Title

Algae, Macroinvertebrate and Water Quality Relationships at North Campus Open Space

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Introduction

Algae are an important part of the ecosystem because algae are the food source for many macroinvertebrates, and these macroinvertebrates are the food source for many primary predators. Algae and macroinvertebrate communities respond to the dissolved oxygen and salinity levels of the water. Dissolved oxygen is required by the macroinvertebrates for respiration. Salinity impacts the algae because every algae has a specific salinity range that they are able to survive in. An example of this is the cyanobacteria *Phormidium*, which has a salinity range of 13.9 ms/cM to 76.9 ms/cM (Rai and Rajeshekhar 2016); with freshwater variants living in the lower range and seawater variants living in the upper range.

Because dissolved oxygen and salinity affect the algae and macroinvertebrates, which are the base of many aquatic ecosystems, these measurements can be used to determine the health of the ecosystem. An application of this is in North Campus Open Space Restoration Project in the Devereux Slough in Santa Barbara. The slough is a temporary open closed estuary. After sufficient winter rains, the estuary breaches and is connected to the ocean tides, which brings in seawater to the estuary. The estuary is also closed from the ocean for the majority of the year, beginning in the Spring. There is an influx of freshwater from rain events and stream runoff. This results in varying levels of salinity and dissolved oxygen in the water throughout the year.

A large variety of algae shapes have been found in North Campus Open Space. The main types found in this study were filamentous algae such as *Phormidium* and *Gonatozygon*, and branched algae such as *Chaetonema* and *Schizomeris*. These algae provide habitat and protection for macroinvertebrates.

Purpose

This project aims to determine how different levels of salinity and dissolved oxygen impact the ratio of algae and macroinvertebrates in the slough. The relationships between algae and invertebrates can be used to indicate ecosystem health.

Methods

A YSI meter was used to measure dissolved oxygen content (mg/L) and conductivity (mS/cm) of the water at three sites at North Campus Open Space: West Pond (NWP), Phelps Bridge (NPB), and Veneco Bridge (NVB). At each site, approximately 1 gram of algae was taken and submerged in 70% isopropyl alcohol to preserve the sample. The algae samples were viewed under a compound microscope and identified using *Common Freshwater Algae of the United States* (Gary E. Dillard). After identifying the algae, the samples are sorted under a light microscope to separate and count the macroinvertebrates in the sample. Once sorted, the algae samples are poured through a 250 micron mesh filter to separate the algae from the 70% alcohol. The samples are then placed in a heat safe dish and placed in an oven set to between 90 and 105°C to evaporate the liquid. After 24 hours in the oven, the algae is taken out and weighed. This sampling was conducted weekly for 4 weeks.

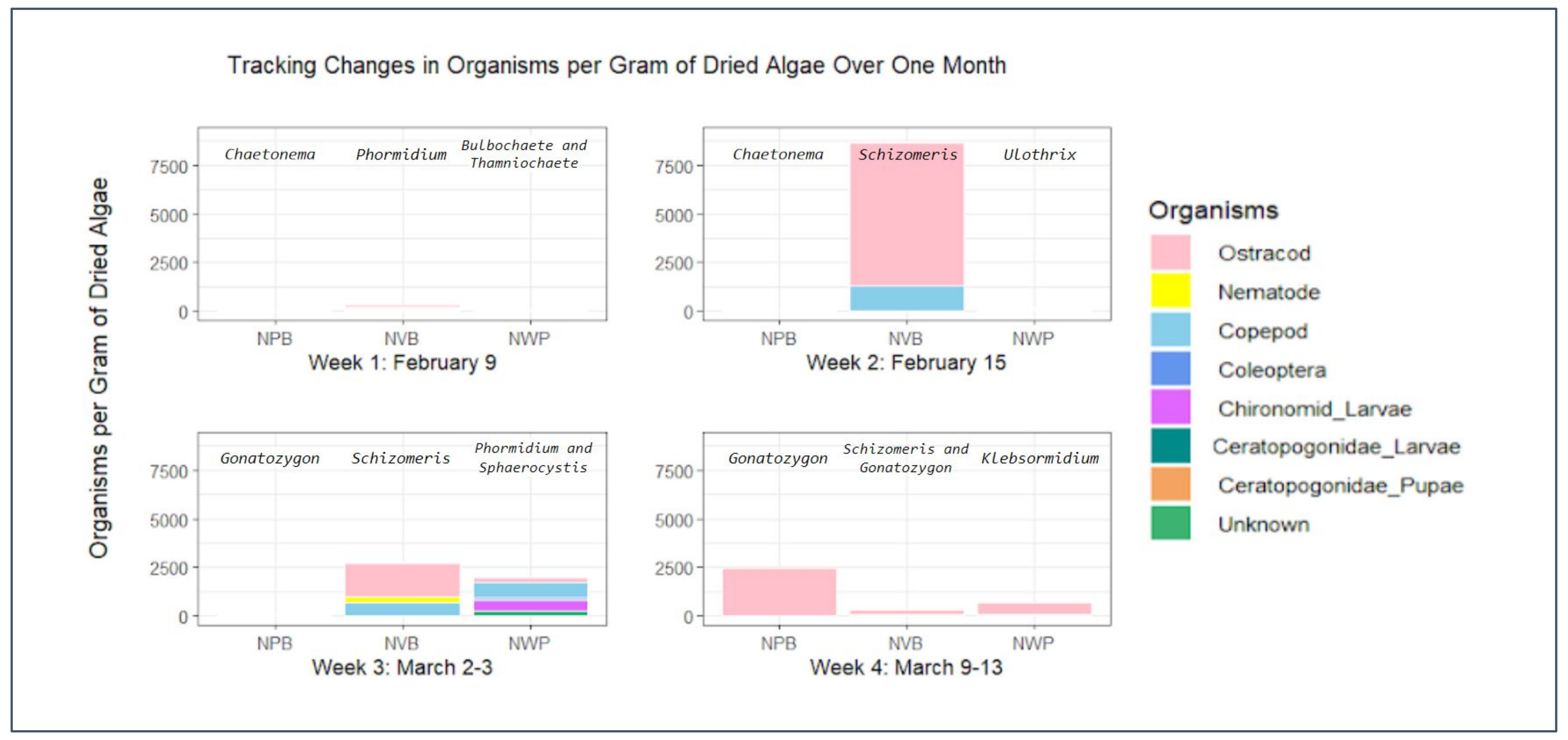

Figure 1. Bar graph plotting number of organisms found per algae mass at sites in North Campus Open Space from each site over four sampling weeks.

Figure 2. Map of sampling locations.

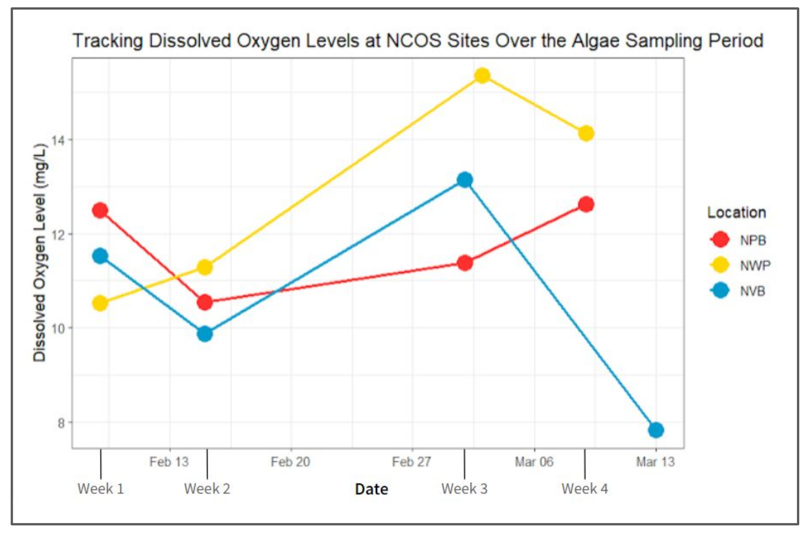

Figure 3. Graph displaying dissolved oxygen levels at each site.

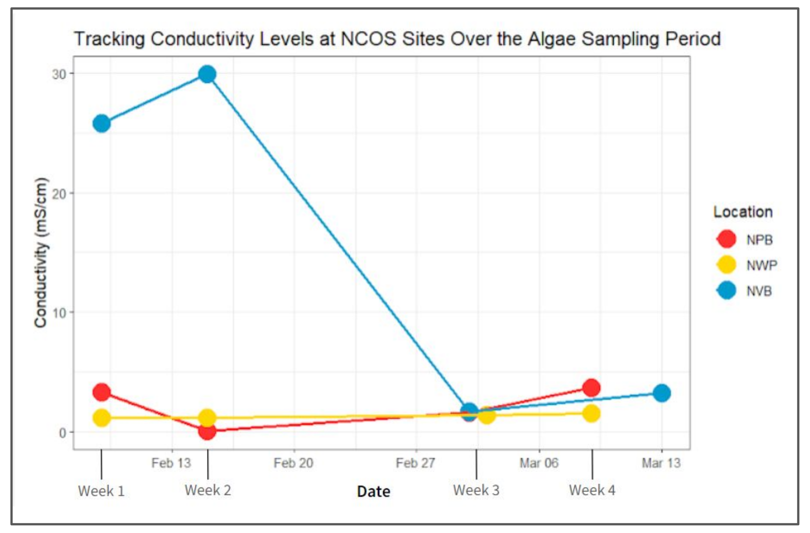

Figure 4. Graph displaying conductivity levels at each site.

Results

In the first week of sampling, the dissolved oxygen levels at the sites are around 10.5 mg/L . NPB and NVB have a decrease in dissolved oxygen level between week 1 and week 2, while NWP has a increase in that period. For all sites there is a steady increase between weeks 2 and 3, with NPB having a smaller slope compared to the other two sites. In week 4 there is a decrease at NWP and NVB, and slight increase at NPB. The conductivity at NPB and NWP stay between 0 and 5 ms/cM throughout the sampling period, while NVB initially has a high conductivity that drops to between 0 and 5 ms/cm in week 4. In the first two weeks of sampling, there is a relatively small organism to algae ratio, with the exception of NWP, which experienced a large increase in organisms in week 2. In week 3, NPB and NVB experience an increase in organisms. All the sites have a decrease in population after experiencing the spike in population size (population size at NPB and NVB decrease in week 4, and population size at NWP decreases in week 3 and again in week 4).

Discussion

At NVB on 2/9, conductivity peaked at 25.83 mS/cm, which is very large compared to the other samples taken throughout the sampling period. Along with the high conductivity measurement, there were a lot of different species present despite the small total population size. This is potentially caused by salt shock in the algae, where the salinity levels are high enough for the algae to survive, but in a stressed state. This is further supported by the lack of increase in diversity at NWP, where the salinity levels remained stagnant throughout the sampling period. There is not enough variation at the other two sites to support a direct connection between conductivity and species diversity at those sites. Studies on salt shock in algae have found that the stressed algae undergo an increase in productivity, which leads to an increase in algae mass (Elloumi et al. 2020). This increase in food supply could reduce competition between macroinvertebrates, allowing for an increase in species diversity.

The sampled macroinvertebrate population increases when the site experiences an increase in dissolved oxygen levels. The increased oxygen levels support larger populations, but low diversity, with ostracods and copepods being the most abundant species. Ostracods and copepods possess many adaptations that make them more competitive in the fluctuating conditions of the slough compared to the other macroinvertebrate species. Ostracod species that reside in temporary pools and stagnant waters have high tolerance to desiccation and high fecundity (Ruiz et al. 2013). Female ostracods are able to reproduce multiple times in their lifetime and natural populations are female biased, which means that the population is capable of expanding quickly. Copepods have sensory organs that are more sensitive compared to other aquatic organisms that are a similar size. They also have efficient mate-finding mechanisms that allows them to reproduce in environments where there are few potential mates (Kiørboe 2010).

Future experimentation can be done to draw a direct connection between salinity levels and algae production. The weekly sampling will be continued determine whether the patterns found in this study will continue to occur. To continue this study we hope to monitor algae blooms with aerial footage or similar technology to better understand the relationship between algae and salinity.

Acknowledgements

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