Cultural eutrophication of three Midwest urban reservoirs: the role of nitrogen limitation in determining phytoplankton community structure

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Introduction

The cultural eutrophication of three Midwest urban reservoirs (Ford Lake, MI; Belleville Lake, MI; and Eagle Creek Reservoir, IN) has resulted in impaired water quality. Nutrient loading to these reservoirs has resulted in the formation of nuisance algal blooms, including possible toxin-producing and/or taste and odor causing, heterocyst-forming blue-green genera such as *Anabaena*, *Aphanizomenon*, and *Cylindrospermopsis*.

Hypotheses

Small urban reservoirs undergo a transition from nitrogen rich, P-limited growth conditions to nitrogen poor, P-abundant growth conditions. Given sufficient physical conditions (abundant incident solar radiation and water temperatures > 25 °C), this transition in the nutritive environment spurs the growth of nuisance algal blooms of heterocyst-forming blue-green genera such as *Anabaena*, *Aphanizomenon*, and *Cylindrospermopsis*.

Methods

Monthly nutrient concentrations (Total P, NO_3^-, NH_4^+) taken from 1998 – 2000 for two southeastern Michigan reservoirs, Ford Lake and Bellville Lake, and weekly nutrient data taken from 1976 – 1996 and bi-weekly data collected in 2003 for Eagle Creek Reservoir, Indiana were analyzed for relationships between nutrient concentrations and phytoplankton standing stock measured as either Chlorophyll *a* or phytoplankton counts.

Results

Data analyses showed consistent annual trends of $NO_3^- + NH_4^+$ depletion and P abundance from mid- to late summer, suggesting that phytoplankton growth became seasonally N-limited in these reservoirs. Data from the three reservoirs showed that low N-to-P ratios correlated more strongly with phytoplankton standing stock than N or P alone. Data from Eagle Creek Reservoir showed that low N-to-P ratios preceded an increase in heterocystous *Anabaena* and *Aphanizomenon* concentrations.

Conclusion

During the study periods for the three reservoirs, nutrient concentrations show a trend of decreasing nitrogen concentrations and increasing phosphorous concentrations during the mid- to late summer when nuisance algal blooms were recorded. Overall phytoplankton abundance and heterocystous blue-green abundance was highest during times of low nitrogen-to-phosphorous ratios. In June 2005, a study using a combination of growth limitation bioassays and high temporal resolution sampling began on Eagle Creek Reservoir to determine if nuisance algal blooms of heterocystous blue-green algae were preceded by a transition from nitrogen rich (P-limited) to nitrogen poor (N-limited) growth conditions.