Ocean Acidification: The Enemy of Washington State Locals and Native American tribes

Shellfish aquaculture in Washington State is an important piece of the Pacific Northwest's heritage and culture. However, as acidity levels continue to rise in the Salish Sea, scientists say the economy and livelihoods of state locals are at great risk.

Extending from the south-western region of British Columbia to the north-western region of Washington State, the Salish Sea is an intricate network of coastal waterways. This includes the Strait of Juan de Fuca, Strait of Georgia, Puget Sound, and all of their connecting channels and adjoining waters.[1] Over time, carbon dioxide, the primary human-emitted greenhouse gas, has infiltrated this network of coastal waterways, resulting in a drop of pH levels and ultimate danger for local shellfish.

Since the Industrial Revolution, humans have substantially increased the concentration of carbon dioxide in the atmosphere through deforestation and burning of fossil fuels.[2] Since the ocean absorbs 20-30% of carbon dioxide released into the atmosphere, ocean acidity and atmospheric carbon dioxide concentrations have a directly proportional relationship. As levels of atmospheric carbon dioxide increase, so does the amount of carbon dioxide being absorbed by the ocean. This absorption causes a series of chemical reactions that ultimately increases the concentration of hydrogen ions in the water and as the concentration of hydrogen ions increases, the ocean's chemistry changes. This change in chemistry is often referred to as *ocean acidification*: carbon dioxide molecules interacting with water molecules that lower the ocean's pH.[3]

The Salish Sea is acidifying at a remarkably fast pace due to carbon emissions, upwelling currents bringing up higher acidity water, and algae blooms caused by runoff fertilizer. As the sea continues to increase in acidity, more businesses and communities are speaking out about the

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[1] "About the Salish Sea," Skywater, http://skywateracres.com/salish-sea-map

[2] "Acidification in Puget Sound," Department of Ecology State of Washington, https://ecology.wa.gov/Water-Shorelines/Puget-Sound/Issues-problems/Acidification

[3] NOAA, "What is Ocean Acidification?" National Ocean Service, 2019, https://oceanservice.noaa.gov/facts/acidification.html

negative impacts ocean acidification is having on shellfish. For the past 47 years, Antolin Garcia has been well immersed in the west coast's restaurant industry. Since moving to Seattle in 1993 and opening Pomodoro Ristorante in 1995, Garcia (chef/owner) has personally experienced how ocean acidification has gradually affected the price and quality of the shellfish he buys to incorporate into his dishes. Garcia points out that "shellfish prices have steadily gone up through the years," and explains how "there are fewer shellfish available and the ones that are available are not as healthy as they used to be."

According to a report made by the Washington Sea Grant in 2015, "the Manila clam has experienced a doubling in price — $1.29 in 2005 to $2.69 in 2006 — and has maintained prices around that level ever since."[4] To compensate for the decrease in shellfish availability, prices increase.

Price increases occur as pH levels drop since the acidity disrupts shellfish and their ability to form skeletons when trying to develop and grow. Carbonate ions are very important in building the structures of seashells and acidic ocean water causes carbonate ions to be relatively less abundant. This decrease in carbonate ions makes building and maintaining shells difficult for calcifying organisms such as oysters and clams living in these acidic conditions.[5]

If pH levels in the Salish Sea continue to drop at this rate, Garcia fears that he will soon be unable to sell shellfish at his restaurant. Since shellfish are not as healthy in their environment as they used to be, once harvested and cleaned, Garcia claims, "they don't live as long as they did in the past. I used to use them year-round but stopped using them in the summer all together because when they come to my restaurant, they are so weak that they are either dead or dying." Furthermore, Garcia highlights, "I used to stop using them for two months, now it's 4 months, and eventually it will be 6 months and so on until we cannot use them anymore."[6]

To prevent this from happening to businesses like Garcia's and to avoid going out of business, some hatcheries have taken steps to combat the cascading effects that ocean acidification is having on shellfish by adding sodium carbonate into hatchery waters.

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[4] "Shellfish Aquaculture in Washington State," Washington Sea Grant, 2015, https://wsg.washington.edu/wordpress/wp-content/uploads/Shellfish-Aquaculture-Washington-State.pdf

[5] NOAA.

[6] Garcia, Antolin. Interview by Graciella. Oct. 22, 2019.

Unfortunately, while their attempts are sincere, scientists say that this solution isn't very effective as carbonate levels continue to drop.[7] "It's a temporary solution," says Alex Stote, a graduate student at the University of Washington whose research integrates natural and social science methods to better understand how climate change is affecting marine and coastal realms. Stote claims, "ultimately you outplant them into a natural environment and then they are sort of imperial again of lower pH." The Salish Sea's low pH prevents developing shellfish from growing their skeletons and eats away at the shells of those who are fully developed. While Stote believes "it's a really intelligent solution to use within commercial operations that are enclosed," she argues, "it would be really difficult to deploy that kind of strategy in a natural environment."

As of 2017, some 70% of all oysters in Washington were grown in Willapa Bay. However, oysters haven't reproduced on their own in that area since 2005.[8] Willapa Bay is not technically associated with the Salish Sea, but it plays a significant role in the Pacific Northwest's shellfish industry. Growers there now have to rely on hatchery produced larvae, which prompts hatchery owners originally stationed in Washington State to relocate to Hawaii in hopes of less corrosive ocean water.[9]

Washington's lethal coast left the Nesbit family no choice but to move their hatchery from Willapa Bay to Hawaii so that their oysters could have a chance to fully grow. Though their hatchery's relocation was beneficial, it was not easy and it came with a large price tag. "They took out loans and spent $1 million and moved half their production 3,000 miles away to the Big Island of Hawaii."[10] Not everyone can afford to move like the Nesbit family has. Who are the people that are going to be able to relocate? Those who have more money. In response to hatchery relocations, Stote mentions, "then you are looking at these kinds of disproportionate

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[7] "Acidification in Puget Sound."
[8] Jim Camden, "Shell games: Washington a Leader in Oyster Farming,"*The Spokesman-Review*, 2017, https://www.spokesman.com/stories/2017/dec/17/shell-games-washington-a-leader-in-oyster-farming.
[9] Craig Welch, "Willapa Bay Oyster Grower Sounds Alarm, Starts Hatchery in Hawaii," *The Seattle Times*, 2012, https://www.seattletimes.com/seattle-news/willapa-bay-oyster-grower-sounds-alarm-starts-hatchery-in-hawaii/
[10] The Columbian, "Ocean Acidification Drives Oyster Farm to Hawaii," *The Columbian*, 2013, https://www.columbian.com/news/2013/oct/19/ocean-acidification-oyster-farm-hawaii/

effects where there are people who can't afford to do that or people who view moving as kind of meaningless to them, such as the tribes."

People on the Washington coast and in the Pacific Northwest may be able to adapt to ocean acidification, but not everyone can simply pick up and move like the Nesbit family has. Local small businesses, like Pomodoro, and Native American Tribes do not always have the option of relocating. While some people are able to adapt by moving, Stote claims, "tribes are often rooted to their land spiritually and have been for thousands of years. Moving is not a viable option for them." Tribes in the Salish Sea region are facing a serious problem as rising sea levels are taking over more of their low-lying reservations and ocean acidification threatens the fish and shellfish that these tribes rely on for food and income.[11] Stote believes, "it's a triple whammy because it would impair their livelihoods, food source, and cultural connection." For this reason, the Swinomish tribal members are trying to find alternative solutions by building clam gardens.[12]

The Swinomish tribe is not alone, other tribes, such as the Suquamish tribe, have joined in taking steps to try and reduce the effect of the Salish Sea's acidic waters. The Suquamish tribe is employing innovative ideas in attempts to improve their resilience to ocean acidification's cascading effects.[13] According to a paper published in 2012 by the Washington State Blue Ribbon Panel on Ocean Acidification, "almost all of the commercial wild clam fisheries in Puget Sound are tribal."[14] The oceans changing chemistry is a natural resource issue and significant challenge to Native American tribes' continued identity and cultural survival.[15]

Apart from having a cultural connection to shellfish, Washington State is the country's top provider of farmed shellfish such as clams, oysters, and mussels.[16] In the Washington State Blue Ribbon Panel on Ocean Acidification's paper, it was found that the annual sales of farmed

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[11] Elis O'Neill, "Pacific Northwest Tribes FAce CLimate Change with Agricultural Ancient Practice," NPR, 2019, https://www.npr.org/2019/10/08/767896285/pacific-northwest-tribes-face-climate-change-with-agricultural-ancient-practice.

[12] Ibid.

[13] Paul WIlliams, "Suquamish Build Resilience to Ocean Acidification Through Education," U.S Climate Resilience Toolkit, 2017, https://toolkit.climate.gov/case-studies/suquamish-build-resilience-ocean-acidification-through-education.

[14] *Ocean Acidification: From Knowledge to Action*, Washington State Blue Ribbon Panel on Ocean Acidification (2012) xvi, https://fortress.wa.gov/ecy/publications/documents/1201015.pdf.

[15] Ibid.

[16] *Ocean Acidification: From Knowledge to Action*, xv.

shellfish coming from Washington accounts for almost 85% of the United States West Coast sales.[17] The shellfish market in Washington is huge, the estimated total annual economic impact of shellfish aquaculture is about $270 million. In addition, the industry directly and indirectly employ's upwards of 3,200 people.[18]

Needless to say, the economy in Washington State is supported by shellfish aquaculture. Without the constant production of shellfish, many will lose their jobs and suffer economically while others will indirectly suffer from the constant decrease in shellfish availability. However, Washington is taking steps to decrease the state's carbon emissions. Their 2019 legislative session presented opportunities for the state to chart a path towards a clean energy future.[19] Locals have also taken action in an attempt to slow down the Salish Sea's rapidly acidifying water by finding ways to reduce their carbon footprint whilst maintaining a similar lifestyle. Additionally, some locals have become more politically active and attentive since the people who are in office hold a lot of power to make changes. As Stote stated, " the people that we put in office are the people who sign legislation."[20]

[17] *Ocean Acidification: From Knowledge to Action*, 3.
[18] *Ocean Acidification: From Knowledge to Action*, 4.
[19] "Climate Priorities for Washington State in 2019," Climate Solutions, 2019, https://www.climatesolutions .org/policy/washington
[20] Stote, Alex. INterview by Graciella. Oct. 9, 2019.