

## **Abstract** (Document Summary)

Phytoplankton are a focal point in management strategies to improve or maintain lake water quality. Although much research has focused on macroscopic phytoplankton attributes such as total biomass and bloom-forming cyanobacteria, more subtle responses may be also be important for trophic relationships and may serve as indicators of ecosystem change. The objectives of this dissertation were to: (1) evaluate macroscopic and subtle responses of phytoplankton community structure to experimental manipulations of nutrient inputs and food web structure in three small lakes, and (2) test the theoretical expectation that ecosystem components (species, genera) are better indicators of ecosystem perturbation than aggregate properties (biomass, primary productivity) because components respond to perturbation both more quickly and more strongly than aggregate properties.

I used time series analysis to quantify the effects of nutrients and zooplankton on phytoplankton biomass and community structure. In general, effects were consistent with those predicted in the literature. Increased nutrients increased total biomass, biomass of small and large phytoplankton, mean phytoplankton size, cyanobacteria, chlorophytes and cryptomonads, but decreased species diversity, dinoflagellates, chrysophytes and the proportion of small phytoplankton. Increased zooplankton size decreased species diversity and small phytoplankton, increased large phytoplankton and mean phytoplankton size, and had different effects on total biomass and taxonomic divisions in different lakes. Overall, changes in size structure were more consistent among lakes (and hence more predictable) than changes in taxonomic structure.

Contrary to theoretical expectation, aggregate parameters were better indicators of increased nutrients than system components. Based on analyses with dynamic linear models, primary productivity and total phytoplankton biomass responded to enrichment as quickly and nearly as strongly as individual species and genera. Furthermore, significant changes in species and genera were detected as frequently in an unmanipulated lake as in manipulated lakes, suggesting that background variability is too high to reliably detect changes in these components. Although species change is a useful indicator of toxic chemical stress, this conclusion does not extend to nutrient enrichment.