BC FoodWeb

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RESEARCH SUMMARY

Is seawater buffering with soda ash harming your Pacific oysters?

C. L. Mackenzie, C. M. Pearce, S. Leduc, D. Roth, C. T. E. Kellogg, R. B. G. Clemente-Carvalho, and T. J. Green.

Production Type
- Shellfish aquaculture

Practice Benefit(s)
- Improved adult oyster survival
- Improved resilience to ocean acidification

Research Location
- Vancouver Island, B.C.

Figure 1. Tagged oyster seed used for lab and field tests. Photo by Clara Mackenzie.

KEY TAKEAWAYS

- Adding **soda ash** (sodium carbonate) to seawater, to combat ocean acidification, during the **first day of Pacific oyster larval development** can negatively affect the oyster's microbiome (community of microorganisms in the body).
- These microbiome changes can **weaken the oyster's defenses** to stressors like increased temperatures (marine heatwaves) and bacterial infections, leading to **higher mortality rates**.
- While adjusting seawater pH with soda ash has helped oyster larvae survive in the short term, it's important to consider potential long-term effects on oyster health and survival.

Key Terms:
- *Ocean acidification: when the ocean becomes more acidic (lower pH) because it absorbs extra carbon dioxide from the air, making it harder for marine life, like shellfish, to survive.*
- *Chemical pH buffering: increasing the pH of seawater (less acidic) in aquaculture hatcheries.*
- *Summer mortality: a general term for when oysters die during the summer for unclear reasons, often related to warmer water, stress, and disease.*
- *Oyster microbiome: the community of microorganisms (bacteria, fungi, viruses) that naturally live on or in an oyster.*

HOW CAN THIS RESEARCH BE USED?

- Aquaculture hatcheries can **avoid** buffering seawater with soda ash. There are **alternative strategies** to reduce the impact of ocean acidification and disease, such as **selective breeding and** probiotics, that hatcheries can explore.

WHY WAS THIS RESEARCH DONE?

The goal of this study was to evaluate if adding soda ash to seawater (to combat ocean acidification) during Pacific oyster larval production is causing problems in spat and adult stages.

RESEARCH SUMMARY

In 2007, the Pacific oyster industry on the west coast of North America experienced unprecedented levels of larval mortality. The failure of oyster hatcheries to produce meant oyster farmers in B.C. could not purchase seed (“baby” oysters). This mortality was later linked to ocean acidification, which happens when the ocean absorbs more carbon dioxide from the air, making it more acidic. To combat the acidified seawater, many hatcheries added soda ash to incoming seawater to raise the pH (make it less acidic), creating a more favourable environment for oyster larvae. These treatment systems were initially a giant success, resulting in billions of additional oyster seed supplied to the region. However, while this pH adjustment helps larvae survive in the short term, its long-term effects on oyster health were not fully understood.

Shellfish growers around the world continue to face mass mortality events during summer months with marine heatwaves and the spread of bacteria and viruses. Understanding how soda ash impacts oyster health beyond the larval stage can help the shellfish farming industry make informed decisions around oyster disease and climate change challenges.

WHAT WAS THE OUTCOME?

Rearing oyster larvae in soda-ash-treated seawater can change the oysters’ microbiome

Oysters, like humans, host a community of microorganisms—bacteria, viruses, and other microbes—collectively known as the microbiome. Changes to the microbiome can affect the oysters’ ability to defend against diseases and other stresses.

The types of bacteria in the microbiome of oyster larvae were noticeably different when they were grown in soda-ash-treated water compared to natural seawater. Larvae grown in soda-ash-treated water had more of one type of bacteria (*Alteromonadales*) and less of two other types of bacteria (*Flavobacteriales* and *Rhodobacterales)* compared to larvae grown in natural seawater. Research has found that increased levels of *Alteromonadales* are associated with stress and disease in animals, while *Rhodobacterales* were linked with disease resistance in Pacific oysters. We saw similar microbiome patterns in the juvenile stage (~9 months after fertilization), suggesting that these changes to the microbiome and immunity may carry on into adulthood.

Figure 2. Researcher Dr. Clara Mackenzie during the seawater buffering experiments. Photo by Tim Green.

Rearing oyster larvae in soda-ash-treated seawater leads to increased mortality in juvenile and adult oysters during stressor events (heatwaves and bacterial infection)

There was a significant difference (statistically) in survival after exposing juvenile oysters to prolonged heat and *V. aestuarianus* (a bacteria that causes disease in oysters) for 7 days: **all oysters grown in natural seawater survived, while only 65% of oysters grown in soda-ash-treated water survived.** After 4 days of putting adult oysters in the same conditions, **100%** of the oysters grown in natural seawater survived while **90%** of oysters grown in soda-ash-treated water survived, though this difference was not statistically significant (i.e. it might not have been caused by the conditions we tested).

WHAT'S NEXT?

Our findings show that soda ash pH buffering in shellfish hatcheries may be partially contributing to mass mortality events of Pacific oysters in later-life stages under stressor events. Seawater buffering may be necessary in the first 24-48h of development, however, alternatives to soda ash buffering after this period should be investigated.

HOW WAS THE RESEARCH DONE?

This study was conducted at Vancouver Island University's Deep Bay Marine Field Station (DBMFS) located near Baynes Sound. Pacific oyster broodstock were sourced in August 2020 from a shellfish producer based in Baynes Sound.

On the day of spawning, we filled 6 larval rearing tanks (cylindrical, ~250 L) with natural seawater pumped directly from Baynes Sound. The temperature was kept around 21-22°C. We then mixed in technical grade soda ash to half of the tanks until pH levels reached 8.0-8.1. Oysters were strip-spawned within 24h of receiving them from the shellfish producer and split equally between the 6 tanks. The tanks were left for 24h with gentle aeration to keep the eggs suspended in the water. After the 24h period, we returned the larvae to their original tanks and placed on flow-through with seawater (~24-25°C). The tanks were cleaned every 2 days until larval settlement.

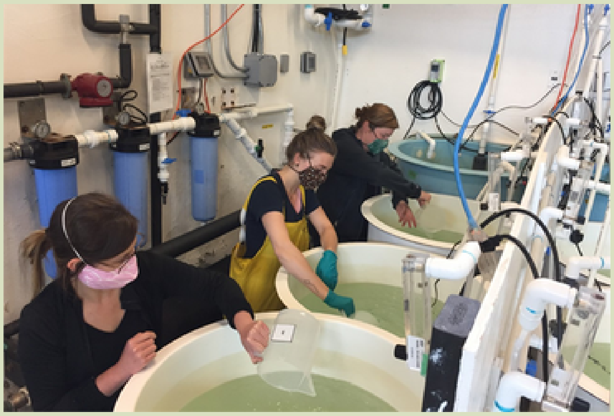

Figure 3. Stocking oyster larval rearing tanks with fertilized eggs. Photo by Tim Green.

At 19 days post-fertilization, all spat were moved to the DBMFS nursery system (ambient flow-through seawater system). The spat were fed mixed culture algae every day. Every 2 days, we took larval samples for microbiome analysis. 3 months post-settlement, we exposed juveniles (~5-10 mm shell height) to a 7-day simulated marine heatwave (~24°C) and *Vibrio aestuarianus*. Oyster mortality was recorded daily. 9 months post-settlement, we exposed adult oysters to the same conditions and recorded mortality daily.

ABOUT THIS BRIEF

This brief is based on the following scientific journal articles:

- Mackenzie, C. L., Pearce, C. M., Leduc, S., Roth, D., Kellogg, C. T. E., Clemente-Carvalho, R. B. G., & Green, T. J. (2022). Impacts of seawater pH buffering on the larval microbiome and carry-over effects on later-life disease susceptibility in Pacific oysters. *Applied and Environmental Microbiology, 88*(22). **https://doi.org/10.1128/aem.01654-22**

Want to learn more?

- For any questions regarding this research, contact Tim Green at **Timothy.Green@viu.ca**
- To learn more about the use of probiotics for disease resistance, check out this factsheet by Washington State University: Use of Probiotics in Pacific Oyster and Manila Clam Aquaculture (**https://rex.libraries.wsu.edu/esploro/outputs/book/Use-of-Probiotics-in-Pacific-Oyster/99901118641401842**)

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Funding for this research was provided by Fisheries and Oceans Canada (Aquaculture Collaborative Research and Development Program), the British Columbia Shellfish Growers Association, Canada Chair Research Program, and the Natural Sciences and Engineering Research Council (NSERC). This research was conducted by Vancouver Island University, Fisheries and Oceans Canada, and the Hakai Institute.

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Hakai Science on the Coastal Margin

Funding for this research brief was provided by CleanBC.

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