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Ocean Acidification Impacts on Oyster Aquaculture

Meredith White

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Ocean Acidification Impacts on Oyster Aquaculture

January 17, 2020

Meredith M. White

Director of Research and Development



Ocean Acidification

Carbonate Chemistry

- **Increase in $\text{CO}_{2(\text{aq})}$**



- **Decrease in ocean pH**

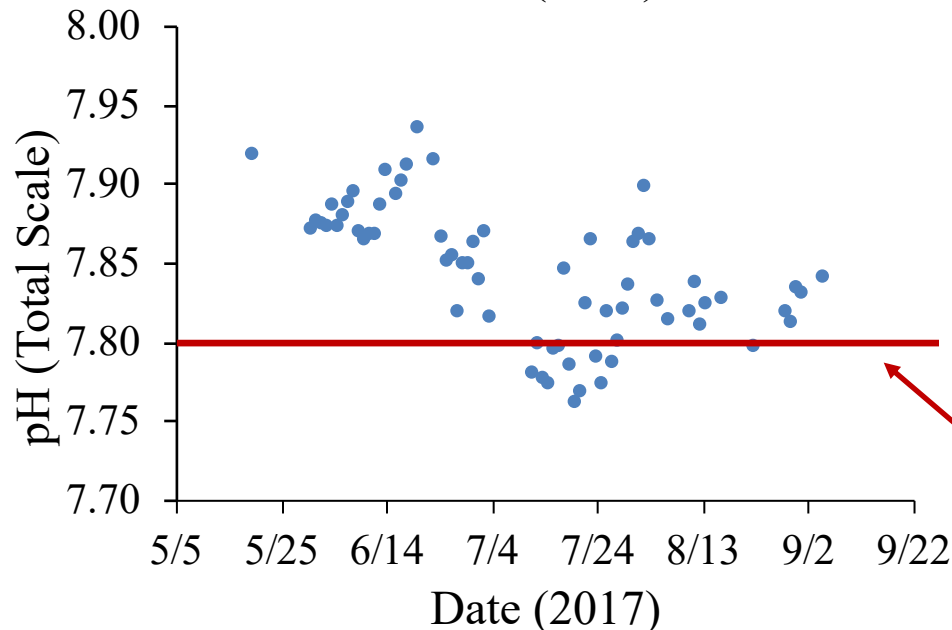
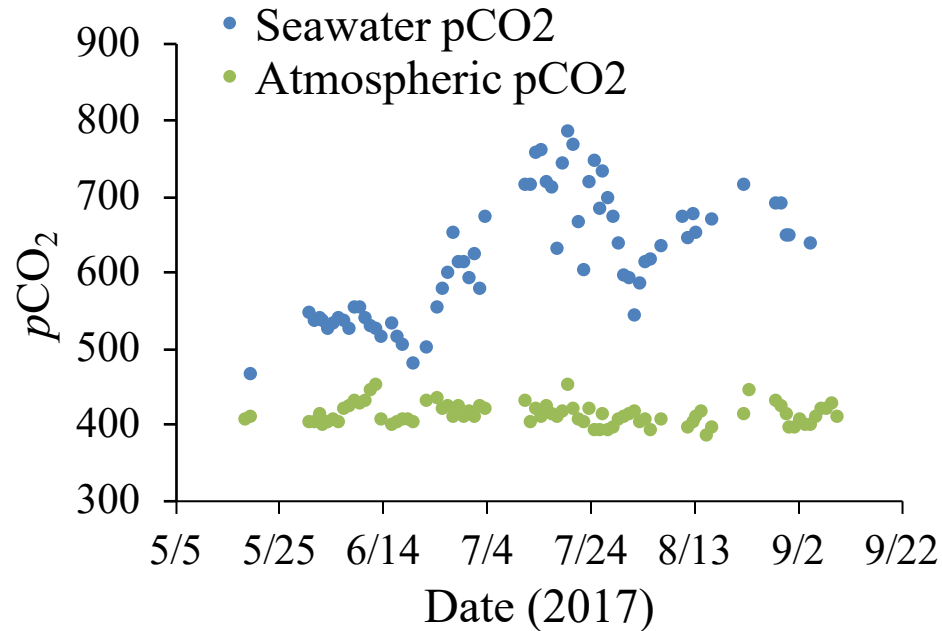


- **Decrease in Ω** (calcium carbonate saturation state)

Coastal Acidification

- Factors affecting Coastal Acidification
 - Atmospheric CO₂
 - Coastal Upwelling
 - Seasonal Primary Production and Eutrophication
 - Freshwater Input

Coastal Acidification



- Mook Sea Farm seawater monitoring system summer 2017

- pH range of 0.2 units, currently below year 2100 projection for open ocean

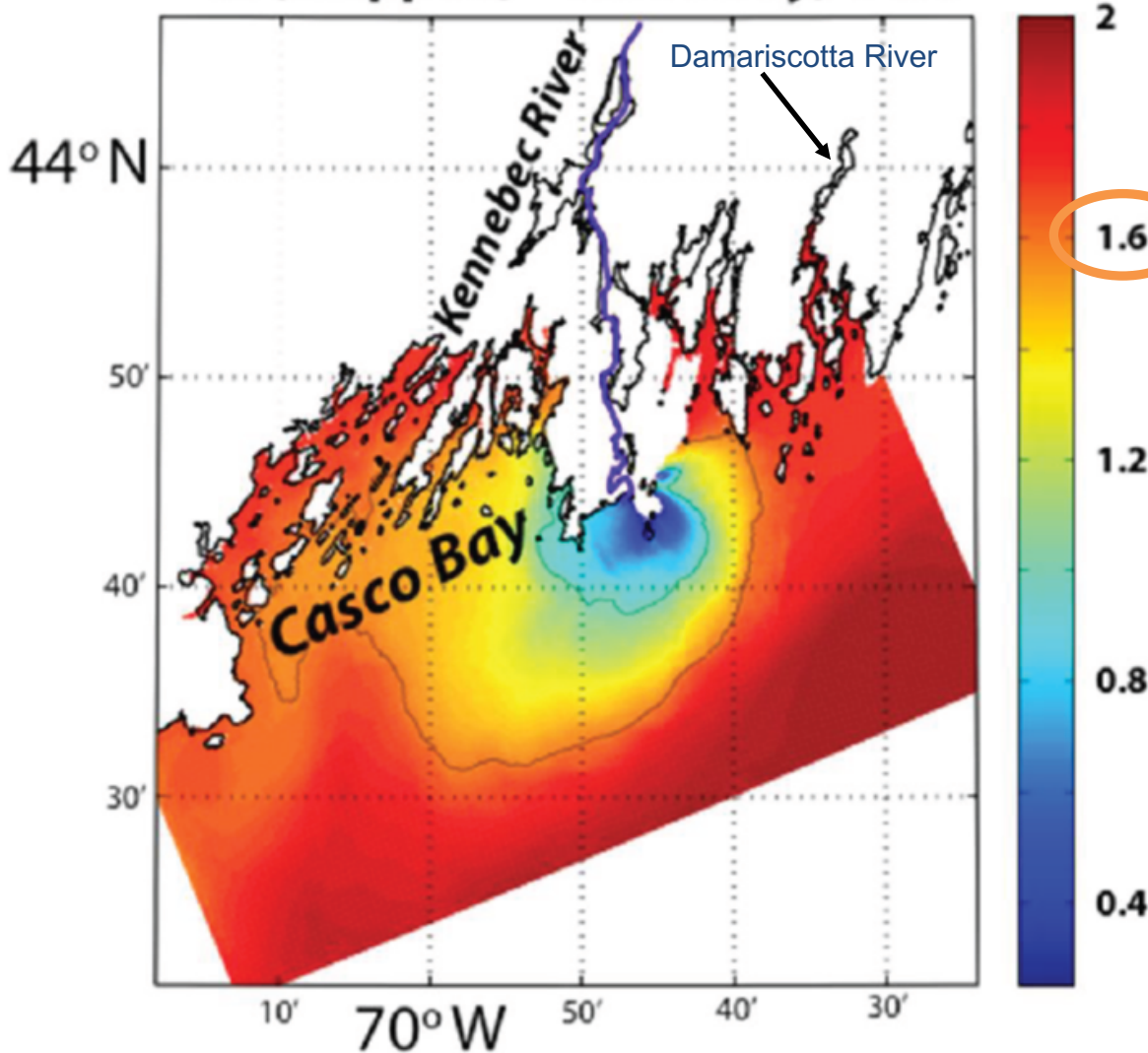
- $p\text{CO}_2$ fluctuations due to cycles of respiration and photosynthesis

Open ocean in
2100: pH=7.8

Coastal Acidification

Freshwater Input

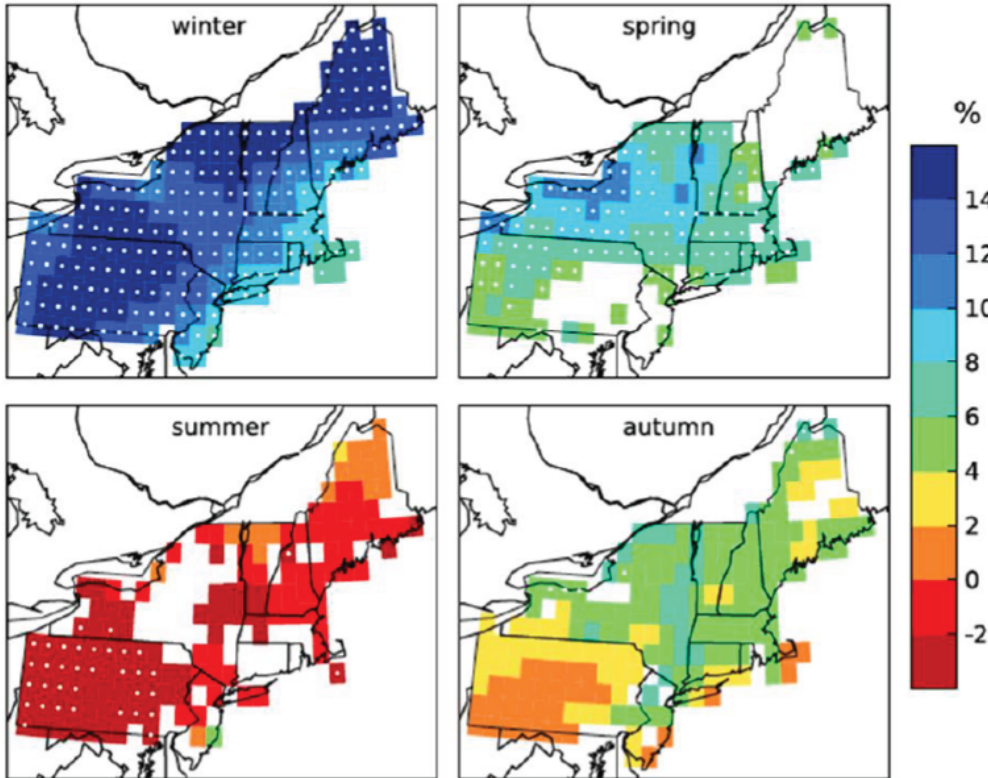
Ω (mapped) - Casco Bay, USA



Freshwater has a lower saturation state than seawater

Kennebec River influences saturation state well into Casco Bay in the Gulf of Maine'

Increased Precipitation Predicted



Projected relative % change in seasonal precipitation:

$$\% \Delta = P_{2041-2070} - P_{1971-2000} * 100\%$$

Positive value means there is a projected *increase* in precipitation

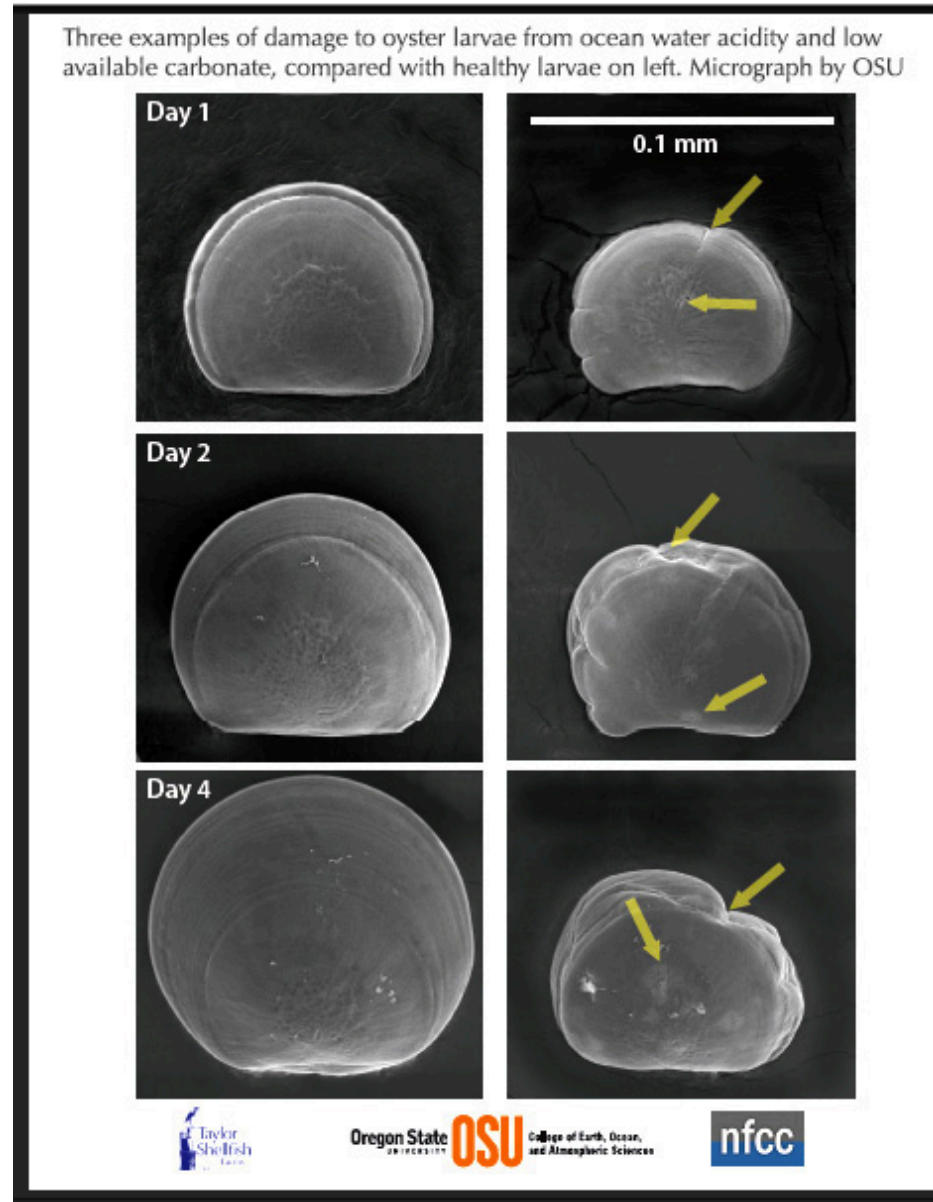
Precipitation projected to increase in **winter, spring, and autumn**

(Rawlins et al. 2012)

Impacts of OA on Bivalve Larvae

Larval Development

Pacific oysters





When we buffer the water:

- Larvae grow fast
- High survival
- High conversion to juveniles
- Reliable production



Impacts of OA on Seed Oysters & Potential Mitigation by Shell Hash

Questions:

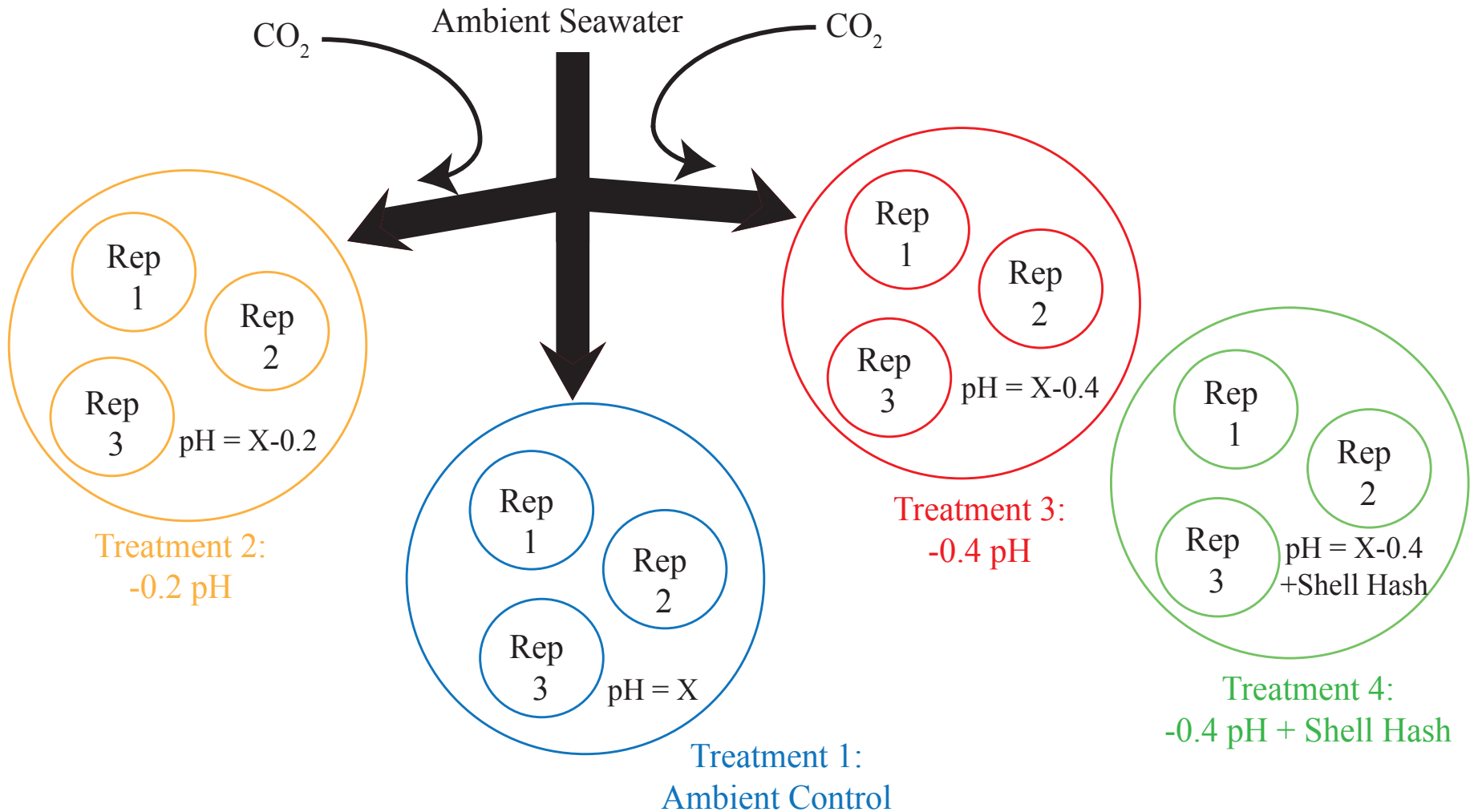
- 1. How does OCA affect juvenile (seed) oysters after they have left controlled conditions in hatcheries and are grown in upwellers in natural seawater?**
- 2. Can ground up shell (shell hash) buffer water in upwellers as a potential mitigation strategy for aquaculture operations?**

Funding Sources & Partners

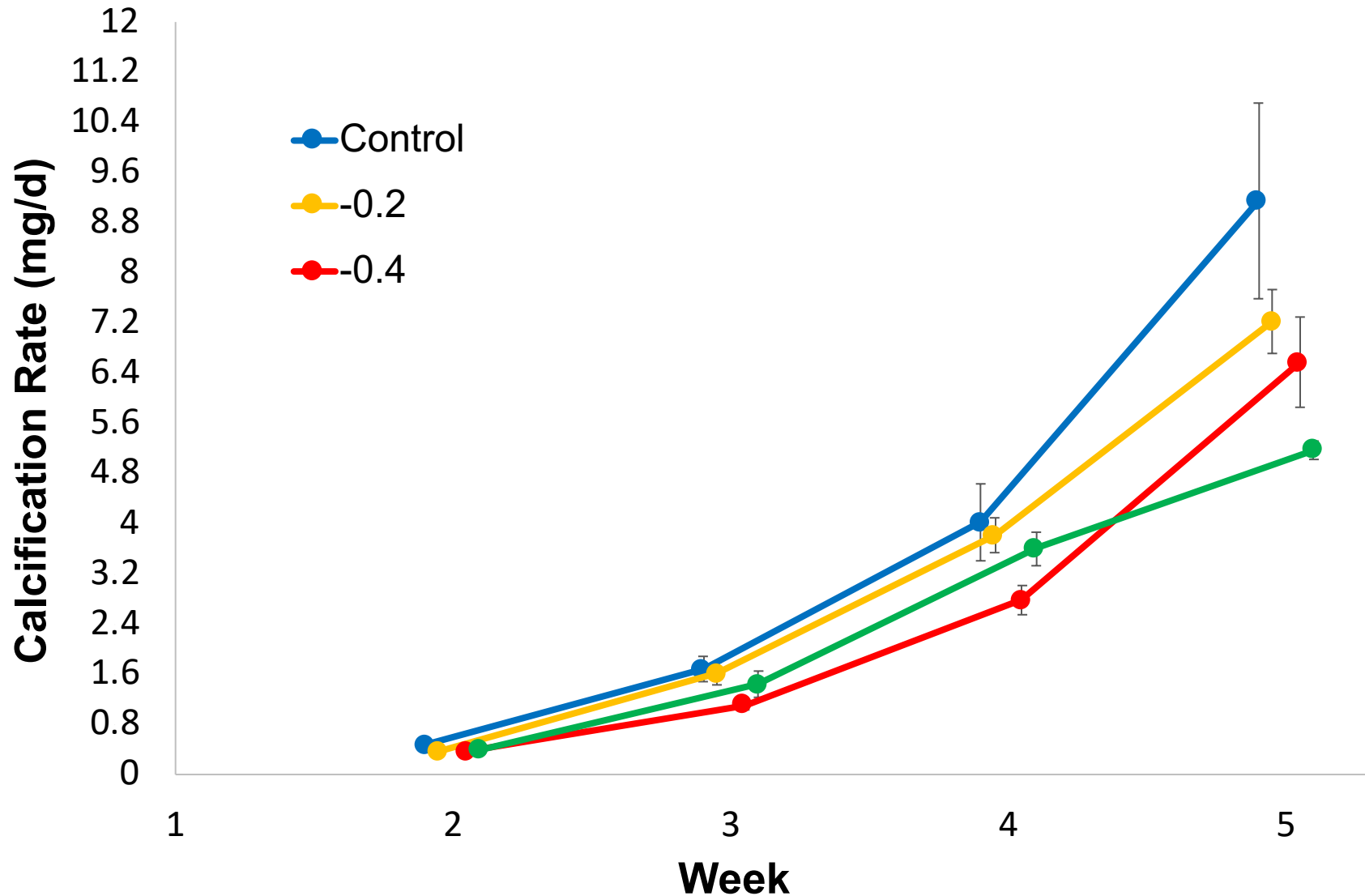


NOAA FISHERIES
Northeast Fisheries Science Center

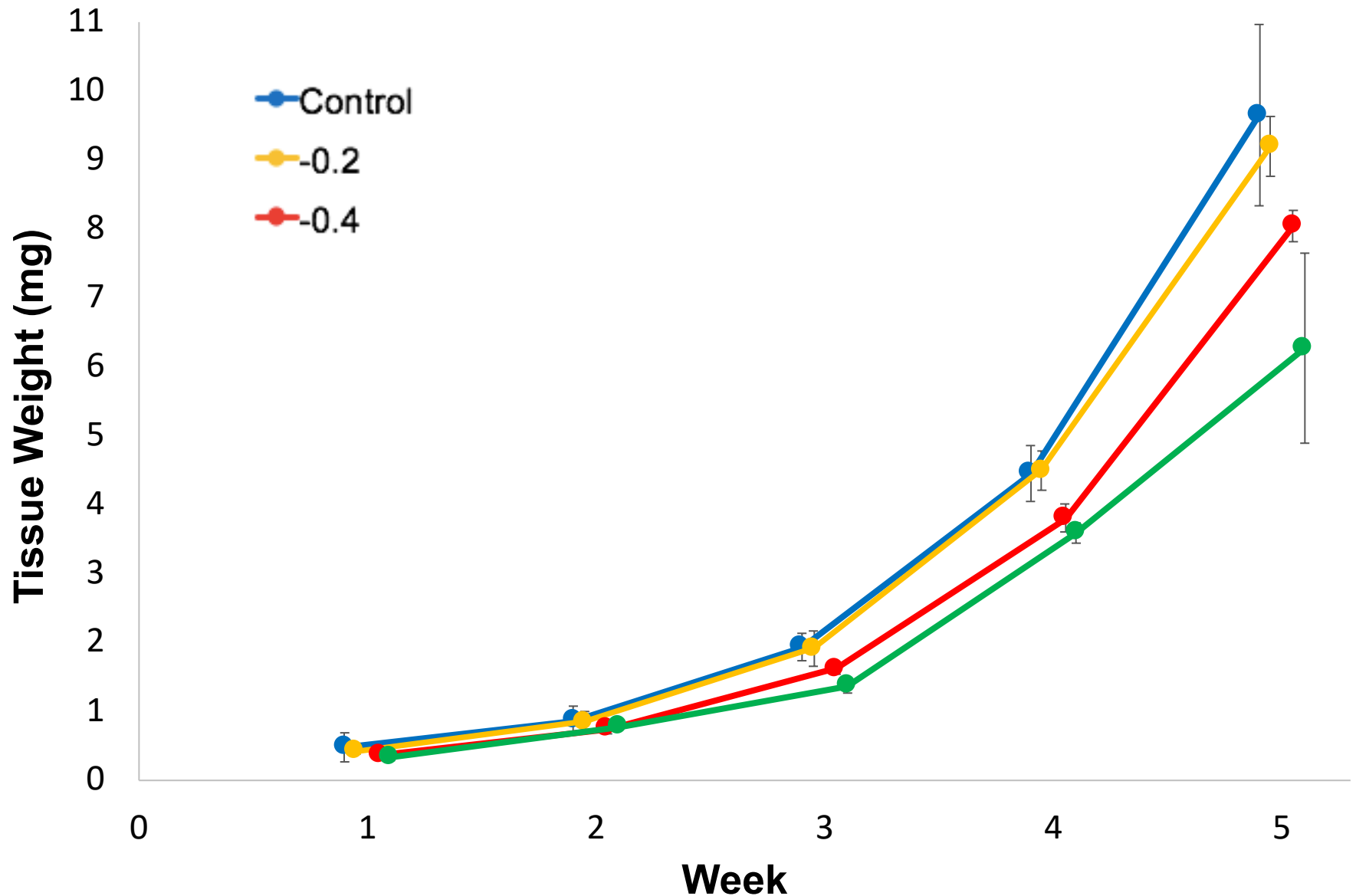
Experimental Design



Results: Calcification Rates



Results: Tissue Weights



Conclusions

- **No significant difference in calcification rates or tissue weights** among oysters grown in ambient, -0.2 pH, -0.4 pH, and -0.4 pH with shell hash treatments
 - **No mortality** observed in any treatment
 - Results of expression of genes related to sublethal stress responses forthcoming
 - May explain how oysters are compensating
- **Seed oysters may be resilient to coastal acidification** at present-day food levels
- **Shell hash may buffer the water in upwellers to improve oyster growth in the future OA scenarios**



Oyster seed, Week 1



Oyster seed, Week 5



MOOK SEA FARM

Our world is your oyster!

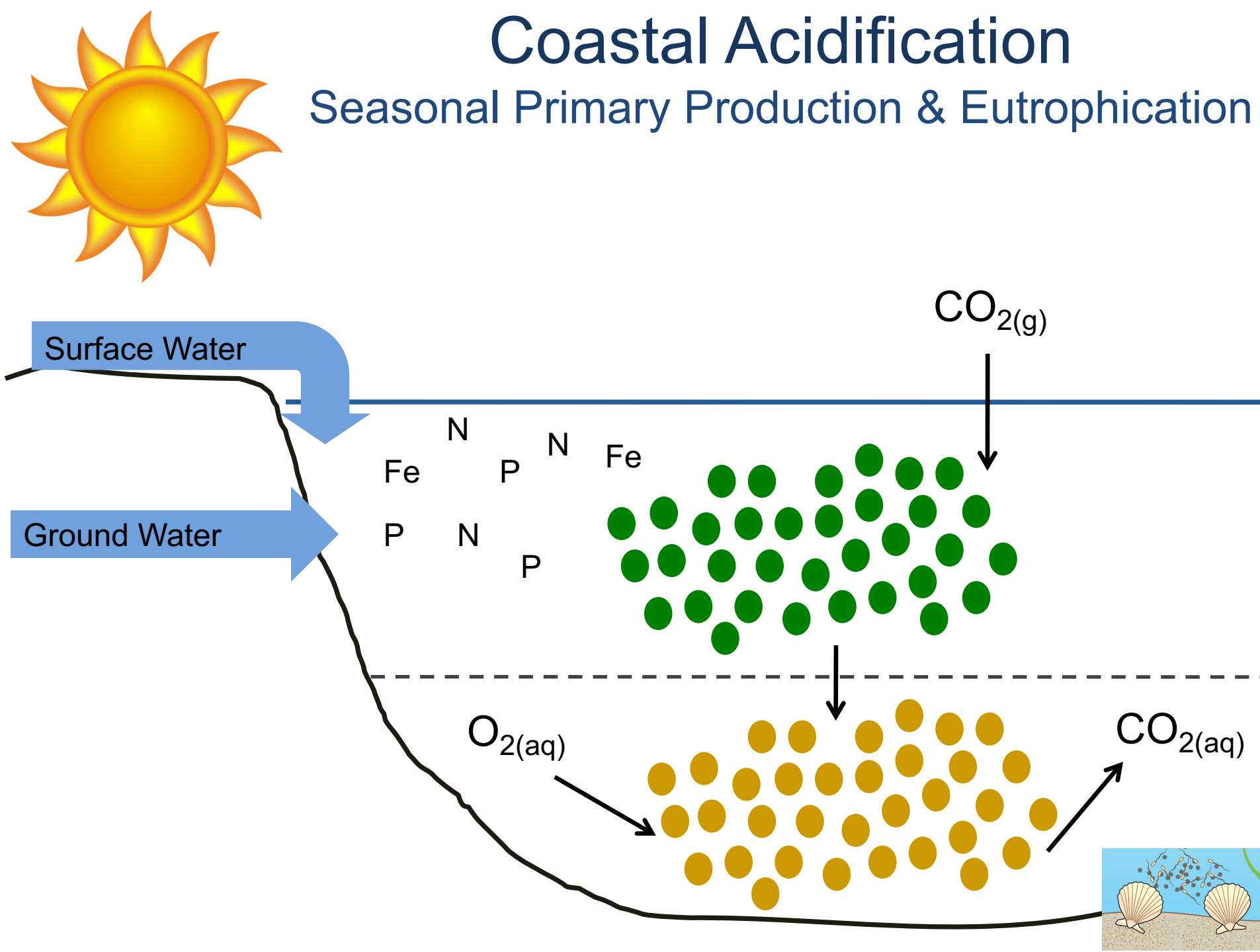
Thank
you!



Extra Slides

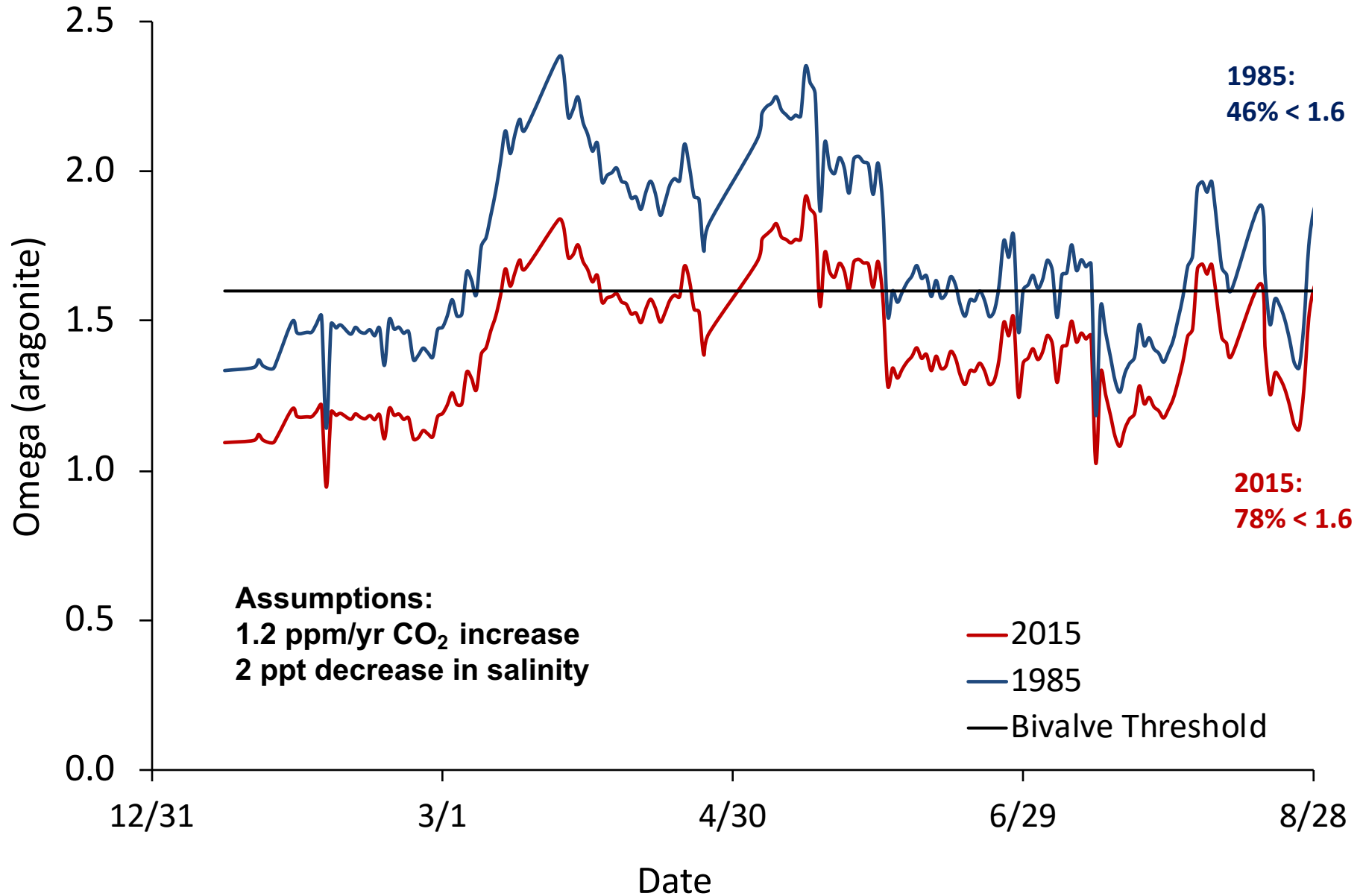
Coastal Acidification

Seasonal Primary Production & Eutrophication

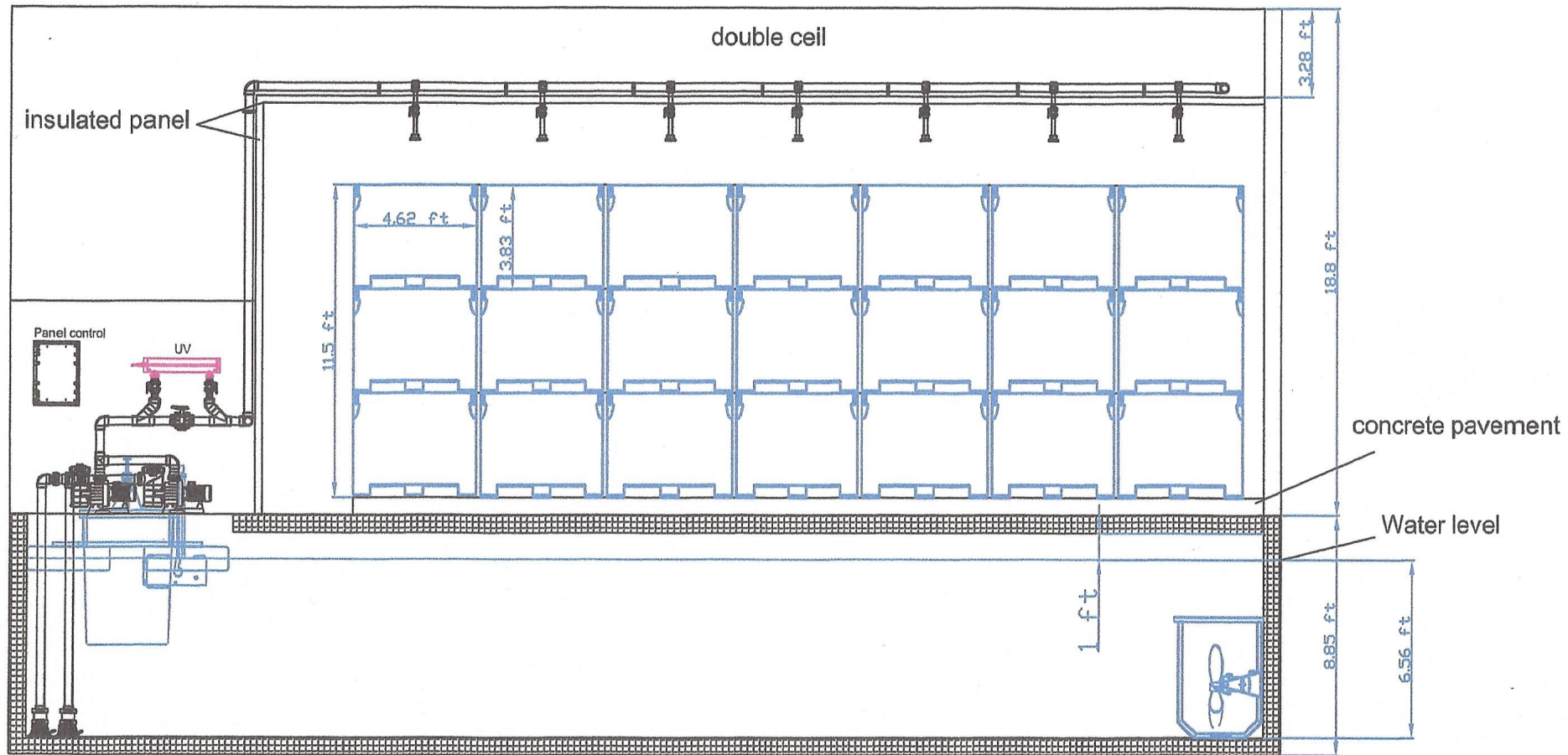


Hatchery Season: January 1 - August 31

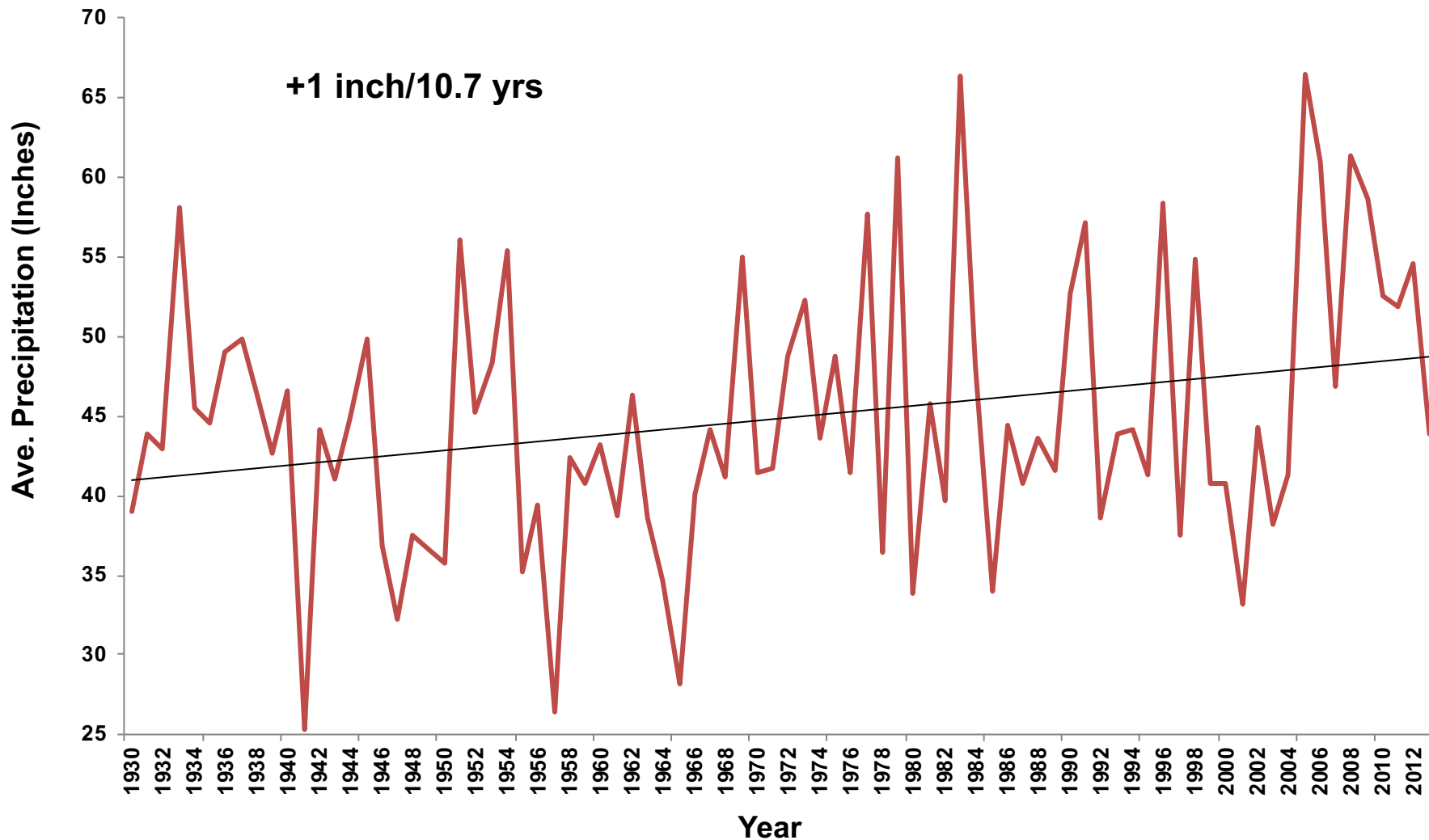
(198 days measured)



Land-based Holding Facility



Average Annual Precipitation in Portland Maine 1930 -2013

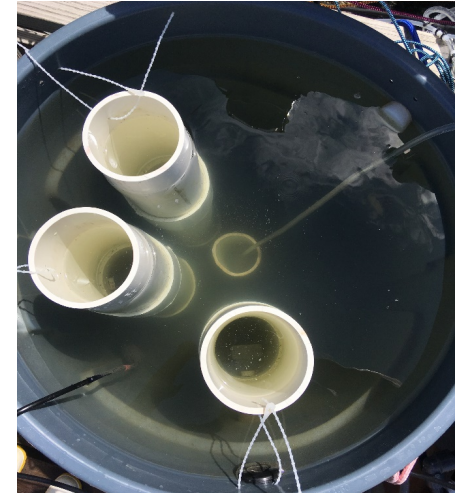


Created from data obtained at <http://ncdc.noaa.gov/cag>

Experimental Design



Treatments 1-4

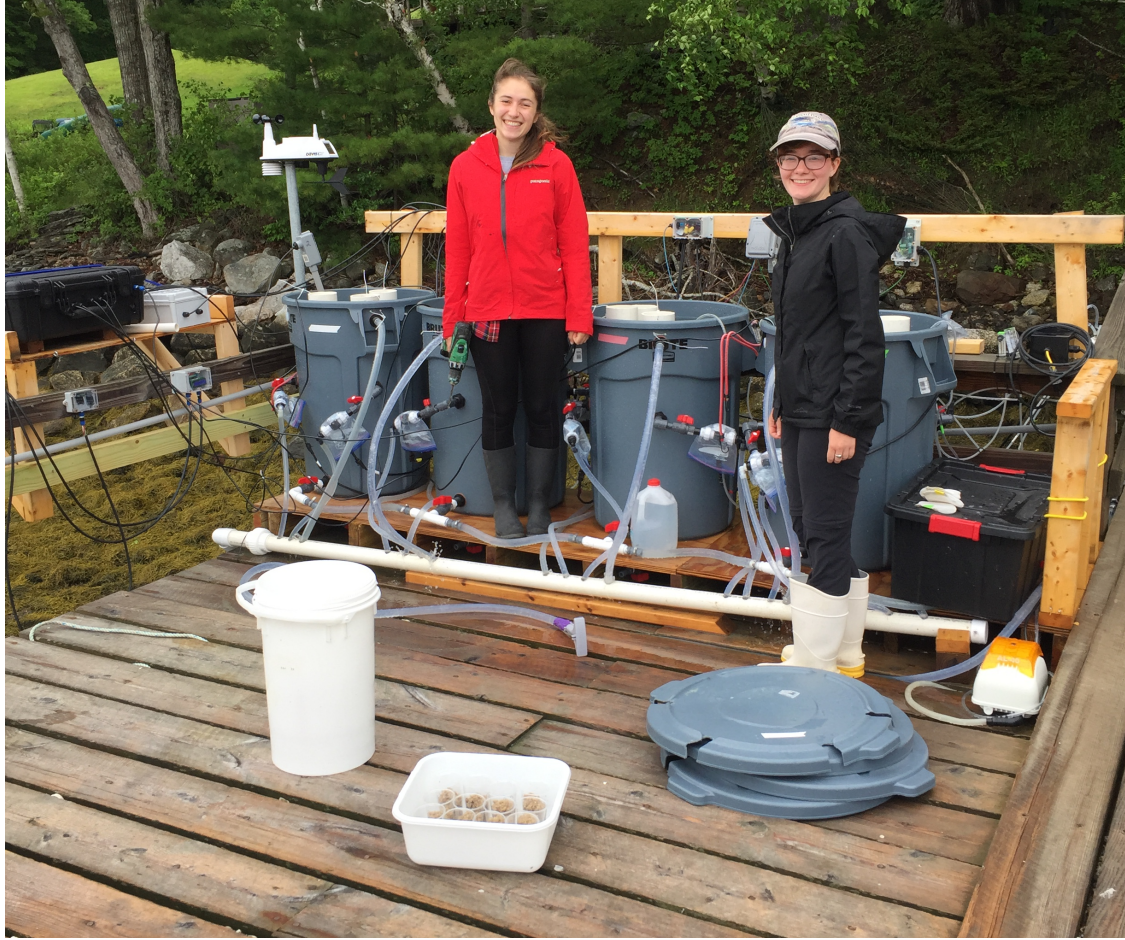


3 replicate silos



Packets of shell hash

Methods



20,000 seed per replicate

Two summer interns: Tessa Houston and Catherine Wilhelm

Results: pH Control

