An in-Depth Look at Harmful Algae Blooms along the Coast of Southern California

Alexa Lutz, Dr. Amber Bratcher-Covino
Loyola Marymount University

Abstract

Harmful Algae Blooms pose as a threat to costal marine life, as well as to the health of humans. To get a better understanding of HABs along the coast of Southern California, we looked at the last 12 years of data (recorded once a week) from NCAA's buoy located at Santa Monica Pier. With this data we were able to compare species as well as variables, such as time, temperature, phosphate, silicate, nitrite, ammonium, and nitrate. After analyzing the data, we were able to identify the ideal environment for HAB growth.

Introduction

A harmful algal bloom (HAB) is the overabundant accumulation of one or multiple toxic phytoplankton species. HABs can show up anywhere in the world during any season of the year. They are most commonly found along coastlines in more Northern waters, with warmer temperatures and higher nutrient concentrations. A HAB is a huge potential risk for not only the aquatic ecosystem it's present in, but also for any city that shares its shoreline. The phytoplankton present within a HAB possess various types of toxins that can range from levels of undetected to paralysis. Mussels and other mollusks eat these phytoplankton, transferring the toxins to themselves. Then, those mussels are either consumed by larger animals, such as birds and fish, or they are eaten directly by humans, poisoning them. Meaning that humans are at extreme risk if fishing waters contain toxic phytoplankton. Unfortunately, it is very difficult to "take care of" or get ride of a HAB. Because of this, it is very important to identify the HAB species early on and deal with them before they get too big. In order to do that, we must first better understand the phytoplankton species themselves and each species' specific trend responses to various variable changes.

Methods and Materials

Due to COVID-19, this study was conducted completely online and at home. To prepare for the study, researchers read and summarized 20 scientific papers referencing HABs. Once enough

Methods and Materials

background knowledge had been obtained, the data was obtained from the SCCOOS ERDDAP Santa Monica HAB Monitoring Station from 2008-2020. The team then used Rstudio to analyze the data that was collected by the buoy. The researchers compared various variables to various phytoplankton species. When all of the data was analyzed, the team determined the ideal environment for a HAB to flourish.

Results

- Most common species: *Lingulodinium_polyedra*
- Second most common species: *Prorocentrum_spp*.
- Ideal Temperature: ~13-24 C°
- Ideal nutrient levels:
  - Phosphate: ~0.1-0.9 uM
  - Silicate: ~2-7 uM
  - Nitrite: ~0.1 uM
  - Nitrate: ~0-2.5 uM
  - Ammonium: 0-6 uM

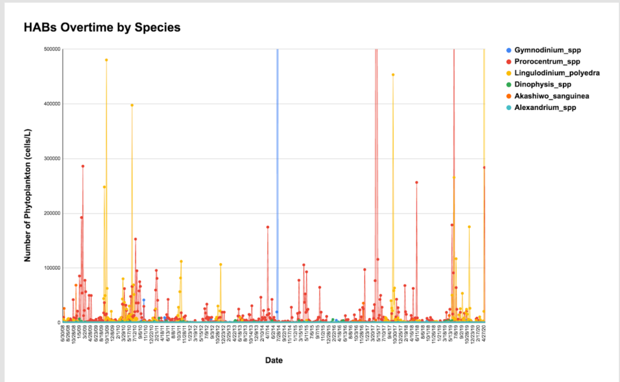

Figure 1 is a graph depicting the trends of various HAB species over 12 years.

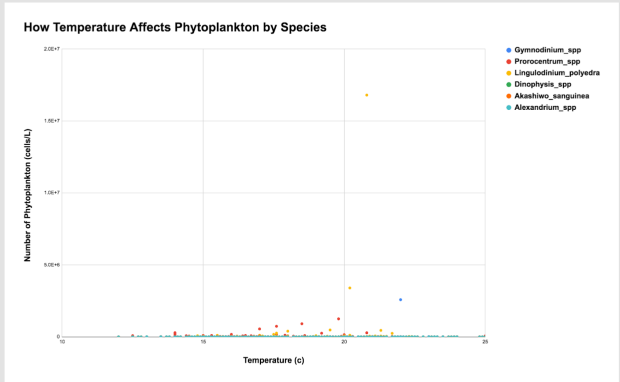

Figure 2 represents the effect that temperature has on HAB size.

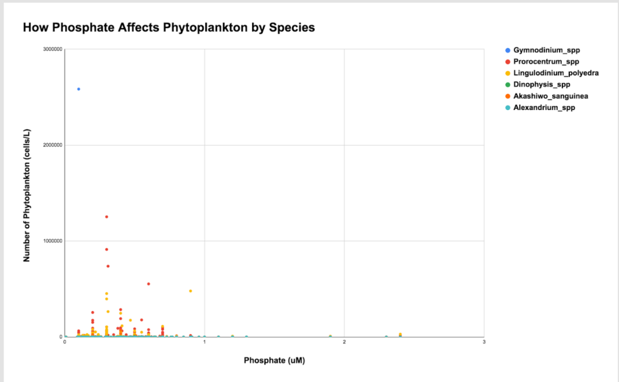

Figure 3 represents the effect that phosphate levels have on HAB size.

Results

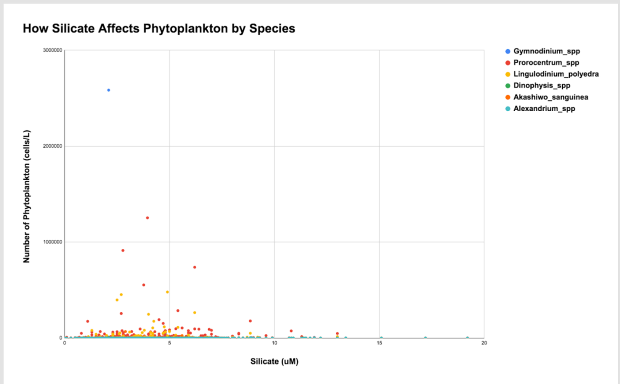

Figure 4 represents the effect that silicate levels have on HAB size.

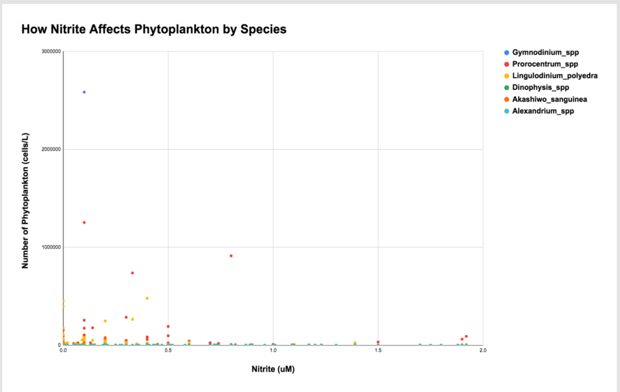

Figure 5 represents the effect that nitrite levels have on HAB size.

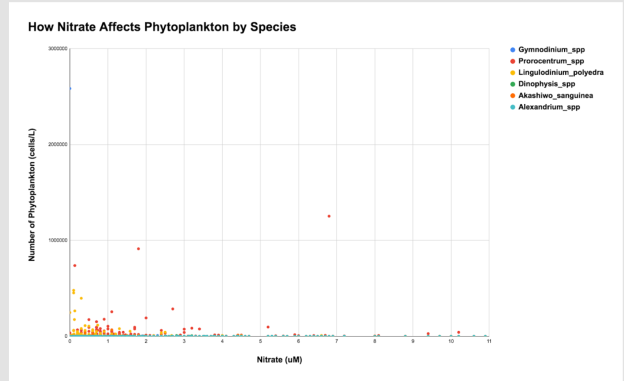

Figure 6 represents the effect that nitrate levels have on HAB size.

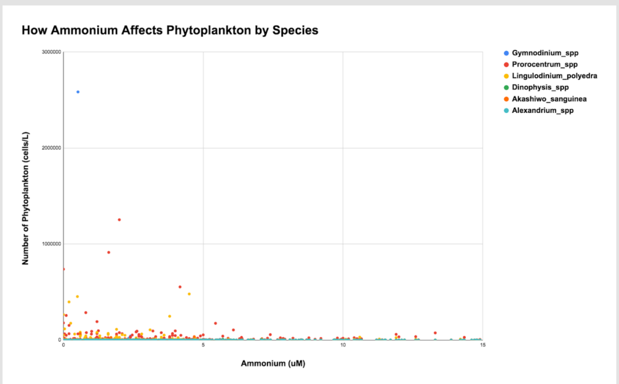

Figure 7 represents the effect that ammonium levels have on HAB size.

Discussion and Conclusion

Over the last 12 years, there have been patterns among the HABs along the coast of Southern California. As you can see in Figure 1, the most common phytoplankton species has been *Lingulodinium_polyedra* (29% of total phytoplankton recorded), and the second most common has been *Prorocentrum_spp*. (12.30%). The other species that have been recorded in the area, *Akashiwo_sanguinea*, *Alexandrium_spp*, *Dinophysis_spp*, and *Gymnodinium_spp*., don't even add up to 1% of the total number of phytoplankton recorded, so there is little focus on them in the research.

Represented in Figure 2, the ideal water temperature for HAB growth is ~13-24 C°. Represented in Figures 3-7, the ideal nutrient levels for HAB growth are 0.1-0.9 uM of Phosphate, 2-7

Discussion and Conclusion

uM of Silicate, 0.1 uM of Nitrite, 0-2.5 uM of Nitrate, and 0-6 uM of Ammonium. As you can see in the graphs, there isn't a clear difference between species in regards to ideal nutrient levels--both species have values all over the board. This means that any observations made from the data, can represent both *Lingulodinium_polyedra* and *Prorocentrum_spp*.

Density/size of a HAB isn't the only factor in determining its threat level. Each phytoplankton species carries a specific toxin, some of which are more deadly than others. Figure 8 shows the toxin that each studied species possesses, as well as their most common harmful effect.

Phytoplankton Species	Physical Characteristics	Most Common Harmful Characteristics
Akashiwo_sanguinea	Unknown	Sea bird deaths caused by surfactant-like proteins
Alexandrium_spp	Saxitoxin	Paralysis
Lingulodinium_polyedra	Yessotoxins (YTXs)	Paralysis
Prorocentrum_spp	Okadaic acid	Promote tumors
Gymnodinium_spp.	Saxitoxin	Paralysis (most dangerous)
Dinophysis_spp	Okadaic acid and Dinophysistoxins	Diarrhetic shellfish poisoning

Figure 8 is a chart that shows the specific toxin and effect associated with each phytoplankton species.

With the data collected, we can better understand which phytoplankton species that pose a threat to Southern California's coast, as well as what that species' ideal environment is. Because we know what temperatures and nutrients are ideal for each species, we also know what temperatures and nutrients are not ideal for each species, and so we use that information to attempt to fluctuate those variables along the coast, making it an unideal HAB location.

Future Studies

This study was able to give us a background understanding of the HABs along Southern California's coast. Now we can go collect our own phytoplankton samples in more condensed locations to get more accurate readings for the area. We will look at how HAB levels compare on each side of Marina Del Ray—on the marina/ocean side as well as the creek/river side. We will also collect ocean samples via boat, hitting all coastal points of LA and then some. With these studies, we hope to learn more about the phytoplankton species in LA and how we can better deal with and prevent local HABs.

References

- Sellner, Kevin G., et al. "Harmful Algal Blooms: Causes, Impacts and Detection." Journal of Industrial Microbiology and Biotechnology, vol. 30, no. 7, 2003, pp. 383–406., doi:10.1007/s10295-003-0074-9.
- Lewitus, Alan J., et al. "Harmful Algal Blooms along the North American West Coast Region: History, Trends, Causes, and Impacts." Harmful Algae, vol. 19, 2012, pp. 133–159., doi:10.1016/j.hal.2012.06.009.
- Caron, David A., et al. "Harmful Algae and Their Potential Impacts on Desalination Operations off Southern California." Water Research, vol. 44, no. 2, 30 June 2009, pp. 385–416., doi:10.1016/j.watres.2009.06.051.
- www.NCAA.com