Ocean Acidification

AUTHORS

Jeff Marliave, Senior Research Scientist, Howe Sound Conservation and Research Team, Ocean Wise Research Institute

Laura Borden, Research Biologist, Howe Sound Conservation and Research Team, Ocean Wise Research Institute

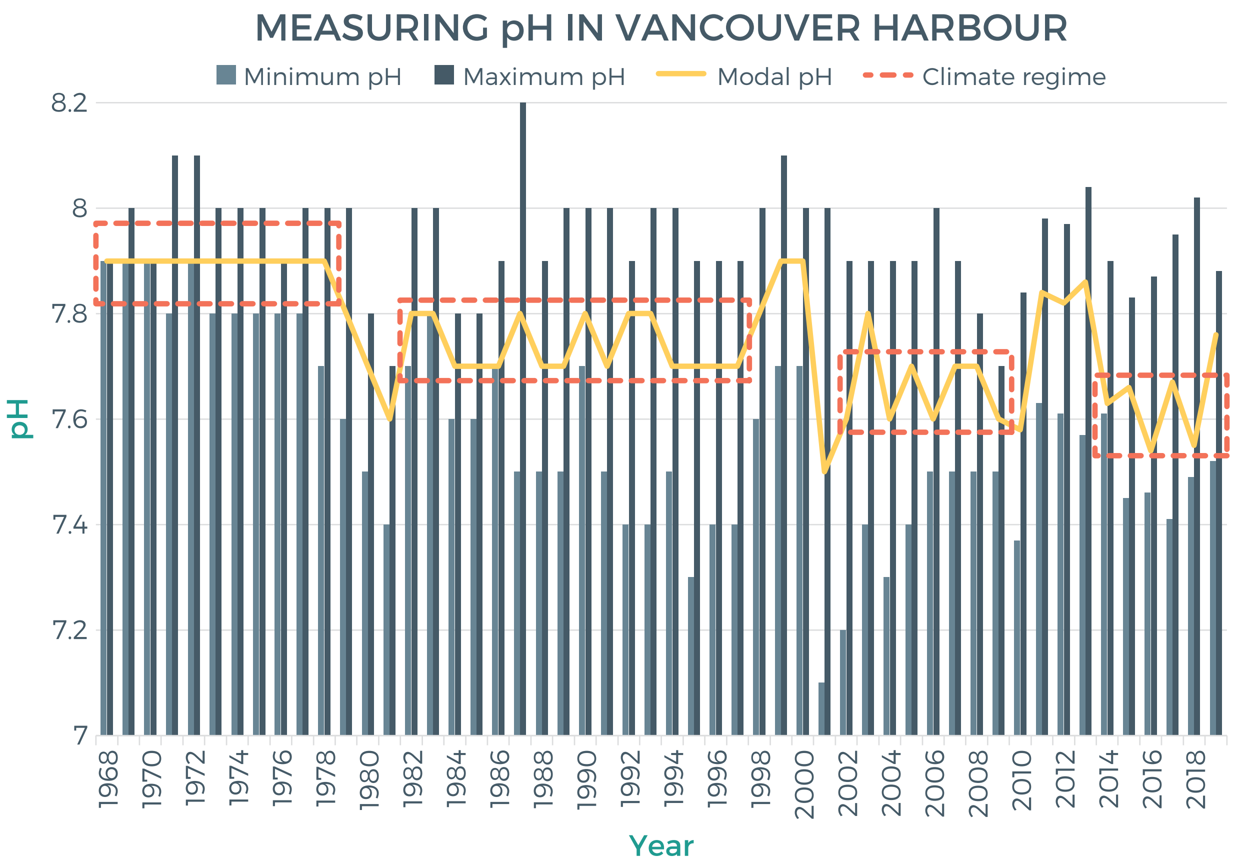
REVIEWER

Christopher Harley, Professor, Institute for Oceans and Fisheries, Department of Zoology, University of British Columbia

What is ocean acidification?

Ocean acidification refers to a decrease in pH of oceanic waters. Globally, ocean pH tends to be greater than 8.0. The northeast Pacific Ocean, with its large river inputs and upwelling of deep water, tends to have a lower pH, i.e., it is more acidic compared to the open ocean. Seawater intake records monitored since 1956 at the Vancouver Aquarium show that pH tends to remain at a relatively stable plateau until a climate regime shift occurs. A climate regime shift is an abrupt change from one climate state to another. Three major climate regime shifts have been discerned using pH measured in seawater intake records (Figure 1) in combination with broad seabed biodiversity data.[1,2] After a climate regime shift, ocean pH appears to go through a correction phase where pH rises, i.e., becomes less acidic, and then falls off, becoming more acidic. From there, it levels off at this new plateau, which may or may not be more acidic than what was occurring previously.[1]

Lower pH values can affect bivalves such as mussels by preventing shell formation at the larval stage, and preventing the formation of byssus threads in mussels, which are used to attach the mussel to the substrate. (Credit: Aroha Miller)



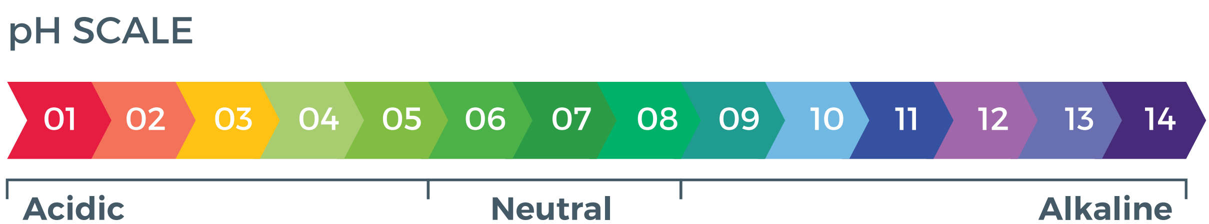


Figure 1. Modal pH and extreme range (minimum five measures for low or high values) for Vancouver Harbour from 1968 to July 2019. (Climate regime shift: an abrupt change from one climate state to another; the spaces between the dashed red boxes are where the regime shift takes place).

What is happening?

Since 2015, water quality measurements have been collected at two locations in Átl'ḵa7tsem/Txwnéwu7ts/ Howe Sound – Ḵw'émḵw'em/Defence Island and Nínich Ḵw'émḵw'em sponge reef and Skwákwtsa7s/ Popham Island – at depths of 10 to 25 m. Data collected include temperature, pH, salinity, dissolved oxygen and turbidity. Since 2015, across all locations and seasons that water quality data have been recorded, the average pH was 7.6–7.8. Seasonal relationships between temperature and pH have been documented (Figure 2, 3). During winter, when water temperatures are at their coldest, pH tends to be closer to 7.8 and inversely related to temperature, while during summer, pH tends to mirror patterns of temperature – as temperature increases, pH also increases. However, an uncharacteristically cold winter in 2017 may be responsible for anomalously high pH values (Figure 3).

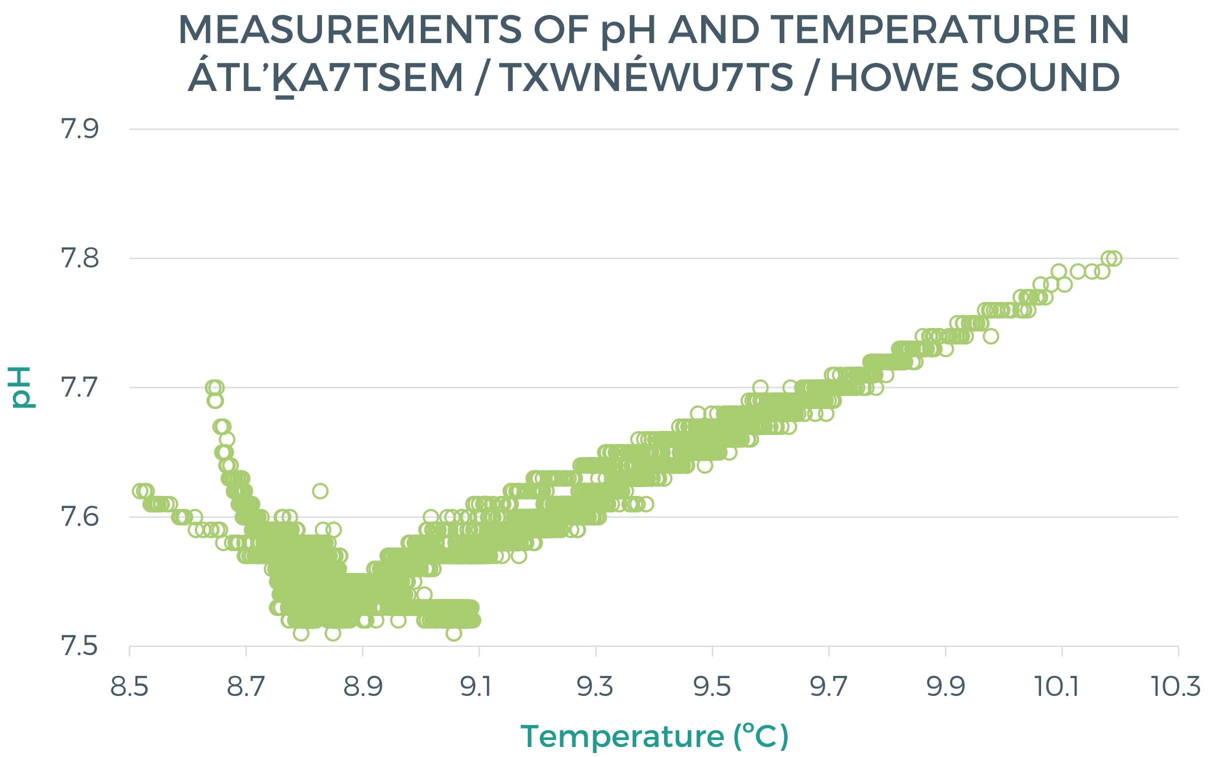


Figure 2. Measurements of pH and temperature taken during spring 2016 (Ḵw'émḵw'em/Defence Island and Nínich Ḵw'émḵw'em sponge reef, 22 m depth), indicating how changes in temperature affect pH. Data represent 10-minute interval points.

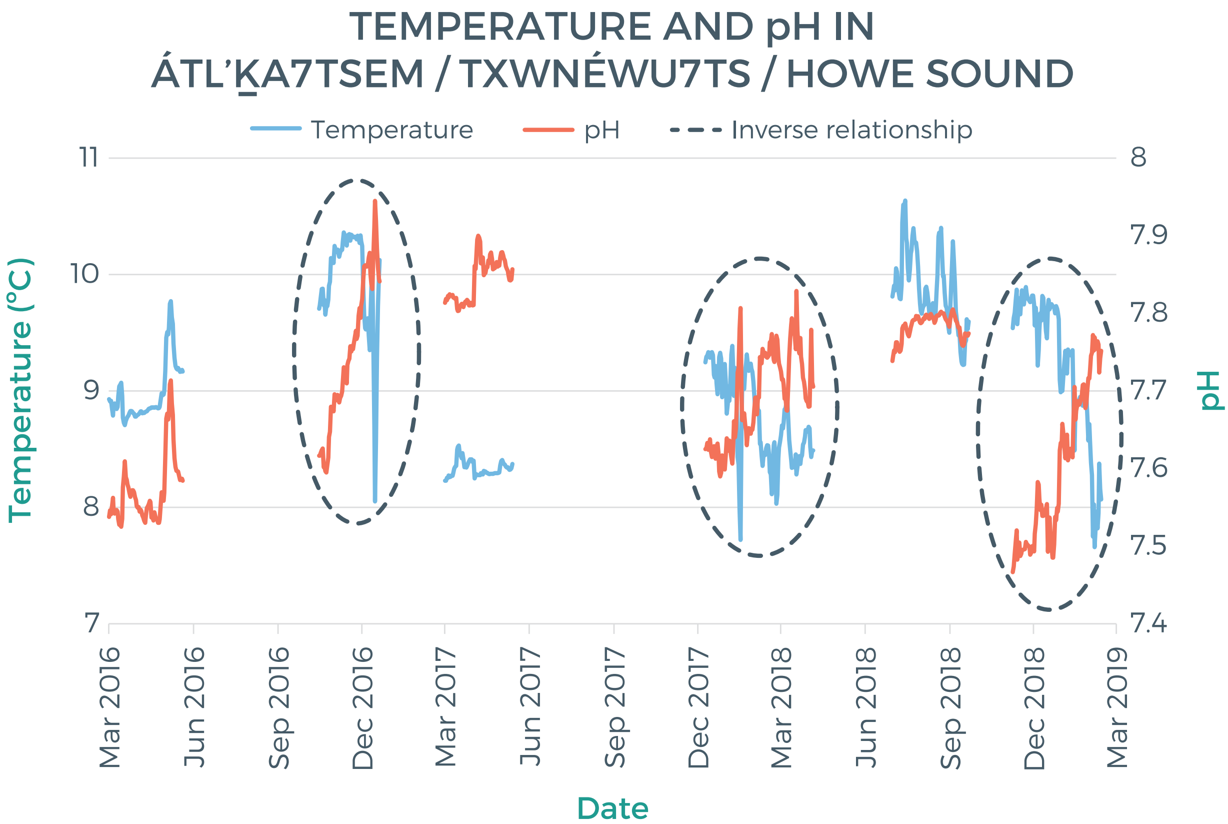


Figure 3. Temperature and pH at the Ḵw'émḵw'em/Defence Island and Nínich Ḵw'émḵw'em sponge reef (22 m depth) during six three-month deployments of equipment to measure physical parameters. Black ovals indicate inverse seasonal relationships between pH and temperature.

Although limited in time and space, these data provide a general sense of existing seabed conditions in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound. Examining these results alongside ocean water samples measured in Burrard Inlet at 20 m depth (Figure 1) shows the need for decadal length time series to identify real declines in pH and distinguish them from seasonal patterns and the effects of deep-water flushing events in the Salish Sea. Monitoring of water quality using these parameters continues and will eventually provide a more comprehensive picture of acidity in Átl'ḵa7tsem/Txwnéwu7ts/Howe Sound on a decadal or longer time scale.

Why is it important?

Many marine species may be negatively impacted by ocean acidification, either directly due to the need for calcium carbonate in shell formation, or indirectly, for example through the loss of prey. Lower pH values (i.e., more acidic) can impact marine animals that use calcium carbonate to form shells, such as oysters and mussels, preventing shell formation at the larval stage, and preventing the formation of byssus threads in mussels, which are used to attach the mussel to the substrate. These changes can result in death. Shellfish hatcheries in Puget Sound and the Strait of Georgia have been affected.[3] However, more research is needed regarding the cascade effects within the food web due to the relatively "recent" recognition of ocean acidification impacts (the term ocean acidification was only coined in 2003 after an abrupt climate regime shift was observed[4]).

What is the current status?

Current efforts at the Ocean Wise Research Institute suggests a relationship between climate regimes and ocean acidification in Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound.[2] Acidification appears to change in a step-wise fashion. In contrast, seabed biodiversity records in the Strait of Georgia and from the west coast of Vancouver Island have not shown any changes in a particular direction in correlation with this step-wise decrease in pH (i.e., pH always decreases, whereas biodiversity both increases and decreases).[5]

What can you do?

A detailed overview of recommended actions is included in *The path to zero carbon municipalities* (OWHS 2020).

Methods

Data were collected by Ocean Wise researchers from the Howe Sound Conservation and Research Team using a YSI EXO2 Sonde buoy deployed at various locations across Átl’ḵa7tsem/Txwnéwu7ts/Howe Sound in a depth range of 10 to 30 metres. Data collection began in July 2015, and has continued intermittently up until, and including, 2019. Water quality information pertaining to temperature, salinity, pH, dissolved oxygen and turbidity was collected at 10- to 15-minute intervals for up to three months at a time.

Ocean Wise staff have recorded pH for the Burrard Inlet intake during water quality sampling on an approximately bi-monthly basis since 1968. Current sampling utilizes an EXO Sonde.

References

1 Marliave JB, Gibbs DM, Young S, Borden LA. 2011 climate regime shift revealed by seabed biodiversity. In: State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2017Canadian Technical Report of Fisheries and Aquatic Sciences. 2018. p. 245.

2 Marliave JB, Gibbs DM, Borden LA, Gibbs CJ. Seabed biodiversity shifts identify climate regimes: The 2011 climate regime shift and associated cascades. Sel Stud Biodivers [Internet]. 2018;59–82. Available from: https://tinyurl.com/climateregime

3 Marliave JB. Personal communication. 2019.

4 Smithsonian Institute: Ocean Portal Team. Ocean acidification [Internet]. Smithsonian Ocean. 2018. Available from: https://ocean.si.edu/ocean-life/invertebrates/ocean-acidification

5 Marliave JB, Gibbs CJ, Gibbs DM, Lamb AO, Young S. Biodiversity stability of shallow marine benthos in Strait of Georgia, British Columbia, Canada through climate regimes, overfishing and ocean acidification. In: Grillo O, Venora G, editors. Biodiversity loss in a changing planet [Internet]. IntechOpen; 2011. p. 49–74. Available from: https://www.intechopen.com/books/biodiversity-loss-in-a-changing-planet/biodiversity-stability-of-shallow-marine-benthos-in-strait-of-georgia-british-columbia-canada-throug