Horizontal

Long-term trends in phytoplankton species composition in the California Current

Charlene Ruiz, Elizabeth Venrick, Moira Decima
University of California San Diego

Introduction

- The California Current Ecosystem (CCE) has shown a long-term warming trend in response, and the consequent changes for phytoplankton species composition is poorly understood.
- We investigate changes in phytoplankton species composition using long-term CalCOFI phytoplankton abundance data.
- Seasonal and long-term trends in abundance are evaluated for four regions (Fig. 1.
- Ecosystem responses to climate change are complex and dynamic shifts in phytoplankton species (and size) structure will likely have important consequences for the productive CCE as a whole.

Methods

- Samples were collected from 1997 to 2018 in 36 of the 66 routine CalCOFI stations between station 90 and shore (Fig. 1).
- Samples were from the mixed layer (5m-15m).
- Individual samples were preserved with 1% buffered formalin and then pooled into four regional samples [1]
- Samples were counted at 100x (large cells) and 250x (small cells) magnification. Small cells noted on a low-power count but not seen in a higher power were ignored in taxonomic sums.
- Analyses were completed via R using the tidyverse and vegan packages.

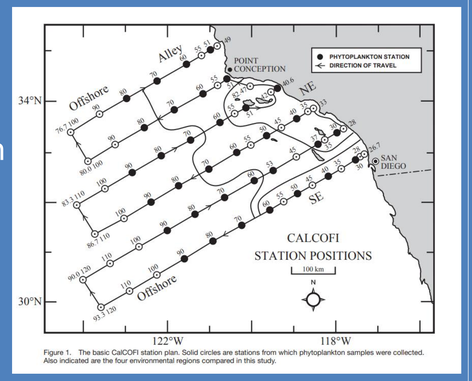

Figure 1. The basic CalCOFI station plan. Solid circles are stations from which phytoplankton samples were collected. Also indicated are the four environmental regions compared in this study.

Results

- Smoothed line of phytoplankton abundance indicates negative trend from 2010 to 2018. (Fig. 2.)

Statistic	Value
R^2	0.0577
P-value	0.02337

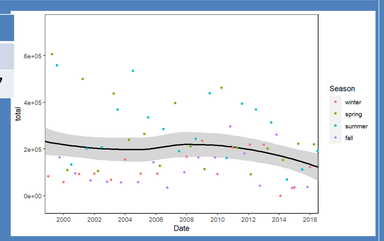

Fig. 2. Smoothed regression of log-transformed abundance of phytoplankton counts.

- Seasonal abundance has two peaks in spring and summer (Fig. 3).
- Alley and NE regions have high diatom abundance and an apparent long-term decreasing trend (Fig. 4).
- Lower abundances in the offshore and SE area.
- Relative abundance in terms of percent composition of phytoplankton groups show similarities in the Alley and NE regions (Fig. 5).
- Shannon diversity index shows decrease in biodiversity from approximately 2008 to 2018, when it begins to increase again. (Fig. 6)

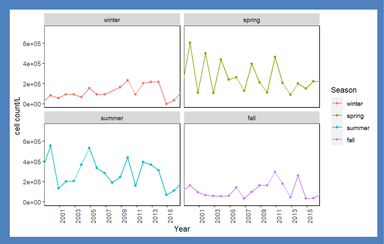

Fig. 3. Total linear abundance of phytoplankton by season for all four regions.

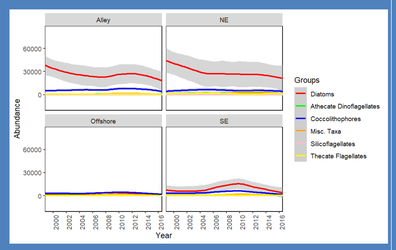

Fig. 4. Total abundance of each phytoplankton group over time.

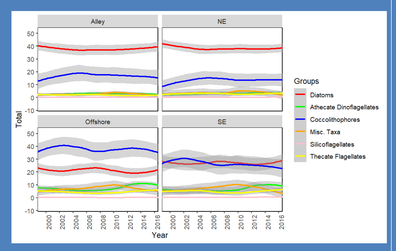

Fig. 5. Relative percent composition of phytoplankton groups over time.

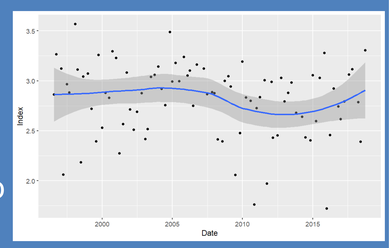

Fig. 6. Shannon diversity index of all phytoplankton species over time.

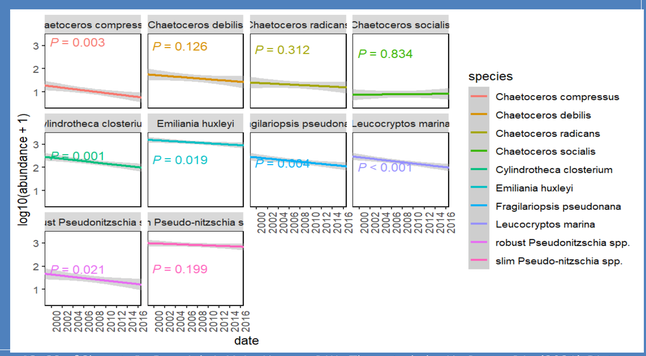

Fig. 7. Linear regression of log-transformed phytoplankton abundance for top ten species of phytoplankton within the entire CalCOFI grid.

- Linear regression performed on top ten most abundant species in dataset. Most species have a significant negative trend (Fig. 7).
- 3 species of Chaetoceros diatoms, and slim Pseudo-nitzschia did not show a statically decreasing trend(Fig. 7)
- Relationship among the major phytoplankton groups are largely positively correlated.

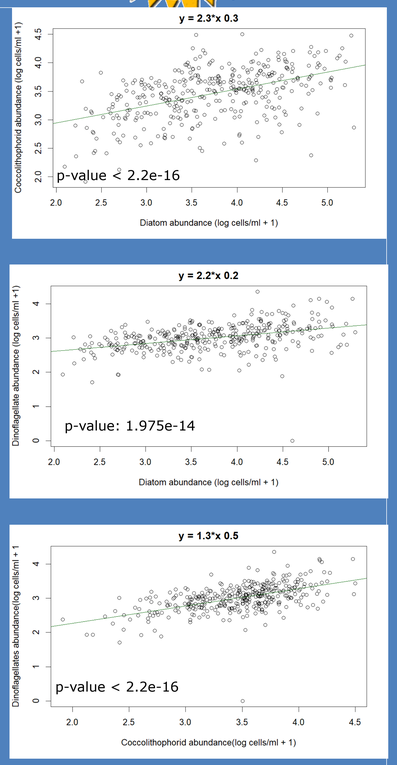

Fig. 8-10. Linear regressions between three major phytoplankton groups.

Conclusions

- Changes in phytoplankton interannual abundance are heavily weighed by diatom abundance.
- Positive relationships between diatoms and other phytoplankton groups including coccolithophores and dinoflagellates suggest a decrease for all phytoplankton groups.
- The Shannon diversity index changes may reflect changes in phytoplankton composition within lesser-abundant species as group abundance decreases.
- Future investigation should be considered with inter-decadal cycles such as NPGO and PDO alongside the changing overall abundance and biodiversity for phytoplankton.

[1]Mantyla, M.W., Bograd, S.R., Venrick, E.L. (2008) Patterns and controls of chlorophyll-a and primary productivity cycles in the Southern California Bight. *Journal of Marine Systems,* **48-60.** [2]Closset, I., Brzezinksi, M.A., Krause, J.W., Thamatrakoln, K., Jones, J.L. (2021) Diatom response to alterations in upwelling and nutrient dynamics associated with climate forcing in the California Current System. *Limnology and Oceanography,* **66,** 1578-1593. [3]McMurdie, P. J. and Holmes, S. (2013) phyloseq: An R Package for Reproducible Interactive Analysis and Graphics of Microbiome Census Data. *Plos One,* **8**. [4]Taylor, A.G., Goericke, R., Landry, M.R., Selph, K.E., Wick, D.A., Roadman, M.J. (2012) Sharp gradients in phytoplankton community structure across a frontal zone in the California Current Ecosystem. Journal of Plankton Research **34,** 778-789