Aquatic Enhancement
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2014 Season Water Quality Results
Pine Canyon Lake

Prepared for Pine Canyon Lake Association
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Summary of Results

Pine Canyon Lake is a 40 acre glacial lake located in Steuben County Indiana. Pine Canyon Lake generally exhibits above average water clarity. To protect water the water quality of the lake the Pine Canyon Lake Association (PCLA) requested monitoring of basic water quality parameters in 2014. For this work a basic regime of water quality testing/monitoring was performed on July 30, 2014. Water sampling included analysis of lake water samples for E-coli bacteria as an indicator of human or animal waste contamination from lakeside septic systems, wildlife, or agricultural animal waste runoff. Three water samples were collected at various points in the lake and analyzed for E-coli bacteria. Sampling of lake waters also included analysis for total phosphorus, Secchi depth (water clarity) and Chlorophyll "a". The measurement of these parameters was used to score Pine Canyon Lake in Carlson's Trophic State Index to provide a basic measure of lake health. (See figure one and two below for sampling locations)

All three of the E-coli samples collected from the lake showed very acceptably low counts, ranging between 5.2 and 7.5 MPN (most probable number of cells per 100 milliliter). Concern for swimmers does not typically arise until this number is above 235.

The total phosphorus result of .02 milligrams per liter (mg/l) was representative of a lake with low nutrient enrichment and generally satisfactory water quality. Satisfactory water clarity was also indicated by the Secchi disc measurement of 13.6 feet which is above average for Indiana Lakes.

Pine Canyon Lake scored 38 on Carlson's Trophic State Index. This places the lake between the "oligotrophic" and "mesotrophic" categories showing that the lake has experienced a relatively low amount of nutrient enrichment. Lakes with this type of score generally support healthy ecosystems, clear waters, and are user-friendly for most recreational purposes.

Water quality data collected indicate that Pine Canyon Lake is likely to support the uses of the surrounding community. No significant sources of nutrient enrichment or human or animal waste contamination were indicated in the data. Water quality recommendations of this report are limited to continued annual monitoring. Over time data collected can reveal trends that could be very relevant to lakeside property owners.

Eurasian watermilfoil at Pine Canyon Lake

Pine Canyon Lake had been heavily colonized by the non-native invasive plant Eurasian watermilfoil *Myriophyllum spicatum* in 2013. An early-season treatment performed in April of 2014 had dramatic results in eliminating the Eurasian milfoil while allowing the native plant community to thrive. A cursory plant survey of the lake was performed at the time of water quality sample collection on July 30, 2014. Several milfoil plants were noted growing throughout the lake. These plants were difficult to identify, showing some characteristics of Eurasian watermilfoil, but also being similar to the native northern watermilfoil *Myriophyllum sibiricum* . A sample of the plants was collected and sent to Grand Valley State University for genetic identification. The genetic testing showed the plants to be a hybrid between the two plants. It not known if the hybrid will exhibit the same invasive behavior in Pine Canyon Lake as the Eurasian watermilfoil it appears to have replaced. It is recommended that PCLA budget for an early-season herbicide treatment in 2015 for the treatment of 20.5 acres at $350.00 per acre utilizing 2,4-D liquid herbicide. The total cost is expected to be $7175.00. Further research will be conducted into the expected results of colonization of the lake by the hybrid milfoil and reported to the PCLA prior to the end of September 2014. Because treatment programs for hybrid milfoils are relatively rare, a number of personal contacts will need to be made to determine what has been happening at other lakes where this particular plant has shown up.

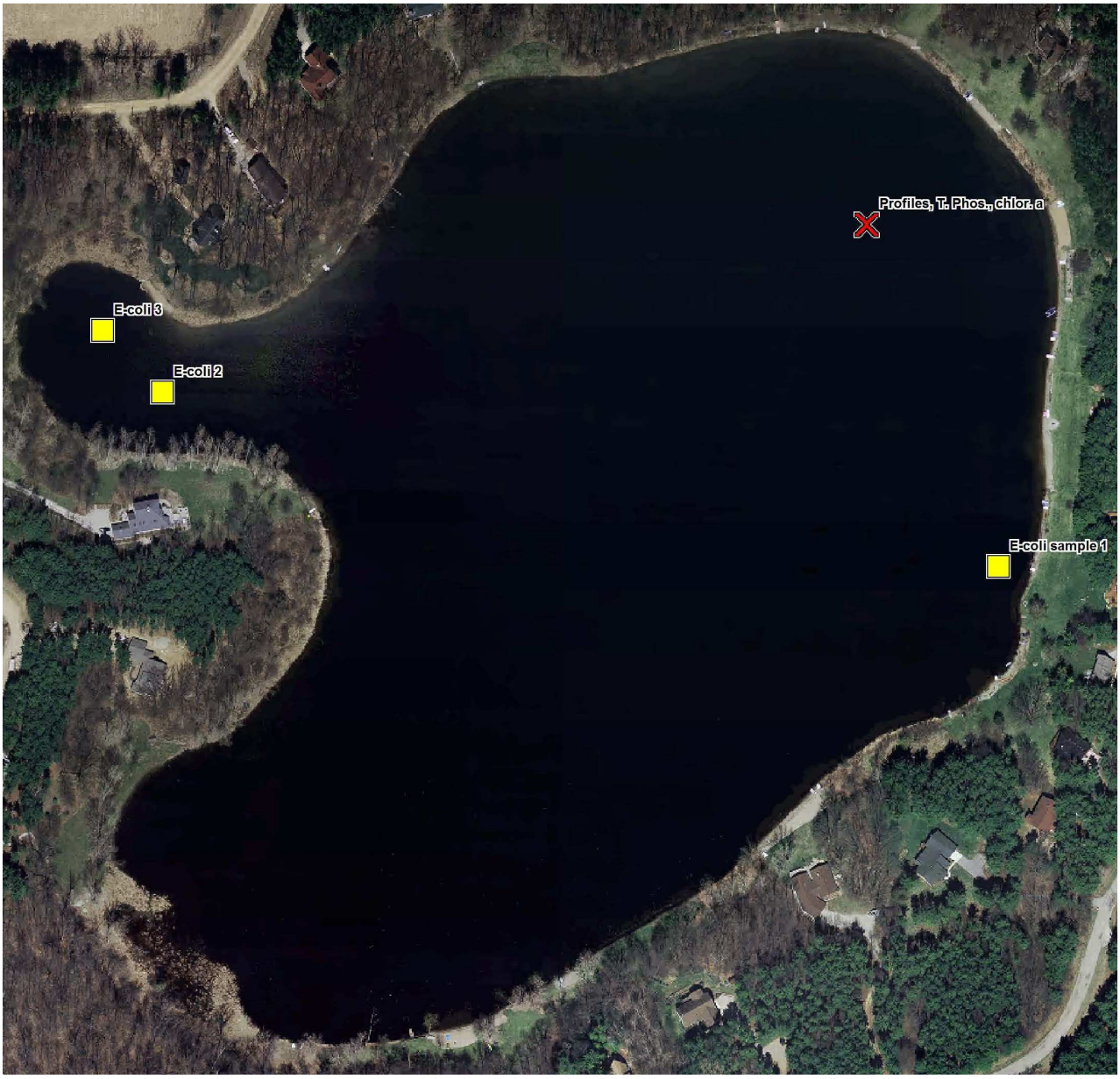

Figure 1 Pine Canyon Lake 2014 general sampling locations.

Sampling site (7/30/14)	E-coli measurement (MPN/100ml)
1	7.5
2	7.5
3	5.2

Table 1 E-coli sampling results for 2014

Selected Measured Parameters Defined

D.O. (Dissolved Oxygen)- Level of dissolved oxygen present in lake waters, measured in parts-per-million. Dissolved oxygen levels of at least 3 to 5 parts per million are required to sustain most fish and other gill-breathing aquatic animals and insect larvae.

Total Phos. (total phosphorus)- Level of total phosphorus present in lake waters. Includes that contained in plants, animals, and sediments suspended in the water column. As a nutrient necessary for the growth of planktonic algae, phosphorus levels profoundly influence lake productivity and water clarity/quality.

Chlorophyll-a A pigment present in all green plants. Chlorophyll-a, measured in parts-per-billion, provides a rough measure of the biomass or total amount of microscopic plants (algae) which float in the water column. This is closely tied to nutrient levels and productivity.

Secchi Depth A basic measure of water clarity. Secchi depth is produced by lowering an eight inch black and white disk (secchi disk) into the water and averaging the depths of its disappearance/reappearance.

E-coli A count of a particular genera of bacteria that provide an indication of the presence of human or animal waste. E-coli is generally measured in CFU (colony forming units) per 100 milliliters of water. Because the presence of large numbers of E-coli in waters indicates a potential presence of associated disease causing organisms, it is measured to gage the safety of swimming or drinking waters. A count of 235-250 CFU E-coli or higher in lake waters generally indicates unsuitability for swimming or bathing.

Lake Trophic State

With regard to water quality, phosphorus is studied and measured more than any other nutrient. A huge volume of literature exists on the fate and effects of increased phosphorus levels in living aquatic systems. This is because relatively small changes in phosphorus levels can have profound effects on an aquatic ecosystem, with changes in functioning at all levels of the food chain. In-lake phosphorus levels of .04 parts-per-million and above can sometimes boost algal populations and cause algae blooms associated with poor water clarity. This is because phosphorus is typically the limiting factor in the growth of planktonic algae. These tiny plants float in the water column and are the primary producers, forming the most basic level of the food-chain. An algae "bloom" is a rapid increase in algal populations in a short period of time. Repeated algae blooms or an elevated biomass of algae over a long period of time has ramifications at all levels of ecosystem functioning. More immediately evident is the destruction of water clarity, quickly affecting the aesthetic and recreational value of a lake. The term "eutrophication" is often used to describe increasing phosphorus levels accompanied by the corresponding higher primary productivity. To some extent, natural lakes like Pine Canyon Lake undergo eutrophication naturally over time, as soil and organic materials migrate to lakes and other depressions in the landscape, driven by rainfall, wind, and snow-melt runoff. These materials become committed to the lake's sediments and eventually lead to a filling-in, succession into a bog or wetland, and ultimately the creation of upland. Examples of glacial depressions in each of these states of succession can be found throughout Steuben County. Human land uses and urban development can be said to hasten this process of natural "eutrophication" or lake succession, causing the rapid introduction of soil borne and dissolved pollutants in a mere millisecond on the geologic time scale that would normally govern this process. Because of this, ecosystem adjustment does not occur as it naturally would, and systems can become unstable, exhibiting signs of disturbance, shifts to disturbance oriented plant and animal species, and unstable water chemistry and fish populations. It is often useful to classify lakes and their degree of eutrophication, taking one or more chemical or biological characteristics as a measure of lake character.

Basic classification of lakes based on "trophic" condition (biological productivity)

Oligotrophic- clear water, very low levels of nutrients (total phosphorus <.006ppm) support few algae, dissolved oxygen is present in the hypolimnion, can support salmonid (trout and cisco) fisheries.

Mesotrophic- water less clear, moderate levels of nutrients (total phosphorus .01-.03ppm), support healthy algal populations, decreasing dissolved oxygen in the hypolmnion, loss of salmonids

Eutrophic- transparency less than two meters, relatively high concentrations of nutrients (total phosphorus > .035ppm), no dissolved oxygen in hypolimnion during summer, weeds and algae abundant.

Hypereutrophic- transparency less than 1 meter, no dissolved oxygen in hypolimnion, extremely high nutrient concentrations (total phosphorus > .08ppm) support thick algal scums, very dense weeds

(adapted from Jones 1996) Jones, W.W., 1996 *Indiana Lake Water Quality Update for 1989-1993*, Indiana Department of Environmental Management Clean Lakes Program, Indianapolis, Indiana

Carlson's Trophic State Index
Carlson's Trophic State Index utilizes one or more of three measured water quality parameters to generate a numeric score for a lake. This score is useful for classifying the health and nutrient enrichment of the scored lake relative to a large set of lakes used by Bob Carlson to produce the index. The index score can then be used to detect the effectiveness of land treatment activities designed to increase lake health over time or to track a decline in lake health due to poor land-use practices in the watershed. A Carlson's index score was generated for Pine Canyon Lake from the 2014 sampling. With an overall score of 38 Pine Canyon Lake scored between the oligotrophic and mesotrophic categories indicating a moderate level of nutrient enrichment. On Carlson's index a lower score indicates higher water quality and less nutrient enrichment.

Date	Depth (m)	Temp (C)	D.O. (PPM)
7/30/2014	0	23.4	6.98
Lake	1	23.5	7.21
Pine Canyon	2	23.5	7.26
	3	23.4	7.0
	4	22.2	4.78
	5	15.9	4.37
	6	11.5	5.22
	7	8.4	4.51
	8	7.2	4.01
	9	6.4	4.11
	10	6.0	4.14
	11	5.8	4.12
	12	5.8	4.08
	13	5.9	4.04

Table 2 Pine Canyon Lake 7/30/14 Temp. and Oxygen Data

Pine Canyon Lake's Temperature and Oxygen Profiles
Pine Canyon Lake showed a normal temperature and oxygen profile for a lake of high water clarity in July. The profile showed a slight decline in oxygen below a depth of 3 meters and a normal amount of thermal stratification. The lake exhibited no anoxic "dead zone" in the deepest strata of the lake which is often an indicator of a relatively clean lake with low nutrient enrichment.

Recommendations

●Continue to control Eurasian watermilfoil/hybrid milfoil with aquatic herbicides to maintain the lake's recreational value and maintain the establishment of more beneficial vegetation.

● Continue to monitor basic water quality each season to track changes in lake health, track water quality, and spot faulty septic systems or sources of waterborne animal waste.