. *New York Times*. Retrieved from https://www.nytimes.com/2024/10/14/climate/mobile-homes-hurricanes.html

Jablonski, Z. (2021). UPDATE: West End cut off by floodedhighways. *Sequim Gazette*. Retrieved from https://www.sequimgazette.com/news/flooding-shuts-down-highway-101-cutting-off-west-end/

Jamestown S'Klallam Tribe. (2020). Watershed Planning. Retrieved from https://jamestowntribe.org/natural-resources/environmental-planning/environmental-planning/

Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan. (2023). *https://jamestowntribe.org/wp-content/uploads/2018/09/3-JSK_Climate_Change_Adaptation_Report_Final_Aug_2013s.pdf*.

Jamestown S'Klallam Tribe. (n.d.). *Habitat Restoration & Enhancement*. Retrieved from https://jamestowntribe.org/natural-resources/habitat/habitat-restoration-enhancement/

KOMO News Staff. (2022, November 17). *3 wildfires burning on Makah Indian Reservation, evacuation orders issued*. Retrieved from KOMO News: https://komonews.com/news/local/makah-indian-reservation-wildfires-neah-bay-cape-flattery-hobuck-clallam-county-evacuations-emergency

Krueger, K. (2017). *Climate Plan for the Quileute Tribe of the Quileute Reservation*. Retrieved from https://quileutenation.org/wp-content/uploads/2024/04/April-2017-UPDATE-to-Climate-Plan-QT-of-the-QR.pdf

Makah Tribe. (2023). *Makah Hazard Mitigation Plan*.

McDaniel, C. (2015). Fixing damaged Olympic Discovery Trail bridge over Dungeness River could cost $1.8 million. *Peninsula Daily News*. Retrieved from https://www.peninsuladailynews.com/news/fixing-damaged-olympic-discovery-trail-bridge-over-dungeness-river-could-cost-1-8-million-2/

McMillan, J. S. (2021). Historical Records Reveal Changes to the Migration Timing and Abundance of Winter Steelhead in Olympic Peninsula Rivers, Washington State, USA. *North American Journal of Fisheries Management*.

Miller, Ian et al. (2019). *Projected Sea Level Rise for Washington State*. Washington Sea Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey.

My Clallam County. (2023). *State funding is available now for businesses affected by last winter's floods*. Retrieved from https://www.myclallamcounty.com/2023/02/02/state-funding-is-available-now-for-business-affected-by-last-winters-floods/

Nash, M. (2021, January 03). Sequim Experiences Flooding. *Peninsula Daily News*. Retrieved from https://www.peninsuladailynews.com/news/sequim-experiences-flooding/

Nash, M. (2024, February 21). *Council extends manufactured home moratorium again*. Retrieved from Sequim Gazette: https://www.sequimgazette.com/news/council-extends-manufactured-home-moratorium-again/

Nash, M. (2025, January 15). *Fire District 3 sees record call load in 2024*. Retrieved from Sequim Gazette: https://www.sequimgazette.com/news/fire-district-3-sees-record-call-load-in-2024/

National Park Service. (2023). *Olympic National Park*. Retrieved from Temporary sport fishing closure necessary to protect declining populations of wild steelhead : https://www.nps.gov/olym/learn/news/temporary-sport-fishing-closure-necessary-to-protect-declining-populations-of-wild-steelhead.htm),

Neah Bay. (2005). Retrieved from https://www.flickr.com/photos/logicalrealist/34814134/

NOAA. (2022). *Olympic Coast National Marine Sanctuary*. U.S. Department of Commerce. Retrieved from https://sanctuaries.noaa.gov/science/condition/ocnms/

NOAA. (2022). *Sea Level Rise*. Retrieved from https://coast.noaa.gov/snapshots/#&state=eyJmaXBzIjoiNTMwMDkiLCJzbmFwc2hvdElEIjoiZnV0dXJlRmxvb2QiLCJzZWN0aW9uSUQiOiJmdXR1cmVQcm9qZWN0aW9ucyIsInNsclZhbHVlIjoiMiJ9

NOAA. (2023). *Harmful Algal Blooms, Acidification and Climate Change in the Salish Sea*. Retrieved from National Centers for Coastal Ocean Science: https://coastalscience.noaa.gov/project/harmful-algal-blooms-acidification-and-climate-change-in-the-salish-sea/

NOAA National Centers for Environmental information. (2024). *Climate at a Glance County Time Series*. Retrieved from https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series

North Olympic Development Council. (2015). *Climate Change Preparedness Plan for North Olympic Peninsula*. North Olympic Peninsula Resource Conservation & Development Council (NODC). Retrieved from https://irp-cdn.multiscreensite.com/6c85e905/files/uploaded/The%20NOPRCD%20Climate%20Change%20Preparedness%20Plan%20for%20the%20North%20Olympic%20Peninsula.pdf

North Olympic Development Council. (2022). *Natural Disaster Resiliency Planning on the North Olympic Peninsula*. Prepared by North Olympic Economic Development Council (NODC) and Cascadia Consulting Group. Retrieved from Available: www.nopcdr.org

North Olympic Peninsula Resource Conservation and Development Council. (2022). *Natural Disaster Resiliency planning on the North Olympic Peninsula*. Retrieved from https://irp.cdn-website.com/6c85e905/files/uploaded/Natural%20Disaster%20Resiliency%20Planning%20on%20the%20NOP%20-%20Final%20Report.pdf

Northwest Clean Energy Atlas. (n.d.). *Manufactured Housing and Energy Burden*. Retrieved from https://www.nwceatlas.org/visualization/manufactured-housing-and-energy-burden

Northwest Treaty Tribes. (2017). *Jamestown Shellfish Hatcheries Address Ocean Acidification and Oyster Populations*. Retrieved from https://nwtreatytribes.org/jamestown-shellfish-hatcheries-address-ocean-acidification-oyster-populations/)

Olympic Peninsula Community Museum. (2010). *IMLS Digital Collections*. Retrieved from https://www.flickr.com/photos/imlsdcc/4754710435

Olympic Peninsula Tourism Commission. (2018). *Visitor Spending Impacts in Clallam County*. Retrieved from https://olympicpeninsula.org/wp-content/uploads/2019/06/Clallam-Co-2018_One-Sheet-Data.pdf#:~:text=%E2%80%A2%20Visitors%20staying%20in%20commercial%20lodging

Olympic Peninsula Tourism Commission. (2024). *Value of tourism to Clallam County*. Retrieved from https://olympicpeninsula.org/wp-content/uploads/2024/07/2023-WA-State-County-Tourism-Economics-for-Olympic-Peninsula-Counties_June-2024.pdf

Pappas, Stephanie. (2023). *Wildfires and Smoke Are Harming People's Mental Health. Here's How to Cope*. Retrieved from Scientific American:

https://www.scientificamerican.com/article/wildfires-and-smoke-are-harming-peoples-mental-health-heres-how-to-cope

Peninsula Daily News. (2021). *Peninsula Daily News*. Retrieved from Clallam Bay boil-water advisory: https://www.peninsuladailynews.com/news/clallam-bay-boil-water-advisory-lifted/

Peninsula Daily News. (2024). *Clallam Transit Sees Large Rise in Ridership*. Retrieved from https://www.peninsuladailynews.com/news/clallam-transit-sees-large-rise-in-ridership/

Peninsula Trails Coalition. (2024). Trail Segment Maps. *Olympic Discovery Trail*. Retrieved from https://olympicdiscoverytrail.org/explore/trail-segments/

Perlwitz, J. (2017). *Large-scale circulation and climate variability*. Retrieved from https://digitalcommons.unl.edu/usdeptcommercepub/588/

Petersen, S. B. (2015). *Climate CHange Preparedness Plan for the North Olympic Peninsula*. . Retrieved from North Olympic Peninsula Resource Conservation and Development Council: https://irp-cdn.multiscreensite.com/6c85e905/files/uploaded/The%20NOPRCD%20Climate%20Change%20Preparedness%20Plan%20for%20the%20North%20Olympic%20Peninsula.pdf

Port Angeles. (2017). *City of Port Angeles Comprehensive Water System Plan.* Retrieved from https://www.cityofpa.us/DocumentCenter/View/5994/Water-System-Plan-2018?bidId=

Port Angeles. (2022). *Climate Resiliency Plan.* Retrieved from https://www.cityofpa.us/DocumentCenter/View/11771/2022-Climate-Resiliency-Plan---Final

Quilete Tribe. (n.d.). *Move to Higher Ground.* Retrieved from https://mthg.org/projects/

Riedel, J.L. et al. (2015). *Glacier status and contribution to streamflow in the Olympic Mountains.* doi:10.3189/2015JoG14J138

Rogers, M., & Mauger, G. S. . (2021). *Pacific Northwest Climate Projection Tool.*

Salathé, E.P. et al. (2010). *Regional climate model projections for the State of Washington.* Retrieved from https://link.springer.com/article/10.1007/s10584-010-9849-y

Sexton, R. (2022, October 4th). WRAP Announces Full Participation of Phase 3A. *Western Powerpool*. Retrieved from https://www.westernpowerpool.org/news/wrap-announces-full-participation-of-phase-3a

Sheehan, T., et al. (2015). *Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures.* Retrieved from https://doi.org/10.1016/j.ecolmodel.2015.08.023

Surging Seas Risk Finder. (n.d.). Retrieved from https://riskfinder.climatecentral.org/county/clallam-county.wa.us?comparisonType=postal-code&forecastType=NOAA2017_int_p50&level=4&unit=ft

Trust for Public Land. (2021). *The economic benefits of conserved lands, trails, and parks on the North Olympic Peninsula.* Retrieved from https://www.tpl.org/wp-content/uploads/2021/01/NOP-Economic-Benefits-Report.pdf

U.S. Census Bureau. (2022). *Year Structure Built. American Community Survey, ACS 5-Year Estimates Detailed Tables.* Retrieved 10 17, 2024, from https://data.census.gov/table/ACSDT5Y2022.B25034?q=year built&g=050XX00US53009.

U.S. Fish and Wildlife Service. (2023). Retrieved from Olympic Peninsula Fish Hatcheries Adapt to a Changing Climate: https://www.fws.gov/story/2023-05/olympic-peninsula-fish-hatcheries-adapt-changing-climate

United States Department of Agriculture. (2022). *Census of Agriculture*. Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/

United States Department of Agriculture. (2022). *Census of Agriculture County Profile: Clallam County, Washington.* Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/County_Profiles/Washington/cp53009.pdf

United States Geological Service. (2023). *Land Cover Statewide Ecopia Data 2021 2022 3ft Raster*. Retrieved from Washington Geospatial Open Data Portal: https://geo.wa.gov/datasets/fc19471352fb4a6195715cf5a7f40a0a/explore?location=47.194146%2C-120.536502%2C7.43

University of Washington, Climate Impacts Groups. (2023). *In the Hot Seat: Saving Lives from Extreme Heat in Washington State*. Retrieved from https://cig.uw.edu/wp-content/uploads/sites/2/2023/06/CIG-Report-Heat-202-pages.pdf

US Energy Information Administration. (2024). *Western U.S. hydropower generation fell to a 22-year low last year.* Retrieved from https://www.eia.gov/todayinenergy/detail.php?id=61645

US Global Change Research Program. (n.d.). *Fifth National Climate Assessment, Northwest Chapter*. Retrieved from https://nca2023.globalchange.gov/chapter/27/

USDA Forest Service. (2024). *Wildfire Likelihood*. Retrieved from Wildfire Risk to Communities: https://wildfirerisk.org/explore/wildfire-likelihood/53/53009/

Washington Department of Commerce. (2023). *CLIMATE ELEMENT PLANNING GUIDANCE.* Retrieved from https://deptofcommerce.app.box.com/s/bhqov8pvbiygss9jxbmtezzgzrtr7nal

Washington Department of Natural Resources, W. D. (2022). *Cooperative Forest Health Alert.* Retrieved from https://www.dnr.wa.gov/publications/em_cedar_handout_sept_2022.pdf

Washington Employment Security Department. (2022). Retrieved from Clallam County profile: https://esd.wa.gov/labormarketinfo/county-profiles/Clallam#:~:text=Clallam%20County%20had%20an%20estimated%2023,300

Washington Policy Center. (2023). *Some good news for coho salmon on the Elwha, but Chinook still struggling.* Retrieved from https://www.washingtonpolicy.org/publications/detail/some-good-news-for-coho-salmon-on-the-elwha-but-chinook-still-struggling

Washington Recreation and Conservation Office. (n.d.). *State of Salmon in Watersheds.* Retrieved from https://stateofsalmon.wa.gov/executive-

summary/challenges/climate/#:~:text=Warmer%20water%20has%20fewer%20nutrients,eat%2C%20making%20survival%20less%20likely.

Washington Sea Grant. (2016). *Washington Coastal Hazards Risk Reduction Project Mapper*. Retrieved from Washington Sea Grant.

Washington State Blue Ribbon Panel on Ocean Acidification. (2017). *Ocean Acidification in Washington Marine Waters*. Retrieved from https://oainwa.org/wp-content/uploads/2023/01/2017_Addendum_BRP_Report_fullreport.pdf

Washington State Department of Commerce. (2024). *Intermediate Planning Guidance*. https://deptofcommerce.app.box.com/s/fpg3h0lbwln2ctqjg7jg802h54ie19jx.

Washington State Department of Ecology. (2023).

Washington State Department of Ecology. (2024). *Wildfire smoke information*. Retrieved from Ecology.WA.org.

Washington State Department of Ecology. (n.d.). *Puget Sound Watershed Characterization Project*. Retrieved from https://apps.ecology.wa.gov/coastalatlas/wc/landingpage.html

Washington State Department of Health. (n.d.). *Heat Wave 2021*. Retrieved from https://doh.wa.gov/emergencies/be-prepared-be-safe/severe-weather-and-natural-disasters/extreme-heat/hot-weather-precautions/heat-wave-2021#:~:text=According%20to%20the%20report,%20the%20mean%20daily

Washington State Department of Health. (n.d.). *Washington Environmental Health Disparities Map*. Retrieved from https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Washington State Department of Natural Resource. (n.d.). *WA State's Wildland Urban Interface (WUI)*. Retrieved from https://www.arcgis.com/apps/View/index.html?appid=21683af70ece4bd495c319915f7a9232

Washington State Department of Transportation. (2011). *Climate Impacts Vulnerability Assessment*. Retrieved from https://wsdot.wa.gov/sites/default/files/2021-10/Climate-Impact-AssessmentforFHWA-12-2011.pdf

Washington State Department of Transportation. (2021). Retrieved from https://www.flickr.com/photos/wsdot/51689191256

Washington State Department of Transportation. (2021). *US 101 - Jefferson and Clallam Counties Fish Barriers - Remove Fish Barriers*. Retrieved from Washington State Department of Transportation: https://wsdot.wa.gov/construction-planning/search-projects/us-101-jefferson-and-clallam-counties-fish-barriers-remove-fish-barriers

Washington State Department of Transportation. (2021). *Washington State Dept of Transportation Flickr site*. Retrieved from https://www.flickr.com/photos/wsdot/51689097356

Washington State Department of Transportation. (2023). *US 101 Paving Pre-design Study*. Retrieved from Washignton State Department of Transportation: https://wsdot.wa.gov/construction-planning/search-studies/us-101-paving-pre-design-study

Washington State University. (n.d.). The Secrets of Stormwater. *Washington's Water, Washington State University Extension*. Retrieved from https://extension.wsu.edu/water/article/the-secrets-of-stormwater/

Wendel, J. (2024). Hydropower Generation Projected to Rise, but Climate Change Brings Uncertain Future. Retrieved from https://www.pnnl.gov/news-media/hydropower-generation-projected-rise-climate-change-brings-uncertain-future

Wild Salmon Center. (2017). *Updated: Are Olympic Peninsula Steelhead Healthy?* Retrieved from Updated: Are Olympic Peninsula Steelhead Healthy?

Wildfire Risk to Communities. (2024). Retrieved from USDA Forest Service: wildfirerisk.org.

Working Forests. (n.d.). *Private working forestry in Clallam County has a unique role.* Retrieved from https://workingforests.org/working-forests-in-clallam-county-wa/#:~:text=Working%20Forests%20in%20Clallam%20County,%20WA%20-

Appendix A: Documents Reviewed

These are the primary local and regional plans and documents we reviewed (organized by date), though we used and referenced others as relevant to specific sectors.

Name	Year	Source/ Author
Clallam County's Multi-jurisdictional Hazard Mitigation Plan	2024	Clallam County
Clallam County's Climate Action Plan	2023	Clallam County
Makah Hazard Mitigation Plan	2023	Makah Tribe
Clallam County Comprehensive Emergency Management Plan	2022	Clallam County
Natural Disaster Resiliency Planning on the North Olympic Peninsula	2022	North Olympic Peninsula Resource Conservation and Development Council
Building a Resilient Peninsula Through Local Conservation	2020	North Olympic Land Trust and Jefferson Land Trust
Port Angeles Climate Resilience Plan	2019	Port Angeles
Jamestown S'Klallam Tribe Vulnerability Assessment and Adaptation Plan	2018	Jamestown S'Klallam Tribe
Climate Plan for the Quileute Tribe of the Quileute Reservation	2017	Quileute Tribe
Sequim Resolution Adopting Policies that Improve the City's Sustainability and Resiliency	2016	City of Sequim
Climate Change Vulnerability Assessment for the Treaty of Olympia Tribes	2016	Oregon Climate Change Research Institute
Climate Change Preparedness Plan for the North Olympic Peninsula	2015	North Olympic Peninsula Resource Conservation & Development Council
Adapting to Climate Change at Olympic National Forest and Olympic National Park	2011	United States Department of Agriculture

To complement our review of local documents, we also utilized federal and state data sources, which are referenced when used in the document, and include:

- Council on Environmental Quality, Climate and Economic Justice Screening Tool
- Center for Disease Control, Social Vulnerability Index
- Center for Disease Control, PLACES Local Data for Better Health
- Fifth National Climate Assessment, Northwest Chapter
- National Oceanic Atmospheric Administration, Climate Resilience Toolkit
- Washington State Department of Health, Washington Tracking Network

- University of Washington Climate Impacts Group, Climate Mapping for a Resilient Washington

Cascadia also accessed newspaper articles, which discuss recent events, and integrated input from project team partners and community members during our robust engagement activities, to complement data with lived experiences.

Appendix B: Engagement Input

Thie CVA is part of a larger project to update Clallam County's HMP and to develop a Climate Element. A variety of internal, stakeholder, and public engagement activities were held throughout the project, including one stakeholder and one public workshop and a Climate Element public survey. Input from these activities was used to bolster this CVA. Typically, what we heard from stakeholders and members of the public reflected similar points and themes to what we found in documents and professional reports, though sometimes input from experts and community members contributed additional details or added nuance. We referred to the source of engagement activity as relevant in the document.

Summaries from the various engagement activities, including surveys and workshops, are available on the County website, as noted below:

- August Workshop summary: 87-Workshop-Summary---For-website

Figure 44: August 2024 Community Workshop held at the Jamestown S'Klallam Tribal Center Red Cedar Hall in Sequim

Appendix C: Climate Impacts Summary

Clallam County is already experiencing the effects of climate change. Since 1895, the County's average annual temperature has increased by 1.4°F (NOAA National Centers for Environmental information, 2024). By the end of the century, average summer maximum temperatures are projected to rise by 9°F from the historical baseline of 68.4°F (Abatzoglou and Brown, 2012). This warming trend will bring significant consequences, including altered precipitation patterns, increased wildfire risks, and higher rates of heat-related illnesses. Heat waves and heat dome events are also expected to become more frequent and intense (NODC, 2022).

Expected Climate Impacts

Without strong greenhouse gas (GHG) reduction measures globally, nationally, and at the state level, Clallam County is likely to face the following challenges:

- **Coastal Flooding:** Rising sea levels will increase the frequency and severity of coastal flooding.
- **Reduced Snowpack:** Less snow in winter will decrease water availability during late summer, impacting salmon habitats, water quality, and streamflow.
- **Increased Riverine Flooding:** Heavier winter precipitation and more rain (instead of snow) will lead to greater flooding along rivers.
- **Ocean Acidification:** Marine life and fisheries will be adversely affected by more acidic ocean conditions.
- **Drought and Wildfire Risk:** Longer and more severe droughts will increase the frequency and intensity of wildfires.
- **Rising Temperatures:** Annual average temperatures will continue to climb, with hotter summers and more days exceeding 86°F.

Climate Change and Variability

Climate change refers to the long-term alteration of environmental conditions and weather patterns caused by human activities, particularly the emission of greenhouse gases from burning fossil fuels. Since the Industrial Revolution, increased atmospheric GHG levels—especially carbon dioxide—have driven higher land and ocean temperatures. These changes have resulted in more frequent and intense heatwaves, wildfires, storms, droughts, melting glaciers, rising sea levels, and ocean acidification.

Natural processes, such as the El Niño-Southern Oscillation and the Pacific Decadal Oscillation, also influence climate variability over shorter timeframes. However, the rate of human-induced climate change far outpaces any natural variability (Perlwitz, 2017).

Climate Scenarios and Projection Models

The rise in atmospheric GHG emissions has already caused significant climate changes. Future climate conditions are projected using scenarios that consider factors such as land use, population growth, technological advancements, and emission levels.

This Climate Impacts Summary primarily uses the Representative Concentration Pathway (RCP) 8.5 scenario, which represents a "business-as-usual" trajectory where emissions continue at current rates. RCP 8.5 is the highest emissions scenario and projects global warming of about 4.3°C (7.7°F) by 2100 relative to pre-industrial temperatures.

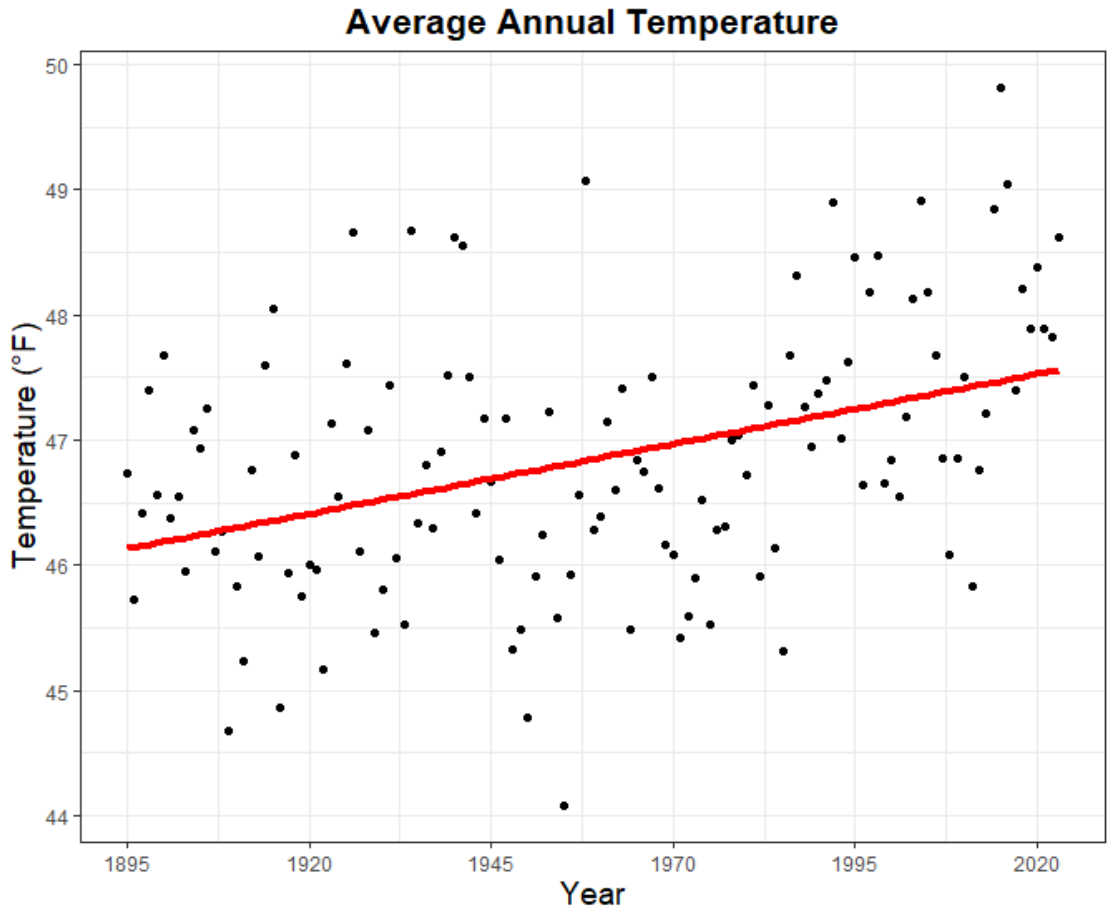
Understanding these projections helps Clallam County prepare for and adapt to the challenges of a changing climate. Detailed analyses and further discussion can be found below.

Temperature

Since 1900, average temperatures in Washington state have risen nearly 2°F, most notably in western Washington. Over the past three decades, freezing days have decreased, while warm nights and days exceeding 90°F have increased, particularly from 2015 to 2020 (Frankson, et al. , 2022).

Within Clallam County, the average annual temperature from 1895 to 2023 has already increased by 1.4 °F (NOAA National Centers for Environmental information, 2024), as shown in Figure 46.

Figure 45: Average Annual temperature in Clallam County



Data from National Centers for Environmental information. Accessed 20 December 2024. Figure created by Cascadia Consulting Group.

Climate projections suggest continued temperature rise in Washington state under all greenhouse gas emission scenarios. By the 2080s, temperatures west of the Cascades are projected to increase by 4.5°F (2.2-7.2°F range) under RCP 4.5 and 7.5°F (4.2-10.7°F range) under RCP 8.5 (Rogers, M., & Mauger, G. S. , 2021). In Clallam County specifically, average monthly temperatures are projected to increase by 6°F midcentury and 9°F by the end of the century under RCP 8.5 (Table 15).

Warmer temperatures and more extreme hot days will have significant consequences for the region, including changing precipitation patterns with less snow and more rain in winter, increased wildfire risk, higher rates of heat-related illnesses and vector-borne diseases, water scarcity, and ecosystem degradation. In addition, the frequency and intensity of heatwave or heat dome events may increase with higher temperatures (North Olympic Development Council, 2022).

Table 13. Climate Impacts to Clallam County (Climate Mapping for a Resilient Washington)

	2050-2079	2070-2099
Climate Impact	Clallam County	Clallam County
Average monthly max temperature in Summer	+6.7°F	+9.3°F
(Change in temperatures are relative to 1980-2009 and use the higher emissions scenario RCP 8.5).		

Under the RCP8.5 scenario, summertime (June–August) average maximum temperatures are projected to increase significantly compared to 1990-2009. This nearly 10°F rise by the latter part of the 21st century underscores the growing risks of heat stress for people, ecosystems, and infrastructure.

Figure 46. Projected increase in average summertime (Jun-Aug) temperature under the RCP8.5 scenario, in Clallam County

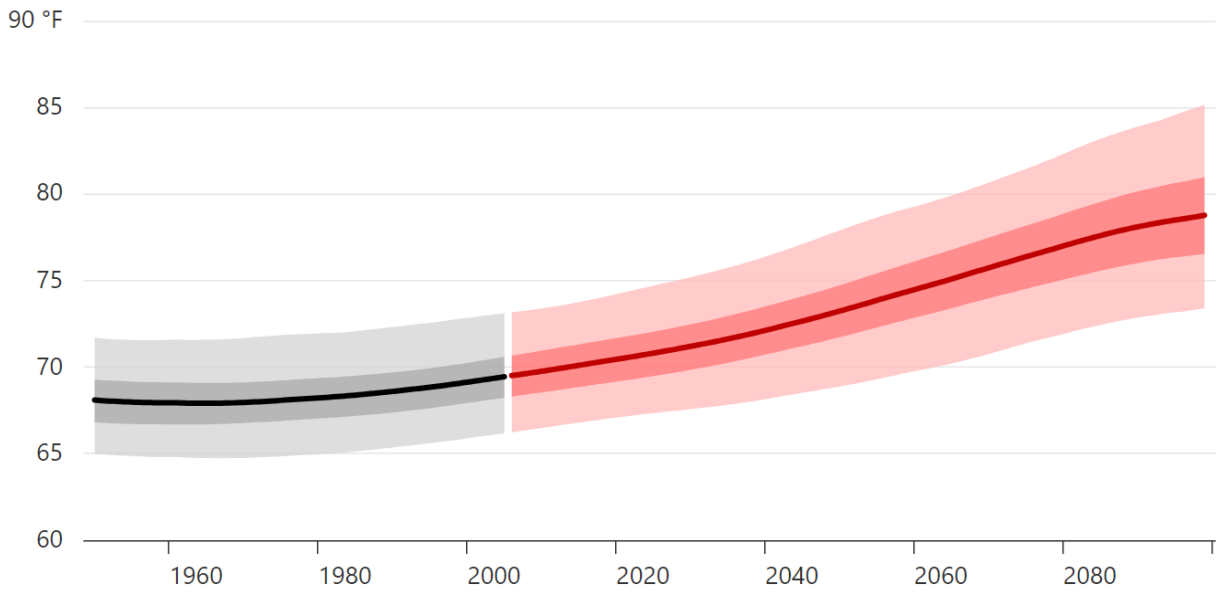


Figure from Climate Toolbox. Accessed 19 December 2024.

Table 15 summarizes projected temperature impacts to North Olympic Peninsula Tribal Lands. By midcentury, North Olympic Peninsula Tribal Lands are projected to experience an average annual temperature increase of around 5°F, an average daily summer maximum temperature increase of around 6.1°F, 4.9 additional days with daily maximum temperature above 86°F, and a 42 day (about 1 and a half months) increase in freeze free days. By the end of the century, North Olympic Peninsula Tribal Lands are projected to experience an average annual temperature increase of around 8.2°F, an average daily summer maximum temperature increase of around 9.9°F, 13.1 additional days with daily maximum temperature above 86°F, and a 60.7 day increase in freeze free days.

Table 14. Climate Impacts to North Olympic Peninsula Tribal Lands

	2040-2069				2070-2099			
Climate Impact (Source: CIG Tribal Climate Tool*)	Makah Indian Tribe (Clallam)	Lower Elwha Tribal Community	Port Gamble S'Klallam Tribe	Jamestown S'Klallam Tribe	Makah Indian Tribe (Clallam)	Lower Elwha Tribal Community	Port Gamble S'Klallam Tribe	Jamestown S'Klallam Tribe
Annual Average Temperature (Historical 1990 48.9°F)	+4.8°F	+5°F	+5°F	+5.1°F	+7.9°F	+8.3°F	+8.3°F	+8.4°F
Average Daily Summer Max Temperature (Historical 67.9°F)	+5.7°F	+6.1°F	+6.3°F	+6.3°F	+9.3°F	+10.0° F	+10.1° F	+10.1° F

Average number of days with daily max temp above 86°F (Historical 1.4 days)	+4.8 days	+4.1 days	+5.7 days	+4.9 days	+13.8 days	+11.6 days	+13.8 days	+13.2 days
Freeze Free Days (Historical 323.7)	+29.8 days	+23.4 days	+58.0 days	+56.0 days	+36.3 days	+28.4 days	+89.3 days	+88.6 days

** The projections on this table come from the Climate Toolbox and Climate Impacts Group Tribal Climate Tool and use the RCP 8.5 high emissions scenario, accessed on July 6, 2022.*

Precipitation, Flooding, and Drought

The North Olympic Peninsula has both rain-dominant and transient watersheds, experiencing both rain and snow precipitation. Transient watersheds have high mid-summer flows from melting snowpack, while rain-dominant peak during heavy fall and winter rains. Projections indicate that transient watersheds in Clallam, historically located in the eastern half of the peninsula, will be most affected by climate change (North Olympic Development Council, 2015). The North Olympic Peninsula is already experiencing region-wide decrease in snowpack and is projected to experience continued declining snowpack with a significant loss of snowpack in the Olympics by 2080 (North Olympic Development Council, 2015). This snowpack is crucial for water supply in the dry summer months.

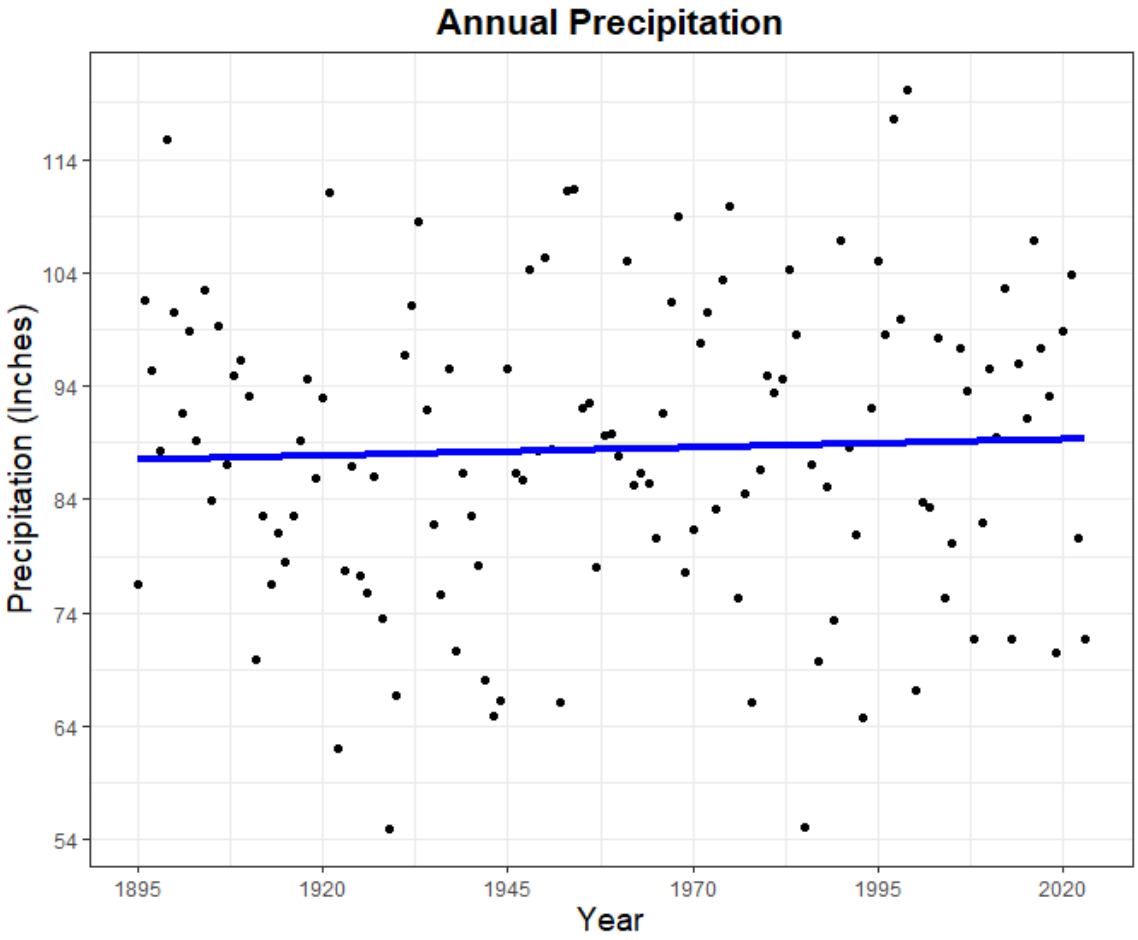
Although projections of overall annual precipitation are uncertain, summer precipitation is projected to decrease. Total annual precipitation is the total input of water each year, which limits the overall amount of water available for human uses and ecosystems. In addition, rain instead of snow can harm industries like timber and agriculture, especially when temperatures are extreme (Frankson, et al. , 2022). Changing environmental conditions such as low average river flow, high water temperatures, and more

intense flooding events with diminished water quality also threaten culturally and economically significant salmon and shellfish populations.

Rainfall

Despite interannual variability in Clallam County precipitation (NOAA National Centers for Environmental information, 2024), the overall trend from 1895 to 2023 has remained relatively stable (Figure 48).

Figure 47. Annual Precipitation in Clallam County

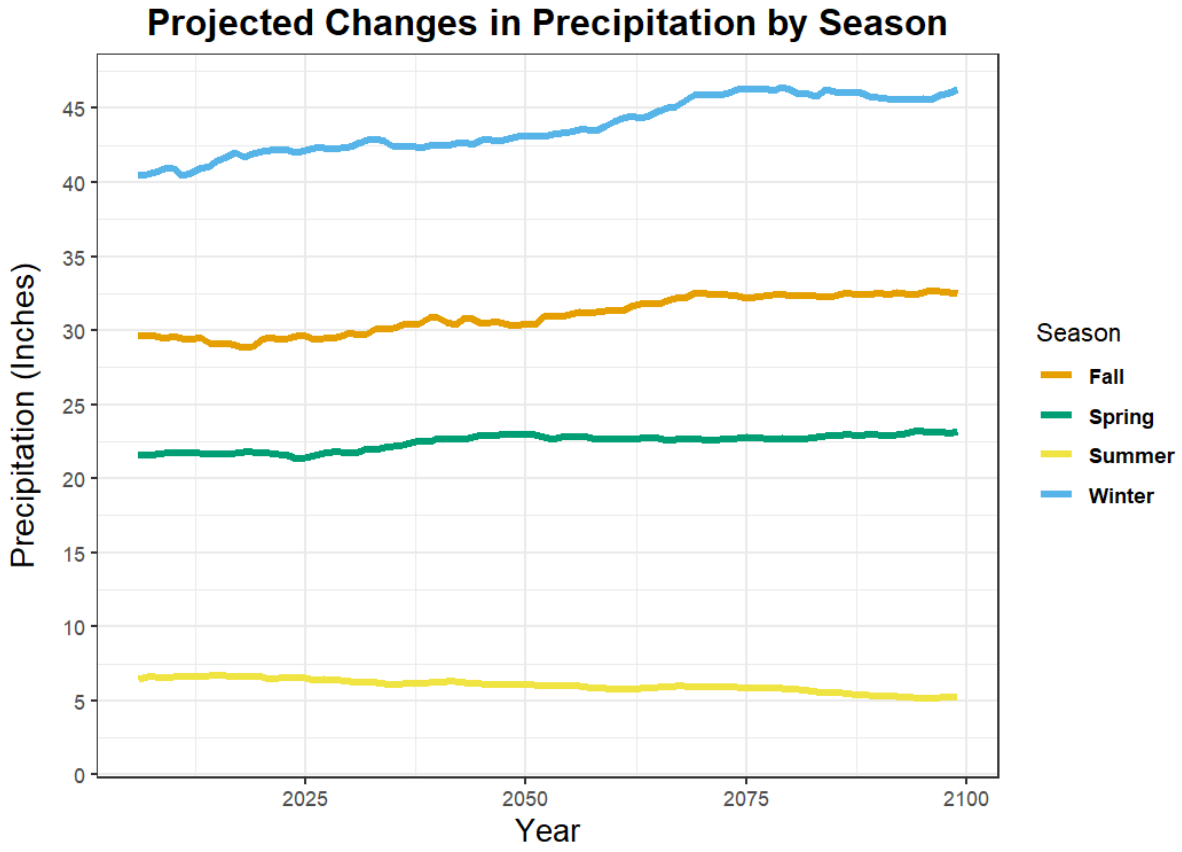


Data from Climate Toolbox. Accessed 20 December 2024. Figure created by Cascadia Consulting Group.

Clallam County projections suggest a 9% increase in annual precipitation by the end of the century under the RCP8.5 scenario, compared to the 1950–2006 baseline (Figure 47). Seasonal patterns are expected to shift, with winter precipitation (December–February) increasing by 14% and summer precipitation (June–August) decreasing by 21% during the same period and scenario

(Hegewisch & Abatzoglou, Future Time Series' web tool). These patterns will likely lead to lower summer streamflow and increased winter flooding (North Olympic Development Council, 2022).

Figure 48. Projected seasonal shifts in precipitation in Clallam County under the RCP8.5 scenario, compared to the 1951–2005 baseline.



Data from Climate Toolbox. Accessed 1 December 2024. Figure created by Cascadia Consulting Group.

By mid- and end-century in Clallam County, average August monthly rainfall is projected to decrease by 0.62 inches and average November monthly rainfall is projected to increase by 1.5 inches (Table 17). Precipitation magnitude represents the percent change in the maximum amount of water from a rainstorm that occurs on average once every 2 years (heavy) and 25 years (extreme) relative to the average for 1980-2009. By mid-century, Clallam County is projected to experience a 12% increase in heavy precipitation magnitude and 13% increase in extreme precipitation magnitude. By the end of the century, Clallam County is projected to experience a 14% increase in heavy precipitation magnitude and 18% increase in extreme precipitation magnitude (Table 18).

Table 15. Monthly Rainfall Change Clallam County

	2050-2074	2075-2099
Monthly Rainfall (North Olympic Development Council, 2022)	Clallam County	Clallam County
Average Monthly Rainfall in August	-0.62 inches	-0.62 inches
Average Monthly Rainfall in November	+1.5 inches	+1.5 inches

Figure 49: Projected seasonal shifts in precipitation in Clallam County under the RCP8.5 scenario, compared to the 1951–2005 baseline.

Table 16. Precipitation Magnitude Clallam County

	2050-2079	2070-2099
Precipitation Magnitude (Salathé, E.P. et al., 2010) *Accessed via Climate Mapping for a Resilient Washington.**	Clallam County	Clallam County
Heavy Precipitation Magnitude	12% (1% to 21%)	14% (5% to 17%)
Extreme Precipitation Magnitude	13 % (0% to 27%)	18 % (8 to 24%)

** Percent change in the maximum amount of water from the 24-hour rainstorm that occurs on average once every 2 years (Heavy) and 25 years (Extreme) relative to the average for 1980-2009.*

Table 19 summarizes projected precipitation impacts to North Olympic Peninsula Tribal Lands. By mid-century, North Olympic Peninsula Tribal Lands are projected to experience an annual precipitation increase of 3.8 inches, an increase in total precipitation from October to March of 4.1 inches, and a decrease in total precipitation from April to September of 0.45 inches. By the end of the century, North Olympic Peninsula Tribal Lands are projected to experience an annual precipitation increase of 6.2 inches, an increase in total precipitation from October to March of 7.2 inches, and a decrease in total precipitation from April to September of 1.0 inch.

Table 17. Precipitation Impacts to North Olympic Peninsula Tribal Lands

	2040-2069				2070-2099			
Climate Impact (Data Source: CIG Tribal Climate Tool*)	Makah Indian Tribe (Clallam)	Lower Elwha Tribal Community	Port Gamble S'Klallam Tribe	Jamestown S'Klallam Tribe	Makah Indian Tribe (Clallam)	Lower Elwha Tribal Community	Port Gamble S'Klallam Tribe	Jamestown S'Klallam Tribe
Annual Precipitation (Historical 95.3 in)	+5.4 inches	+1.4 inches	+4.9 inches	+3.3 inches	+8.5 inches	+2.3 inches	+8.2 inches	+5.7 inches
Total precipitation from October to March (Historical 74.5 in)	+5.7 inches	+1.5 inches	+5.3 inches	+3.7 inches	+9.9 inches	+2.7 inches	+9.4 inches	+6.7 inches
Total precipitation from April to September (Historical 20.8)	-0.5 inches	-0.2 inches	-0.6 inches	-0.5 inches	-1.4 inches	-0.4 inches	-1.2 inches	-1.0 inches

** The projections on this table come from the Climate Toolbox and Climate Impacts Group Tribal Climate Tool and use the RCP 8.5 high emissions scenario, accessed on July 6, 2022 (Climate Impacts Group, 2022).*

Drought

While projections of annual precipitation are relatively uncertain, Clallam County is projected to experience a decrease in summer precipitation by mid- and end-century (Table 20). Reduced snowpack and reduced summer rainfall will lead to increased risk of summer drought in the region. In addition, the combination of drier summers, higher temperatures, and earlier snowpack melting is likely to increase both the frequency and severity of wildfires. Increased drought events are likely to stress agricultural and forest lands (e.g., pests, fire risk) (North Olympic Development Council, 2015).

Table 18. Precipitation Drought Clallam County

	2050-2079	2070-2099
Precipitation Drought (Salathé, E.P. et al., 2010) *Accessed via Climate Mapping for a Resilient Washington.**	Clallam County	Clallam County
Likelihood of a year with summer precipitation below 75% of historical normal	30% (18 to 47%)	33% (23 to 48%)

**Likelihood that summer (June-August) precipitation in any given year is below 75% of average precipitation, the historical normal for the period 1980-2009.*

Sea Level Rise

For coastal areas of the North Olympic Peninsula, more coastal flooding from increased sea level rise is expected. The amount or expected rise varies and is mitigated by the reality that the northwestern part of the Olympic Peninsula is rising and parts of it will experience lower amounts of sea level rise compared to areas that are dropping, like much of Puget Sound (Washington State Department of Ecology, 2023). Still, up to four feet of sea level rise is anticipated in Port Townsend by 2100 (North Olympic Development Council, 2015). Sea level rise will increase coastal flooding, shoreline erosion, and saltwater inundation in Clallam County. Federal sea level rise data projects that Clallam County will experience between 0.46-0.85 ft of sea level rise by 2050 and 2.3-5.4 ft by 2100 (NOAA, 2022).

Sea level rise will vary across the county based on specific local processes. In Table 8 and Table 9, relative sea level rise indicates how much the average water level is expected to rise due to the combined effects of climate change and movement of the land (Miller, Ian et al., 2019). The Miller et al. 2019 projections include local processes such as rates of vertical land motion and identify sea level rise patterns from 171 locations along the WA coastline. For this projection, there is a 50% chance that by 2050, Clallam County will experience 0.5 feet of seal level rise and by 2100, 1.7 feet of sea level rise. There is a 1% chance that Clallam County will experience 1.2 feet sea level rise by 2050 and 4.5 feet by 2100 (Table 21). Note that updated projections are expected in fall 2025.

Table 19. Sea Level Rise Projections Across the North Olympic Peninsula

SEA LEVEL RISE *The amount of sea level rise expected with a 50% and 1% likelihood relative to the 1991 - 2009 average sea level.**	Neah Bay *Clallam County*	Clallam Bay/ Sekiu *Clallam County*	Port Angeles *Clallam County*
	50% chance of 0.1 feet (2050) and 1.0 feet (2100)	50% chance of 0.4 feet (2050) and 1.1 feet (2100)	50% chance of 0.6 feet (2050) and 1.2 feet (2100)
	1% chance of 0.8 feet (2050) and 3.8 feet (2100)	1% chance of 1.4 feet (2050) and 4.2 feet (2100)	1% chance of 1.8 feet (2050) and 4.6 feet (2100)

** The projections in this table come from (Miller, Ian et al., 2019)*

Table 20. Relative Sea Level Rise

SEA LEVEL RISE *The amount of sea level rise expected with a 50% and 1% likelihood relative to the 1991 - 2009 average sea level.**	Clallam County	
	2050	2100
	50% chance of 0.5 feet (0.3 to 0.7 feet)	50% chance of 1.7 feet (1.2 to 2.1 feet)
	1% chance of 1.2 feet (0.9 to 1.4 feet)	1% chance of 4.5 feet (4.0 to 4.9 feet)

**Relative sea level rise with a 50% and 1% likelihood of occurring for future 30-year periods compared to the average sea level in 1991-2009, using RCP 8.5 (Miller, Ian et al., 2019).*

Snowpack

Changes in snowpack levels and rainfall patterns and increased demand will impact the region's water supply. Projected temperature increases will increase the likelihood that precipitation will fall as rain instead of snow, reducing water storage in the snowpack (Frankson, et al. , 2022). Figure 4 shows the percent change over the next century of April 1 snowpack in Clallam County. April 1st snowpack is used as an indicator for the amount of stored water that becomes available during the melt season. The projected decrease of April 1st snowpack indicates that less stored water will be available to supply streams, soil, and reservoirs during the melt season (Chegwidden, O. S., et al., 2017). By mid-century, there is a 64% chance that any year in the time period will have an April 1st snowpack below 75% of average in Clallam County. This increases to 79% by end of century and is an indicator of high likelihood of drought in the region (Figure 51; Table 23).

Figure 50. Percent Change of April 1st snowpack for future 30-year periods compared to the 1980-2009 average.

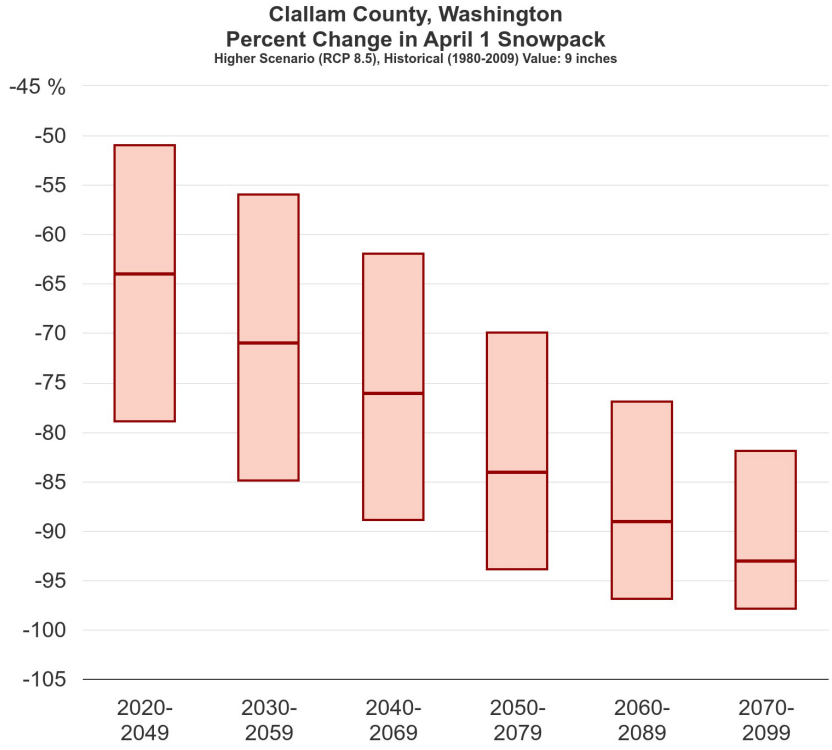


Table 21. Snowpack Drought Clallam County

	2050-2079	2070-2099
Snowpack Drought (Chegwidden, O. S., et al., 2017) *Accessed via Climate Mapping for a Resilient Washington.**	Clallam County	Clallam County
Likelihood of April 1st snowpack below 75% of normal	64% (53 to 82%)	79% (64 to 92%)

**Likelihood that any year in each time period has April 1 snowpack below 75% of average, the historical normal for the period 1981-2010 (Chegwidden, O. S., et al., 2017).*

Ocean Acidification

Ocean acidification is the process by which the ocean's pH decreases due to the absorption of carbon dioxide (CO2) from the atmosphere, impacting marine life and ecosystems. Washington's marine waters are highly susceptible to ocean acidification due to regional factors that amplify the effects of global CO2 emissions such as coastal upwelling and runoff of nutrients from land (Washington State Blue Ribbon Panel on Ocean Acidification, 2017). Acidification has increased in Washington coastal waters over the last several years because of the combined effects of global and local sources of the carbon dioxide that drive the acidification process.

Small marine species, crucial to the food webs supporting salmon and other important marine life in the North Olympic Peninsula, are particularly vulnerable to ocean acidification. In 2012, regional assessments revealed that economically and culturally significant invertebrates like oysters, clams, and mussels are adversely affected. Other species, including fish and phytoplankton, also exhibit negative responses, highlighting the widespread impact on the entire ecosystem. Additionally, higher seawater temperatures worsen the effects of acidification (North Olympic Development Council, 2015). Shell dissolution due to ocean acidification is evident off Washington's coast and is severe in the Salish Sea — and projected to increase in the future (Washington State Blue Ribbon Panel on Ocean Acidification, 2017).

Wildfire and Smoke

Clallam County currently has a low wildfire risk likelihood (Figure 52) (USDA Forest Service, 2024).

Figure 51. Wildfire risk to Clallam County.

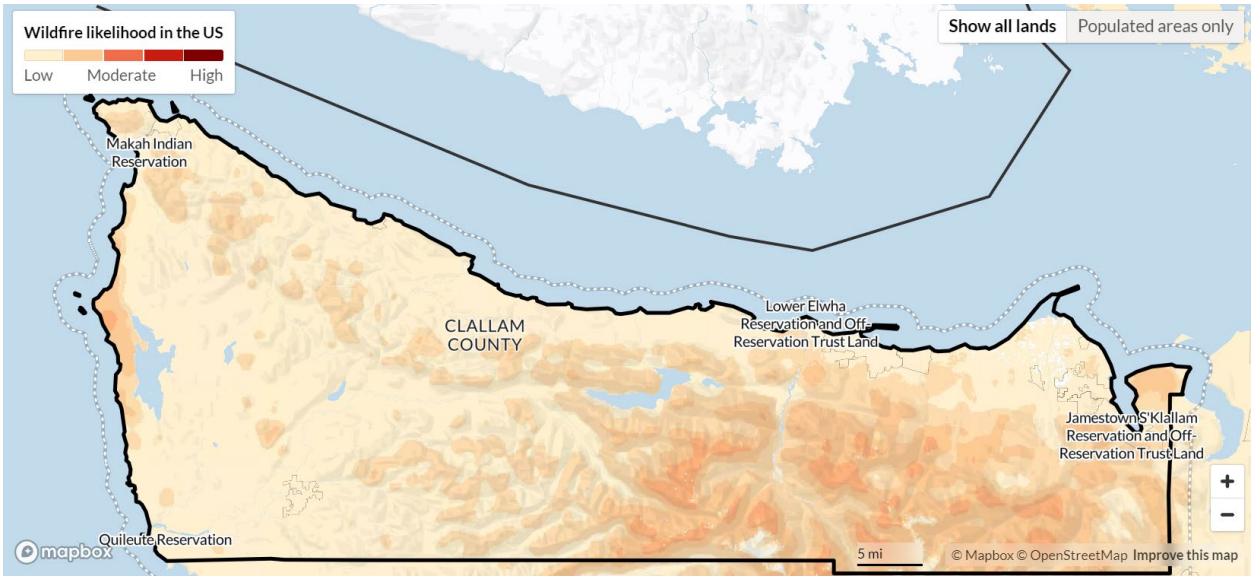


Figure from Wildfire Risk.org. Assessed 20 December 2024

However, despite this low current risk, the North Olympic Peninsula is projected to see an increase in wildfire risk and smoke due to increasing dry conditions in summer months (North Olympic Development Council, 2022). Table 24 presents the change in high fire danger days, indicating a greater potential for wildfire activity if ignition sources and ample fuels are present. More frequent wildfires may lead to lower air quality days, ecosystem impacts, and infrastructure risk.

Table 22. Wildfire Danger Clallam County

	2010-2039	2040-2069
Wildfire Danger (Sheehan, T., et al., 2015) *Accessed via Climate Mapping for a Resilient Washington.**	Clallam County	Clallam County
Change in annual high fire danger days	5 days (-1 to 10 days)	10 days (1 to 16 days)

**Table shows the change in annual high fire danger days compared to the 1971-2000 average.*

Wildfire smoke, Washington's largest source of particle pollution, poses serious health risks, including increased hospital admissions and worsened respiratory and cardiac conditions (Washington State Department of Ecology, 2024). Climate change is expected to drive more frequent wildfires, amplifying these health impacts (Clarke, Cirulis, & Borchers-Arriagada, 2023). While long-term trends are unclear (Figure 53), Clallam County has experienced spikes in PM2.5 levels, with recent years showing significant high pollution days (Environmental Protection Agency, 2024).

Figure 52. $PM_{2.5}$ AQI Index from 2003 to 2024 in Clallam County.

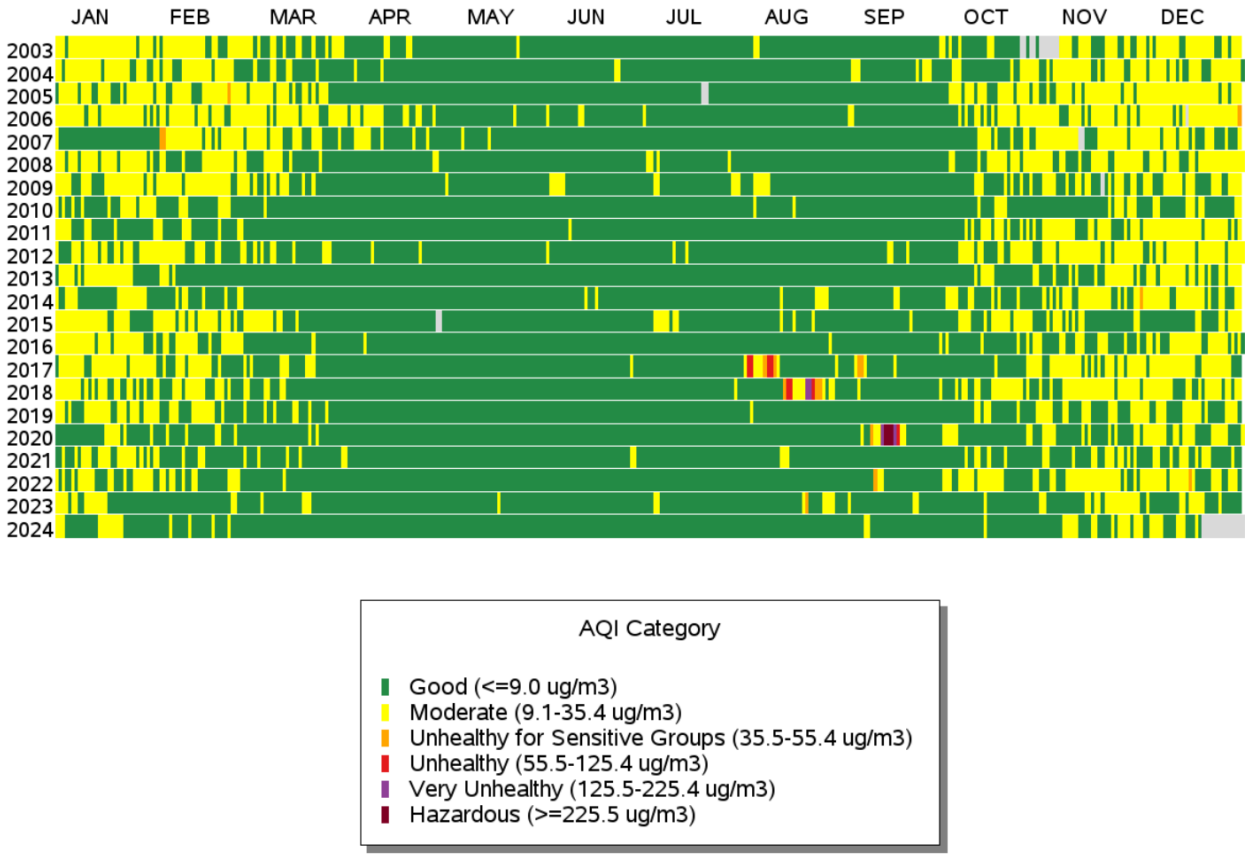


Figure from AirData, Environmental Protection Agency. Accessed 20 December 2024.