Report for 2003CT25B: Effects of Variation in Nitrogen and Phosphorus Ratios and Concentrations on Phytoplankton Communities of the Housatonic River

There are no reported publications resulting from this project.

Report Follows

Problem and Research Objectives

One of the most serious threats to freshwater and marine ecosystems is an overabundance of nutrients, particularly nitrogen and phosphorus. These nutrients fuel high algal growth (blooms), leading to numerous other changes in aquatic systems. Surface blooms reduce light and nutrient availability to other algal species leading to lower algal diversity. When algae die, they provide an organic carbon source for bacteria. Bacterial decomposition consumes oxygen and in temperature or salinity stratified systems, bottom waters are depleted of oxygen. In addition, algal blooms impair recreation and may cause taste and odor problems in drinking water systems. The series of symptoms including high nutrient levels, high algal growth, and low oxygen concentration is called eutrophication.

Many freshwater and estuarine systems in Connecticut are highly eutrophic. The leading cause of eutrophication in estuarine systems is excess nitrogen, whereas the nutrient contributing to algal blooms in freshwater systems is typically phosphorus. Nitrogen and phosphorus enter freshwater and estuarine systems in many different chemical forms (dissolved vs. particulate and biologically available vs. biologically unavailable). Sewage treatment plants, runoff from urban and agricultural lands, storm sewer overflow, and atmospheric deposition are the main sources of nutrients in Connecticut. In order to comply with the Clean Water Act, Connecticut and New York, in collaboration with the Environmental Protection Agency, have implemented the Long Island Sound Study, which aims to improve the water quality of Long Island Sound by reducing nitrogen input. Under that plan, phosphorus is not targeted for reduction and many of the methods used to reduce nitrogen will not alter phosphorus concentration. Because nutrients enter Long Island Sound *via* rivers and streams, these freshwater systems are targets for reduction. A model has been constructed to predict how dissolved oxygen levels in Long Island Sound will change with particular reductions in nitrogen loading; however, it is not clear how the proposed management will affect algal growth in freshwater systems. This study addresses the impacts on freshwaters by assessing the effects of changing nitrogen and phosphorus ratios and concentrations on algal growth in the Housatonic River.

To begin to identify how nutrient concentration and N:P ratios impact the phytoplankton on the lower Housatonic River, I 1) Identified seasonality of phytoplankton and nutrient concentrations in the lower Housatonic River, 2) Identified areas of nitrogen vs. phosphorus limitation from upstream to the mouth of the Housatonic River, and 3) explored how changes in the nitrogen to phosphorus ratio (N:P ratio) in the Housatonic affect short-term phytoplankton growth.

Methodology

The three objectives listed above were accomplished using two approaches. To identify seasonality in phytoplankton abundance, species composition, and nutrient concentration, I continued the monitoring program I began during Summer 2002. Phytoplankton biomass, species composition, concentrations of nitrate, ammonia, phosphate, total nitrogen, total phosphorus, secchi depth, temperature, salinity, conductivity, and oxygen were sampled monthly from May - September. Phytoplankton biomass was estimated using chlorophyll *a* concentration. Chlorophyll *a* concentration was quantified using the non-acidification fluorometric method of Welschmeyer 1994. Species composition was determined through microscopic examination. Nutrient concentrations were analyzed at the University of Connecticut Environmental Research Institute (protocols available upon request). Temperature, salinity, conductivity, and oxygen were measured in the field using a YSI meter.

To assess the degree of nitrogen vs. phosphorus limitation, standard nutrient bioassays were conducted at 5 sites starting at Lake Lillinonah and ending at the mouth of the Housatonic River. These sites included 1 freshwater impoundment, 1 site in the freshwater tidal portion of the Housatonic River, 2 sites at which salinity varies from ~5 ppt to 20 ppt, and a site in Long Island Sound. Bioassays were be performed early June, mid-July, and mid-late September to assess seasonal changes in nutrient limitation. Water and phytoplankton collected at each site were incubated in 4-liter plastic mesocosms at either ambient nutrient concentration, elevated phosphorus, elevated nitrogen, or elevated phosphorus and nitrogen concentrations. Because differences in herbivory between sites may bias the results, zooplankton were excluded from the experiments. Phytoplankton growth in each treatment was assessed by looking at changes in chlorophyll *a* concentration over 3 days.

To identify how changes in N:P ratio affect short-term phytoplankton growth and species composition, I conducted an experiment in Lake Lillinonah using 120 liter plastic limnocorrals. In this experiment, changes in dissolved nutrient concentration and phytoplankton species composition were monitored over the course of 13 days in treatments with different N:P ratios.

Principal Findings and Significance

The results from objectives 1 and 2 suggest that changes in nitrogen loading to the Housatonic River could impact the phytoplankton community by changing patterns of nutrient limitation. Bioassay experiments showed that phytoplankton in Long Island Sound were always strongly N limited and were co-limited by P in spring. In spring, phytoplankton in the upper river were P-limited. During low flow (summer), phytoplankton in the lower river were N limited. Phytoplankton in the middle reaches showed no evidence of N or P limitation. In general, periods of N or P limitation correlated with lower concentrations of nitrate or phosphate but not with changes in N:P ratio. These results suggest that decreases in N concentration should increase the prevalence of N limitation in the upper river which could alter species composition and nutrient export to LIS. These results were presented at the Ecological Society of America meeting in Portland, OR in August 2004. A manuscript based on this part of the project will be submitted by the end of August 2005.

The data from objective 3 is still being processed and analyzed. Preliminary results suggest that the experimental reduction in N:P ratio increased algal nitrogen limitation but did not have a large impact on phytoplankton community composition over the short-term. I plan to finish working on this part of the project by the end of 2005.