Investigation of Annual Cycling of *Pseudo-nitzschia* in relation to Silicate Concentrations, Water Temperature, and Time of Year

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Introduction

- Though microscopic, *Pseudo-nitzschia* is one of many phytoplankton capable of destroying entire ecosystems and economies.

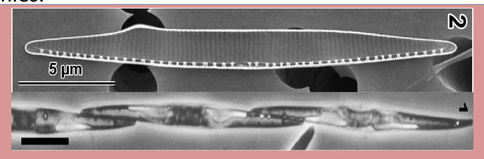

Figure 1: *Pseudo-nitzschia delicatissima* above (Obtained from Reid et al., 2006) and *Pseudo-nitzschia seriata* below(Obtained from Hasle et al., 2005)

- With a suitable environment—usually consisting of adequate nutrients (nitrogen, phosphorus, silica) and light, warm and still water, little wind, and low salinity—Phytoplankton such as *Pseudo-nitzschia* can become a Harmful Algal Bloom (HAB) (Pal et al., 2020). Through a process known as eutrophication, phytoplankton can accumulate into numbers large enough to have adverse effects on local organisms including humans (Dhar et al., 2015 & Pal et al., 2020).

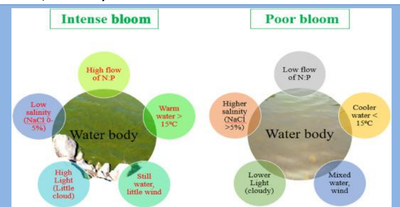

Fig. 2: Factors that usually contribute to HAB formation (Obtained from Pal et al., 2020)

- For the intents and purposes of this poster, *Pseudo-nitzschia was* analyzed based on the following HAB factors: silicate concentrations, water temperature, and time of year.
- Present in coastal waters of North America, Europe, and Australia, *Pseudo-nitzschia* has established itself as a global threat to marine biomes everywhere (Dhar et al., 2015).

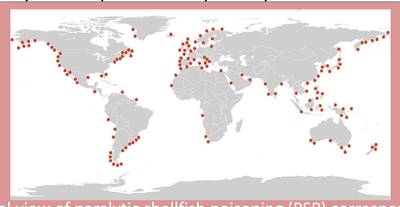

Fig. 3: Global view of paralytic shellfish poisoning (PSP) corresponding to global number of HABs (Obtained from U.S. National Office for Harmful Algal Blooms, 2016)

- Data retrieved from Santa Monica Pier in Southern California from the CalHABMAP - Santa Monica Pier HAB data repository (2008-2020).
- Overall, *Pseudo-nitzschia's relationship to* HAB factors (i.e. silicate levels, water temperatures, and time of year) is an area demanding more examination. Hence, this study was designed to compile and analyze data on *Pseudo-nitzschia* and these elements.

Objective

To investigate, compile, and analyze current data on *Pseudo-nitzschia* and field work from the Santa Monica Pier in relation to silicate concentration, water temperature, and time of year.

Methods

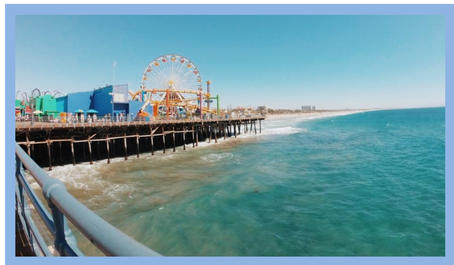

Fig. 4: Image of Santa Monica Pier (Obtained from Painter A. G., 2020)

- RStudio data obtained from the Santa Monica Pier
- Samples collected from 2008-2020

```
> sessionInfo()
R version 4.0.2 (2020-06-22)
Platform: x86_64-apple-darwin17.0 (64-bit)
Running under: macOS Catalina 10.15.6

Matrix products: default
BLAS:   /System/Library/Frameworks/Accelerate.framework/Versions/A/Frameworks/vecLib.framework/Versions/A/libBLAS.dylib
LAPACK: /Library/Frameworks/R.framework/Versions/4.0/Resources/lib/libRlapack.dylib

locale:
[1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

loaded via a namespace (and not attached):
[1] compiler_4.0.2 tools_4.0.2    tinytex_0.25   xfun_0.16
```

Fig. 5: Image of RStudio Session Information ("sessionInfo()") (Obtained from work in RStudio)

Results (RStudio)

Pseudo-nitzschia delicatissima

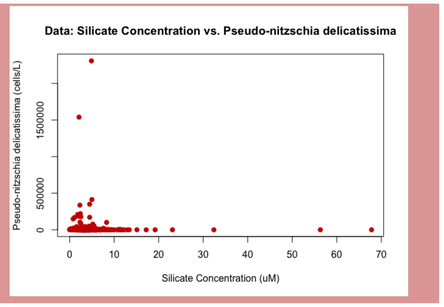

Fig. 6: *P. delicatissima* and Silicate

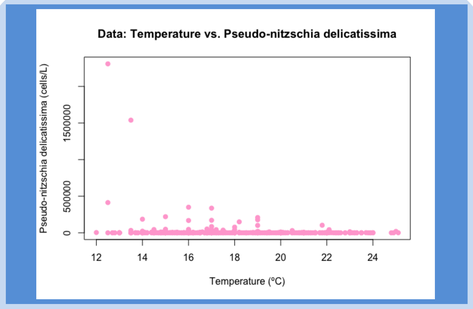

Fig. 7: *P. delicatissima* and Temperature

Pseudo-nitzschia seriata

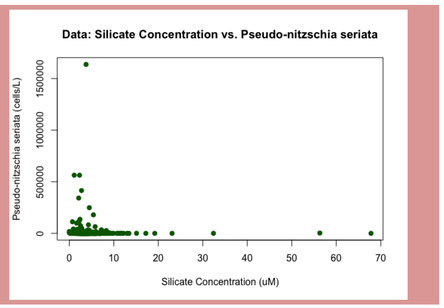

Fig. 8: *P. seriata* and Silicate

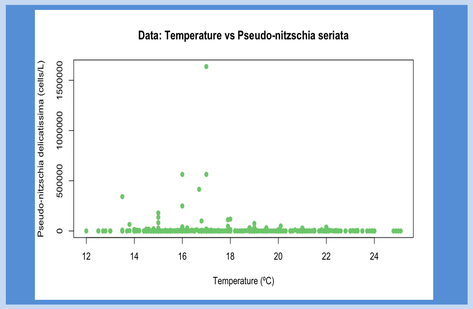

Fig. 9: *P. seriata* and Temperature

Pseudo-nitzschia delicatissima and *seriata*

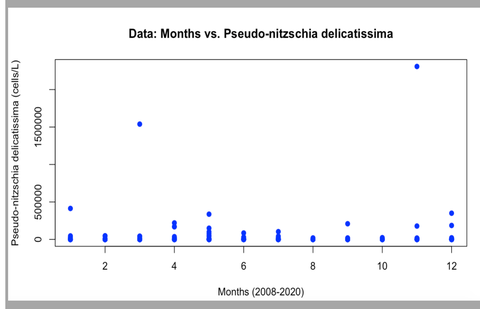

Fig. 10: *P. delicatissima* and Time

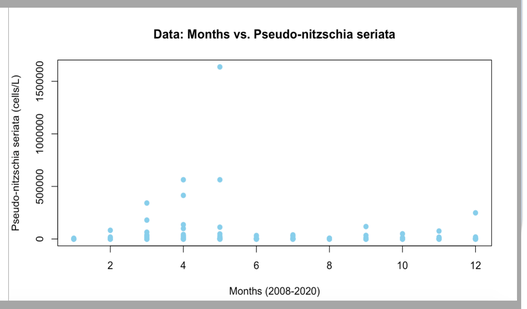

Fig. 11: *P. seriata* and Time

All data fit assumptions of normality (Shapiro Test)

Discussion

- Overall, this experiment was designed to investigate, compile, and analyze current data on *Pseudo-nitzschia* and field work from the Santa Monica Pier in relation to silicate levels, water temperature, and time of year.
- There appears to be a relationship between *P. delicatissima* and silicate concentrations; there are noticeable measurement overlaps in elevated *P. delicatissima* population at silicate levels between 0-10 uM (Fig. 6). Similarly, comparisons between temperature and *P. delicatissima* revealed periodic population spikes in somewhat of a bell curve at 1ºC intervals; specifically, between 14º-19ºC, suggesting lower temperatures in the Santa Monica Bay allow for increased *P. delicatissima* growth (Fig. 7).
- Moving on to *Pseudo-nitzschia seriata*, analysis of Fig. 8 revealed *P. seriata*—much like *P. delicatissima*--responded well to lower silicate concentrations. Although there seem to be some outliers at higher silicate levels, the majority of *P. seriata's* cells per liter seem to gravitate towards levels near 0-10 uM. Furthermore, comparisons between *P. seriata* and temperature shows a slight preference for temperatures ranging from 13º-19ºC. Meaning, in the Santa Monica Area, *P. seriata*, like *P. delicatissima*, functions better at lower-ranging water temperatures.
- The relationship between *P. delicatissima* and *P. seriata* with regards to silicate levels and temperature and are statistically significant (ANOVA, $p<0.006$).
- Comparing the monthly numbers of *P. delicatissima* and *P. seriata* there seems to be an overall trend of increased numbers in the months of April-May (fig. 8 and 9). Additionally both figures exhibit sporadic smaller-scale spikes near the months of September and December.
- In context, the monthly population flux of *P. delicatissima* and *P. seriata* in Southern California remains relatively under analyzed in academia; thus, this data could be used to inform future research decisions, management opportunities.
- On a grander scale, this data and its conclusions should not come as a surprise as HAB research is slowly picking up national attention; however, given the gaps in knowledge (relationship between time and *Pseudo-nitzschia*), this research should be used as a gateway and foundation for further research studying *Pseudo-nitzschia* in Southern California.

Literature Cited

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