Development of a new approach for setting lacustrine restoration targets based on phytoplankton community assemblages

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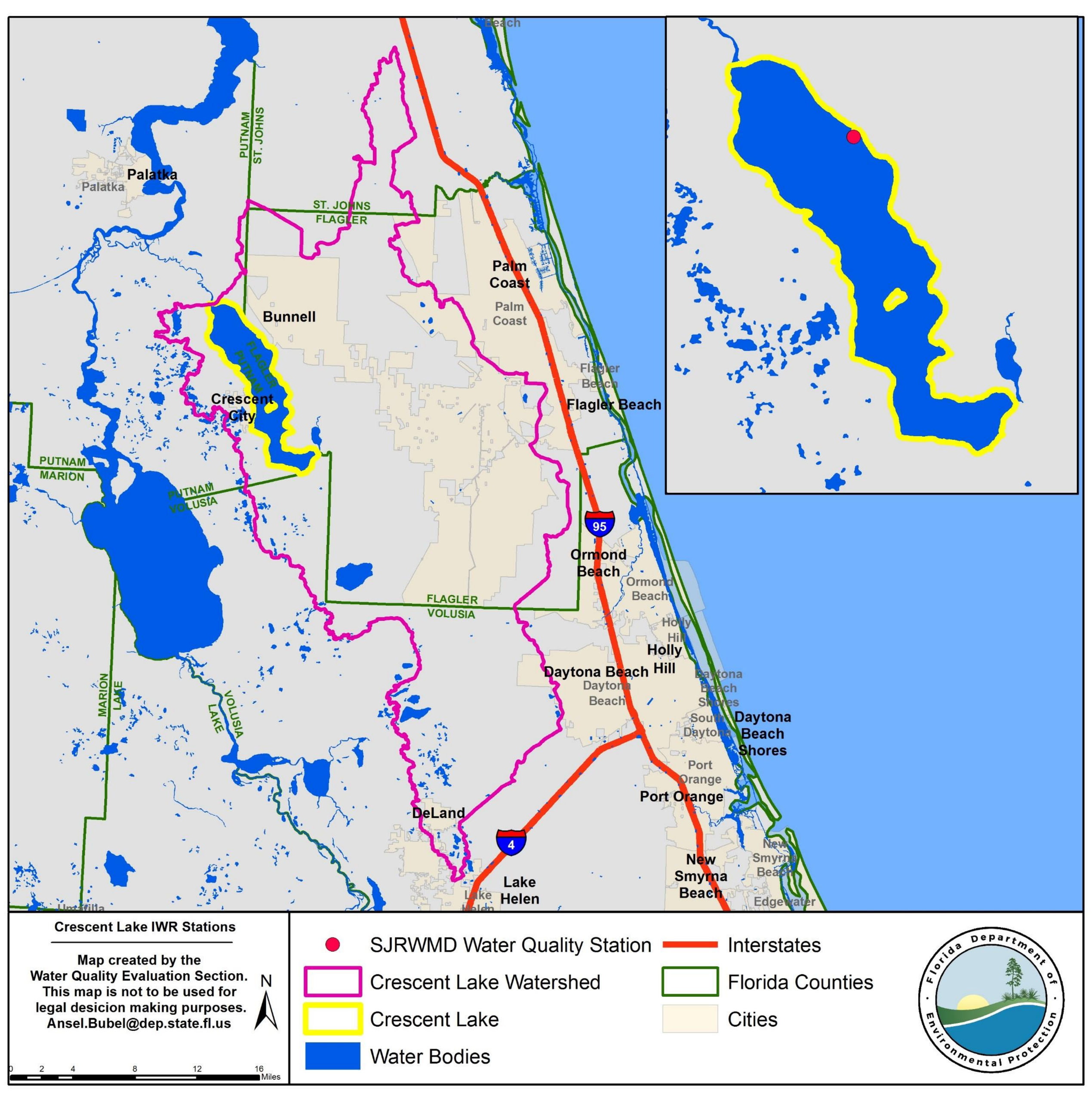
Introduction

Water is an important resource for Florida, which is not always available at sufficient quality to meet the needs of local ecosystems and economies. Collaborative restoration efforts by groups of local stakeholders, state agencies, and federal agencies are necessary to achieve success in Florida's complex hydrologic systems. A critical part of the restoration process is deciding upon a site specific water quality target which is broadly accepted and scientifically defensible. High quality targets are important to guide restoration projects and allow for meaningful assessment of progress. Here we propose a new approach for analyzing phytoplankton communities in eutrophic lakes, with the goal of producing defensible site specific water quality targets for restoration.

Background information

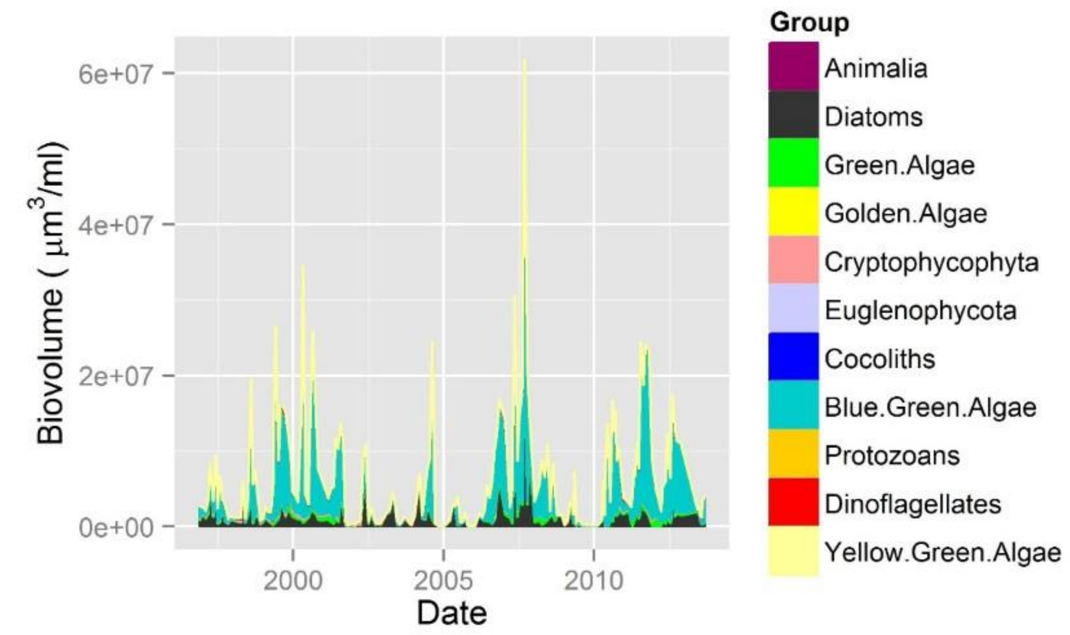


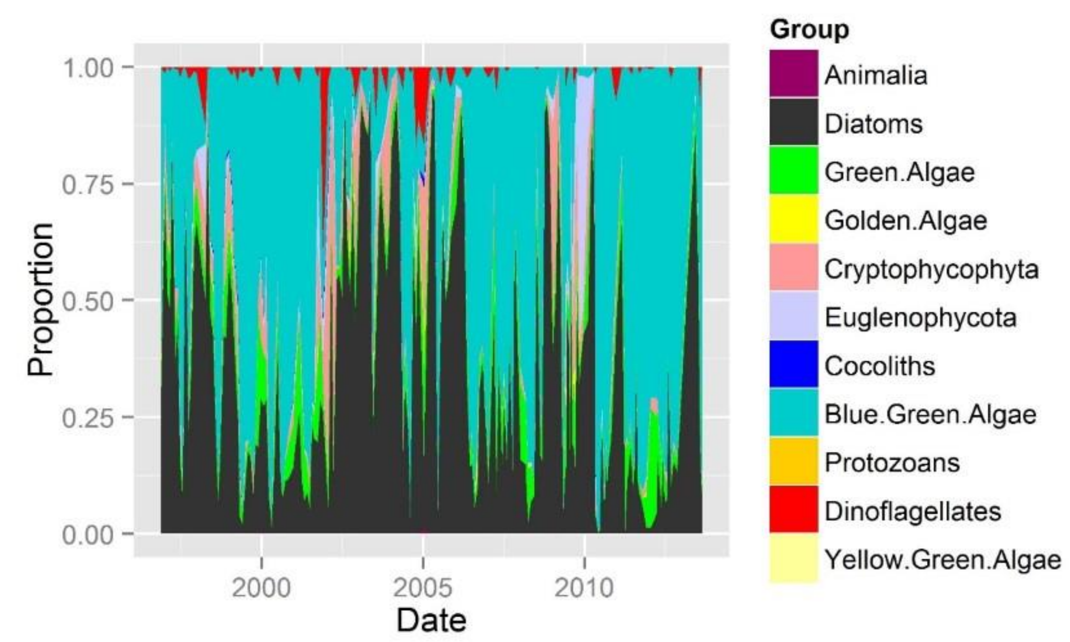
Crescent Lake serves as the test case for the proposed target setting methodology. This waterbody is the ninth largest lake in Florida, and is located in northeastern part of the state, in the St. Johns River watershed. The lake is 10 miles long by 2 miles wide, draining northward into the St. Johns River through Dunns Creek. The watershed of Crescent Lake is primarily covered by wetlands and mixed forests with additional land used for agriculture and urbanized areas. Of the land in forest and scrubland, a majority is managed for short rotation slash pine. The dominant types of agricultural in the watershed are row crops, pasture land, and leatherleaf fern growing operations.

Phytoplankton communities in Crescent Lake

Phytoplankton communities are an ecologically important marker of health in lacustrine systems. Within Crescent Lake, phytoplankton and zooplankton community composition has been sampled monthly by SJRWMD since 2000 at a site in the northern end of the lake.

Phytoplankton community composition was investigated in terms of both species composition and species abundances. Over the measurement period, species abundances and dominance shifted significantly at seasonal and yearly timescales.

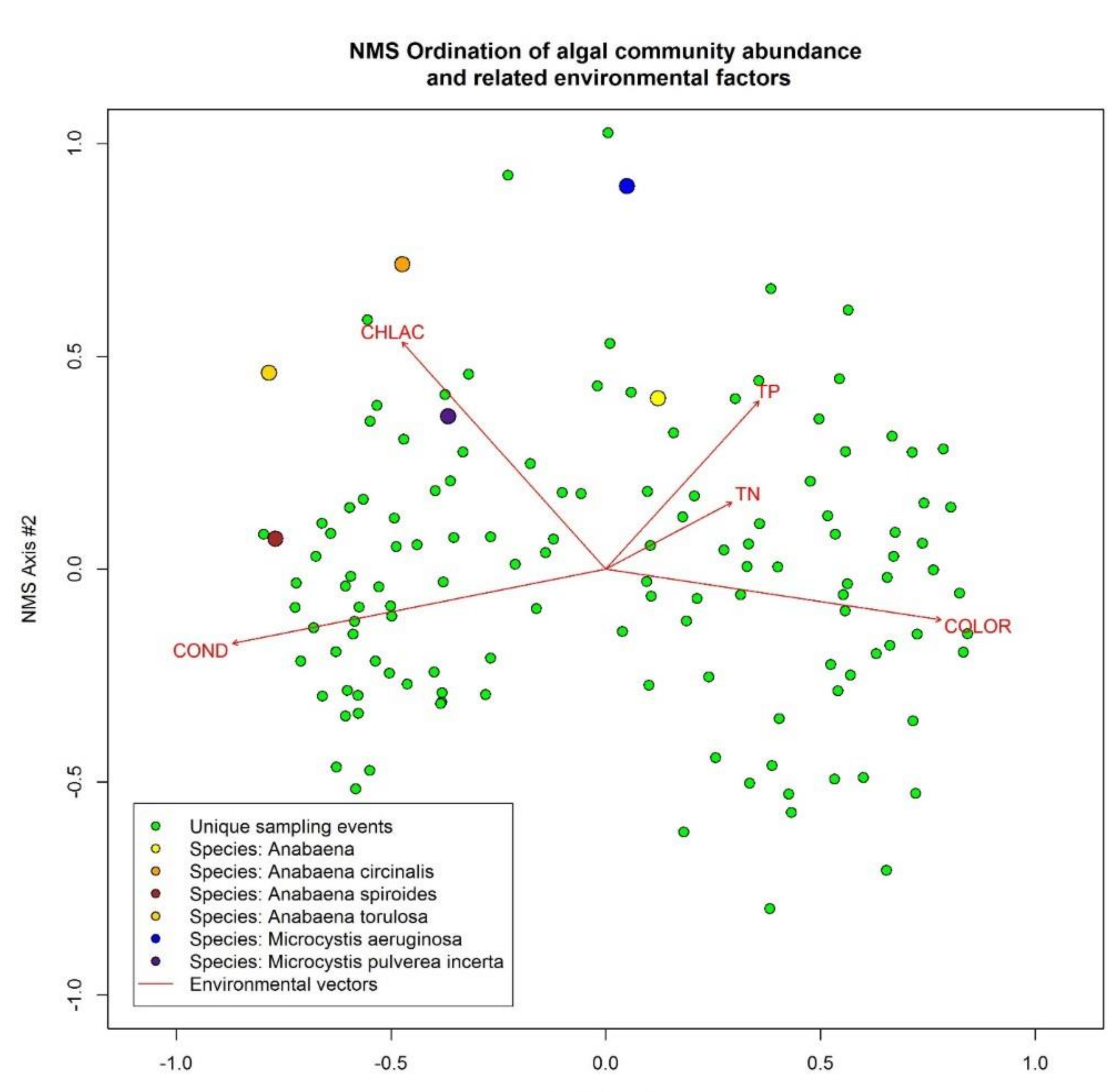




A non-metric multidimensional scaling ordination was performed with Bray Curtis distances calculated on Wisconsin double standardized phytoplankton abundances using the vegan package in R.

In the resulting two dimensional solution, the second ordination axis is likely to be related to dominance by blue-green algae (*Anabaena* and *Microcystis* both plot high in ordination space on axis 2).

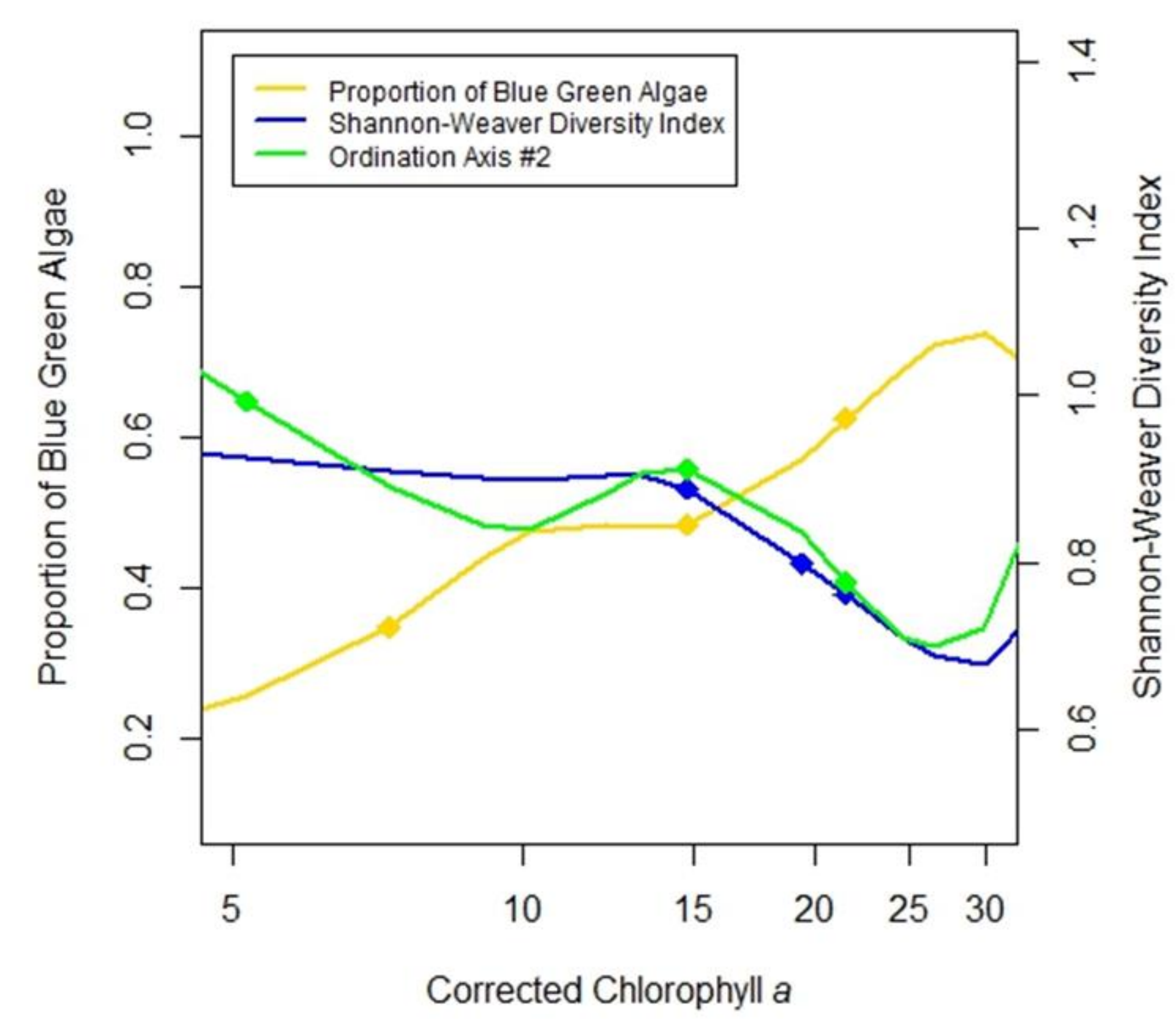
Relevant environmental variables were extracted from the DEP IWR database from the same site in Crescent Lake and displayed on the ordination diagram. The length of the vector represents the strength of the correlation while the angle of the vector specifies the degree of correlation with each axis. The environmental variables which displayed the strongest correlation with the algal assemblage were conductivity and color, both of which load onto the x-axis in opposite directions. Chlorophyll, total phosphorus, and total nitrogen load partially onto the second ordination axis. Environmental factors related to water quality are clearly linked to changes in the community composition. From this evidence, it is can be determined that phytoplankton communities are sensitive to eutrophication and therefore could be used as for the basis for a site specific water quality target.



Phytoplankton diversity and restoration targets

While the phytoplankton community composition is the biological endpoint of interest, the necessary data to characterize these organisms are not routinely collected from all stations. Therefore, the ideal target will tie algal community composition to a more commonly collected water quality parameter. Chlorophyll *a* is the best choice of a summary metric, which should give similar information to the total biovolume across all taxa.

Three different statistical indicators were used to examine the relationship between annual geometric mean Chlorophyl *a* concentrations and algal community composition. Annual geometric mean chlorophyll *a* concentrations were used as the basic unit against which the three statistical indicators were compared and plotted. In the first indicator, the Shannon-Weaver diversity index was calculated on the annual average algal community abundance data. The proportion of blue-green algae compared to the total algal biovolume was calculated for each measurement period and then averaged for each calendar year as the second indicator. The final indicator was formed using the second axis from the previously described NMS ordination.



Across the range of observed chlorophyll concentrations, the percentage of blue-green algae increases linearly while the diversity of the algal community remains high until the chlorophyll concentration exceeds 15 µg/L. Above that point, the community diversity and the second ordination axis decrease linearly. This indicates that annual geometric mean nutrient concentrations which do not exceed 15 µg/L will protect phytoplankton diversity. A Bayesian change point analysis was performed on the Shannon-weaver diversity index, which identified 15 µg/L as the only significant, and most likely change point. Therefore, setting the 80th to 100th percentile of the target chlorophyll distribution at 15 µg/L should protect phytoplankton diversity and other organisms which depend on the primary producer community.

References

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