Phytoplankton in Changing Oceans:
The Effects of Carbon Dioxide on Phytoplankton Abundance, Health, and Community Structure

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INTRODUCTION

Different phytoplankton species have varied responses to increases in CO_2 concentrations.[1, 4] There is evidence that some phytoplankton grow better at higher CO_2 concentrations when free of competition.[5] It has also been shown that seawater pH has significant potential to impact the species of phytoplankton present in an environment.[3] As CO_2 concentration and PH are intrinsically linked there is potential for a rapid shift in phytoplankton community composition as emissions rise.

Changes in phytoplankton community composition and abundance will impact the effectiveness of carbon sequestration in the ocean and have large-scale cascading effects throughout the trophic web.[2] Understanding the effects of increased CO_2 concentrations on different species and the changes to their abundance in nature will be crucial for future conservation efforts.

We hypothesized that as CO_2 increased in concentration the varied responses of phytoplankton would lead to a higher level of stress in the population categorized by quantum yield and that the phytoplankton community composition would change.

SAMPLING SITES

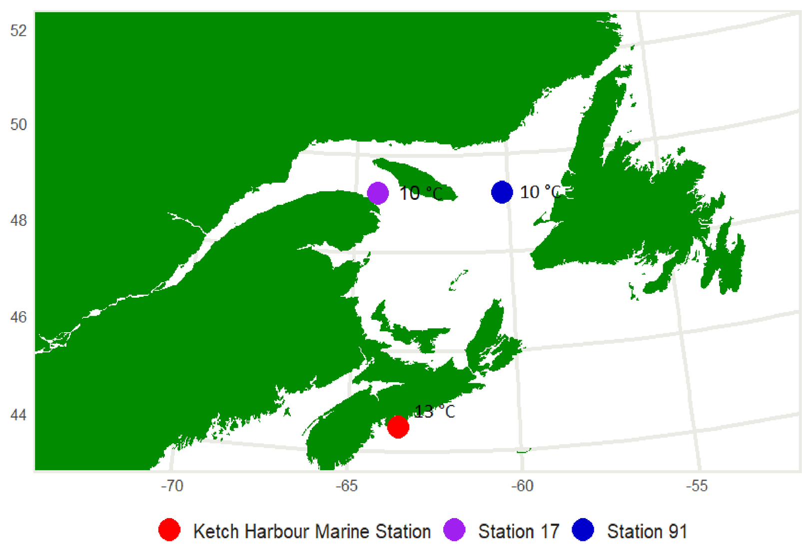
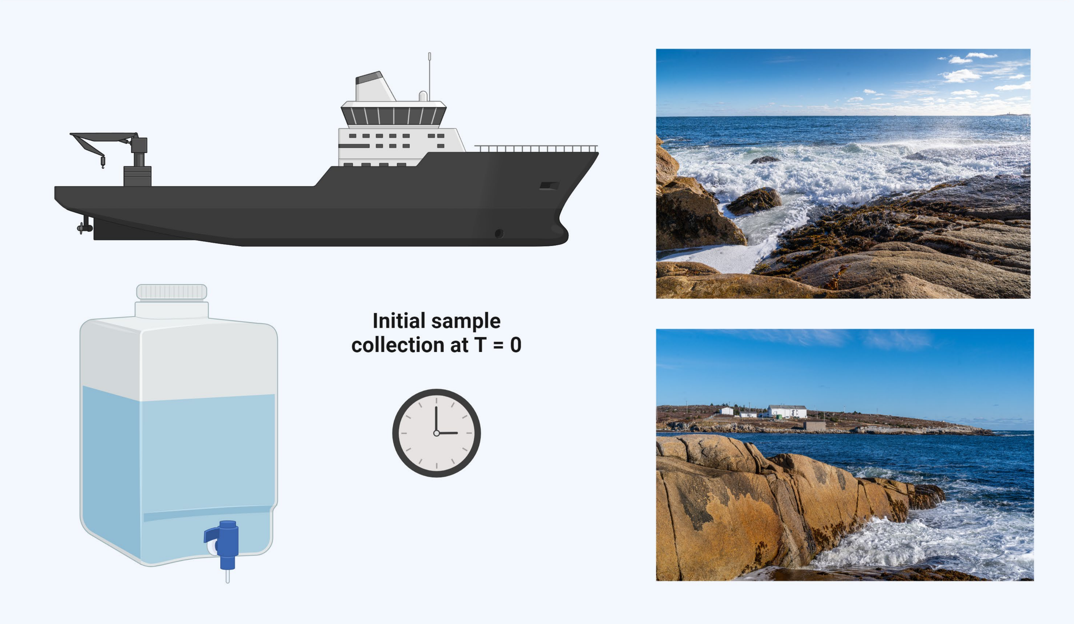


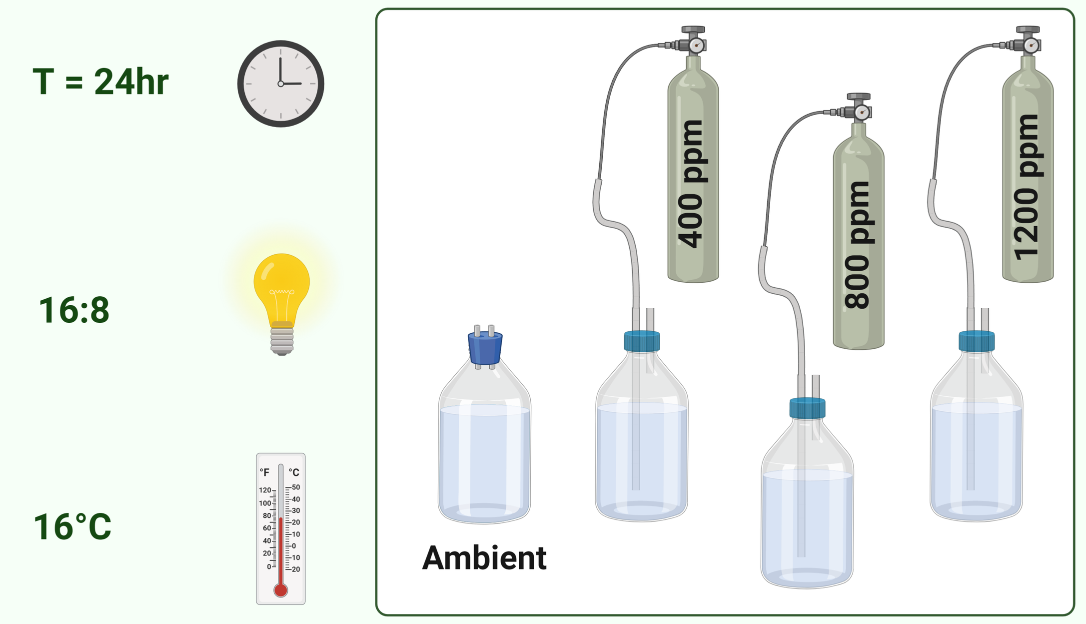
Figure 1. Sampling sites for CO_2 treatments experiments at Ketch Harbour in October 2023 and on the TreX expedition in June 2022. Station 17 corresponds to PH004 and Station 91 corresponds to PH005.

METHODS

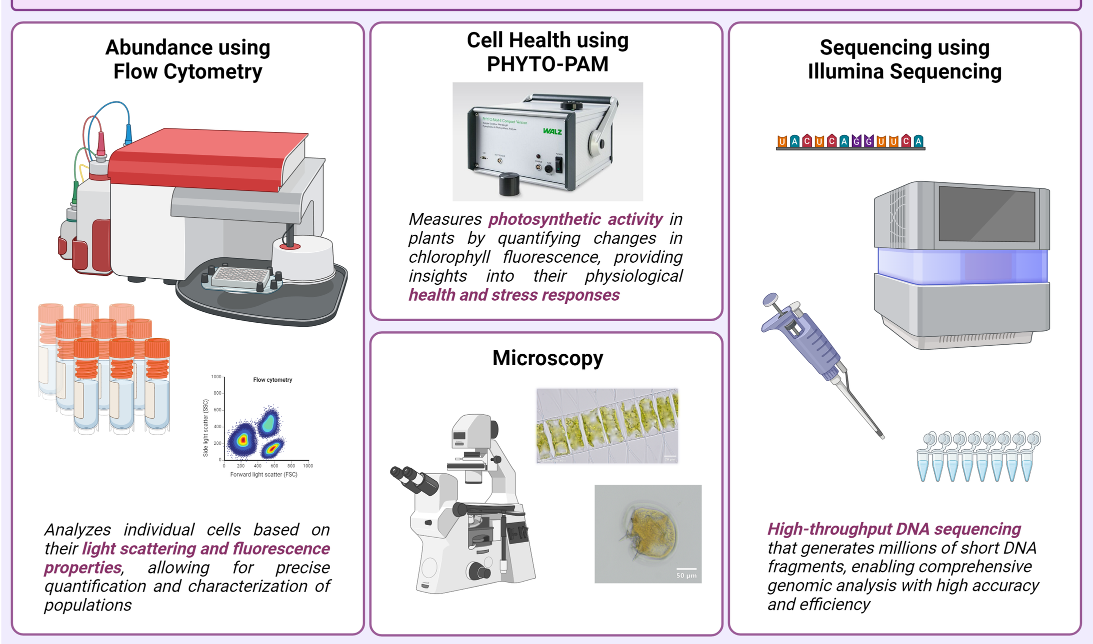
WATER COLLECTION



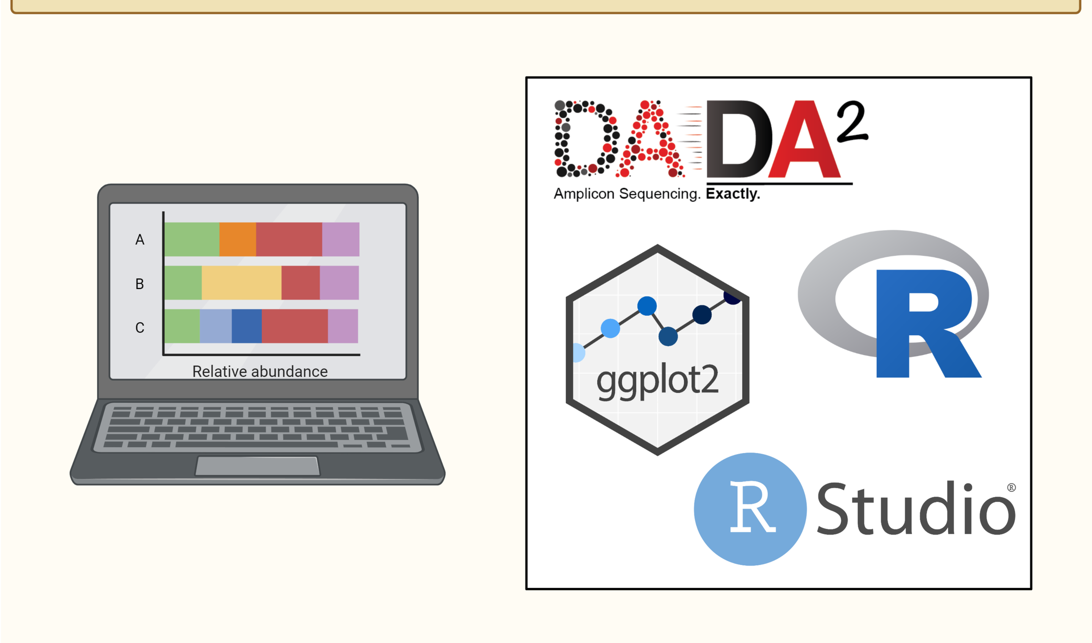
INCUBATION EXPERIMENT



SAMPLE ANALYSIS



DATA ANALYSIS



RESULTS

PHYTOPLANKTON ABUNDANCE

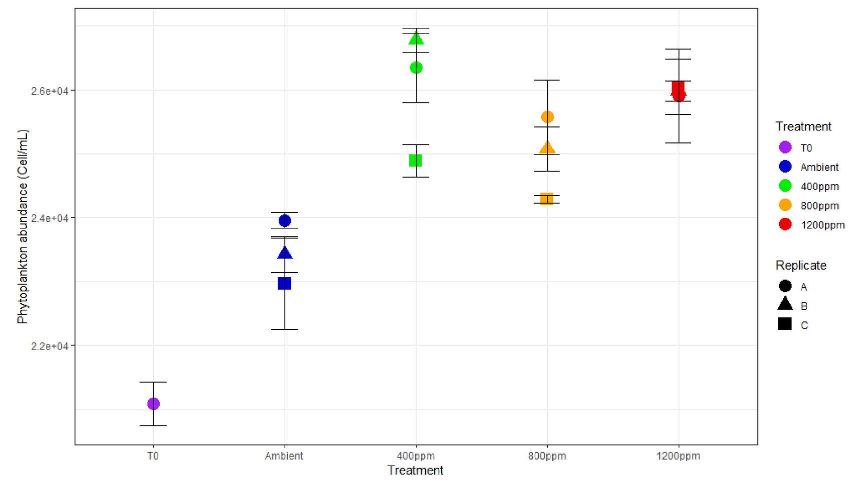


Figure 2. Average phytoplankton abundance (cells/mL) across CO_2 treatments for the Ketch Harbour experiment.

COMMUNITY STRUCTURE

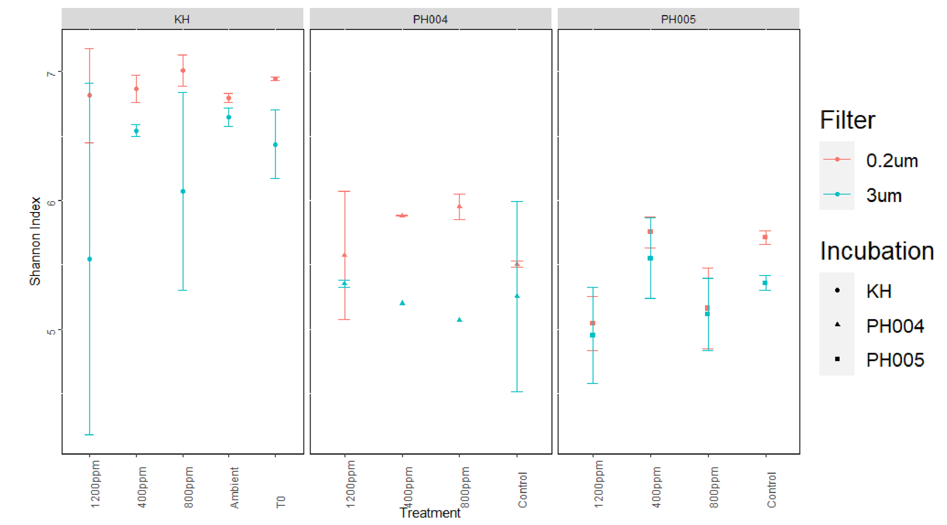


Figure 5. Shannon Diversity Index at each level of CO_2 treatments for the Ketch Harbour experiments and PH004 and PH005 TreX cruise.

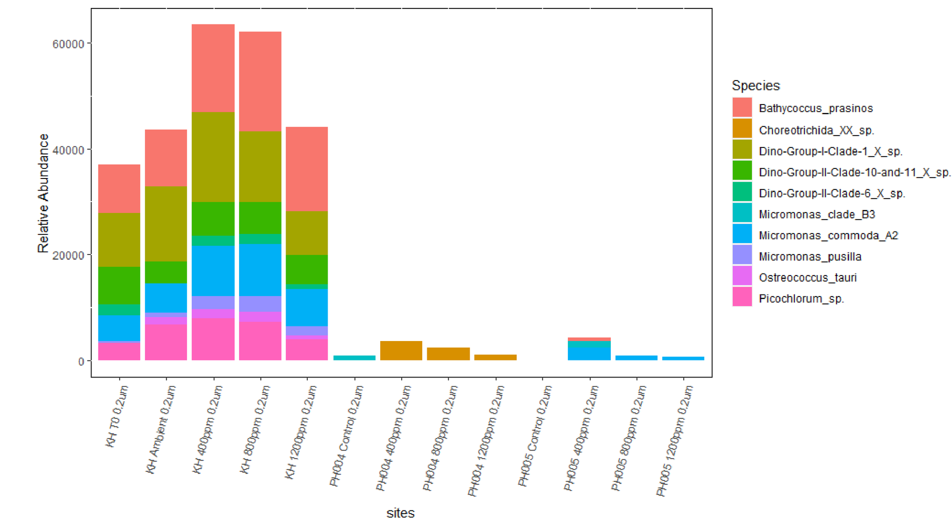


Figure 4. Relative abundance of the top 10 ASV per treatment for 0.2 µm fraction size based on CO_2 treatment.

HEALTH

Quantum Yield
Quantum yield is a measurement of stress in photosynthetic species. Across all four treatments the value of quantum yield did not significantly change, suggesting that phytoplankton were neither stressed or made more comfortable.

Table 1. Average quantum yield values across CO_2 treatments for the Ketch Harbour experiment. A one way ANOVA test returned an F-value of 5.75 with DF1=3 and DF2=8 resulting in a p-value of 0.02141.

Treatment	Mean+/- StDev
T0	0.42+/-NA
AMBIENT	0.387+/-0.015
400ppm	0.417+/-0.006
800ppm	0.407+/-0.015
1200ppm	0.383+/-0.006

NMDS
An NMDS is a way of visualising difference between points. The more similar phytoplankton communities are, the shorter the distance between the points. Filter size shows different population.

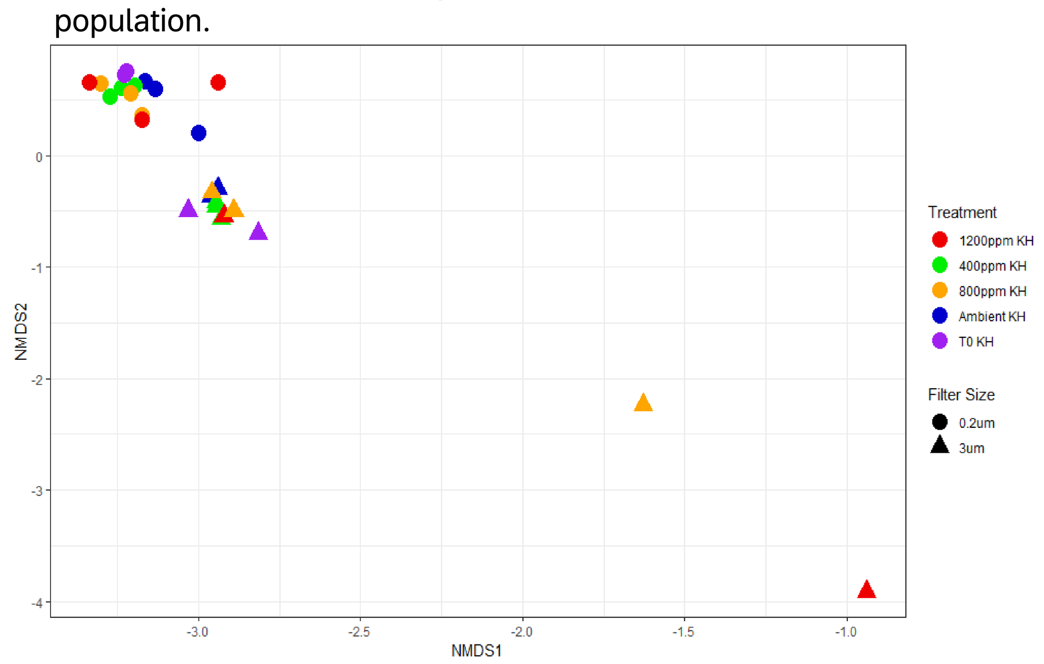


Figure 6. NMDS showing the differences between phytoplankton communities from the Ketch Harbour experiment across different CO_2 treatments and filter sizes.

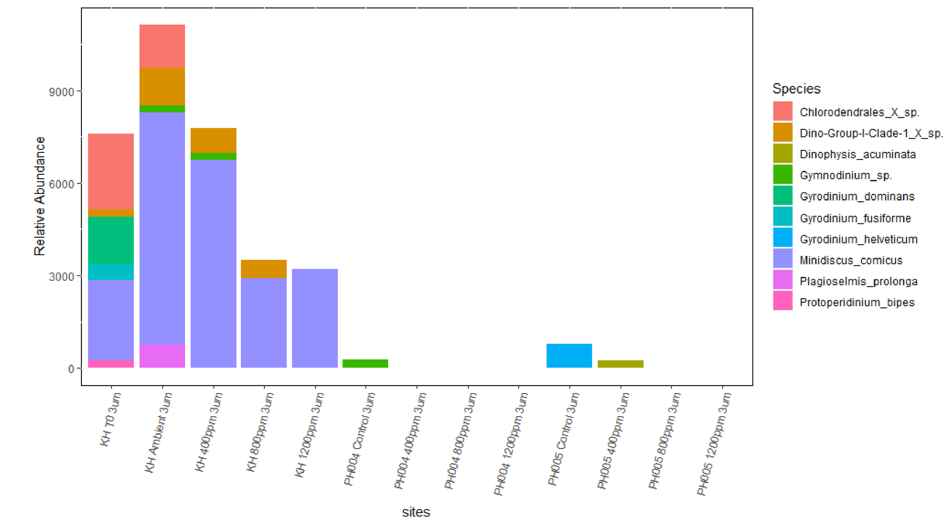


Figure 3. Relative abundance of the top 10 ASV per treatment for 3 µm fraction size based on CO_2 treatment.

BARGRAPHS
Phytoplankton communities are more abundant and diverse nearshore at Ketch Harbour than in open ocean at Station 17 and 91. 0.2 µm communities are dominated by *Bathycoccus prasinos* while 3 µm communities are dominated by *Minidiscus comicus* and *Chlorodendrales* prasinophytes.

CONCLUSIONS

- Our results were not sufficient to reject the null hypothesis. The differences in sampled natural population composition are mostly the result of filter size (*Figures 5-6*).
- Our results also suggest that phytoplankton populations do not experience increased or decreased levels of stress at higher levels of CO_2 concentration (*Table 1*), this implies that while communities have a high tolerance for environmental CO_2 it is not a limiting factor for phytoplankton growth.
- Our flow cytometry data suggests an increase to phytoplankton abundance under increased CO_2 concentration (*Figure 2*). though the effect is likely due to increased light levels from experimental setting rather than the CO_2 treatment.
- Phytoplankton populations are different based on filter size and sampling site (*Figures 4,5-6*).
- While we fail to reject the null hypothesis further work on a longer timescale is still required to determine how environmental factors will impact phytoplankton communities.

REFERENCES

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