Climate Change Implications for the Quileute and Hoh Tribes[1]

By

Chelsie Papiez[2]

Abstract

Native peoples are the world's early warning system that climate change is affecting human communities. Climate disruptions are impacting hardest on their place-based rights and way of life. On the northern coast of Washington State, Traditional Ecological Knowledge (TEK) gathered through in-depth interviews strongly suggests climate change is impacting the reservations of the Quileute and Hoh peoples. Both Nations live on low-lying coastline, bordered on three sides by the Olympic National Park, and are susceptible to sea-level rise, extreme storm surge events, and shoreline erosion. Among the key impacts identified, TEK tells us that species range shifts in the ocean are becoming more common with the arrival of new warm water species. This change alone poses negative implications for Native and non-Native peoples.

Climate Change and Native Peoples

Native peoples are the world's early warning system that climate change is affecting human communities. Climate change is impacting hardest on their place-based rights and way of life. This extends from villages in Alaska suffering from unstable ground associated with melting permafrost and ice, to Pacific Islanders becoming the first climate change refugees due to sea-level rise inundating small island nations. Native people are experiencing the first major effects of global climate change.

Washington tribes are limited to sovereign land bases, essentially fixed political islands within a landscape without space to migrate away from climate change impacts, such as sea-level rise. In the West Coast States, tribes limited to small land bases on the coastline are most at risk. In Washington State, the Shoalwater Bay, Quinault, Hoh, Quileute, Makah, Skokomish, Lower Elwha Klallam, Jamestown S'Klallam, Port Gamble

 This material is based upon work supported by the National Science Foundation under Grant No. 0817624. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

[2] Chelsie Papiez is a 2009 graduate of the Master of Environmental Studies program at The Evergreen State College. This case is based upon her thesis.

S'Klallam, Squaxin Island, Suquamish, Tulalip, Swinomish, and Lummi are all coastal dwelling people that will have to respond to increased storm surges, warming seas, and sea-level rise (See Figure 1)[3]. Many other tribes in Washington are located on rivers only a short distant from the coast. One reservation in particular that has been experiencing increased river and rainfall induced flooding, especially during the last two winters (2008-09), is the Confederated Tribes of the Chehalis Reservation.

Figure 1 – Map of Western Washington Tribes. All of the reservations are located on waterways (Courtesy of Zoltan Grossman).

Tribes with exceptionally small reservations are at even more risk. The Shoalwater, Hoh and Quileute reservations on the outer coast of Washington all have reservations of only one square mile or less (Shoalwater has 335 acres), and therefore have very little land for retreating from increased storm surges and sea-level rise.

The effects that marine and terrestrial ecosystem disruptions will have on tribes' way of life will disproportionally affect the viability of these low-lying reservations along

[3] In Washington State the coastline pertains to the interior coastline of the Puget Sound and the outer coast of the Pacific Ocean. Of the tribes living on Washington's coastline only five tribes (Quiluete, Hoh, Quinault, Makah, and Shoalwater Bay) live on the outer coast which is much different ecosystem in regards to waves and storm surge impacts. The Puget Sound is referred to by Native People of the region as the Salish Sea.

the Washington coastline, making it difficult to maintain traditional and non-traditional place-based practices. This is especially true for the Quileute and Hoh tribes, whose reservations are low-lying coastal land bordered on three sides by the Olympic National Park (Figure 2-6). Not only are their reservation lands close to sea level, but their economy that is subsistence relies on the availability of natural resources such as fisheries.

In response to the threat of storm surges, flooding, and tsunami dangers the Quileute and Hoh Tribes are currently in pursuit of higher ground out of harms way. This requires legislation at the federal level since both reservations' inland borders are adjoining National Park Service lands. Through recent federal legislation (October 21, 2009) the Hoh Tribe received 37 acres of previously logged National Park Service land to connect their Reservation to an additional 260 acres of privately purchased lands. This addition to the Hoh trust lands will allow the tribe to move critical governmental infrastructures and homes to higher ground out of the harms way.[4]

Figure 2 – Olympic National Park shoreline (shown in pink) surrounds the Quileute and Hoh reservations (Pendleton et al., 2004).

[4] U.S. Senate Legislation
http://www.senate.gov/pagelayout/legislative/g_three_sections_with_teasers/legislative_home.htm

Figure 3 – Quileute Reservation aerial map from 1994 shows the low-lying village along the ocean and the Quillayute River (TerraServer USA, 2009).

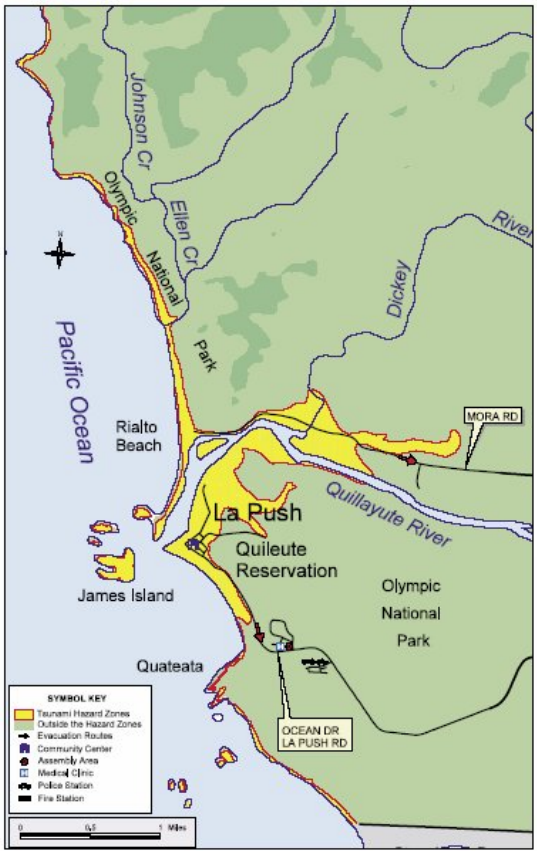

Figure 4 – A map of the Quileute Reservation depicting the high risk tsunami zone. This is an example of the low-lying nature of the reservation, making it susceptible to sea-level rise and storm surges (WA DNR, 2007b).

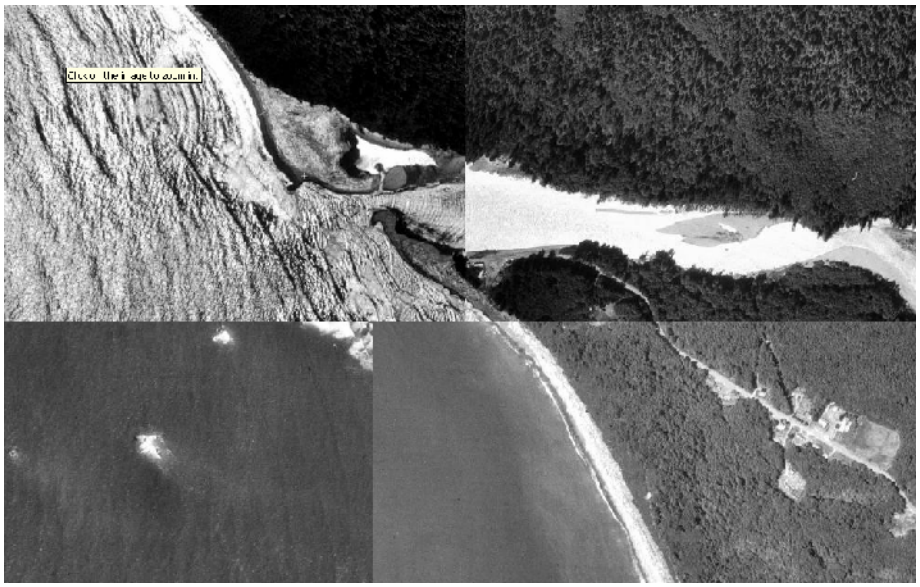

Figure 5 – Hoh Reservation aerial map from 1994 shows the low-lying village along the ocean and the Hoh River (TerraServer USA, 2009)

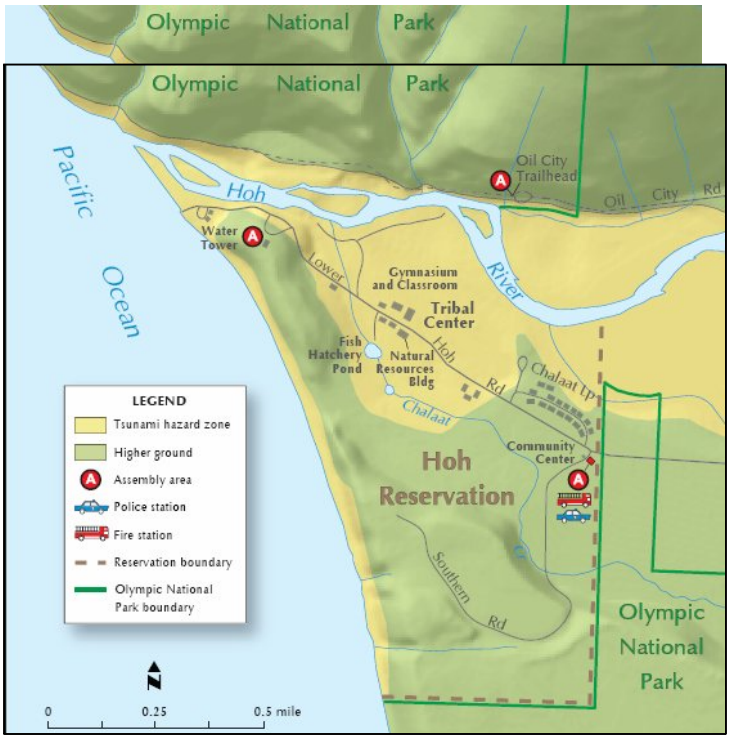

Figure 6 – Hoh Reservation tsunami inundation map. All major government structures are within the tsunami risk zone (WA DNR, 2007a).

Global climate change may be the greatest challenge for Washington tribes since the arrival of European-American settlers. This challenge is occurring due to global

phenomena, much of it distant from our shores. The ice caps are rapidly melting with increasing global temperatures. Scientists have predicted that sea-level will rise with the melting of the polar ice and the thermal expansion of the ocean in warmer temperatures. Not only will sea level rise, but marine life is in jeopardy as the water warms above natural levels, putting communities that depend on the intricate marine ecosystem at risk.

Traditional Ecological Knowledge

Native peoples of Washington coast have an intimate connection to the land and sea, and have adapted to previous environmental and social changes from the receding glaciers of the last ice age to European American colonization. Yet they may be facing unprecedented disruptions to their coastal way of life due to climate change. It is important to hear the changes being felt by the Hoh and Quileute peoples so that their intimate knowledge of the coastal landscape can be shared with other communities that will soon experience the impacts from climate change. Papiez (2008) conducted in-depth interviews of Quileute and Hoh people to document these changes. Changes in species abundance and distribution have been witnessed up and down Washington's coastline. New species are arriving. Changes are well documented through Traditional Ecological Knowledge (TEK) held by Native peoples around the world.

Traditional Ecological Knowledge (TEK) is a knowledge base that Quileute and Hoh communities, like many Indigenous communities, still possess. TEK is important to environmental studies because it can help us "…understand and predict environmental events upon which the livelihood or even survival of the individual depends" (Huntington, p.1270).

TEK is a knowledge base that holds an immeasurable amount of value that can greatly add to our understanding of the environment. Historically TEK "has been marginalized by disciplinary boundaries that accord to science, the study of nature and to social science, the study of human societies" (Neis et al., 1999), though it can greatly add to many, if not all, disciplines. There is no universally accepted definition of TEK. A commonly cited definition is "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationships of living beings with one another and their environment" (Berkes et al., p. 1252). Cajete provides a working definition:

> …Indigenous science is that body of traditional environmental and cultural knowledge that is unique to a group of people and that has served to sustain those people through generations of living within a distinct bio-region. This is founded on a body of practical environmental knowledge learned and transformed through generations through a form of environmental and cultural education unique to them. Indigenous science may also be termed "traditional environmental knowledge" (TEK), since a large proportion of this knowledge served to sustain Indigenous communities and ensure their survival within the environmental contexts in which they were situated (Cajete, p. 268).

This working definition can be used for TEK, which can also be termed "Indigenous science."

Climate Change

Climate change (also referred to as global warming, global climate change, and global climatic disruption) is a term used to describe human-induced changes to the global environment as a result of increased atmospheric greenhouse gases (GHGs). The primary source of GHGs come from the increased combustion or burning of fossil fuels since the industrialization era that have resulted in higher levels of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and other gases in the atmosphere. These gases have continued to build up in the atmosphere and we have only recently begun to see their effects. According to the Intergovernmental Panel on Climate Change (IPCC), atmospheric concentrations of carbon dioxide and methane in 2005 far exceeded the 'natural' levels exhibited in ice cores for the last 650,000 years (IPCC, 2007a). These gases act as heat absorbers that are causing the earth to heat up through a greenhouse effect (IPCC, 2007b) (Figure 7).

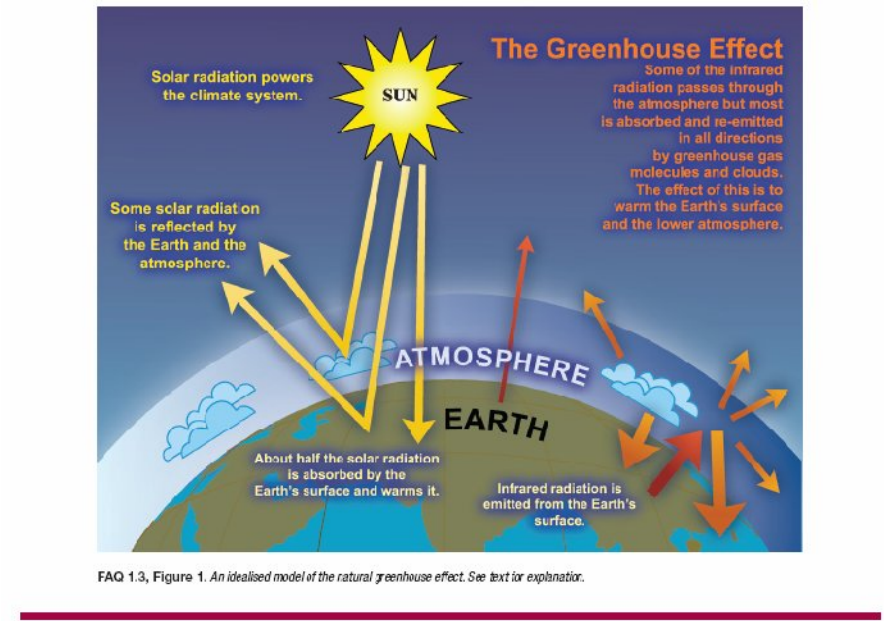

Figure 7 – IPCC greenhouse effect diagram (IPCC, 2007b).

To better understand the impacts of the greenhouse effect numerous studies have looked at and are continuing to evaluate the climatic impacts on earth's natural systems at the global, regional, and local scales. The IPCC is a Nobel prize-winning, worldwide renowned source for climate change data. The IPCC is made up of hundreds of scientists from countries around the world that devote themselves to compiling bi-annual reports. These reports focus on the "the causes of climate change, its potential environmental and socio-economic consequences and the adaptation and mitigation options to respond to it" (IPCC, 2008). These current changes have been observed worldwide (IPCC, 2007a):

- Sea level has risen 3.1 mm every year from 1993 to 2003 and since 1975 occurrences of more extreme high sea levels have increased (Figure 8)

- Terrestrial ecosystems are responding with earlier onset of spring events

- Poleward and upward elevation shifts in plant and animal ranges

- Ocean acidification from uptake of carbon dioxide since 1750 has decreased pH by 0.1 units

- From 1995-2006 eleven of the twelve years rank among the twelve warmest years in global surface temperatures since 1850 (Figure 8)

- Marine and freshwater systems have exhibited shifts in algal and fish species ranges and abundances associated with increased water temperatures, ice cover, salinity, oxygen levels and circulation.

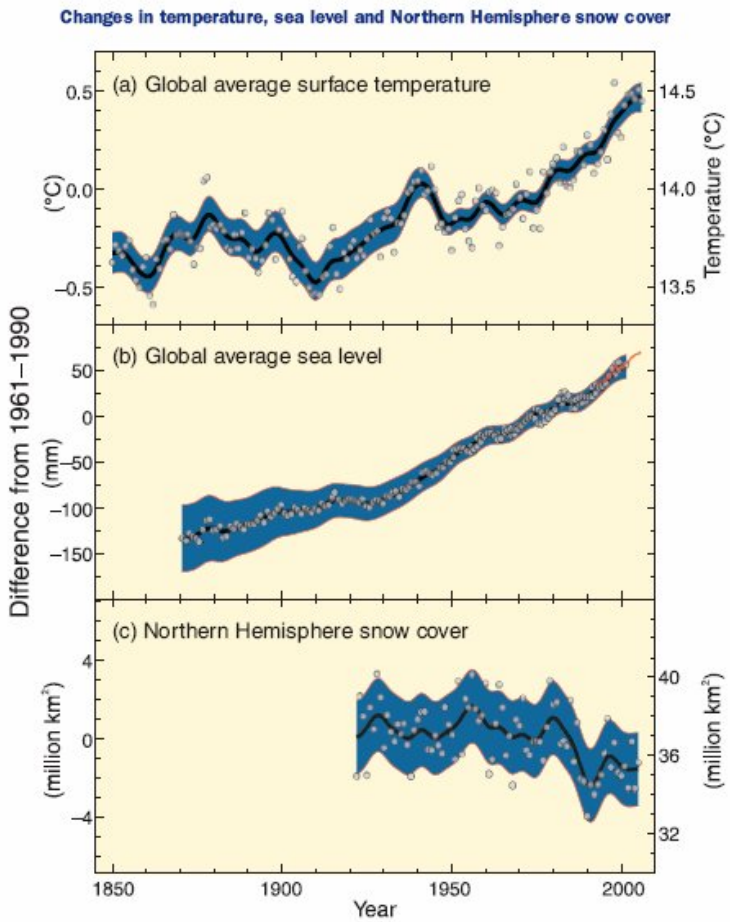

Figure SPM.1. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}

Figure 8 – (IPCC, 2007a).

Pacific Northwest Climate Change Impacts

Climate change is a global phenomenon that has impacts on the local level. The University of Washington's Climate Impacts Group (CIG) provides local and regional data specific to the Pacific Northwest (PNW) climate. In this changing climate the CIG predicts that the PNW will have "warmer, wetter winters, and warmer summers, with stream flow increasing in fall and winter, and decreasing in summer" (Canning, 2001). Along with wetter winters CIG researchers expect to see an increase in erosion and landslides associated with increased winter rainfall, flooding, and ocean storm surge events. Natural climatic cycles in the PNW are predicted to be enhanced by anthropogenic[5] climate change, such as the increased rainfall seen during La Niña years.

The Pacific Northwest weather is a highly complex system that has many divergent factors making studying climate change difficult. The region's weather is dominated by two main systems, the Pacific Decadal Oscillation (PDO) and the El Niño Southern Oscillation (ENSO) cycles. ENSO is also commonly referred to as El Niño (dry warm phase) and La Niña (wet cool phase) years. The PDO cycle operates on a 40-60 year time scale, whereas ENSO operates on a 2-3 year time scale, both of which naturally influence the PNW's warm and cool phases (CIG, 2008). Figure 9 shows how the warm and cool cycles dominate the weather in Washington. However, with climate change the PDO and ENSO cycles are "breaking down" (NOAA, 2008c).

[5] Anthropogenic is a term used to describe human induced changes to the natural environment. In the case of climate change it is the increased abundance of greenhouse gases.

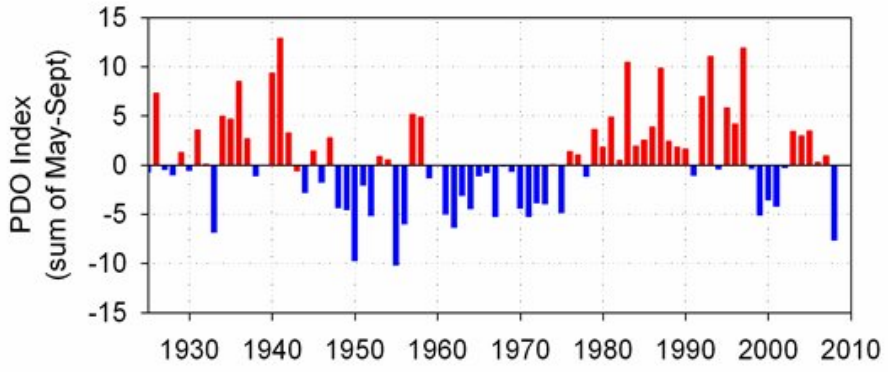

Figure 2. Time series of shifts in sign of the Pacific Decadal Oscillation (PDO), 1925 to 2008. Values are averaged over the months of May through September. Red bars indicate positive (warm) years; blue bars negative (cool) years. Note that 2008 was the most negative since 1956.

Figure 9 – Pacific Decadal Oscillation (PDO) cycles from 1925-2006 (NOAA, 2008).

We will likely see an increase in landslides, especially where land development or disturbance has occurred, as well as an increase in frequency of flooding at river-mouths during high tide and flood staged rivers (Canning, 2001). These impacts will likely affect the Quileute and Hoh tribes who both have lands bordering major river mouths and whose watersheds have been logged in the past and continue to be logged under new regulations that can include riparian buffer zones.[6] Coastal communities such as the Quileute and Hoh are looking at specific impacts to their local coastline.

Specific impacts for PNW coasts include:

- Sea level rise increase risk of coastal erosion
- Increased winter precipitation increase the risk of coastal riverine flooding and of landslides
- Southeasterly winter storms increase risk of coastal erosion
- Co-occurrence of all these conditions increases the likelihood of large, damaging coastal erosion and flooding events

(CIG, 2008)

[6] Beyond the immediate surrounding lands of the National Park Service the Quileute and Hoh reservations lie within larger watersheds where logging has taken place on State and private lands.

Along with heavier rainfall events, climate change will result in lower-than-average snow pack and increased water temperatures. Higher water temperatures in the Pacific Ocean are likely to "exacerbate the impact of excess nutrient runoff into coastal waters, enhancing harmful algal blooms (HABS) and hypoxia[7] events" (Glick et al., p. vi). Higher terrestrial and water temperatures will also continue to facilitate invasive species and diseases to spread into regions where colder temperatures used to limit their expansion (IPCC, 2007a). Thus far the Pacific Northwest in the 20th century has already experienced the following changes (CIG, 2008):

- Temperature has increased on average 1.5˚ F between 1920 to 2003, the warmest period on record was the 1990s
- Daily minimum temperatures on the rise, rising faster than the maximum daily temperature through the mid-20th century
- Precipitation has increased annually by 14% during 1930 to 1995
- Snow water equivalent for April 1st is on the decline in almost all recorded sites from 1950 to the year 2000. Low to mid level elevations exhibiting the highest decline
- Timing of peak runoff has shifted up to 20 days earlier for many rivers in the PNW

Local Ecological Knowledge and Species Range Shifts

Both Native and non-Native inhabitants of an area may hold local ecological knowledge (LEK) that is valuable in understanding changes in the environment. Their residence and occupations may bring them into close proximity with the environment, and, of course, they are also most immediately impacted by changes. LEK is knowledge based on a shorter timescale than traditional ecological knowledge. A recent study by Papiez (2009) looked at perceptions of Natives and non-Natives on climate change in tribal communities and indicated similar views on the significant events underway in their area.

[7] Hypoxia means low oxygen levels. Hypoxia is often used to describe extreme low oxygen levels in lakes, streams, estuaries, the ocean and other water bodies that cause unfavorable conditions for aquatic life.

In depth interviews with Quileute and Hoh tribal members gives a long-term perspective on species range shifts on the local landscape. Many different species range shifts were identified from terrestrial to marine and freshwater ecosystems. All of these range shifts impact the local environment and the people dependent on it for cultural, social, economic, and subsistence practices.

Marine and terrestrial species have shifted their ranges in response to the warming climate. Species range shifts were predicted to move to cooler areas to the north and/or to higher elevations as temperatures warm on land and sea. For fish and other marine species, this means that ranges would shift away from their original grounds towards northern latitudes. "Climate-related changes in fish distribution have been typically characterized as range shifts or displacement away from the center of the home range, as temperatures grew warmer" (Perry et al., 2005 referenced by Zeidberg & Robison, p. 12949).

On the Quileute and Hoh reservations some potential range shifts have already been observed in avian, marine, and terrestrial species.

Bird Species

Brown pelicans (*Pelecanus occidentalis*) are a new visitor to the Washington coastline (Figure 10). According to many interviews with elders (Jackson, 2008; Matson, 2008; Morganroth III, 2008), LEK (Dickerson, 2008; B. Johnson, 2008; G. Johnson, 2008; Payne, 2008), tribal fishermen (Moon, 2008; Ratcliff, 2008; J. Schumack, 2008) and natural resource staff (Geyer, 2008; Northcut, 2008) the brown pelicans are a new arrival to the coast. The consensus arrival time was around the mid-1980s (Moon, 2008; Morganroth III, 2008; Payne, 2008). Now, the brown pelican has begun to stay longer on the coast. They are now arriving during the second or third week in June and departing the last week in October (Geyer, 2008; Moon, 2008; Morganroth III, 2008; Penn Jr., 2008).

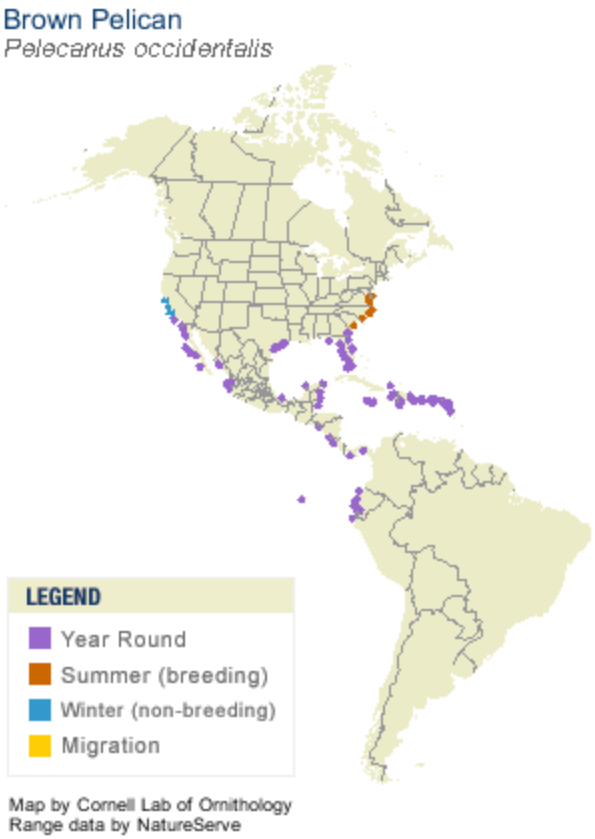

Figure 10 – This figure shows the current range of the brown pelican, which lacks inclusion of more recent populations off the coast of Washington State (Cornell, 2003).

Ocean species

The Humboldt squid (*Dosidicus gigas*) has started frequenting the waters off the coast of Washington. TEK (Black III, 2008; Moon, 2008; Ratcliff, 2008; J. Schumack, 2008; Williams, 2008) and LEK (Dickerson, 2008; G. Johnson, 2008; Northcut, 2008; Payne, 2008) indicate that the Humboldt squid originally arrived during an El Niño event, but kept returning even during colder La Niña cycles. This coincides with several reports from the scientific community that indeed the Humboldt squid has started expanding its original range away from the warm waters around the equator but, not migrating north of central California (Blumenthal, 2008; Cosgrove, 2004; Zeidberg & Bruce H. Robison, 2007). "This geographic expansion occurred during a period of ocean-scale warming, regional cooling, and the decline of tuna and billfish populations throughout the Pacific" (Sibert et al., 2006 referenced by Zeidberg &. Robison, p. 12948).

Though the change in the distribution does not follow the 'normal' range shifts or displacements, because the Humboldt squid is not leaving its original range but rather expanding north and south, the shift in range into historically colder waters is concerning. Waters may be warming enough to support its habitation. "The fact this is happening in both hemispheres could be a sign it is tied in with global warming" (Blumenthal, p. 1). Fishermen in La Push have been seeing an increasing number of squid during La Niña years, as recently as 2008, when ocean waters should be cooler. "They're showing up more then usual, yesterday [Sept. 17, 2008] one of the sport fishermen caught a 5 ½ footer. For the last couple of years, few years actually, there's been a Humboldt free for all… just enormous size squid..." (Steve Ratcliff, Quileute 2008). The Humboldt squid's presence means something is shifting in the food chain off the Washington coast, with the arrival of a new top predator.

Sea Turtles

Turtles were also commonly referred to in interviews from LEK and TEK holders. The loggerhead turtle (*Caretta caretta)* was indicated as an unusual sighting by Quileute fishermen (Moon, 2008; J. Schumack, 2008; Williams, 2008) and other local people (Dickerson, 2008; G. Johnson, 2008). Loggerhead turtles migrate from the equator to feeding grounds off the coast of Alaska, and have been shown to be sensitive to warming sea surface temperature (Chaloupka et al., 2008). In response, they are predicted to "shift foraging habitats to cooler and more productive waters" (Chaloupka et al., 2008). This could mean that more loggerhead turtles will be seen in the future off the Washington coast with climatic warming.

In addition to the loggerhead turtle, the leatherback turtle (*Dermochelys coriacea)* has been sighted during El Niño years, which is very rare and unusual according to LEK (G. Johnson, 2008) and TEK (Moon, 2008; Ratcliff, 2008).

Fish

Increases in warm-water fish such as mackerel, tuna, and sardines were reported by fishermen in La Push. During the 1997-98 El Niño event, LEK, and TEK reported higher numbers of mackerel that were inhibiting their ability to catch salmon (Black III, 2008; Moon, 2008; Morganroth III, 2008; Northcut, 2008; Williams, 2008). Tuna moving with warm water 10 miles to 40 miles offshore was reported by tribal members as a major

change, as opposed to 'normal' temperature conditions when tuna are 100 to 500 miles offshore (Black III, 2008; Morganroth III, 2008; Ratcliff, 2008; Sampson, 2008; Williams, 2008). Tuna appear to have warm water affinity and may continue to return earlier in the summer if the ocean continues to warm.

Increased water temperature has not only brought new competitive fish species to the area but has further stressed declining salmon populations. Increased water temperature is likely to bring new diseases that may further reduce salmon populations (IPCC, 2007a). Other impacts, such as the timing of rainfall and low river flow events have impacted salmon spawning migration upriver. Low flow events have limited access to spawning grounds (Golder Associates, 2005) and extreme high flows during winter months have scoured salmon redds[8] from the river bed (United States Geological Survey, 2007).

Historically salmon runs in the Pacific Northwest were plentiful. Mary Leitka from the Hoh Tribe recalled a hike she took with an elder upriver to visit areas that were used for seasonal fish camps. The elder told her that the chum had been so thick "we could walk on their backs" and "now we don't see them anymore" (Leitka, 2008). The Hoh and Quileute communities are dependent on the seasonal returns of salmon species for their livelihood and to maintain their ancestral cultural connection to the land. "…the reason why Quileute people settled here is because it provided the 5 species of salmon, berries, cedar…everything" (Morganroth, C., 2008). Global climate change poses a threat for both the welfare of the people and the salmon. In response to declining salmon populations harvests are co-managed by the State and Tribes to ensure sustainable yields are continued for future generations.

Sunfish

The sunfish or common mola (*Mola mola)* were frequently referred to as a new arrival to the coast by Quileute and Hoh fishermen (Black III, 2008; Moon, 2008; Morganroth III, 2008; Ratcliff, 2008; Sampson, 2008; Williams, 2008). Sunfish were first seen during strong El Niño years, but have now been present during the cooler La Niña cycle. "Then the oddball stuff, sunfish, a lot of that type of stuff is seen more in the last 10 years, there's more of them in the areas that we never used to see them before"

[8] Redds are salmon spawning sites where eggs have been laid in the gravel of the river bed.

(Roy Black**,** Quileute fisherman 2008). Fishermen took notice of the sunfish because they have the unusual behavior of surfacing in an act that looks as if they are sunning themselves.

Conclusion

For tribal fishermen, the changes that are being seen are unusual and not necessarily following the ENSO and PDO cycles. As one tribal fisherman put it, "it doesn't take a rocket scientist to figure out what's going on in your industry that those kinds of fish are coming around" (Black III, 2008). TEK indicates that these new species were not present during the time of their Quileute and Hoh ancestors.

TEK held by Quileute and Hoh peoples is providing an early warning that impacts are occurring in the present. TEK provides an early warning system for commercial and subsistence fisheries off Washington coast. In the North Sea, scientists have already identified distribution shifts among "nearly two-thirds" of the marine fish species (Perry et al., 2005). The species that have exhibited a range shift were reported to have smaller body sizes and faster life cycles. Perry et al. (2005) stated that this will likely have "profound impacts on commercial fisheries through continued shifts in distribution and alterations in community interactions." (p. 1912)

Communication between Tribal, State and Federal governments is essential in order to safeguard tribal treaty rights and the future of tribal fishing. Knowledge of change is available and must be used to timely respond to the changes present in the marine ecosystem. We no longer have the luxury to wait for certainty. Climate change will continue to impact our rains, water and land temperatures, timing of harvests and many other natural cycles. It is up to us to prepare for future generations. With these changes and those to come, people may choose to respond to climate change through mitigation and adaptation. In this context, mitigation would be to respond by lowering the negative effects of climate change through some action, while adaptation would be to respond to the effects of climate change by creating or doing something that would work within the changed environment.

References

Interviews

Black, Roy III (2008) Quileute Interviews. La Push, WA.

Dickerson, D (2008) Commercial Fisherman Interview (LEK). La Push, WA.

Geyer, Frank (2008) Quileute Natural Resources Interview (LEK). La Push, WA.

Jackson, Roger (2008) Quileute Interviews. La Push, WA.

Johnson, Babs (2008) Local Ecological Knowledge Interviews. La Push, WA.

Johnson, Gerry (2008) Local Ecological Knowledge Interviews. La Push, WA.

Matson, Pat (2008) Quileute Interviews. La Push, WA.

Moon, Mel (2008) Quileute Interviews. La Push, WA.

Morganroth, Chris III (2008) Quileute Interviews. La Push, WA.

Northcut, Kris (2008) Quileute Natural Resource Interviews (LEK). La Push, WA.

Papiez, Chelsie (2009) *Climate change implications for the Quileute and Hoh tribes of coastal Washington: A multidisciplinary approach to assessing climatic disruptions to coastal indigenous communities*. [MES thesis]. Olympia, Washington: The Evergreen State College.

Payne, Sue (2008) Local Ecological Knowledge Interviews. La Push, WA.

Penn, Chris Jr. (2008) Quileute Interviews. La Push, WA.

Ratcliff, Steve T. (2008) Quileute Interviews. La Push, WA.

Sampson, Gene (2008) Hoh Interviews. Hoh Reservation, WA.

Schumack, John (2008) Quileute Interviews. La Push, WA.

Williams, Mark (2008) Quileute Interviews. La Push, WA.

Other Sources

Berkes, F., Colding, J., and C. Folke (2000) Rediscovery of Traditional Ecological Knowledge as adaptive management. *Ecological Applications*. 10(5): 1251-1262.

Blumenthal, Les (2008) Jumbo squid makes new home in northwest. *The Olympian* (April 27).

Cajete, G. (2000) *Native Science: Natural Laws of Interdependence*. Santa Fe: Clear Light Publishers.

Canning, Douglas J. (2001) *Climate variability, climate change, and sea-level rise in Puget Sound: Possibilities for the future.* Seattle. JISAO/SMA Climate Impacts Group University of Washington and the Washington Department of Ecology.

Cartamil, D.P. and C.G. Lowe (2004) Diel movement patterns of ocean sunfish *Mola mola* off southern California. *Marine Ecology Progress Series*. 266: 245-253.

Chaloupka, M., Kamezaki, N. & C. Limpus (2008) Is climate change affecting the population dynamics of the endangered Pacific loggerhead sea turtle? *Journal of Experimental Marine Biology and Ecology*. 356: 136-143

CIG (2008) University of Washington Climate Impact Group. Retrieved: October 31, 2008, From: http://cses.washington.edu/cig/

Cornell (2003) All About Birds. Cornell Lab of Ornithology website Retrieved: December 15, 2008, From: www.birds.cornell.edu/AllAboutBirds/BirdGuide/Brown_Pelican.html

Cosgrove, J.A. (2004) The first specimens of Humboldt squid in British Columbia. Natural History Section Royal British Columbia Museum. Victoria [newsletter].

Glick, P., Clough, J. and B. Nunley (2007) Sea-level rise and coastal habitats in the Pacific Northwest: An analysis for Puget Sound, Southwestern Washington, and Northwestern Oregon. National Wildlife Federation.

Golder Associates, Inc. (2005). *WRIA 20: Watershed Planning Draft Multi-Purpose Storage Assessment Report*. Redmond, WA.

Huntington, H.P. (2000) Using Traditional Ecological Knowledge in Science: Methods and Applications. *Ecological Applications.* 10(5): 1270-1274.

IPCC (2007a) *Climate change 2007: Synthesis report summary for policy makers*. Intergovernmental Panel on Climate Change Plenary XXVII. Valencia, Spain.

IPCC (2007b) *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change Fourth Assessment Report (AR4). Geneva, Switzerland.

Neis, B., Felt, L., Haedrich, R.L. and D.C. Schneider (1999) An interdisciplinary method for collecting and integrating fisher's ecological knowledge into resource management. *Fishing Places, Fishing People: Traditions and Issues in Canadian Small-Scale Fisheries*, edited by Dianne Newell and Rosemary E. Ommer. Toronto, Buffalo, London: University of Toronto Press.

NOAA (2008) National Oceanic and Atmospheric Administration, United States of America. Retrieved: October 1, 2008 From: www.nwfsc.noaa.gov/research/divisions/fed/oeip/ca-pdo.cfm

Pendleton, E. A., Hammar-Klose E.S., Thieler, R.E., and J.S. Williams (2004) *Coastal vulnerability assessment of Olympic National Park to sea-level rise*. United States Geological Survey (USGS).

Perry, A.L., Low, P.J., Ellis, J.R. and J.D. Reynolds (2005) Climate change and distribution shifts in marine fishes. *Science.* 308(5730): 1912-1915.

Sibert, J., Hampton, J., Klieber, P., & M. Maunder (2006) Biomass, size, and trophic status of top predators in the Pacific Ocean. *Science*. 314: 1773-1776.

TerraServer USA (2009) Images provided by United States Geological Survey (USGS). Retrieved: January 8, 2009, From: http://terraserver-usa.com/

United States Geological Survey. (2007). *Water-Data Report 2007: 12041200 Hoh River at U.S. Highway 101, Near Forks, WA*. United States Geological Survey.

Washington State Department of Natural Resources (2007a) Tsunami! Evacuation map for the Hoh Reservation. Washington State Department of Natural Resources, Division of Geology and Earth Sciences.

Washington State Department of Natural Resources (2007b) Tsunami! Evacuation map for the Quileute Reservation. Washington State Department of Natural Resources, Division of Geology and Earth Sciences.

Zeidberg, L.D. and B.H. Robison (2007) Invasive range expansion by the Humboldt squid, *Dosidicus gigas*, in the Eastern North Pacific. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*. 104(31): 12948-12950.