# Gradients of Macronutrients and Chlorophyll-α at Three Different Sites in Buzzards Bay

**Gabriel Duran[1,2], Marc A. Fontánez[1,3], George Manning[1,4]**

[1]Sea Education Association, Falmouth, MA; [2]University of Maryland Baltimore County, Baltimore, MD; [3]University of Puerto Rico at Humacao, Humacao, PR; [4]North Carolina Central University, Durham, NC

## INTRODUCTION

Buzzards Bay is an elongated estuarine that covers an area of approximately 600 km$^2$ (Williamson *et. al*, 2017). Between 1992-2013, Chlorophyll-α concentration nearly doubled across the majority of estuaries surrounding Buzzards Bay. As well, these freshwater estuaries in Falmouth are exceeding their critical threshold for macronutrients, resulting in impaired water quality (Cape Cod Commission, 2017; Williamson *et al*, 2017). Nitrogen and Phosphorus are limiting nutrients for phytoplankton, and, when present as nitrate and phosphate respectively, effects are given at the Chlorophyll-α concentrations (Lenton *et. al*, 2000). Thus, upper reaches of the bay are suffering from significant ecological impacts (Cape Cod Commission, 2017). Sources that contributed to the macronutrient load include septic systems, fertilizers, stormwater from impervious surfaces and wastewater treatment facilities (Williamson *et. al*, 2017). Investigations are to be centered around nitrate, phosphate and Chlorophyll-α concentrations in Buzzards Bay to measure the effects that nitrogen loading may have on the environmental ecology. Samples were taken in Niskin bottles from three different sites in Buzzards Bay, including Vineyard Sound. Colorimetric analysis was utilized in the study to determine the concentrations of macronutrients and Chlorophyll-α from the water samples. The purpose of finding these concentrations will help determine if whether macronutrient loading from surrounding fresh water sources has an immense impact on Chlorophyll-α concentrations in respect to phytoplankton growth.

## HYPOTHESIS

Due to increasing Nitrate and Phosphate concentrations in estuarine waters, an outburst of phytoplankton will arise, therefore, it can be expected for Chlorophyll-α concentrations to increase.

## MATERIALS & METHODS

***Figure 1:*** *Carousel of Niskin Bottles*

***Figure 2:*** *Water sample analysis for nutrients and Chlorophyll-α.*

1) A carousel of Niskin bottles were submerged at various depths in Buzzards Bay. 2) Samples were collected and transferred into plastic hermetic bottles; dark bottle were use for Chlorophyll samples. 3) The water samples were filtered and treated with indicator solutions for nutrients, and fluorophore for Chlorophyll-α. 4) Analytical procedures for nutrients and Chlorophyll-α were made with a Spectrophotometer and Fluorometer, respectively.

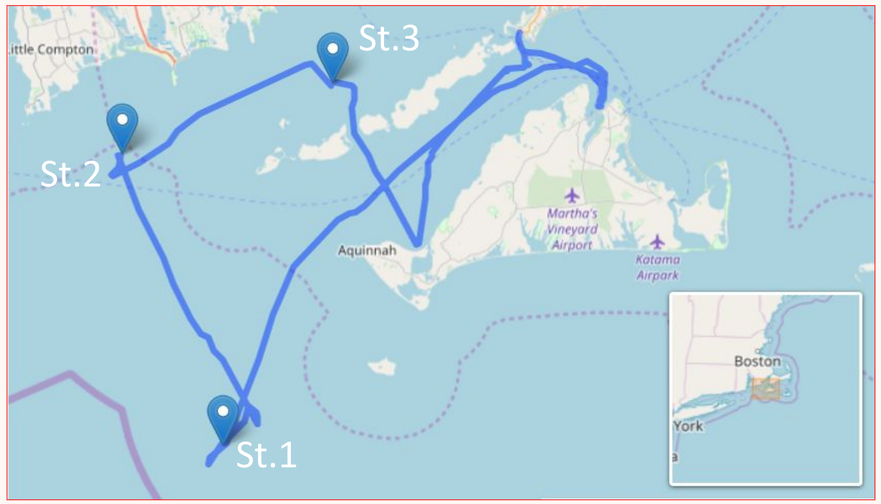


***Figure 3:*** *Corwith Cramer's track for the three stations analyzed in Buzzards Bay. The locations of the stations are as they follow: 1) Station 1; -70.99° (Lon), 41.19° (Lat), Time: 00:00, Sunday June 10th, 2) Station 2; -71.08° (Lon), 41.43° (Lat), Time: 08:00, Sunday June 10th and 3) Station 004; -70.87° (Lon), 41.48° (Lat), Time: 13:00, Sunday June 10th.*

## RESULTS

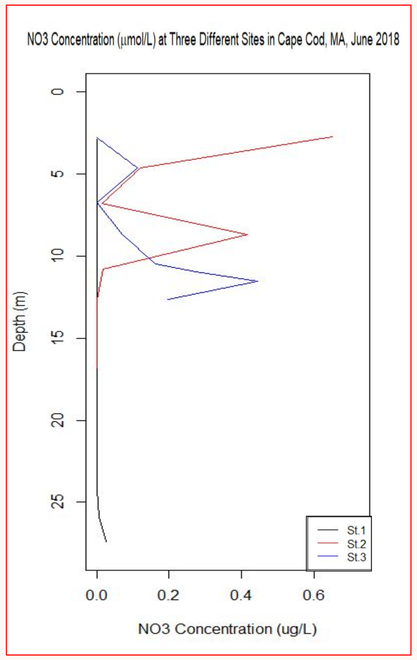


***Figure 4:*** *Nitrate gradient profile in stations 1, 2 and 3. Station 1 had a global maximum of 27.4m. Meanwhile St. 2 had a local maximum at 8.7m and St. 3 at 11.5m.*

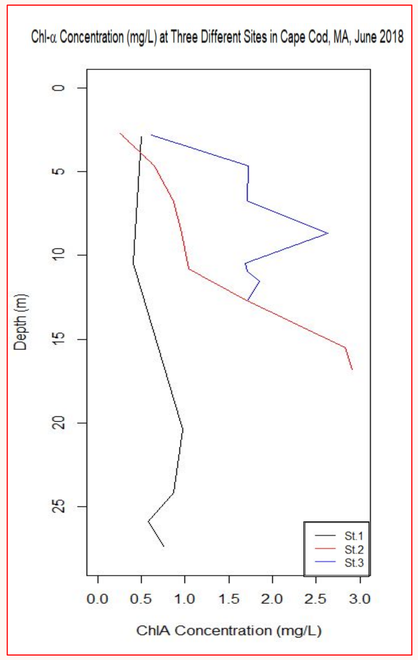


***Figure 5:*** *Chlorophyll-α gradient profile in stations 1, 2 and 3. Station 1 had a local maximum at 20.4m, St. 2 a global maximum at 16.8m and St. 3 a local maximum at 8.6m.*

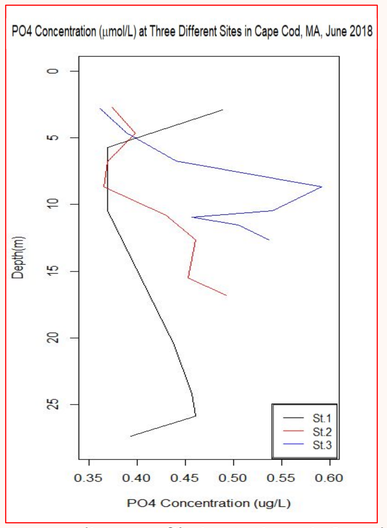


***Figure 5:*** *Phosphate gradient profile in stations 1, 2 and 3. Station 1 had a local maximum at 2.9m, St. 2 a global maximum at 16.8m and St. 3 a local maximum at 8.6m.*

## DISCUSSION

The macronutrient concentrations in the euphotic zone of the first and third stations appears to increase with increasing depth. In station two, nitrate concentrations started with high profiles at the surface and decayed as it got deeper. In fact, the global and local maximum of phosphates and nitrates concentrations at Station 1 and 2 were similar. On the other hand, Chlorophyll-α's profiles does not show a direct relationship with depth nor nitrate and phosphate concentration; Chlorophyll-α was independent. Thus, the hypothesis was neither supported nor refuted in this study. A possible explanation is that, the studied sites, all form part of the euphotic zone, therefore, proliferation of phytoplankton will not vary dramatically in the column of water as long as there are macronutrients available. This may explain why at station one, where nitrate concentrations were zero, phytoplankton proliferation was low, compared to the other two stations. Another factor to consider is the distances of the stations relative to the shore and anthropogenic effects due to the macronutrient loading.

## FUTURE DIRECTIONS

A better understanding can be achieved by 1) broadening the study at deeper depths , 2) considering the amount of carbon dioxide in the water to determine photosynthesis efficiency, 3) analyzing temperature and its effects on vertical mixing of the nutrients, 4) analyzing the geomorphology of Buzzards Bay and 5) analyzing the amount of secondary metabolites of phytoplankton and their toxicity to the marine ecology.

## REFERENCES


- Chapman, D. (n.d.). Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring (2nd ed.). Retrieved from http://www.who.int/water_sanitation_health/resourcesquality/watqualassess.pdf
- Lenton, T., & Watson, A. (2000). Redfield revisited: 1. Regulation of nitrate, phosphate, and oxygen in the ocean. Global Biogeochemical Cycles, 14(1), 225-248. doi: 10.1029/1999gb900065
- Millero, F., & Sohn, M. (1992). Chemical Oceanography (pp. 323-344, 349). Boca Raton: CRC.
- Nitrogen Cycling in the Open Ocean. (n.d.). Retrieved from http://cmore.soest.hawaii.edu/cruises/biolincs/nitrogen.htm
- Plastics at SEA North Pacific Expedition - Investigating the effects of plastic in the ocean ecosystem | Home. (2018). Retrieved from https://www.sea.edu/plastics/school_email_exchange
- Van de Waal, D., Smith, V., Declerck, S., Stam, E., & Elser, J. (2014). Stoichiometric regulation of phytoplankton toxins. Ecology Letters, 17(6), 736-742. doi: 10.1111/ele.12280
- Williamson, S., Rheuban, J., Costa, J., Glover, D., & Doney, S. (2017). Assessing the Impact of Local and Regional Influences on Nitrogen Loads to Buzzards Bay, MA. Frontiers In Marine Science, 3. doi: 10.3389/fmars.2016.00279