Introduction

Nitrogen fixation is a vital role in the regulation of plankton production. Major components of the marine nitrogen cycle was discovered by the mid-1900s in such that bacterial chemoautotrophs known as nitrifiers played an important role in the marine nitrogen cycle (Hutchins & Capone, 2022). Biologist have been studying climate change and how it affects ecosystems and their living oceans biomass. Within the system heterotrophic prokaryotes make up most of the biomass and is clustered into two different groups based on their nucleic acid content. These are classified into low (LNA) and high (HNA) nucleic acid bacteria. The HNA are generally bigger than LNA. Biomass is measured in combination with abundance and size. Usually biologist will apply ecological principles that higher abundance is closely associated with smaller size known as the abundance-size rule (ASR). Another principle they consider is the higher the ambient temperature it will likely result in smaller individuals known as the temperature size rule (TSR). These two rules help to explain changes in planktonic heterotrophic bacteria (Moran, et al., 2015).

This study will go through data that was collected from 2003-2012 that will be able to provide us with some insight to the relative biomass size of HNA over the years to see if any affects from temperature and nitrogen had any impact. Based on the principles stated above I would assume that if the temperature did in fact show an increase over those ten years then the biomass of the bacteria should result in a smaller size according to the TSR rule. We can also look to see if there are any differences among the seasons to see if the biomass of HNA varies among the time of year. Since nitrogen fixation is a major component of the marine ecosystem

this study aids to test the hypostasis that seasonal changes of nitrogen dioxide (NO2) from warming ocean waters effects the biomass of high nucleic acid (HNA) bacteria.

Materials & Methods:

Using the data collected from a study done previously I will compare the biomass of HNA across the seasons for each of the years from 2003-2012. I will run a statistical ANOVA analysis to see if any differences are among the seasons. Since biomass is my main concern, I will run a statistical Welch two sample t-test to see if there are any differences between 2005 and 2009 data on the biomass because those two years showed the largest difference in seasonal temperatures.

Results:

Looking at the season plot that is in Figure 1 it shows that season 2 and 4 has the most variance in the size of HNA bacteria over the years. According to this in the summer of 2005 the amount of HNA topped the chart being the highest (14 ug CL-1) record of numbers and the record of lowest (4 ug CL-1) biomass that winter. The winter of 2009 ranked the highest of winters biomass at (10 ug CL-1). The Welch t-test results in Figure 2 revealed that the mean of x (7.605455) and the mean of y (7.593333), t = 0.0054815, and a p-value = 0.9957.

Discussion:

In another study that was done they explained how biologist measure the prokaryotes cells biomass. The average cell concentration is calculated and then the total number of marine prokaryotes are estimated through multiplication by the water volume in each depth range they measure. The total number of cells is then converted to biomass by using the characteristic carbon content per marine prokaryote (Phillips & and Milo, 2018). Marine organisms are dependent on the ability of bacteria to be able to fix nitrogen by oxidation. The marine nitrogen

cycle aids in denitrification, where dissolved NO_3 is reduced to N_2 gas through a series of intermediates (NO_2^-, NO, and N_2O). As most marine organisms that require nitrogen for nutrition cannot assimilate either N_2O or N_2, denitrification generally results in a net loss of N from the system (Hulth, et al., 2005). The results from the Welch's two sample t-test showed us that between the two years of 2005 and 2009 which had the largest difference in seasonal temperatures had a p-value (0.9957). So, since that p-value is not less than the significance level of (p=0.05) then my data failed to reject the null hypothesis. The data that was given does not show any changes in the biomass from the amount of nitrogen dioxide levels. This means that the results of the NO2 did not effect the HNA bacteria's biomass during the most drastic period of temperature changes during the ten year study from 2003-2012.

Acknowledgements:

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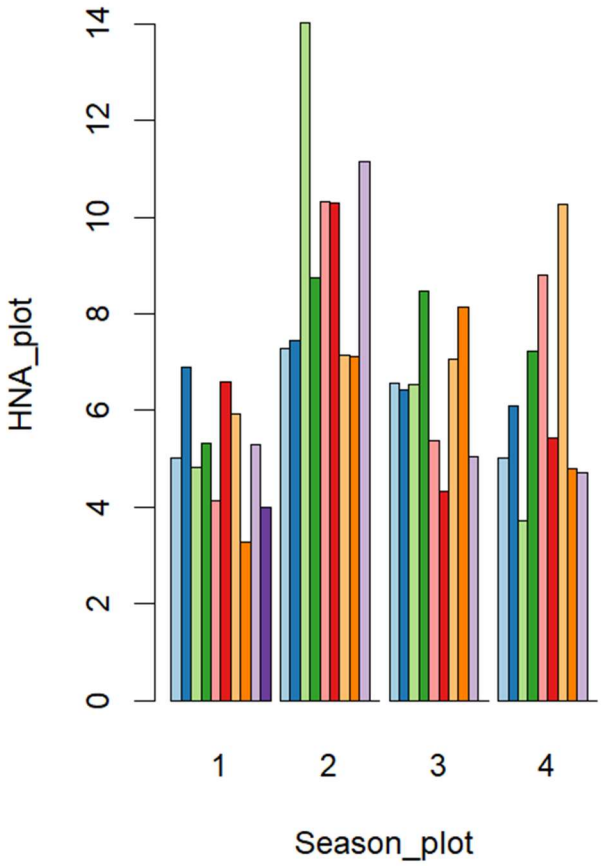

Figure 1: Seasonal plot of HNA biomass from 2003-2012

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        Welch Two Sample t-test

data:  data5$HNA.B[which(data5$year == 2005)] and data5$HNA.B[which(data5$year == 2009)]
t = 0.0054815, df = 14.18, p-value = 0.9957
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -4.724943  4.749185
sample estimates:
mean of x mean of y
 7.605455  7.593333

>
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Figure 2 Statistical t-test results

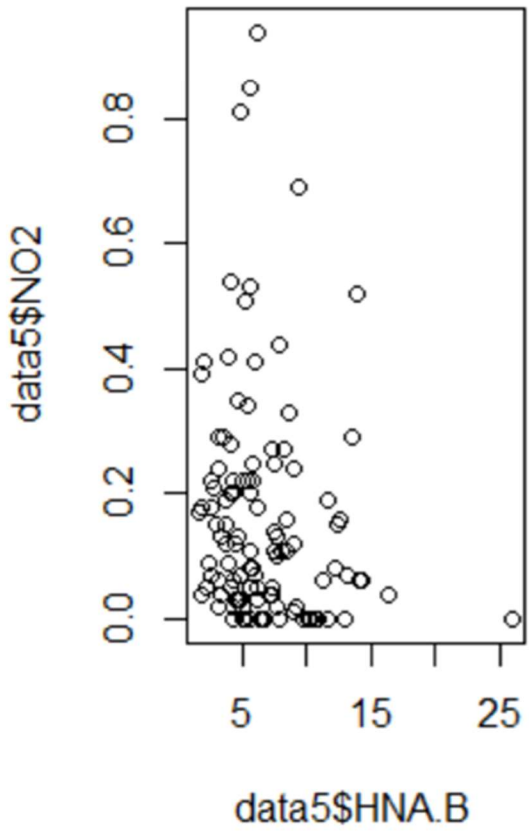

Figure 3: Biomass of HNA to the NO2 measurement

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