Role of Phosphorus on Phytoplankton Concentrations
Marni Friedman and Brittany Klein
College of Charleston, Charleston, SC 29401

INTRODUCTION
Phytoplankton are the primary producers of the marine ecosystem and are consequently often the subject of environmental and scientific research. As species of phytoplankton are extremely diverse, it is difficult to completely elucidate the mechanisms by which their productivity is regulated. However, it has been shown that the most dominant factor involved in limiting productivity is nutrient availability. There is still debate over the specific nutrient that is most limiting the best candidate being Phosphorus and Nitrogen or possibly Silicon in the case of diatoms (Roelke et al. 1999). All of these nutrients are necessary for basic biological processes; however, certain species flourish at their optimal nutrient ratios. Charleston Harbor is a temperate environment that supports a biennial diatom bloom. Nutrients flood in from rivers, such as the Ashley and Cooper, and mix with the more saline and nutrient-diluted ocean waters. In the similar ecosystem of Chesapeake Bay that reported high phytoplankton blooms in early Spring that were limited by DIP during the spring (Maioresco et al. 1994). Spring was the time of year with the most nutrient input from rivers, and as such, dissolved inorganic nitrogen (DIN) and dissolved silicate (DSi) were available at much higher concentrations than DIP. It was Phosphorus that the organisms ran out of first. After the spring bloom died, summer phytoplankton were limited by DIN (Maioresco et al. 1994). In an additional study, Nitrogen alone was shown to always stimulate phytoplankton growth. Phosphorus alone stimulated growth in May and July, and their combination stimulated growth in July and August (Vindel et al. 1999). It is also important to note that phytoplankton productivity due to nutrient availability cannot be independently observed in natural habitats. A large reason for this is that their presence can be easily obscured by solar radiation or other environmental factors. While small phytoplankton flourish in low nutrient environments, high pressure from competitive communities, low light, or low water temperatures can drastically reduce growth. One possible management claim has been proposed that involves providing nutrients from a point source so that edible phytoplankton have multiple blooms and the inedible blooms are inhibited (Rass et al. 1999). Our study investigates the fluctuations in phosphate levels during Spring in Charleston Harbor and attempts to correlate these fluctuations to the presence of phytoplankton blooms by measuring changes in absorbing chlorophyll a concentration over 5-6 weeks. We also look at the effect of temporally spaced pulses of a limiting amount of Phosphorus in a specific phytoplankton diatom species, Phaedactylum from the Sargasso Sea.

MATERIALS AND METHODS
Culture Pulsing Experiment
We added 2ml of a Phaeodactylum culture to each of fourteen flasks containing 250ml of sterile 35‰ sea water (dH2O and Crystal Sea Salt Mix). The flasks were provided with an abundant level of essential nutrients excluding Phosphorus (0.25µM NaNO3, 0.5µM Na2SO4-9H2O, 0.25µM trace metals, and 0.25µM vitamins). Each experimental group had 3 replicates. There were 4 experimental groups, 3 of which received the same total amount DIP (150µl) over 3 weeks. Set one received the entire amount the first week. Set two received two 75µl treatments five days apart, and Set 3 received three 50µl treatments each five days apart. Set four did not receive any phosphate additions. All of these flasks were kept in 22˚C incubator on a 12:12 light dark schedule. Chlorophyll readings were taken with a fluorometer from subsamples of each flask on March 23, 28 and April 4th.

RESULTS
In another seasonal study, Nitrogen alone was shown to always stimulate phytoplankton growth. Phosphorus alone stimulated growth in May and July, and their combination stimulated growth in July and August (Vindel et al. 1999). It is also important to note that phytoplankton productivity due to nutrient availability cannot be independently observed in natural habitats. A large reason for this is that their presence can be easily obscured by solar radiation or other environmental factors. While small phytoplankton flourish in low nutrient environments, high pressure from competitive communities, low light, or low water temperatures can drastically reduce growth. One possible management claim has been proposed that involves providing nutrients from a point source so that edible phytoplankton have multiple blooms and the inedible blooms are inhibited (Rass et al. 1999). Our study investigates the fluctuations in phosphate levels during Spring in Charleston Harbor and attempts to correlate these fluctuations to the presence of phytoplankton blooms by measuring changes in absorbing chlorophyll a concentration over 5-6 weeks. We also look at the effect of temporally spaced pulses of a limiting amount of Phosphorus in a specific phytoplankton diatom species, Phaedactylum from the Sargasso Sea.

CONCLUSIONS

- Phosphate concentrations at the North shore of Grice Marine Facility were high in early March and correspond with an increase in phytoplankton concentrations. This is in accordance with a study on Chesapeake Bay that reported high phytoplankton blooms in early Spring that were limited by DIP (Malone et al. 1996).
- Phaedactylum did not reflect different growth rates as a result of phosphate pulsing. However, lack of DIP resulted in significantly lower chlorophyll concentrations.
- Possibly, our phosphate treatments of 150µl were non-limiting as Phaeodactylum is a diatom species that grows exceptionally well in most conditions.
- Preliminary observations at the cellular level revealed a clumping of the diatom individuals in the pulsed experimental groups. The untreated Set four did not show clumping but rather cells remained isolated. While it appeared Set 3 had the most clumping activity this was not monitored regularly throughout the experiment and data is purely subjective. However, colonization of phytoplankton in response to temporarily spaced phosphate availability is a possible topic for further investigation.
- One study reveals a necessary 7 day time period for phytoplankton to uptake at least 50% of DIP (Reinhardt et al. 2005). This would suggest our experimental design was limited by time and perhaps pulses would have significant effects on chlorophyll concentrations of the time between each pulse was longer.

BIBLIOGRAPHY


Field Experiment
We collected 1.0ml water samples at 10 sea miles off the coast of Grice Marine Laboratory. We collected the first sample on February 10th and continued to take samples each consecutive Wednesday from 10 sea miles until March 11th. We filtered 10ml for each of the four sample dates and stored them at -80˚C for chlorophyll analysis. We then cut the chlorophyll coated filters paper into tiny pieces each in a tube filled with 10 ml of scavenge for forty-eight hours. The tubes were centrifuged and the final chlorophyll concentrations in the supernatant was measured using a fluorometer. The initial 100µl of the six collection were used at -10°C wild for plaque reading. A standard plaque plate curve (r = 1.532x + 0.235) was derived with a representing (Absorbance-Turbidity) and a representing plaque plate concentration (PCC-1). A set minus was subsequently obtained for an initial turbidity notebook of the untested sample. After adding 100µl of Mixture Base and a second absorbance reading was recorded. The final plaque reading (y) was extracted from the standard curve.