

# **Priority 1:**

## **Climate Change and Wellbeing**

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### **Introduction:**

The Salish Sea, spanning the coasts of the Georgia Basin in British Columbia, the Strait of Juan de Fuca, and the Puget Sound in Washington State, and encompassing many historic Indigenous lands, is home to a diverse array of people. Climate change is predicted to cause environmental changes throughout this region, inevitably resulting in drastic changes to ecosystems and their inhabitants. As is well-supported by the best social science, human wellbeing is strongly connected to the health of these ecosystems, and thus will be impacted by climate change effects to the region. Wellbeing in this sense is defined by Breslow and Sojka (2016) as “a state of being with others and the environment, which arises when human needs are met, when individuals and communities can act meaningfully to pursue their goals, and when individuals and communities enjoy a satisfactory quality of life.” Different communities and groups within the Salish Sea will not only experience different environmental changes due to their geography, but also varying social, mental, and physical health impacts based on different demographics and factors (such as income level, occupation, education level, age, sex, ethnicity, and cultural customs).

In addition to existing climate anxiety and uncertainties, future projected increased frequencies of natural disasters and storms resulting from climate change will have drastic effects on human physical and mental wellbeing. Low-income, rural, Indigenous, and other

vulnerable communities are already experiencing climate-related changes to their wellbeing, with most of these populations relying heavily on natural resource infrastructure (e.g., fisheries, forestry, agriculture) for economic security. While concerns and predicted impacts vary widely across sectors and circumstances, it's clear that holistic health and wellbeing are strongly correlated with social, economic and environmental fitness, all of which will be increasingly influenced by climate change.

In my synopsis, I non-exhaustively review the available current literature relevant to the top priority identified by the 2019 Social Science for the Salish Sea report, "How does, and will, climate change impact the holistic health and wellbeing of Salish Sea communities?" to provide further insight for the Puget Sound recovery community. While social science is becoming an increasingly recognized field within environmental studies, local literature on specific subjects is not always available. My research process entailed utilizing Google Scholar and the Oregon State University database to locate interdisciplinary literature focused on local climate change impacts, and in turn, these impacts on human health and wellbeing. I utilized combinations of keywords to guide my search, for example: "Puget Sound, climate change, human wellbeing, social." In my research, I came across numerous natural science articles detailing the projected physical impacts of climate change on the Salish Sea region, but those referencing human dimensions were lacking. Therefore, when needed I supplemented with nonlocal material which better suited the priority.

The body of the review is divided into three sections, each addressing different key sub-themes and associated literature: (1) how food webs are being impacted by climate change and how these changes are affecting human wellbeing; (2) differences in the impacts of climate change and adaptive capacities on urban and rural sectors; and (3) the psychological impacts of

climate change effects. Within each section, the key findings are summarized, analyzed, and compared, giving special consideration to the locality and the relevance to the subject matter.

This literature review is meant to represent a compilation of current knowledge on the effects of climate change on the collective wellbeing (environmental, spiritual, emotional, physical, intellectual, social, occupational, and financial) of communities within the Salish Sea.

### **Climate Change and Food Webs:**

Salmon is a culturally, economically, spiritually, and environmentally important species of the Salish Sea region. Not only does salmon provide sustenance to the local communities, but it is also a vulnerable and irreplaceable natural resource upon which many base their livelihoods and cultures. To the Yakama Nation of Washington State, the act of catching salmon is of cultural and spiritual importance, providing an opportunity to pass along Traditional Knowledge and continue the historical consumption of traditional protein sources (Montag et al., 2014). Salmon is considered a part of the identity of local tribes that have harvested the fish for generations and maintain close connections to the environment. Salmon plays a vital role in established cultural customs and practices, and thus is intricately interwoven with Indigenous community wellbeing.

In addition to providing sustenance (historically up to 40% of daily food intake) and economic utility, the act of harvesting and celebrating salmon provide an opportunity to pass along Native language and wisdom among generations of the Yakama Nation community (Montag et al., 2014). This contributes to community and individual wellbeing and strengthens cultural resilience and sovereignty. Through conserving traditional nutritional sources and

activities, salmon benefits the wellbeing of the Yakama Nation by supplying the means to continue long-established customs, encourage community interaction and celebration, and preserve Traditional Knowledgebases.

Salmon are a keystone species of the Salish Sea, playing a vital role in the health of local ecosystems and food webs. The fish serves as primary food sources for a wide variety of terrestrial wildlife, providing nutrients and energy to coastal watersheds and riparian vegetation, and structuring streambed ecosystems, paving the way for other species survival (Bottom et al., 2009). Salmon also provide a plethora of ecosystem services which benefit human wellbeing through food resources, (commercial and sustenance), recreational benefits, wetland functioning (flood management, temperature regulation and water filtration), and provision of nutrient inputs for neighboring agricultural crops (Bottom et al., 2009). Salmon's influence reaches far beyond the bodies of water they occupy.

Salmon do not reside in one class of ecosystem, instead dividing their time between freshwater estuaries and rivers, and marine ocean systems, increasing their vulnerability to projected changes. Projected climate change impacts to the Pacific Northwest include increased ocean temperatures, altered precipitation patterns, reduced snowmelt, altered stream flow, and diminished water supply, which despite their relative (often inland) impacts will affect all life stages of salmon and the composition of local marine species (Bottom et al., 2009). In one example provided by Bottom et al. (2009), in recent years shifting climate patterns have caused influxes of salmon to the Gulf of Alaska, resulting in diminished harvests in the Pacific Northwest. As a keystone species, changes to salmon populations will ripple up and down the food chain, affecting populations of microscopic organisms and crustaceans that they feed on, to the larger predators (including humans) that feed on them.

These seasonal and annual population shifts also affect commercial and recreational fishing industries, causing major economic losses among coastal communities and regional fisheries (both Native and non-Native; Bottom et al.). Coastal communities, such as those along the Salish Sea, rely heavily on natural resource industries (e.g., tourism, recreation, fisheries, timber) thus any changes to coastal ecosystems and watersheds can cause rippling effects that are felt at all levels of the population. These shifts can result in market shifts (e.g., harvesting more abundant species), economic losses from outsourcing (e.g., seasonal harvests in Alaska when local fisheries are scarce) or loss of labor (e.g., switching careers; Bottom et al., 2009).

Shellfish is another marine resource which is closely tied to the wellbeing of those living in coastal communities. Many coastal Indigenous communities consider salmon and shellfish to be “first foods,” or foods that they identify as being a prominent part of their belief systems, customs, and values (Donatuto et al., 2014). Shellfish not only supply traditional sustenance and resources for Indigenous communities, contributing to their physical health, they also provide social, cultural, spiritual, and emotional benefits.

Modest simulations suggest that key shellfish habitat at Lone Tree Point on the Swinomish reservation (currently area of around 11.0 hectares) will be submerged by rising sea level resulting from climate change before 2100, reducing the harvest band by 3 hectares (about 27%; Donatuto et al., 2014). Similar factors could also eliminate over 75% of intertidal shellfish habitat within the Tsleil-Waututh community (Donatuto et al., 2014). Sea level rise, changes to wave patterns, ocean acidification, increasing natural weather events, and other climate-driven changes could cause further damage to shellfish habitat, including increased sediment suspension from shoreline armoring, which prove unfavorable to shellfish production (Donatuto et al., 2014). These changes would deal devastating blows to Coast Salish communities by limiting or

eliminating cultural use of traditional resources which provide community connection and pathways for sharing Traditional Knowledge, while undermining natural resource security and self-governance, impacting wellbeing across multiple levels.

While Bottom et al. (2009) stress institutional changes at a management scale and suggest socio-economic incentives to limit climate change impacts are the key to promoting salmon and marine ecosystem resilience, Montag et al. (2014) and Donatuto et al. (2014) both emphasize the need for Indigenous social and cultural values in the decision-making process. Given the reach of climate change, Montag et al. (2014) maintain that ecosystem recovery will require efforts at local, state, tribal and federal levels, which emphasizes the need for diverse and inclusive viewpoints and values in the decision-making process.

Bottom et al. (2009) also reference the modern drive to constantly maintain optimal harvest rates, which is not only unsustainable but unrealistic. Ecosystems and the species that live within them are constantly moving and adapting to the changing world around them, and climate change will put further stresses on salmon and shellfish to adjust to a modified environment. Indigenous communities have historically respected the seasonal and yearly patterns of salmon migrations, using harvest techniques and schedules that optimize the salmon's survival and return rates, while providing ample sustenance for local communities (Bottom et al., 2009). We can learn from past failed management efforts that nature cannot be perpetually augmented, it is not only unsustainable but unethical. Access to nature and provision of natural resources is necessary to human wellbeing in a plethora of ways, from sustenance and economic security to social connections. It is not the ecosystems which need to adapt to supply a growing human population, it is humans that need to adapt to a changing world.

It is important to note that while Montag et al.'s (2014) and Donatuto et al.'s (2014) studies are based out of the Salish Sea region, Bottom et al.'s (2004) research derives from Portland, Oregon. There is a surprising lack of literature on human wellbeing in connection to food webs in general, making finding local research on the subject more challenging. That which I did find frequently lacked reference to climate change and its impacts on existing food webs. Additionally, most available literature on the subject references Indigenous values and wellbeing, showing that there is a large gap in available information on non-Indigenous cultural values and wellbeing components. Due to the spiritual nature of Indigenous Knowledge and history of exploitation, there also exists a lack of understanding of the true depth and complexity of Indigenous connections to natural resources.

Further research should focus on the intricacy of human actions on food webs, and the impacts of foods webs on human dimensions such as spiritual, emotional, physical, social, occupational, and financial. Further research could be conducted on a local level as to how those in the fishing industry are affected by climate change impacts to ocean conditions and thus marine food webs. Additionally, how will declining food resources (e.g., salmon declines, increased incidence of shellfish poisoning) affect the holistic health of Salish Sea communities economically (as a region which relies heavily on marine resources) and emotionally (e.g., potential challenges of food procurement, loss of industry jobs). While some of this information can be found in available literature, little local research has been done in the Salish Sea region.

### **Climate Change in Rural Communities:**

Rural communities within the Salish Sea face a unique threat as the primary producers of agricultural crops and livestock in the region. Rural communities financially rely on the natural resource industry in sectors such as forestry, fisheries, and agriculture, creating solid cultural and economic ties between these communities and the environment. These relationships place rural communities at a disadvantage when it comes to impending climate change ramifications, putting individuals at higher risk for economic loss, increased uncertainties, and the associated mental burdens.

Agriculture plays a vital role Washington state's economy, contributing over \$6 billion dollars annually, but its future is uncertain in the face of changing socioecological conditions (Hammond et al., 2013). In Hammond et al.'s (2013) study, the authors analyze the resilience, defined here as the level of change an agricultural system can endure without hindering functionality, of local farms to climate change and socioeconomic factors in San Juan, Snohomish, and Whatcom counties. Resilience to disturbances such as increasing weather events and natural hazards, as well as increased urbanization and energy costs, is vital for farms to survive the foreseeable future.

Projected climate change impacts in Northern Puget Sound include decreases in snow runoff, premature peak spring runoff, and increasingly unpredictable cool season precipitation (Hammond et al, 2013). These changes will likely increase severe flooding events in an already historically flood-prone area as river systems experience changes to seasonal flows. As unrenowable resources such as fossil fuels dwindle and demand increases, agricultural outfits will presumably experience sharp rises in expenses towards conventional fertilizers and diesel fuel, as well as indirect losses through declining job availability and reduced incomes, causing blows to the agricultural market. Despite impending climate change effects, the population

continues to grow, rapidly expanding development into historical agricultural regions, significantly increasing real estate values and decreasing viable fertile land.

While the agriculture industry relies heavily on weather conditions, water resources, and ability to retain resilience to pests and disease, all of which are vulnerable to climate change impacts, the livestock industry faces yet another threat. Livestock farmers depend on regular shipments of feed and goods to and from production, making them reliant on transportation infrastructure which will also face challenges arising from climate change (e.g., fuel resources, emission caps; Hammond et al, 2013). While natural resource industries are heavily reliant on climactic conditions and ecosystem services, they also depend on external resources and industries which in turn, are vulnerable to the effects of climate change.

To address these potential outcomes, Hammond et al. (2013) conducted a workshop to evaluate the resilience of the local agricultural sector, addressing community stakeholders and key informants. Among key concerns addressed were uncertainty of the future (e.g., climate conditions, regulations, ownership), shifting societal perceptions (increasing politicization), and financial challenges (Hammond et al., 2013). Many stakeholders expressed exasperation that preparing for future climactic events required hefty investing in preventative measures (e.g., riparian buffers) which could face repercussions down the line due to changing regulations (e.g., salmon habitat protections; Hammond et al., 2013). These heavy financial burdens place challenges on individual farms which already require malleability in production regime to keep up with an everchanging market to maintain profitability. Many farmers also referenced a declining interest in the occupation from their children and in general, citing a lack of profitability and security, posing a threat to an industry which will face increasing production demand in coming years (Hammond et al, 2013).

Many respondents referenced the need for more self-sustaining farms that would be less vulnerable to environmental and economic impacts from climate change, citing a disengagement between the policy implementors and the farmers affected by such legislature (Hammond et al, 2013). This would call for a reworking of current farm and agricultural policies that allow for increased flexibility and control of farmers and operators, including strengthened control over market prices to shift support towards smaller scale producers, emphasizing the importance of diverse and inclusive stakeholder involvement throughout the entire decision-making and implementation process. Additionally, the creation of internship programs, university partnerships and public education would ensure social networks for knowledge and reinforce the resilience of small farms by increasing the awareness of and importance of the agricultural sector (Hammond et al., 2013). Many participants suggested that above all else, personal traits such as limitless optimism and perseverance are necessary to maneuver through the social, cultural, and environmental challenges of operating a small farm such as trying to maintain family customs in a changing political and economic sphere.

While this article is local to the region (Northwestern Washington), there is a lack of reference to the natural resource industry of fisheries, instead focusing on the agricultural sector. As mentioned in the previous section, commercial fishing is economically important to the Salish Sea, and thus this should be acknowledged in future research. Additionally, though this study is extremely relevant to climate change and the livelihoods of rural communities, it fails to address wellbeing at an emotional level, instead primarily focusing on financial and occupational levels and touching on social connections, therefore, in my analysis some informed inferences were made as to what impacts these repercussions would have on emotional wellbeing, which will be addressed more in the depth in the next section.

In a recent Australian article, Ellis and Albrecht (2017) reaffirm the relevancy of farmers sense of place in regard to their relationship with their land. The Western Australian Wheatbelt is a region of great interest in this sense as it has experienced considerable climate change impacts in recent years, causing alterations to the land and farming practices. Ellis and Albrecht (2017) determined that these weather pattern changes have resulted in increased anxieties, depression, and suicides of farmers within the region. These mental health effects are the result of a sense of uncertainty for the future and feelings of powerlessness due to erratic weather patterns and the implications this has on the livelihoods of farmers who depend on the land (Ellis and Albrecht, 2017). While climate change impacts will ultimately affect everyone, this article suggests that due to their close working relationships with the land, generational farmers may be more predisposed to climate change impacts (Ellis and Albrecht, 2017).

There are relatively few studies on the predicted climate change impacts of rural versus urban populations, and the pickings are even slimmer when limited to the Salish Sea region. Future research should focus on the direct and indirect effects of climate change on different natural resource industries (e.g., fisheries, timber, agriculture, power generation), and how in turn these industry changes will affect the local economies, in addition to community and individual wellbeing. Will job shortages and declining resources negatively affect resource allocation, affordability, and access? How will urban populations, which will undoubtedly continue to encroach on rural regions, be impacted by climate change? Will urban industries (e.g., service, trade, commerce) fare better due to their less direct dependance on natural resources, or will they be equally afflicted due to higher dependance on industry and transportation?

Threats to job security and livelihood, financial burdens and uncertain futures will undoubtedly bear a psychological toll on the wellbeing of rural communities. As climate change impacts create challenges of natural resource allocation, it is likely that many small farms may not be able to compete with the rising costs of production, fluctuating market prices, and environmental challenges. These losses would deliver blows to the local economy, contribute to food allocation challenges, and increase dependence on external sources. Individuals directly dependent on the natural resource sector would experience a lower satisfaction of life with decreased income and access to essentials, including healthcare.

### **Climate Change and Human Wellbeing:**

While the prevailing and forecasted physical effects of climate change in the Salish Sea region are well studied and documented (e.g., increased exposure to disease vectors, decreased air quality, changes to food availability, and increased injury and death from natural events), the psychological effects of changes are far less understood. As the future becomes increasingly uncertain, individuals will experience increased levels of anxiety and feelings of lack-of-control; increased prevalence of natural disasters (e.g., flooding, earthquakes) will have sudden and deep influence on community mental health and access to mental health resources; and changing environmental, economic, and social conditions will continue to disproportionately affect low-income and at-risk communities (Fritze et al, 2008). Many individuals respond to climate change with feelings of hopelessness, anger, sadness, or fear, while others, as a form of coping mechanism, may choose to simply deny its existence.

Human wellbeing is inextricably connected to the state of the world, the health of our communities and social networks, and our personal financial and sustenance security. The looming uncertainty of Earth's future, as referred to by Fritze et al. (2008), is comparable to the threat of war, as in both situations there is a factual risk to the survival of the planet and the future of everyone on it. These fears can manifest themselves in the form of extreme anxiety, depression, or anger, greatly influencing an individual's personal wellbeing and psychological health. With constant exposure to different viewpoints in the media and in our social networks, compounded with suggestions to change our standard of living to lessen impacts on the planet, emotional turmoil is not a stretch. As climate change impacts are not always immediate (or even tangible) during one's lifetime, it can be difficult to know what to believe, or how to act.

Subjection to natural disasters resulting from climate change will have far-reaching effects on psyches of those on the frontlines as well as those indirectly touched. Fritze et al. (2008) reference the after-effects of Hurricane Katrina which displaced hundreds of thousands of individuals, exposing them to unstable or complete loss of shelter (which increases the potential for domestic and child abuse), absence of support services (e.g., health care) and occupation (i.e., income). While acute stress responses are expected among most individuals, lingering effects can result in Post Traumatic Stress Disorder (PTSD), depression, or suicide attempts (Fritze et al., 2008). Those not directly affected can experience the loss of loved ones, financial burdens, and increased anxiety.

While climate change impacts will affect the wellbeing of all humans in one aspect or another, low-income and other vulnerable communities (e.g., minority communities, Indigenous communities, natural-resource dependent communities, coastal communities) will be disproportionately impacted by resulting changes (Fritze et al., 2008). Due to their high

dependence on climate-sensitive industries (e.g., power generation, tourism, agriculture), these communities are at risk of pay cuts or losing employment from climate change impacts, while coastal and rural regions will likely experience higher direct impacts due to their vulnerable geography and limited infrastructure (Fritze et al., 2008). These financial burdens could be compounded by potential damage of assets from natural disasters or relocation, lack of resources (e.g., logistical, financial) as well as the rising costs of goods and services (e.g., food, energy, communication, water) due to global shortages, droughts, and decreased arable land (Fritze et al., 2008). These changes will likely widen the rift of economic exclusion affecting low-income households as insurance rates rise and personal belongings and homes are irrecoverable, contributing to mental burdens (Fritze et al., 2008). Within Indigenous communities, especially those residing along coastal regions, there is an increased risk of mental health impacts due to loss of culturally significant places, deprivation of traditional customs, and lack of ability to protect their lands (Fritze et al., 2008).

Unemployment and socioeconomic limitations are associated with higher exposure to mental health risk factors including increased stress levels, social isolation, self-doubt, and lack of self-determination (Fritze et al., 2008). Heightened financial burdens often lead to increased workloads, family separation, and declines in social events and hobbies, which can lead to greater emotional burdens, relationship strain, and increased suicide attempt rates (Fritze et al., 2008). Forced or voluntary migration (due to loss of assets, financial reasons, or exposure to violence) can further fragment social networks and increase financial susceptibility, create a loss of sense of place, and potentially increase exposure to ethnic or cultural discrimination over threat of resource competition (Fritze et al., 2008). Intensified demand for declining resources

has also been historically associated with increased conflicts and violence, which can contribute to anxiety, PTSD, and other mental burdens (Fritze et al., 2008).

While the current effects of climate change may still be subtle or intangible to most, they are already making an impact on the mental health of people around the world. Uncertainty of the future and conflicting information can fuel anxiety, fear, and depression, resulting in increased mental burdens. Dependence on highly climate driven industries is causing many to reconsider their future occupations, and increased natural disasters are causing direct financial, social, and emotional stresses on those impacted. As climate change influences amplify, these psychological effects will continue to increase in size and scope while access to mental health resources will simultaneously decline, especially for those in socioeconomically vulnerable communities.

While one major limitation of this study is that it derives from Australia, the content is still applicable to the Salish Sea as it discusses the different adaptive capacities of diverse demographics. Its lack of locality, however, highlights the absence of local information on the subject and the need for more targeted research. While it discusses coastal and Indigenous communities, it would benefit the situation to identify regional Salish Sea distinctions. For instance, how will rising sea levels, precipitation changes, and other region-specific climate change impacts affect the mental health of diverse local communities? As a highly natural resource-dependent state, will the Salish Sea feel greater psychological impacts than other regions? Is the Salish Sea region equipped to appropriately address rising mental health challenges, especially as resource and labor challenges arise, above all in rural, Indigenous, and at-risk communities? Is mental health and wellbeing appropriately represented in climate change policy and legislature? What resources are available to those who will be directly impacted by

changes to the natural-resource industries or experience necessitated migration? How can we mitigate current and future climate-influenced socioeconomic inequalities in mental healthcare?

The authors recommend that individual states address holistic health climate change responses at local levels, in addition to federal efforts, to address regional and community-level challenges (Fritze et al., 2008). This includes monitoring and surveillance, policy and legislation changes, increased public awareness campaigns and communication outlets, mental health mediation, and development of infrastructure (Fritze et al., 2008). This re-emphasizes the need for increased local data and research on the specific vulnerabilities of local Salish Sea communities, especially those that have been historically socially or economically excluded from health care access.

### **Conclusion:**

Human holistic health and wellbeing is the collective result of diverse everchanging factors and circumstances, including but not limited to the health of our environment, social influences, financial and occupational situations, physical health, and spirituality. While the five pieces of literature discussed here vary greatly in subject matter, they each address one or more dimensions of wellbeing which will be impacted by climate change. Both ecological food webs, and community structure influence one's psychological health by determining access to resources and opportunities.

Food web dynamics are greatly influenced by our changing climate, causing drastic modifications to ecosystem services, food supplies, and spiritual or cultural practices. These shifts can also result in occupational shifts and financial burdens for the heavily natural-resource

dependent region of the Salish Sea. In one example, varying salmon migration flows have caused many Salish Sea fisherman to work seasonally in Alaska to accommodate for slow seasons, not only hurting individuals financially and emotionally (e.g., social isolation, family separation, etc.), but also hurting local economies (Bottom et al., 2009). Declines in Indigenous “first foods” such as salmon and shellfish are threatening not only to community sustenance, but also Indigenous traditions, spiritual health, methods for knowledge sharing, and self-sovereignty. Furthermore, salmon and other native keystone marine species are part of an intricate and extensive food web which supports the existence of other wildlife, plants, and humans. Healthy salmon and shellfish populations support functioning ecosystems, operational food chains, thriving industry, economic security, recreational resources, cultural services, and ecosystem services such as water filtration and flood management.

Rural communities face distinct and serious threats from a changing climate. As principal producers of natural resource products in the region (e.g., timber, crops, seafood), rural communities face direct threats to their livelihoods as precipitation patterns shift, natural disasters increase in frequency, water supplies ebb, and food webs are disconnected. Many current and prospective future farmers and fisherman are now reconsidering their career choices as the future of these industries grow more uncertain. Diminished job markets, financial burdens and states of uncertainty undeniably contribute to increased mental burdens and decreased individual wellbeing, while an unpredictable future for these industries means challenges for the future health and wellbeing of the local economy and communities.

As awareness and acceptance of climate change continues to increase, so do the associated psychological effects of an uncertain future. With a lack of financial and personal

security, many people feel a loss of control and dread concerning the future of climate change, manifesting in the form of anxiety disorders, depression, resentment, or denial. More tangible climate change impacts will hit low-income, minority, Indigenous, rural, and coastal communities the hardest, causing more extreme environmental impacts (due to geography), greater threats to infrastructure and job security (due to heavy dependence on climate-driven industry), greater financial burdens (due to already limited resources), and loss of culturally significant resources and places (Fritze et al., 2008). These physical setbacks are associated with increased mental burdens such as higher stress levels, social isolation, loss of sense of place, depression, and PTSD (Fritze et al., 2008).

While climate change is largely studied in the realm of physical influence on the planet and the resulting material repercussions such as interruptions to the global food chain and increasing scope and frequency of natural disasters, these impacts will also govern the holistic health and wellbeing of local communities through different avenues. While all humans are dependent on food web functioning for survival, some communities rely on these resources for financial security as well. Some communities are more at-risk or inequitably burdened with climate change impacts to the fisheries and other natural resource industries due to their economic connections or limitations and adaptive capacities. In addition to food and financial security, climate change will also increase community and individual exposure to physical damages (e.g., material, personal), and social and cultural disruptions, leading to a decreased satisfaction of life. Climate change does and will continue to play a major role in the holistic health and wellbeing of local Salish Sea communities.

While there is a general lack of targeted research on social and institutional adaptations to combat the effects of climate change on human dimensions, the authors did make specific

suggestions as to how adaptive capacities can be improved upon. Bottom et al. (2009) emphasize the importance of incurring tailored socioeconomic incentives for ecosystem recovery and resilience. Both Montag et al. (2014) and Donatuto et al. (2014) underscore the need for inclusion of Indigenous values and Traditional Knowledge in the decision-making and implementing process, reinforcing the need for collaborated ecosystem recovery efforts at all levels. In natural resource industries, with focus on the agricultural sector, stakeholders assert the need for more self-sustainable operations through modified legislature and policy, lessening both the economic and environmental impacts of climate change on small outfits (Hammond et al., 2013). Increased education opportunities and partnerships would furthermore reduce future threats to the sustainability of the industry and decrease social challenges (Hammond et al., 2013). To increase social resilience, Fritze et al. (2008) suggest increased public awareness campaigns and communication, increased mental health mediation, development of relevant infrastructure (e.g., mental health resources), and monitoring and surveillance at a local level.

While there is no shortage of literature on human wellbeing in association with the environment, there is a surprising lack of available information on how this connection will be altered by climate change. Furthermore, there is a large data gap in local research regarding human wellbeing specific to the Salish Sea region. All available literature referencing food webs and human wellbeing are predominantly focused on Indigenous communities, identifying a lack of research in non-Indigenous coastal communities, most notably, those that rely heavily on the fishing industry or other natural resource industries. Additionally, due to historical wrongs and the need to protect Traditional Knowledge, available literature often lacks a true representation of the profound and complex relationships between Indigenous communities and these resources, making it difficult to fully address the subject in legislative efforts.

Another subject lacking investigation is the impacts of climate change on urban versus rural populations in the Salish Sea. While Hammond et al. (2013) detail the agricultural industry in depth, no reference is made for comparison to urban community impacts, which despite their less-direct industry dependence on natural resources, will undoubtedly feel repercussions through different avenues. Lastly, there is a notable absence of local research on the adaptive capacities of different socioeconomic demographics and geographic sectors of the Salish Sea and how these factors will influence both direct climate change effects, as well as the ability to recover and adjust to impacts. Fritze et al.'s (2008) article encompasses different general groups (such as low-income, coastal, and Indigenous communities), but lacks a specific and targeted analysis of the unique and diverse communities of the Salish Sea's adaptive resources and abilities.

Future research should identify, first and foremost, the unique and specific vulnerabilities and adaptive resources of Salish Sea communities. While generalized information on demographics and projected impacts are available, each sector and community face unique challenges at geographic and socioeconomic levels, creating diverse threats and the need for tailored resources and efforts. This includes increased research on the different concerns, values, and adaptive capacities of rural and urban communities, different cultures and Indigenous Nations, and natural-resource dependent communities. Additional exploration should also be invested on the interconnectedness of food webs and human wellbeing. At a local level, more research should be conducted on the social and personal impacts of evolving fish stocks, marine resources and ocean conditions on those in the fishing and shellfish industries. In addition, how will food supply hurdles (e.g., increasing incidence of shellfish poisoning, declining salmon and

shellfish stocks) and the resulting economic, emotional, and physical challenges affect individuals both directly and not directly dependent on the industry for financial security?

In conclusion, human wellbeing is highly influenced by our natural environment, and thus is governed by the state of our changing climate. As climate change impacts, community values, and adaptive capacities are highly variable geographically, local knowledge and responses are necessary for ensuring socioecological resilience. My hope is that this research will prove important to the Puget Sound Partnership and other public agencies' continued efforts to identify, address, and guide future research into ecosystem recovery for the Salish Sea.

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