Feeling the Heat: Climate Change Adaptation Policy in Snohomish County

Submitted by

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Table of Contents

Table of Contents 2

Introduction 5
- Climate Change Overview 5
- Capstone Overview 6

Mitigation vs. Adaptation 9

Literature Review 10
- Snohomish County Reports 10
- Rural and Urban Differences 12
- Equitable Climate Strategies 14
- Non-Snohomish Models for Vulnerability Assessment and Adaptation Plans 14

Methodology 16

Demographics 20

Snohomish County Climate Threats 22
- Sea Level Rise 22
- Flooding 24
- Wildfire 26
- Species and Habitats 28
- Public Health 31
- Food Security 33
- Water Resources 36
- **Urban, Suburban, and Rural Threats** 37
  - Urban Threats 37
  - Suburban Threats 39
  - Rural Threats 40
- Area Specific Threats 41
  - Everett 41
  - Edmonds 42
  - Sultan 43
  - Gold Bar 44
  - Index 45
- **Threat Summary** 46

Treaty Obligations 47

Equity 50

Snohomish County Climate Policy 53

Countywide Initiatives 53
County Operations 53
Mitigation Policies 55
Adaptation Policies 59
Everett 63
Edmonds 65
Sultan, Gold Bar, Index 68

Barriers to Enacting New Policies 76
Funding 76
Government Budgets 76
COVID-19 Pandemic 77
Private Budgets 79
Population Growth 80
Political Will 81
Competing Interests 82
Competing Adaptation Interests 82
Other Competing Interests 82

Policy Proposals 84
Co-Benefits and High Priority Needs 84
General Recommendations 84
More Staff Dedicated to Climate Work 84
Mandated Use of Climate Change Decision Support Tool 85
Stronger Policy Language and Increased Enforcement 86
Community Input 88
Emergency Response 89
Sea Level Rise 117
Managed Retreat 90
Shift from "Hard" to "Soft" Solutions for Coastal Management 90
Flooding 117
Countywide Flood Control District 92
Flood Control Infrastructure Upgrades 93
Stormwater Infrastructure Upgrades 94
Green Infrastructure 95
Stormwater Capture and Filtration 97
Equitable Solutions to Stormwater Management 97
Low Impact Development 99
Flood Warning Systems 99
Wildfires 100
Fire Safety Education 100
Forest Management 100

Power Infrastructure Upgrades 101
Let It Burn 102
Public Health 117
Greenhouse Emission Reducing Policies 102
Cooling Urban Areas 103
Land Use and Development 117
Growth Management 103
Affordable Medium and High Density Housing 104
Relocating Infrastructure 105
Habitat/Species Restoration 117
Protect Against Future Habitat Degradation 106
Restore Natural Processes 106
Estuary and Wetlands Restoration 107
Salmon/Fish Recovery 108
Beaver Repopulation 109
Agricultural Resiliency 117
Education and Funding for Agricultural Changes 109
Carbon Credits 110
Drought Resilient Practices 111
Irrigation District 111
Water Banking 113
Seasonal Water Rights 113
Water Storage 114
Farmland Conservation 115
Upland Runoff 116
Compensation for Land Loss Due to Resilience Practices 117
Urban Agriculture 117
Community and Backyard Gardens 117
Small Space Gardening 118
Educational Agriculture 118
Food Banks 120

Conclusion 122

Bibliography 124

Acknowledgements 135

Introduction

Climate Change Overview

Climate change is defined by NASA as the “long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates” (NASA, n.d.). These changes are already taking place; the atmosphere and ocean have gotten warmer, the amounts of snow and ice have decreased, the sea level has risen, and the concentration of greenhouse gases in our atmosphere have increased (IPCC, 2013). According to the Intergovernmental Panel on Climate Change, “many of the observed changes are unprecedented over decades to millenia” (IPCC, 2013).

The overwhelming majority (>>90%) of climate scientists agree that humans are the dominant cause of the observed warming of our climate (Cook et al, 2016). These changes have primarily been caused by industrialization, especially through the burning of fossil fuels and from deforestation (Walsh et al, 2014). Greenhouse gases such as carbon dioxide, methane, and nitrous oxide trap heat in the atmosphere and lead to an overall warming of the planet and a shift in climate patterns (Walsh et al, 2014).

United Nations scientists reported in 2018 that the world has “just a decade to take ‘unprecedented’ action to cut carbon emissions and hold global warming to a moderate – but still dangerous and disruptive – level” (Mooney & Dennis, 2018). To do so would require a “‘rapid and far reaching’ transformation of the world’s economy, one of such scale and magnitude that it has no historical equivalent” (Erickson, 2018).

In 2015, 195 countries pledged to cut their greenhouse gas emissions to try to keep global warming under 2 degrees celsius, although their pledges were not sufficient to meet this goal (UN Environment Programme, 2019). Further, very few countries are meeting that pledge and the United States has since begun the process of withdrawing from the Paris agreement

(Erickson, 2018). Scientists predict that “there will be a four degree Celsius rise by the century’s end if countries take no meaningful action to curb their carbon output” (Eilperin, Dennis, & Mooney, 2018).

Climate change will have several significant impacts, including increased floods, droughts, sea level rise, extreme weather events, and other significant physical impacts (IPCC, 2014). It will also threaten human health, food security, water resources, livelihoods, infrastructure, and ecosystems (IPCC, 2014). These threats are already being realized throughout the world, but they will continue to get worse as global warming increases. The less we are able to reduce greenhouse gas emissions, the more severe the impacts will be.

Policy that mitigates climate change through reducing emissions is one response we can and must take, but given that we already are facing climate change impacts, we also need policies that help us adapt to these challenges. Both mitigation and adaptation measures need to be adopted to slow the process of climate change and protect against current or future damage caused by climate change.

Capstone Overview

This capstone was conducted to determine what changes will need to be made in Snohomish County to prepare for a changing climate, specifically with regard to adaptation rather than mitigation strategies. This project focuses on the differences between representative urban (Everett), suburban (Edmonds), and rural areas (Sultan, Gold Bar, and Index). Everett is an urban city with a population of 111,475 people (Census Bureau, 2019). Edmonds is a suburban city with a population of 42,605 people (Census Bureau, 2019). Sultan, Gold Bar, and Index are rural towns along the same road with a combined population of 7,959 people (Census Bureau, 2019). All of these areas face similar hazards, but they also have distinct challenges due to their differing resources, levels of development, and population sizes.

This capstone reviews what threats are faced by the county and these individual areas within the county. It will then look into what actions the county and individual cities have already taken or are planning to take in the future, and then determine any other additional actions that should be taken for these areas to become more resilient to climate threats. It will also examine what differences there are between rural and urban areas in Snohomish County with regard to their level of climate preparedness and their capability to adapt for the future.

To come up with a comprehensive view of the needs of Snohomish County, several government officials, experts, and climate activists were interviewed to gain an in-depth understanding of the threats faced by Snohomish County and the recommended solutions to address those threats. They also gave a better understanding of the work that is already being done in the county and cities within the county to prepare for a changing climate.

This capstone also utilizes information gathered from several different literature sources. These sources include reports written by the state, county, or individual cities that examine the climate threats that these areas will face and the current states of climate policies in these areas. Additionally, academics and NGOs have analyzed and reported on the expected threats to these areas. There are also several pieces of literature related to the specific challenges of helping rural areas adapt to climate change, including the economic challenges and the agricultural impacts. Other literature details the disproportionate risks communities of color, indigenous peoples, and communities with lower incomes face in relation to climate threats. This literature focuses on the importance of including vulnerable populations in the creation of any climate action plan.

Climate change is already impacting the environment, contributing to harsher storms, worsening flooding, increased wildfires, significant agricultural impacts, and many other harmful threats. These threats are projected to get much more severe as climate change worsens. Snohomish County is not yet prepared to face those risks. Without a strong action plan that

focuses on ways that it can become more resilient, these threats could be devastating to the public safety and economic future of the county.

Mitigation vs. Adaptation

There are two different policy strategies for addressing climate change: mitigation and adaptation. Mitigation policies seek to address the causes of climate change by finding ways to reduce the amount of greenhouse gases in the atmosphere (UCAR Center for Science Education, 2011a). Adaptation policies, on the other hand, seek to address the effects of climate change by increasing resilience or reducing vulnerability to changes in the climate (UCAR Center for Science Education, 2011a). Because some amount of continued warming is guaranteed and harmful consequences are already occurring, both strategies are necessary.

Despite the fact that both kinds of policies are needed, this report will focus almost entirely on adaptation policies. The main reason for this is that the majority of climate policies that are currently being considered in Snohomish County are mitigation policies. This will be explored more thoroughly in the Snohomish County Climate Policy section. There have already been significant strides towards beginning to address mitigation policy, but there has been significantly less consideration of adaptation policies. This capstone seeks to remedy that gap by providing adaptation policy ideas that Snohomish County can implement to become more resilient.

As will be seen later in the Policy Proposals section, there are some overlaps between adaptation and mitigation policies. Several policies that will help reduce greenhouse gases will also address environmental impacts, especially regarding air quality and human health effects. Additionally, many policies that help adapt to climate change also will help mitigate climate risks, such as several farming practices that will help absorb carbon from the atmosphere.

Literature Review

This literature review is broken up into four different sections: reports about the threats faced in Snohomish county, literature about the differences between rural and urban climate change plans, literature about making equity a focus in climate change adaptation policies, and vulnerability assessments created for other areas.

Snohomish County Reports

The *Everett Climate Action Plan* sets targets for the city of Everett to try to achieve a 50% reduction in greenhouse gas emissions by 2030 and an 80% reduction by 2050. It also documents some of the expected impacts, including an increase in flooding, storms, droughts, wildfires and smoke, vector-borne diseases, heat stress, and other climate-related natural disasters. This plan lays out several targeted plans for mitigating the climate risks, but only a few of the actions in the plan will help improve the city's resiliency. This plan is limited due to the lack of adaptation plans to improve areas that are likely to be at risk from the changing climate in the near- to mid-term. It was passed by the City Council in 2020.

The *Edmonds Climate Action Plan* seeks to reduce greenhouse gases and create a more sustainable community. The plan primarily focuses on mitigation efforts, but also details plans to adopt policies to preserve wetlands and lower risks by rezoning land use, strengthening sea walls and armoring embankments, and designing buildings to handle storm surge. There are not many details about how they intend to carry out these plans, but the action plan is just meant to be an overview. It was adopted in 2010.

Everett's *Hazard Inventory and Vulnerability Analysis 2018* (HIVA) and the *Hazard Mitigation Plan 2018* (HMP) were created to report the available data about hazards that Everett will face and come up with plans to address those risks. The HIVA covers more threats than just

climate change, but it has a chapter directly about the risks Everett will face due to climate change. Many of the other sections are also related to climate change due to the fact that the frequency and severity of many natural disasters will increase as climate change worsens. The HMP addresses these risks by creating mitigation plans, which include replacing and upgrading infrastructure and vulnerable buildings, creating training and exercises to prepare residents and businesses, planning to reduce risk and support disaster recovery, and adaptation plans for the waterfront and port. These reports are very detailed and create specific plans to address climate risks, but there is no timeline or specific action plan from the city government about how they intend to fund these changes or when these changes are likely to be completed.

The *Snohomish County 2015 Hazard Mitigation Plan* includes annexes for the cities of Edmonds, Index, Sultan, and Gold Bar. Each annex highlights the main risks for each city, which includes many climate related risks, such as flooding, severe weather, or wildfires. These annexes also include some maps that show areas of concern for each of these towns, but they do not go into a large amount of detail about the risks that they face. It does give information about what financial resources are available for the towns and details what other plans may exist, such as emergency response plans or floodplain or basin plans.

Snohomish County created a *Sustainable Operations Action Plan for County Operations* in 2013. This plan also focuses on mitigation, rather than adaptation, and specifically only looks at county government operations rather than the county as a whole. There are no strategies about what will need to be moved, rebuilt, or otherwise protected in Snohomish County due to climate threats. This plan can be used to determine what plans Snohomish County has already implemented or planned to try to fight against climate change.

The Climate Impacts Group at the University of Washington prepared a report called *State of Knowledge: Climate Change in Puget Sound* for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration in 2015. This report was created to explain the expected effects of climate change within the Puget Sound region. The Puget Sound region

contains all of the cities and towns explored in this assessment and Edmonds and Everett are both located on Puget Sound's coast. It covers the implications for land in the Puget Sound area as well as consequences for the marine waters. This report solely focuses on the impacts of climate change, and does not suggest many solutions for how these risks could be mitigated.

Lastly, a Washington State Blue Ribbon Panel also created the *Scientific Summary of Ocean Acidification in Washington State Marine Waters* in 2012. This report was developed to examine the likely biological and ecological responses to ocean acidification in the estuarine and coastal waters of Washington. It has a chapter focused on the Ocean Acidification in the Puget Sound, which forms the western border for both Everett and Edmonds.

Rural and Urban Differences

The Rural Policy Research Institute wrote an article entitled *Climate Change and Rural Communities in the US* in 2009. This report details how climate change has already impacted rural populations and economies and the ways that these impacts are likely to increase in scope and scale in the future. Because rural economies are often closely tied to their environment, their economies and communities are more vulnerable to changes in the climate. It also details how climate change legislation and policies will impact rural areas, occasionally in ways that will cause additional stress on rural economies. It details the opportunities in rural communities to create mitigation and adaptation policies that will both improve their economies and reduce their contributions to greenhouse gas emissions.

Socio-economic impacts of climate change on rural United States explores how rural areas will be affected by climate change. It finds that rural communities tend to be more vulnerable than urban areas. This is due to several factors, such as demography, occupations, earnings, literacy, poverty incidence, and dependency on government funds.This article from 2012 uses existing knowledge sources to create a summary of how rural areas are likely to be

impacted by climate change. There are many different projections and scenarios that can vary considerably based on different assumptions regarding the rate of policy adoptions, the amount of expected economic and technological growth, and the scope and timeline of climate change.This article also notes that some rural areas may benefit, at least temporarily, if the changing climate allows for improved growing conditions in some agricultural areas.

The Snohomish Conservation District created an *Agriculture Resilience Plan for Snohomish County* in 2019. This report was made to create plans for resilient agricultural landscapes in Snohomish County. It has a chapter specifically devoted to the expected impacts of climate change on agricultural areas in Snohomish County, including risks from flooding, increasing groundwater levels and saturation, saltwater intrusion, land subsidence and channel aggradation, and crop destruction. The other chapters explore how to plan for these changes and what the priorities should be in Snohomish County to make our agricultural areas more resilient to these threats.

For urban areas, the U.S. Department of Health and Human Services released an article entitled *Rural and Urban Differences in Air Quality, 2008–2012, and Community Drinking Water Quality, 2010–2015 — United States.* This report measures air quality and water quality in rural and urban counties, and found that air quality improves in countries that are more rural, while water quality worsens in counties that are more rural. Limitations to this study include the fact that counties can have a lot of variability within them that include more and less rural areas, and that the specific measures used might obscure some of the findings. This capstone also utilized two different sources to explain urban heat islands, one from the Environmental Protection Agency and another from the University Corporation for Atmospheric Research’s Center for Science Education. These resources are broad overviews explaining the effects of urban heat islands.

Equitable Climate Strategies

An Unfair Share: Exploring the Disproportionate Risks from Climate Change Facing Washington State Communities was created by the University of Washington Climate Impacts Group in 2018. It explores the climate change hazards that are expected in Washington state with an emphasis on the disproportionate impacts for communities of color, indigenous peoples, and communities with lower incomes. It also highlights the ways that climate policies and programs can effectively address existing or future inequities.

Guide to Equitable, Community-Driven Climate Preparedness Planning, was created for the Urban Sustainability Directors Network in 2017. This report illustrates how an inclusive, community-centered planning process that includes people from communities of color and lower-income populations can create a greater resilience to the threats from climate change by empowering the people who are most affected. This report can be used as a source to find the best practices for including the vulnerable populations most likely to be affected in determining what strategies should be put in place to fight climate change.

Non-Snohomish Models for Vulnerability Assessment and Adaptation Plans

The *Seattle City Light Climate Change Vulnerability Assessment and Adaptation Plan* is a vulnerability assessment and adaptation plan created for the city of Seattle in 2015. This plan identifies specific actions that can be taken to increase climate resilience in Seattle. It is focused on adaptation plans, rather than mitigation plans. It identifies areas of risk and then details potential adaptation actions. These actions include plans that can be done in the short term with existing capacities or long term goals that will need more extensive planning or infrastructure.

Due to the fact Seattle is an urban environment, it may be especially helpful for determining the next adaptation steps for Everett.

King County created a *Strategic Climate Action Plan* in 2015. Unlike the Snohomish, Everett, and Edmonds climate action plans, it contains an entire section on preparing King County for Climate Change Impacts. It outlines ongoing, priority, and long term actions in twelve focus areas that need to be done to make King County more resilient to climate threats. It also includes information about the equity impact review process that will be used to ensure that the process for these changes is inclusive, open, and equitable for all residents of King County. This focus on adaptation plans provides a framework for ways that Snohomish County could make a similar adaptation plan. Due to the geographic similarities of the regions, there are many plans that can be used as ideas for Snohomish County.

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments is not a vulnerability assessment itself, but it gives information on how to create a vulnerability assessment and develop a preparedness plan. This resource from 2007 gives a detailed explanation of what should be included in an action plan, and also includes information about how to prioritize and implement a preparedness plan after it is created.

Methodology

This capstone uses a case study design that focuses on Snohomish County's climate change policies. It also focuses on three embedded subunits: the urban city of Everett, the suburban city of Edmonds, and three rural towns. These embedded units will be studied to determine if there are any differences between the levels of preparedness and the capability to adapt in urban, suburban, and rural areas. It will also address how the cities have tried to create their own climate policies and the ways that cities interact with the county to make these plans.

The capstone utilizes semi-structured interviews with government officials, experts and scientists, and climate activists to get an understanding of the threats Snohomish County faces and past and current actions that the county and the cities have taken to fight climate change with an emphasis on policies that will help the county adapt to become more resilient to climate threats. It will then look at the future steps that should be taken to increase climate resiliency. These interviews included both prospective and retrospective questions to get a historical context and understand what steps still need to be taken.

Thirty-six interviews were conducted and recorded via Zoom, Skype, or phone conversations and then transcriptions of the recordings were created. Interview lengths ranged from nineteen minutes and thirty-seven seconds to ninety-four minutes and fifty-six seconds. The average interview lasted forty-seven minutes and twenty-six seconds. One interview was not recorded and the total length of that interview is unknown. Information from that interview was gathered through note-taking rather than through an exact transcription. Not including that interview, cumulatively this included one day, two hours, and fifty-three minutes worth of interviews.

Several government officials were interviewed, including County Executive Dave Somers, Snohomish County Council Members Megan Dunn, Nate Nehring, and Jared Mead, Everett Executive Director Bob Bolerjack, Everett City Council Member Liz Vogeli, Edmonds

City Council Members Diane Buckshnis and Susan Paine, Gold Bar City Council Member Jordan Sears, Energy and Environmental Sustainability Manager Lisa Dulude, Public Works Director Kelly Snyder, Sustainability and Special Projects Coordinator for the Public Works Department Manuela Winter, PUD Commissioner Rebecca Wolfe, PhD, and the Manager of Natural Resources for the PUD Keith Binkley. The Environmental Programs Manager for the City of Edmonds, Kernen Lien, was not interviewed but did offer some information and resources over email.

Additionally, six members of the Snohomish Conservation District were interviewed. Conservation Districts are political subdivisions of the state government with no regulatory authority ("Who We Are", n.d.). They offer free help to residents for the purpose of conserving land, water, forests, wildlife and related natural resources ("Who We Are", n.d.). Agriculture Program Director Bobbi Lindemulder, Habitat Restoration and Floodplain Program Director Cindy Dittbrenner, Community Conservation Program Manager David Jackson, Agriculture Resource Planner Carrie Brausieck, Urban Agriculture Coordinator Joe Crumbley, and Agriculture and Floodplains Resilience Project Manager Bennett LaFond were all interviewed for this project.

Three employees for the Tulalip Tribes were interviewed, including Restoration Ecologist Brett Shattuck, Environmental Scientist Colin Wahl, and Conservation Scientist Phillip North. All three of these scientists are employed by the Tulalip Tribes, but are not Tribal members. The Executive Director of the Snoqualmie Valley Watershed Improvement District, Cynthia Krass, and a Project Manager for Washington Water Trust, Emily Dick, were also interviewed.

Lastly, several climate activists or members of environmentally focused groups were interviewed. Three residents who are on Snohomish County's Climate Action Advisory Committee were interviewed, including Jon Witte from Washington Physicians for Social Responsibility, Yolimar Rivera Vázquez from Ecotrust, and Jeanine SanClemente from Snohomish County Climate Alliance who was the person who originally suggested the Climate

Action Advisory Committee. Andrea Matzke and Rich Senderoff of the Sno-Isle Chapter of the Sierra Club were interviewed, and Andrea is also the founder of Wild Washington Rivers. Pam Kepford of 350 Everett was interviewed. Local climate activist Dean Smith who also is one of the founders of Sunnyside Village Cohousing was interviewed. Retired NOAA fishery biologist Joe Scordino from Save Our Marsh was also interviewed. Finally, interviews were conducted with former Snohomish mayor and climate activist Karen Guzak and the leader of the Snohomish County chapter of the Citizens Climate Lobby, Lee Alley.

The questions asked varied based on the expertise and position of each of the people interviewed. For government officials, the focus was on describing their past and current efforts to enact climate policies, whether they faced any resistance, and what coalitions of community groups, residents, or other government officials were created to fight for these changes. The questions also looked at what coordination there was between individual towns and cities and the county. For experts, the main focus was on detailed explanations of how climate change is already impacting the county and how it is projected to impact the county in the future. I also focused on what efforts they've taken in their position to try to adapt to climate change and what policies they think would be helpful to create more climate resiliency. These questions were often tailored to their field of expertise. For activists, interviews looked at what legislation or policies they pushed for, whether they were successful, and whether there was a difference when interacting with city or county officials.

The answers that were given in these interviews were then compared to see if there were any common themes. Additionally, the answers of officials, experts, and activists working in rural areas were compared to the answers of officials, experts, and activists working in more developed areas to see if there were any significant differences. This information was then combined with information gained from the literature and mapping projection data to create a comprehensive view of the threats of climate change and the history of climate change policy in the county to create detailed policy proposals to increase resiliency.

The main limitation of this research design is that there is a limited amount of external validity. By design, this method looks solely at Snohomish County and the conclusions found in this capstone can not be expected to remain true for other areas. Additionally, due to the fact that the interviews focus on activists, experts, and government officials, the demographic makeup of the people being interviewed does not reflect the demographic complexity of the county. Government officials, experts, and scientists tend to be disproportionately white and higher income, and many of the environmental groups that were interviewed are also led by predominantly older, white voices. This is especially problematic with regard to equity because the impacts of climate change disproportionately harm people with lower incomes and people of color.

Demographics

According to 2019 Census predictions, Snohomish County has a population of 822,083 people (United States Census Bureau, 2019), in which 77% of the population is white, 12% is Asian, 10.6% is Latinx, 3.8% is Black, and 1.6% is Native American or Alaskan Native (United States Census Bureau, 2019). The median household income is $82,751 (United States Census Bureau, 2019). Within the county, 7.5% of the population is estimated to be in poverty (United States Census Bureau, 2019).

Everett's population is estimated at 111,475 people (United States Census Bureau, 2019). It is more diverse than the county as a whole in which 73.5% of the population is white, 15.6% is Latinx, 9.1% is Asian, 4.7% is Black, and 1% is Native American or Alaskan Native (United States Census Bureau, 2019). The median household income is significantly lower than the county as a whole at $57,205 (United States Census Bureau, 2019). Far higher than the county's average, 15% of the population in Everett is estimated to be in poverty (United States Census Bureau, 2019).

Edmonds' population is estimated at 42,605 people (United States Census Bureau, 2019). Edmonds is less diversified than the county as a whole as 81.2% of the population is white, 7.9% is Asian, 6.9% is Latinx, 1.3% is Black, and 0.3% is Native American or Alaskan Native (United States Census Bureau, 2019). The median household income is higher than the county's median at $87,693 (United States Census Bureau, 2019). A significantly lower 5.6% of the population is estimated to be in poverty in Edmonds (United States Census Bureau, 2019).

Sultan's population is estimated to be 5,388 people (United States Census Bureau, 2019). The area is significantly less diverse than the county's average with 89.1% of the population identifying as white, 12.8% Latinx, 1.9% Asian, 1% Native American or Alaskan Natives, and only 0.2% Black (United States Census Bureau, 2019). The median household income is less than the county's median at $78,688 (United States Census Bureau, 2019). The

estimated poverty rate in Sultan is 7.3%, which is similar to the county's average (United States Census Bureau, 2019).

Gold Bar's population is estimated at 2,352 people (United States Census Bureau, 2019). Gold Bar is significantly less diverse than the county as a whole; 95.6% are white and 1.62% are Native American or Alaskan Natives (United States Census Bureau, 2018). All other races are under one percent of the population (United States Census Bureau, 2018). The median income was estimated to be $72,188, which is lower than the county's average (United States Census Bureau, 2018). The poverty rate in Gold Bar is estimated to be 11.17% of the population, which is significantly higher than the county's average (United States Census Bureau, 2018).

Index has the smallest population with only an estimated 219 people (United States Census Bureau, 2019). Similar to Gold Bar, the population is 94.79% white and 5.21% Asian with all other demographics estimated at 0% of the population (United States Census Bureau, 2018). The median income is estimated to be $71,699, which is lower than the county's average (United States Census Bureau, 2018). The poverty rate in Index is estimated to be 6.77% of the population, which is lower than the county's average (United States Census Bureau, 2018).

Snohomish County Climate Threats

This section will explore some of the main climate threats that are either currently impacting Snohomish County or are projected to impact Snohomish County in the future. It will address major threats to the region, then look at threats to urban, suburban, and rural areas based on their population sizes or levels of development. Lastly, it will review threats that are specific to Everett, Edmonds, Sultan, Gold Bar, and Index.

Sea Level Rise

Using a medium climate scenario, the sea level is projected to rise in Puget Sound by 14 to 54 inches by 2100 (Mauger et al, 2015; Figure 2). The wide range of projected change is due to different methods for estimating ice melting rates in Greenland and Antarctica (Mauger et al, 2015). Figure 2 shows the potential levels of inundation in Snohomish County if sea level rise reaches four feet (48 inches). Green areas are low-lying areas at risk of flooding, while light blue areas have a lesser inundation depth, and dark blue areas have a greater inundation depth (NOAA Office for Coastal Management, n.d.). Although most areas of Puget Sound's shorelines are expected to see increased sea level rise, some areas may actually experience a declining sea level due to vertical tectonic uplift (Snohomish County, 2015).

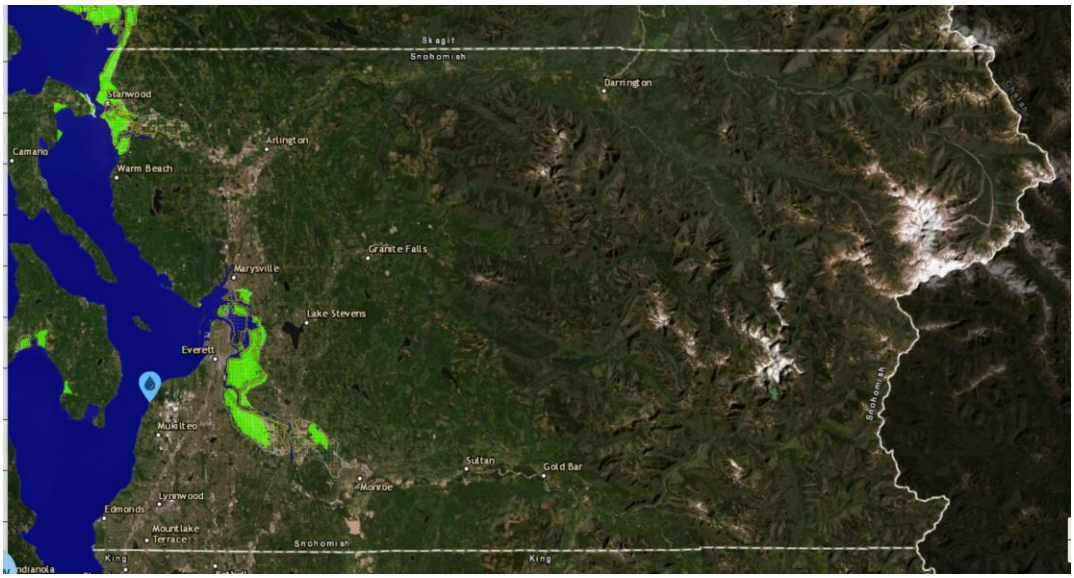

Figure 1: Current Mean Higher High Water Levels (NOAA)

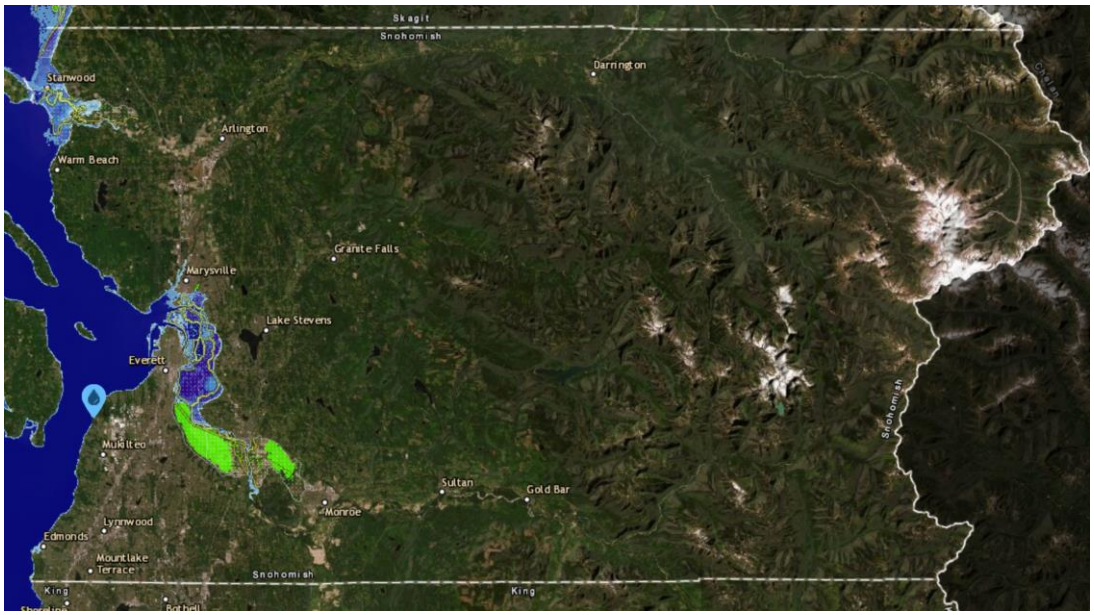

Figure 2: Four Feet of Sea Level Rise (NOAA)

The expected sea level rise will “permanently inundate some low-lying areas and will increase the frequency, depth, and duration of coastal flood events by increasing the reach of storm surge and making it harder for flood waters in rivers and streams to drain into Puget Sound” (Mauger et al, 2015). Sea level rise will also damage coastal infrastructure, increase

erosion of coastal bluffs, cause habitat and species loss, and create economic and cultural consequences (Mauger et al, 2015).

Flooding

Sea level rise is not the only potential cause of increased flooding due to climate change. There will be an increase in heavy rain events, which will increase the flood risks in all Puget Sound watersheds (Mauger et al, 2015). In watersheds that accumulate snow, flood risks will also increase in the winter as the snowline recedes (Mauger et al, 2015). According to the Snohomish County Hazard Mitigation Report, “Future floods are expected to exceed the capacity and protective abilities of existing flood protection facilities, threatening lives, property, major transportation corridors, communities, and regional economic centers” (Snohomish County, 2015).

A study of four Snohomish County rivers, the Sauk, Stillaguamish, Skykomish, and Snohomish, simulated that by the 2040s, all four rivers will have ten year floods every four to five years and 100 year floods every 28-83 years depending on the river. By 2080, those numbers increased to 10 year floods every 2-3 years and 100 year floods every 10-16 years (Snohomish County, 2015). The total amount of acres that would be flooded in these scenarios can be seen in Figure 3.

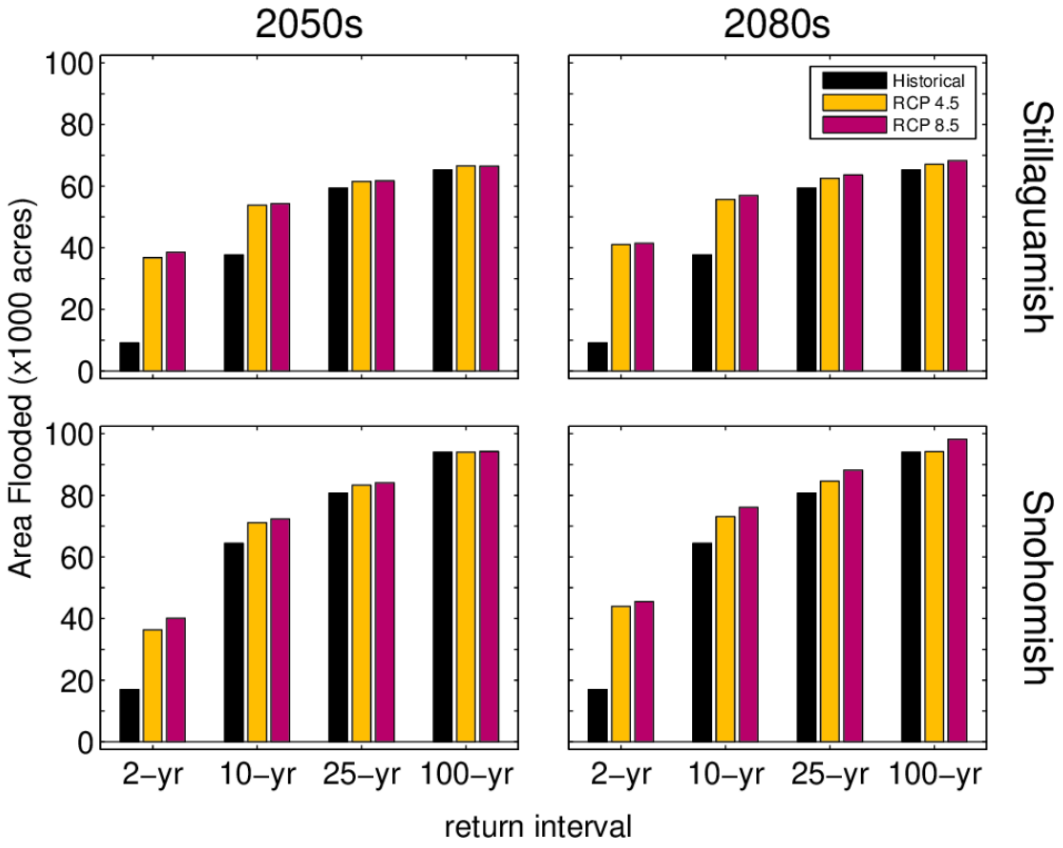

Figure 3: "Total area flooded (in thousands of acres) for the Snohomish and Stillaguamish watersheds, for each time period and greenhouse gas scenario. Results are derived from the average peak flow projection and do not include the range of projections among models" (Mauger, Lee, & Won, 2018).

Levee and dam failures are another significant risk for severe floods. Dams have spillways that are created as a safety measure in case a reservoir fills too quickly. Spillway overflow events can cause increased downstream discharges and flood risks, and the chance of these events occurring will be increased by climate change (Snohomish County, 2015). Changes in weather patterns can also increase the chances of levee failures (Snohomish County, 2015). Levees are maintained by flood control, diking, and draining districts, which are special districts controlled by landowners and farmers who have limited available resources for maintenance or repair (author interview with Dittbrenner, 2020).

If levees meet certain Army Corps of Engineers standards, they can be enrolled in the PL84-99 program, which means that “the federal agency will repair levees that have been damaged as a result of a flood. The agency will also assist with the costs, permitting, and design of regular levee maintenance, although this is ultimately the responsibility of the District” (Snohomish Conservation District, 2019). Although he did not know the exact numbers, Bennett LaFond, the agriculture and floodplains resilience project manager of the Snohomish Conservation District, estimated that 60% of the conservation's dikes and levees are enrolled in that program and 40% are not (author interview with LaFond, 2020).

Wildfire

According to a report by the Climate Impacts Group at University of Washington, “climate change is expected to increase fire activity in the Puget Sound region, even though the area is not thought to have been fire prone historically” (Mauger et al, 2015). The Snohomish County Hazard Mitigation Plan further states that climate change will increase wildfire risk due to an increase of hot and dry weather that will warm and dry out vegetation (Snohomish County, 2015; see Figure 4 for example). On average, the area burned annually in Northwest forests west of the Cascade crest is expected to more than double by 2070-2099, compared to 1971-2000, according to two different studies (Mauger et al, 2015). However, for large parts of Western Washington, “quantitative projections of future changes in fire frequency or area burned are limited or not available” (Morgan et al, 2019). Further research is needed to fully understand the changing fire risks and severity in Snohomish County.

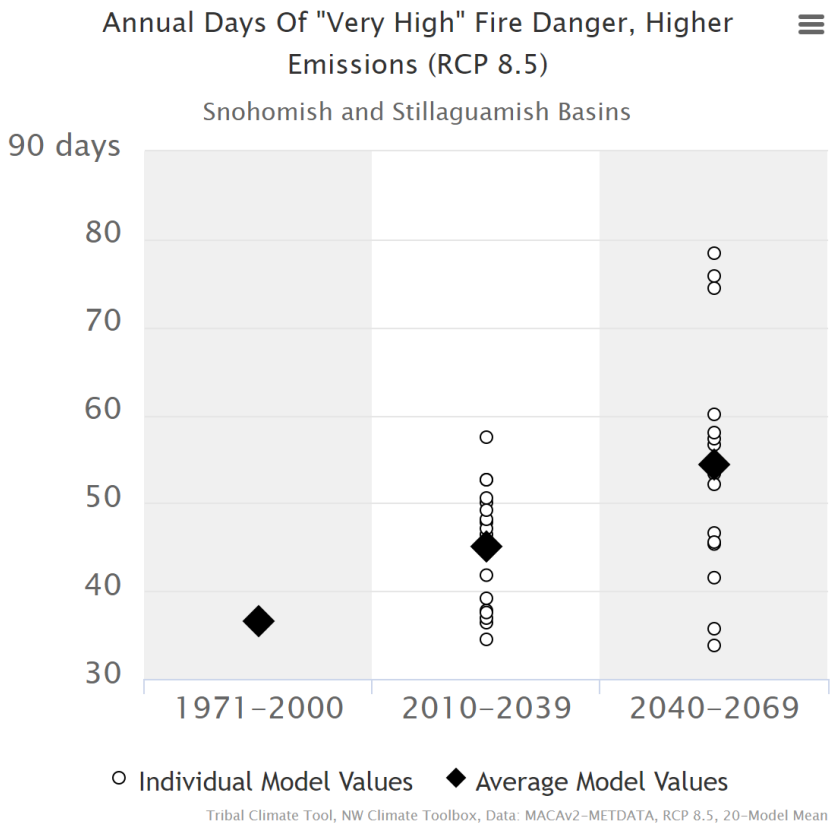

Figure 4: Annual Days of Very High Fire Danger (Northwest Climate Adaptation Science Center)

Additionally, climate change may increase wind that will make fires spread faster and farther, which will make it more likely for the fires to reach residential areas before being contained (Snohomish County, 2015). Snohomish County has warm winds from the east, also referred to as synoptic winds, which "not only reduce humidity and dry out fuel, they also can be sustained and move with great speed. Winds of this type are associated with some of the Pacific Northwest's most-catastrophic wildfires" ("Community Wildfire Protection Plan", n.d.). Another increased risk is that fires used to rarely burn through riparian areas or cooler nighttime temperatures, which gave firefighters a larger opportunity to contain them, but fires are increasingly now burning in wet forest areas and during the night (Morgan et al, 2019).

These risks are further exacerbated by a lack of available state resources. The Department of Natural Resources only has 43 permanent year-round firefighters, and the majority of the firefighters utilized by the department are either seasonal employees or

permanent staff who work in other departments and help out with firefighting seasonally (Morgan et al, 2019). Due to the increased length of the fire season, it has become harder to recruit fire suppression volunteers because of the increased time commitment (Morgan et al, 2019). However, for extreme fires, the agency does have cooperative agreements with seventeen states and some international countries to help with firefighting capacity (Morgan et al, 2019).

It is also important to note that 95% of the fires in western Washington over the past four years have been ignited by humans, so Snohomish County's increasing population and development could be another risk factor (Morgan et al, 2019). Snohomish County has an estimated 128,000 people and property that is valued at more than $9.7 billion ("Community Wildfire Protection Plan", n.d.). It is important that wildfire plans are strong enough to be able to protect the lives and property of Snohomish County's residents to the highest degree possible.

Species and Habitats

Climate change is expected to cause significant changes in terrestrial, freshwater, and marine ecosystems. Terrestrial ecosystems are likely to be impacted by a shift in geographic distribution of species, increased wildfires, changes in forest productivity, and an increase in insects, pests, diseases, and invasive species (Mauger et al, 2015). Freshwater ecosystems will be impacted by an increase in water temperatures, earlier peak streamflows, changes in precipitation, and declining snowmelt, which is projected to create a decline in wetland ecosystems (Mauger et al, 2015). Lastly, marine ecosystems will be affected by increased sea surface temperatures, sea level rise, and ocean acidification, which is expected to have significant impacts on the food chain, increase the magnitude and frequency of harmful algal blooms, and change the areas of some coastal habitats (Mauger et al, 2015).

These changes are compounded by existing damage that has already been done to habitats and species due to development, agricultural practices, and pollution. This is especially

true when it comes to fish species, particularly those listed under the US Endangered Species Act, such as Chinook salmon and Steelhead. According to Brett Shattuck, a restoration ecologist who works for the Tulalip Tribes, “virtually all of the fish species in the Snohomish last year was their lowest abundance ever going back on record” (author interview with Shattuck, 2020).

The Washington Fish and Wildlife Commission has classified 45 species as endangered, threatened, or sensitive, including 18 mammals, 13 birds, 4 reptiles, 3 amphibians, 4 invertebrates, and 3 fish species. There are an additional 102 species that were listed as candidates to be added to these lists, including 10 mammals, 17 birds, 10 reptiles and amphibians, 37 fish species, 9 mollusks, 18 insects, and 2 other invertebrates (Washington Department of Fish and Wildlife, 2020).

In many areas, critical natural ecological functions need to be restored to protect natural resources. This is particularly true in floodplains, wetlands, lakes, marine waters, and riparian areas. Ecological functions work through “a combination of the environmental elements of soil, water, plants, terrain and weather working together to produce natural dynamic ecological systems” (Snohomish County, 2010). These key processes include the “flow and storage of surface and groundwater; exchange between ground and surface waters; transport and deposition of sediments; filtration and uptake of sediments, nutrients and toxic compounds; shading and temperature control; recruitment of large woody debris and the creation of habitat diversity” (Snohomish County, 2010). Figure 5 highlights some of the main areas that have been identified as priorities for riparian protection and restoration.

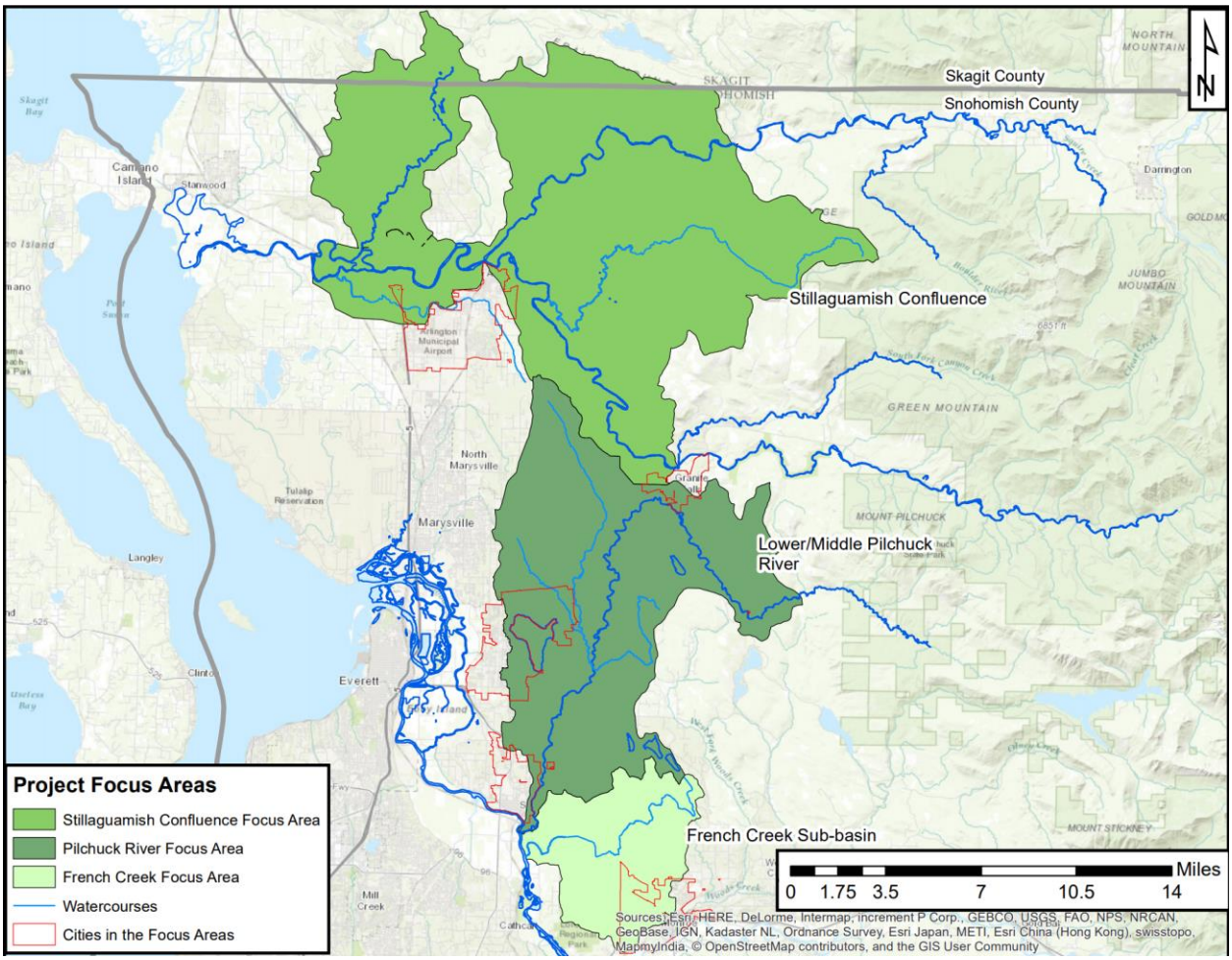

Figure 5: High priority focus areas identified by Snohomish Conservation District for riparian restoration projects (Snohomish Conservation District, 2017).

Ocean acidification is another change resulting from increased carbon dioxide concentrations that is causing threats to habitats and species. Around a quarter of human generated CO_2 has been absorbed into the ocean, which caused the ocean's pH to decrease by about 0.1 by 2012, and the surface ocean pH is expected to decline by another 0.3-04 pH units within 12-40 years from that point (Washington State Blue Ribbon Panel, 2012). Washington state is particularly vulnerable to acidification because regional factors can combine with the global atmospheric CO_2 levels to exacerbate the process (Washington State Blue Ribbon Panel, 2012). The effects of ocean acidification are wide-ranging, but they include negative impacts on

several organisms, especially calcifying species like shellfish, and disruptions of the food web (Washington State Blue Ribbon Panel, 2012).

Public Health

The Lancet Commission on Health and Climate Change stated that “trends in climate change impacts, exposures, and vulnerabilities show an unacceptably high level of risk for the current and future health of populations across the world” (Lockwood, 2019). Many of the risks already listed have severe health impacts. Extreme heat, flooding, and wildfires all have potential health impacts. There’s also possibilities of increased disease vectors due to climate change (see Figure 6).

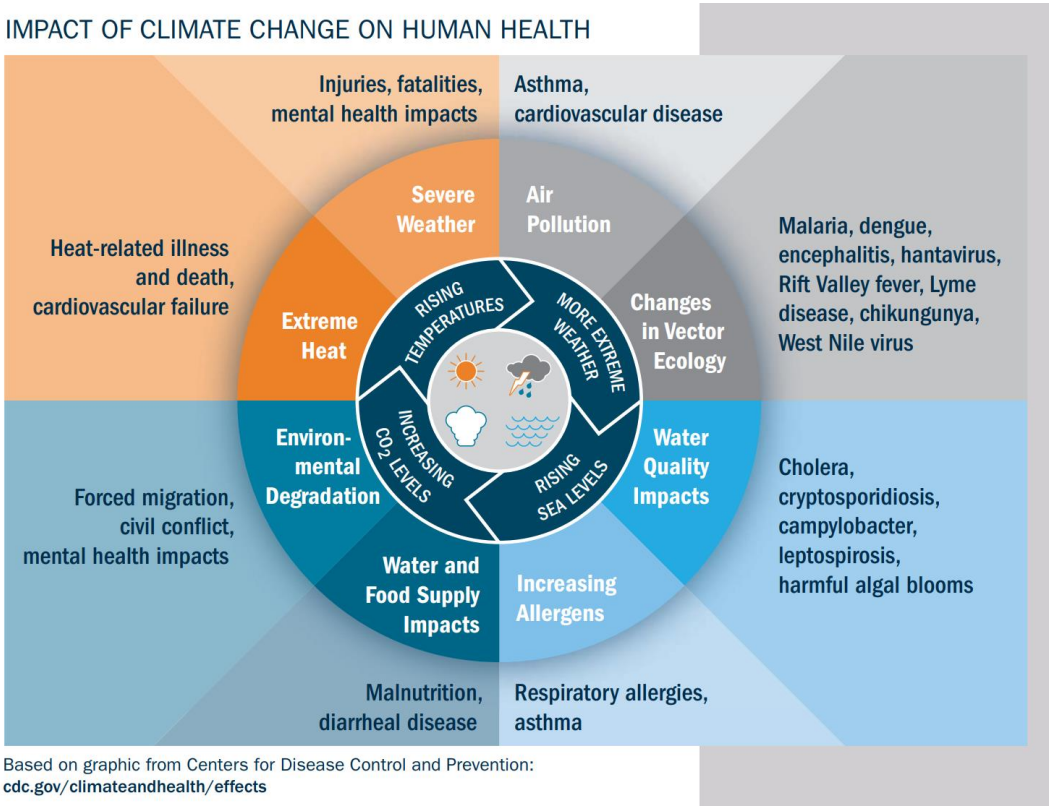

Figure 6: Examples of how climate impacts can cause human health effects (Public Health, 2017).

Extreme heat may be the single most dangerous human health impact. Extreme heat can lead to heat stroke and dehydration, and exacerbate or cause cardiovascular, respiratory,

and cerebrovascular disease (Washington Physicians for Social Responsibility, n.d.). Between 1988 and 2017, heat-related illnesses were the leading cause of weather related deaths (Lockwood, 2019). As of 2015, only a third of homes in the Seattle area had installed any kind of air conditioner, either through central air or a room unit (Balk, 2018). Lack of air conditioning can make it hard to escape extreme heat, especially for people with limited incomes.

Wildfires are another major health risk related to climate change. The Natural Resources Defense Council released a study in 2019 that found that 245 deaths in Washington state were linked to wildfires in 2012, along with 371 hospital admissions, 1,897 emergency room visits, and 49 outpatient encounters (Limaye et al, 2019). Immediate fire impacts can cause death and injuries, but the more common health concern is particulate air pollution (pm <2.5mm) which can trigger asthma, worsen conditions for people with underlying heart or lung conditions, cause heart attacks and strokes, or increase long term cancer risks (Lockwood, 2019). Wildfires can also make burned areas more likely to have landslides, which can cause significant injuries and deaths (Lockwood, 2019).

Flooding is another major concern when it comes to human health impacts. As with fires, there are immediate impacts from people who may end up stuck in deadly situations during more dangerous, fast moving floods (author interview with Jackson, 2020). However, the more insidious impacts come from runoff and flooding contaminating water used for recreation, habitats of animals we eat, or drinking water (Washington Physicians for Social Responsibility, n.d.). The health impacts of contaminated water can include “gastrointestinal illnesses, negative impacts on nervous and respiratory systems, or liver and kidney damage” (Washington Physicians for Social Responsibility, n.d.).

Ocean acidification and temperature rises in marine water can also cause harmful health impacts. The increased presence of harmful algal and cyanobacterial blooms can contaminate shellfish with toxins and make them dangerous to eat (Washington Physicians for Social Responsibility, n.d.). Climate change will also cause the pollen season to increase in duration

and severity, which will worsen allergies and asthma (author interview with Witte, 2020). The severity of allergies can also be worsened by changes in temperature and humidity (Washington Physicians for Social Responsibility, n.d.).

Vector-borne diseases are expected to increase as the geographic area of mosquitoes, ticks, and fleas is expanded and the temperature and precipitation changes can also increase the amount of time they are active (Washington Physicians for Social Responsibility, n.d.). In 2018, a Seattle woman became the first person to be infected locally with West Nile virus (Rodriguez, 2018). Jon Witte, a retired physician who is now part of Washington Physicians for Social Responsibility, said that he had never seen a case of locally-acquired lyme disease during any of his years as a practicing rheumatologist, but local physicians are now seeing cases of lyme disease that were contracted in the northwest (author interview with Witte, 2020). Other diseases, such as Zika, may also become more common as mosquitos become more able to thrive in the area (author interview with Witte, 2020).

Lastly, mental illness can be severely impacted by climate change. Climate change and exposure to extreme weather events have been linked to several acute and chronic mental health concerns, including “strong emotional responses, such as sadness, distress, despair, anger, fear, helplessness, hopelessness and stress; elevated rates of mood disorders, such as depression, anxiety, and pre- and post-traumatic stress; increased drug and alcohol usage; increased suicide ideation, attempts and death by suicide; threats and disruptions to sense of place and place attachment; and loss of personal or cultural identity” (Cunsolo & Ellis, 2018). These can be linked to physical ecological losses, loss of environmental knowledge, and anticipation of future losses (Cunsolo & Ellis, 2018).

Food Security

Some of the previously mentioned climate risks threaten the food supply, such as habitat destruction and ocean acidification, and will interrupt the food chain and disrupt plant and

animal species that historically have been gathered, fished, or hunted for human consumption. Additionally, the nutritional value of some foods is expected to decrease as elevated CO_2 levels in the atmosphere decrease the concentration of nitrogen in plants and also decrease the amount of protein in several crops, such as barley, sorghum, and soy (Public Health, 2017). At the same time, it will also increase the concentrations of pathogens and toxins in food sources (Public Health, 2017).

The most crucial risk to the food supply, though, may be the abundance of risks faced by agricultural cultivation, especially in Snohomish County. The majority of Snohomish County's agriculture is established in the floodplains and is already seeing major impacts from climate change, especially from flooding and groundwater saturation (Snohomish Conservation District, 2019). The Agricultural Resilience Plan created by Snohomish Conservation District found that climate change will impact agriculture through flooding, groundwater saturation, saltwater intrusion, drought, and crop impacts (Snohomish Conservation District, 2019).

Because the floodplains have nutrient rich soils and excellent growing conditions, the most valuable and productive farmlands tend to be located within the floodplains (Snohomish Conservation District, 2019). Being situated in the floodplains poses an obvious increased risk of flooding, which will continue to become more severe as climate change worsens (Snohomish Conservation District, 2019). Flood impacts can include damaged infrastructure, costly repairs and cleanup, erosion resulting in loss of land, and risks to crops and livestock (Snohomish Conservation District, 2019). Aggradation, or the accumulation of sediment in the river channels, has been observed near the mouth of the Stillaguamish River and in the upper reaches of the Snohomish River (Snohomish Conservation District, 2019). Aggradation can increase flood risk by decreasing the capacity of the river to carry flood waters (Snohomish Conservation District, 2019). Flooding is also worsened by large amounts of stormwater runoff coming down from upland development (Snohomish County Conservation District, 2019).

Groundwater saturation can shorten growing seasons by delaying when farmers are able to access their fields to begin planting (Snohomish Conservation District, 2019). Sea level rise is expected to raise groundwater levels and further extend the period of saturation into the spring, which will significantly impact the farmers' yields (Snohomish Conservation District, 2019). Historically, the installation of drain tiles was one method used to open up floodplain agricultural lands for production. To be able to continue to access their fields, farmers need to maintain this drainage infrastructure, which is very expensive and requires extensive maintenance (author interview with Lindemulder, 2020).

Furthermore, sea level rise could cause increased amounts of saltwater intrusion into the groundwater (Snohomish Conservation District, 2019). Unlike groundwater saturation and flooding, most agriculture is not yet seeing huge impacts from saltwater intrusion (author interview with Brausieck, 2020). Some areas, especially in the lower Stillaguamish, are starting to notice some saltwater intrusion, which has been noticed in wells and in pockets of soils, but it is not yet a main concern (author interview with Brausieck, 2020). However, they are anticipating that saltwater intrusion will become more of an issue, especially in the Stillaguamish and on Ebey Island (author interview with Brausieck, 2020). Saltwater intrusion may harm crops because several crops are not able to tolerate higher salinity levels (author interview with Brausieck, 2020).

Drought will also be another significant area of concern for farmers due to the flood drought cycle. Modeling suggests that the county is going to see dryer, longer, and hotter summers, which will increase the need for water resources to irrigate crops (author interview with Brausieck, 2020). Snohomish County has peak flows in the river during the winter, and low flows during the summer (author interview with LaFond, 2020). Bennett LaFond explained, "When there are low flows, there is not enough water for anybody and when there are peak flows, there's too much water for everybody" (author interview with LaFond, 2020). Farmers who never needed to irrigate much before are finding they have to irrigate more often now, but many

farmers do not have water rights and available water resources are scarce (author interview with Lindemulder, 2020). Without sufficient water resources, crops and livestock will suffer.

Crops can be harmed by drought, flooding, and saltwater intrusion, but those are not the only ways that crops can be impacted. There are actually some ways that climate change could help crops, because higher temperatures and higher levels of CO_2 can create a longer growing season, which could allow you to plant more crops (author interview with Dittbrenner, 2020). However, this benefit is rarely realized because the increased drainage and flooding concerns delay when farmers can plant, which shortens the growing period (author interview with Dittbrenner, 2020). As the temperature changes, farmers may need to change the kinds of crops they are growing to ones that are more suited to the new climate zone (author interview with Brausieck, 2020). Pests, like insects and fungus, could also begin to destroy more crops, but research is still being done into what pests are likely to expand populations on the western side of Washington (author interview with Dittbrenner, 2020).

Livestock can also face risks, including heat stress and feed difficulties. Heat stress can become a major issue because it can make it harder for livestock to put on weight or produce as much milk (author interview with Brausieck, 2020). New diseases may also become an issue (author interview with Brausieck, 2020). Furthermore, in drier and hotter summers, the grass that livestock eats will stay green for a shorter period of time and won't be as nutritious later in the season, so farmers may have to supplement by buying hay (author interview with Dittbrenner, 2020).

Water Resources

Heat can cause increased evaporation of bodies of water and reduced snowfall, which can create a larger demand for water (Public Health, 2017). There are going to be longer periods of drought due to dryer, longer, and hotter summers (author interview with Brausieck, 2020). As previously mentioned, water rights are already very contentious and it can be hard for

farmers to be able to get a sufficient amount of water for their needs (author interview with Lindemulder, 2020).

Water quality can also suffer because decreasing water resources can increase the amount of pollutants in the water supply as they become more concentrated (Public Health, 2017).The growth of toxin-producing harmful algae and bacteria due to water temperature increases can also harm the quality of the water supply (Public Health, 2017). Additionally, heavy precipitation and flooding can increase waterborne disease outbreaks (Public Health, 2017).

Urban, Suburban, and Rural Threats

Urban Threats

The EPA reports that air temperatures in cities, particularly at nights, can be as much as 22°F warmer than air in neighboring less developed areas (“Heat Island Impacts”, n.d.). Heat islands exist because asphalt and concrete for roads, buildings, and other structures absorb the sun’s heat, causing surface and overall ambient temperatures to rise (UCAR Center for Science Education, 2011b). Vegetation that is removed to make room for development has natural cooling effects due to shading and evaporation of water from soil and leaves (UCAR Center for Science Education, 2011b). Tall buildings and narrow streets can also reduce air flow and heat air that is trapped between them (UCAR Center for Science Education, 2011b). Lastly, waste heat from vehicles, factories, and other sources can also contribute to warming the environment (UCAR Center for Science Education, 2011b). This phenomena is summarized in Figure 7.

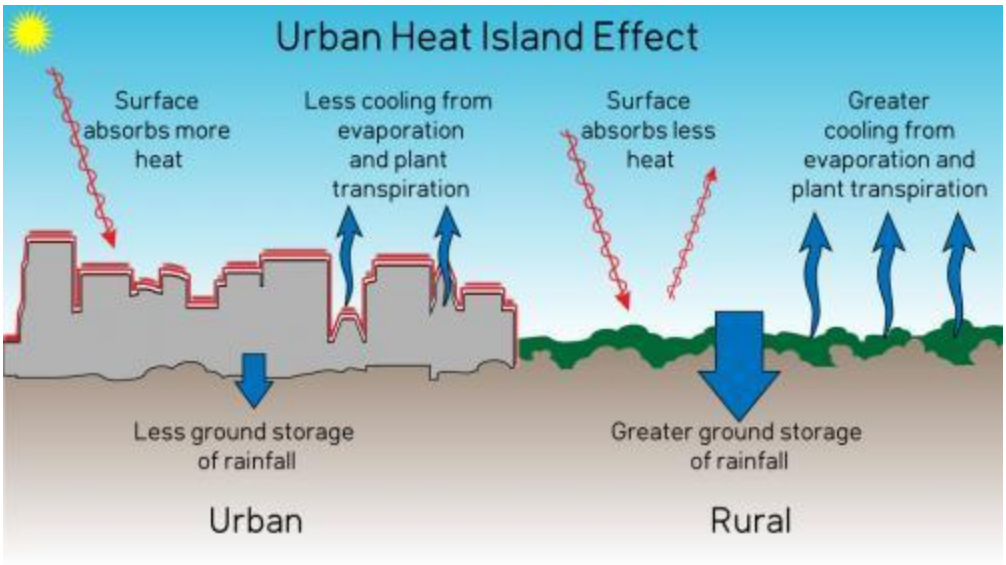

Figure 7: Urban Heat Island Effect (Pilie, 2020).

Air quality is another area where urban environments can have a significant impact. Climate change has the potential to harm air quality significantly, and this can be exacerbated in urban environments that already have factors that cause poor air quality. Particulate matter and ozone are two pollutants that can affect air quality (Strosnider et al, 2017). Particulate matter is defined as solid or liquid particles suspended in the air, and can include natural particles such as pollen and sea salt, or less natural particulate matter, such as smoke, fumes, soot, and combustion by-products (Strosnider et al, 2017). The latter category is much more common in urban than rural environments. Ozone is a gas that occurs naturally in the stratosphere, and vehicular and industrial emissions are main contributors to ozone production in urban areas (Strosnider et al, 2017). A study looking into air quality found that air quality decreases as counties became more urban in all three measures of air quality that were tested (Strosnider et al, 2017). Atmospheric warming is expected to worsen air quality by increasing ground level ozone (“Air Pollution”, n.d.). Particulate matter can also be increased due to wildfire emissions and air stagnation episodes (“Air Pollution”, n.d.)

Stormwater management is another major concern for urbanized areas. Urban development has altered how water flows during and after storm events, which has contributed

to contamination into rivers, lakes, and estuaries (National Resource Council, 2009). The increase in water velocity and volume also will harm aquatic habitats and stream function (National Resource Council, 2009). The runoff from stormwater gets more dangerous as it runs over roads, rooftops, and compacted land, gathering extra chemical and microbial contaminants (National Resource Council, 2009). In some cases, stormwater management infrastructure can also combine stormwater with raw sewage, which can be especially harmful when it overflows, which is increasingly likely as rain events become heavier and more frequent (author interview with Jackson, 2020). Without sufficient stormwater management infrastructure and strategies, stormwater runoff can cause serious flooding concerns (author interview with Jackson, 2020).

Development, unsurprisingly, also leads to the loss of forests, wetlands, and wildlife habitats. Without sufficient land use and growth management strategies, this causes cascading effects to ecosystems throughout the region. The destruction of natural environments in these areas contributes heavily to the preceding problems of urban heat islands, air pollution, and stormwater management.

Suburban Threats

Over the past century, the increasing trend towards suburbanization has contributed to urban sprawl and habitat destruction (Nechyba & Walsh, 2004). This is especially true in suburban areas that have prioritized single family homes. According to an EPA analysis, new single-family home construction was one of the most environmentally burdensome sectors of the US economy (Janjic, 2014). This is due to the fact that single family homes require much larger areas to be developed, and building new homes disturbs and erodes soil, disrupts habitats, depletes natural resources, and pollutes the air and water (Janjic, 2014).

Many of the urban threats will also be experienced in suburban areas, though at a smaller scale than more urbanized environments. The more a suburban area prioritizes creating green spaces and leaving natural environments intact, the smaller the threat of heat islands, air

pollution, and stormwater management will be. Depending on the location of the suburban city, there may be increased risks of wildfires or sea level rise. Suburban environments can take many different forms, so it can be hard to generalize just based on population size.

Rural Threats

Flooding is often a major concern on rural land because larger cities and towns are often on higher land. In the floodplains, farmland is heavily impacted by runoff from upland development (Snohomish Conservation District, 2019). Because of the lack of sufficient stormwater management, runoff comes down from the upland and brings contaminated water and sediment. The sediment can fill drainage ditches up, which means that the ditches are not able to capture all of the runoff, leading to increased flooding and contamination issues (author interview with Dittbrenner, 2020).

Outside of the floodplains, many rural areas are situated near or on more forested land, which can increase the risks of wildfires. Low water flows in the summer can affect rural water availability, because a lot of rural areas may get their water through wells and there may not be a sufficient water supply for the wells to be able to draw water (author interview with Somers, 2020). Moreover, a study conducted by the U.S. Department of Health and Human Services found that water quality improves in areas that are less rural (Strosnider et al, 2017).

Finally, emergency management can be a serious concern. Although there are regional, county, state, and federal resources available for emergency management, the availability of those resources still may be limited. The time it takes for help to get out to some more remote areas may lead to further damage or death. If there is only one road leading into a rural area and a disaster destroys roads or bridges that block that route, this can further harm the ability to respond to an emergency (author interview with Sears, 2020). Jordan Sears also noted that areas like Gold Bar may be one of the last areas to get help during large scale natural disasters

because other areas may be deemed more urgent due to them having more people and property at risk (author interview with Sears, 2020).

Area Specific Threats

Everett

The Everett Hazard Inventory and Vulnerability Analysis from 2018 identified climate change as a major threat, especially due to the possibility of increased flooding or severe storms (Everett Hazard Mitigation Steering Committee, 2018). It further identifies landslides, fire, heat waves, and pandemics as hazards that will be worsened by climate change (Everett Hazard Mitigation Steering Committee, 2018).

Everett's water supply comes from reservoirs that are fed by snowmelts, and the water system will be threatened as snowpack is reduced in the Cascade Range (Everett Hazard Mitigation Steering Committee, 2018). Bob Bolerjack, the executive director for Everett, explained that this is an especially large threat because Everett is the water provider for most of Snohomish County and supplies over 600,000 people with water (author interview with Bolerjack, 2020).

Sea-level rise may also impact the Port of Everett and endanger the buildings and infrastructure along the port (Everett Hazard Mitigation Steering Committee, 2018). Increases in peak river flows will lead to the need for additional dredging due to an increase in the sedimentation of the port area (Everett Hazard Mitigation Steering Committee, 2018). Buildings and other infrastructure by the waterfront may also be threatened.

Everett is the only city in Snohomish County that utilizes a combined sewer overflow system, which is a system that ties the grey stormwater infrastructure into the sewage treatment system so that stormwater is conveyed by the same pipe that sewage moves through (author interview with Jackson, 2020). In a massive overflow due to a heavy rain event, the pipe will

overflow in a remote area, but that overflow will now include polluted stormwater runoff combined with raw sewage (author interview with Jackson, 2020). As flooding and heavy rain events get more frequent, it increases the risk of these overflow events occurring (author interview with Jackson, 2020).

Edmonds

Edmonds has many of the same risks as other areas in Snohomish County. The City of Edmonds' annex in Snohomish County's Hazard Mitigation Plan indicates that the main threats to the city include severe weather, flooding, sea level rise and landslides (Snohomish County, 2015). There may be flooding and property damage due to sea level rise along shorelines and by the waterfront, and there may also be flooding and property damage along urban creeks and Lake Ballinger (Snohomish County, 2015).

An area of significant concern is the Edmonds Marsh, which is one of the few urban saltwater estuaries remaining in the Puget Sound area (Edmonds Discovery Programs, n.d.). It is the only remaining salt marsh within the nearshore habitat zone of the Lake Washington, Cedar, and Sammamish Watersheds (Watershed Resources Inventory Area 8). The marsh used to occupy nearly 40 acres, but development has reduced the area to 22.5 acres (Edmonds Discovery Programs, n.d.). The marsh provides habitat for wildlife and many different species have been documented within the Marsh and its buffer areas, including birds, fish, mammals, and invertebrates (Windward, 2019). A study of the marsh found that the marsh and its tributary creeks generally have good water quality that is sufficient to support salmon and fish species, but the water quality in some areas has been impacted by typical urban pollutants (Windward, 2019).

The marsh's connection to the Puget Sound was cut off when the Port of Edmonds marina was built in the 1960s (author interview with Scordino, 2020). The marsh-estuary outfall was placed into a 1600-foot pipe that drains into deep water in the Puget Sound. The pipe has a

tidegate in it that allows fresh water to flow out, but prevents tidal water from entering the marsh-estuary (author interview with Scordino, 2020). In 1988, the saltwater flow into the marsh was reestablished by securing the flap tidegate in an open position for the spring and summer months (author interview with Buckshnis, 2020). The long pipe and its outfall location in deep water has prevented salmon from entering the saltwater marsh (author interview with Scordino, 2020). Additionally, the Windward study found that there were areas with poor water circulation within the marsh and indicated that reconnecting the marsh to the Puget Sound would help improve water circulation and improve water quality (Windward, 2019).

Sultan

Snohomish County's Hazard Mitigation Plan's annex for Sultan identifies severe storms, wildfires, flooding, and landslides as threats that could be worsened due to climate change (Snohomish County, 2015). There is also a small, but possible chance of a dam failure, which would have catastrophic impacts. Flooding and severe storms have previously done significant damage to Sultan.

Because Sultan is located at the confluence of the Skykomish and Sultan rivers, flooding is a major threat (Snohomish County, 2015). The older downtown area of Sultan already floods on an annual basis (Snohomish County, 2015). Jordan Sears also mentioned that on some occasions, people can get trapped because flooding will happen on both sides of a road, limiting their ability to leave the area (author interview with Sears, 2020). Farmers in the area have had real problems with land loss due to flooding. Bobbi Lindemulder, the agricultural program director for the Snohomish Conservation District, told the story of one farmer who lost four acres in one flood, and explained how he will possibly continue to lose acreage with every subsequent flood if flooding patterns continue to be more frequent and significant than in the past (author interview with Lindemulder, 2020).

Wildfires are another possible threat to Sultan. The vast majority of construction in the city is made with wood frames (Snohomish County, 2015). It is also surrounded by forests, which increases the risk (Snohomish County, 2015). The high ground south of Sultan may be an area that is particularly vulnerable to wildfire risks (“Community Wildfire Protection Plan”, n.d.).

Lastly, Sultan lies directly downstream from the Culmback Dam. Although the probability of a dam failure is low, the results of such a failure could be catastrophic (Snohomish County, 2015). If a dam failure were to happen, residents would have approximately fifty minutes to reach high ground or they would risk death (Snohomish County, 2015). It would also do significant property and infrastructure damage.

Gold Bar

Snohomish County’s Hazard Mitigation Plan’s annex for Gold Bar found that the main climate change related risks to Gold Bar include severe weather, flooding, landslide, and wildfires (Snohomish County, 2015). Infrastructure, buildings, roads, and bridges are all at risk from these threats (Snohomish County, 2015).

Historically, Gold Bar has not had the flooding problems that Sultan and other areas have had (author interview with Sears, 2020). However, floods could destroy property, compromise wells, and potentially destroy bridges (Snohomish County, 2015). If waterways are blocked due to landslides, this could also cause flooding in the town (Snohomish County, 2015).

There is a moderate fire hazard within the city, but there are forested areas with high fire hazard risks adjacent to the city that could threaten to spread into the city (Snohomish County, 2015). Much of the high ground above US 2 is considered to have a high fire risk (“Community Wildfire Protection Plan”, n.d.). A few years ago, fires got close enough to Gold Bar to put them into a stage two level of evacuation, which meant people were given warnings that they would have to evacuate as soon as they announced the next stage of evacuation. Fortunately, they

were able to keep the fires far enough away from Gold Bar that they never needed to evacuate (author interview with Sears, 2020).

Index

Index faces many of the same challenges as the other rural areas. Snohomish County's Hazard Mitigation Plan warned about the threats of severe weather, flooding, wildfires, and landslides (Snohomish County, 2015). The Town of Index has also experienced several power outages annually due to wind events, which could become life threatening for people without alternative heat and cooking options (Snohomish County, 2015).

Index has had ongoing and historical incidences of flooding (Snohomish County, 2015). Half of the town's land area and about one third to a half of the homes occupied by full time residents have previously been impacted by flooding (Snohomish County, 2015). For a variety of reasons, flood losses within Index have not been accurately recorded, so the extent of historical flooding is not fully known (Snohomish County, 2015). In 2015, the town of Index estimated that three or four homes have been repeatedly flooded, and there was one structure that was elevated during 2008/2009 that had repetitive flood losses (Snohomish County, 2015).

Dry summer conditions could cause wildfires to encroach on property and buildings from the north, west, and east sides of town (Snohomish County, 2015). Much of the high ground above US 2 is considered a high fire risk ("Community Wildfire Protection Plan", n.d.). Index has previously had to be evacuated due to wildfire risk (author interview with Sears, 2020).

Threat Summary

Treaty Obligations

For thousands of years, the land that is now Snohomish County was inhabited by several Coast Salish tribes. The Snohomish were the largest Native population and lived along the shores of the Puget Sound and along the Snohomish River (Riddle, 2006). The Stillaguamish lived on the north and south forks of the Stillaguamish, the Skykomish lived along the Skykomish river, the Sauk-Suiattle lived in the area that is now Darrington, and the Snoqualmie lived near the area that is now Duvall and Monroe (Riddle, 2006). In 1792, British Captain George Vancouver claimed the Puget Sound region for King George III, despite the fact there were already Native populations living in the area (Riddle, 2006).

In 1855, representatives for several tribes signed the Treaty of Point Elliott, including representatives for multiple tribes that are now known as the Tulalip Tribes (Tulalip Tribes Natural Resources, n.d.). The Tribes ceded millions of acres of land to the United States government in exchange for a small amount of money and permanent protection from the US government (Tulalip Tribes Natural Resources, n.d.). Crucially, the Tribes also retained fishing, hunting, and gathering rights. Article five of the treaty states, “The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory, and of erecting temporary houses for the purpose of curing, together with the privilege of hunting and gathering roots and berries on open and unclaimed lands” (Treaty of Point Elliott, 1855).

United States v. Washington, 443 U.S. 658 (1979), also known as the Boldt decision, further guaranteed these rights. It established that Tribes have the “right of taking fish [outside of reservations] at all usual and accustomed grounds and stations” and that they were entitled to take a fair share of the available fish (The United States Department of Justice, 2017). It further defined a fair share as meaning that Tribes are entitled to up to 50% of a fishing harvest, “but no

more than is necessary to provide the Indians with a livelihood--this is to say, a moderate living" (The United States Department of Justice, 2017).

Brett Shattuck, a restoration ecologist employed by the Tulalip Tribes, stated that the county is integral to maintaining the Tribe's treaty protected resources (author interview with Shattuck, 2020). The retained rights to fish, hunt, and gather in common with others in Washington State are at risk due to climate change (author interview with Shattuck, 2020). Threatened species of plants and animals are really important to the tribe for economic, spiritual, and cultural reasons (author interview with Shattuck, 2020). Salmon, orcas, other wildlife, and several rare and important plant species are all at risk due to climate change (author interview with Shattuck, 2020).

Colin Wahl, an environmental scientist employed by the Tulalip tribes, stated that the state and the county have an obligation not to infringe upon treaty rights, which means that they have a responsibility to ensure that wildlife and habitats are protected (author interview with Wahl, 2020). He elaborated that the Boldt decision directed the state to act with the Tribes as co-managers of the resources, and gave states an obligation as a trustee of lands to restore and protect the resources under their jurisdiction (author interview with Wahl, 2020).

Phillip North, a conservation scientist employed by the Tulalip tribes, also stated that local governments have an obligation to protect natural resources (author interview with North, 2020). Despite this responsibility, Snohomish County has never lived up to this obligation because the way that the county utilizes its land is about consumption and is not sustainable (author interview with North, 2020). Urbanization prevents sustainable land management, degrades habitats, and takes away from the dynamism of the natural landscape (author interview with North, 2020). Brett Shattuck agreed, stating that pollution and development in places that significantly harm the environment are essentially infractions of the treaty (author interview with Shattuck, 2020). At the same time, climate change is expected to harm fish by

creating lower and warmer flows in the rivers, and many traditionally gathered materials and foods are at risk from flooding, changes in growing conditions, or fire risks.

Equity

The Climate Impacts Group at University of Washington created a report in 2018 that addressed the disproportionate risks that communities in Washington will face due to climate change. This report found that “local social, economic, demographic and geographic factors ultimately determine how severe climate change-related risks will likely be” (Casola et al, 2018; Figure 8). It further found that communities of color, indigenous peoples, and communities with lower incomes tended to face the most severe climate risks (Casola et al, 2018).

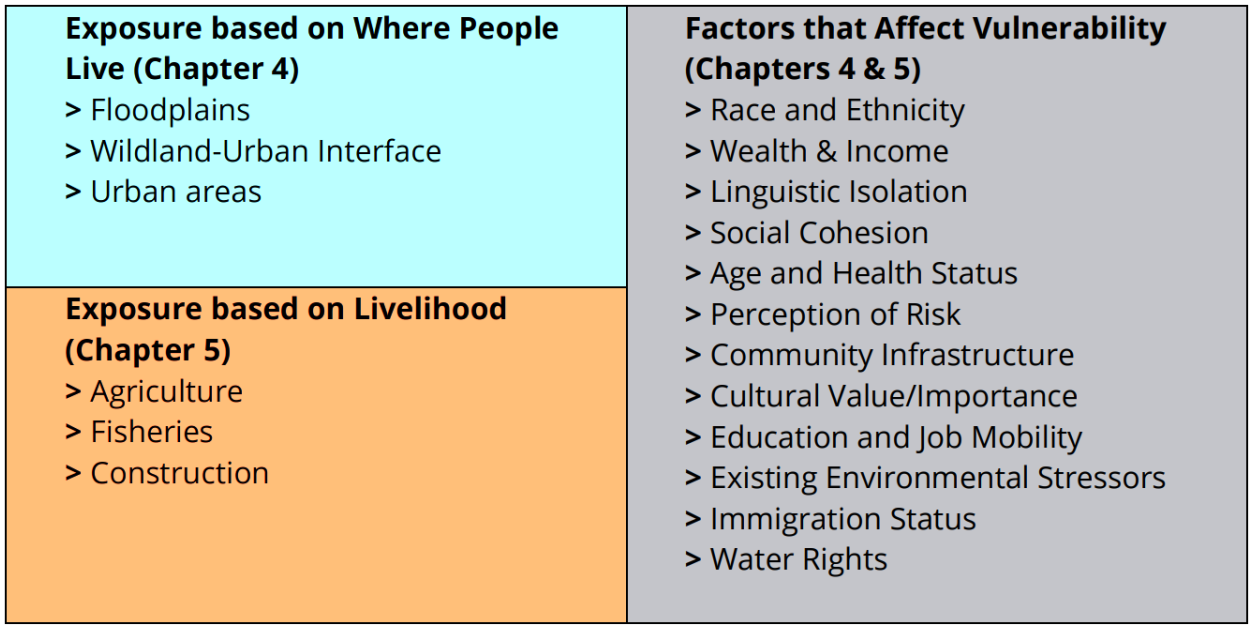

Figure 8: Areas and industries that are exposed to increased climate threats and factors that impact vulnerability (Casola et al, 2018).

Climate risks are increased by the level of exposure to natural hazards, sensitivity to hazards, and the ability to adapt (Yuen et al, 2017). According to a report by the Urban Sustainability Directors Network, “Systemic and institutional racism and classism have resulted in increased exposure and sensitivity to hazards and a reduced capacity to adapt among people of color, immigrants, refugees, and lower-income residents, often referred to as frontline communities” (Yuen et al, 2017).

For example, 53% of agricultural workers are nonwhite and 40% are Latinx in Washington state (Casola et al, 2018). Many of these workers work long hours, have little formal education, and are more likely to suffer from chronic health problems (Casola et al, 2018). Around 79% of outdoor farmworkers reported experiencing a heat-related illness during the summer harvest season (Casola et al, 2018). Many of these workers are here on H-2A visas for temporary workers, which can only be gotten if the employer can justify that there are no domestic laborers available (author interview with Vázquez, 2020). Most domestic laborers do not want to work in these kinds of jobs, and the people that take these jobs may take them to flee poverty or other dire circumstances (author interview with Vázquez, 2020). Because these workers are dependent on these jobs to stay in the country and make a living, they do not have the ability to find other, safer employment if the conditions become unsafe (author interview with Vázquez, 2020).

Furthermore, it can be harder for lower income communities to be able to adapt to climate risks. People with lower incomes have fewer resources to repair flood or other storm damage and may live in poor housing conditions that are more susceptible to damage (Yuen et al, 2017). People who do not read or speak English are less likely to be able to know about or access programs that could help them during or after an extreme weather event (Yuen et al, 2017). They also may not receive emergency warnings during disaster scenarios if those warnings only go out in English (author interview with Vázquez, 2020).

Many communities of color, indigenous peoples, and lower income communities already experience health disparities and have more limited access to healthcare, which can lead to increased risk from the health impacts of climate change (Casola et al, 2018). Air quality is often worse in low income communities and communities of color, which often are near large transportation corridors with significant amounts of air pollution (author interview with Witte, 2020). Risks such as extreme heat or poor air quality can exacerbate pre-existing conditions such as asthma (author interview with Witte, 2020). People with higher incomes are also more

able to buy air conditioners which can significantly reduce the risks of extremely hot weather (author interview with Dunn, 2020).

The majority of people in the government making climate related policies are from white and higher income communities. Similarly, the majority of people advocating for climate change are also whiter, older, and from higher income communities. Public outreach is often conducted after the policies have already been crafted and the public is generally only given the opportunity to make last minute comments or small modifications, rather than being a part of the decision-making process (author interview with Vázquez, 2020). Government planning processes often value technical expertise over knowledge gained through lived experience that community members possess (Yuen et al, 2017). To create equitable climate solutions, the communities who are most impacted must be included in the decision making process.

Snohomish County Climate Policy

Countywide Initiatives

County Operations

The County has an Office of Energy and Sustainability, which works on environmental protection, adaptation, mitigation, and resiliency for the county government and for the county as a whole (author interview with Dulude, 2020). The office conducts a lot of data analysis, policy work, and oversees programs to increase sustainability (author interview with Dulude, 2020). They are responsible for measuring and tracking whether the county is meeting its climate goals (author interview with Dulude, 2020). However, the office only has two employees and it is at the whim of the executive, so a new County Executive could potentially remove the office (author interview with Dunn, 2020).

The County recently formed a Climate Action Advisory Committee, which will help revise the internal sustainability plan for the county government, and then help create a climate action plan for the county as a whole (author interview with Dulude, 2020). The committee was first suggested by Jeanine SanClemente who founded the Snohomish County Climate Alliance, a group that helps local environmental groups coordinate with each other and share strategies (author interview with SanClemente, 2020). County Council Member Steph Wright read about the idea on the Snohomish County Climate Alliance's Facebook page and helped her advocate for its creation with the help of County Executive Dave Somers (author interview with SanClemente, 2020). The committee is under the County Executive's jurisdiction and will be used to help advise the county government and formulate policies that the county can adopt (author interview with SanClemente, 2020).

This committee tried to include diverse perspectives with different areas of expertise. People on the committee include a representative from the Tulalip Tribes, a Puerto Rican representative who focuses on giving a voice to underserved communities, a high school student and a college student, a green sustainable builder, a member of the Snohomish County Public Utility District, a member of the Snohomish Conservation District, a retired physician, and several other climate activists or experts (author interview with Dulude, 2020). Each person on the committee is assigned to a different area of expertise to research and then report their findings back to the whole committee (author interview with SanClemente, 2020). They are hoping to draft an update to the County's Sustainable Operations Action Plan (SOAP) by the end of the year, and they're expecting the countywide climate action plan may take 2-2.5 years to complete (author interview with Dulude, 2020).

The Emergency Management Department, Public Works Department, and Planning and Development Services Department also have crucial roles in responding to climate change. The Department of Emergency Management creates the Hazard Mitigation Plan for the county, which incorporates climate risks into its assessment (author interview with Dulude, 2020). It also helps respond to climate damage after emergency situations, along with help from FEMA and other state resources (author interview with Dunn, 2020). The Public Works Department helped create a tool with Cascadia Consulting Group that provides projected impacts of climate change and guidance considerations for staff to consider (author interview with Somers, 2020). Their Stormwater Management Division is also helping to update critical infrastructure and restore habitats (author interview with Somers, 2020). The Planning and Development Services Department works at creating regulations, codes, and plans that prevent harmful development (author interview with Dittbrenner, 2020).

The county government helps cities when requested. For some cities, the county takes the lead in making climate change recommendations, while other cities create their own plans. Megan Dunn explained that many smaller cities "don't even have a dedicated policy person, so

when there's an imbalance like that, the county usually takes authority and makes recommendations that are adopted by cities" (author interview with Dunn, 2020). The County Executive, Dave Somers, explained that they "try to be a funnel or focal point for information and resources" for cities (author interview with Somers, 2020).

Mitigation Policies

Snohomish County has begun to make significant strides on mitigation policies, even though there is still plenty of room to grow. Executive Order 13-48A was passed in 2013 with a goal of reducing greenhouse gas emissions 20% below year 2000 levels by 2020 (Snohomish County Executive Office, 2013). That executive order was passed as part of Snohomish County's Sustainable Operations Action Plan (SOAP) plan (Snohomish County Executive Office, 2013). The SOAP plan sought to provide "a strategic and systematic approach to integrating environmentally sustainable practices into County government operations" (Office of Energy and Sustainability, 2013).

The county sought to do this by implementing green building practices and using green materials, reducing greenhouse gas emissions from county operations, conserving resources, utilizing renewable energy, recycling and repurposing waste, implementing green purchasing practices, and promoting ecological preservation and healthy ecosystems (Office of Energy and Sustainability, 2013). Importantly, this plan was aimed at improving sustainable practices for county government operations, and did not necessarily apply goals to the county as a whole (Office of Energy and Sustainability, 2013).

In February 2019, more ambitious goals were set in a joint resolution between the County Executive and the County Council. Joint Resolution 19-006 committed the county to a goal of 100% clean electricity by 2030 and 100% clean energy for government operations by 2045 (Snohomish County Council & Snohomish County Executive, 2019). The Chair of the County Council, Nate Nehring, introduced the resolution and explained that it also included

“moving Snohomish County’s vehicle fleet to hybrid and electric vehicles, new county facilities being built to LEED standards, and installing solar panels where feasible” (author interview with Nehring, 2020). These actions also help implement more action items from the SOAP plan (author interview with Nehring, 2020).

County Council member Megan Dunn explained that an exemption from the requirement for LEED certified buildings can be requested, so it is important to watch to ensure that these exemptions are not being abused (author interview with Dunn, 2020). Dunn also noted that when Puget Sound Clean Air Agency proposed a regional fuel standard which would have helped the County meet their Clean Energy goals, the county council voted in 2019 to write a letter opposing the regional standard (author interview with Dunn, 2020).

One of the main areas where Snohomish County is leading is in the Snohomish County Public Utility District (commonly called PUD or SnoPUD). The PUD’s electricity is 98% carbon free (“Carbon Solutions”, n.d.). Although the PUD uses energy sources that do not produce direct carbon dioxide emissions, there are some critics due to the potential environmental impacts of hydroelectric dams and nuclear power plants.

Hydroelectric dams can obstruct fish migration and cause other negative impacts on plants and animals in and around the river (U.S. Energy Information Administration, 2020a). Nuclear power plants produce radioactive waste, and the unlikely scenario of an uncontrolled nuclear reaction could result in catastrophic, widespread contamination of air and water (U.S. Energy Information Administration, 2020b). As of December 2019, the PUD reported that eighty percent of their energy supply is generated from hydroelectricity, and less than ten percent is generated from nuclear energy (“Quick Facts”, 2019). These are from existing power sources and there are no current plans to build any new hydropower or nuclear power facilities, but they are working with Energy Northwest to support a program to build Small Modular Reactors (SMRs), which are nuclear fission reactors that are smaller than conventional reactors (author interview with Wolfe, 2020).

The reason that the PUD uses several different energy sources is that it provides them with the ability to balance energy supplies (author interview with Wolfe, 2020). Rebecca Wolfe, the PUD commissioner for District 2, explained, “When the sun's not shining and the wind's not blowing and power is low, they can amp it up by pushing out more nuclear energy. Whenever the river flows are low, they can amp up the nuclear and vice versa. Whenever the rivers are high and producing a lot of energy, they can reduce the amount of nuclear energy they produce. So it's a balancing act all the time to provide energy” (author interview with Wolfe, 2020).

Other energy sources include wind power, solar power, biomass, biogas, and landfill gas. The PUD currently has three wind projects, which produce 7% of the PUD’s overall fuel sources (“Quick Facts”, 2019). All other energy sources provide only 1% of the PUD’s energy or less. The PUD also has a solar project in Arlington, which provides backup power in case they have a major failure, ensuring that all of their data and systems are backed up (author interview with Wolfe, 2020). This power supply generates 500 kilowatts, which is enough to power about 50 homes (“Quick Facts & Figures”, 2020). They also help PUD customers install solar panels at their homes or businesses, providing technical assistance and in some cases offering credit for the energy generated (“Solar”, n.d.). Currently, customers of the PUD who have installed solar panels have a combined solar energy production of 15 megawatts, which is a very small fraction of the PUD’s total power sources (“Solar”, n.d.).

They also have two biomass energy projects that help supply renewable energy in the region. First, biomass energy is generated by Hampton Lumber Mills in Darrington, which burns wood waste by-products to generate electricity (“Quick Facts & Figures”, 2020). Second, a biogas facility, Qualco Energy in Monroe, takes waste such as cow manure, restaurant trap grease, and expired alcohol and soda to be able to produce electricity (“Quick Facts & Figures”, 2020). Both of these projects are also helpful from an adaptation perspective because they reduce waste, which can harm the environment. The Qualco Energy biogas project is especially helpful because it helps to keep rivers clean from agricultural sewage, urine, and manure

(author interview with Wolfe, 2020). The Qualco Energy project was established by a nonprofit partnership between Northwest Chinook Recovery, the Tulalip Tribes, and the Sno/Sky Agricultural Alliance (“Biogas”, n.d.). The PUD used to have a contract with H.W. Hill Landfill Gas Power Plant which converted methane gas that was produced from solid waste, but the contract expired in 2015 (“Landfill Gas”, n.d.).

The PUD has also begun energy storage projects (author interview with Wolfe, 2020). The PUD has already installed two energy storage systems at multiple sites using Modular Energy Storage Architecture (MESA) (“PUD Energy Storage Program”, n.d.). These battery installations were “designed to improve reliability and the integration of renewable energy sources” (“PUD Energy Storage Program”, n.d.). They also passed a resolution in favor of moving forward on electrification of transportation (author interview with Wolfe, 2020). This is critical because the county’s main source of greenhouse emissions is transportation (author interview with Dulude, 2020).

In 2014, the county launched a zero waste initiative to reduce the amount of waste produced at the Evergreen State Fair (author interview with Dulude, 2020). The County Council also passed resolution 19-015 in 2019, which aimed to reduce waste in county operations and expanded the zero waste initiative at the fairgrounds to be a year-round initiative (Snohomish County Council, 2019). This could be considered a mitigation effort because waste in landfills causes landfill gas, which is the decomposition of organic materials in landfills (“Basic Information About Landfill Gas”, n.d.). Landfill gas is composed of around 50% methane and 50% carbon dioxide (“Basic Information About Landfill Gas”, n.d.). This is significant because methane is 28 to 36 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year period (“Basic Information About Landfill Gas”, n.d.).

Adaptation Policies

Adaptation policies have not been focused on as heavily as mitigation measures in Snohomish County. Despite the lack of general policy, there are several ways that the county has begun to increase resiliency. These efforts are significant, but they are still largely insufficient. There is currently no coordinated countywide strategy for adapting to climate change and building resiliency. There has been a significant amount of restoration work, but not nearly enough to make up for the damage caused by development or to prepare for the risks of climate change.

One major area where the county has made strides is through the creation of the climate change decision support tool, which was created to provide climate and science data that could be used to inform design, maintenance, and operations decisions for the county (author interview with Winter, 2020). This tool is “a way to get data easily to employees that don’t have the time to research climate data” which will allow the county employees to consider climate change risks and give them information about ways those risks could be addressed (author interview with Winter, 2020).

They are currently in the process of updating the tool and creating a menu of different places to get information that is not included in the tool (author interview with Winter, 2020). However, use of the tool is not mandated and it has not gotten much use in departments outside of the Public Works Department (author interview with Winter, 2020). The county has also not approved allowing outside entities to use the tool, such as businesses in the county who may be interested in seeing that information (author interview with Winter, 2020).

The Surface Water Management Division (SWM) and Engineering Services (ES) of the Public Works Department does a lot of work to try to reduce flood risks. They established educational programs to help residents learn about practices they can utilize on their own properties to reduce flood risks (author interview with Snyder, 2020). Furthermore, SWM

coordinates with the Road Maintenance Division and Engineering Services to perform joint projects to capture stormwater and reduce flood risks (author interview with Snyder, 2020). SWM also coordinates with the Snohomish Conservation District on flooding related to rivers, levees, and dikes and related coordination with diking districts to help reduce flood risks (author interview with Winter, 2020).

Crucially, the county has purchased and acquired land for the purposes of protecting and restoring critical habitats (author interview with Somers, 2020). Although this is largely in response to land that has been harmed by development, the actions that are needed to address risks to habitats caused by development pressures are often the same actions that can help reduce the risks to habitats caused by climate change. There has been a significant amount of restoration work in the floodplains and in the estuaries (author interview with Somers, 2020). They have partnered with the Tulalip Tribes to do projects that are important for watershed restoration and fish recovery, such as removing dikes and replacing or removing culverts to allow for better fish passage (author interview with Somers, 2020). This work will also help reduce flood risks (author interview with Shattuck, 2020).

There is a Snohomish River Basin Salmon Conservation Plan, which they use as a framework for protection and restoration work in the Snohomish River Basin (author interview with Shattuck, 2020). The Snohomish River estuary is the second largest estuary in Puget Sound, and it has been thoroughly changed through agriculture and development (author interview with Wahl, 2020). Large parts of it have been drained and diked and turned into pasture land (author interview with Wahl, 2020). Since the conservation plan was incepted, there has been a large focus on estuary restoration (author interview with Wahl, 2020).

The county, the Tribes, and the Snohomish Conservation District utilize Floodplains by Design grants offered by Washington State's Department of Ecology to do restoration and resiliency work in the floodplains (author interview with Shattuck, 2020). Floodplains by Design grants do multi-benefit work that will help agricultural interests, fish interests, and help with

habitat restoration (author interview with LaFond, 2020). Instead of having competing interests all seeking the same sources of funding, it funds projects that integrate multi-benefit work that assists with multiple different priorities (author interview with LaFond, 2020).

For example, one current project involves converting a mostly unused old slough and restoring it into wetlands (author interview with LaFond, 2020). This will create more drainage space and hold water in the landscape, which will help the farmers by giving them increased drainage and easier permitting (author interview with LaFond, 2020). It will also help the flood planners by giving them new space to infiltrate water, and it gives fish new habitat space (author interview with LaFond, 2020).

The Surface Water Management (SWM) division of the Public Works Department also works on projects that help improve water quality and restore habitat (author interview with Winter, 2020). When they have to do projects that disturb habitat, they usually are required to do stream mitigation or restoration projects in order to be able to receive a permit (author interview with Winter, 2020). SWM often goes beyond the bare minimum when doing these habitat mitigation or restoration projects (author interview with Winter, 2020). They are strongly involved in the salmon recovery efforts for the region and are involved in many of the estuary restoration projects, such as the Smith Island Project that restored about 378 acres of tidal marsh estuary (author interview with Winter, 2020).

The Snohomish basin is considered a leader in terms of how much area has been opened back up to restoration, but it can take decades before restored land returns to a fully functional habitat (author Wahl, 2020). Although there has been significant restoration work done in the Snohomish River basin, the Stillaguamish is a lot more contentious and it is harder to be able to do multi-benefit work (author interview with LaFond, 2020). This is because the farmland pushes right up against coastal tideland, which is critical rearing habitat for Chinook salmon (author interview with LaFond, 2020). There is very little farmland that is unused or

underutilized near the Stillaguamish, which can make it hard to find land that can be used for restoration work (author interview with LaFond, 2020).

Although there have been significant efforts, one major concern is that the county currently has a no net loss policy on fish and habitat, but they have not been achieving no net loss (author interview with Shattuck, 2020). Due to climate change and population pressures, the no net loss policy is still resulting in a loss of fish and habitats (author interview with Shattuck, 2020). To achieve habitat restoration and restore the natural processes of the environment, the county needs to adopt a net gain policy (author interview with Shattuck, 2020).

The Public Works Department is also working on updating their Engineering Design and Development Standards (EDDS) for plantings on County property and creating a new plant manual (author interview with Winter, 2020). When the county plants on property they own, they have to use certain plants and they have to plant them in a certain way, but the EDDS that they currently use is over twenty years old (author interview with Winter, 2020). The intent is for this work to also be coordinated with the Planning Department if they update their tree canopy and retention requirements (author interview with Winter, 2020). They have developed a team of biologists, ecologists, botanists, planners, and engineers to work on updating the lists of plants, which includes picking plants that are more likely to withstand climate change impacts and explaining how to plant them effectively. However, this project has been put on hold due to the pandemic and other resource limitations (author interview with Winter, 2020).

To secure agricultural interests, the Snohomish Conservation District helps farmers look for funding opportunities for best management practice implementation and provides technical assistance on resilient practices to address the impacts related to climate change and other impacts like stormwater runoff from development, deforestation, and increased impervious surfaces (author interview with Lindemulder, 2020). This can include helping farmers get grants to improve flood control infrastructure, helping them get funding to adopt sustainable farming

practices such as cover cropping, and sharing modeling and data that will help farmers learn how climate change is likely to impact their land (author interview with Lindemulder, 2020).

There is also a Snohomish Farmland Conservation Strategy that was created in partnership with Snohomish Conservation District, PCC Farmland Trust, Forterra, The Nature Conservancy, Snohomish County, and the Washington Department of Fish and Wildlife ("Snohomish Farmland Conservation Strategy", n.d.). The goal is to preserve 15,000 acres of farmland over 10 years by purchasing conservation easements or acquiring land from willing sellers ("Snohomish Farmland Conservation Strategy", n.d.).

Lastly, the county has partnered with Forterra for a "Snohomish County Healthy Forest Project" that gets volunteers to come into urban parks and do restoration work, which includes removing invasive species and tree planting (author interview with Dulude, 2020). This program provides training to make volunteers become forest stewards, who can then organize and host restoration projects on their own using that training (author interview with Dulude, 2020).

Everett

Everett is the only city in this report that created their own hazard mitigation plan, which goes into more detail than the annexes created by the county for the other cities. This plan is laid out in two documents, the Hazard Inventory and Vulnerability Analysis which examines the risks that Everett faces and the Hazard Mitigation Plan that addresses what actions could be taken to increase resiliency. Both of these documents were created in 2018.

Everett has also developed a climate action plan, which was adopted by the city council in January 2020 (City of Everett, 2020). Everett hired Cascadia Consulting, which worked with the planning commission to create the plan (author interview with Bolerjack, 2020). Cascadia looked at the reports that Everett had done in the past and updated that information with new data, and then created goals for how Everett could move forward on climate policies (author

interview with Bolerjack, 2020). The action plan created a menu of options that the city council could consider and prioritize (author interview with Bolerjack, 2020). The city is also planning to put together a citizen's input committee for the climate action plan to help decide what direction the city should take when prioritizing the actions laid out in the plan (author interview with Kepford, 2020).

The plan set new targets for the city of Everett to try to achieve a 50% reduction in greenhouse gas emissions by 2030 and an 80% reduction by 2050 (City of Everett, 2020a). Many of the strategies considered in the plan try to help the city reach that goal (City of Everett, 2020a). There are a few adaptation items included in the plan, such as adopting new stormwater regulations and implementing infrastructure and landscaping to reduce heat island effects (City of Everett, 2020a). On January 29, 2020, the same day that the climate action plan was passed, the city also adopted a resolution declaring a climate crisis in the City of Everett (City of Everett, 2020b).

To achieve these goals, Everett is partnering with the PUD for the installation of electric vehicle chargers that the public can use (author interview with Bolerjack, 2020). Similarly, the city is replacing all light duty vehicles with electric vehicles when the vehicles are due to be replaced (author interview with Kepford, 2020). The City of Everett bought hybrid buses a few years ago and is now doing some trial programs with electric buses (author interview with Kepford, 2020). The city also partnered with Lime, a transportation company that builds electric scooters and bikes, to deploy electric scooters that residents and visitors can use throughout the city (author interview with Vogeli, 2020). Everett is additionally in the process of creating some no-car streets in downtown to promote walking, biking, scootering, and other forms of transportation that reduce greenhouse gas emissions (author interview with Vogeli, 2020).

To adapt to some of the climate risks, there is a plan to raise the ground near coastal development (author interview with Bolerjack, 2020). There have also been upgrades to the stormwater management system and the sewer system (author interview with Bolerjack, 2020).

Although much of Everett is exempted from being part of the Snohomish Conservation District, the city has partnered with the district to do green stormwater infrastructure installations almost every year (author interview with Jackson, 2020). Everett recently had issues with flooding on the north side of the city that led to flooding with raw sewage leaking into people's basements, and they had to do a significant reworking of the storm sewage system in that area (author interview with Kepford, 2020). Despite the work that has already been done, there may be more work that needs to be done in the future to protect Everett from stormwater and sewage runoff concerns.

Edmonds

In 2006, former Mayor Gary Haakenson formed the Mayors' Climate Protection Committee ("Mayors' Climate Protection Committee", n.d.). This committee was formed after former Seattle mayor Greg Nickels passed the U.S. Mayors Climate Protection Agreement in 2005, which more than 1000 mayors have since signed ("US Mayors Climate Protection Agreement", n.d.). Mayor Haakenson signed onto the agreement in April 2005 ("Mayors' Climate Protection Committee", n.d.).

The Climate Protection committee includes four members of the city government: the mayor, the developmental services director, the planning manager, and the environmental program manager ("Mayors' Climate Protection Committee", n.d.). It also includes eleven members from the community ("Mayors' Climate Protection Committee", n.d.). The mission of the Climate Protection Committee is to encourage citizens to be part of the solution, encourage city staff and citizens to conserve resources, work with the city council to implement ideas, and effectively address the future impacts of climate change ("Mayors' Climate Protection Committee", n.d.).

They also have a Mayor's Conservation Advisory Committee, which develops ideas for environmental and conservation policies to present to the Mayor that his administration could implement (author interview with Paine, 2020). This group has only been in existence since the beginning of 2020, and consists mainly of citizens, a Councilmember, and the Parks Department Director (author interview with Paine, 2020). According to City Council Member Susan Paine, this committee includes at least three people with PhDs in the environmental field and several people with master's degrees (author interview with Paine, 2020). However, she did note that the committee has a lack of diversity and could do a better job being representative of more communities (author interview with Paine, 2020).

Edmonds passed a climate action plan in 2010 which largely focused on mitigation measures with a goal of reducing greenhouse gas emissions to 50% below 1990 levels by 2050 (City of Edmonds, 2010). There are some adaptation action items recommended, including plans to preserve wetlands and lower risks by rezoning land use, strengthening sea walls and armoring embankments, and designing buildings to handle storm surge (City of Edmonds, 2010). City Council Member Diane Buckshnis said they were in the process of updating this plan to include the impacts of a restored marsh estuary and various ways of changing the mindset of citizens regarding fossil fuels (author interview with Buckshnis, 2020).

In 2017, Edmonds passed Resolution No. 1389, which committed to achieving or exceeding the goals established in the Paris Climate Accord (City of Edmonds, 2017). To achieve that goal, they have begun working with the consulting firm Environmental Science Associates to review existing climate related policies, create a greenhouse gas inventory, create a tracking tool, and review climate action plans from other jurisdictions (K. Lien, personal communication, Mar. 23, 2020).

The city adopted an urban forest management plan in 2019, which focuses on managing trees on public lands and identifies goals for protecting Edmonds' tree canopy (Davey Resource Group, 2019). Diane Buckshnis said that along with the plan, the city needs to update their

codes to protect the tree canopy (author interview with Buckshnis, 2020). Right now, the tree codes only exist in critical areas, so there are no mandates for preserving or planting trees in other areas (author interview with Buckshnis, 2020).

One of the main areas of contention is the Edmonds Marsh. There are currently ownership issues with part of the marsh being owned by Unocal, who is in the process of transferring the land to the Washington Department of Transportation (WSDOT) (author interview with Paine, 2020). This process is currently in the middle of a lawsuit, and the Department of Ecology has also gotten involved (author interview with Paine, 2020). The City of Edmonds is not a party in this lawsuit, and they are just awaiting this lawsuit to be resolved before they can join the discussion (author interview with Paine, 2020).

Edmonds considers the restoration of the Edmonds Marsh Estuary to be a very high conservation priority for the city (author interview with Paine, 2020). There has been discussion among the community and the City of Edmonds Administration regarding acquiring this parcel to be able to restore the entire area into a near-shore estuary and wildlife habitat by reconnecting the marsh to the Puget Sound (author interview with Buckshnis, 2020). This land purchase would be an essential component as the tidal channel created would restore the natural creek's function and reconnect the marsh to the Puget Sound (author interview with Scordino, 2020).

However, there are some people who do not want the City of Edmonds to acquire the land (author interview with Buckshnis, 2020). There are discussions within the city that the land should not be acquired because it is degraded land that some think it would be a liability (author interview with Buckshnis, 2020). Instead, they want to use the marsh primarily as a way to reduce stormwater risks and floodplain control, rather than try to restore the habitat (author interview with Buckshnis, 2020).

There have been some crucial steps taken to begin the restoration of the marsh. On a narrow 4-3 vote, the city council approved a buffer surrounding the marsh that would stop new development from being built within 110 feet of the marsh (author interview with Buckshnis,

2020). Additionally, a study was done to determine the health of the marsh and do feasibility studies on restoration projects (Windward, 2019). The study found that it was feasible for salmon to recover and that many animals are surviving, despite the degraded areas (author interview with Buckshnis, 2020). There is a large amount of community support for plans to restore the marsh, including a community group called Save Our Marsh which has been pivotal for moving restoration plans forward (author interview with Senderoff, 2020).

Other initiatives have included updating buildings for better energy efficiency, a solar initiative project, and stormwater infrastructure improvements, including a new pump station near the Edmonds Marsh which should allow the City to leave the tidegate open year round (author interview with Buckshnis, 2020). There is also a greening parks project that used an integrated pest management approach to landcare, which has achieved a 60% reduction in pesticide use since 2008 (“Greening Parks”, n.d.). Many park areas in Edmonds are completely pesticide free (“Greening Parks”, n.d.). Diane Buckshnis noted that people were shocked when water quality studies found that water quality by the dog park is better than other water quality areas along the shoreline (author interview with Buckshnis, 2020). Additionally, they have installed drip irrigation systems to replace overhead irrigation, which has reduced water consumption and costs by seventy percent (“Greening Parks”, n.d.).

Sultan, Gold Bar, Index

Few examples of actions to respond to climate change impacts have been taken in the more rural areas, as represented by the towns of Sultan, Gold Bar and Index. Part of this is due to a lack of funding, staff, and resources, which has hampered the ability to enact new policies (author interview with Sears, 2020). All of them receive planning documents from the county, including annexes to the Snohomish County Hazard Mitigation Plan that look at the threats faced in each area (Snohomish County, 2015).

In 2001, the city of Sultan adopted a repetitive flood loss plan and in 2005, they adopted a comprehensive floodplain management plan (Snohomish County, 2015). They have also built some flood fencing, though it has been prone to failures (author interview with LaFond, 2020). The City of Sultan received a grant that allowed them to install solar panels, which they use to power city hall and the library (author interview with Sears, 2020).

The City of Gold Bar passed Resolution 19-09 in 2019 which called for the city to produce a report on energy usage and actively look for funding sources to make Gold Bar more environmentally efficient (City of Gold Bar, 2019). They also recently passed a flood plan (author interview with Sears, 2020). The city also purchased a new snow plow to prepare for increased winter storm risks (author interview with Sears, 2020).

It was hardest to find information about the town of Index. The Snohomish County Hazard Mitigation Plan's annex for the town has indicated that they have implemented critical area regulations to protect critical habitat (Snohomish County, 2015). They have also adopted an emergency response plan (Snohomish County, 2015).

Outside of the cities' jurisdiction, there are other environmental activities and concerns happening in this region. Keith Binkley, the manager of natural resources for the PUD, talked about the Henry M. Jackson hydroelectric project, which is located in the Sultan River basin on the Spada Lake Reservoir. Before the dam was installed, the reservoir was used solely as a water supply source (author interview with Binkley, 2020). In 1984, the dam was built to add hydroelectricity capability (author interview with Binkley, 2020). This dam does a number of functions to try to enhance fish and wildlife habitats and moderate stream flows (author interview with Binkley, 2020).

To protect fish, it was built above a natural barrier outside of the historic zone where fish can migrate (author interview with Binkley, 2020). Crucially, it has the capability to regulate temperatures and volumes of water seasonally, which can create conditions that are favorable for salmon and other fish in the lower river (author interview with Binkley, 2020). One of the

ways they do this is through using a selective withdrawal structure, which is technology that allows you to draw water from different layers in the reservoir (author interview with Binkley, 2020). Because water temperatures vary within the reservoir and cooler water exists at the bottom, they can use this as a way to regulate the temperature of the rivers (author interview with Binkley, 2020). It has been observed that the coolest water in the rivers is below the two reservoirs (author interview with Binkley, 2020).

They can also start lowering the volume of water in the reservoir to prepare for larger storms during flood season (author interview with Binkley, 2020). This helps regulate stream flows and reduce flood risks (author interview with Binkley, 2020). Brett Shattuck agreed that the dam has been doing a lot of habitat enhancements to offset their impacts, and that hydropower in the Snohomish specifically had a lesser degree of impact on fish than other factors (author interview with Shattuck, 2020).

There were discussions starting in 2011 about the possibility of building a dam on Sunset Falls on the South Fork of the Skykomish River (Stevick, 2018). Sunset Falls is located near the town of Index (Stevick, 2018). The PUD board of commissioners decided to abandon the project in 2018 after a significant amount of controversy (Stevick, 2018). The Tulalip Tribes, environmentalists, and a large number of community members all opposed the dam (Stevick, 2018). At one point, there was a large gathering of people who had taken the day off work and came with signs to protest the building of the dam during a site visit from the Federal Energy Regulatory Commission on a Tuesday afternoon (author interview with Matzke, 2020). A member of the Hydropower Reform Coalition, who had gone to hundreds of these site visits, said that it was the highest turn out that he'd ever seen (author interview with Matzke, 2020).

Andrea Matzke was one of the leading community members that fought against the dam's construction. Matzke stated that the project would have lowered the water supply and harmed fish migration for seven species of salmon (author interview with Matzke, 2020). It also could have exposed minerals such as arsenic, cadmium, mercury, and lead into the waterways,

which would have threatened wildlife and drinking water (author interview with Matzke, 2020). The Hydropower Reform Coalition hired an independent environmental economist who found that the PUD had underestimated the cost of the project by two and a half times the real cost (author interview with Matzke, 2020). This analysis showed that the amount of power produced would not match the amount of money going into the project (author interview with Matzke, 2020).

Rebecca Wolfe, one of the current PUD commissioners, stated that she first became involved with the PUD by opposing the building of this dam (author interview with Wolfe, 2020). She further explained that while the project was originally going to be a full dam, they changed plans to try to reduce the risks to salmon and habitat and assuage some of the concerns that community members had about the project (author interview with Wolfe, 2020). To reduce the risks to fish species, they planned to have an inflatable weir which could be deflated at peak water and low water times (author interview with Wolfe, 2020). This plan would still be harmful to fish, but it would also further make it cost inefficient due to the amount of times the weir would be deflated and unable to produce power (author interview with Wolfe, 2020). Because of the environmental and economic concerns, the PUD eventually decided to abandon the project.

There is a current controversy regarding logging near Wallace Falls, a state park that is one mile northeast of Gold Bar. The Department of Natural Resources (DNR) owns the land directly adjacent to the park and plans to log the site (essentially clear cutting the site) (author interview with Dunn, 2020). The DNR does not call the proposed logging “clear cutting” because they would retain trees on the site according to state guidance on forest logging practices, but Dunn disagreed because they are planning to leave only 8 trees per acre, which would cut down more than 90% of the trees (author interview with Dunn, 2020). With a majority vote of 3-2, the County Council approved this planned logging project (author interview with Dunn, 2020).

The Department of Natural Resources claims that these logging projects are done for forest management purposes to reduce wildfire risk, but cutting down that many trees also

releases a lot of carbon into the atmosphere (author interview with Dunn, 2020). They are planning to replant the trees, but replanting also poses a risk for wildfire and stream flows (author interview with Wahl, 2020). When young trees grow, they grow really quickly and use up a lot of water (author interview with Wahl, 2020). Once trees reach a certain height, thickness, density, and maturity, they take much less water from their environment (author interview with Wahl, 2020). Additionally, when forests are cut down and allowed to regrow, they grow back extremely thick, which increases the danger for wildfires (author interview with Wahl, 2020). Logging could also increase the risk of landslides (author interview with Matzke, 2020).

Another reason for the planned logging is that the DNR sends the money gained from logging to fund counties, schools, hospitals, and fire districts (author interview with Dunn, 2020). Megan Dunn estimated that the logging around Wallace Falls would bring in about two million dollars, which the county would get 70% of and the Sultan School District would get around $40,000 (author interview with Dunn, 2020). This funding structure creates an incentive to do logging even if it's not what's best for the environment.

Jared Mead, a member of the County Council, pointed out that this plan could be detrimental to Gold Bar and surrounding areas, because it could dissuade hikers from going to Wallace Falls due to the views being not as spectacular with so much surrounding empty land (author interview with Mead, 2020). Jordan Sears echoed that concern because hikers bring money into the town, and they may go elsewhere if they see the empty lands surrounding Wallace Falls (author interview with Sears, 2020).

Because the area is outside city limits and owned by DNR, Gold Bar had no input into whether the logging would take place, even though three of their five city council members were completely opposed to it (author interview with Sears, 2020). There was only one County Council meeting about it, which was on a Wednesday at ten AM in a location far away from the City of Gold Bar (author interview with Sears, 2020). The agenda item was only announced the day before, and only ten Gold Bar residents were able to go to the meeting (author interview

with Sears, 2020). Although Stephanie Wright proposed setting up a meeting in Gold Bar or Sultan, no other meeting was planned before the Council voted (author interview with Sears, 2020). This has caused some contention with residents in this region, who feel that the County did not do enough to listen to the concerns of the people who would be most impacted by the logging project (author interview with Sears, 2020).

The following comparison report shows the different levels of climate policies that have been enacted in the county and the cities. Although this chart has been created to compare differences between the areas, it is important to note that these areas may also have different needs that can make direct comparisons difficult. For example, rural areas with more green spaces do not have the same stormwater runoff concerns as more urban areas.

Comparison Report

To assess the differences between these areas, a comparison chart was created. A red dot indicates that no relevant information has been found for the category. This may indicate a hole in the research rather than a lack in the area. Some threats may also not be as urgent in some areas.

General	County	Everett	Edmonds	Sultan	Gold Bar	Index
Climate Action Plan	●	Climate Action Plan (adopted in 2020)	Climate Action Plan (adopted in 2010) - in process of being updated	●	●	●
Hazard Mitigation Plan	2015 Hazard Mitigation Plan	2018 HIVA and HMP Reports	Annex to 2015 Snohomish County Hazard Mitigation Plan	Annex to 2015 Snohomish County Hazard Mitigation Plan	Annex to 2015 Snohomish County Hazard Mitigation Plan	Annex to 2015 Snohomish County Hazard Mitigation Plan
Citizen Climate Committee	Climate Action Advisory Committee	Planned for the future - not yet in place	Mayor's Climate Protection Committee	●	●	●

Mitigation	County	Everett	Edmonds	Sultan	Gold Bar	Index
Emissions Goals	Goal to reduce greenhouse gas emissions 20% below year 2000 levels by 2020	50% reduction in greenhouse gas emissions by 2030 and an 80% reduction by 2050	Goal to reduce greenhouse gas emissions to 50% below 1990 levels by 2050	●	●	●
Clean Energy Initiatives	PUD has 98% carbon free energy	Solar installations	Solar installations	Solar installations	●	●
Transportation	Electrification of the county's vehicle fleet	Electric vehicle chargers, hybrid/electric buses, no-car streets, plan to receive light rail	Comprehensive transportation plan (2015) which includes support for electrification	●	●	●

Adaptation	County	Everett	Edmonds	Sultan	Gold Bar	Index
Habitat Protection/ Restoration	Several habitat restoration projects in the Snohomish River Basin and floodplains	There is a wetlands sanctuary area in Everett	Edmonds marsh has been studied, a buffer has been approved, and some restoration work has been done	Less habitat destruction in rural areas - but critical areas should avoid new development	Less habitat destruction in rural areas - but critical areas should avoid new development	Less habitat destruction in rural areas - but critical areas should avoid new development
Development	Critical Area Requirements exist, but need better regulation	Some medium and high density housing, including permanent affordable housing for homeless families	Mostly single family homes, though there is beginning to be some higher density housing	Rural areas should try to avoid allowing too much urban sprawl	Rural areas should try to avoid allowing too much urban sprawl	Rural areas should try to avoid allowing too much urban sprawl
Sea level rise	2019 Shoreline Management Program	There are plans to raise the ground around some waterfront development				
Flooding	Public Works and Emergency Management Departments help mitigate flood risks	Stormwater infrastructure improvements	Stormwater infrastructure improvements	Stormwater utility adoption and some ineffective flood fencing		
Wildfire	Healthy Forest Projects with Forterra					
Food Security	Food banks	Several community gardens and food banks	Community gardens and food banks	Food bank		
Water Resources	Surface Water Management division of Public Works and a Ground Water Management Plan	Water quality testing program and annual quality reports	Water Comprehensive Plan and water quality reports	Water quality reports	Water System Plan and water quality reports	Presumably has water quality reports due to state regulations, but they were unable to be located online

All information received from interviews or literature cited within this report.

Barriers to Enacting New Policies

Funding

Government Budgets

Ultimately, most climate actions require funds to enact. Nate Nehring, the chair of the County Council, said that he thought funding was the top barrier to implementing climate policies (author interview with Nehring, 2020). He explained that the county has mandates that they have to comply with, and there isn't a lot of extra money that can be put into discretionary spending, which stretches their ability to address climate risks (author interview with Nehring, 2020). Two other County Council members, Megan Dunn and Jared Mead, also pointed to budget concerns as a major barrier (author interviews with Jared Mead, 2020; Megan Dunn, 2020).

Everett's Executive Director Bob Bolerjack said that Everett has been facing a structural budget deficit for many years, which is largely tied to the 1% property tax cap (author interview with Bolerjack, 2020). They are heavily dependent on property taxes, and costs have been rising at a rate much higher than that cap, which has led to budget shortfalls (author interview with Bolerack, 2020). Everett City Council member Liz Vogeli said that implementing action items from the climate action plan would be difficult to do in a timely fashion due to budgetary constraints (author interview with Vogeli, 2020).

Edmonds City Council member Susan Paine said there may be some areas where they do not have the funding necessary, but that she believes that there are still steps they can take to move forward, such as updating codes and regulations (author interview with Paine, 2020). City Council Member Diane Buckshnis added that the City Council already set aside $1.5 million to restore the marsh (author interview with Buckshnis, 2020). Because of her decade of

experience representing the City of Edmonds on the WRIA 8 (Water Resource Inventory Area 8) Salmon Recovery Council, she is confident that salmon recovery dollars would be available should the City decide to seek grant money to be able to acquire the property for a complete near-shore estuary restoration (author interview with Buckshnis, 2020).

The main threat to rural areas is a lack of funding and resource availability. A study into the socio-economic impacts of climate change in rural areas found that “vulnerability to climate change tends to be greater for rural communities who typically have fewer resources and fewer alternatives than urban areas” (Lal, Alavalapati, & Mercer, 2011). Jordan Sears, a member of the Gold Bar city council, explained that their city budget is extremely limited with almost no extra money for discretionary spending that could be used to adapt to climate change (author interview with Sears, 2020). There was no money allocated towards fighting climate change in the last budget, and he said there probably wouldn’t be in the next budget either (author interview with Sears, 2020). Sultan and Index are likely to be similar, but no interviews with city officials from Sultan or Index were conducted.

COVID-19 Pandemic

The County Executive, Dave Somers, said that the impact of COVID-19 on climate change-related funding could be significant (author interview with Somers, 2020). He stressed that they still did not know the full economic impacts from the virus (author interview with Somers, 2020). At the time of the interview (June 1), they were estimating that there would be a 28-30 million shortfall this year, and that the next year would have further economic shortfalls (author interview with Somers, 2020). His priority was to ensure that the climate change programs they already have implemented do not get cut (author interview with Somers, 2020).

At the local and state level, the pandemic is expected to have a significant impact (author interview with Nehring, 2020). This will significantly impact the amount of discretionary spending they can do or their ability to start new projects (author interview with Nehring, 2020).

Along with the budget implications, the virus made it so that government officials were unable to focus on other priorities, including climate change (author interview with Mead, 2020). In the Public Works Department, climate change has not been consistently addressed since the pandemic started, but the hope is that it should receive more attention again by late 2020 (author interview with Winter, 2020).

Everett's existing budget woes are expected to grow worse due to COVID-19, according to Bob Bolerjack and Liz Vogeli (author interviews with Bolerjack, 2020; Vogeli, 2020). They reported that it will be a challenge to do much that costs money for the next year and a half at least, and probably until 2022 (author interview with Bolerjack, 2020). Millions of dollars have been lost due to the virus and they’re not going to have funds available to make new investments (author interview with Bolerjack, 2020).

The Edmonds council members were unsure of exactly how COVID-19 would impact their budget (author interviews with Paine, 2020 and Buckshnis, 2020). Susan Paine said that she needed to do more research to figure out how much money the city has and how coronavirus will impact their budget (author interview with Paine, 2020). It was noted that the city previously had a very conservative finance director, so Edmonds might not be in as bad a position as some of the other municipalities (author interview with Paine, 2020). However, it is not yet known how long Edmonds will have to accommodate their reduced financial circumstances or financially assist struggling residents and businesses (author interview with Paine, 2020).

Because rural areas did not have funding to address climate change before the pandemic began, the pandemic will not substantively change the amount of funding that would go towards adapting to climate change, but it may further harm their ability to respond to an emergency. It may also be harder to receive county and state funds to help areas facing climate risks.

Private Budgets

Many of the areas that need to be adapted are owned by private landowners, farmers, or developers. Many of the changes that need to be made are very expensive, and the funding and grants available are very limited and highly competitive (author interview with Brausieck, 2020). Many of the updates to infrastructure needed require special permitting, especially when it will impact or connect to waterways, which is an extremely expensive process (author interview with LaFond, 2020).

One especially concerning area is flood control, drainage, and diking districts, which are run solely by the landowners participating in that area (author interview with Lindemulder, 2020). There may be only a handful of landowners who are responsible for paying the entire cost of everything that needs to be done (author interview with Lindemulder, 2020). This is especially problematic when it comes to drainage issues, because they are getting an increased amount of water from upland development, but most are still solely responsible for being the ones to maintain the drainage infrastructure (author interview with Lindemulder, 2020). Because the districts are fairly small, they generally can not collect enough money amongst themselves to properly maintain the flood control infrastructure (author interview with Lindemulder, 2020). Big infrastructure like pumps, tide gates, and floodgates are often prohibitively expensive to build or maintain without the assistance of grant funding (author interview with Lindemulder, 2020).

Rural areas may be especially susceptible to climate risks. The rural economy is often highly linked to the natural environment, including through agriculture, fisheries, tourism for hikers and campers, and other climate-sensitive sectors of employment (Jensen, 2009). All of these sectors of employment are at risk due to climate change, which will negatively impact the economic security of these areas. Climate change has already begun to negatively impact the economic security of these sectors of employment, especially when it comes to agriculture, hunting, and fishing. This will not just hurt the cities, but can also reduce the incomes of

individual landowners, which will make it harder for them to adapt their land to be able to manage climate risks.

Population Growth

Snohomish County's population is projected to grow to 955,281 total residents by 2035, which represents a 33.9% population gain between 2010-2035 (Snohomish County Tomorrow, 2015). As of 2019, the Census Bureau estimated that Snohomish County had 822,083 residents (United States Census Bureau, 2019). This population growth creates a huge amount of development pressure, especially when it comes to building housing.

There has been a lot of pressure to expand urban growth area boundaries, particularly in the south region of the county, to allow for more development (author interview with Mead, 2020). There are serious concerns about how the county can develop responsibly without allowing development to remove too much open space or natural areas (author interview with Mead, 2020). Zoning regulations and the enforcement of those regulations are integral to maintaining climate change resiliency and restoring habitat (author interview with Shattuck, 2020). This problem becomes more severe if development is largely done through single family units, rather than medium and high density development (author interview with Mead, 2020).

Pressures to further develop may also impact rural towns as urban and suburban areas begin to run out of land. These development pressures then lead to many of the same issues faced in urban and suburban areas, and can lead to a further loss of agricultural land. As populations grow, there will also be an increased cost due to needed infrastructure upgrades, such as new roads, curbs, sidewalks, sewers, wastewater treatment plants, and utility lines (Overmann, n.d.).

Political Will

Political polarization can be a major factor when it comes to addressing climate change (author interview with Somers, 2020). Although Republicans are often less likely to support climate change plans, Snohomish County does have bipartisan support for many climate change or environment related initiatives. Conservative members of the County Council have voted for several climate change related priorities. Megan Dunn (D) talked about working with Nate Nehring (R) on several climate change related items, even before she was a member of the council (author interview with Dunn, 2020). Bobbi Lindemulder mentioned that Sam Low (R) has been a great supporter of agriculture on the council (author interview with Lindemulder, 2020). Andrea Matzke said that former state senator Kirk Pearson (R) was the government official who gave her the most support in her fight against the dam, even though he was a Republican senator in a highly conservative district (author interview with Matzke, 2020).

Human beings are often better at responding to crises after the fact than they are at planning for them, which makes political efforts to combat climate change “woefully, woefully inadequate at many levels” (author interview with Somers, 2020). Similarly, it is often hard to get support for climate change because it is something that is not obvious and can be hard to see (author interview with Mead, 2020). It can be tough to get people to care about long term problems when there are other immediate concerns (author interview with Mead, 2020). Often, climate change initiatives need to be framed as having other benefits, such as economic benefits, to get enough support to pass (author interview with Somers, 2020).

Getting public buy-in is important to being able to push political officials in the right direction (author interview with Bolerjack, 2020).Politicians have so many bills and policies that they need to consider that it can be hard to get them to focus on a specific one (author interview with Alley, 2020). Campaigning can be like a full time job, and the length of most terms makes it so that politicians need to focus on campaigning, which can be to the detriment of being able to actually pass legislation if they do not rely on the critical research and advice by experts (author

interview with Alley, 2020).

Competing Interests

Competing Adaptation Interests

Historically, there has been a lot of competition for land use between farmland and habitat (author interview with Brausieck, 2020). Colin Wahl explained, “The floodplain needs to be engaged by the river, and it’s a really difficult thing to do because farmers are there” (author interview with Wahl, 2020). Agriculture is necessary for food security, but habitat restoration is critical for wildlife and fish survival (author interview with Wahl, 2020). The habitat destruction is not the fault of modern day farmers who are just farming the land of their ancestors, but the historical establishment of agriculture in the valleys destroyed fish habitat in the river (author interview with Wahl, 2020). Wahl stated, “The historical practices of land clearing and draining that occurred with the settlement and establishment of agriculture in the valleys was the biggest harm for fish here” (author interview with Wahl, 2020).

Other Competing Interests

Many industries, especially fossil fuel related industries and developers, will be harmed by climate change initiatives. In many cases, these industries have a lot of money and influence, which can make it hard to pass legislation that goes against their interests (author interview with Smith, 2020). As an example, there was a large backlash from the natural gas industry to the cap on natural gas that was placed in Everett’s climate action plan (author interview with Bolerjack, 2020). There have been huge investments made and a lot of livelihoods that are dependent on natural gas, which leads to backlash against actions that would harm the natural gas industry (author interview with Bolerjack, 2020).

Climate change regulations can make it more expensive for developers to build housing, and that increased cost is then passed on to the people who buy or rent the houses (author

interview with Mead, 2020). Unions are often against measures like gas taxes, because it makes it more expensive in many labor sectors, which means they may create less jobs or lower wages for workers (author interview with Mead, 2020). These competing interests can sometimes cause divides even within Democratic politics, because affordable housing and labor laws are also considered major party priorities (author interview with Mead, 2020).

Policy Proposals

Co-Benefits and High Priority Needs

Several of the following policy proposals have more than one possible adaptation benefit. Although they have been placed into particular categories for the sake of organization, they may also have benefits that extend into other categories. To try to show the multi-benefit impacts of each policy, the icons above will be used to label each proposal. Habitats refers to anything that will positively benefit habitats or wildlife. Water resources refers to anything that will help water quality or quantity. Emergency management refers to any measures that will help respond to emergency scenarios. High priority needs are highlighted in red.

General Recommendations

More Staff Dedicated to Climate Work

King County has a huge government with around 14,000 employees (author interview with Winter, 2020). In contrast, Snohomish County has just under 3000 employees (author interview with Winter, 2020). Only a small percentage of those employees are assigned to climate-related work (author interview with Winter, 2020). The Office of Energy and Sustainability only has two employees and it is hard to develop county-wide policies with only

two employees (author interview with Dulude, 2020). To have significant progress on climate change related priorities, there needs to be more staff that is dedicated to working on the issue.

In some cases, there may also be gaps in expertise needed for county operations. The county is unable to do everything internally because they don't have the specialists available, such as climate scientists (author interview with Winter, 2020). They are currently able to contract with consultants or with universities, but that contract work would benefit from being broadened and allowing more consultation with experts (author interview with Winter, 2020).

Another important thing to implement is education for county employees that will explain how climate change is likely to impact the county in the future (author interview with Winter, 2020). There are still employees who do not understand climate change or know what the expected impacts will be, which stops them from being able to consider climate change perspectives in their decisions (author interview with Winter, 2020). Having researchers, scientists, and staff that is assigned to work on climate change come in to do presentations and workshops could help elevate people's understanding of the issues (author interview with Winter, 2020).

Mandated Use of Climate Change Decision Support Tool

The Climate Change Decision Support Tool gives county employees the opportunity to easily get climate data to learn what risks might be associated with whatever project or policy they are considering (author interview with Winter, 2020). However, currently only specific project teams in the Public Works Department are mandated to use the tool (author interview with Winter, 2020). For instance, when the planning department does environmental reviews of projects that need permits, it may be appropriate for climate change to be a consideration into whether the permits should be granted or conditioned. The tool could be utilized to address

climate change depending on the location, type, and/or life span of the project (author interview with Winter, 2020). The county also could mandate that climate change is addressed when considering grading permits, land use permits, shoreline review, and other functions of county government (author interview with Winter, 2020).

At one point, there were around twenty-five different organizations or individuals outside of the county government who wanted to be able to use the tool (author interview with Winter, 2020). The county has not made the tool available to these outside organizations (author interview with Winter, 2020). If outside organizations were able to use the tool, it could influence the plans that are being made by private developers and companies, which could positively benefit the county's overall climate resiliency.

Stronger Policy Language and Increased Enforcement

The County Comprehensive Plan and Planning Policies should be updated to more substantively address climate change (author interview with Winter, 2020). Climate change considerations within the County Code could create more formal obligations that the county would be mandated to follow (author interview with Winter, 2020). These types of formal obligations are important, because the county has often focused on incrementalism and easy measures that can be done with no money (author interview with Dulude, 2020). Policies and executive orders have often had their language softened before being adopted (author interview with Dulude, 2020). Resolutions where there are no formal obligations are much easier to pass than measures that require actual implementation of their stated goals (author interview with Dunn, 2020).

The use of the word *may* in legislation, rather than the word *shall*, in reference to what our agencies or governments are responsible for can make regulations unenforceable,

especially for enforcement with larger companies that have legal representation (author interview with Matzke, 2020). For example, there is a state law, the Scenic Rivers Act, which used to have language that said no hydropower could be developed on certain rivers, but they changed the language to instead say that hydropower development should be *discouraged* (author interview with Matzke, 2020). By reducing the strength of the language, they lessened the ability to enforce these laws and keep environmental areas protected (author interview with Matzke, 2020).

In many cases, Snohomish County's policies and regulations are sufficiently protective, but they are not sufficiently enforced (author interview with Wahl, 2020). Loopholes in the regulations need to be removed and there needs to be stronger enforcement (author interview with Shattuck, 2020). There are floodway fringe regulations that strongly restrict development in the floodplains, but land still keeps being converted, so it's evident that the county is not strictly adhering to those policies (author interview with Dittbrenner, 2020). Developers are also able to ask for upzones, and pretty consistently are able to get those upzones, which occasionally leads to development in critical areas (author interview with Mead, 2020).

Community Input

The majority of county staff and people involved in environmental advisory boards are white, older, and higher income (author interview with Vázquez, 2020). It is hard to reach communities when you have little awareness of the cultures within that community, and it is especially hard to reach non-English speakers (author interview with Vázquez, 2020). To get more diverse perspectives, the county needs to do a better job doing outreach with communities of color, non-English speaking communities, and low income communities (author interview with Vázquez, 2020). This is especially important because these communities are likely already facing a lot of the effects of climate change, so they are more likely to know the solutions to some of these problems (author interview with Vázquez, 2020).

The county can put information in localized newsletters or radio pieces in the communities that need more outreach (author interview with Vázquez, 2020). This kind of outreach needs to be included in languages other than English to be able to reach all citizens (author interview with Vázquez, 2020). That kind of outreach is not enough, and there needs to also be in person communication (author interview with Vázquez, 2020). One possible way to reach communities would be to have community advocates that could organize or attend events within their community that are unrelated to any government activities and let them know where they can go for more information and what meetings they can attend to have their voices heard (author interview with Vázquez, 2020).

If meetings are created to try to get community input, there needs to be consideration into the timing and resources provided at the meetings. For people who have multiple jobs or children, it can be hard to attend meetings that happen in the middle of weekdays (author interview with Vázquez, 2020). It can be hard to attend at all if there is no childcare provided, or if there are no snacks provided when meetings take place over typical meal times (author

interview with Vázquez, 2020). Consultation with communities over the best times and locations to hold meetings, providing childcare services and snacks, coordinating with local community groups, and participating in local events may be helpful towardings gaining meaningful relationships and gathering important information and ideas.

Emergency Response

Before COVID-19 hit, there was an effort to try to find funding to set up generators for areas of Skykomish, Index, Gold Bar, and Sultan so that if a massive storm hit, people would have a place to go to keep warm and get help (author interview with Sears, 2020). They were trying to get four generators, one in Startup, one in Gold Bar, one in Index, and one in Skykomish, and were hoping to pool their funds together and get the state to match the money to be able to afford these generators (author interview with Sears, 2020). Plans and preparations to respond to the impacts of major storms are critical, especially snow storms where people could die from hypothermia without heat. This is particularly important for rural areas that may get cut off due to road or bridge failures.

Solar, wind, or other renewable energy sources can be used in more areas as backup power sources (author interview with Wolfe, 2020). More battery storage would also be extremely helpful for responding to widespread outages (author interview with Wolfe, 2020). Programs that encourage solar panel installations and battery storage could help prepare the county for power outages.

Sea Level Rise

Managed Retreat

In some cases, people or buildings may need to move away from land that is highly likely to get inundated as sea level rises. Managed retreat is “the purposeful, coordinated movement of people and assets out of harm’s way” (Carey, 2020). Part of this might include the county or cities acquiring the land that people are retreating from and using it for restoration purposes. Individual landowners who are forced to move due to climate change should be given enough compensation to be able to afford new land.

Shift from "Hard" to "Soft" Solutions for Coastal Management

Hard barriers can harm adjacent lands because waves will be deflected by the wall into their area (Spiegel, 2016). A hard structure will also result in scouring, where the waves hit the wall and begin digging out whatever is below the wall (Spiegel, 2016). If waves go over the top of the wall, they can scour out the other side too, which leads to the wall eventually collapsing (Speigel, 2016). Hard barriers create habitat loss for fish and animals, and if there is a salt marsh blocked off, it will prevent it from being able to soak up water during storms (Spiegel, 2016).

Most of the county’s shorelines are armored with rock, which prevents natural process function and disturbs important spawning habitat for foraged fish that salmon eat (author interview with Shattuck, 2020). Bulkhead development is an especially large problem, because people build them to protect their properties and do not get permits to do it (author interview with

Wahl, 2020). Some hard barriers are worse than others, but “the bulkheads seem to be by far the worst” (Spiegel, 2020). Figure 9 shows bulkheads being the worst way to protect against sea level rise in terms of protecting ecosystems.

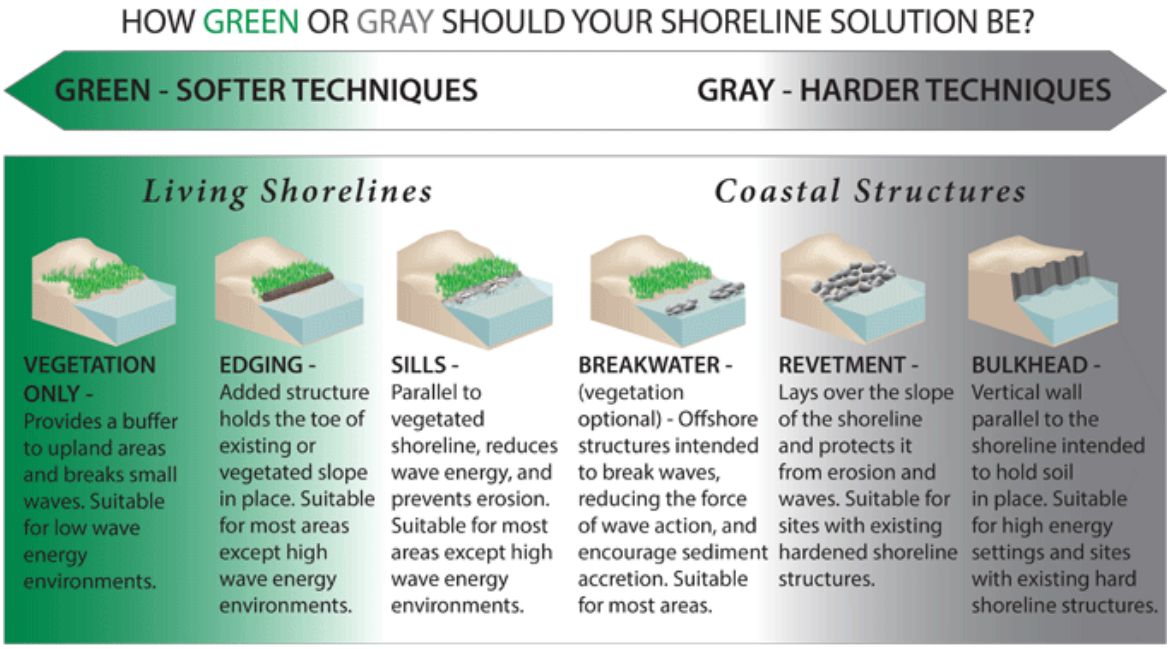

Figure 9: The difference between softer and harder shoreline techniques

To protect from sea level rise, natural “soft” solutions are recommended as both less harmful and more effective methods of protecting shorelines. Steven Scyphers, a researcher at Northeastern’s Marine Science Center, explained, “The natural science is becoming increasingly clear that artificial structures just are not as ecologically beneficial as the natural” (Spiegel, 2016). Soft solutions such as living shorelines and vegetated dunes work by providing a slope the water can run up to dissipate and soften its impact (Spiegel, 2016). These solutions keep habitat protected for plants and animals (Spiegel, 2016).

Seagrass beds help absorb the impacts of waves and currents, prevent erosion, and hold sediment in place (Snohomish County Public Works, n.d.). Seagrass plays an important role in coastal ecosystems, providing food and shelter for a wide variety of animal species, improving water quality, and mitigate some effects of ocean acidification (Christiaen et al, 2017).

In the Puget Sound, eelgrass is by far the most abundant seagrass species (Christiaen et al, 2017). Coastal wetlands can also stabilize shorelines by absorbing wave energy and holding sediments in place (“Conserving Coastal Wetlands for Sea Level Rise Adaptation”, n.d.).

Flooding

Countywide Flood Control District

Flood Control Districts are generally managed by local farmers who often don’t have the time or resources necessary to commit to it (author interview with LaFond, 2020). It is important to make sure that infrastructure is maintained and functioning properly. There are many drainage ditches that have not been dredged for 10-15 years and they are not functioning properly, but there is not enough funding to be able to clean them (author interview with Brausieck, 2020). There are a lot of new technologies that could be put into place, such as pumps that are safer for salmon to pass through and drainage tiles that have water controls on them that allow you to hold water back or let it out (author interview with Brausieck, 2020). Installing new technologies would go a long way toward protecting natural resources (author interview with Brausieck, 2020).

A larger district that could help the local districts deal with permitting or larger policy issues could be helpful (author interview with LaFond, 2020). King County has a countywide flood control district that is financed by per parcel fee collections, which enables them to be able to fund projects that help control floods and protect fish (author interview with Lindemulder, 2020). For example, Bobbi Lindemulder and her husband operate a cow/calf operation on 100 acres in the Snoqualmie Valley, and their drainage ditches became filled with sediment over time and had to be cleaned out to effectively maintain the drainage infrastructure on the land.

The process of getting the permits, engineering, and design plans needed to clean up less than 3000 feet of ditch and replace a crushed culvert with a bridge was going to be cost prohibitive to do on their own, and likely would have forced them out of business (author interview with Lindemulder, 2020).

Because they operate within King County, their flood control district, along with the King Conservation District and King County, was able to provide cost share and they were able to get the necessary work completed (author interview with Lindemulder, 2020). Bobbi added, “Without that, we never would have been able to do it. We probably would not be farming today, and are very grateful” (author interview with Lindemulder, 2020).

Flood Control Infrastructure Upgrades

Levee and dike failures can cause serious flooding damage. There needs to be a comprehensive strategy for levee maintenance, which would include assessing the condition of all the levees, working with the flood control and diking districts to see if improvements need to be made, and helping them get the permits for and afford these improvements (author interview with Brausieck, 2020). Building levees or dikes requires special permitting, especially if it is connected in any way to a fish bearing stream (author interview with LaFond, 2020). While this process is necessary to protect fish habitats, the process is extremely expensive and can be cost prohibitive to do (author interview with LaFond, 2020). In some cases, these projects may cost around half a million dollars (author interview with Brausieck, 2020). This could mean that repairs and upgrades that would ultimately be beneficial for fish or reduce flood risks may get delayed or never get done due to the expensive and burdensome work involved with permitting (author interview with LaFond, 2020).

The county currently only has an extremely small amount of money set aside to help with these upgrades (author interview with Brausieck, 2020). A program that gave landowners funding to help them through the permit process in situations where their upgrades would be beneficial to habitat restoration could be conducive to advancing these projects. Another possible idea could be an extremely low or no interest loan program that landowners could access to make costly repairs which would give them the opportunity to slowly pay for a project that they otherwise could not afford (author interview with Brausieck, 2020).

If a levee or dike is up to Army Corps of Engineers standards, it can get enrolled in the PL84-99 program. However, these levees or dikes were originally built by landowners who often did not have the initial upfront investment to make them high and wide enough to be up to the Army Corps of Engineers standards (author interview with LaFond, 2020). If the dikes are brought up to their standards and enrolled in the program, then the Army Corps of Engineers will pay for a portion of maintenance costs each year (author interview with Dittbrenner, 2020). They will also come out to inspect the dike and tell the owners what maintenance needs to be done to keep the dike up to their standards (author interview with Dittbrenner, 2020).

Crucially, if there is a big levee failure and water is rushing into the land, they will come out to fix the dike, giving landowners the security of knowing that the federal government will help in the case of a catastrophic event (author interview with Dittbrenner, 2020). A grant program that would help local flood control and diking districts get their dikes up to Army Corps standards would be helpful (author interviews with LaFond, 2020; Dittbrenner, 2020).

Stormwater Infrastructure Upgrades

Many areas in the county have stormwater infrastructure that could be upgraded or retrofitted (author interview with Jackson, 2020). Completely replacing old infrastructure would

be enormously destructive, and the environmental impacts of digging up pavement to replace them would outweigh whatever benefits you'd get from replacing them (author interview with Jackson, 2020). However, when there are opportunities to do so without causing extra damage, such as when culvert replacements are going in or they are expanding a road, it is a good idea to take that as an opportunity to remove old pipes (author interview with Jackson, 2020).

Generally, the best way to manage stormwater is to retrofit with green infrastructure so that the grey systems become more of a redundancy (author interview with Jackson, 2020). There are several different methods of green infrastructure, including native vegetation, street trees, and rain gardens. Stormwater catchment systems that capture rainwater can also be beneficial for reducing flood and contamination risks.

Native vegetation and trees are the "real heroes" of stormwater management (author interview with Jackson, 2020). They are adapted to our flood drought cycle and our climate, so they do not need a large amount of maintenance (author interview with Jackson, 2020). Native vegetation is installed simply by digging a hole in the ground, putting in special soil that allows water to be retained and percolated down to the water table, and then with a couple of years of maintenance, native vegetation will be able to naturally store and filter water (author interview with Jackson, 2020). According to David Jackson, "it's incalculable how effective and how helpful" native vegetation is in reducing flood and contamination risks from stormwater runoff (author interview with Jackson, 2020).

Street trees, especially deciduous hardwood trees, are especially helpful in their ability to store water (author interview with Jackson, 2020). Trees reduce stormwater runoff by "capturing and storing rainfall in their canopy and releasing water into the atmosphere" (Environmental

Protection Agency, 2013). They help create soil conditions that will allow for better infiltration of rainwater into the soil (Environmental Protection Agency, 2013). Trees are also able to transform pollutants into less harmful substances (Environmental Protection Agency, 2013). Other than the stormwater benefits, trees are also beneficial in terms of habitat and carbon sequestration (author interview with Mead, 2020).

Tree ordinances can be put into place to mandate that a certain number or percentage of trees are not removed during development (author interview with Mead, 2020). If they do have to cut down most or all of the trees, developers can be mandated to plant and grow other trees in that area (author interview with Mead, 2020). A lot of tree codes in the county, including in Edmonds, only exist for critical areas, and there are often no regulations about how many trees need to be planted in less critical areas or code requiring developers to either save or replace trees cut using a tree bank process (author interview with Buckshnis, 2020).

The City of Lynnwood has developed a tree voucher program, where developers need to put money into a tree fund whenever they cut down trees (“Tree Voucher Program”, n.d.). People can then apply for a tree voucher, which is a coupon that can be used to buy almost any type of tree from a participating Washington State Landscape and Nursery Association nursery (“Tree Voucher Program”, n.d.). Anyone is eligible to apply for this voucher as long as the tree will be planted within Lynnwood city limits and they haven’t received another tree voucher within the last twelve months (“Tree Voucher Program”, n.d.). Diane Buckshnis stated that Edmonds is interested in the possibility of adding a tree voucher program and other incentives to educate citizens and developers that trees are essential in maintaining, enhancing or retaining our tree canopy (author interview with Buckshnis, 2020).

Rain gardens are another green stormwater infrastructure system. Rain gardens are landscaped gardens that enhance the landscaping and appearance of yards, provide habitat for insects and birds, filter stormwater runoff, reduce flooding on neighboring properties, and increase the amount of water that soaks into the ground (Hinman, 2013). Installing rain garden

clusters in neighborhoods is one of the most successful projects at the Snohomish Conservation District (author interview with Jackson, 2020). They are especially beneficial due to homeowners wanting them for their aesthetic value as well as their ecological value (author interview with Jackson, 2020).

Stormwater Capture and Filtration

Stormwater catchment allows for the possibility of using rainwater as a resource (author interview with Jackson, 2020). Rainwater can be treated and then absorbed into the aquifer through the soils, where it will then enter streams and rivers through the soil matrix (author interview with Wahl, 2020). Stormwater catchment systems also help slow the water runoff down and settle out any sediment before it gets into the streams (author interview with Wahl, 2020). Some examples of stormwater catchment can include rain barrels and cisterns (author interview with Jackson, 2020)

Equitable Solutions to Stormwater Management

In Seattle, there is a program called RainWise that provides rebates to property owners or contractors for installing rain gardens or stormwater cisterns in the highest priority stormwater management areas (Office of Sustainability and Environment, 2015). Seattle's government also provides low income grants for on-site projects and advance loans to be able to build without up-front expenditures (Office of Sustainability and Environment, 2015). Snohomish County could provide similar options to help low income communities be able to reduce their risks of flooding and heat islands.

One concern with a tree voucher policy is that it could widen gaps in the equitable distribution of natural amenities, such as tree cover, and fail to address the problems of heat islands and pollution impacts when there are no guidelines about where trees can be planted using tree vouchers. Tree vouchers could have conditions that mandate that trees are planted in areas that have the highest stormwater management risks or in areas that are otherwise lacking green spaces. Consultation with communities of color and low income communities can help ensure that tree voucher programs are designed in an equitable way.

Low Impact Development

Higher development leads to impermeable surface which does not allow water to soak into the ground where it falls (author interview with Jackson, 2020). Low Impact Development (LID) is “an alternative site design strategy that uses natural and engineered infiltration and storage techniques to control storm water where it is generated” (Guillette, 2016). Natural solutions can include many of the previously mentioned green infrastructure techniques (Guillette, 2016). Engineered solutions can filter stormwater from impervious surfaces or store and slowly release water (Guillette, 2016). For example, LID can create areas within the footprint of buildings that allow for an infiltration rate high enough to offset the impermeable surface that has been created (author interview with Jackson, 2020). LID also can involve reducing the amount of impervious pavement built into infrastructure (Guillette, 2016) LID helps reduce the risks of flooding and contamination, and recharges the water table (author interview with Jackson, 2020). Although there is still a lot of room to grow, “low impact development standards are better now than they probably ever have been” (author interview with Jackson, 2020).

Flood Warning Systems

The flood warning system in Snohomish County is one opportunity where improvements may be made (author interview with Lindemulder, 2020). Floods have become way more unpredictable, and the farming community is interested in looking at existing gauge locations to see if they are in the appropriate places for the best information (author interview with Lindemulder, 2020). In the Stillaguamish, farmers say they are experiencing much higher, faster

and unpredictable flood events in some areas that do not allow them the time to prepare as they had historically (author interview with Lindemulder, 2020). This is partially due to flooding events becoming much faster, but the flood warning system should also be looked at and adapted to be more accurate with current flood data (author interview with Lindemulder, 2020).

Wildfires

Fire Safety Education

Because 95% of fires in western Washington over the past four years have been ignited by humans, education for Snohomish County's residents is crucial for any fire reduction plan (Morgan et al, 2019). The Emergency Management department puts on seminars for landowners to create fire safe zones (author interview with Somers, 2020). Programs like this should be expanded and should be made available virtually and in multiple languages.

Forest Management

Currently, the state has short forestry rotations where they cut down an area, plant more trees, move on to the next area, and then eventually get back to that area to cut the trees down again in a few decades after they have regrown (author interview with Wahl, 2020). When this happens, replanted areas have grown back at high tree and shrub density, which adds to wildfire risk (author interview with Wahl, 2020). This practice is also bad for hydrology, because young trees suck large amounts of water out of the soil, which makes summer flows lower and warmer (author interview with Wahl, 2020). Instead of entirely clearing out large areas, thinning or clearing out small sections may be a better solution (author interview with Sears, 2020).

Power Infrastructure Upgrades

Some power infrastructure can spark fires, so it is important to ensure that equipment that is installed on poles and the grid structure are well protected and unlikely to spark (author interview with Wolfe, 2020). Fires can occur within the meters themselves or on the lines (author interview with Wolfe, 2020). One of the main ways to protect power infrastructure against sparks is by deterring or preventing squirrels, rats, and other small animals from chewing on power lines because rodents are the leading cause of fires on power lines (author interview with Wolfe, 2020). Keeping vegetation and trees near power lines under control is also important to avoiding fire risks (author interview with Wolfe, 2020). Burying electric lines can be helpful for preventing damage from rodents from eating their lines, falling trees, or snow storms damage (author interview with Wolfe, 2020). Lines are rarely buried due to the large implementation cost and the increased cost of repairs when there is a break, but it may be cost effective and safer in the long run because they are less susceptible to damage (author interview with Wolfe, 2020).

Let It Burn

In some cases when fires are far away from residential areas, the best course of action may be to let wildfires burn (author interview with Wahl, 2020). Fires can play an important ecological and cultural role (Morgan et al, 2019). Historically, indigenous peoples “used wildland fire as a tool for centuries to remove undergrowth for easier travel and to promote growth of edible plants” (Morgan et al, 2019). Fire has been shown to influence which tree species grow in the forest and help ecosystem processes such as nitrogen fixation and nutrient cycling (Morgan et al, 2019). However, this solution may not be possible because the Department of Natural Resources is required to actively suppress all fires (Morgan et al, 2019).

Public Health

Greenhouse Emission Reducing Policies

Although policies that reduce greenhouse gas emissions are usually considered mitigation policies, they will also have direct and immediate health benefits through reducing harmful air pollution (author interview with Witte, 2020). Electrifying the transportation grid by using electric buses and incentivizing the use of electric vehicles can have an especially large impact (author interview with Witte, 2020). Incentivizing and encouraging the use of active transportation, such as bicycling and walking, will not only get more fossil fuel vehicles off the road, but will also improve the health of people utilizing those methods of transportation (author interview with Witte, 2020).

Cooling Urban Areas

Public Health

Increasing green spaces in urban areas will not only help capture some carbon dioxide and help with stormwater runoff, but it will also reduce the heat island effect (author interview with Witte, 2020). Incorporating more green spaces is associated with “increased life expectancy, improved respiratory health, and positive mental health and cognitive benefits” (Vossler et al, 2019). Passive cooling refers to “any technologies or design features adopted to reduce the temperature of buildings without the need for power consumption” (Taleb, 2014). This is in contrast to active cooling methods which use energy to cool a building, such as air conditioning units (Chetan et al, 2020). Both passive and active cooling methods may be needed to counteract the heat island effect. Because many low income houses may not have access to air conditioning units, increased funding for air conditioning units in low income areas would be beneficial.

Land Use and Development

Growth Management

Water Resources Food Security Habitats Flooding Sea Level Rise

The State of Washington established the Growth Management Act to reduce sprawl and incentivize coordinated planning at the county to city level across the state. However, due to rapid immigration into the state, and even more rapid rise in housing costs, there has been a lot of pressure to expand the growth management boundaries (author interview with Dulude, 2020). Boundaries continue to be pushed back, contributing to urban sprawl and increasing flood and habitat risks (author interview with Jackson, 2020). Development needs to be focused in the

uplands and out of the floodplains (author interview with Wahl, 2020). Regulations need to prohibit building or expanding into nearshore, high risk areas (author interview with Wahl, 2020).

Affordable Medium and High Density Housing

To avoid pushing growth boundaries, we need to create more housing stock using less land (author interview with Mead, 2020). Most of the housing developers in Snohomish County are single family home developers (author interview with Mead, 2020). Zoning policy and regulations need to be put into place to have areas that require medium or high density with mandates that a large fraction of housing is dedicated to affordable housing for low income communities (author interview with Mead, 2020). This could include multifamily housing, detached condos, or townhomes (author interview with Mead, 2020). More sustainable, low income, and high density housing would reduce the total footprint of impermeable surface and decrease flood risk (author interview with Jackson, 2020).

Cohousing communities have small houses that face each other, a shared common house where people can gather for meals, open green space, walkways that allow the area to be walkable, and a parking lot that is set away from the homes (author interview with Smith, 2020). Some cohousing communities also have a large organic community garden that will be used to produce a lot of their own food (author interview with Smith, 2020).

In Marysville, development codes allow for cottage style development with no minimum lot size, which allows for this kind of development (author interview with Smith, 2020). This kind of development should be encouraged throughout Snohomish County because it better utilizes the land by increasing the numbers of people that can be housed in one area and by allowing for more green space which will help with reducing heat island and stormwater runoff concerns. In some areas, the costs of lots may be a barrier, so incentives for developers to make this kind

of community could be beneficial. Dean Smith noted that they originally planned to build a cohousing community in Everett, but they were unable to get far in their planning due to the high cost of land (author interview with Smith, 2020).

Public housing should also be built to help the homeless population (author interview with Mead, 2020). Someone would need to spend 60% of median family income to be able to afford the cheapest unit they could find in Snohomish County, which is not financially possible for many families (author interview with Mead, 2020). The homeless population is going to get much worse if public housing is not made available (author interview with Mead, 2020). This is especially crucial because “individuals experiencing homelessness are disproportionately impacted by disasters due to factors such as exposure to the elements, lack of resources and services, as well as disenfranchisement, and stigma associated with homelessness” (Gibson, 2019).

Relocating Infrastructure

Roads, buildings, commercial and industrial facilities, elderly facilities, health and safety structures (fire/police/hospitals), and other infrastructure may need to be relocated or removed (author interview with Winter, 2020). New infrastructure plans may need to be created for alternate locations that can better withstand climate risks, including flooding, fires, urban heat island impacts, or landslide and erosion hazard areas (author interview with Winter, 2020). Because relocating infrastructure is enormously expensive, this may require federal and state partnerships.

Habitat/Species Restoration

Protect Against Future Habitat Degradation

It is always better and cheaper to protect something before it gets degraded rather than restoring it (author interview with Shattuck, 2020). Protection work can be done through appropriate regulations and acquisition of functioning habitat (author interview with Shattuck, 2020). Avoiding development within critical areas is crucial to habitat protection (author interview with Shattuck, 2020). The regulations need to not just exist, but be strongly enforced (author interview with Shattuck, 2020).

Restore Natural Processes

The main way to improve natural habitats is to restore natural processes, which organically help stave off some of the effects of climate change (author interview with North, 2020). Natural process restoration gives habitats room to reestablish themselves and protect species without having to try to find a way to engineer better outcomes, which often doesn't work and requires a lot of maintenance (author interview with Shattuck, 2020). Some of the main threats to natural process restoration are development in floodplains, development in riparian areas adjacent to streams and rivers, development on shorelines, armoring on shorelines to protect that development, and urban sprawl (author interview with Shattuck, 2020).

Riverine and wetland restoration often requires removal or set back of levees and berms to allow a river to flow naturally (author interview with Wahl, 2020). Doing this will improve the habitat and will drastically decrease the likelihood of the engineered constraints (levees/berms) failing (author interview with Wahl, 2020). Moving levees back helps

accommodate floodwaters, which decreases the flooding impacts on people living in these areas (author interview with Wahl, 2020).

In many cases, the struggle is that levees were built too close to rivers, and the towns or farms are directly adjacent to them, which means the only way to move them back is to acquire that space (author interview with Wahl, 2020). In many cases, these areas have been extremely flood prone and as flooding gets worse, people may be forced to move on their own (author interview with Wahl, 2020). This land can be utilized for floodplain restoration, giving the river an opportunity to restore its natural processes (author interview with LaFond, 2020). When landowners have to give up land due to environmental changes, they should be compensated or given resources to help them buy new land (author interview with LaFond, 2020). They could also be given the opportunity to sell the land to the county at fair market value (author interview with Wahl, 2020).

Connecting habitats is another important piece of resilience and needs to be done on a large scale (author interview with Shattuck, 2020). You can not make big gains by only having a few small restoration projects (author interview with Shattuck, 2020). Brett Shattuck explains, “If you can’t see it from a zoomed out Google view of the Snohomish basin, it’s probably not big enough” (author interview with Shattuck, 2020).

Estuary and Wetlands Restoration

Estuaries are crucial habitats, especially for salmon production (author interview with Shattuck, 2020).There are not a lot of intact estuaries and marshes in urban areas (author interview with Shattuck, 2020). The marsh habitats give a refuge habitat for juvenile salmon to forage, escape predators, and grow before they go out into the salt water (author interview with Shattuck, 2020). If the Edmonds Marsh was reconnected to the Puget Sound, it would be one of

the few places in that area where fish would have the opportunity to utilize that kind of habitat (author interview with Shattuck, 2020). It also provides habitats for birds and other species that may not thrive in other areas (author interview with Shattuck, 2020).

Additionally, urban wetlands are incredibly important for water storage and filtration (author interview with Jackson, 2020). There was a survey done on wetlands in Everett that found the wetlands were doing a huge amount of heavy lifting to prevent flooding (author interview with Jackson, 2020). Wetlands that are further up in the watershed do a great job for runoff and water quality management (author interview with Jackson, 2020). Estuaries also have significant potential benefits when it comes to accommodating sea level rise (author interview with Shattuck, 2020). Wetlands and estuaries should be preserved if they are in functional condition, and acquired, restored, and reconnected when they are degraded.

There are significant water quality concerns, especially in the Snohomish near the estuary (author interview with Shattuck, 2020). Water coming out of water treatment facilities has been a hotbed for contaminants (author interview with Shattuck, 2020). Water quantity is also important, especially since climate change is going to have a significant impact on lowering flows during the summer (author interview with Shattuck, 2020). Some exempt wells are problematic for drawing too much water out of the streams and rivers (author interview with Shattuck, 2020).

The county has a lot of culverts that are very harmful for fish passage (author interview with Shattuck, 2020). The county needs to put more funding into culvert repairs or bridge replacements for improved fish passage (author interview with Shattuck, 2020). Much more

funding also needs to be put into habitat and estuary restoration, as seen in the previous section.

There has been a good working relationship with hydropower facilities on the Snohomish and they've been successful at reducing impacts from hydropower and even getting some potential benefits (author interview with Shattuck, 2020). Despite this, any additional hydropower facilities should be highly scrutinized to make sure that there is no development in places where it would harm fish (author interview with Shattuck, 2020).

Beaver Repopulation

Historically, there were huge colonies of beavers throughout the watershed, whose dams would hold water up in the watershed longer and keep it in the landscape (author interview with Wahl, 2020). Beavers are at risk because they get in the way of development and most people do not want beaver swamps on their land (author interview with Wahl, 2020). Instead of killing beavers, there have been efforts to trap and relocate them, usually upstream, where they will create habitat and store water (author interview with Wahl, 2020).

Agricultural Resiliency

Education and Funding for Agricultural Changes

Funding to create programs that would help educate farmers about what further changes they can expect due to climate change and how they can best adapt their farming practices would be hugely beneficial (author interview with Dittbrenner, 2020). These programs could be done through the county itself or through the Snohomish Conservation District (author interview

with Dittbrenner, 2020). This could help farmers anticipate the changes to the flood and drought cycle and learn about crops that are better suited to higher temperatures or higher salinity, more effective and sustainable agricultural management styles, drought resilient practices, and effective pest management techniques (author interview with Dittbrenner, 2020). Planning workshops could be created to assist farmers in using climate planning tools, such as Cool Farm which is a simulator where they can plug in their management, crops, and livestock and build a climate resilient farm that helps sequester carbon (author interview with Brausieck, 2020).

Farmers will also have huge costs associated with adapting their farms to prepare for climate change and the funding that is currently available for this is extremely limited (author interview with Dittbrenner, 2020). Getting these funds is also a very time consuming and bureaucratic process with no guarantee of ever receiving any funds (author interview with Dittbrenner, 2020). One possible solution that will be explored in the next section is giving funding to farmers who implement carbon sequestering projects, which are often practices that can also help them adapt to climate change (author interview with Brausieck, 2020).

There are a few federal and state programs that provide funding for sustainable resilient farming practices, including the Sustainable Farms and Fields bill which was signed into law by Jay Inslee in April 2020 (author interview with Brausieck, 2020). This bill created a new grant program to fund farmers who adopted practices that sequester carbon and reduce emissions (author interview with Brausieck, 2020). There are also a lot of private companies that are starting investment schemes that will pay farmers to farm in a climate friendly way, such as by putting in cover crops, reducing their tillage, or establishing perennial crops (author interview

with Brausieck, 2020). Most of these practices also are linked to increasing resiliency (author interview with Brausieck, 2020). Some practices, like agroforestry, have long term benefits in higher value tree crops and drought resilience, but are expensive upfront due to the amount of land that is lost to trees, so these practices may not be possible without more carbon credit programs like these (author interview with LaFond, 2020).

Farmers can protect against drought by improving soil health and building organic capacity (author interview with Dittbrenner, 2020). Agroforestry can improve organic matter in soils and provide shade to the ground that helps hold the water in (author interview with Dittbrenner, 2020). No till farming and cover cropping can also increase the organic matter of the soil (author interview with Dittbrenner, 2020). There are also some sensor systems that are being piloted that give really specific groundwater measurements that allow farmers to know exactly how much water to use (author interview with LaFond, 2020).

Funding to help farmers implement these techniques for the first few years until they start to reap the benefits could be helpful (author interview with Dittbrenner, 2020). Pilot programs for commercial farmers are helpful because there's a lot more risk for commercial farmers and they need to see a practice working on a larger scale for it to get widespread adoption (author interview with LaFond, 2020).

Farmers could benefit from having an irrigation district that allows for collective water rights management (author interview with LaFond, 2020). Many farmers do not have water rights and it can be hard or impossible to be granted a water right because the water levels in the rivers are too low in the summer (author interview with Dittbrenner, 2020). Irrigation districts are non-regulatory special purpose districts that have broad statutory authority to address water-related issues (author interview with Krass, 2020). Water banking can be one major function of irrigation districts, and can be used as a way to manage voluntary transfers of water rights (author interview with Krass, 2020). Irrigation districts can be used as an administrative tool to organize the sale of water rights in a central location by setting the prices, filling out paperwork, and building awareness to bring buyers and sellers together (author interview with Krass, 2020).

The Snoqualmie Valley Watershed Improvement District (SVWID) is an irrigation district in the Snoqualmie Valley which manages the transfer of water rights (author interview with Krass, 2020). The district assembled an auction to sell water rights, including water rights that they purchased and water rights owned by other interested sellers who were not using their entire water right, to sell to interested buyers who needed more access to water (author interview with Krass, 2020). Irrigation districts do not have the authority to move water rights around or create new water rights, but it can help with voluntary transfers of water rights or secure funding to buy water rights that are for sale (author interview with Krass, 2020).

Irrigation districts can also help with other agricultural needs, including helping with best management practices for irrigation and drainage maintenance (author interview with Krass, 2020). One of the other major priorities for SVWID is helping with drainage maintenance (author interview with Krass, 2020). As previously mentioned, drainage is a huge concern for farmers and maintaining drainage networks can be cost prohibitive for individual farmers. The irrigation districts assist with planning, design, construction, and maintenance of agricultural drainage networks (author interview with Krass, 2020). SVWID has also coordinated extensively with

King County Stormwater Services and their Agricultural Drainage Assistance Program, and the King County Flood Control District has provided a lot of the funding necessary for drainage maintenance (author interview with Krass, 2020).

Water Banking

Water banking does not need to be done through irrigation districts, and could be managed through other entities (author interview with Krass, 2020). In Snohomish County, expanding existing or creating new water banking programs may be more effective than creating an irrigation district (author interview with Krass, 2020). Because Snohomish County has less contiguous farmland, it may be harder for an irrigation district to have the same benefits in Snohomish County that it has in the Snoqualmie Valley (author interview with Krass, 2020).

Washington Water Trust has an existing water banking program that buys water from water rights holders and then allows people to buy that water (author interview with Dick, 2020). Washington Water Trust also returns water to creeks to help sustain biological functions that would be harmed from flows that are too low (author interview with Dick, 2020). Water banks can also help increase stream flows and/or increase productivity of water used because the market price of water can make it so that people want to use water wisely and buy the smallest amount of water possible (author interview with Krass, 2020).

Seasonal Water Rights

Seasonal water rights exist, but they are not easy to receive or manage (author interview with LaFond, 2020). One possible solution would be to expand seasonal water rights, allowing farmers to pull from rivers during high flow periods and store the water, while not allowing them to pull from rivers during low flow periods (author interview with LaFond, 2020). To be successful, farmers would need storage mechanisms so they can use the water later for irrigation during low flow periods (author interview with LaFond, 2020).

Water that has been captured and stored during high flow periods could be used for irrigation during low flow periods. One limitation is that the restrictions on the types of water farmers can use can be stringent, especially for crop farmers who need their water source to meet a certain FDA standard (author interview with LaFond, 2020). There is a good chance that water quality of water stored in a pond over the winter would not be high enough to use on crops (author interview with LaFond, 2020). There is also a risk of water going stagnant, which would create significant health concerns (author interview with LaFond, 2020).

“Living systems” are one possible solution to this concern. Bennett LaFond worked at some smaller farms that used water loving plants, such as water lilies or willows, along with some minnows to create an aquaponics system (author interview with LaFond, 2020). This system worked because fish would keep the plants alive and the plants would filter the water (author interview with LaFond, 2020).

If this could be scaled up to be used at larger farms, it could help create larger supplies of water for farms to use (author interview with LaFond, 2020). A pilot program could be created to fund some larger farms installing water storage utilizing aquaponics systems, which would then hopefully lead to other farms following their lead (author interview with LaFond, 2020).

Stormwater catchment and treatment could also be used for sectors that do not have as stringent water quality regulations (author interview with LaFond, 2020). Some horse farmers already utilize rainwater catchment systems for their water needs (author interview with LaFond, 2020).

Farmland Conservation

Farmland conservation is a very tricky problem. A lot of the new younger farmers want to farm, but farmland is too expensive for them (author interview with Brausieck, 2020). At the same time, older farmers want to retire and get money for retirement, so they often end up selling to a developer who ends up turning it into five acre parcels (author interview with Brausieck, 2020). Huge amounts of agricultural land has already been lost. The American Farmland Trust reported that 70 percent of urban development happens on agricultural land (Snohomish Conservation District, 2019).

Another area of concern is that a lot of the farmland in the floodplains may not be sustainable as flooding worsens with climate change. These farmers may need to move to higher ground, but finding large plots of land with good agricultural soil can be difficult (author interview with Dittbrenner, 2020). Easements or property swaps may be good options, but there is a limited amount of land available (author interview with Dittbrenner, 2020).

One possible program is a transfer of development rights (TDR) which pays farmers to keep their land as farmland and transfers the development rights for a developer to use at another location (author interview with Dittbrenner, 2020). With this program, the land stays farmland and they get paid the value of the development rights (author interview with Dittbrenner, 2020). Another program purchases development rights to pay farmers to not

develop their land, and in this program, the development rights get extinguished (author interview with Dittbrenner, 2020).

Even though there are local, state, and federal money sources available for these programs, the money from any of these single sources is insufficient and they all require a match, so you need to be able to receive funding from more than one source (author interview with Dittbrenner, 2020). If the different levels of government coordinated and pooled the money in a more efficient way so they would no longer require a match, that could be a huge improvement (author interview with Dittbrenner, 2020).

Runoff from upland development causes significant drainage and flooding concerns. These threats can be mitigated by mandating that developers include methods to increase permeability, such as through planting native vegetation or adding infiltration ponds (author interview with LaFond, 2020). Mandates for developers to include strategies that will minimize runoff would be helpful.

Giving farmers compensation from upland runoff is another solution. Within the county, there are a small number of diking, drainage, and flood control districts that have agreements with local jurisdictions to collect stormwater fees that they can utilize to offset the costs of increased runoff (Snohomish Conservation District, 2019). This money is then utilized to clean out drainage ditches that get filled with sediment (author interview with Brausieck, 2020). Compensation for runoff from upland development is not available in most areas of the county, and a countywide policy could help fund critical drainage costs.

Compensation for Land Loss Due to Resilience Practices

The county could institute a program that gives farmers compensation for land they utilize for resiliency purposes, such as through riparian planting that helps establish riparian buffers (author interview with LaFond, 2020). Financial incentives for levee setbacks would also be beneficial (author interview with Wahl, 2020). Bennett LaFond stated, “Private landowners are being asked to invest their own money to protect a public good and that’s just not going to work long term” (author interview with LaFond, 2020). In many cases, farmers are working on extremely tight margins, and giving up land to increase resiliency means they lose that same amount of farmland, which may not be a feasible option without compensation (author interview with LaFond, 2020).

Urban Agriculture

Community and Backyard Gardens

Community gardens could be incorporated in urban areas to increase food security, reduce stormwater runoff, and counteract the heat island effect. Community gardens give fresh, local food sources that promote healthy eating (author interview with Witte, 2020). The Snohomish Conservation District has been helping to install community gardens in underserved communities, especially in areas that are considered food deserts (author interview with Crumbley, 2020). In Snohomish County, community gardens typically use raised garden beds because the soil in many areas in Western Washington has been contaminated by previous smelting plants which left lead and arsenic in the ground (author interview with Crumbley, 2020).

There is also a Lawns to Lettuce program, which encourages landowners to convert their yard to grow edible food (author interview with Crumbley, 2020). This program is beneficial beyond helping increase food security, because produce uses a lot less water and decreases the use of harmful agricultural inputs like pesticides, herbicides, and fertilizers (author interview with Crumbley, 2020). More funding into community and backyard garden initiatives could help increase resiliency from several different climate threats.

Small Space Gardening

In many cases, residents in urban environments may not have yards or larger areas where they can grow food. In these scenarios, you can implement planter boxes, hanging baskets, or balcony gardening boxes (author interview with Crumbley, 2020). This can help people who live in food deserts and want to grow their own food, but are unable to establish larger gardens (author interview with Crumbley, 2020).

Vertical gardening can also be used as a way to grow a lot of food in small spaces by utilizing vertical space for planting. The Boys and Girls Club in North Everett made a vertical farming device out of PVC piping that they use to grow lettuce, mint, and other crops (author interview with Crumbley, 2020). There are other projects in Snohomish County where people grow shallow root system vegetables and herbs on upright pallets (author interview with Crumbley, 2020). There are also vertical aquaponic systems which allow plants to grow using organic waste made by fish (“Vertical Aquaponic System”, n.d.).

Educational Agriculture

Schools and educational programs can be incorporated into gardening practices in urban areas. This could include growing a garden by a school or taking youth groups to a garden to learn about nature and gardening. These programs already exist, but they could be expanded and given more resources. The Snohomish Conservation District worked with a local high school's Future Farmers of America program and taught sustainable agricultural classes which included teaching about soil health, plant propagation, and different aspects of sustainable agriculture and how it can pertain to urban environments (author interview with Crumbley, 2020).

Alongside teaching those classes, the Snohomish Conservation District and the Future Farmers of America program were able to utilize the high school's greenhouse and grow around 13,000 vegetable starts that were then utilized to build more gardens in underserved areas of Snohomish County (author interview with Crumbley, 2020). Snohomish Conservation District also worked with Early Childhood Education and Assistance Programs (ECEAP) to teach family classes about nutrition and implement community garden spaces by the early education facilities (author interview with Crumbley, 2020).

A local nonprofit, Farmer Frog, also works with teachers, parents, and students from all grade levels to establish and maintain school gardens ("Our Work in Schools", n.d.). According to their founder, Zsofia Pasztor, "Farmer Frog started in the winter of 2009 and 10 when teachers at Olivia Park Elementary School had asked us if we could help them grow food for the families who lost their homes in the economic crisis and were camping out at the parking lot overnight in their cars" (Pasztor, 2017). They have since created a STEM curriculum called "SOIL to STEM": Social Outreach Innovative Learning (SOIL) leading to Science, Technology, Engineering, and Math (STEM). This curriculum is "a project-based, hands-on learning system rooted in agriculture" that incorporates school gardens and meets Common Core requirements and Next Generation Science Standards ("Teaching children to grow food", n.d.). The county

could create its own educational programs or give funding to the groups that are already doing this work.

Food Banks

Gleaning is a practice where people go to local farms and pick leftover produce that couldn't be sold and take it to a food bank (author interview with Crumbley, 2020). There is also a Plant a Row program that allows people who have installed backyard gardens to donate any surplus food that they grow to a local food bank (author interview with Crumbley, 2020). Snohomish Conservation District works with twenty-one different food banks throughout Snohomish County (author interview with Crumbley, 2020). With more resources and funding for these kinds of programs, they could be able to provide much more food to the areas and people that need them the most.

There are many farmers outside of rural areas who are also providing food to food banks (author interview with Lindemulder, 2020). This may not be feasible or sustainable for some farmers because their margins are often so low (author interview with Lindemulder, 2020). For farmers who make their livelihood off of their crops, programs could be implemented to buy the food at a livable working wage to provide local food to food banks. This would be a win-win to provide more security to food banks, as well as provide local farmers with another opportunity for local sales (author interview with Lindemulder, 2020).

TOP PRIORITY

RECOMMENDATIONS

SEA LEVEL RISE

- shift from hard to soft solutions for coastal management

WILDFIRE

- forest management strategies
- fire safety education

HABITATS AND SPECIES

- protect against future degradation
- restore natural processes in already degraded areas

PUBLIC HEALTH

- reduce greenhouse gas emissions
- more green spaces

GENERAL

- more staff and resources dedicated to climate work
- stronger policy language and increased enforcement
- community input

FLOODING

- countywide flood control district or increased assistance for upgrading flood control infrastructure
- stormwater management improvements

LAND USE AND DEVELOPMENT

- responsible growth management
- affordable medium and high density housing

AGRICULTURAL RESILIENCY

- funding for agricultural changes and implementing resilience practices
- water management and storage strategies
- increased support for urban agriculture initiatives

Conclusion

Climate change is a significant and growing threat in Snohomish County. The potential consequences of climate change are enormous, and the work that needs to be done to try to adapt has an extremely long way to go. Climate change is such a huge, global problem that there is no possible way to adapt to all of the possible risks. This capstone explains the main threats the county is facing, and gives policy proposals that could help reduce those risks.

Because the impacts of climate change are so wide ranging, there needs to be a combination of several different proposals enacted to adequately address the risks. There needs to be more coordination across agencies within the county government, with the cities in the county, with neighboring counties, and with the state and federal governments. The county needs more personnel and a much larger budget for climate change adaptation measures. As one of the fastest growing counties in the state, Snohomish County should be provided more funding to be able to proactively reduce impacts from climate change by the state.

Prioritizing these proposals can be difficult because they all correspond to serious threats, but some threats are more urgent than others. Priorities that focus on reducing flooding concerns through addressing sea level rise, creating better stormwater management, and helping flood control districts manage their infrastructure are paramount. Our current forest management system needs to be reevaluated to produce the best environmental outcomes and reduce wildfire risks. Habitat restoration efforts, especially in the estuaries and the floodplains, are crucial to protecting species and ecosystems. Lastly, agriculture is already seriously struggling from climate change and farmers need significant help in order to ensure food security within the county.

Climate change will significantly disrupt the health and economic well being of citizens throughout the county, and will disproportionately impact low income communities and communities of color. When considering any climate change proposals, equity needs to be

taken into account and marginalized communities need to be included in the decision making process. Residents in urban areas are at risk from flooding, urban heat islands, and poor air quality, all of which will be exacerbated by climate change. Rural areas are likely to have a disproportionately large economic impact due to the ways in which rural economies are linked to the environment, and they have fewer resources and funding to be able to adapt to these changes. These challenges need to be taken into consideration when prioritizing climate actions.

Although most of these proposals require funding and resources that the county does not currently have, adapting to climate change must become a main priority. In the long run, it will likely be much less costly to take significant steps to adapt to climate change rather than waiting for disasters to strike. It can be difficult for people to undertake and fund the actions required to prepare for crises, but this is one area where preparation is key to avoiding the loss of human lives and livelihoods. Failing to significantly address the climate crisis would be catastrophic.

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