



## Lake Nokomis Water Quality Improvement Project: Biomanipulation Update

### Background

Lake Nokomis is a 201-acre lake located in Minneapolis, Minnesota. Water quality in Lake Nokomis is impaired for nutrients, algal abundance and water transparency. Lake analyses and lake modeling scenarios suggest phosphorus from internal sources may be keeping Lake Nokomis reaching acceptable nutrient goals. One of the many internal sources that may be contributing to the nutrient impairment is the omnivorous, bottom feeding fish populations – black bullheads and bluegill sunfish.

An estimated reduction of 126 kg of phosphorus in Lake Nokomis via fish community manipulation would bring the water quality of the lake closer to Minnesota Pollution Control Agency's (MPCA) nutrient criteria. MCWD staff and Blue Water Science designed a water quality improvement project to address the TMDL goals for Lake Nokomis and move the lake towards meeting the MPCA's nutrient criteria.

The water quality improvement project was a fish-manipulation or biomanipulation project over a three-year period that would attempt to reduce the elevated phosphorus concentrations in Lake Nokomis. The biomanipulation plan involved (1) a fish removal targeting adult-sized black bullheads, (2) stocking walleye to control bluegill sunfish and young black bullheads (coordinated with MnDNR), and (3) conduct plant and fish community surveys every year. In April 2010, MCWD Board of Managers approved the Lake Nokomis Biomanipulation project and authorized funds to carry out the first year of project activities.

### Biomanipulation Project

#### Project Objectives

Lake Nokomis is in an implementation phase of a Total Maximum Daily Load (TMDL) project. TMDL projects include piscivore (predatory) fish stocking and benthivore (bottom feeding) fish removal in conjunction with watershed water quality improvement programs. From 2010-2013, the biomanipulation project worked on re-balancing the fish community, then from 2014-2016, project effectiveness monitoring occurred. By re-balancing the fish community in Lake Nokomis, the following was expected to occur:

1. Increase walleye population
2. Reduced black bullhead and blue gill populations
3. An increase in native aquatic plants up to 40% of the lake area
4. Reduce an estimated 126 kg of phosphorus
5. Water quality parameters meet the MPCA's nutrient criteria

## Project Summary

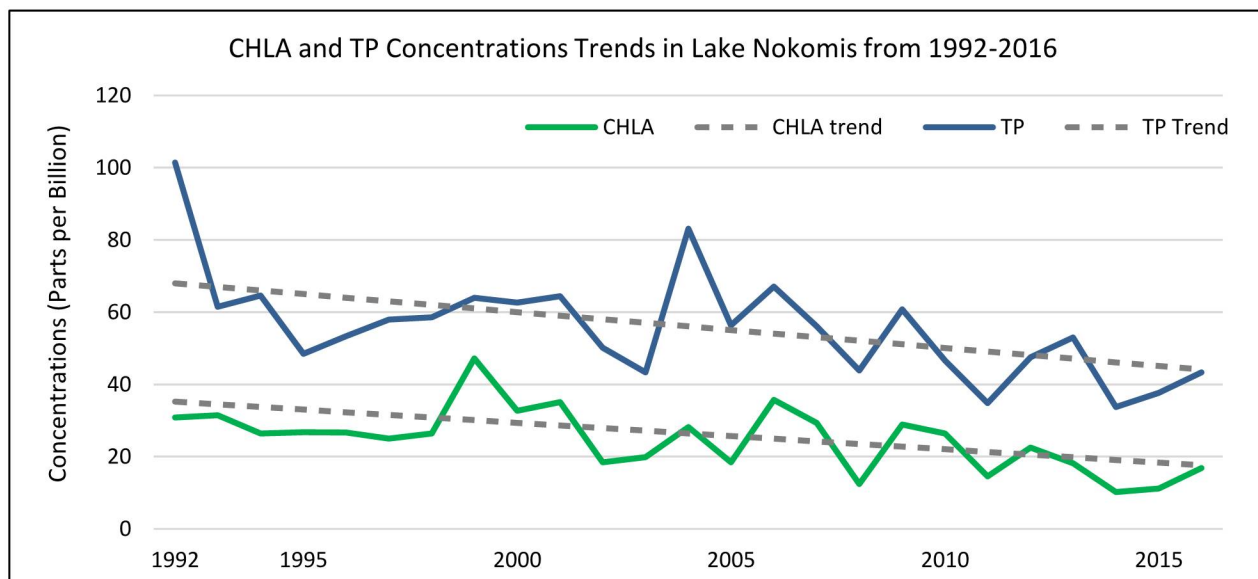
At the end of 2013, the biomanipulation project resulted in achieving the first three objectives: an increase in the walleye population, reduction in the black bullhead and bluegill populations and an increase in number of native aquatic plants species. Positive changes in the water quality of natural systems, such as Lake Nokomis, often are observed after the timeframe of the project. At the end of 2016, water quality improvements were meeting 2 out of 3 MPCA's nutrient criteria.

**Table 1. Mann-Kendall trend statistics from 1992-2016 on water quality parameters in Lake Nokomis.**

Parameters	Slope	p-value*	Improving or Degrading
SECC	-0.007 m	0.388	
CHLA	-0.734 ppb	0.003	Improving
TP	-0.993 ppb	0.002	Improving

\*Statistical significance  $\leq 0.05$

**Graph 1. Significant trends in chlorophyll (CHLA) and total phosphorus (TP) concentrations in Lake Nokomis.**



Note: 2010: Start of the Biomanipulation Project; 2014: Start of Project-effectiveness monitoring

The total phosphorus: chlorophyll (TP:CHLA) ratio of  $2.5 \pm 0.5$  for a 15-year average (2001-2015) indicated a mild top-down impact of piscivores on planktivores and zooplankton. This indicates the walleye and other predatory fish in Lake Nokomis are managing to keep the blue gills and other plankton-consuming fish in check.

A major source for the reduction of the lake TP concentration was the inferred decrease in internal loading due to a decrease in sediment nutrient suspension. With a decrease in benthic planktivores, which included bluegill sunfish, sediment nutrient re-suspension in the lake decreased. Aquatic plants have doubled in coverage from 2010–2016, but distribution was only at 15% of the lake area.

During the project timeframe, the Twin Cities experienced two record high water years (i.e., 2011 and 2014). Staff suspect that carp re-entered Lake Nokomis from Minnehaha Creek during the flood events and became trapped in the lake. Carp are known to churn up the bottom sediment in lakes. Snap-shot carp surveys in 2014 and 2015 estimated carp biomass to be 200-300 kg/ha above 100 kg/ha threshold. Carp biomass above 100 kg/ha threshold has been found to cause ecological damage in shallow lakes.

Continued walleye stocking by the MnDNR, combined with carp removal, will likely be necessary to sustain biomanipulation impacts until plant coverage reaches a goal of 40% which should maintain clear water conditions in moderately fertile lakes like Nokomis. Bio-manipulation has been a contributing factor to achieving TMDL goals for a shallow lake like Lake Nokomis.

### Project Partners

- Blue Water Science
- Minneapolis Park and Recreation Board
- and Minnesota Department of Natural Resources