

## **PRIORITY 1:**

### **How does, and will, climate change impact the holistic health and well-being of Salish Sea Communities?**

\* = not local

- (1) Biedenweg, K., Hanein, A., Nelson, K., Stiles, K., Wellman, K., Horowitz, J., and Vynne, S. (2014). Developing human wellbeing indicators in the Puget Sound: focusing on the watershed scale. *Coastal Management*. 42(4), 374-390. DOI: 10.1080/08920753.2014.923136

The authors' purpose of this article is to determine how human wellbeing is directly or indirectly related to natural resources and how conservation and restoration efforts in turn affect human wellbeing. Biedenweg et al. express that human wellbeing is directly correlated with the health of natural resources while successively our state of wellbeing plays a role in health of natural resources. Among 100 potential human wellbeing indicators suggested, 26 indicators were deemed priority by stakeholders, Indigenous Nations, and social scientists among the categories of agriculture, shell fishing, commercial fishing, forestry, cultural heritage, recreation, livable communities, sustainable employment and water for human health and prosperity. The top selected attributes included: exercise, access to safe local food and drinking water, air quality, access, communication, stewardship, positive emotions, traditional resource practices, cultural events, trust, strong families and friendships, community supportive job sector, and industry. The authors suggest that incorporating these indicators into policy and decision-making would influence more effective planning, design, and monitoring of natural resources. The authors utilized a multi-phase project to first identify human wellbeing attributes via open-ended interviews with Hood Canal residents, refining the attributes down from 1,400 to 100 through collaboration with local stakeholders, Nations, and social scientists. The indicators were then ranked via three workshops composed of residents from three different counties and two different local tribes. While this article is not specifically correlated with climate change, it still proves relevant to priority one as it addresses the connections between human wellbeing and

natural resources as well as recommendations for social and institutional responses for ecosystem recovery which incorporate these indicators.

- (2) \*Bottom, D.L., Jones, K.K., Simenstad, C.A., and Courtland, L.S. (2009). Reconnecting social and ecological resilience in salmon ecosystems. *Ecology and Society*. 14(1). DOI: 10.5751/ES-02734-140105

Bottom et al. assert that the failures of past and current fishery management to protect Pacific salmon populations has resulted in increased unpredictability for salmon populations and ecosystems, as well as diverse stakeholders and communities who rely on salmon for their subsistence as well as cultural, spiritual, social, and economic resources. The authors elaborate that these programs failed to recognize fluid social-ecological interactions across levels which continue to shift with climatic changes (e.g., temperature and precipitation patterns, stream flow and water supply), creating mismatches among jurisdictions and management efforts. As keystone species, Pacific salmon species serve as a primary food source for terrestrial and marine wildlife, provide nutrients to coastal watersheds and vegetation, and serve as ecosystem engineers through stream and riverine habitat structuring. Salmon also provide services which result in untold benefits to human wellbeing, including provisioning of food resources, economic resources, educational, spiritual, and recreational resources, and ecosystem services through healthy wetland functioning. The primary means of data collection for this article result from literature reviews and a 2007 conference held in Portland, Oregon. Thus, one limitation of this article is its geography (not local to the Salish Sea). The literature proves relevant to priority one as it provides sound evidence for the connections between ecological food webs and the ecosystem and cultural services that salmon provide for humans.

- (3) Donatuto, J., Grossman, E.E., Konovsky, J., Grossman, S., and Campbell, L.W. (2014). Indigenous community health and climate change: integrating biophysical and social science indicators. *Coastal Management*. 42(4), 355-373. DOI: 10.1080/08920753.2014.923140.

In this study, Donatuto et al. assess how climate change impacts on shellfish habitat and other shoreline resources will affect the health and wellbeing of Salish Sea Indigenous communities in both Washington state and Canada. The authors indicate that Indigenous community health is directly impacted by changes to shellfish habitat both physically (natural resources, sustenance, physical health) and mentally (socially, culturally, emotionally), as shellfish, salmon and other marine resources are considered “first foods” which are intertwined with tribal beliefs, morals, and customs. Modest estimates suggest that average sea level rise will reduce coastal Swinomish shellfish beds by nearly 27% and Tseil-Waututh shellfish habitat by 75% by the year 2100. Natural resources security was selected as the highest impacted and highest priority concern among the Tseil-Waututh, citing that these changes would result in weakening of the connections to tribal ancestors and neglect of cultural responsibilities. The authors are careful not to compare the two communities, as each community has unique connections with their environment and associated priorities or concerns. Methods utilized included identifying environmental indicators for both Swinomish and Tseil-Waututh communities (final selected indicators were shellfish beds and shoreline archaeological resources), locating and analyzing relevant data on indicators, and literature review and interviews with tribal knowledge holders to identify community health data. These indicators were pilot tested in facilitated workshops, and each tribal community completed a Community Health Impact Assessment. Two of the authors (Donatuto and Campbell) are Swinomish staff, with the later also being an elder. Limitations include weighted indicators which could sway results. This article proves relevant to priority one as it discusses the connections between natural resources (shellfish) and the physical and mental wellbeing of Indigenous communities in the Salish Sea, and how climate change will impact this relationship.

- (4) \*Fritze, J.G., Blashki, G.A., Burke, S., and Wiseman, J. (2008). Hope, despair and transformation: climate change and the promotion of mental health and wellbeing. *International Journal of Mental Health Systems*. 2(13), 1-10. DOI:10.1186/1752-4458-2-13

In this article, Fritze et al. discuss the connection between humankind's mental health and both the immediate and future projected effects of climate change. The authors report climate change will affect mental health in three ways: Anxiety about the future and psychological hardships will become increasingly more prevalent as awareness of climate change grows; low-income and other vulnerable populations are already being affected by disturbances to economic, social and environmental factors that influence mental health; and increasing extreme weather events will have instantaneous repercussions on community mental health and mental health systems. As the media and social pathways are the main ways in which people receive information about climate change, individuals' acknowledgement of this threat will greatly vary by source- with some feeling great fear, depression, hopelessness or frustration, and others denying or avoiding the problem as a means of coping. Low-income communities experience restricted adaptive capacities due to economic dependence on climate-driven economies (e.g., agriculture, power generation, tourism), lack of access to resources (logistic, social, financial), and limited infrastructure, which will be exacerbated by reduced income, damage to assets from extreme weather events or forced relocation (especially in coastal or rural regions), and increased costs of goods and services from disruptions to supply chain. Historical extreme weather events (such as Hurricane Katrina) show that affected communities experience higher levels of depression/anxiety, violence, and suicide resulting from lack of access to services and support, loss of or unstable housing, and increased exposure to domestic abuse. One major limitation of this study is its lack of locality (Australia), but the topics discussed are relevant globally. This literature is applicable to priority one as it discusses how climate change will affect the mental health and wellbeing of individuals, as well as the different vulnerabilities and adaptive capacities of affected communities.

- (5) Hammond, B., Berardi, G. and Green, R. (2013). Resilience in agriculture: small- and medium-sized farms in Northwest Washington state. *Agroecology and Sustainable Food Systems*. 37(3), 316-339. DOI: 10.1080/10440046.2012.746251

The authors stress the importance of understanding how climate change and urbanization, among other factors, will ultimately affect the rural and farm communities of Puget Sound, posing

threats to local agricultural sectors and food availability. These impacts are further compounded by rules, regulations and policies which fail to recognize the changing physical and economic conditions that the agricultural sector faces. Predicted climate change factors for rural Puget Sound include declining snow water runoff, earlier spring peak runoffs and increased variability of cool season precipitation- ultimately leading to challenges of water allocation, flooding/damage to croplands and financial burdens. Farmers in the Puget Sound region stress for re-framing of farm and agricultural policies that support adaptive and innovative practices that lead to self-sustaining farms, reducing vulnerability to economic and environmental changes through risk-reduction approaches. The authors collaborated with a diverse range of sources including relevant stakeholders in the agricultural sector from three different counties in Puget Sound via organized workshops. While this article is not solely focused on climate change impacts, it does provide invaluable information and stakeholder perspectives into the matter. This article will provide insight into the sub-priority of priority one referencing the different impacts of climate change on rural versus urban populations in Puget Sound.

- (6) \*Hoelting, K., and Burkardt, N. (2017). *Human dimensions in climate change in Coastal Oregon* (BOEM 2017-052). Bureau of Ocean Energy Management.  
[https://www.researchgate.net/profile/Kristin-Hoelting/publication/321198108\\_Human\\_Dimensions\\_of\\_Climate\\_Change\\_in\\_Coastal\\_Oregon/links/5a6f7ad9aca272e425eaa904/Human-Dimensions-of-Climate-Change-in-Coastal-Oregon.pdf](https://www.researchgate.net/profile/Kristin-Hoelting/publication/321198108_Human_Dimensions_of_Climate_Change_in_Coastal_Oregon/links/5a6f7ad9aca272e425eaa904/Human-Dimensions-of-Climate-Change-in-Coastal-Oregon.pdf)

This report explores the current and projected environmental, cultural, social, and economic impacts of climate change on coastal Oregon communities and social systems, as well as barriers and knowledge gaps to implementing human-dimensions related policies in environmental planning. Hoelting and Burkardt report that human dimensions factors were predominantly considered current concerns (versus future), citing increasing rates of shellfish poisoning, surging tourism, and economic/recreational changes due to alteration of access to shellfish and fish harvest. Future concerns included increasing coastal retirement rates (rising local population), declining natural resources, and economic damages from rising sea level/coastal

erosion and increased rainfall. The authors note that current and predicted concerns varied drastically across demographics, with livelihood/resource expertise categories strongly influencing responses (e.g., fishermen citing declining fish stocks, industry changes, toxic algal blooms). Additionally, culturally significant natural resources (e.g., huckleberry, salmon, specific agricultural crops) for both Tribal and non-Tribal members swayed individual perceived wellbeing impact responses. The data was collected via literature review, open-ended interviews and associated ethnographic questionnaires (2015-2016), and examined by qualitative data analysis. The authors cite limitations including respondent lack of knowledge on subject and temporal constraints (data is largely reflective of current climate state and prone to change in future). An additional limitation is that this data represents coastal Oregon communities, not the Salish Sea region, but is still local to the Pacific Northwest. This report proves useful to priority one as it explores climate change impacts on human wellbeing with reference to the influence of different demographics.

- (7) \*Manning, C. and Clayton, S. (2018). Threats to mental health and wellbeing associated with climate change. In *Psychology and climate change: human perceptions, impacts, and responses* (pp. 217-244). London: Elsevier.

In this literature, Manning and Clayton discuss the less-recognized effects of climate change on human wellbeing through increased stress and uncertainty from environmental and physical health impacts resulting from changes to peoples' lifestyles, home environments, and places of work. The authors elaborate that climate change will lead to urgent physical events (e.g., flooding and storms) in addition to continuous, drawn-out changes such as declining biodiversity, alterations to natural plant growth cycles and animal migration periods, and changing local microclimates, that will ultimately impact humans' mental health. Trauma derived from life disruptions or natural disasters results in mental changes or disorders in 7-40% of those impacted, generating anxiety, phobias, depression, and potential substance abuse or other unhealthy behaviors. Rising temperatures are associated with decreased school performance and increased suicide rates. Increased droughts will impact food supplies which will increase food insecurities and attributed stress burdens. Necessitated migrations will increase

emotional discomforts such as uncertainties and loss of power. Additionally, changes to local environments will create a sense of loss and negatively affect sense of place which is a well-studied dimension of human wellbeing. Manning and Clayton add that certain demographics will likely feel the mental impacts of climate change more intensely, with women being more affected than men, and low-income, minority, and Indigenous communities being disproportionately exposed to climate change impacts (the latter being most impacted by natural resource loss). Additionally, children will likely be more prone to long-term health and development effects. A major limitation of this resource is the lack of locality (not specific to Puget Sound), thus climate change effects discussed are more general and not particular to the Pacific Northwest. Despite this limitation, this article provides invaluable insight into priority one as it demonstrates that human wellbeing is intertwined with the health of natural environment and thus how climate change will impact mental and holistic health. Additionally, it discusses how different demographics and communities will be impacted by these changes.

- (8) Miles, E.L., Elsner, M.M., Littell, J.S., Binder, L.W. and Lettenmaier, D.P. (2010). Assessing regional impacts and adaptation strategies for climate change: the Washington Climate Change Impacts Assessment. *Climate Change*. 102(1), 9-27.  
DOI: [10.1007/s10584-010-9853-2](https://doi.org/10.1007/s10584-010-9853-2)

The authors' purpose of this article is to address the predicted impacts of climate change in Washington State on eight sectors of natural and human systems: energy, agricultural, urban stormwater infrastructure, salmon, forests, human health, coasts, and water resources. All these sectors are in some way dependent on water availability, which is predicted to be highly variable temporally and spatially as climate change effects increase. The following briefly summarizes the authors' findings. Predicted changes include a 35% increase in annual heating energy demand and a 400% increase in cooling energy demand. Crop yields are expected to decrease by 3-15% as increased extreme rainfall magnitudes vary by region. Substantial reduction is expected in viable salmon habitat. Forest fire damage will likely increase by 100-250% in addition to spatial shifts and increases in Mountain Pine Beetle outbreaks resulting in increased tree mortality. Changing sea level will lead to increased shoreline erosion, and there will be

roughly an additional 150 human mortalities annually. These findings are deduced from both the Washington State Climate Change Impacts Assessment (WACCIA) and climate model projections from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007) paired with biophysical models. This article is useful in addressing priority one as it details the vulnerabilities of different groups and industries of Puget Sound to climate change impacts as well as direct and indirect effects on dimensions of human well-being.

- (9) Montag, J.M., Swan, K., Jenni, K., Nieman, T., Hatten, J., Mesa, M., Graves, D., Voss, F., Mastin, M., Hardiman, J., and Maule, A. (2014). Climate change and Yakama Nation tribal well-being. *Climatic Change*. 124, 385-398. DOI 10.1007/s10584-013-1001-3.

This article examines the climate change concerns and goals of Indigenous communities within the Yakima River Basin in Washington, primarily focusing on threatened salmon populations and their close connections to tribal wellbeing. The authors describe that salmon and the act of catching salmon, are not just a source of sustenance or economic profit, but provide cultural, social, and spiritual benefits to the Yakima Nation, directly and indirectly contributing to their wellbeing. Salmon populations are faced with a changing climate, including temperature, precipitation, and water supply changes which will alter fish health and population size, and will ultimately reduce the number of harvestable fish by the Columbia River tribes. This decline will infringe on traditional tribal fishing activities which provide cultural and social benefits through traditional activities and ceremonies, shared beliefs and values, Traditional Knowledge transmission (including native language), and traditional nutrition sources. The authors go on to suggest potential management actions for declining salmon populations in the face of climate change. Data for this article was provided by a decision analysis workshop composed of stakeholders and Indigenous peoples from diverse backgrounds for discussion of local climate change concerns (specifically on water resources). This article is particularly relevant to priority one as it reinforces the connectedness of human, specifically local Indigenous tribes, wellbeing with changing ecological food webs.