Indian Lake Management Plan

Dane County Wisconsin

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For

Friends of Indian Lake County Park

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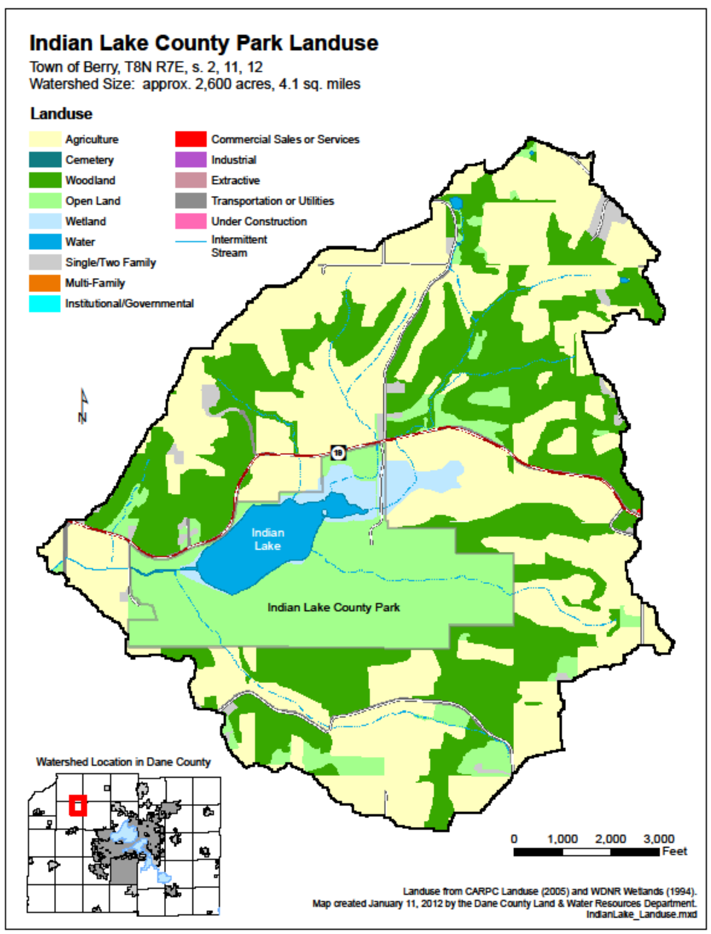
Summary

The recent common carp expansion in the lake has destroyed native fish habitat and degraded water quality. The dense Cyanobacteria blooms, with associated rancid odors, affected recreational uses and park patrons complained that these conditions undermined the value of the park experience. Indian Lake is a shallow lake that drains a relatively large watershed (40:1 drainage basin to lake size) and therefore nutrient management will continue to be a challenge. However, eliminating the common carp population can shift the lake from a Cyanobacteria nuisance to a macrophyte dominated ecosystem that is more aesthetically desirable and compatible with native fish populations and recreational uses. Our recommendations are to temporarily draw the lake down to a manageable size for an effective rotenone application to eradicate common carp, followed by native fish restocking and establishing desirable floating-leaf aquatic plants such as white water lily. A common carp migration barrier would be needed at the lake outlet to prevent future carp related problems. These options recognize the eutrophic nature of a shallow lake that drains a large agricultural watershed and can be used to channel nutrients and biomanipulate the lake to achieve optimum conditions. They are listed as alternatives 2 through 5 in the recommendations section.

Background

Indian Lake is a 27 ha (66 acres) shallow kettle lake that is maintained by groundwater and surface runoff. The entire lake is surrounded by the popular Indian Lake County Park with recreational uses that include fishing, bird watching, picnicking, cross country skiing, dog walking, hiking with link to Ice Age Trail, canoeing and boating that do not involve gas engines. The lake is primarily managed for largemouth bass and panfish angling. An aeration system has been used since the lake has a history of winterkill. Aeration has been primarily used during late winter months when dissolved oxygen levels often become critically low. The operation of the aeration system has been a challenge given the unpredictable changes in wintertime dissolved oxygen.

Figure 1. Indian Lake County Park Land Use



The Indian Lake Watershed is 4.1 square miles and consists primarily of agricultural, woodland, and open land uses. (See figure 1.) Indian Lake outlets to the west and into Halfway Prairie Creek. The eastern most portion of the lake has shallow marsh characteristics and is reflective of variations in the water table. While agricultural inputs are minimal, deposits of sediment on the lake bed provide a source of nutrients for algal production.

In addition to a history of winterkill conditions, the lake had a long history of severe bluegreen algal blooms. During the early 1980's, WDNR Bureau of Research conducted an experiment to determine if adding nitrogen to the lake would trigger a shift from nitrogen fixing bluegreen algae (Cyanobacteria) species to non-bloom species (Lathrop 1988). The findings indicated that nitrogen applications were not effective due to short-term responses and other complicating factors. Bluegreen algal blooms in the lake had declined until recently as a response to sustained dense aquatic plant growths and perhaps other factors such as higher water levels.

Indian Lake water levels have increased over time. The maximum recorded depth during the 1970s was 6 feet (Day et al. 1985). In 2006, the maximum water depth had increased to 8.5 feet. The water levels in all three lakes may reflect increased regional groundwater recharge associated with agricultural conservation land use practices (Gebert and Krug 1996). The lake area also expanded significantly to the east.

Eurasian watermilfoil (EWM), coontail and curly-leaf pondweed had become established in the lake and suppressed phytoplankton blooms for over a decade. Harvesting the dense beds had become the primary management focus in the shallow lake. Dane County had been operating mechanical harvesters to create navigation channels for non-motorized boating access in the lake. These efforts likely improved predator prey interactions in the lake (Marshall 2007). Long term secchi trends indicated improved water clarity since the 1980's and partly reflected increased macrophytes in the lake. From 2007 through 2009, secchi measurements ranged from 0.5 meters (1.6') to 1.7 meters (5.6') with a mean Secchi Trophic State Index value of 56.

Fish species richness has been limited by periodic winterkills in the past. Fish populations in the lake had changed over the years with species including fathead minnows (*Pimephales promelas*), bluntnose minnow (*Pimephales notatus*), white suckers (*Catostomus commersoni*), black bullhead (*Ameiurus melas*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*) (Lathrop 1988, Day et al. 1985). Following winterkills, bullhead populations periodically exploded and exacerbated turbidity and internal phosphorus loading in the lake. This occurred when dense bullhead populations disturbed bottom sediments when feeding. Until recently, bluegill and largemouth bass populations were sustained by late winter aeration.

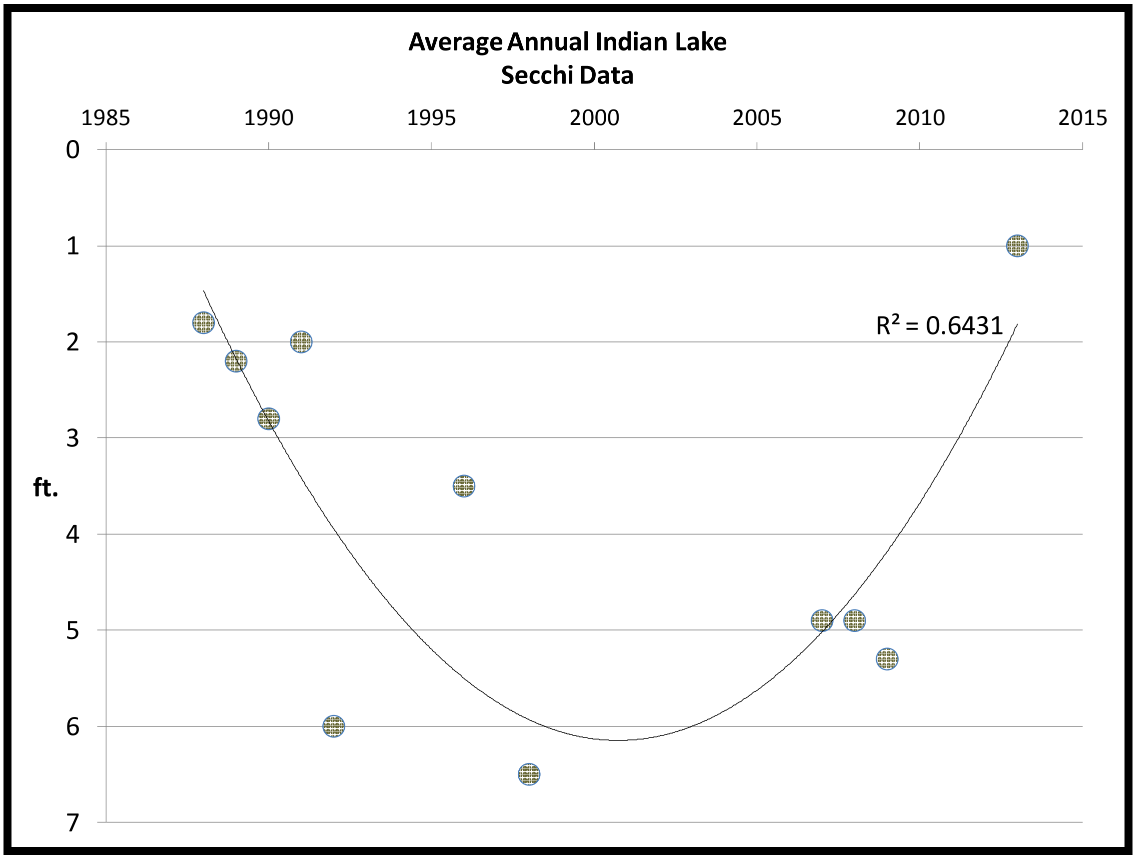
A point intercept aquatic plant survey was completed in 2006 and the information was used to prepare an aquatic plant management plan for the lake (Marshall 2007). At that time, the goals for managing Indian Lake macrophytes were to (1) improve non-motorized boat access within dense coontail, Eurasian watermilfoil and curly-leaf pondweed beds, (2) sustain lake-wide aquatic plant beds in desirable densities to prevent Cyanobacteria blooms that had historically occurred before the 1990's, (3) manage aquatic plants to enhance the largemouth bass and bluegill fisheries and (4) enhance native floating-leaf plant populations. Figure 3 demonstrates the density and distribution of coontail across the lake in 2006.

In the last few years, the lake water quality and ecology changed radically and appear to have reverted back to the degraded conditions that were prevalent prior to around 1990. A partial winterkill allowed common carp (*Cyprinus carpio*) populations to eliminate the dense macrophyte beds and the lake has shifted to a Cyanobacteria bloom dominated ecosystem. Except for few widely scattered submersed plants, the previous dense beds of coontail, EWM and CLP disappeared. Water quality has declined significantly and heavy Cyanobacteria blooms pose threats to humans, dogs and wildlife with potential toxins. The WDNR citizen monitoring database captures that long term changes in water quality, including the recent decline (Figure 2). This project was designed to better assess the current water quality impairments and evaluate management alternatives.

Methods

Monthly water samples were collected and submitted to the Madison and Dane County Public Health Lab for baseline analysis of total phosphorus (TP), total kjeldahl nitrogen (TKN), nitrates (NO_3-N + NO_2-N), chlorophyll A and chlorides (Cl^-). Field parameters were collected using Yellow Springs Instrument Model 63 pH and Specific Conductivity meter, Yellow Springs Instrument Model 52 dissolved oxygen/temperature meter, standard secchi disc, secchi tube and Hach 2100P Turbidimeter. A towed gas generator DC electroshocker was used to sample for potential nearshore fish populations in Indian Lake on June 8, 2013. Estimated phosphorus inputs were analyzed using WILMS (Wisconsin Lake Modeling Suite) based on percent loading within the watershed. Notes were recorded on wildlife observations, habitat conditions and management options.

Figure 2: Average Annual Indian Lake Citizen Monitoring Secchi Data Trend

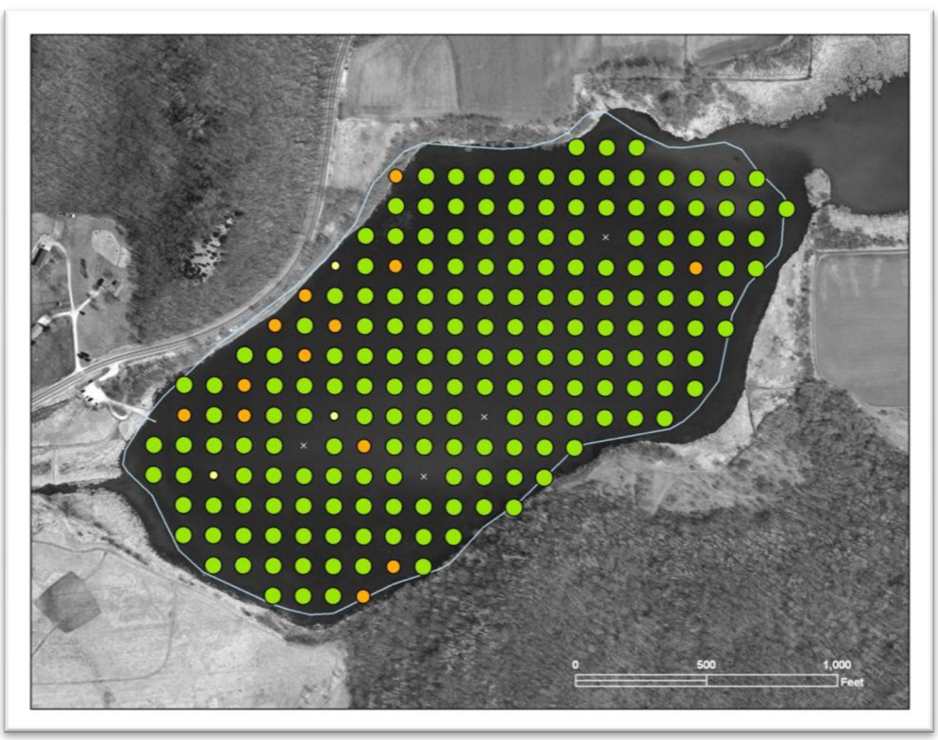


Findings

Dissolved oxygen (d. o.): The dense Cyanobacteria blooms resulted in highly erratic conditions in the lake including dissolved oxygen. D. O. levels ranged from supersaturated conditions when the Cyanobacteria was thriving to critically low concentrations, less than the Water Quality Criteria for d. o., after the bloom declined and was in a state of decomposition. It was this latter stage when strong odors around the lake were evident and numerous dead floating common carp were observed. Figure 4 displays the 2013 dissolved oxygen profiles data. Even though the lake is very shallow, anoxia at the bottom created conditions for internal phosphorus loading.

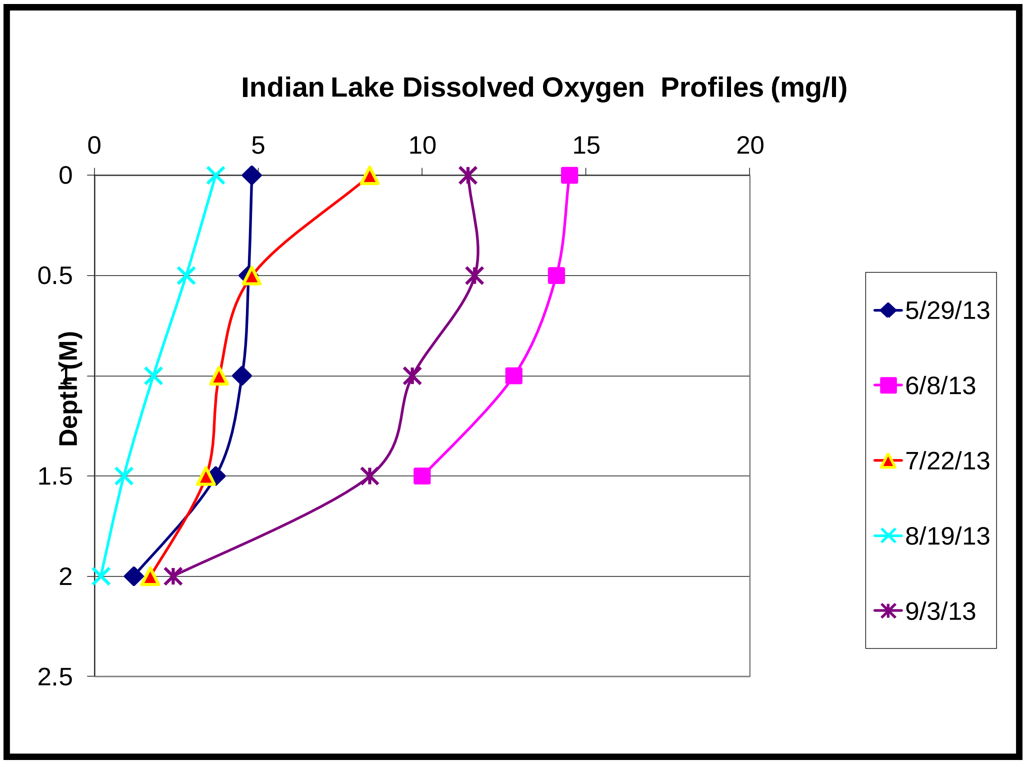
Photo by Pete Jopke of dead common carp and severe Cyanobacteria bloom in Indian Lake, Aug. 2013.

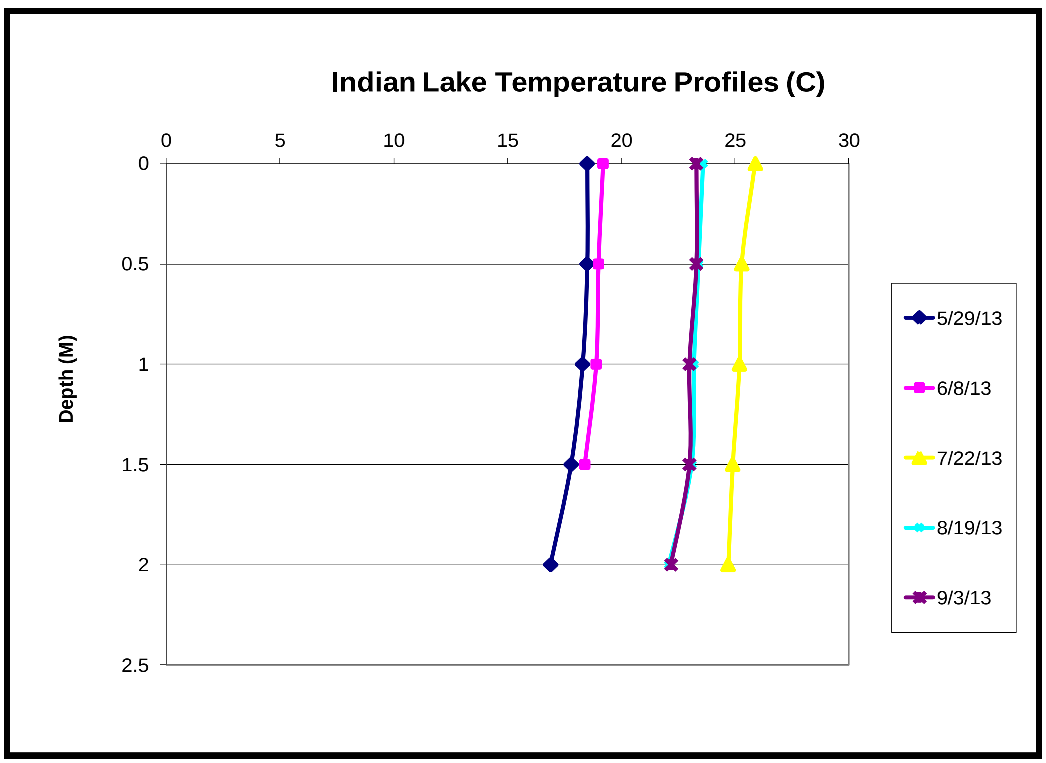
Figure 3: Distribution of Coontail across Indian Lake in 2006. Large green dots indicate maximum plant density rank.



Temperature: The temperature profiles in Figure 5 demonstrate that the shallow lake doesn't stratify with minimal temperature change from top to bottom.

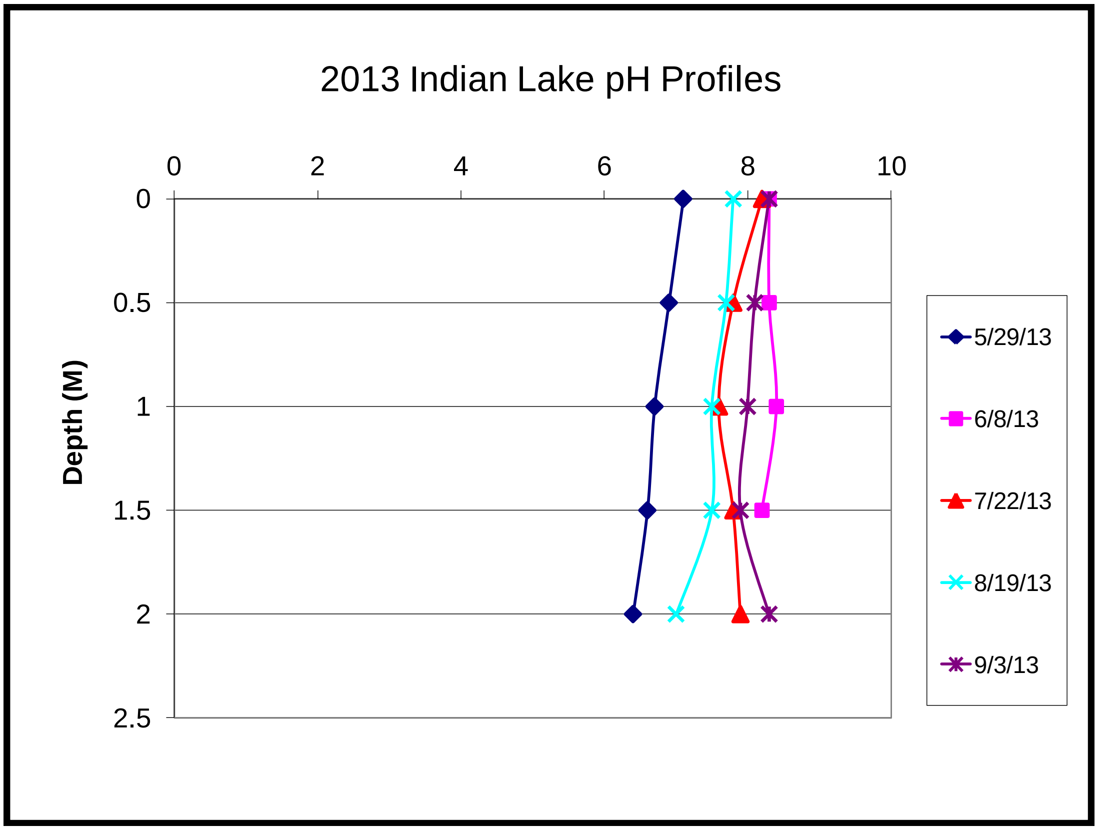
Figures 4 and 5: 2013 Indian Lake Dissolved Oxygen and Temperature Profiles





pH: In Figure 6 the pH profiles varied significantly depending on the date and amount of Cyanobacteria growths and photosynthesis. The profiles did not vary with depth and reflected shallow lake mixing.

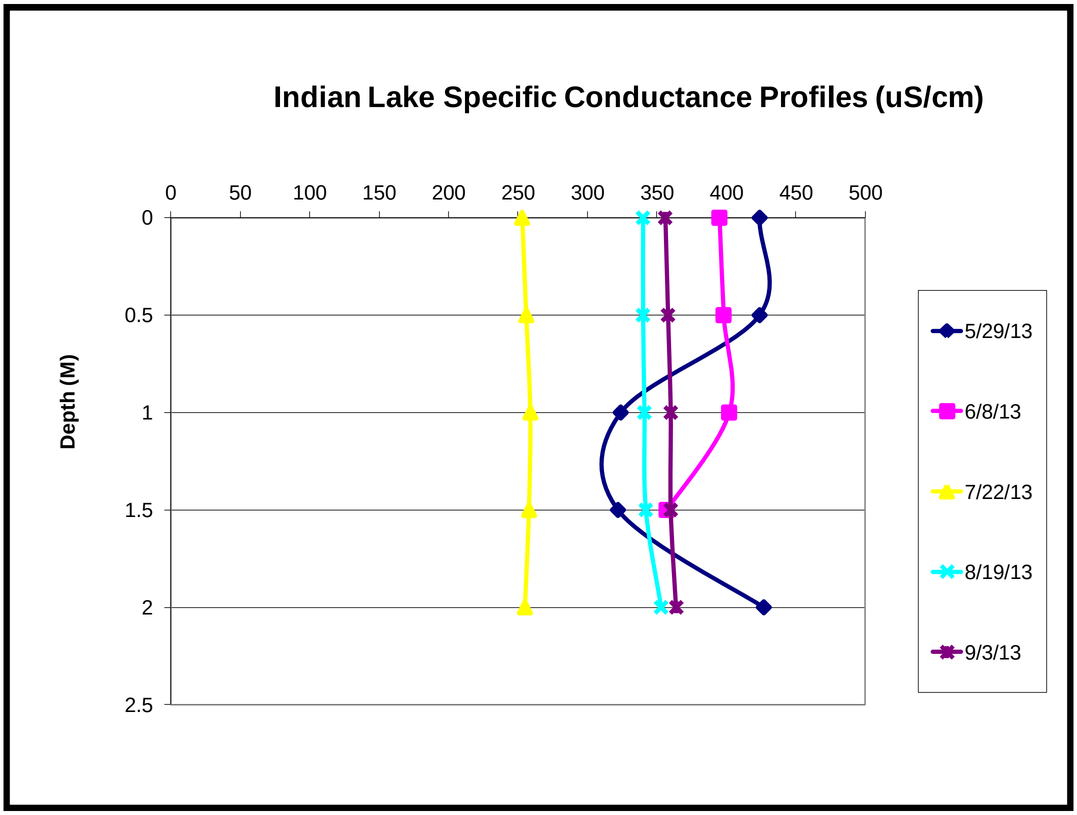
Figure 6: 2013 Indian Lake pH Profiles



Specific conductance: The conductivity measurements in Figure 7 were no less variable than the pH and d. o. and reflected unstable ecosystem processes linked to common carp and Cyanobacteria.

Water clarity: In addition to the standard secchi disc measurements, additional water clarity measurements were taken with a 120 cm secchi tube and Hach Turbidimeter. All measurements reflected very poor transparency due to the heavy Cyanobacteria blooms. The 2013 standard secchi measurements appear in Figure 8 and comparative water clarity measurements in Figure 9. The secchi tube units were changed from centimeters to feet for direct comparison with standard secchi measurements. The secchi and secchi tube data relate to the left axis that is inverted to reflect water clarity with depth. The turbidity data relate to the right axis with highest levels at the top of the graph. Very low secchi depth measurements reflected hypereutrophic conditions and very high secchi Trophic State Index values (Figure 11).

Figures 7 and 8: 2013 Indian Lake Specific Conductance Profiles and Secchi Measurements



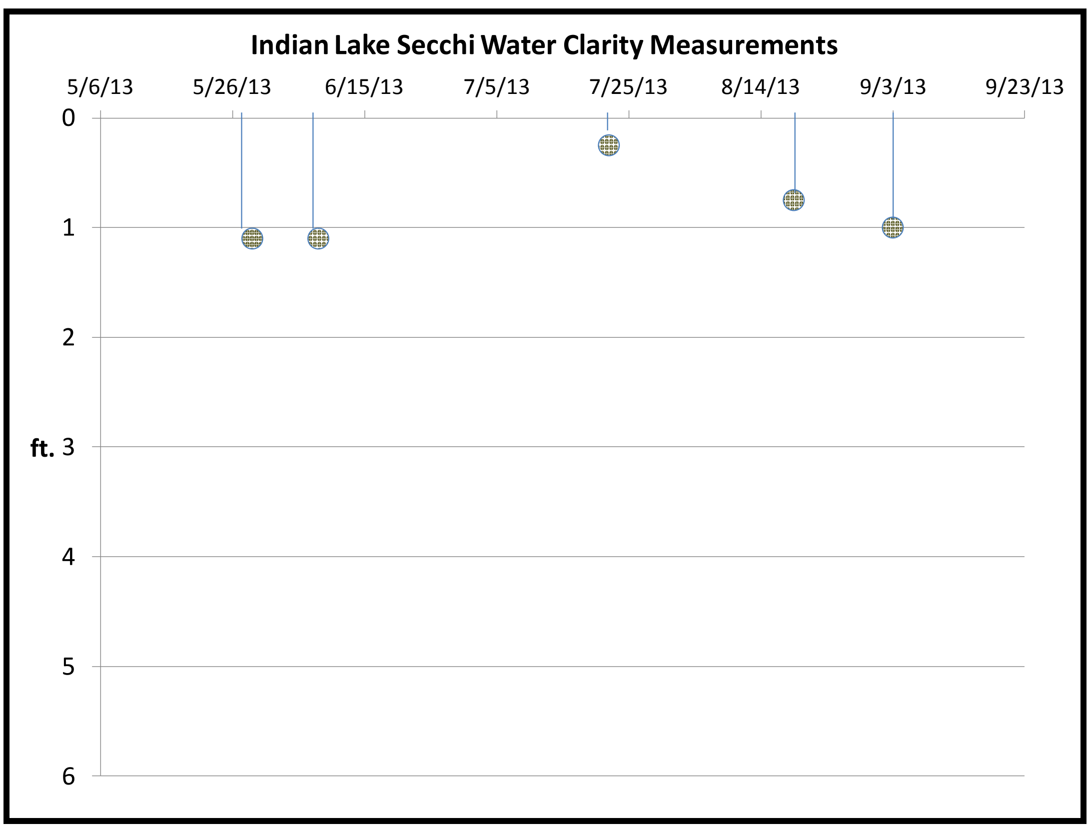
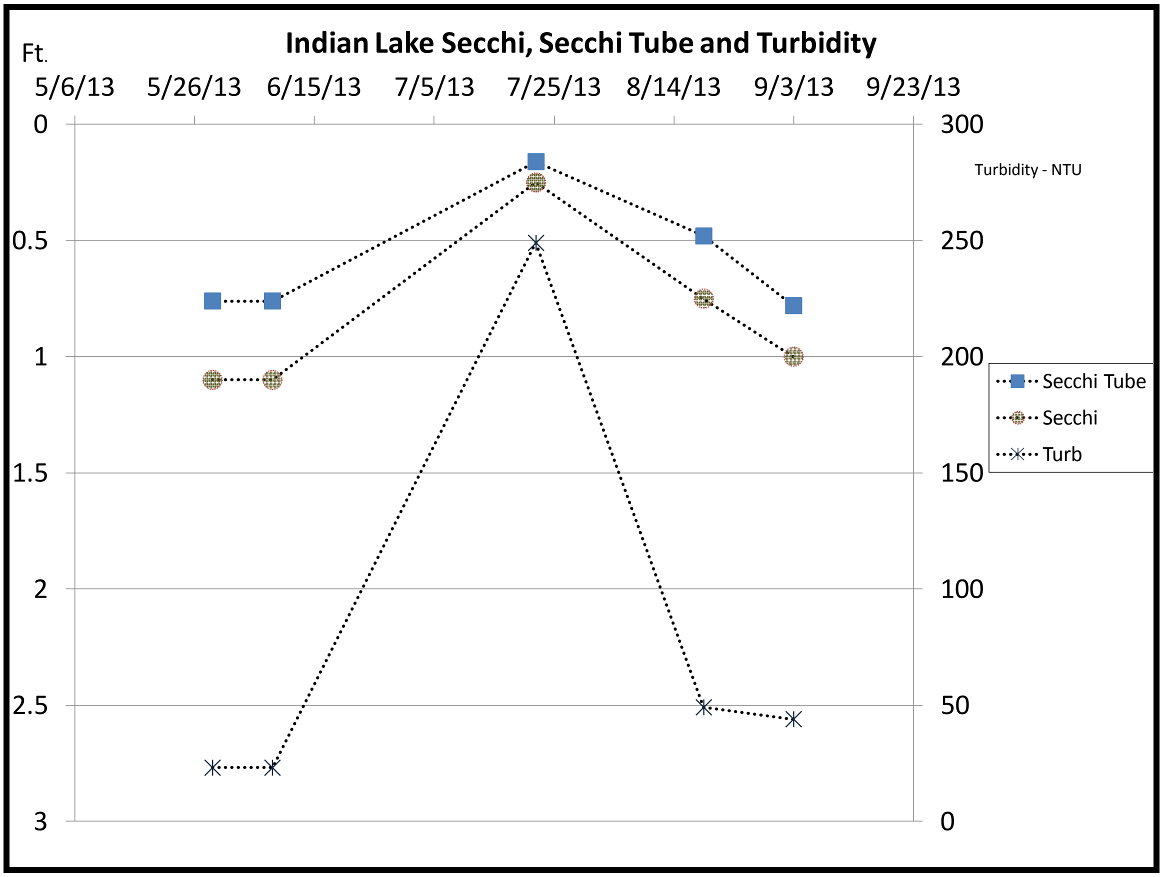
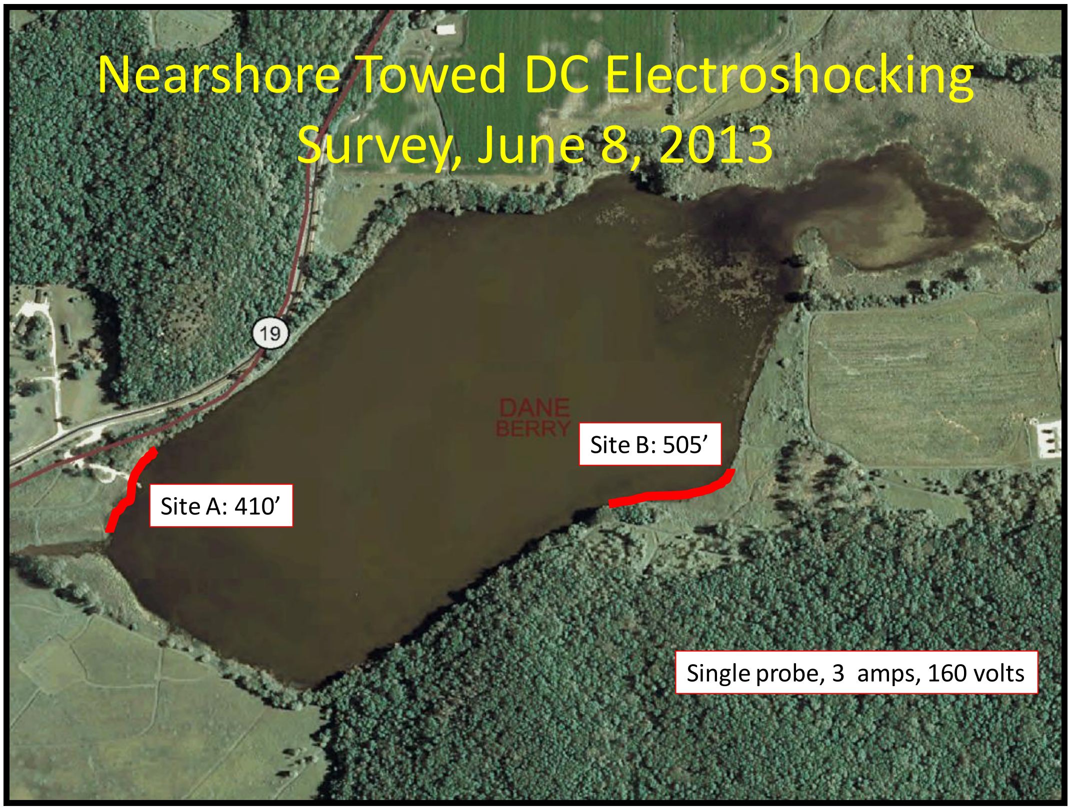


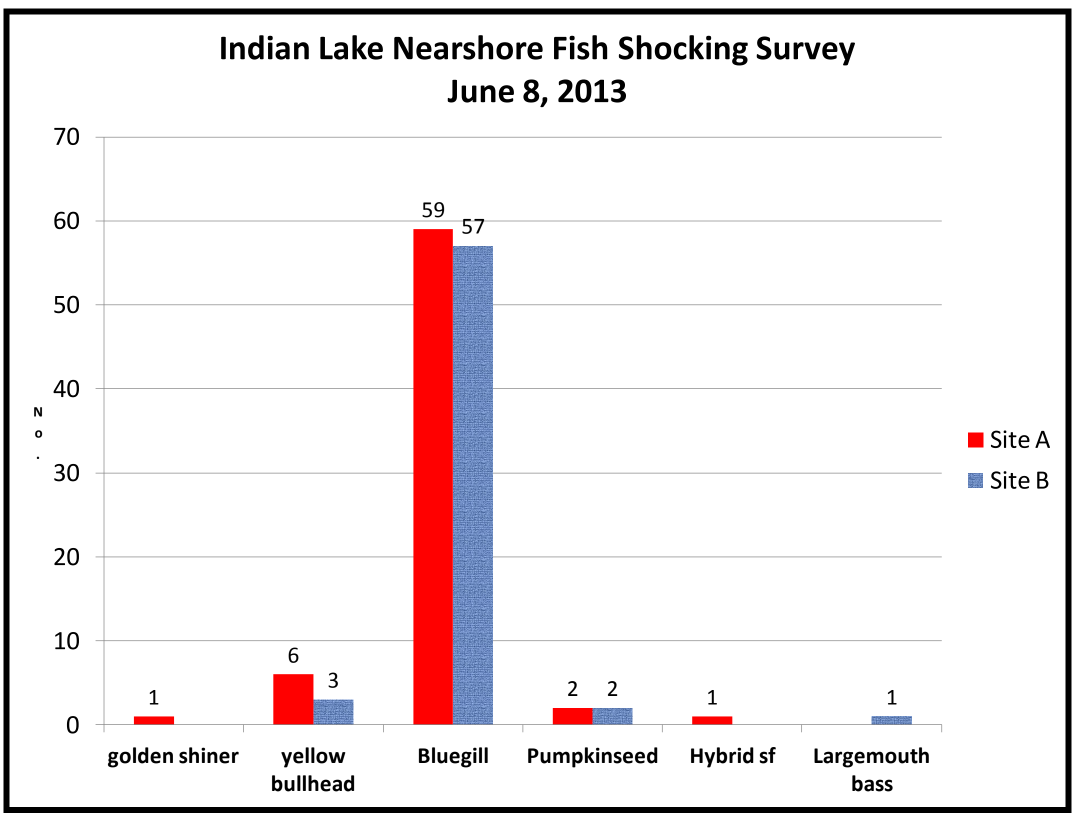
Figure 9: 2013 Comparative Indian Lake Water Clarity Measurements



Nearshore Fish Shocking Survey: Two locations were sampled on June 8, 2013 (see map Figure 10). Site A was about 410 feet long and Site B was about 505 ft. long. Only five species were collected including bluegills with sizes ranging from 1" to 6" (latter more abundant), yellow bullhead, pumpkinseed sunfish, largemouth bass and one golden shiner. Greater numbers of juvenile bluegills were found at Site B with habitat that was predominantly boulders and gravel. One nice 20" largemouth bass was found at this site as well. An angler reported catching 6 largemouth bass and one yellow perch that day, at locations west of Site B. No common carp were found, including juveniles that might suggest an insignificant year class was produced in 2012. Otherwise, numerous carp were surfacing offshore across the lake. Aquatic plant habitat was very scarce and limited to very sparse EWM and coontail. Survey results are summarized in Figure 11).

Figures 10 and 11: Fish Shocking Sample Locations and Results





Habitat and Wildlife Observations: In general, physical habitat is poor due to very poor water clarity and lack of rooted submersed and floating-leaf aquatic plants. The nearshore zones around the lake offer favorable habitats in the forms of tree falls and emergent vegetation. However, these habitat benefits did not offset the impairments linked to poor water quality and lack of aquatic plants. Wildlife observations were limited to a few painted turtles and Canada geese. However, as part of the Indian Lake Site Analysis for developing the park (undated), early season frog populations were evident including chorus frogs, spring peepers, leopard frogs and green frogs.

Chlorides: Chloride levels in Indian Lake were highest in June and suggest sources such as animal waste and road salts. Levels ranged from 21.8 mg/l to 15.2 mg/l and were significantly higher than the statewide mean of 4 mg/l (Lillie and Mason 1983). However, the Indian Lake chloride levels were lower than levels found in the Madison Lakes where urbanization and impervious surfaces are much higher (Public Health Dane County and Madison 2010).

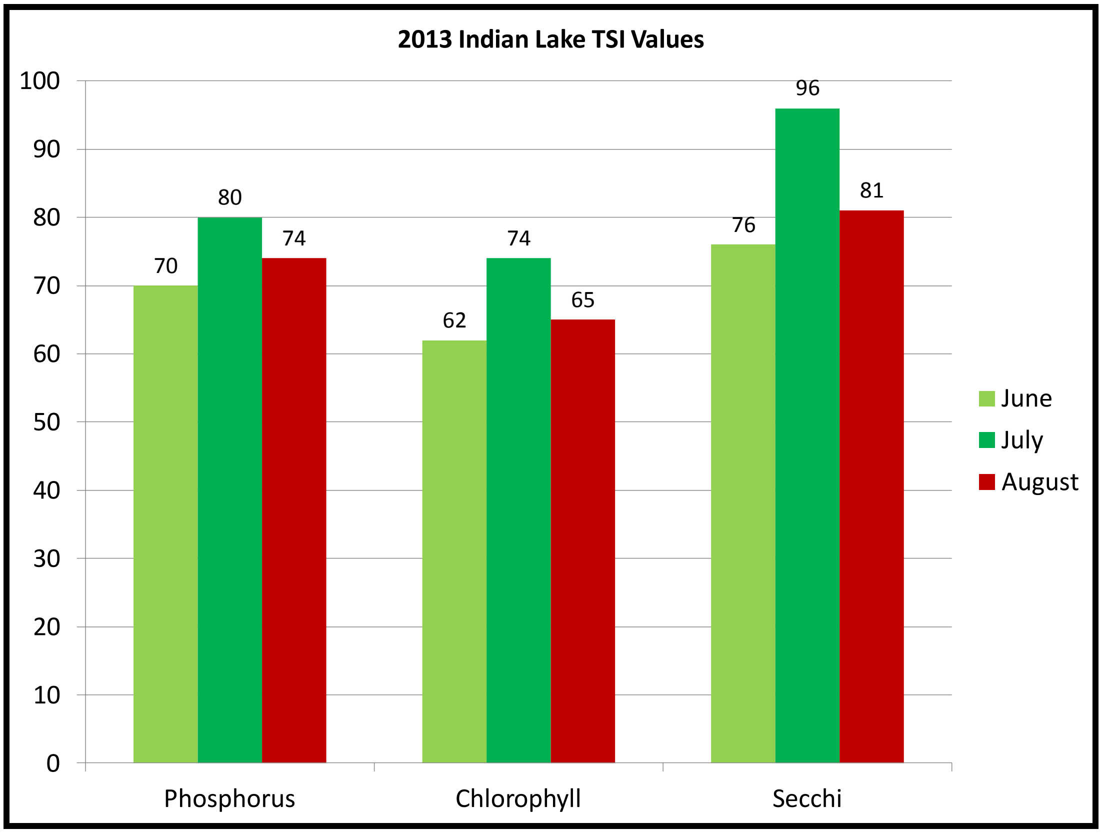
Nitrogen: Total nitrogen is calculated by adding the TKN and $NO_3 – N + NO_2 – N$ concentrations. Most of the nitrogen in Indian Lake is in organic forms and NO_3 was below the detection limit of 0.16 mg/l. Concentrations of total nitrogen increased during the summer and likely reflected Cyanobacteria nitrogen fixation and internal loading.

Phosphorus: Very high phosphorus concentrations were found in Indian Lake and the levels increased during the summer (206 ug/l in June, 833 ug/l in July and 340 ug/l in August). The higher summer concentrations suggested internal loading that was likely linked to the common carp population. Very high phosphorus TSI values indicated hypereutrophic conditions in 2013 (Figure 12). Concentrations of phosphorus were also relatively high compared with total nitrogen (N:P ratios of 13:1 in June, 5:1 July and 5:1 in August) and indicated nitrogen limitation and conditions conducive for Cyanobacteria blooms.

Chlorophyll A: Concentrations of photosynthetic pigment chlorophyll A mirrored concentrations of nitrogen and phosphorus and also increased during the summer as Cyanobacteria blooms became severe (36.5 mg/l in June, 195 mg/l in July, 53.1 in August). Figure 12 displays the highly eutrophic chlorophyll a TSI values with both phosphorus TSI and secchi TSI values.

TSI: The TSI results (Figure 12) suggest that phosphorus concentrations were greater than predicted chlorophyll a concentrations. These results suggest that the very high secchi TSI levels and very poor water clarity limited photosynthesis, particularly in July 2013. Highly eutrophic TSI values typically exceed 60 (Carlson and Simpson 1996).

Figure 12: 2013 Indian Lake TSI Values for June and July



Watershed nutrients: While Indian Lake is surrounded by a county park, the estimated 2,600 acre watershed includes about 60% agriculture. The Indian Lake watershed topography that provides "spectacular and dramatic views of the lake" also creates nutrient management issues due to runoff from the steep terrain. The estimated annual watershed phosphorus load to Indian Lake is about 1153 lbs. (523 kg.) per year with 94% originating from agricultural sources. Given that Indian Lake drains a large agricultural watershed with a watershed to lake ratio of 40:1, highly eutrophic conditions will likely persist in the lake but can be managed to reduce severe water quality degradation that occurred in 2013.

Management Alternatives

1. Do nothing: The least expensive option is to allow the lake to channel high nutrient inputs without intervention but an uncertain lake future follows. Without management, erratic lake conditions will continue with likely fluctuations ranging from common carp dominated fisheries and Cyanobacteria blooms to dense weedy beds of coontail and EWM.

2. Common carp rotenone treatment following lake drawdown: This option involves lowering the lake level sufficiently to concentrate the common carp population for treatment. Lake level manipulation is often used for fisheries management, particularly for reservoirs (Cooke et al.

2005). Lower lake level will also reduce the amount of chemical needed for the eradication. Drawdown will include pumping the lake at a rate greater than the normal outflow rate (0.2 cfs measured on August 19, 2013). The outlet flow rate was increased after the channel was excavated and increased to 0.4 cfs on September 3, 2013). The pumped water can be spray irrigated on adjoining grasslands and pumped downstream. Rotenone is a natural substance, derived from tropical plants, that inhibits oxygen uptake in fish and juvenile amphibians (Baker et al. 1993). Rotenone is unstable and breaks down quickly when exposed to light, oxygen and alkaline water. Potassium permanganate can be used to neutralize the toxicity. This may not be needed if sufficient lake drawdown occurs with outlet flow temporarily ceased.

3. Commercial fishing of common carp. Explore feasibility of hiring a commercial fisherman to seine the lake. Gear efficacy may be an issue due to size structure of the fish. While costs may be less than a full rotenone treatment, overall success of desired conditions is unlikely.

4. Construct a common carp migration barrier. This option will prevent migration of common carp into the lake from Halfway Prairie Creek. In 1981, a berm was constructed across the lake outlet to Halfway Prairie Creek to raise lake levels and this structure likely functioned to reduce upstream fish migrations from Halfway Prairie Creek. Over the years, this structure and banks eroded and no longer served as an impediment for fish migrations into the lake. Constructing a carp barrier is an option that will only be usefull if the existing Indian Lake common carp population is eradicated.

5. Improve in-lake habitat by establishing native aquatic plants. This option will improve fish habitat but is not feasible with the existing common carp population in Indian Lake. Establishing white water lilies would provide an attractive form of fish habitat and could suppress weedy submersed species in nearshore areas.

6. Mechanical harvesting would likely be necessary to sustain boat access channels and improve habitat within dense coontail and EWM beds if the common carp are eradicated.

7. Alum treatments can be effective if external sources of phosphorus are significantly reduced (Cooke et al. 2005). However, the very large watershed coupled with the shallow lake characteristics make this option ineffective for reducing phosphorus concentrations.

8. Dredging can be effective at removing internal sources of phosphorus but this option is very expensive (up to $26.88/m^3 in 2002 dollars) and is not recommended without eliminating or significantly reducing sources (Cooke et al. 2005).

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