The relationship between nutrients and phytoplankton abundance in the Savannah River estuary

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ABSTRACT

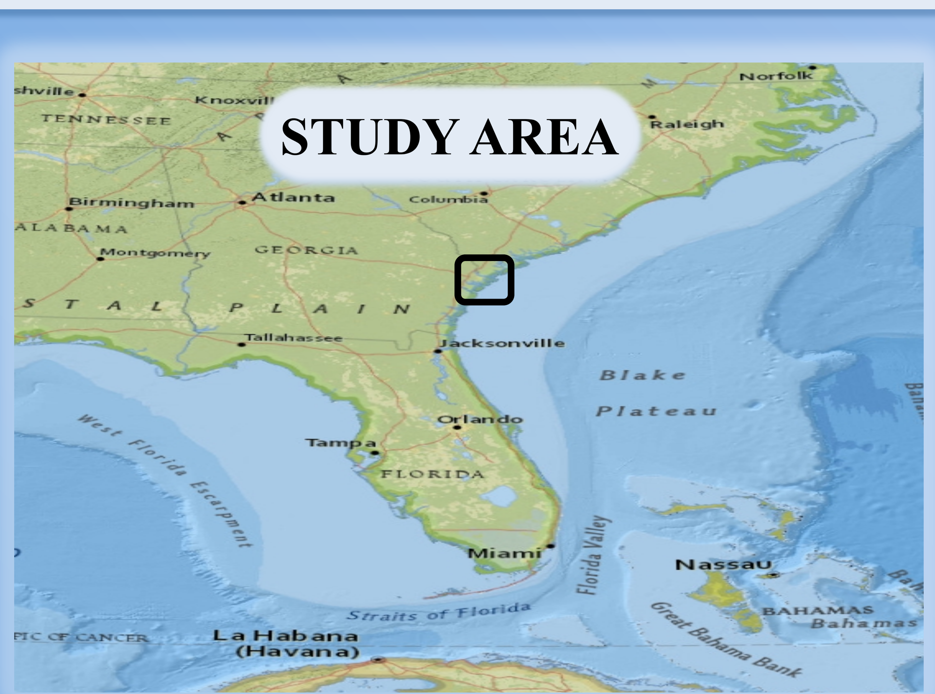
Phytoplankton abundance and distribution are dependent upon several factors including light availability, temperature and nutrient concentration of the water column..The purpose of this study was to determine if there is a relationship between nutrient concentrations and phytoplankton abundance in coastal and estuarine waters of Savannah, GA. Ten liters of water were filtered through a 20 µm plankton net for each sample; temperature, salinity, and turbidity were recorded on site. Nutrient concentrations were determined in the laboratory using spectrophotometric techniques. Abundance of phytoplankton increased (10 to 103 ±41.6 cells/mL) in Tybee Creek over 3 month period. The abundance of phytoplankton increased, while the concentrations of nitrate and phosphate decreased. Phosphate concentration steadily decreased over the study period, with the greatest decrease in the Savannah River (3.72 to 1.46 ±1.6 µM). An occasional increase in nitrate concentrations was observed in Lazaretto Creek (25 to 31 ±5.2 µM). The increase in nitrate concentration was considered a result of rainfall events similar to what was observed by Randall and Mulla, (2001). The Savannah River had the lowest phytoplankton density during each sampling event, which may be due to reduced light availability.

INTRODUCTION

Phytoplankton are the primary producers in most aquatic ecosystems. Light availability and nutrient levels are generally the limiting factors for phytoplankton growth or population blooms (Hecky and Kilham, 1988). An increase in nutrient concentration can increase phytoplankton abundance and provide ideal conditions for population blooms, assuming steady light intensity (Sharma and Bhardwai, 2011). However, seasonal variations in surface water temperature and light availability can also affect the density of phytoplankton in a given area. Many estuaries have anthropogenic sources of excess nutrients leading to eutrophication and harmful algae blooms (Anderson et al., 2002). **The purpose of this study was to determine whether there is a relation between nutrient concentration and phytoplankton abundance in the Savannah River estuary.**

METHODS

- 10L of water collected using Niskin bottle and filtered through 20 µm plankton net.
- Three sampling locations: Tybee Island, Lazaretto Creek and Savannah River estuary, Georgia.
- Temperature and salinity recorded on-site using Hach Meter.
- Phytoplankton densities were counted using a Sedgewick Rafter cell and nutrient concentration were determined using spectrophotometric techniques.
- GPS Coordinates, cloud coverage, and turbidity were recorded on site.
- Maps created in ArcGIS 10, Projection: Transverse Mercator.



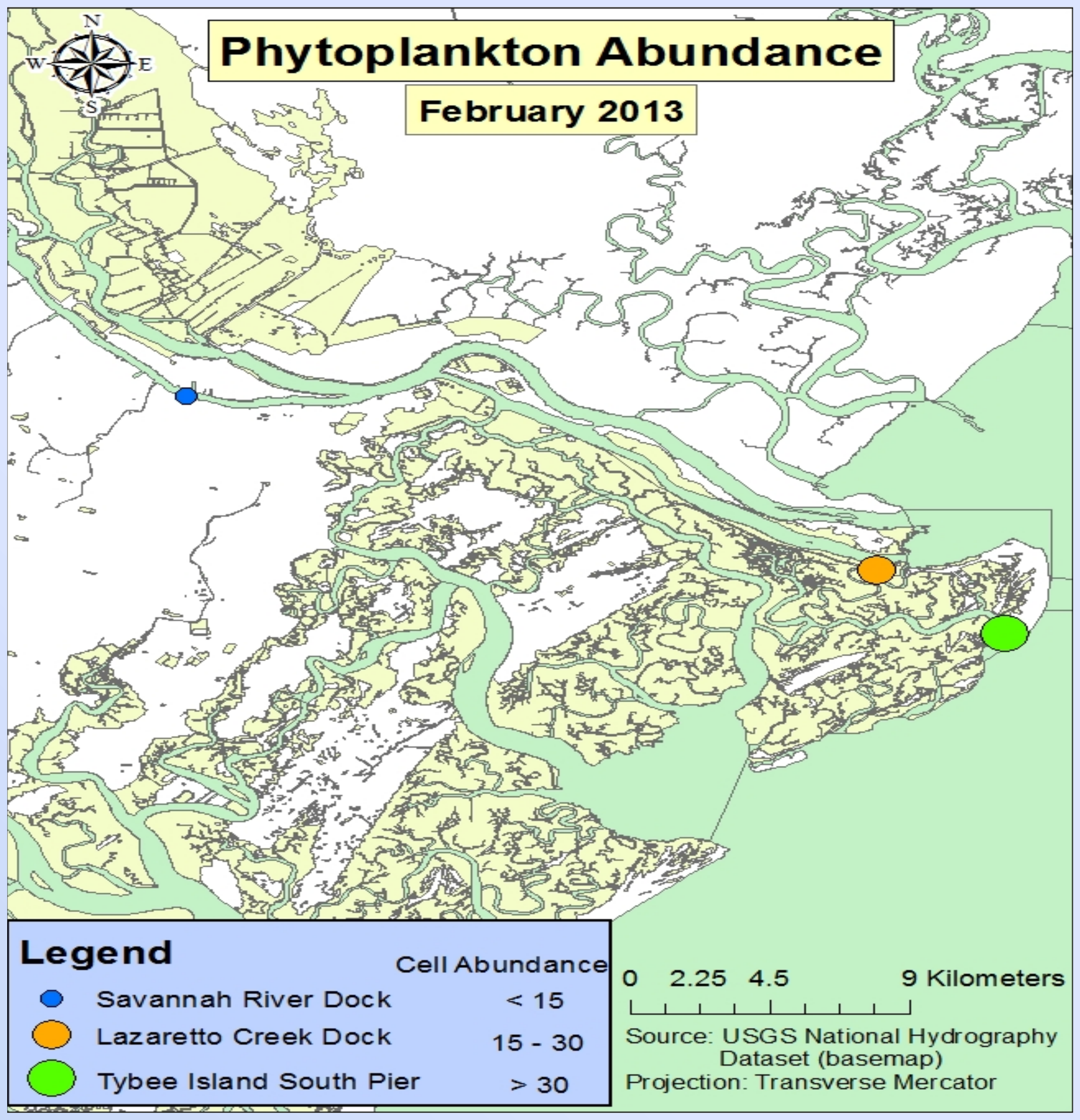


Figure 1. Phytoplankton abundance was measured during February 2013 at three locations. Abundance was highest at Tybee Island pier (31 cells/L) and lowest at Savannah River dock (15.2 cells/L).

Tybee Island

Date	Temperature (°C)	Salinity (ppt)	Phosphate (µM)	Nitrate (µM)	Cell count (cells/mL)
1/26/2013	17	29.1	0.65	35	9.75
2/23/2013	14.4	30.2	0.56	27	31
3/10/2013	14.4	28.4	DNS	16	72.1
3/23/2013	15.1	29.5	DNS	18	102.9
Average ±SD	15.2±1.23	29.3±0.75	0.61	24±8.7	53.9±41.6

Savannah River

Date	Temperature (°C)	Salinity (ppt)	Phosphate (µM)	Nitrate (µM)	Cell count (cells/mL)
1/26/2013	14.6	13.32	3.72	44	4.25
2/23/2013	12.5	7.73	1.46	52	15.2
3/23/2013	15.1	10.97	DNS	34	31.5
Average±SD	14.07±1.38	10.67±2.81	2.59±1.60	43.33±9.02	16.98±13.71

Lazaretto Creek

Date	Temperature (°C)	Salinity (ppt)	Phosphate (µM)	Nitrate (µM)	Cell count (cells/mL)
1/26/2013	16.0	27.6	DNS	25.0	13.4
2/23/2013	14.4	24.7	1.0	31.0	17.8
3/10/2013	13.1	25.4	DNS	20.0	124.4
3/23/2013	14.6	23.8	DNS	20.0	88.8
Average±SD	14.5±1.2	25.4±1.6	1.0	24.0±5.2	61.1±54.5

DNS=did not sample/record/observe.

RESULTS

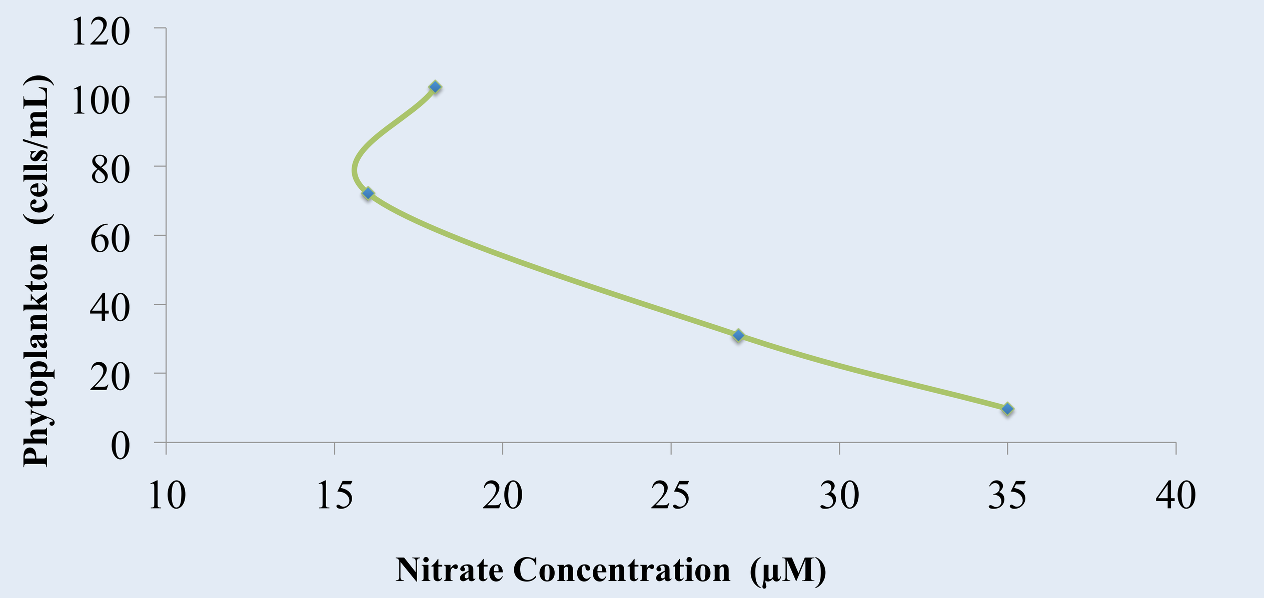


Figure 2. The nitrate concentration (µM) in Tybee creek decreased as phytoplankton abundance (cells/ml) increased over three month period.

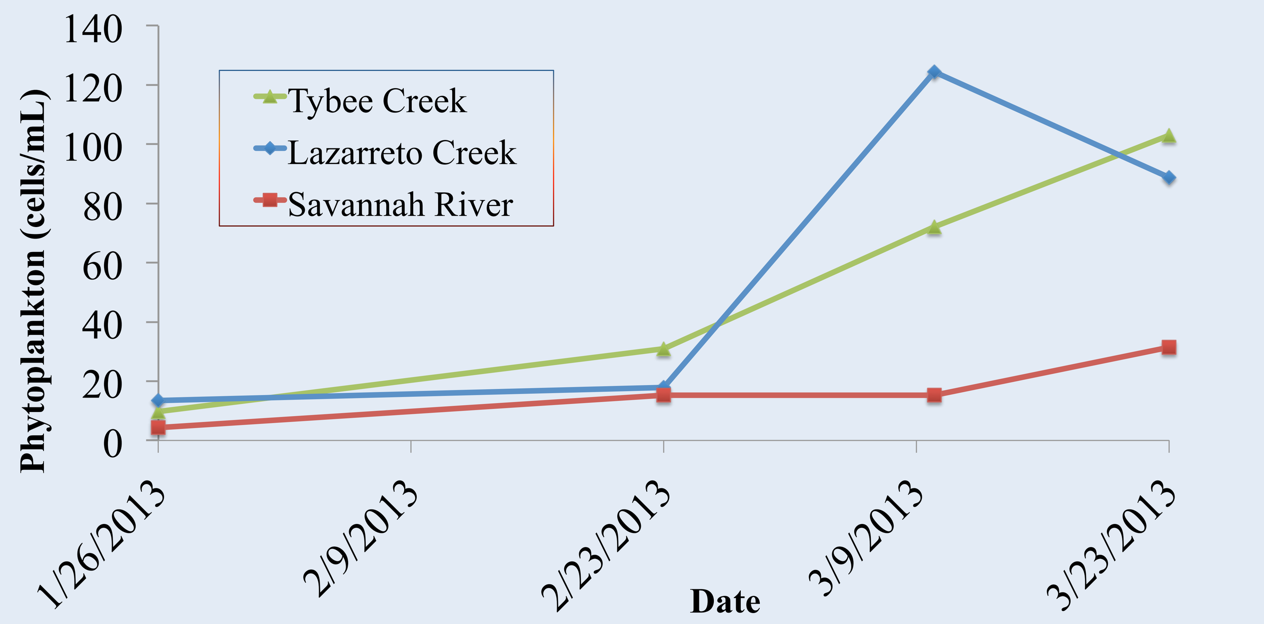


Figure 3. Variations in phytoplankton abundance (cells/mL) for each site from January to March 2013.

DISCUSSION

The major finding of this study was that as the concentrations of nitrate and phosphate decreased, the abundance of phytoplankton in all three sites increased (Figure 3). Tybee Creek standing stocks increased from 9.7 to 102.9 cells/mL±41.6, Lazaretto Creek standing stocks increased from 13.4 to 88.8 ±54.5 cells/mL and the Savannah River standing stocks increased from 4.2 to 31.5 ±13.7 cells/mL. The nitrate concentration steadily decreased in all locations from January to March, with the exception of the occasional increase in Lazaretto creek (from 25 to 31 ±5.2 µM) in January. The increase in nitrate concentration was considered a result of rainfall events similar to what was observed by Randall and Mulla, (2001). The Savannah River estuary in Georgia is downstream of many industrial areas and the port. Therefore, the water near this station may be heavily influenced by the pollution input of industries as well as upstream agriculture and development. Excess levels of nutrients were present in the samples; therefore, the limiting factor is possibly sunlight availability. In the past few decades the Savannah River shipping channel was dredged multiple times, which allowed a larger amount of water to pass through the river and caused an increased turbidity (Anderson et al., 2002). There is also a high load of CDOM which absorbs light in the water column. A longer research study could indicate better linkages between excess nutrients and primary production.

LITERATURE CITED

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