Water Quality Monitoring
The First Step to Protect Ocean Life

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Introduction

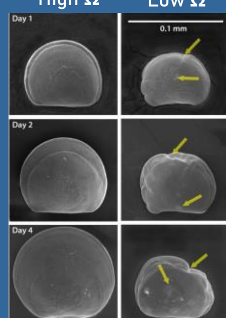
Everyone loves coral, right? They form beautiful underwater landscapes, and are home to many species. Most people are probably aware though, that the world's coral reefs are under threat, and one reason for that is ocean acidification (OA). OA is due to the increase of CO_2 emissions from human activities such as cars, factories, and deforestation. One third of atmospheric CO_2 is absorbed by the oceans, and the increase of CO_2 in the ocean ultimately makes it difficult for coral reefs to grow. This is because OA lowers Ω, which is a unitless value that describes the favorability of water for biocalcification. The higher Ω is, the easier it is for calcifying organisms to grow and reproduce. OA is currently lowering Ω values, which can inhibit shell formation and cause already formed shells to dissolve. High Ω values are not only crucial for corals, but any organism that has a shell structure: crabs, mussels, and oysters. All of these organisms rely on their tough shell for survival, so if the water they are living in makes it difficult for their shells to remain strong, then fewer will survive and reproduce. Water quality monitoring is essential for understanding the drivers of Ω change and its potential impact on marine organisms.

Goal: understand when water conditions are optimal for shell formation

The sensors placed in Tillamook Bay

What happens to oyster larvae at different Ω values

High Ω Low Ω



Methods

Source of data:

- 3 sensors placed at North end of Tillamook Bay under a dock in Garibaldi
    - SeaEFT or SeapHOX — pH, salinity
    - SAMI — pCO2, temp
    - YSI — pH, temp, DO, salinity, depth….
- Sensors were placed in 2017, collect data every 15 minutes

All data analyzed in R Studio

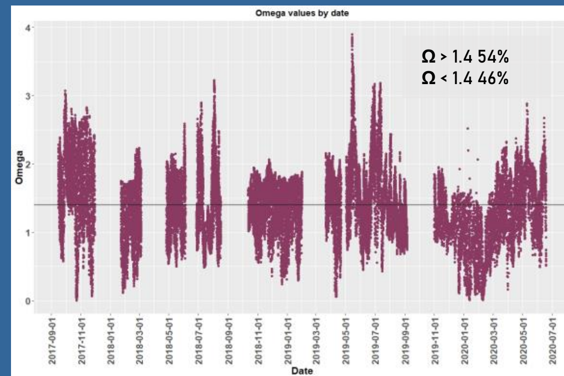
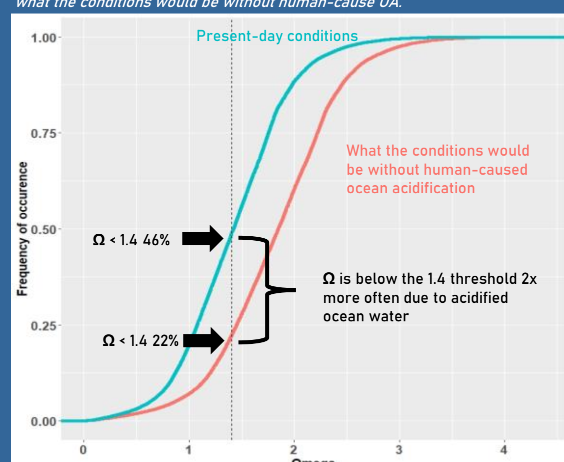


Figure 1. Change in Ω over time, from 2017-2020. The black line is where Ω equals 1.

> Water in Tillamook Bay is optimal for shell formation only about half the time

Figure 2. Ω frequency of occurrence, comparing present-day conditions to what the conditions would be without human-cause OA.



Results

The main finding from this study is that conditions in Tillamook Bay are optimal for shell formation only about half the time. Figure 1 shows the changes in Ω over time, compared to the black line where Ω equals 1.4, which is the Ω value that researchers have generally agreed is the threshold for shellfish such as oysters. Above Ω = 1.4, oysters are able to pretty easily build their shells, but below that conditions become less than optimal. This data from Tillamook Bay shows that the water is only above 1.4 54% of the time. This means that 46% of the time organisms like oysters have a hard time building and maintaining their shells, which can then affect the level of survival and reproduction of calcifying organisms.

Discussion

Why does any of this water quality monitoring matter? Because it allows us to better understand when biological thresholds are not being met and what the possible impacts are. Figure 2 illustrates how much worse conditions are now due to OA. Currently, the water in Tillamook has an Ω value of less than 1.4 about 46% of the time. Without human-cause OA, however, this would drop to 22%. This means that today, Ω is below the 1.4 threshold 2 times as often due to the more acidified ocean water. This can have harmful implications for coastal economies that rely on oyster aquaculture and crabbing, as lower Ω values in the water makes it more difficult for those calcifying organisms to grow and reproduce.

Further applications of this data include:

(1) Understand the environmental drivers that are responsible for low **Ω**
(2) Understand the timing and frequency of low **Ω** occurrence
(3) Understand the human drivers that are responsible for low **Ω**
(4) Help inform the effectiveness of local and global OA management strategies
(5) Predict **Ω** by creating a multiple linear regression

Acknowledgements: Special thanks to Steve Pacella for his support and assistance with this project. Thank you to Cynthia Leonard (Marine Studies Initiative) and Itchung Cheung (Hatfield Marine Science Center) for their support and for providing the opportunity to learn and grow as a scientist through the Marine Studies Initiative summer internship.