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ECOSYSTEMS

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Appendix A

Biological Nitrogen Fixation Prevents the Response of a Eutrophic Lake to Reduced Loading of Nitrogen: Evidence from a 46-Year Whole-Lake Experiment

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Abstract

A whole-ecosystem experiment in Lake 227 (L227) at the Experimental Lakes Area, ongoing since 1969, examined the roles of carbon (C), nitrogen (N), and phosphorus (P) in controlling eutrophication. During 2011, we conducted a series of sub-experiments and more intensive monitoring to improve estimates of N fixation and its ability to meet algal growth demands in the decades following the cessation of artificial N loading, while maintaining long-term high artificial P loading. Stoichiometric nutrient ratios indicated both moderate N and P limitation of the phytoplankton during spring, preceding a shift in phytoplankton community structure toward dominance by N fixing cyanobacteria. During bloom development, and for the remainder of the stratified period, stoichiometric nutrient ratios indicated moderate to strong P limitation. N fixation rates, corrected using $^{15}N_2$ methods, increased 2× after 1990, when N loading ceased. Ambient dissolved inorganic nitrogen prior to the bloom represented less than 3% of N demands of the phytoplankton. N fixation accounted for between 69–86% of total N loading to the epilimnion during the period of rapid bloom development, and 72–86% of total N loading during the May–October period. Phytoplankton biomass did not decline in L227 during the 40 years since artificial N loading was reduced, or the nearly 25 years since artificial N loads ceased entirely (1990–2013), and remained approximately 20× higher than four nearby reference lakes. These results suggest that despite constraints on biological N fixation, it retains a large capacity to offset potential N loading reductions in freshwaters.

Key words: eutrophication; freshwater; phytoplankton; nutrient limitation; lake management; whole-lake experiment.

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Author contributions SNH conducted 2011 experiments, analyzed data, and wrote the manuscript; MJP, REH, DWS conceived and undertook the long-term study and analyzed the long-term data; DLF analyzed algal taxonomy and heterocyst abundance: JJV and SNH conducted and analyzed the $^{15}N_2$ experiment.

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Appendix B

April 26, 2023

City Hall
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I am writing in support of the motion to request that the provincial task force:

a) amend the North End Water Pollution Control Centre (NEWPCC) operating licence to require phosphorus compliance in Phase II; and

b) complete a review of current scientific knowledge to determine whether it is desirable to proceed with the nitrogen removal components of the Phase III project.

Over five decades of peer-reviewed research at the IISD-Experimental Lakes Area has demonstrated conclusively that phosphorus – not nitrogen – is the cause of harmful algal blooms in freshwater ecosystems – including Lake Winnipeg.

Phosphorus reduction is required to protect Lake Winnipeg, and the City of Winnipeg can do its part by accelerating compliance with the 1.0 mg/L phosphorus limit at NEWPCC. Chemical phosphorus reduction has been successful at Winnipeg's south end treatment plant, reducing phosphorus concentrations to as low as 0.11 mg/L. This efficient and cost-effective solution should be integrated into the design of the NEWPCC Phase II Biosolids Facilities Project.

Sincerely,

Alexis Kanu, PhD
Executive Director