Investigating the Effects of Ocean Alkalinity Enhancement Towards the Microbial Community in Atlantic Canada

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INTRODUCTION

- Ocean Alkalinity Enhancement (OAE): enhance the ability of the ocean to draw down atmospheric carbon dioxide.
- Goal: Asses if OAE impacts the surface phytoplankton communities
- Round-robin study (20 institutions worldwide).

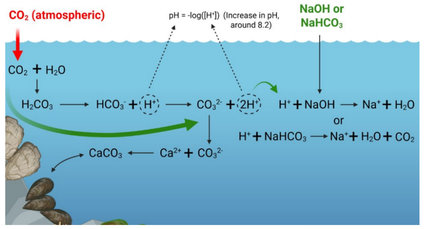
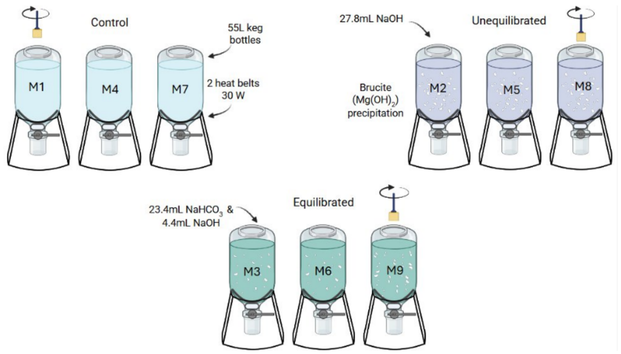
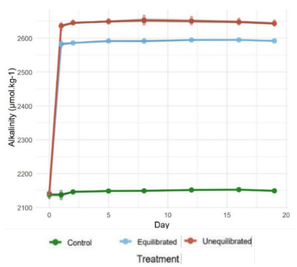


Figure 1. The chemical process following the addition of alkalinity into the ocean. Courtesy of Dr. Fanny Fronton.

METHODS

- Water collected off of McNabs Island for a 19-day experiment





Parameter	Sampling Frequency
Alkalinity	8
pH	daily
Temperature	daily
Nutrients (NO_x, PO_4, SiO_4, NH_3)	11
Chlorophyll-a	11
POC/PON	11
Biogenic silica (BSi)	11
Flow cytometry (FC)	11
Microscopy	7
Nucleic acids	7

Figure 2A. The experimental designs. **Figure 2B**. The alkalinity measurements (umol.kg-1) for each treatment, alkalinity was raised by ~500umol.kg-1 in equilibrated & unequilibrated treatments. Courtesy of Dr. Fanny Fronton. **Table 1**. The parameters collected throughout the experiment and their sampling frequencies.

RESULTS

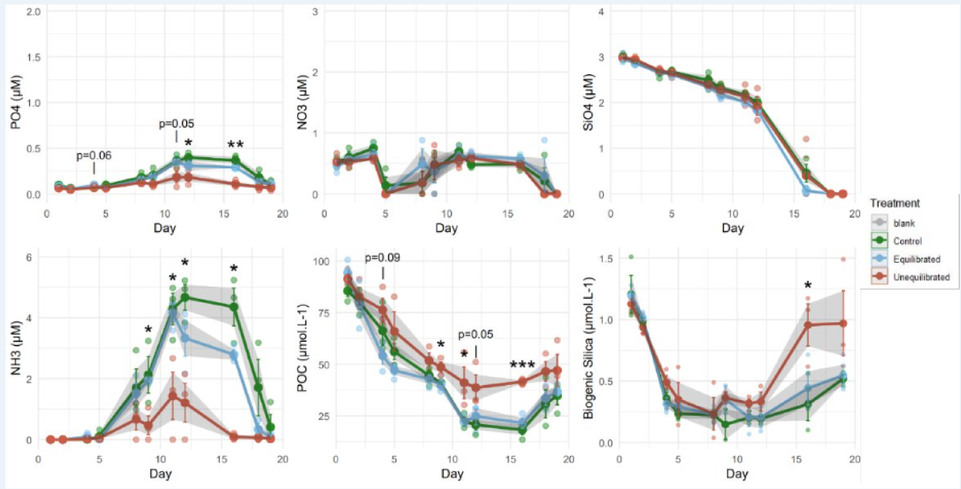


Figure 3. The levels of various nutrients (PO_4, NO_3,SiO_4, NH_3), particulate organic carbon (POC), and biogenic silica (BSi) throughout the experiment. Overall, the same trend can be seen in all treatments, though the unequilibrated treatment had the most pronounced effects in POC, NH_3 and BSi. Significant difference is denoted with an asterisk. p values of days when there were close to a significant difference were also shown. Courtesy of Dr. Fanny Fronton.

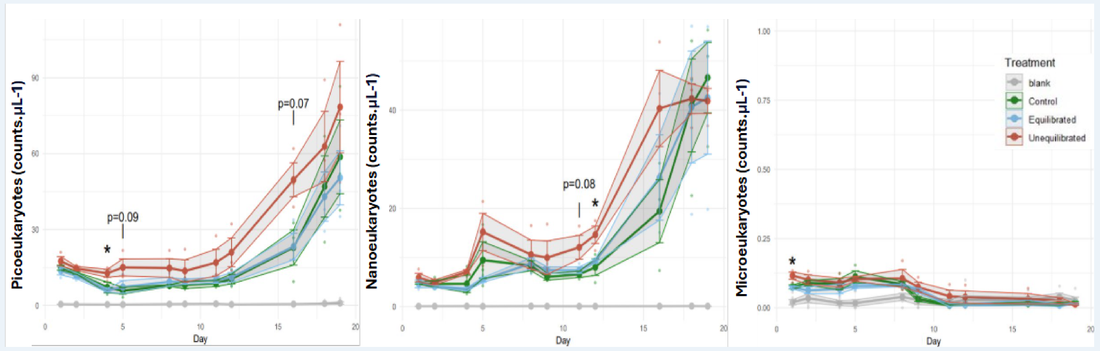


Figure 4. Mean cell counts (uL-1) by day of Picoeukaryotes, Nanoeukaryotes, and Microeukaryotes. Significant difference between the means is denoted with an asterisk. p values of days when there were close to a significant difference were also shown. Overall, there was a slight increase in Picoeukaryote and Nanoeukaryote biomass, with the unequilibrated treatment higher than the rest. Microeukaryotes showed the least changes throughout the experiment.

	Model	AIC	R^2
Picoeukaryotes	gamm4	461.407	0.992
Nanoeukaryotes	gamm3	495.613	0.979

Table 2. Results from GAMMs analysis along with the Akaike information criterion (AIC) and the R-squared values for Picoeukaryotes, Nanoeukaryotes, and Microeukaryotes.

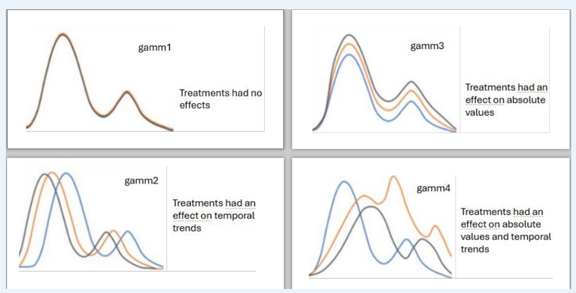


Figure 5. The gamm models with their hypothesized smoothers. For each parameter, the model with the lowest AIC was considered the best at representing the temporal trend and thus was chosen. Modified from Ferderer et al. (2022).

CONCLUSION

Treatments had a slight effect on the phytoplankton community.

- Microeukaryotes: at the start, genus Karenia (Dinoflagellates) dominated the community.
- Increase in Picoeukaryote & Nanoeukaryote biomass. (Fig. 4)
  - Genus Minidiscus and Thalassiosira (Diatoms) dominate the community at the end.
- Picoeukaryotes showed changes in temporal trends and absolute abundance (gamm4).
- Nanoeukaryotes showed changes in absolute abundance (gamm3). (Table 2, Fig. 5)

Changes in the carbonate chemistry can affect species composition.

- Silicate-shelled organisms seemed to benefit from the unequilibrated treatment. (Fig. 3)
  - Affect the foodweb
- OAE may favor species that are better adapted to lower CO_2 concentrations.
- Benefits calcifying organisms, which can have adverse effects towards OAE.

Future directions

- FlowCam & DNA analysis
- Repeat the study at a different time of year
  - Change in nutrient levels
  - Change in water temperature
  - Change in community composition
- Using mineral-based OAE

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