Simonton Lake Diagnostic/Feasibility Study
Elkhart County, Indiana

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Prepared for:
Simonton Lake Home Owners Association
c/o William Broderick
1424 Johnson St.
Elkhart, IN 46514

Prepared by:
JFNew
708 Roosevelt Road
Walkerton, Indiana 46574
(574) 586-3400

EXECUTIVE SUMMARY

Simonton Lake is a 301 acre (121.8 hectares) groundwater fed lake located in the northwest portion of Elkhart County Indiana. The Simonton Lake watershed extends north of Simonton Lake into Cass County, Michigan and encompasses approximately 5,233 acres (2,177.7 ha). The lake drains south through Lilly Creek (Osolo Township Ditch) into the St. Joseph River then to Lake Michigan. The soils surrounding the lake are primarily sands from glacial outwash or low muck areas that are wetlands. Soil erosion is not an issue as there are no permanently flowing surface streams entering Simonton Lake. Historically, the watershed was primarily upland deciduous forest pocketed with prairie, sedge meadow, swamp, and seeps. The watershed is now approximately 60 percent agricultural and 40 percent low intensity residential development, with residents in the vicinity of the lake connected to sewers since 1999-2000.

A review of residential development around the lake noted 20 structures in 1939 on the south side of the west basin. By 1951, North Shore Drive had been extended to the narrows with over 30 homes along the northern lakeshore and approximately 30 homes on the south side. Development of the channels on the east end of the east basin began in 1957. By this time, as many as 100 structures existed on the south side of the west basin. Prior to 1965, the channel between the two basins was dredged; homes were being built on the east end of the east lake, and a channel adjacent to Forest Avenue was completed. The shoreline was nearly 100% developed except for the southeast corner of the east basin by 1973. A Conservancy District was formed and the majority of residents around the lake hooked to a sewer system by 2000.

Simonton Lake has a volume of approximately 2,686 acre-ft (3,313,132 m^3) with a maximum depth of 24 feet (7.3 m) and a mean depth of 12.1 ft (3.7 m). Approximately 84% of the lake surface area is less than 10-feet deep with less than 6 acres (2.4 ha) deeper than 20 feet. Approximately 99% of the total volume of the lake is within the photic zone and available for growing plants. The length of the shoreline is 43,170 ft (14,073 m), which results in a development ratio of 3.6:1.

The Simonton Lake fishery is dominated by bluegill, largemouth bass, and redear sunfish. The sportsman's club stocks the lake with walleye annually. IDNR surveys from 1964-2007 indicate the fishery has remained relatively consistent in regards to dominant fish species composition, relative growth rates, and condition factors (length/weight) of those species. Bluegills and largemouth bass have exhibited average to above average growth rates.

Simonton Lake has been sampled five times since 1988 for water quality. The concentration of total phosphorus has decreased steadily over the years from a mean of 0.055 mg/L in 1988, to under 0.030 mg/L in 2010; keeping overall densities of algae low. The concentration of total nitrogen has also declined due to declines in ammonia and nitrate. The lake had adequate DO in the well-mixed epilimnion, but it decreased rapidly below 16 feet in the west basin. At the 20 foot (~6 m) depth, the concentration of DO was less than 1 mg/L, which is insufficient to support fish. The 1% light level extended to 21.5 ft (~7 m) meaning 99% of the lake can support aquatic submersed vegetation. Overall, there was a nice mix of phytoplankton and zooplankton in both basins and this resulting balance is important for a healthy lake ecosystem. The water quality of Simonton Lake is much better than most of Indiana's lakes. Simonton Lake water quality parameters place the lake in the mesotrophic range with an Indiana TSI score of 22. The total nitrogen to total phosphorus ratios of 40N:1P for the west basin and 35N:1P for the east basin show a strong phosphorus limitation, which means more phosphorus will stimulate more algae growth. The water that enters Simonton Lake stays in the lake for 1.2 years on average.

The plant community was surveyed in the two basins on May 27 and August 27, 2010. Aquatic plants were found at all 70 sites and muskgrass was the dominant submersed species of 16 different species collected. Four invasive species: Eurasian water milfoil, curly leaf pondweed, brittle naiad, and spiny naiad were all found in sparse populations. The state listed threatened species, white-stem pondweed was documented during the surveys at two locations. The most common of seven emergent species documented were cattail and arrowhead. Two floating leaf species noted were spatterdock and white water lily. Secchi disc transparency depths ranging from 8.5 feet in the spring to 6.2 feet in the summer indicated good water clarity.

Concerns of lake residents included overuse of the lake by nonresidents, too many boats accessing the lake, lake level control, aquatic plants in the channels, a decline in the fisheries, pier and funneling issues, water quality, and the need for dredging the channel between the lake basins. Swimming and boating are the primary uses of the lake, followed by fishing and irrigation. The public access site is located between the two lake basins on the south side of the lake. A boat count conducted by lake volunteers documented that pontoon boats were the most popular watercraft on all days. On weekdays, fishing boats are the second most common watercraft followed by speedboats. On the weekend (excluding July 3), fishing boats, speedboats, and personal watercraft have similar densities on Simonton Lake. Excluding July 3, the average number of boats on the lake was 15.6 during any one counting period. Approximately half that many were present in the morning hours with peak use occurring between 5pm and 7pm on the weekday and around 3pm on the weekend. Research suggests lake users should tolerate 6-8 pontoon boats or 3-4 high speed boats operating at the same time safely given the size of Simonton Lake. The lake may be at, or close to its socially acceptable carrying capacity for watercraft during most of the summer.

The following management recommendations are suggested:

1) Limit phosphorus inputs by education of residents about fertilizer and animal waste
2) Encourage continued sewer system hookups
3) Establish and enforce an ecozone in the southeast corner of the east basin
4) Protect existing aquatic plants from damage by boat traffic
5) Encourage natural vegetated shorelines as alternatives to seawalls
6) Educate residents on invasive aquatic plants and implement monitoring & control
7) Consider dredging the channel between the basins to reduce sediment resuspension

The projects selected as being feasible to implement are the establishment of an ecozone and the dredging of the channel between the two lakes. Establishing an ecozone in Simonton Lake can improve water quality and fish habitat. JFNew recommends the Simonton Lake Area Home Owners Association begin the petition process to the IDNR to create an ecozone. Dredging of the channel between the two basins will reduce sediment resuspension from watercraft. Hydraulic dredging is proposed for a maximum extent of 60,000 square feet based on a channel length of 2000 feet and a channel width of 30 feet. The estimated cost for engineering, permitting, and implementation of this dredging project is $105,000 of which potentially 80% could be paid for through the LARE program and another 10% through local in-kind services.

Simonton Lake's water quality has improved in the last 10 years and is considered to have good water quality when compared to other Midwestern lakes. This trend should continue with attention to management of phosphorus inputs from the vicinity of the lake through continued sewerage of adjacent residents, education of residents on the use of phosphorus free fertilizers, and enforcing idle speed limits in the shallow areas of the lake. Implementing the two feasible projects of an ecozone and the dredging are not critical to preserving the water quality of the lake, but would play an important role in controlling phosphorus resuspension.

ACKNOWLEDGEMENTS

The Simonton Lake Diagnostic/Feasibility Study was completed with funding from the Indiana Department of Natural Resources (IDNR) Division of Fish and Wildlife Lake and River Enhancement Program with matching funds provided by the Simonton Lake Area Home Owners Association. JFNew appreciates the assistance received from individual Simonton Lake property owners in organizing meetings, providing a boat and driver for the plant surveys, conducting the boat counts, and attending the project meetings. We especially would like to thank Bob Putnam, Bill Broderick, and Bob Evans for their continued support of this project. William Jones, Clinical Professor of Limnology at Indiana University, was the research scientist who supervised the lake water quality data collection and analysis, completed the water budget, and contributed substantially to the summary and recommendations in the report. Individuals from JFNew that participated in the project included John Richardson, Betsy Ewoldt, Brett Peters, Erick Elgin, Tom Estrem, and Christine Dittmar. Heather Cecrle provided administrative support, review, editing, and assembly of the document.

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1.0 INTRODUCTION

Simonton Lake is a 301 acre (121.8 hectares) lake located in the northwest portion of Elkhart County Indiana. Specifically, the lake is located in sections 8, 9, 10, 15, 16, 17 of Township 38 Range 5 East in Elkhart County. The Simonton Lake watershed extends north of the lake into Cass County Michigan and encompasses approximately 5233 acres (2,177.7 hectares or 8.2 square miles, Figure 2) and makes up the northern finger of the 040500012004 HUC watershed.

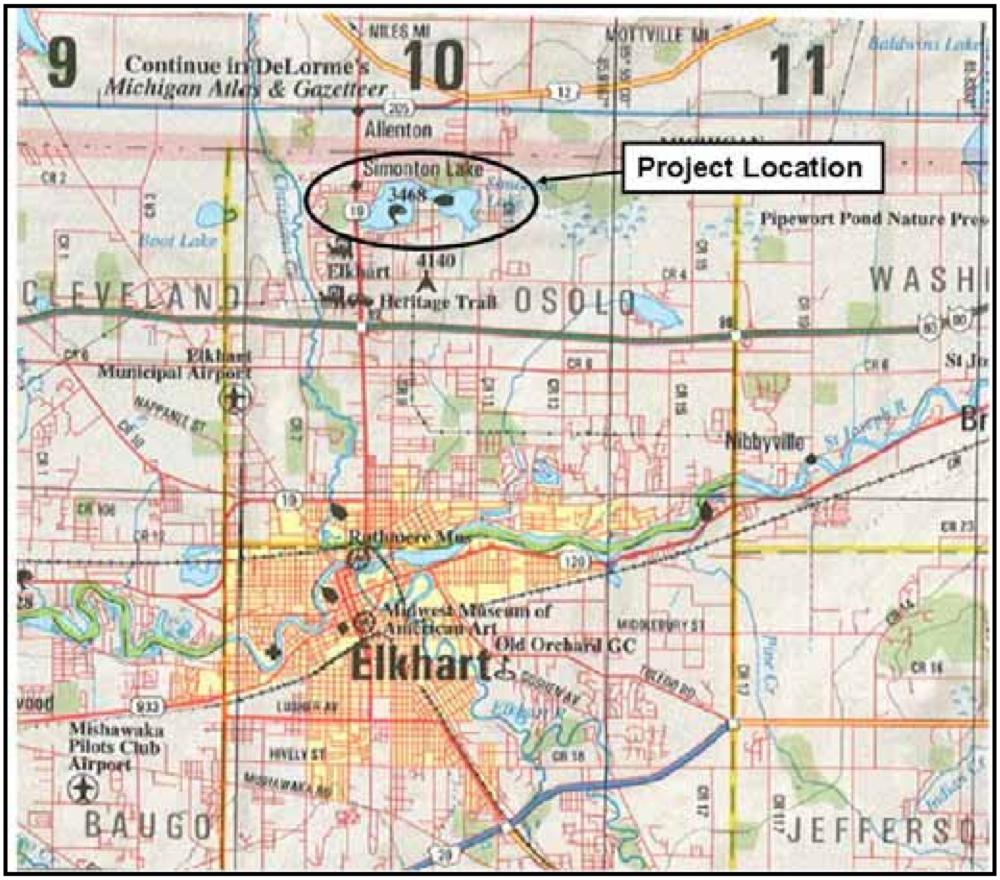


Figure 1. General location of Simonton Lake. Source DeLorme 2004

The Simonton Lake Area Home Owners Association initiated an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) program diagnostic/feasibility study. The purpose of the diagnostic/feasibility study was to describe the conditions and trends in Simonton Lake and its watershed, identify potential problems, and make prioritized recommendations addressing these problems. The study consisted of a review of historical studies, interviews with lake residents and state/local regulatory agencies, the collection of current water quality data, water budget modeling, and field investigations. In order to obtain a broad understanding of the water quality in Simonton Lake, the diagnostic study included an examination of the lake and its biotic communities, (plankton and macrophytes) which tends to reflect the long-term trends in water quality. This report documents the results of the study.

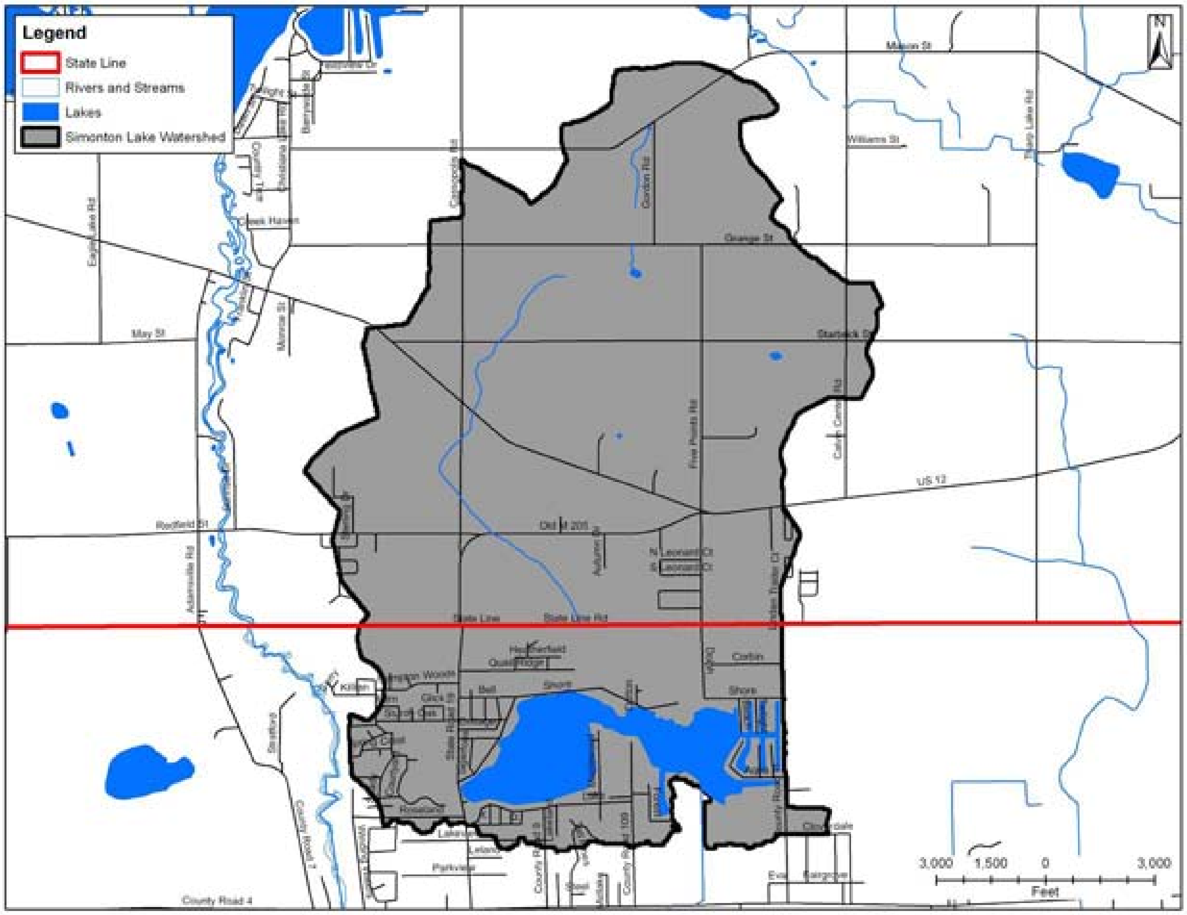


Figure 2. Simonton Lake watershed.

1.1 Topography and Physical Setting

Simonton Lake is a headwater lake in the Great Lakes Basin. The lake and the 5,233 acre (2,177.7 hectares) watershed lie north of the north-south continental divide. Similar to its more famous cousin, the east-west Continental Divide, which divides the United States into two watersheds, one that drains to the Atlantic Ocean and one that drains to the Pacific Ocean, the north-south continental divide separates the Mississippi River Basin (land that drains south to the Mississippi River) from the Great Lakes Basin (land that drains north to the Great Lakes). Groundwater is the biggest driver of Simonton Lake's hydrology, for both inputs and outputs. There is one small inlet ditch on the north side of the lake, but this ditch is often dry. The overland outlet for the lake is through Osolo Township Ditch (Lily Creek), which flows due south from the east basin. Lily Creek continues south until it discharges in the St. Joseph River just east (upstream) of the Elkhart Dam. The St. Joseph River eventually discharges into Lake Michigan at St. Joseph/Benton Harbor, Michigan.

The topography of the Simonton Lake watershed reflects the geological history of the watershed. The highest areas of the watershed lie along the watershed's northern edge. Along the watershed's northeastern boundary, the elevation nears 920 feet (280.4 m) above mean sea level. Simonton Lake, at a legal elevation of 772.86 feet (235.57 m) above mean sea level, is the lowest point in the watershed. Figure 3 presents a topographical relief map of the Simonton Lake watershed.

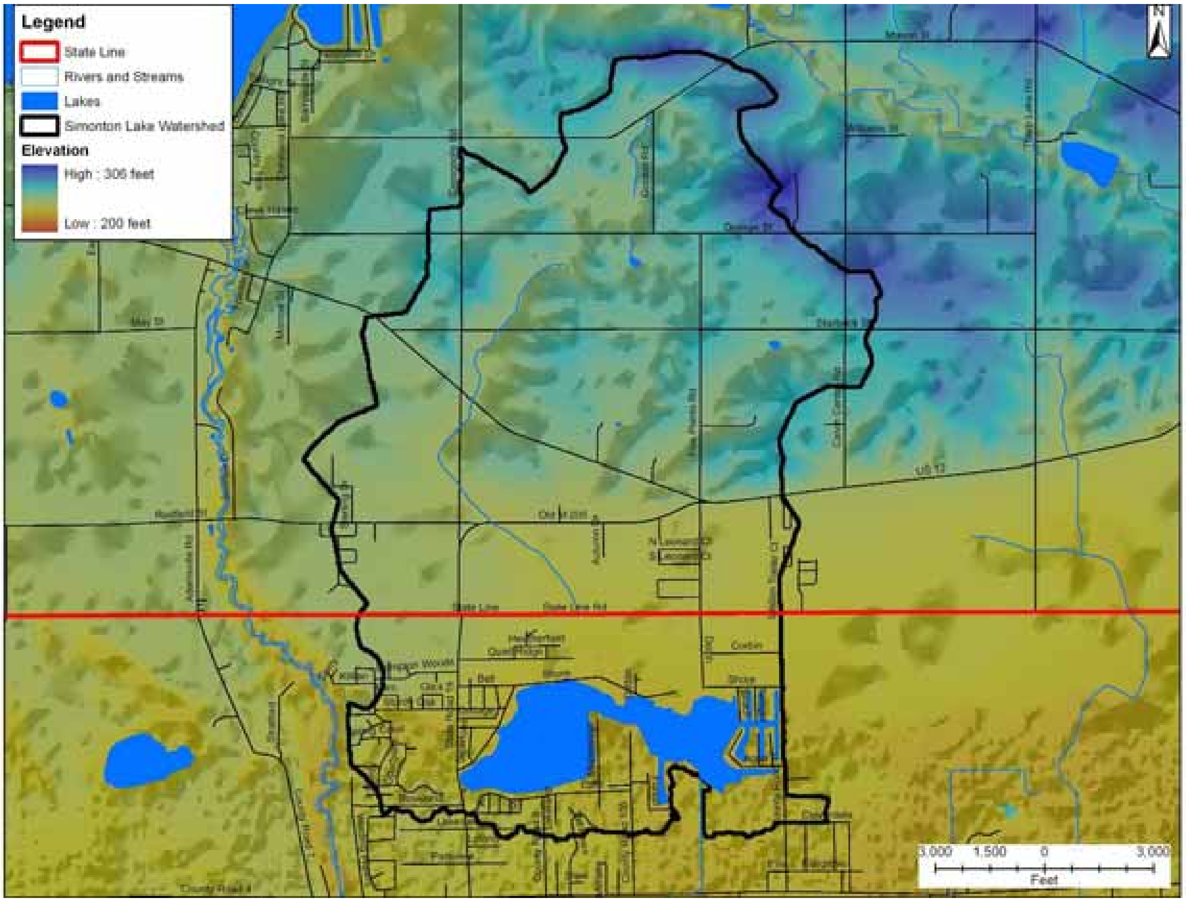


Figure 3. Topographical map of the Simonton Lake watershed.

Watershed size and watershed to lake area ratios can affect the chemical and biological characteristics of a lake. For example, lakes with large watersheds have the potential to receive greater quantities of pollutants (sediments, nutrients, pesticides, etc.) from runoff than lakes with smaller watersheds. For lakes with large watershed to lake ratios, watershed activities can potentially exert a greater influence on the health of the lake than lakes possessing small watershed to lake ratios. Conversely, for lakes with small watershed to lake ratios, shoreline activities and internal lake processes may have a greater influence on the lake's health than lakes with large watershed to lake ratios.

Simonton Lake possesses a watershed area to lake area ratio of approximately 17.4:1. This is relatively normal when compared to other lakes in northern Indiana. Many glacial lakes have watershed area to lake area ratios of less than 50:1 and watershed area to lake area ratios between 10:1 and 30:1 are fairly common (Vant, 1987). Conversely, Lake Tippecanoe, Ridinger Lake, and Smalley Lake, glacial lakes in the Upper Tippecanoe River watershed in Kosciusko, Noble, and Whitley Counties, possess watershed area to lake area ratios of 93:1, 165:1, and 248:1, respectively. All of these lakes have extensive watersheds compared to Simonton Lake.

In terms of lake management, Simonton Lake's relatively small watershed area to lake area ratio means that development and land use near the lake (i.e. shoreline) can exert a significant influence on the health of Simonton Lake. Consequently, having an adequate sewer system to handle human waste in the vicinity of the lake and implementing best management practices along the lake's shoreline, such as maintaining native, emergent vegetated buffers between the lakeside residences and the lake, should be given priority over other watershed best management practices away from the lake. If the watershed area to lake area ratio were larger, it would be more practical to focus primarily on watershed-based issues and actions.

1.2 Climate

Indiana's climate can be described as temperate with cold winters and warm summers. The National Climatic Data Center summarizes Indiana weather well in its 1976 Climatology of the United States document no. 60: "Imposed on the well known daily and seasonal temperature fluctuations are changes occurring every few days as surges of polar air move southward or tropical air moves northward. These changes are more frequent and pronounced in the winter than in the summer. A winter may be unusually cold or a summer cool if the influence of polar air is persistent. Similarly, a summer may be unusually warm or a winter mild if air of tropical origin predominates. The action between these two air masses of contrasting temperature, humidity, and density fosters the development of low-pressure centers that move generally eastward and frequently pass over or close to the state, resulting in abundant rainfall. These systems are least active in midsummer and during this season frequently pass north of Indiana" (National Climatic Data Center, 1976). Prevailing winds in Indiana are generally from the southwest, but are more persistent and blow from a northerly direction during the winter months. In 2010, the Simonton Lake region experienced lower than normal precipitation and normal temperature (Table 1).

Table 1. 2010 precipitation and temperature data compared to values from 1971-2000.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2010 Precipitation	1.22	1.34	1.72	2.38	6.04	5.71	4.35	0.92	2.13	1.87	2.76	1.84	32.28
Normal Precipitation	2.27	1.98	2.89	3.5	3.5	4.19	3.73	3.98	3.79	3.27	3.39	3.09	39.7
2010 Average Temp	23	25.7	41.7	54	61.3	70.1	75.6	74.6	63.9	53.9	41.3	24.7	50.8
Normal Average Temp	23.4	27.3	37.5	48.2	59.6	69	73	71	63.4	52.1	40.1	28.7	49.4

*Data from National Weather Service Northern Indiana, South Bend weather station (CLASBN)

1.3 Geology

The advance and retreat of the glaciers in the last ice age (the Wisconsin Age) removed, shaped, and reshaped much of the landscape found in Indiana today. In the northern portion of the state, ground moraines, end moraines, lake plains, outwash plains, and other geologically complex features dominate the landscape. Further, the interaction of three glacial lobes, (Michigan Lobe, Saginaw Lobe, and the Erie Lobe, respectively) left behind a vast array of deposits and landforms that changed the region's hydrogeology. In comparison to the central portion of the state, surface water, groundwater, and soils are more varied and complex. Large raised landforms, such as the Valparaiso Moraine, the Maxinkuckee Moraine, and the Packerton Moraine, indicate the glacial margins of these ice sheets in the northern portion of the state. Major rivers in northern Indiana cut through course grained outwash and transect these dominant topographical features, suggesting a drainage pattern that was established in an ice proximal and or subglacial environment. Later, outwash plains formed as the glacial melt waters flowed from retreating glaciers. This further altered the drainage of the landscape as dams between ice, morainal deposits and melt water pooled into lakes.

The movement, stagnation, and melting of the Saginaw Lobe of the Wisconsin glacial age is largely responsible for the landscape covering the Simonton Lake watershed. The Saginaw glacial lobe moved out of Canada toward the southwest carrying a mixture of Canadian and Michigan basin bedrock with it. The Packerton Moraine and the Maxinkuckee Moraine mark the extent of the Saginaw Lobe's coverage in northern Indiana. The Simonton Lake watershed lies within Malott's Kankakee Outwash and Lacustrine Plain (Schneider, 1966). The surficial geology of the area consists of sand and gravel over a bedrock of Coldwater, Ellsworth, and Antrim Shales.

1.4 Soils

Major Soil Associations

Before detailing the major soil associations covering the Simonton Lake watershed, it may be useful to examine the concept of soil associations. Major soil associations are determined at the county level. Soil scientists review the soils, relief, and drainage patterns on the county landscape to identify distinct proportional groupings of soil units. The review process typically results in the identification of eight to fifteen distinct patterns of soil units. These patterns are the major soil associations in the county. Each soil association typically consists of two or three soil units that dominate the area covered by the soil association and several soil units that occupy only a small portion of the soil association's landscape. Soil associations are named for their dominant components. For example, the Oshtemo-Kalamazoo-Houghton soil association consists primarily of Oshtemo sandy loam, Kalamazoo loam, and Houghton muck.

The most dominant major soil association in the Simonton Lake watershed is the Oshtemo-Kalamazoo-Houghton association, covering 2940 acres (1189.8 hectares) or 56% of the watershed. This soil association is characterized by loamy soil with good drainage, making it heavily utilized for agriculture. The Riddles-Hillsdale-Gilford association is the next most common major soil association with 1908 acres (772.1 hectares) or 36% of the total watershed area. This soil association is also loamy, but is not as well drained as the Oshtemo-Kalamazoo soils. Six percent of the watershed is open water. The remainder of the watershed is made up of approximately one percent each of Coloma-Spinks-Oshtemo and Houghton-Adrian-Carlisle (Figure 4).

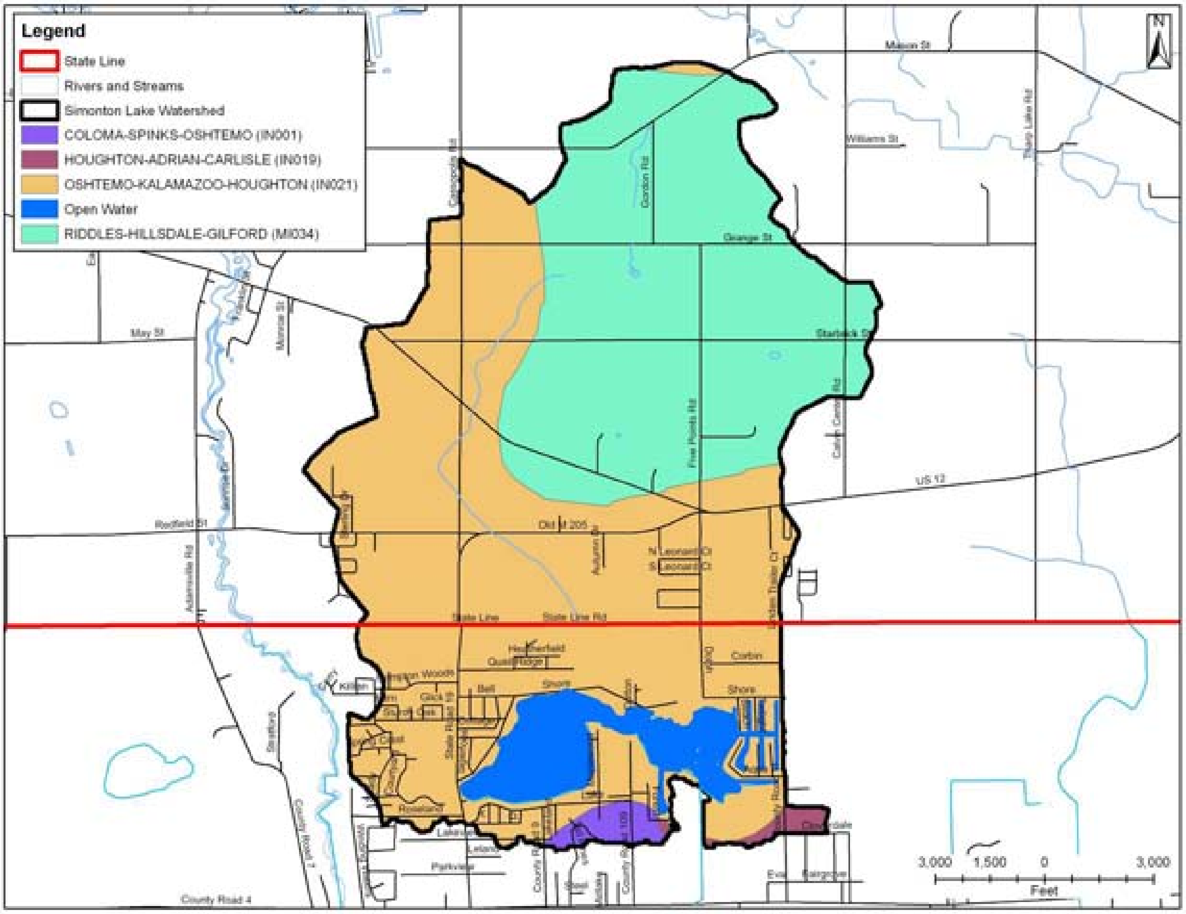


Figure 4. Soil associations for Simonton Lake watershed

Highly Erodible Lands (HEL)

Certain soil types are classified as "highly erodible" due to characteristics of the soil itself and also the steepness of the slope where the soil exits. Soils that erode from the landscape are transported to waterways where they degrade water quality, interfere with recreational uses, and impair aquatic habitat and health. In addition, such soils can carry attached nutrients, which further impair water quality by increasing production of plant and algae growth. Soil-associated chemicals, like some herbicides and pesticides, can kill aquatic life and damage water quality. Highly erodible and potentially highly erodible soil types are classifications used by the Natural Resources Conservation Service (NRCS) to describe the potential of certain soil units to erode from the landscape. The NRCS examines common soil characteristics such as slope and soil texture when classifying soils. The NRCS maintains a list of highly erodible soil units for each county. Table 2 lists and Figure 5 displays the soil units in the Simonton Lake watershed that the NRCS considers to be highly erodible and potentially highly erodible. The Simonton Lake watershed has relatively low amount of erodible soils and there are few stream inlets into the lake to transport sediment, making the likely sediment inputs from surrounding areas low.

Table 2. List of soil units in Simonton Lake watershed that the NRCS considers to be highly erodible or potentially highly erodible.

Map Symbol	Status	Soil Name	Soil Description
Txuc	PHEL	Tyner Loamy Sand	5 to 10 percent slopes
9c	HEL	Kalamazoo Loam	6 to 12 percent slopes
4c	HEL	Oshtemo Sandy Loam	6 to 12 percent slopes
26d	HEL	Riddles Fine Sandy Loam	12 to 18 percent slopes

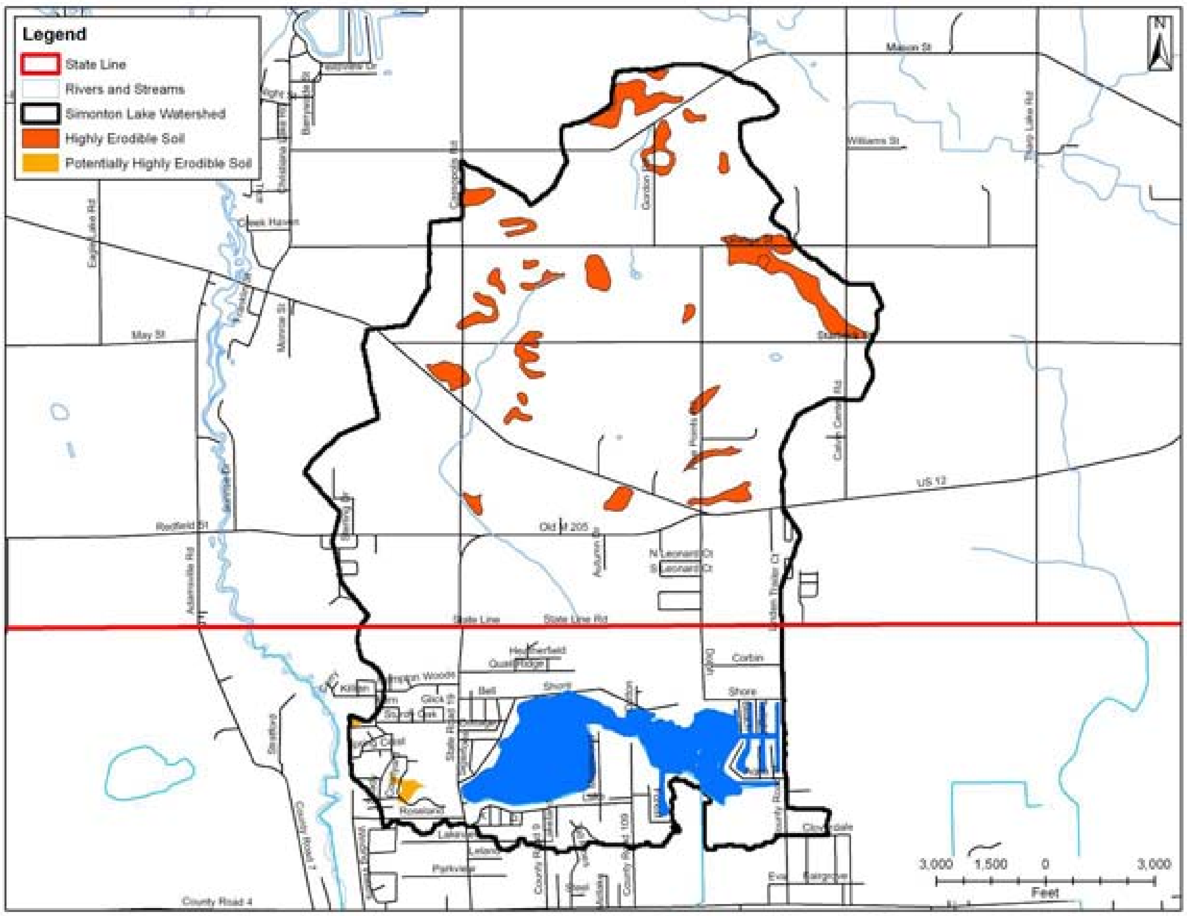


Figure 5. Highly erodible and potentially highly erodible soils in the Simonton Lake watershed.

1.5 Natural History

Geographic location, climate, topography, geology, soils, and other factors play a role in shaping the native floral and fauna communities in a particular area. Various ecologists (Deam, 1921; Petty and Jackson, 1966; Homoya et al., 1985; Omernik and Gallant, 1988) have divided Indiana into several natural regions or ecoregions, each with similar geographic history, climate, topography, and soils. Because the groupings are based on factors that ultimately influence the type of vegetation present in an area, these natural areas or ecoregions tend to support distinctive native floral and faunal communities. The Simonton Lake watershed lies within Homoya's Northern Lakes Natural Region. Similarly, the Simonton lakes watershed lies within Omernik and Gallant's Southern Michigan/Northern Indiana Drift Plains Ecoregion (Omernik and Gallant, 1988). The

Simonton Lake watershed also lies in Petty and Jackson's Oak-Hickory Climax Forest Association (Petty and Jackson, 1966).

Homoya et al. (1985) noted that prior to European settlement, the region was a mixture of numerous natural community types, including bog, fen, marsh, prairie, sedge meadow, swamp, seep spring, lake, and deciduous forest. The dry to dry-mesic uplands were likely forested with red oak, white oak, black oak, shagbark hickory, and pignut hickory. More mesic areas probably harbored beech, sugar maple, black maple, and tulip poplar. Forests are mainly oak-hickory, dominated by white oak, red oak, black oak, bitternut hickory, shagbark hickory, sugar maple, and beech. Wetter soils support red maple, white oak, American elm, and basswood, and forested wetlands are swamps supporting white ash, red maple, quaking aspen, and black cherry. Petty and Jackson (1966) list pussy-toes, common cinquefoil, wild licorice, tick clover, blue phlox, waterleaf, bloodroot, Joe-pye-weed, woodland asters, goldenrods, wild geranium, and bellwort as common components of the oak-hickory forest understory in the watershed's region, and rue anemone, jack-in-the-pulpit, spring beauty, cutleaf toothwort, pretty bedstraw, mayapple, false Solomon's seal, and wild ginger as common components of the beech-maple forest understory.

Historically, wet habitat (ponds, swamps, marshes, and bogs) intermingled with the upland habitats were found throughout the Simonton Lake watershed. The hydric soils map indicates that wetland habitat existed throughout the Simonton lake watershed (Figure 6). These wet habitats supported very different vegetative communities than the drier portions of the landscape (Homoya et. al, 1985). Sycamore, American elm, red elm, green ash, silver maple, red maple, cottonwood, hackberry, and honey locust likely dominated the floodplain forests. Swamp communities bordering lakes typically consisted of red maple, silver maple, green ash, American elm, black ash, and yellow birch. Marshes associated with lake communities typically contained swamp loosestrife, cattails, bulrush, marsh fern, marsh cinquefoil, and sedges. Aquatic species within the lake community included spatterdock, white water lily, milfoils, wild celery, pondweeds, naiads, chara spp., and sedges.

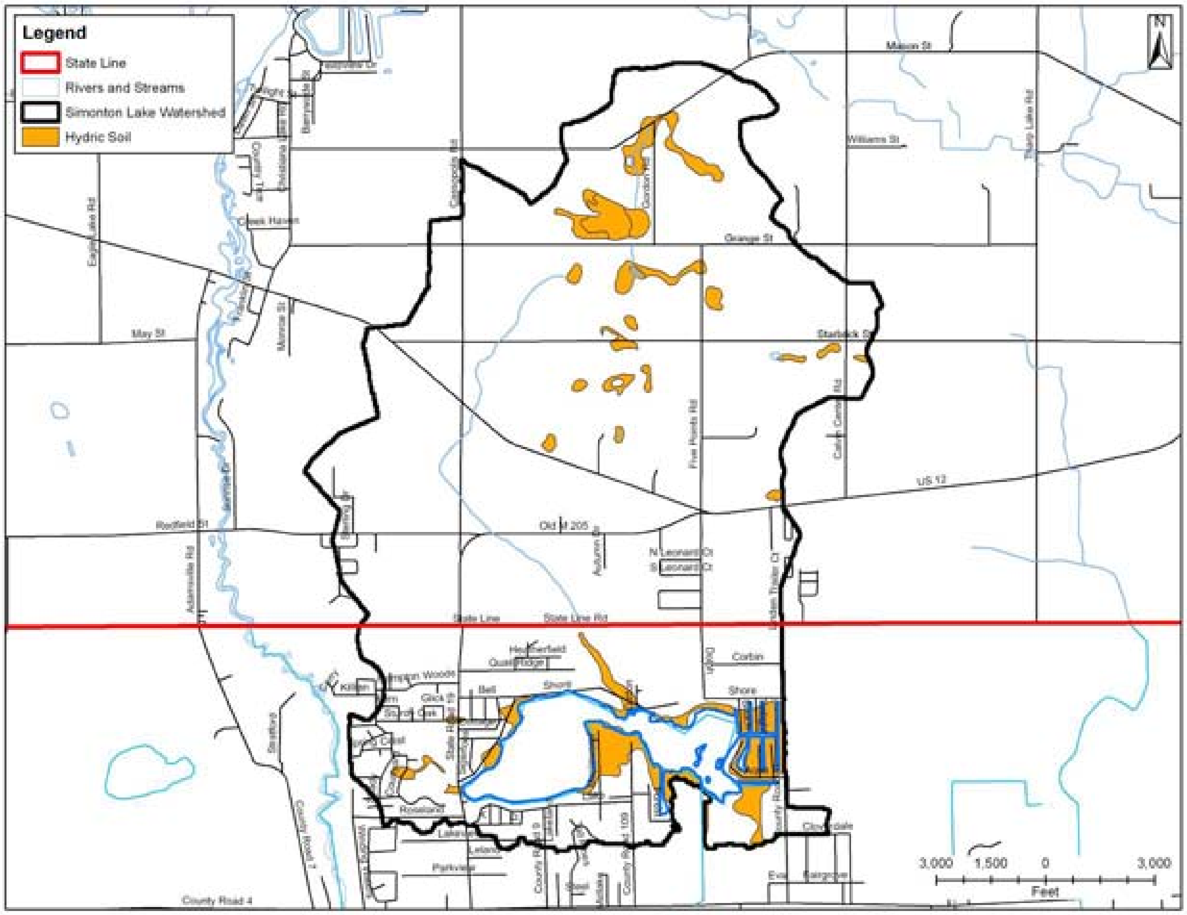


Figure 6. Hydric soils in the Simonton Lake watershed.

Because wetlands perform a variety of functions in a healthy ecosystem, they deserve special attention when examining watersheds. Functioning wetlands filter sediments and nutrients in runoff, store water for future release, provide an opportunity for groundwater recharge or discharge, and serve as nesting habitat for waterfowl and spawning sites for fish. By performing these roles, healthy, functioning wetlands often improve the water quality and biological health of streams and lakes located downstream of the wetlands.

The United States Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) Map (Figure 7) shows that wetlands cover approximately 9% of the Simonton Lake watershed. Table 3 presents the acreage of wetlands by type according to the National Wetland Inventory. Simonton Lake (considered a lacustrine or open water wetland) accounts for approximately two-thirds of this wetland acreage (5.6% of the watershed). Emergent wetlands account for approximately 13.8% of the wetland acreage (1.2% of the watershed). Shrub-scrub and forested wetlands each cover approximately 10.3% of the wetland acreage (<1.0% of the total watershed). The majority of remaining wetland habitat in the watershed is near the northern watershed boundary and at the southeast corner of Simonton Lake.

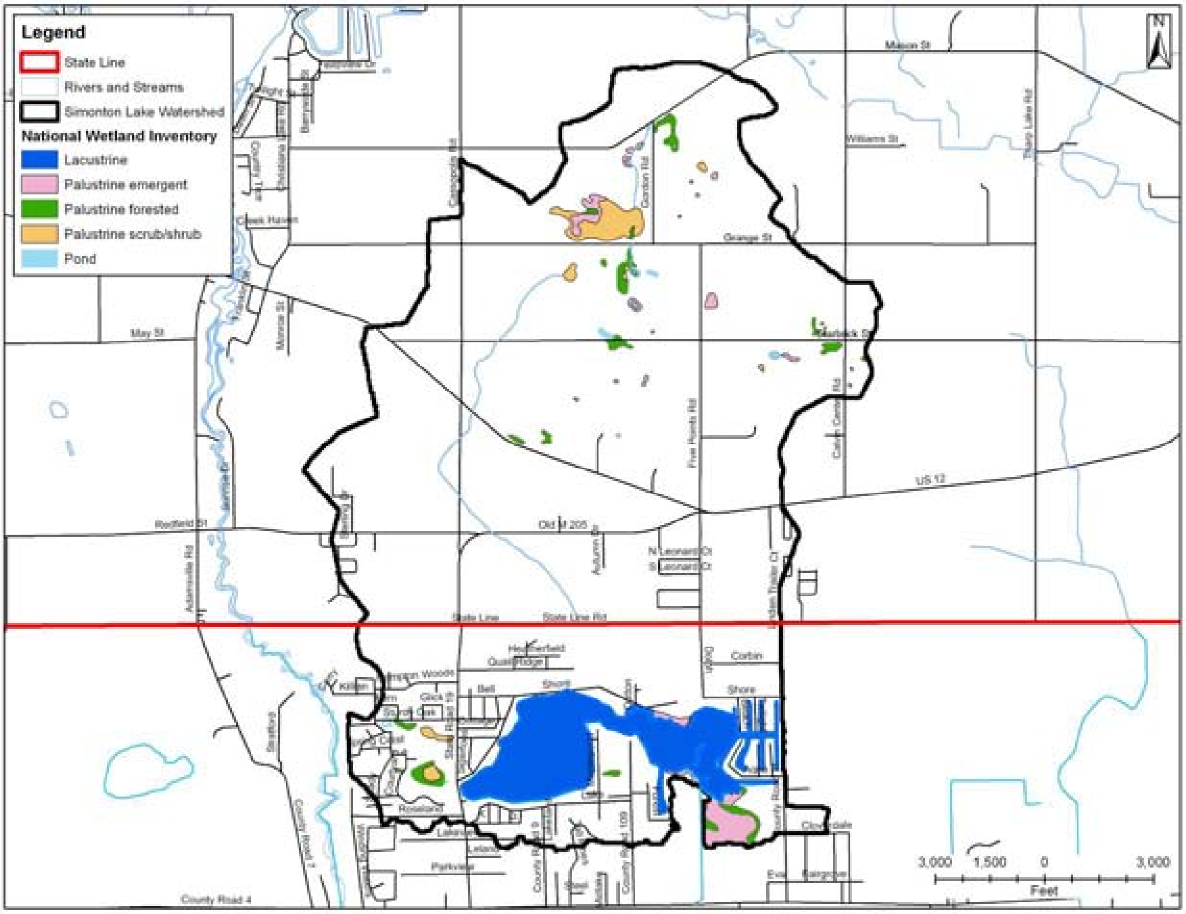


Figure 7: National Wetland Inventory Map of the Simonton Lake watershed

Table 3. Acreage and classification of wetland habitat in the Simonton Lake watershed. (Values are from US Department of Interior – Fish and Wildlife Service, on-line GIS data and may not be precisely the same as other methods of calculating the area of any specific habitat or cover type).

Wetland Type	Area (acres)	Area (hectares)	Percent
Lacustrine	291.6	118.0	5.6%
Pond	6.7	2.7	0.1%
Palustrine emergent	60.7	24.5	1.2%
Palustrine forested	48.7	19.7	0.9%
Palustrine scrub/shrub	45.7	18.5	0.9%
Total	**453.4**	**183.4**	**8.7%**

Overlaying the existing wetland map on the hydric soils map allows an estimate of the area of wetland that has been eliminated by agricultural drainage and development. In the Simonton Lake watershed approximately 243 acres has been lost, primarily to residential development immediately around the lake (Figure 8). This represents 35% loss of wetlands in the Simonton Lake watershed.

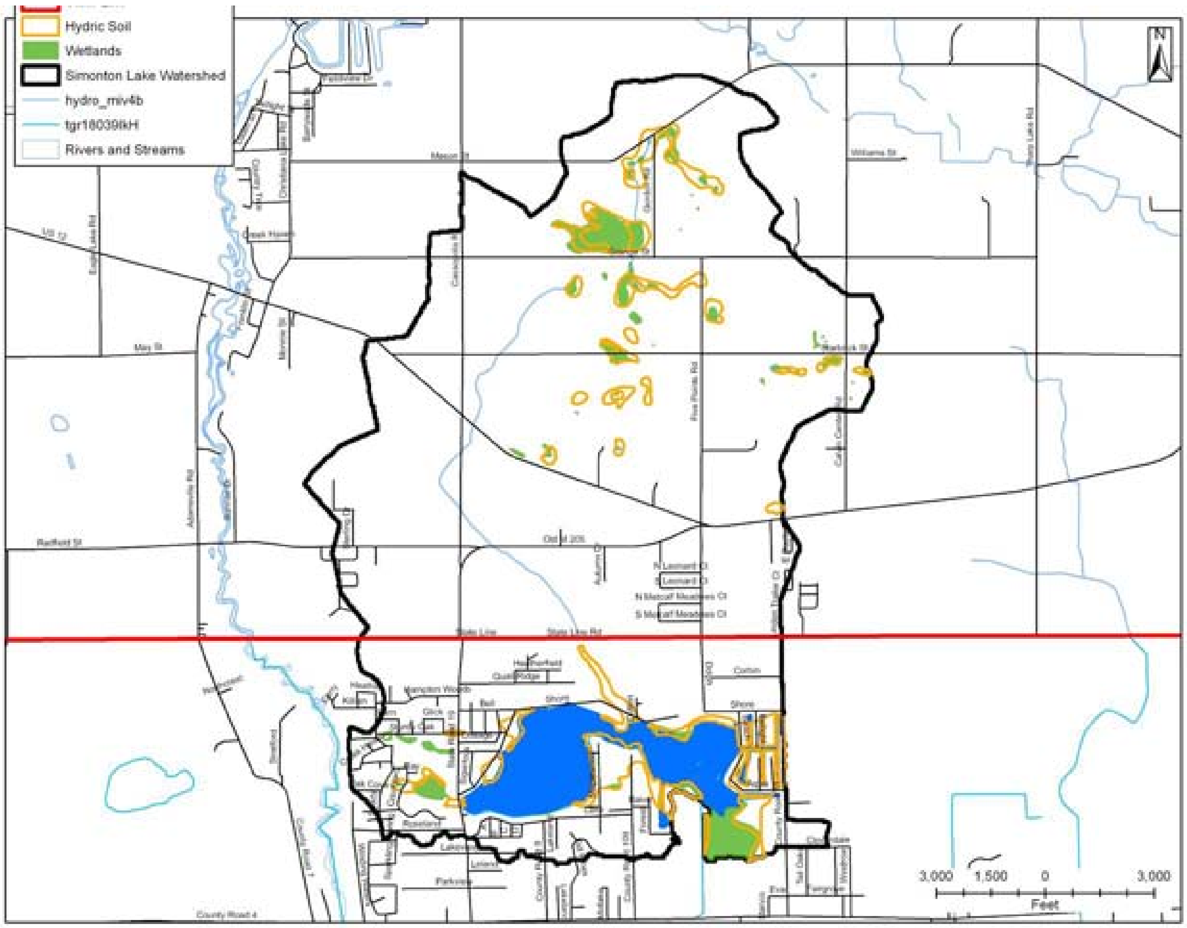


Figure 8: Hydric soil overlay of the National Wetland Inventory map.

1.6 Land Use

Just as soils, climate, and geology shape the native communities within the watershed, how the land in a watershed is used can impact the water quality of a water body. Different land uses have the potential to contribute different amounts of nutrients, sediment, and toxins to receiving water bodies. For example, Reckhow and Simpson (1980) compiled phosphorus export coefficients (amount of phosphorus lost per unit of land area) for various land uses by examining the rate at which phosphorus loss occurred on various types of land. Several researchers have also examined the impact of specific urban and suburban land uses on water quality (Bannerman et. al, 1992; Steuer et al., 1997; Waschbusch et al., 2000). Bannerman et al. (1992) and Steuer et al. (1997) found high mean phosphorus concentrations in runoff from residential lawns (2.33 to 2.67 mg/L) and residential streets (0.14 to 1.31 mg/L). These concentrations are well above the threshold at which lakes might begin to experience algae blooms. (Lakes with total phosphorus concentrations greater than 0.03 mg/L will likely experience algae blooms). Finally, the Center for Watershed Protection has estimated the association of increased levels of impervious surface in a watershed with increased delivery of phosphorus to receiving waterbodies (Caraco and Brown, 2001). Land use directly affects the amount of impervious surface in a watershed. Because of the effect watershed land use has on water quality of the receiving lakes, mapping and understanding a watershed's land use is critical in directing water quality improvement efforts.

Table 4 and Figure 9 present current land use information for the Simonton Lake watershed. (Land use data from the U.S. Geological Survey (USGS) form the basis of Figure 9). Like many Indiana watersheds, agricultural land use dominates the Simonton Lake watershed, accounting for approximately 58.5% of the watershed. Cultivated crops (row crops) make up 43.9 % of the agricultural land use with the pasture/hay making up the remainder of agricultural land use. Land uses other than agriculture account for the remaining 41.5% of the watershed. Natural landscapes, including forests and wetland, cover approximately 10.1% of the watershed. Most of the natural acreage in the watershed is associated with deciduous forests located in the northern portion of watershed and woody wetland in the area southeast of the lake. Approximately 25.9% of the watershed is classified as developed either as low intensity or as open space. The majority of the development is in the Indiana portion of the watershed near the lake. The high proportion of development near the lake makes Simonton Lake vulnerable to nutrient run-off from lawns and roads. Increasing nutrient inputs into the lake will result in decreasing water quality.

Table 4. Detailed land use in the Simonton Lake watershed. (Values are from USGS on-line GIS data and may not be precisely the same as other methods of calculating the area of any specific habitat or cover type).

Cover Type	Area (acres)	Area (hectares)	Percent
Cultivated Crops	2,294.7	928.6	43.9%
Developed, Low Intensity	762.8	308.7	14.6%
Pasture/Hay	720.0	291.4	13.8%
Developed, Open Space	590.9	239.1	11.3%
Deciduous Forest	308.0	124.7	5.9%
Open Water	278.5	112.7	5.3%
Woody Wetlands	165.2	66.8	3.2%
Developed, Medium Intensity	51.4	20.8	1.0%
Grassland/Herbaceous	27.0	10.9	0.5%
Emergent Herbaceous Wetlands	20.1	8.2	0.4%
Evergreen Forest	5.3	2.2	0.1%
Barren Land	5.3	2.1	0.1%
Mixed Forest	1.2	0.5	<0.05%
Shrub/Scrub	1.1	0.4	<0.05%
Total	**5,231.6**	**2,117.2**	**100%**

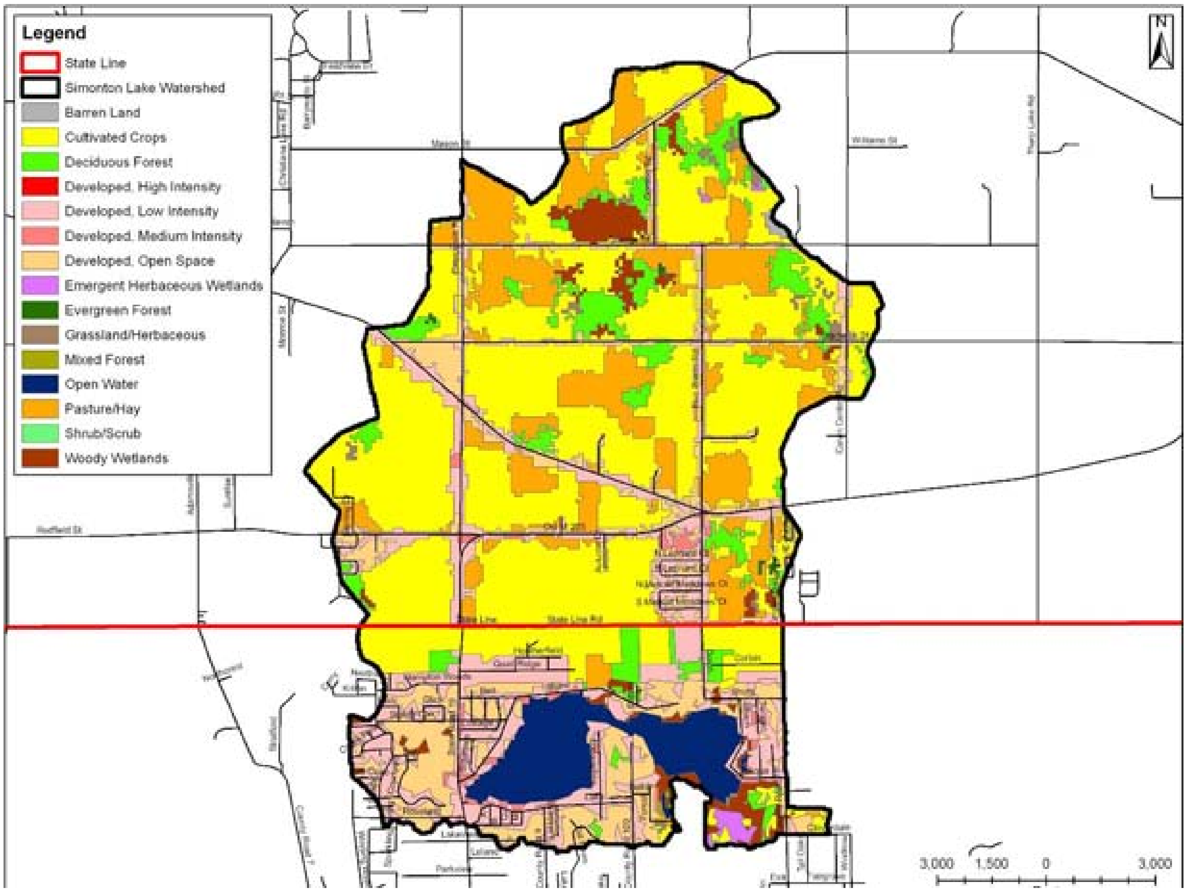


Figure 9. Land use in the Simonton Lake watershed.

1.7 Fisheries

Simonton Lake is defined as a bluegill/largemouth bass fishery and contains a species composition typical of most Indiana lakes. Additional species available to anglers include redear sunfish, yellow perch, black crappie and walleye. Walleye have been stocked in Simonton Lake off and on since 1988 by the Simonton Lake Sportsmen Club and Indiana Department of Natural Resources (IDNR). Numerous fishery assessments have been conducted by IDNR on the Simonton Lake fishery and include general fishery surveys in 1964, 1970, 1977, 1983, 1994, 2005 and 2007. Angler creel surveys were incorporated into the 1994 and 2007 general surveys as well. Simonton Lake was also included in a largemouth bass study conducted by the IDNR which focused on determining the effectiveness of the implementation of minimum size limits for largemouth bass in Indiana lakes from 1980-2007. Simonton Lake was also one of four lakes in Indiana used as part of an advanced walleye fingerling study from 2001-2007 investigating the success of the stocking program.

Results of the IDNR general surveys from 1964-2007 indicate the Simonton fishery has remained relatively consistent in regards to dominant fish species composition, relative growth rates, and condition factors (length/weight) of those species. In general, bluegill is the most abundant species followed by largemouth bass and redear sunfish. Bluegill have exhibited average to above average growth rates and condition during all survey events except during the 1983 general survey in which bluegill had below average growth rates and in 1994 where younger bluegill (age I+ - IV+) had below average growth rates. Results of the general surveys also indicate the bluegill population structure is favorable to anglers with a good percentage of individuals in the quality to preferred size range (6 to 8 in; 15.2 to 20.3 cm). As of the 2007 general survey bluegill had a Proportional Stock Density (PSD) value of 36 suggesting the population is balanced. The target PSD value range for bluegill is 20-60 (Anderson 1985). Proportional stock density (PSD) is an easily calculated statistic used by fisheries biologists when determining if a species population is balanced. A more detailed description of PSD can be found in Appendix B.

Largemouth bass during all survey events have exhibited average to above average condition and growth rates. Surveys over the years have indicated there is a decent number of individuals in the quality size to preferred size range (12 to15 in; 30.5 to 38.1 cm), but very few individuals greater than the minimum legal size limit of 14 inches (35.6 cm). A largemouth bass population considered balanced would have a PSD value of 40-70 and a bass population managed for big bass would have a PSD of 50-80. As of the 2007 general survey, the Simonton Lake largemouth population had a PSD of 7; suggesting the Simonton Lake largemouth bass fishery has a disproportionate number of smaller individuals. Redear sunfish have exhibited average to above average growth rates and condition factors during all survey years. Additionally, the redear sunfish population contains good size structure with a desirable percentage of individuals greater than quality size (7 in; 17.8 cm).

There are also moderate populations of yellow perch, warmouth, and spotted gar. Residents have also reported catching northern pike. Warmouth are often not a desired species by anglers because of their smaller size and competition for food with bluegill, but the warmouth population is not large enough to warrant concern and a decent percentage of individuals in Simonton Lake actually grow to harvestable size. Spotted gar are also not a targeted species among anglers, but can be beneficial to a fishery because they are a top predator and can help reduce competition for food between bluegill through predation. The spotted gar population is at an acceptable level. Historically, yellow perch were shown to be more abundant than that sampled in the most recent survey year; however, the species abundance and size composition still offer anglers a good angling opportunity.

Creel surveys conducted in 1994 and 2007 were used to estimate fishing pressure, fish harvest, and to determine the species of fish anglers most often targeted. Results of the surveys indicate bluegill is the most targeted species on Simonton Lake followed by any type of fish, largemouth bass, and walleye. In 1994, the estimated fishing pressure was 16.7 h/acre and in 2007 it increased to 32 h/acre. The total harvest recorded during the survey period was 3983 individuals in 1994 and 4854 individuals in 2007. Anglers harvested fish at a rate of 0.8 fish/h in 1994 and 0.5 fish/h in 2007. The average for northern Indiana lakes is 1.0 fish/h. Bluegill made up the largest portion of the harvest during both survey years followed by yellow perch and redear sunfish. In 1994, when asked if fishing had improved, declined, or stayed about the same 38% thought fishing had improved, 36% stayed about the same, and 27% thought it had declined. Additionally, in 1994, anglers were asked if they were in favor of the 14 inch size limit on bass: 75.5% responded yes, 15% no and 9.5% had no opinion.

Overall, the Simonton Fishery offers anglers the opportunity to catch and harvest a number of different game fish. An acceptable proportion of bluegill, yellow perch and redear sunfish are available for anglers to harvest. Additionally, the opportunity to harvest walleye is an added bonus to anglers. Currently invasive species such as gizzard shad are not present in

Simonton Lake. Gizzard shad can be detrimental to a fishery as they can out-compete desirable game fish such as bluegill. Gizzard shad are present within the St. Joseph River and possess the ability to migrate up Osolo Ditch and into Simonton Lake. Efforts to maintain the absence of gizzard shad in the Simonton Lake fishery should be a priority. Additionally, efforts to improve water quality within the Simonton Lake watershed and proper management of aquatic vegetation should be pursued. Details on aquatic plant management can be found in Section 2.6.

2.0 LAKE ASSESSMENT

2.1 Morphology

Using a bathymetric map (Figure 10) prepared by the IDNR Lake and River Enhancement staff in 2009, Simonton Lake has a has a maximum depth of 24 feet (7.3 m) deep, a measured surface area of 301 acres (121.8 ha), and a calculated volume of 2,686 acre-ft. We prepared depth-area and depth-volume curves for Simonton Lake (Figures 11 and 12). The area curve from zero to 10 feet indicates that 84% of the lake surface area is less than 10-feet deep (Figure 11). The volume steadily increases until about the 10-foot depth where the steeper curve indicates a more rapid change in depth per unit volume (Figure 12).

A lake's morphology can indirectly influence water quality by shaping the human communities around the lake. The shoreline development ratio is a measure of the development potential of a lake. It is calculated by dividing a lake's shoreline length by the circumference of a circle that has the same area as the lake. A perfectly circular lake with the same area as Simonton Lake (301 acres or 121.8 ha) would have a circumference of 12,832 feet (3,911m). Dividing Simonton Lake's shoreline length (46,170 feet or 14,073 m) by 12,832 yields a ratio of 3.6:1. This means Simonton Lake has 3.6 times as much potential shoreline development as a perfectly round lake. The water quality of lakes with high shoreline development ratios is more easily influenced by the shoreline property owners than lakes with low shoreline development ratios (Table 5).

Figure 10. Simonton Lake Bathymetric Map. Source, IDNR, 1955.

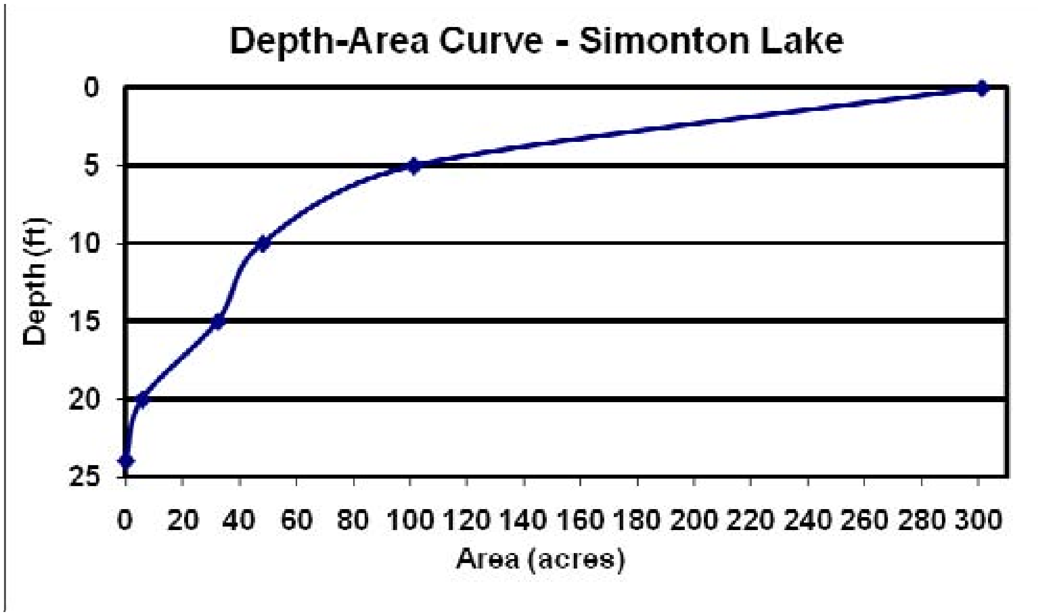


Figure 11. Depth-area curve for Simonton Lake. This curve shows the area of the lake at various depths as determined from the 2009 DNR bathymetric map. For example, 101 acres of Simonton Lake is deeper than 5 feet.

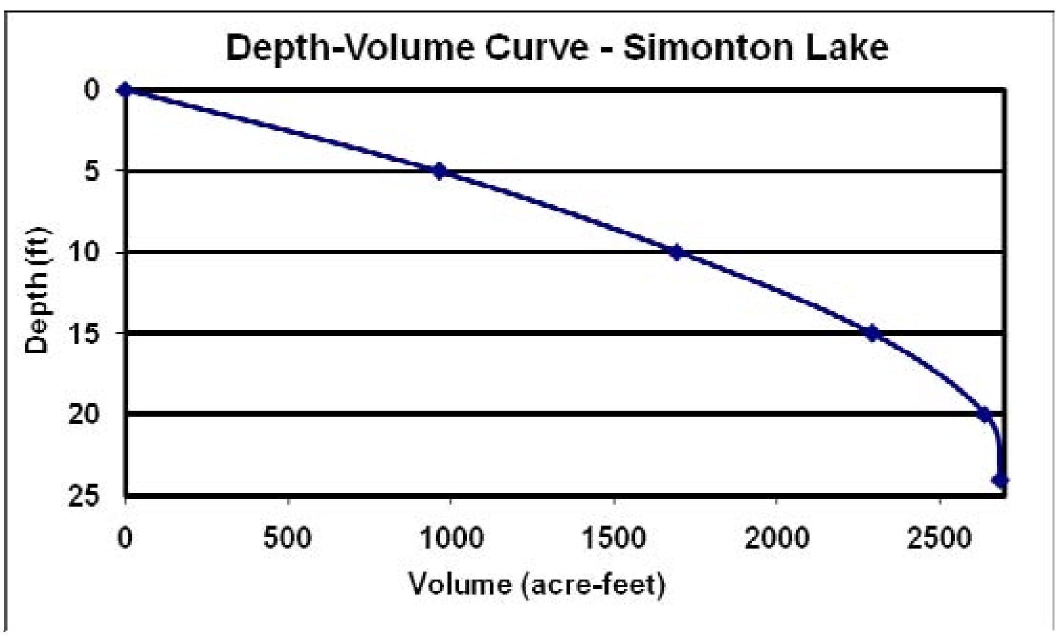


Figure 12. Depth-volume curve for Simonton Lake. This curve shows the volume of the lake at various depths. For example, the volume of Simonton Lake from the surface to 5 feet is approximately 962 acre-feet.

Table 5. Summary of Lake Characteristics

Characteristic	Value
Surface Area	301 acre (121.8 ha)
Volume	2,686 acre-ft (3,313,132 m^3)
Maximum Depth	24 ft (7.3 m)
Mean Depth	12.1 ft (3.7 m)
Shallowness Ratio	0.71
Shoalness Ratio	0.98
Shoreline Length	46,170 ft (13,158 m)
Shoreline Development Ratio	3.6:1

2.2 Shoreline Development

A review of aerial photographs dating back to 1939 tracks the residential development of the lake. There were 20 structures visible on the lake in 1939, with most of those on the south side of the west basin. North Shore Drive extended only part way around the west basin from what is now State Road 19; however, there were only six to eight homes along the lake. The eastern basin was predominantly wetland, which drained out the southeast corner of the lake. By 1951, North Shore Drive had been extended to the narrows with over 30 homes built along the northern lakeshore. Also, the south side CR 9 (Johnson Street) was developed up to what is now the public landing with approximately 30 homes on the south side of the west basin. Development of the channels on the east end of the east basin began in 1957. By this time, as many as 100 structures existed on the south side of the west basin. The channel between the two basins was dredged in 1960 by mechanical means (Personal communication, local resident) In 1965, homes were being constructed on the east end of the east basin and a channel on the south side of the east basin adjacent to Forest Avenue was completed. The lakes shoreline was nearly 100% developed except for the southeast corner of the east basin by 1973.

A modified shoreline usually accompanies shoreline development. Lake residents may install seawalls, convert native vegetation to turf grass, and modify aquatic vegetation by either removing or treating it, or creating personal beaches. The end result can be a loss of habitat for fish and other aquatic organisms and increased wave energy that creates shoreline erosion and re-suspends sediment in shallow water areas.

The shoreline of Simonton Lake was assessed during the diagnostic/feasibility study to quantify the current level of shoreline development. The shoreline was defined as either natural, modified natural, or modified.

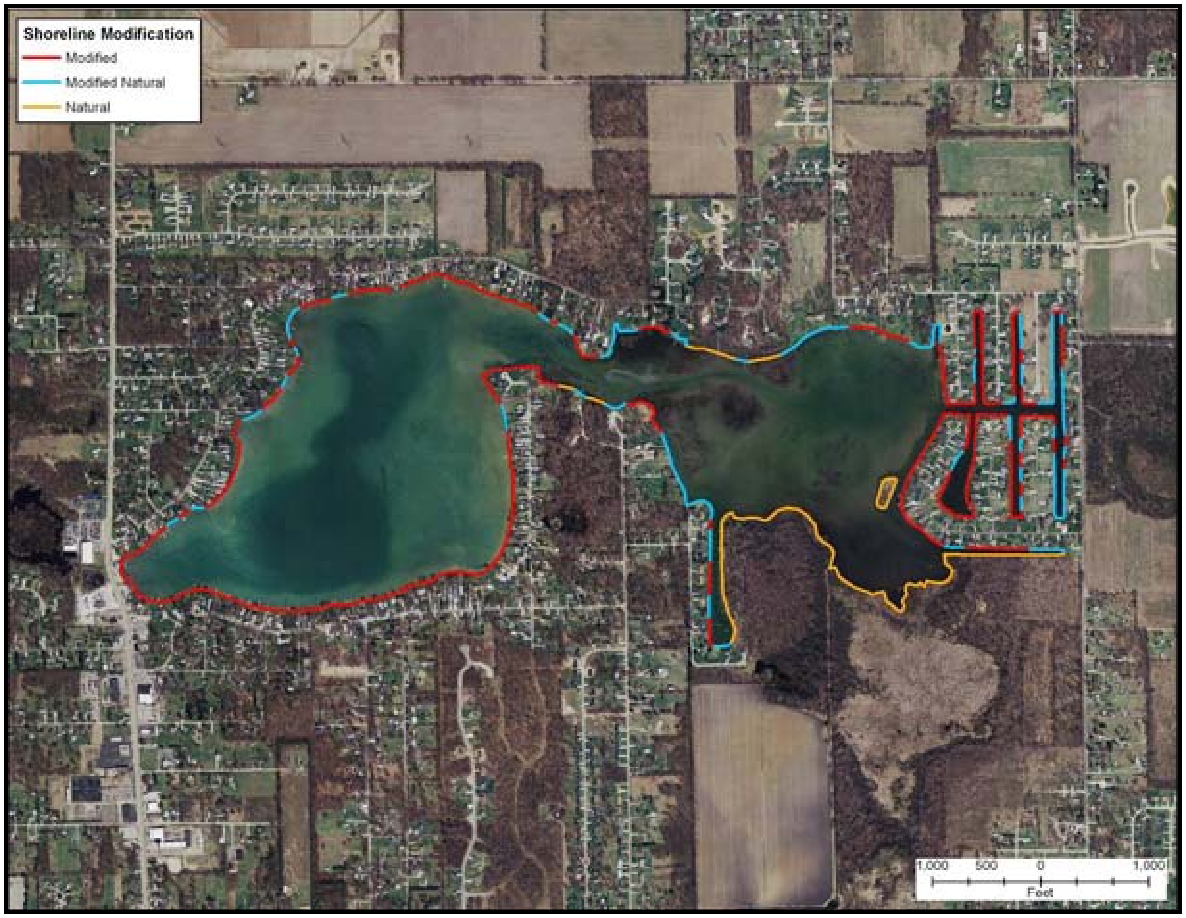


Figure 13. Shoreline development survey results from May, 27 2010.

Natural shoreline remains along approximately 17.4% of Simonton Lake's shoreline (Figure 13). Most of the natural shoreline is located on the southeast portion of the east basin. Along these natural shorelines, trees, emergent vegetation, floating vegetation, and submersed vegetation are all present in distinct zones. In these areas, the submersed, floating, emergent, and shoreline canopy layers all remain intact.

Modified shoreline accounts for 55.6% of the shoreline in Simonton Lake. Along the modified portions of the lake's shoreline, emergent and floating rooted vegetation has been completely removed. This leaves exposed soils or residential lawns exposed to wave action, which have a higher likelihood to erode. In some areas, concrete seawalls, or riprap cover the shoreline.

Modified natural shoreline accounts for 27% of the shoreline in Simonton Lake. Along modified natural shorelines, trees and emergent vegetation have been thinned; however, these areas possess at least a narrow band of emergent plants. These areas are mapped as modified natural shoreline because they still posses at least some submersed, emergent, or floating vegetation. Other portions of the shoreline that are also mapped as modified natural shoreline include those areas where residents removed only a portion of the shoreline vegetation required to view or access the lake. Figure 13 displays the portion of shoreline possessing modified natural shoreline characteristics.

The shoreline surface becomes especially important in and adjacent to shallow portion of Simonton Lake. In areas where concrete seawalls are present, wave energy from wind and boats strike the flat surface and reflect back into the lake. This creates an almost continuous turbulence in the shallow areas of the lake. Where the waves reflect back into the lake and meet incoming waves, the wave height increases resulting in additional in-lake turbulence. This turbulence re-suspends bottom sediments thereby increasing the transfer of nutrients from the sediment-water interface to the water column. Continuous disturbance in shallow areas can also encourage the growth of disturbance-oriented plants and make the water cloudier.

In contrast, shorelines vegetated with emergent, submersed, or rooted floating vegetation will absorb more of the wave energy created by wind or boats. In these locations, wave energy will dissipate along the shoreline each time a wave meets the shoreline surface. Similarly, stone seawalls or those covered by wood can also decrease shallow water turbulence and lake-ward wave energy, and also provide shoreline stabilization.

2.3 Historical Water Quality

Generally, nitrogen and phosphorus are the two most important nutrients affecting lake productivity. In phosphorus-limited lakes like Simonton, an increase in phosphorus will result in an increase in algal growth, which could shift the lake to a more eutrophic state. Since 1988, the west basin of Simonton Lake has been sampled five times by the Indiana Clean Lakes Program. Those data for phosphorus are plotted with data from the current study in Figure 14. While the concentration of soluble reactive phosphorus has decreased somewhat, the concentration of total phosphorus has decreased steadily over the years from a mean of 0.055 mg/L in 1988 to under 0.030 mg/L, an encouraging trend that will result in improved water quality.

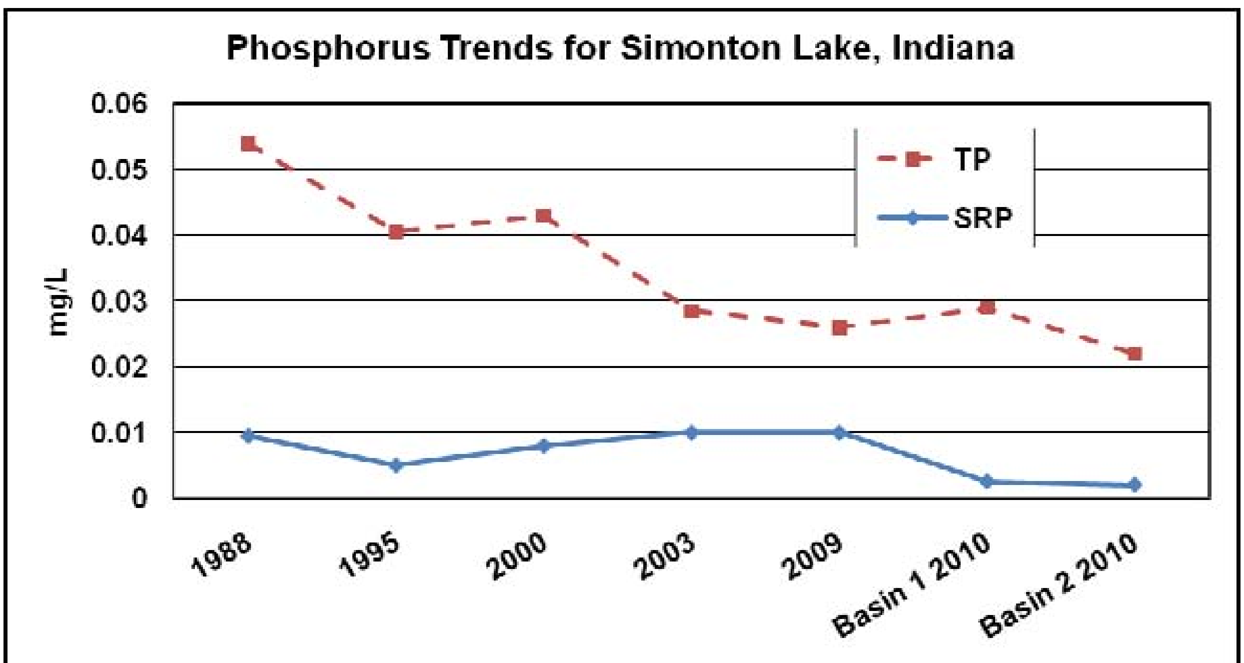


Figure 14. Mean total phosphorus (TP) and soluble reactive phosphorus (SRP) for the West basin (Basin 1) in Simonton Lake from 1988 to 2009 compared with both basins in 2010. Source: Indiana Clean Lakes Program.

The concentration of total nitrogen in Simonton Lake has declined since 1988. Much of this decline was due to declines in ammonia and nitrate (Figure 15). Both ammonia and nitrate are soluble forms of nitrogen that are used by algae and aquatic plants for growth. This is also a positive trend and may be due to the installation of a sanitary sewer system around the lake in 1999-2000.

Secchi disc transparency depth is reduced in lakes having high algae or suspended solids concentrations. Secchi depth in Simonton Lake has been influenced by the concentration of chlorophyll *a*, which is a direct measure of algae (Figure 16). When the chlorophyll *a* concentrations are high, Secchi depth is low, and *vice versa*.

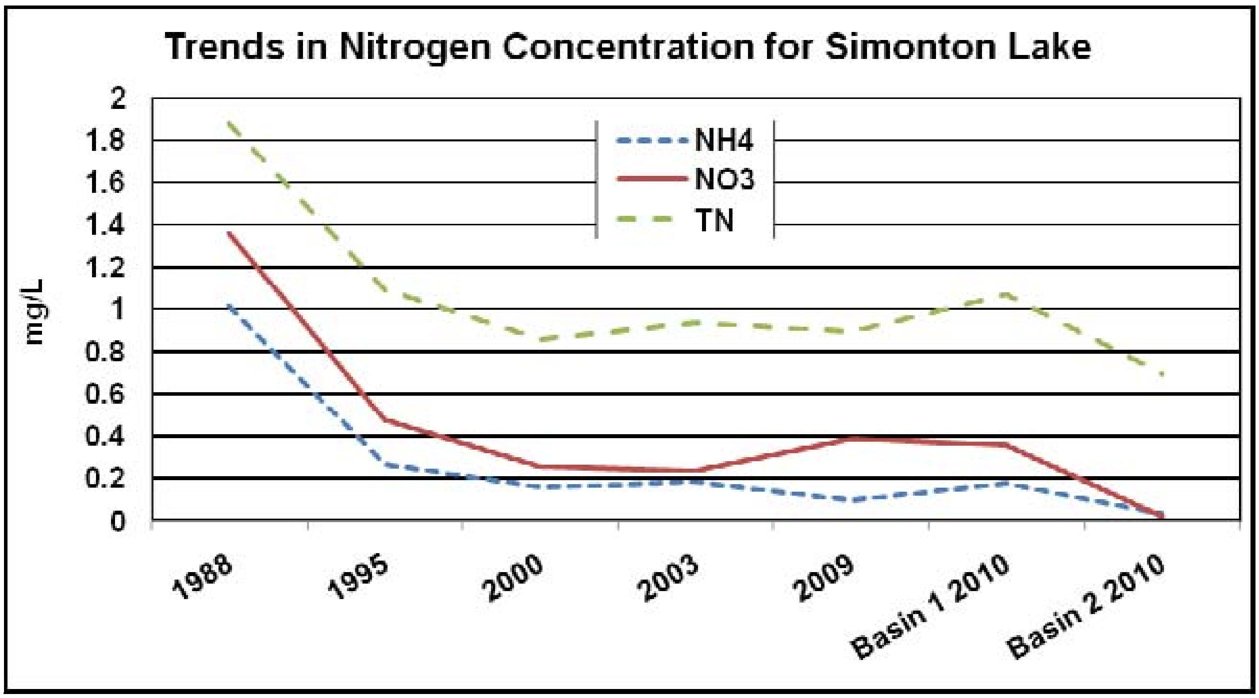


Figure 15. Nitrate (NO_3), ammonia (NH_4) and total nitrogen (TN) trends for Simonton Lake from 1988-2010. Source: Indiana Clean Lakes Program. West Basin (Basin 1); East Basin (Basin 2).

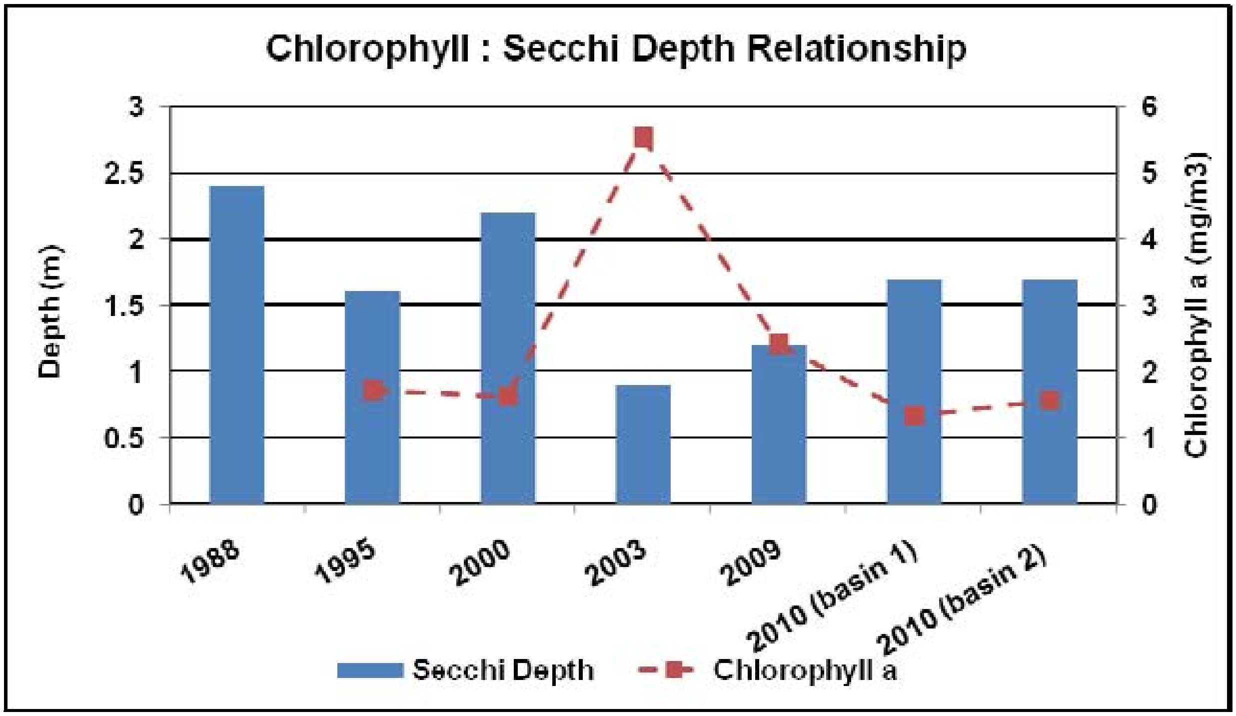


Figure 16. Relationship between water clarity (Secchi depth) and chlorophyll concentrations for Simonton Lake for the 1988-2010 sampling years. Chlorophyll *a* data were not available for 1988. West Basin (Basin 1) ; East Basin (Basin 2).

Since 2000, blue-green algae have become the dominant type of algae in Simonton Lake (Figure 17). In water samples collected July 6, 2010, we found very few green algae. Green algae are considered good for healthy lakes because they are readily eaten by zooplankton grazers. Zooplankton, in turn, are important food for young fish. Blue-green algae, on the other hand, are not as palatable and many zooplankton cannot eat them. Blue-greens often form nuisance blooms and many are known to produce toxins. Despite the dominance of blue-green algae, overall algal densities are relatively low in the lake. We can conclude that algae are not currently causing major problems in Simonton Lake.

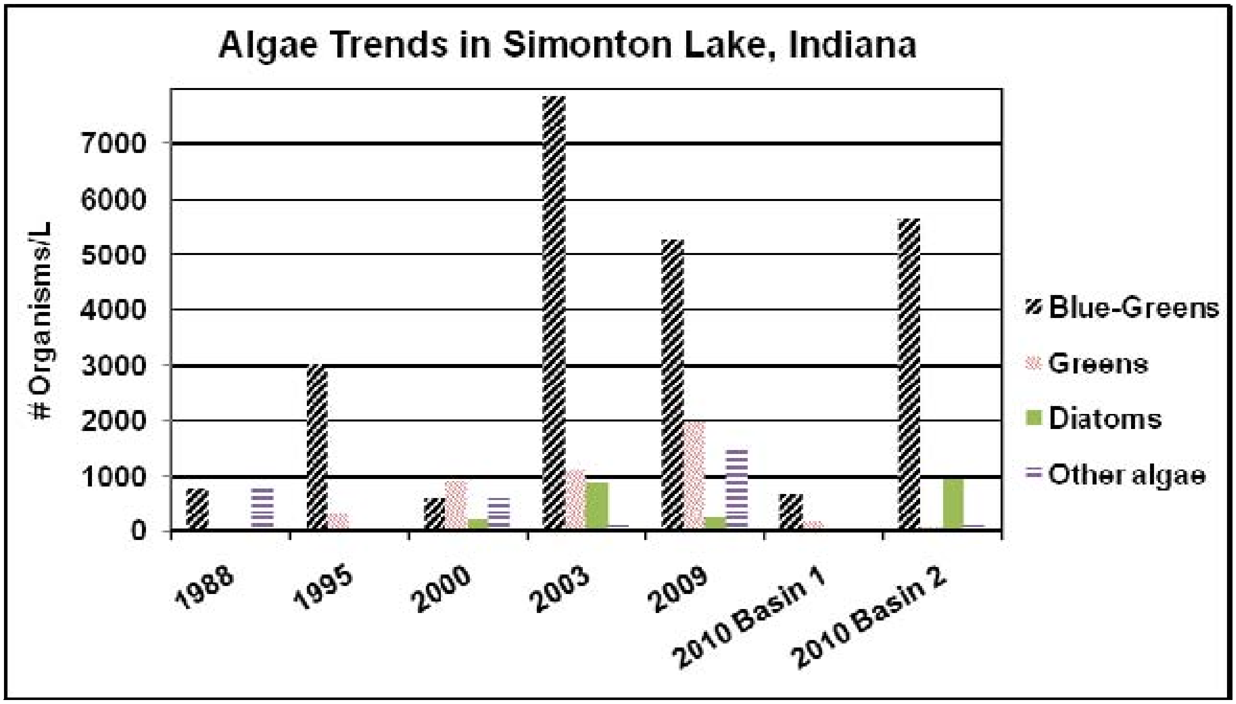


Figure 17. Relationship between total phosphorus and algal abundance in Simonton Lake from 1988-2010. Source: Indiana Clean Lakes Program. West Basin (Basin 1); East Basin (Basin 2).

When we overlay the dissolved nitrogen (ammonia and nitrate) concentrations on the algae trends, we see an interesting relationship (Figure 18). Blue-green algae are known nitrogen fixers. They contain heterocysts, specialized structures where atmospheric nitrogen can be converted into ammonia for use in growth. Since the rise of blue-greens in Simonton Lake coincides with the fall in ammonia and nitrate concentrations, it would appear that with less available nitrogen, the blue-greens were able to dominate other algae because they can fix their own nitrogen. It is reported that low nitrogen to phosphorus ratios favor dominance by blue-greens (Smith 1983), but overall production of algae is controlled by phosphorus (Schindler et al. 2008). Thus, reducing nitrogen inputs to lakes may cause a shift in algal populations from greens to blue-greens, but reductions in phosphorus are required to cause a decline in overall algal production.

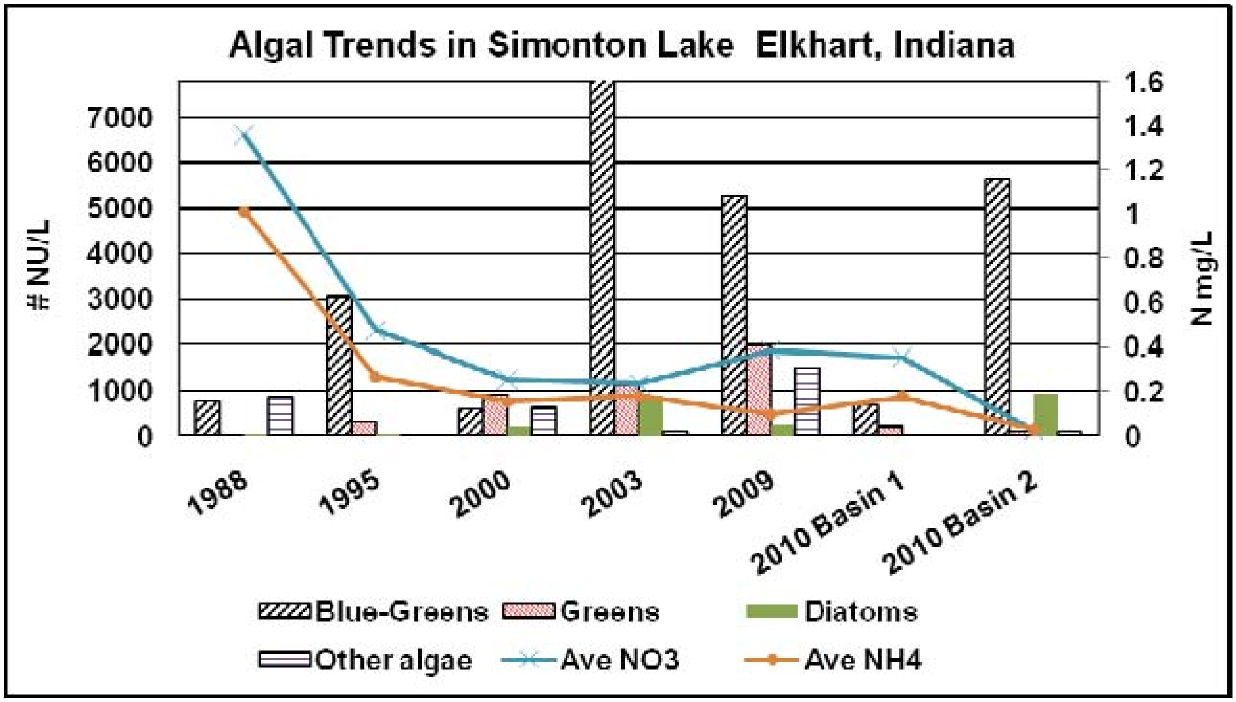


Figure 18. Relationship between dissolved nitrogen and algae in Simonton Lake from 1988-2010. Source: Indiana Clean Lakes Program. West Basin (Basin 1); East Basin (Basin 2).

The Indiana Trophic State Index values calculated for Simonton Lake from assessments conducted under the Indiana Clean Lakes Program and for the current project are shown in Table 6. The trophic state fluctuated from 1988 to 2010 where the TSI was slowly improving from a score of 25 in 1988 to a score of 3 in 2000. The trophic state after 2000 increased back to previous levels. Other than in 2000, when only the epilimnion was sampled, all the Indiana TSI scores are in the mesotrophic range.

Table 6. Simonton Lake: Indiana Trophic Index 1988, 1995, 2000, 2003, 2009 and 2010.

	1988	1995	2000	2003	2009	2010
Simonton Lake	25	17	3	21	24	20

Source: Clean Lakes Program data 1989-2002 and current study (records kept on file at Indiana University SPEA).

2.4 Water Quality Assessment

The comprehensive evaluation of lakes and streams require collecting data on a number of different, and sometimes hard-to-understand, water quality parameters. Some of the more important parameters that we analyze include:

Temperature: Temperature can determine the form, solubility, and toxicity of a broad range of aqueous compounds. Likewise, life associated with the aquatic environment in any location has its species composition and activity regulated by water temperature. Since essentially all aquatic organisms are 'cold-blooded' the temperature of the water regulates their metabolism and ability to survive and reproduce effectively (EPA, 1976). The Indiana Administrative Code (327 IAC 2-1-6) sets maximum temperature limits to protect aquatic life for Indiana streams. For example, temperatures during the month of May should not exceed 80 ^{o}F (23.7 ^{o}C) by more than 3 ^{o}F (1.7 ^{o}C). June temperatures should not exceed 90 ^{o}F (32.2 ^{o}C).

Dissolved Oxygen (D.O): D.O. is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. Fish need at least 3-5 mg/L of D.O. Cold-water fish such as trout generally require higher concentrations of D.O. than warm water fish such as bass or Bluegill. The 327 IAC 2-1-6 sets minimum D.O. concentrations at 6 mg/L for cold-water fish. D.O. enters water by diffusion from the atmosphere and as a byproduct of photosynthesis by algae and plants. Excessive algae growth can over-saturate (greater than 100% saturation) the water with D.O. Conversely, dissolved oxygen is consumed by respiration of aquatic organisms, such as fish, and during bacterial decomposition of plant and animal matter.

Conductivity: Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions: on their total concentration, mobility, and valence (APHA, 2005). During low discharge, conductivity is higher than during storm water runoff because the water moves more slowly across or through ion containing soils and substrates during base flow. Carbonates and other charged particles (ions) dissolve into the slow-moving water, thereby increasing conductivity measurements.

pH: The pH of water is a measure of the concentration of acidic ions (specifically H^+) present in the water. The pH also determines the form, solubility, and toxicity of a wide range of other aqueous compounds. The IAC establishes a range of 6-9 pH units for the protection of aquatic life.

Alkalinity: Alkalinity is a measure of the acid-neutralizing (or buffering) capacity of water. Certain substances, if present in water, like carbonates, bicarbonates, and sulfates can cause the water to resist changes in pH. A lower alkalinity indicates a lower buffering capacity or a decreased ability to resist changes in pH. During base flow conditions, alkalinity is usually high because the water picks up carbonates from the bedrock. Alkalinity measurements are usually lower during storm flow conditions because buffering compounds are diluted by rainwater and the runoff water moves across carbonate-containing bedrock materials so quickly that little carbonate is dissolved to add additional buffering capacity.

Turbidity: Turbidity (measured in Nephelometric Turbidity Units) is a measure of particles suspended in the water itself. It is generally related to suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. According to the Hoosier Riverwatch, the average turbidity of an Indiana stream is 11 NTU with a typical range of 4.5-17.5 NTU (White, unpublished data). Turbidity measurements >20 NTU have been found to cause undesirable changes in aquatic life (Walker, 1978).

Nitrogen: Nitrogen is an essential plant nutrient found in fertilizers, human and animal wastes, yard waste, and the air. About 80% of the air we breathe is nitrogen gas. Nitrogen gas diffuses into water where it can be “fixed”, or converted, by Blue-green algae to ammonia for their use. Nitrogen can also enter lakes and streams as inorganic nitrogen and ammonia. Because of this, there is an abundant supply of available nitrogen to aquatic systems. The three common forms of nitrogen are:

Nitrate (NO_3^-) – Nitrate is an oxidized form of dissolved nitrogen that is converted to ammonia by algae. It is found in streams and runoff when dissolved oxygen is present, usually in the surface waters. Ammonia applied to farmland is rapidly oxidized or converted to nitrate and usually enters surface and groundwater as nitrate. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams that support modified warmwater habitat (MWH) was 1.6 mg/L. Modified warmwater habitat was defined as: aquatic life use assigned to streams that have irretrievable, extensive, man-induced modification that preclude attainment of the warmwater habitat use (WWH) designation; such streams are characterized by species that are tolerant of poor chemical quality (fluctuating dissolved oxygen) and habitat conditions (siltation, habitat amplification) that often occur in modified streams (Ohio EPA, 1999). Nitrate concentrations exceeding 10 mg/L in drinking water are considered hazardous to human health (Indiana Administrative Code 327 IAC 2-1-6).

Ammonia (NH_4^+) – Ammonia is a form of dissolved nitrogen that is the preferred form for algae use. It is the reduced form of nitrogen and is found in water where dissolved oxygen is lacking. Important sources of ammonia include fertilizers and animal manure. In addition, bacteria produce ammonia as a by-product as they decompose dead plant and animal matter. Both temperature and pH govern the toxicity of ammonia for aquatic life.

Total Kjeldahl Nitrogen (TKN) – Organic nitrogen includes nitrogen found in plant and animal materials. It may be in dissolved or particulate form. In the analytical procedures, total Kjeldahl nitrogen (TKN) was analyzed. Organic nitrogen is TKN minus ammonia.

Phosphorus: Phosphorus is an essential plant nutrient, and the one that most often controls aquatic plant (algae and macrophyte) growth in freshwater. It is found in fertilizers, human and animal wastes, and yard waste. There are few natural sources of phosphorus to streams other than what is attached to soil particles, and there is no atmospheric (vapor) form of phosphorus. For this reason, phosphorus is often a limiting nutrient in aquatic systems. This means that the relative scarcity of phosphorus may limit the ultimate growth and production of algae and rooted aquatic plants. Therefore, management efforts often focus on reducing phosphorus inputs to receiving waterways because: (a) it can be managed and (b) reducing phosphorus can reduce algae production. Two common forms of phosphorus are:

Soluble reactive phosphorus (SRP) – SRP is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae themselves. Because phosphorus is cycled so rapidly through biota, SRP concentrations as low as 0.005 mg/L are enough to maintain eutrophic or highly productive conditions in lake systems (Correll, 1998). Sources of SRP include fertilizers, animal wastes, and septic systems.

Total phosphorus (TP) – TP includes dissolved and particulate phosphorus. TP concentrations greater than 0.03 mg/L (or 30μg/L) can cause algal blooms in lakes and reservoirs. The Ohio EPA (1999) found that the median TP in wadeable streams that support modified warmwater habitat (MWH) for fish was 0.28 mg/L.

Secchi Disc Transparency: This refers to the depth to which the black & white Secchi disc can be seen in the lake water. Water clarity, as determined by a Secchi disc, is affected by two primary factors: algae and suspended particulate matter. Particulates (for example, soil or dead leaves) may be introduced into the water by either runoff from the land or from sediments already on the bottom of the lake. Many processes may introduce sediments from runoff; examples include erosion from construction sites, agricultural lands, and riverbanks. Bottom sediments may be resuspended by bottom feeding fish such as carp, or in shallow lakes, by motorboats or strong winds.

Light Transmission: Similar to the Secchi disc transparency, this measurement uses a light meter (photocell) to determine the rate at which light transmission is diminished in the upper portion of the lake's water column. Another important light transmission measurement is determination of the 1% light level. The 1% light level is the water depth to which one percent of the surface light penetrates. This is considered the lower limit of algal growth in lakes and is referred to as the *photic zone*.

Plankton: Plankton are important members of the aquatic food web. Plankton include algae (microscopic plants) and zooplankton (tiny shrimp-like animals that eat algae). Plankton are sampled by filtering water through a net having a very fine mesh (63-micron openings = 63/1000 millimeter). The plankton net is towed up through the lake's water column from the one percent light level to the surface. Algae are reported as *natural units*, which records one colonial filament of multiple cells as one natural unit and one cell of a singular alga also as one natural unit. Of the many different algal species present in the water, we are particularly interested in the Blue-green algae. Blue-green algae are those that most often form nuisance blooms and their dominance in lakes may indicate poor water conditions.

Chlorophyll *a*: The plant pigments of algae consist of the chlorophylls (green color) and carotenoids (yellow color). Chlorophyll *a* is by far the most dominant chlorophyll pigment and occurs in great abundance. Thus, chlorophyll *a* is often used as a direct estimate of algal biomass.

2.4.1 Water Quality Assessment Methods

The water sampling and analytical methods used for Simonton Lake were consistent with those used in IDEM's Indiana Clean Lakes Program and IDNR's Lake and River Enhancement Program. We collected water samples from both basins of Simonton Lake on July 6, 2010. In the west basin (the deeper basin), we sampled from one meter below the water surface (epilimnion) and from one meter above the lake bottom (hypolimnion) at a location over the deepest water. In the shallow eastern basin, we again sampled over the deepest water, but were limited by depth in sampling only the epilimnion. Chlorophyll was determined only for the epilimnetic samples. Other parameters such as Secchi disc transparency, light transmission, and oxygen saturation are single measurements made in the epilimnion. In addition, dissolved oxygen and temperature were measured at one-meter intervals from the surface to the bottom. A tow to collect plankton was made from the 1% light level to the water surface.

Conductivity, turbidity, temperature, and dissolved oxygen were measured *in situ* at the lake sampling site with a YSI Model 85 meter.

In addition, water samples were collected for the following parameters:

- pH
- alkalinity
- total phosphorus (TP)
- soluble reactive phosphorus (SRP)
- nitrate-nitrogen (NO_3^-)
- ammonia-nitrogen (NH_4^+)
- total Kjeldahl nitrogen (TKN)
- turbidity
- plankton
- chlorophyll *a*

For this project, no samples were taken from any inlets or outlets of the lake, because no water was flowing at the time of the sampling.

Water samples were placed in the appropriate bottle (with preservative if needed) and stored in an ice chest until analysis at SPEA's laboratory in Bloomington. SRP samples were filtered in the field through a Whatman GF-C filter.

All sampling techniques and laboratory analytical methods were performed in accordance with procedures in *Standard Methods for the Examination of Water and* Wastewater, 27th Edition (APHA, 2005). Plankton counts were made using a standard Sedgewick-Rafter counting cell. Fifteen fields per cell were counted. Plankton identifications were made according to: Wehr and Sheath (2003), Prescott (1982), Ward and Whipple (1959) and Whitford and Schumacher (1984).

2.4.2 Water Quality Assessment Results

Results from the Simonton Lake water quality assessment are included in Tables 7 and 8, and Figure 19.

Table 7. Water Quality Characteristics of Simonton Lake West Basin (Basin 1), July 6, 2010.

Parameter	Epilimnetic Sample	Deep Water Sample	Indiana TSI Points (based on mean values)
pH	8.3	8.0	-
Alkalinity	135 mg/L	149 mg/L	-
Conductivity	364 μmhos	351 μmhos	-
Turbidity	2.5 NTU	4.0 NTU	-
Secchi Depth Transparency	1.7 meters	-	0
Light Transmission @ 3 ft.	32.4 %	-	3
1% Light Level	21.5 feet	-	-
Total Phosphorus	0.023 mg/L	0.03 mg/L	2
Soluble Reactive Phosphorus	0.010* mg/L	0.010* mg/L	0
Nitrate-Nitrogen	0.420 mg/L	0.291 mg/L	1
Ammonia-Nitrogen	0.039 mg/L	0.317 mg/L	0
Organic Nitrogen	0.933 mg/L	1.197 mg/L	3
Oxygen Saturation @ 5ft.	97.2 %	-	0
% Water Column Oxic	71.4 %	-	1
Plankton Density	938 /L	-	0
Blue-Green Dominance	72.4 %	-	10
Chlorophyll *a*	1.33 μg/L	-	-
*Method detection limit		**TSI Score**	**20**

Table 8. Water Quality Characteristics of Simonton Lake East Basin (Basin 2), July 6, 2010.

Parameter	Epilimnetic Sample	Hypolimnetic Sample	Indiana TSI Points (based on mean values)
pH	8.7		-
Alkalinity	270 mg/L	Not	-
Conductivity	334 μmhos		-
Turbidity	3.2 NTU	Applicable	-
Secchi Depth Transparency	1.7 meters		0
Light Transmission @ 3 ft.	32.4 %	No	3
1% Light Level	21.5 feet		-
Total Phosphorus	0.020 mg/L	Hypolimnion	0
Soluble Reactive Phosphorus	0.010* mg/L		0
Nitrate-Nitrogen	0.022 mg/L	present	0
Ammonia-Nitrogen	0.031 mg/L		1
Organic Nitrogen	0.696 mg/L		2
Oxygen Saturation @ 5ft.	118%		1
% Water Column Oxic	100 %		-
Plankton Density	7612 /L		2
Blue-Green Dominance	74.0 %		10
Chlorophyll *a*	1.56 μg/L		-
*Method detection limit		**TSI Score**	**19**

Temperature and oxygen profiles for Simonton Lake show that the lake was thermally stratified at the time of sampling (Figure 19). The surface water of the west basin was well-mixed down to a depth of 5 meters, as indicated by the steady water temperatures. This depth where the lake is well-mixed is referred to as the *epilimnion*. Below 5 meters, the temperature decreases steadily to the lake bottom. The depths over which temperature decreases at least 1 ^{0}C per meter is referred to as the *metalimnion*. Water density differences caused by declining temperatures in the metalimnion prevent mixing in this zone. By definition, there was no *hypolimnion* present at the time of sampling. The west basin was well-mixed as the temperature and dissolved oxygen measurements were uniform.

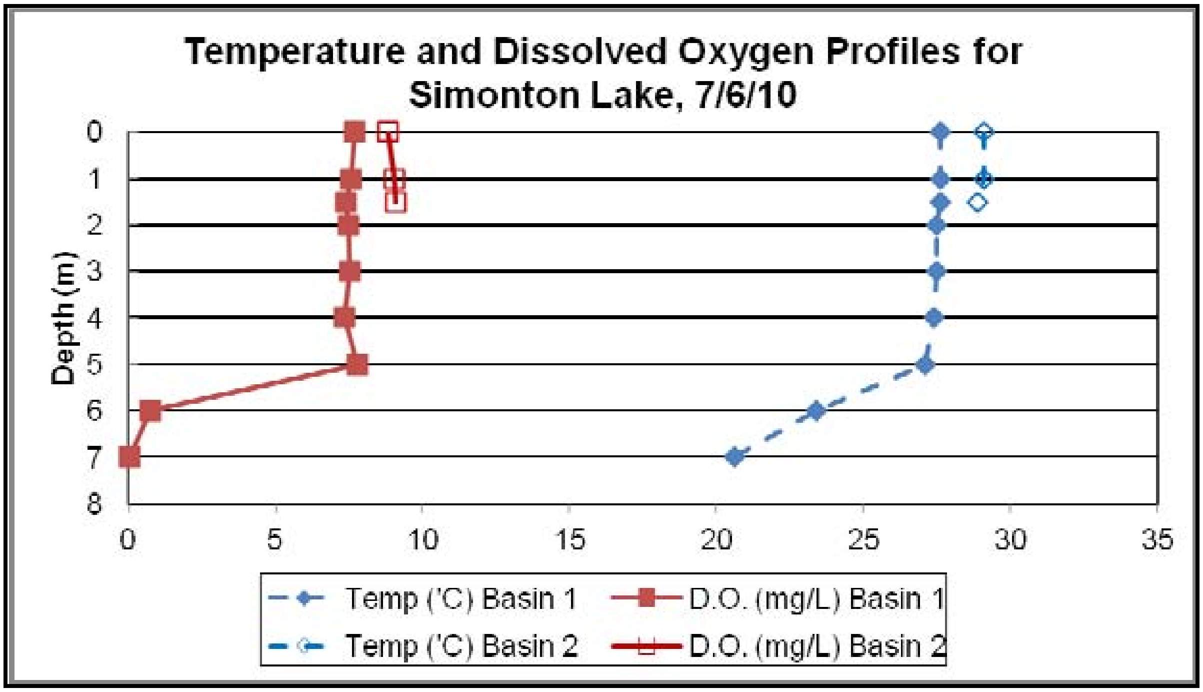


Figure 19. Temperature and dissolved oxygen profiles for Simonton Lake on July 6, 2010. West Basin (Basin 1); East Basin (Basin 2).

Simonton Lake had adequate dissolved oxygen in the well-mixed epilimnion. Dissolved oxygen (DO) decreased rapidly below 5 meters in the western basin. At the 6- and 7-meter depths the concentration of DO was less than 1 mg/L, which is insufficient to support fish.

The 1% light level, which limnologists use to determine the lower limit where photosynthesis can occur, extended to 21.5 ft (~7 m). Based on the depth-area curve in Figure 10, approximately 98% of the lake bottom (approximately 295 acres) is shallower than 21.5 ft. This represents the area of the lake bottom with sufficient light to support rooted plants. This area is called the *littoral zone*. Furthermore, based on the depth-volume curve (Figure 12), we see that a volume of greater than 2,600 acre-feet of Simonton Lake (99% of total lake volume) lies above the 21.5-foot 1% light level. This area, referred to as the *photic zone*, represents the amount of water with sufficient light to support algae growth.

Phosphorus and nitrogen are the primary plant nutrients in lakes. Phosphorus concentrations were similar for all samples in both basins. In the west basin, nitrate-nitrogen was 0.420 mg/L in the epilimnion and 0.291 mg/L in the deep water sample. In the east basin, nitrate-nitrogen was only 0.22 mg/L. Perhaps the extensive rooted macrophyte growth in this basin consumed nitrate. Ammonia in the epilimnion was 0.039 mg/L and 0.317 mg/L in the deep water. Since ammonia is a chemically reduced form of nitrogen and is produced as a by-product of bacterial decomposition we often see elevated concentrations in deep water samples from anoxic waters, which existed at Simonton Lake at the time of sampling. The eastern basin's ammonia concentration was similar to the west basin's epilimnetic sample.

Values for pH are within the normal range for Indiana lakes. The pH values for most fresh water lakes fall between a pH of 6 and 9 (Kalff, 2002). The alkalinity values of 135 mg/L and 149 mg/L, for the epilimnion and deep water, indicate that Simonton Lake is a well-buffered system.

Plankton enumerated from the sample collected from Simonton Lake are shown in Table 9. The eastern basin had a higher density of plankton than the west basin, but the east basin's plankton density was still fairly low. Overall, there was a nice mix of phytoplankton and zooplankton in both basins and this resulting balance is important for a healthy lake ecosystem. Both basins were dominated by blue-green algae. Blue-greens are usually associated with degraded water quality. Blue-green algae are less desirable in lakes because they: 1) may form extremely dense nuisance blooms; 2) may cause taste and odor problems; and 3) are unpalatable as food for many zooplankton grazers. Even though the levels are not high in Simonton Lake, blue-green algae should still be monitored in future surveys.

Table 9. The plankton sample representing the species assemblage on July 6, 2010. West Basin (Basin 1); East Basin (Basin 2).

SPECIES	ABUNDANCE (#/l)	
	Basin 1	Basin 2
Blue-Green Algae (Cyanophyta)		
Anabaena	302	72
Merismopedia	38	3324
Pseuoanabaena		1012
Microcystis	340	1228
Green Algae (Chlorophyta)		
Closterium		72
Pediastrum	57	
Ulothrix	132	
Diatoms (Bacillariophyta)		
Fragilaria		145
Nitzchia		578
Navicula		145
Other Algae		
Ceratium		
Dinobryon	19	289
Euglenophyta		72
Zooplankton		
Kellicottia		72
Keratella		506
Bosmina	0.3 10.2	
Daphnia	11.8	1
Diaphanosoma		
Calanoid Copepod	11.8	1
Cyclopoid Copepod	8.6	3.1
Nauplius	16.3	10.2
Ostracoda	2.1	

2.4.3 Lake Water Quality Assessment Discussion

The interpretation of a comprehensive set of water quality data can be quite complicated. Often, attention is directed at the important plant nutrients (phosphorus and nitrogen) and to water transparency (Secchi disc) since dense algal blooms and poor transparency greatly affect the health and use of lakes. But, how much phosphorus or nitrogen is too much or, what level of transparency is too poor?

To answer these questions, limnologists must compare data from the lake in question to standards, if they exist, to other lakes, or to criteria that most limnologists agree upon. There are no nutrient standards for Indiana lakes so we must compare the Simonton Lake results with data from other lakes and with generally accepted criteria.

Comparison with Vollenweider's Data

Results of studies conducted by Richard Vollenweider in the 1970's are often used as guidelines for evaluating concentrations of water quality parameters. His results are given in Table 10. Vollenweider relates the concentrations of selected water quality parameters to a lake's *trophic state*. The trophic state of a lake refers to its overall level of nutrition or biological productivity. Trophic categories include: *oligotrophic, mesotrophic, eutrophic* and *hypereutrophic*. Lake conditions characteristic of these trophic states are:

Oligotrophic - lack of plant nutrients keep productivity low, lake contains oxygen at all depths, clear water, deeper lakes can support trout.
Mesotrophic - moderate plant productivity, hypolimnion may lack oxygen in summer, moderately clear water, warm water fisheries only - bass and perch may dominate.
Eutrophic - contains excess nutrients, blue-green algae dominate during summer, algae scums are probable at times, hypolimnion lacks oxygen in summer, poor transparency, rooted macrophyte problems may be evident.
Hypereutrophic - algal scums dominate in summer, few macrophytes, no oxygen in hypolimnion, fish kills possible in summer and under winter ice.

The units in the table are in micrograms per liter (μg/L). Remember that these are only guidelines – similar concentrations in Simonton Lake may not cause problems if something else is limiting the growth of algae or rooted plants.

Table 10. Mean values of select water quality parameters and their relationship to lake production. (after Vollenweider, 1975).

Parameter	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Total Phosphorus (μg/L or PPB)	8.0	26.7	84.4	>0.750
Total Nitrogen (μg/L or PPB)	661	753	1875	-
Chlorophyll *a* (μg/L or PPB)	1.7	4.7	14.3	-

Table 11 shows mean concentrations of total phosphorus, total nitrogen, and chlorophyll *a* for the Simonton Lake 07/06/10 samples. The last column shows Vollenweider's classification for each parameter listed. When compared to classification levels reported by Vollenweider in Table 10 above, the 2010 results for Simonton Lake were between the oligotrophic/mesotrophic ranges for total phosphorus, total nitrogen, and chlorophyll *a*. Keep in mind that the 2010 data sampling was completed immediately following the July 4th weekend. Nutrient levels in the water column would have been at or close to their greatest concentrations at this time.

The total nitrogen to total phosphorus ratios of 40N:1P for the east basin and 35N:1P for west basin show strong phosphorus limitation in Simonton Lake. This means that if more phosphorus is added to Simonton Lake, it will stimulate the growth of more algae.

Therefore, phosphorus management and control should be a central part of any management plan. Phosphorus can enter the lake from outside sources like fertilizer use on the shorelines, animal waste (including human), and from the recycling of particulate phosphorus bound to sediment on the lake bed. When sediments get agitated or suspended by motor boat props into the water column, the phosphorus can again become available for algae production.

Table 11. Summary of mean total phosphorus, total nitrogen, Secchi disc transparency, and Chlorophyll *a* results for Simonton Lake in Elkhart, IN. West Basin (Basin 1); East Basin (Basin 2).

Parameter	Basin 1	Basin 2	Vollenweiders' classification
Total Phosphorus (µg/L or PPB)	26.5	20	Mesotrophic
Total Nitrogen (µg/L or PPB)	1064.9	696.6	Mesotrophic
Chlorophyll *a* (µg/L or PPB)	0.75	1.56	Oligotrophic
Sediment phosphorus release factor[1]	0.67	n/a	n/a

[1]Hypo SRP concentration/Epi SRP concentration.

Comparison with Other Indiana Lakes

A wide variety of conditions, including geography, morphometry, time of year, and watershed characteristics, can influence the water quality of lakes. Thus, it is difficult to predict and even explain the reasons for the water quality of a given lake. To help place lake data into perspective, consider the following data for 456 Indiana lakes collected during July and August 1994-2004 under the Indiana Clean Lakes Program (Table 12). The set of data summarized in the table represent median values of epilimnetic and hypolimnetic samples for each of the 456 lakes.

Table 12. Water Quality Characteristics of 456 Indiana Lakes Sampled From 1994 through 2004 by the Indiana Clean Lakes Program. Medians of epilimnion and hypolimnion samples were used. Simonton Lake West Basin (Basin 1) data (taken July 6, 2010) are shown in bold on the last line of the table.

	Secchi Disc (ft)	NO_3 (mg/L)	NH_4 (mg/L)	TKN (mg/L)	SRP (mg/L)	TP (mg/L)	Chl *a*	Plankton	Bl-Green Dominance (%)
Median	6.9	0.275	0.818	1.66	0.12	0.17	12.9	35570	53.8
Maximum	32.8	9.4	22.5	27.05	2.84	2.81	380.4	753170	100
Minimum	0.3	0.01	0.004	0.230	0.01	0.01	0.013	39	0.08
Simonton	**5.6**	**0.30**	**0.23**	**0.60**	**0.0075**	**0.03**	**3.97**	**3401**	**74**

Simonton Lake's values for these water quality parameters were lower than these median statewide values for all the parameters except NO_3 and % dominance of blue-green algae (cyanobacteria). However, algal densities in Simonton Lake were relatively low so having the blue-greens being the most abundant phyla observed is relatively insignificant. The lower Secchi disc transparency in Simonton Lake means that the lake is more turbid than the statewide median (Table 13). The extensive shallows within the lake allow for wind to resuspend sediments from the lake bottom and this is likely causing higher turbidity in the lake since low algal and chlorophyll *a* concentrations suggest that algal productivity isn't adding significantly to the lake's turbidity.

Table 13. Comparison of Simonton Lake to the Median for All Indiana Lakes for Selected Water Parameters. Note: Samples collected on July 6, 2010 after above normal boating traffic during the July 4th weekend. Other Secchi disk readings during the summer ranged from 6.2-8.5 making Simonton Lakes Secchi Disc better than most Indiana Lakes.

Lake	Secchi Disc	NO_3	NH_4	TKN	SRP	Total Phos.	Chl *a*	Plankton	Bl-green dominance
Simonton	worse	worse	better	better	better	better	better	better	worse

Using a Trophic State Index

The large amount of water quality data collected during lake water quality assessments can be confusing to evaluate. Because of this, Indiana and many other states use a trophic state index (TSI) to help evaluate water quality data. A TSI condenses water quality data into a single, numerical index. Different index (or eutrophy) points are assigned for various water quality concentrations. The index total, or TSI, is the sum of individual eutrophy points for a lake.

The Indiana TSI

The Indiana TSI (IDEM, 1986) ranges from 0 to 75 total points. The TSI totals are grouped into the following four lake quality classifications:

TSI Total	Water Quality Classification
0-15	highest quality (oligotrophic)
16-30	intermediate quality (mesotrophic)
31-45	low quality (eutrophic)
46-60	lowest quality (hypereutrophic)

A rising TSI score for a particular lake from one year to the next indicates that water quality is worsening while a lower TSI score indicates improved conditions. However, natural factors such as climate variation can cause changes in TSI score that do not necessarily indicate a long-term change in lake condition. Parameters and values used to calculate the Indiana TSI are given in Table 14.

Table 14. The Indiana Trophic State Index

Parameter and Range	Eutrophy Points
I. Total Phosphorus (ppm)	
A. At least 0.03	1
B. 0.04 to 0.05	2
C. 0.06 to 0.19	3
D. 0.2 to 0.99	4
E. 1.0 or more	5

II.	Soluble Phosphorus (ppm)		
	A.	At least 0.03	1
	B.	0.04 to 0.05	2
	C.	0.06 to 0.19	3
	D.	0.2 to 0.99	4
	E.	1.0 or more	5
III.	Organic Nitrogen (ppm)		
	A.	At least 0.5	1
	B.	0.6 to 0.8	2
	C.	0.9 to 1.9	3
	D.	2.0 or more	4
IV.	Nitrate (ppm)		
	A.	At least 0.3	1
	B.	0.4 to 0.8	2
	C.	0.9 to 1.9	3
	D.	2.0 or more	4
V.	Ammonia (ppm)		
	A.	At least 0.3	1
	B.	0.4 to 0.5	2
	C.	0.6 to 0.9	3
	D.	1.0 or more	4
VI.	Dissolved Oxygen: Percent Saturation at 5 feet from surface		
	A.	114% or less	0
	B.	115% 50 119%	1
	C.	120% to 129%	2
	D.	130% to 149%	3
	E.	150% or more	4
VII.	Dissolved Oxygen: Percent of measured water column with at least 0.1 ppm dissolved oxygen		
	A.	28% or less	4
	B.	29% to 49%	3
	C.	50% to 65%	2
	D.	66% to 75%	1
	E.	76% 100%	0
VIII.	Light Penetration (Secchi Disc)		
	A.	Five feet or under	6
IX.	Light Transmission (Photocell): Percent of light transmission at a depth of 3 feet		
	A.	0 to 30%	4
	B.	31% to 50%	3
	C.	51% to 70%	2
	D.	71% and up	0

X. Total Plankton per liter of water sampled from a single vertical tow between the 1% light level and the surface:

A.	less than 3,000 organisms/L	0
B.	3,000 - 6,000 organisms/L	1
C.	6,001 - 16,000 organisms/L	2
D.	16,001 - 26,000 organisms/L	3
E.	26,001 - 36,000 organisms/L	4
F.	36,001 - 60,000 organisms/L	5
G.	60,001 - 95,000 organisms/L	10
H.	95,001 - 150,000 organisms/L	15
I.	150,001 - 5000,000 organisms/L	20
J.	greater than 500,000 organisms/L	25
K.	Blue-Green Dominance: additional points	10

The Indiana TSI score for Simonton Lake's west basin on July 6, 2010 was 22. This value would be considered in the mesotrophic classification. The Indiana TSI has not been statistically validated. It tends to rely too heavily on algae and does not weigh poor transparency or nutrients high enough in the total score. For these reasons, the Carlson TSI may be more appropriate to use in evaluating Indiana lake data.

The Carlson TSI

The most widely used and accepted TSI is one developed by Bob Carlson (1977) called the Carlson TSI. Carlson analyzed summertime total phosphorus, chlorophyll *a*, and Secchi disc transparency data for numerous lakes and found statistically significant relationships among the three parameters. He developed mathematical equations for these relationships and these form the basis for the Carlson TSI. Using this index, a TSI value can be generated by one of three measurements: Secchi disc transparency, chlorophyll *a* or total phosphorus. Data for one parameter can also be used to predict a value for another. The TSI values range from 0 to 100. Each major TSI division (10, 20, 30, etc.) represents a doubling in algal biomass (Figure 20).

As a further aid in interpreting TSI results, Carlson's scale is divided into four lake productivity categories: oligotrophic (least productive), mesotrophic (moderately productive); eutrophic (very productive) and hypereutrophic (extremely productive).

Using Carlson's index, a lake with a summertime Secchi disc depth of 3 feet would have a TSI of 60 points (located in line with the 1 meter). This lake would be in the mesotrophic category. Because the index was constructed using relationships among transparency, chlorophyll, and total phosphorus, a lake having a Secchi disc depth of 3 feet would also be expected to have approximately 20 µg/L chlorophyll *a*and 50 µg/L total phosphorus.

Not all lakes have the same relationship between transparency, chlorophyll and total phosphorus as Carlson's lakes do. Other factors such as high suspended sediments or heavy predation of algae by zooplankton may keep chlorophyll concentrations lower than might be otherwise expected from the total phosphorus or chlorophyll concentrations. High suspended sediments would also make transparency worse than otherwise predicted by Carlson's index.

It is also useful to compare the actual trophic state points for a particular lake from one year to the next to detect any trends in changing water quality. While climate and other natural events will cause some variation in water quality over time (possibly 5-10 trophic points), larger point changes may indicate important changes in lake quality.

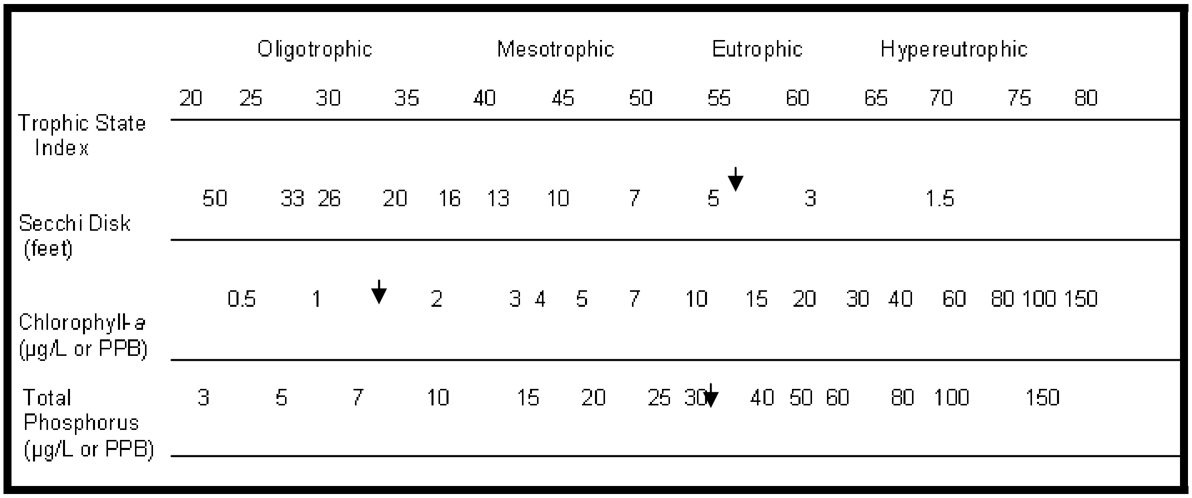


Figure 20. Carlson's Trophic State Index with Simonton Lake Basin (west basin) One 2010 scores indicated with arrows. Note: Secchi disc reading used in this figure taken on July 6th (other readings the same summer ranged from 6.2 to 8.5).

Simonton Lake's Carlson TSI classification for chlorophyll is in the oligotrophic range. This indicates that there is a low amount of algae production in the lake. There is enough total phosphorus in Simonton Lake to yield a classification between the mesotrophic and eutrophic classifications so something else must have been limiting the growth of algae on July 6, 2010. We suspect that low transparency (nearly to the eutrophic classification in the figure above) was likely due to re-suspended sediments in this shallow lake that may have contributed to less light available to grow algae. The sediments were likely suspended during the heavy boat traffic (over 300 boats) documented using the lake two days before the sampling event.

2.4.4 Lake Water Quality Assessment Summary

Overall, the water quality of Simonton Lake is much better than most of Indiana's lakes. The lake can be considered as mesotrophic based upon the 2010 data. The low volume of surface runoff into the lake helps reduce the delivery of nutrients into the lake. Some of the phosphorus loading apparently settles out of the water column down into the deeper waters, where it doesn't contribute to algae growth. Simonton Lake will continue to encounter fluctuations of water quality due to the developed shoreline. The use of fertilizer for lawn and garden maintenance will contribute to phosphorus and nitrogen loading to the lake over the years but can be managed.

While Simonton Lake enjoys good water quality today, the signs suggest that the lake may degrade in the future. The continued development of the shoreline is a threat to the water quality of Simonton Lake. While the data presented in this report show no alarming patterns of water quality degradation they do however, show some areas of concern:

1. The very deepest water contains no oxygen. This is due to the decomposition of organic matter on the sediments by bacteria that consume oxygen in the process. The sources of this organic matter are likely algae and rooted plants produced within the lake, and organic material washed into the lake from the developed watershed.
2. Anoxic conditions in the hypolimnion allow ammonia concentrations to accumulate and increase.
3. Anoxic conditions in the hypolimnion may have allowed phosphorus release from the sediments during previous years' sampling. However, there was no evidence of this on our 2010 sampling date. Internal phosphorus release from the sediments can help fuel algal growth and this, along with hypolimnetic oxygen concentrations should be monitored in the future.
4. Blue-green algae have come to dominate the phytoplankton of Simonton Lake. Although total algal concentrations were relatively low, the dominance of blue-greens suggests that this phylum is positioned to become a nuisance within the lake should phosphorus concentrations increase in the future.

2.5 Water Budget

Inputs of water to Simonton Lake are limited to:

1. direct precipitation to the lake
2. discharge from the inlet stream (very limited)
3. sheet runoff from land immediately adjacent to the lake
4. groundwater

Water leaves the lake system from:

1. evaporation
2. discharge from the lake's outlet channel
3. groundwater

There are no discharge gages in the watershed to measure water inputs and the limited scope of this study did not allow us to determine quantitatively annual water inputs or outputs. Therefore we must estimate the water budget for lakes from other records.

- Direct precipitation to the lakes can be calculated from mean annual precipitation falling directly on the lakes' surface.
- Runoff from the lakes' watershed can be estimated by applying runoff coefficients. A runoff coefficient refers to the percentage of precipitation that occurs as surface runoff, as opposed to that which soaks into the ground. Runoff coefficients may often be estimated by comparing discharge from a nearby USGS gaged watershed of similar land and topographic features, to the total amount of precipitation falling on that watershed. This approach does not work with Simonton Lake because there is very little topographic relief within the watershed and very little surface outflow from the lake.
- As an alternative to using and extrapolating USGS discharge data, we ran the HYMAPS-OWL on-line model (Engel and Harbor, 2010). Although the delineation tool could not accurately delineate the entire watershed of Simonton Lake due to the extremely low relief, it succeeded in delineating 80% of the watershed. The model estimated that 5.6% of precipitation within the watershed would run off into the lake. While this could still overestimate runoff, given the lack of surface outflow, it seems more reasonable than the 32% runoff coefficient derived from extrapolating USGS discharge data.

- Groundwater records do not exist for the lake, so we have assumed that groundwater inputs equal outputs. Although local residents and older reports have said that Simonton Lake is spring fed, hydrogeologic reports (Fenelon and Bobay, 1994) state that the surficial sand and gravel aquifer beneath Simonton Lake is unconfined and is recharged by precipitation falling on higher ground. Good wells can produce up to 2,000 gallons per minute. A lake situated in this aquifer could very well be strongly influenced by groundwater.
- We can estimate evaporation losses by applying evaporation rate data to the lakes. Evaporation rates are determined at six sites around Indiana by the National Oceanic and Atmospheric Administration (NOAA). The nearest site to the study lakes is located in Valparaiso, Indiana. Annual evaporation from a 'standard pan' at the Valparaiso site averages 29.43 inches per year. Because evaporation from the standard pan overestimates evaporation from a lake by about 30%, we correct the evaporation rate by this percentage, which yields an estimated evaporation rate from the lake surface of 20.32 inches per year. Multiplying this rate times the surface area of each lake yields an estimated volume of evaporative water loss from the study lakes.

The water budget for Simonton Lake, based on the assumptions discussed above, is shown in Table 15. When the volume of water flowing out of Simonton Lake is divided by the lake's volume, a *hydraulic residence time* of 1.2 years results. This means that on average, water entering the lake stays in the lake for more than one year before it flows out. This hydraulic residence time is shorter than other glacial lakes in this part of the country. In a study of 95 north temperate lakes in the U.S., the mean hydraulic residence time for the lakes was 2.12 years (Reckhow and Simpson, 1980). Most glacial lakes have a watershed area to lake surface area ratio of around 10:1 (Vant, 1987). Simonton Lake, with a watershed area to lake surface area ratio of 18.5:1, has a larger watershed than the average cited in Vant, and because of its mean depth of only 12.1 feet, the relatively small volume of Simonton Lake contributes to its shorter hydraulic residence time. Without accurate groundwater data, this water budget should be considered as very preliminary.

Table 15. Water Budget Calculations for Simonton Lake.

Watershed	Simonton Lake
Watershed size (ac)	5233
Mean watershed runoff (ac-ft/yr)	890
Lake volume (ac-ft)	2686

Mean ppt (in/yr)[a]	36.60
Mean watershed runoff (in/yr)[b]	2.04
Watershed C	0.056

Pan evaporation (in/yr)[c]	29.43
Pan evaporation coefficient	0.70
Lake surface area (acres)	301
Estimated lake evaporation (ac-ft)	520
Direct precipitation to lake (ac-ft)	924

(blue)	= input data
(yellow)	= output data

Water Budget Summary	
Direct precipitation to lake (ac-ft)	924
Runoff from watershed (ac-ft)	890
Evaporation (ac-ft)	520
TOTAL LAKE OUTPUT (ac-ft)	1294

Hydraulic residence time (yr)	1.2

[a] Indiana State Climate Office, 30-year mean
[b] Engel and Harbor (2010)
[c] National Climate Data Center, for 2009

2.6 Macrophyte Inventory

2.6.1 Macrophyte Inventory Introduction

There are many reasons to conduct an aquatic rooted plant survey as part of a complete assessment of a lake and its watershed. Like other biota in a lake ecosystem (e.g. fish, microscopic plants and animals, etc.), the composition and structure of the lake's rooted plant community often provide insight into the long term water quality and health of a lake. While sampling the lake water's chemistry (dissolved oxygen, nutrient concentrations, etc.) is important, water chemistry sampling offers a single snapshot of the lake's condition. Because rooted plants live for many years in a lake, the composition and structure of this community reflects the water quality of the lake over a longer term. For example, if one samples the water chemistry of a typically clear lake immediately following a major storm event, the results may suggest that the lake suffers from poor clarity. However, if one examines the same lake and finds that rooted plant species such as northern watermilfoil, white-stem pondweed, and large-leaf pondweed, all of which prefer clear water, dominate the plant community, one is more likely to conclude that the lake is typically clear and its current state of turbidity is due to the storm rather than being its inherent nature.

The composition and structure of a lake's rooted plant community also help determine the lake's fish community composition and structure. Submerged aquatic vegetation provides cover from predators and is a source of forage for many different species of fish (Valley et al., 2004). However, extensive and dense stands of invasive aquatic vegetation can have a negative impact on the fish community. For example, a lake's bluegill population can become stunted because dense vegetation reduces their foraging ability, resulting in slower growth. Vegetation removal can have variable results on improving fish growth rates (Cross et al., 1992, Olsen et al., 1998). Conversely, lakes with depauperate plant communities may have difficulty supporting some top predators that require emergent vegetation for spawning. In these and other ways, the lake's rooted plant community can help to explain a lake's fish community composition and structure.

A lake's rooted plant community can impact the recreational uses of the lake as well. Swimmers and power boaters desire lakes that are relatively plant-free, at least in certain portions of the lake. In contrast, anglers prefer lakes with adequate rooted plant coverage, since those lakes offer the best fishing opportunity. Before lake users can develop a realistic management plan for a lake, they must understand the existing rooted plant community and how to manage that community. This understanding is necessary to achieve the recreational goals lake users may have for a given lake.

For the reasons outlined above, as well as several others, JFNew conducted a general macrophyte (rooted plant) survey on Simonton Lake as part of the overall lake and watershed diagnostic study. Before detailing the results of the macrophyte survey, it may be useful to outline the conditions under which lakes may support macrophyte growth. Additionally, an understanding of the role that macrophytes play in a healthy, functioning lake ecosystem is necessary for lake users to manage the lake's macrophyte community. The following paragraphs provide some of this information.

Conditions for Growth

Like terrestrial vegetation, aquatic vegetation has several habitat requirements that need to be satisfied in order for the plants to grow or thrive. Aquatic plants depend on sunlight as an energy source. The amount of sunlight available to plants decreases with depth of water as algae, sediment, and other suspended particles block light penetration. Consequently, most aquatic plants are limited to maximum water depths of approximately 10-15 feet (3-4.5 m), but some species, such as Eurasian watermilfoil, have a greater tolerance for lower light levels and can grow in water deeper than 32 feet (10 m) (Aikens et al., 1979). Hydrostatic pressure rather than light often limits plant growth in deeper water (15-20 feet or 4.5-6 m).

Water clarity affects the ability of sunlight to reach plants, even those rooted in shallow water. Lakes with clearer water have an increased potential for plant growth. Simonton Lake possesses slightly better water clarity than the average northern Indiana lakes. The Secchi disc depth measured in Simonton Lake during the spring plant survey was 8.5 feet (2.59 m). During the summer survey, Secchi disc depth decreased slightly to 6.2 feet (1.89 m). As a general rule, rooted plant growth is restricted to the portion of the lake where water depth is less than or equal to 2 to 3 times the lake's Secchi disc depth. This was generally true in Simonton Lake because rooted aquatic plants were observed at 15-16 feet (5 m).

Aquatic plants also require a steady source of nutrients for survival. Many aquatic macrophytes differ from microscopic algae (which are also plants) in their uptake of nutrients. Aquatic macrophytes receive most of their nutrients from the sediments via their root systems rather than directly utilizing nutrients in the surrounding water column. Some competition with algae for nutrients in the water column does occur. The amount of nutrients taken from the water column varies for each macrophyte species. Because macrophytes obtain most of their nutrients from the sediments, lakes which receive high watershed inputs of nutrients to the water column will not necessarily have aquatic macrophyte problems.

A lake's substrate and the forces acting on the substrate also affect a lake's ability to support aquatic vegetation. Lakes with mucky, organic, nutrient-rich substrates have an increased potential for plant growth compared to lakes with gravelly, rocky substrates. Sandy substrates that contain sufficient organic material typically support healthy aquatic plant communities. Lakes that have significant wave action that disturb the bottom sediments have decreased ability to support plants. Disturbance of bottom sediment may decrease water clarity, limiting light penetration, or may affect the availability of nutrients for the macrophytes. Wave action may also create significant shearing forces prohibiting plant growth altogether.

Boating activity may affect macrophyte growth in conflicting ways. Rooted plant growth may be limited if boating activity regularly disturbs bottom sediments. Alternatively, boating activity in rooted plant stands of species that can reproduce vegetatively, such as Eurasian watermilfoil or coontail, may increase macrophyte density rather than decrease it.

Herbicide treatment can also affect the presence and distribution of aquatic macrophytes within a lake. As species or areas are selectively treated, the density and diversity of plants present within those locations can, and typically do change. For example, continuing to treat a specific plant bed which contains Eurasian watermilfoil can result in the disappearance of Eurasian watermilfoil and the resurgence of a variety of native species. It should be noted, however, that non-native plants can invade and grow in treated areas just as easily as native plants.

Ecosystem Roles and Functions

Aquatic plants are a beneficial and necessary part of healthy lakes. Plants stabilize shorelines holding bank soil with their roots. The vegetation also serves to dissipate wave energy further protecting shorelines from erosion. Plants play a role in a lake's nutrient cycle by up-taking nutrients from the sediments. Like their terrestrial counterparts, aquatic macrophytes produce oxygen which is utilized by the lake's fauna. Plants also produce flowers and unique leaf patterns that are aesthetically attractive.

Emergent and submergent plants provide important habitat for fish, insects, reptiles, amphibians, waterfowl, shorebirds, and small mammals. Fish utilize aquatic vegetation for cover from predators and for spawning and rearing grounds. Different species depend upon different percent cover of these plants for successful spawning, rearing, and protection for predators. For example, bluegill require an area to be approximately 15-30% covered with aquatic plants for successful survival, while northern pike achieve success in areas where rooted plants cover 80% or more of the area (Borman et al., 1997).

Aquatic vegetation also serves as substrate for aquatic insects, the primary diet of insectivorous fish. Waterfowl and shorebirds depend on aquatic vegetation for nesting and brooding areas. Aquatic plants such as pondweed, coontail, duckweed, watermilfoil, and arrowhead, also provide a food source to waterfowl. Duckweed in particular has been noted for its high protein content and consequently has served as feed for livestock. Turtles and snakes utilize emergent vegetation as basking sites. Amphibians rely on the emergent vegetation zones as primary habitat.

2.6.2 Macrophyte Inventory Methods

JFNew surveyed the Simonton Lake plant community on May 27 and August 27, 2010 according to the Indiana Department of Natural Resources sampling protocols (IDNR, 2007). JFNew examined the entire littoral zone of the lake during each of the assessments. Surveys were completed using the Tier II survey protocol updated by the IDNR LARE staff in May 2007 (IDNR 2007). The survey protocol generally follows previous Tier II protocols and requires that the sampling points be stratified over the entire depth of the lake's littoral zone. As defined in the DNR protocol, the lake's littoral zone was estimated to be approximately three times the lake's Secchi disc depth. This estimate approximates the 1% light level, or the level at which light penetration into the water column is sufficient to support plant growth. Total points sampled per stratum were determined as follows:

1. Appendix D of the IDNR protocol was consulted to determine the number of points to be sampled and the maximum sampling depth. This determination was based on the lake size (surface area) and trophic status.
2. Table 3 of the IDNR protocol was referenced as an indicator of the number of sample points per stratum. Table 16 in this report lists the sampling strategy for Simonton Lake.

Stratum refers to depth at which plants were observed. Dominance presented in subsequent tables was calculated by the IDNR protocol. The frequency per species presented in subsequent tables provides a measure of the frequency of a species in each stratum.

Table 16. Tier II sampling strategy for Simonton Lake using the 2007 Tier II protocol. Note: The average summer Secchi disc reading from 1988-2010 was 5.5 feet (1.67 m)

Lake	Size	Trophic Status	Number of Points	Stratification of Points
Simonton	301 acres	Mesotrophic	70	40 pts 0-5 foot stratum 20 pts 5-10 foot stratum 10 pts 10-15 foot stratum

2.6.3 Macrophyte Inventory Results

A spring Tier II survey and a summer Tier II survey were completed on Simonton Lake in 2010 (Table 17). A total of seventy points were surveyed throughout the littoral zone on each survey date. The littoral zone for Simonton Lake sampling was determined by multiplying average summertime Secchi disc reading from 1988 to 2010 of 5.5 by three (as per the DNR protocol) and sampling to the nearest five foot interval on the bathymetric map. Aquatic plants were found at 64 points in the spring survey and 62 sites in the summer survey. When combining the surveys, aquatic plants were found at each of the seventy survey sites. Eleven different aquatic submersed species were collected in May and twelve different submersed aquatic species were collected in August. In all, 16 different submersed aquatic species were collected from the two surveys. Of the species collected, four are considered invasive: Eurasian watermilfoil *(Myriophyllum spicatum),* curly-leaf pondweed *(Potamogeton crispus)*, and brittle naiad (*Najas minor)* and spiny naiad (*Najas marina)*. Also, one state listed threatened species white-stem pondweed (*Potamogeton praelongus*) was found in the lake in two isolated locations.

Table 17. Survey schedule of Tier II surveys.

Survey	Date
Spring Tier II and community survey	May 27, 2010
Summer Tier II and community survey	August 27, 2010

Floating leaf and emergent vegetation data was also collected during this survey. Seven emergent species were noted bordering Simonton Lake's edges, and only two floating leaf species were observed in the lake. It is important to note that there are significantly fewer floating aquatic species that are native to Indiana lakes compared to the number of emergent and submersed plant species. Consequently, many lakes possess low numbers of floating species. Both species of floating leaf plants were common throughout the two basins (spatterdock and white water lily). The most common emergent species include two cattail species and arrowhead.

Simonton Lake's rooted plant community reflects good native species richness. Muskgrass was by far the most dominant submersed species found in each survey. In the May survey, muskgrass and sago pondweed were the dominate species collected, with muskgrass being found at 39 survey points. In the August survey, muskgrass remained fairly dominant; however there were almost equal sites with slender water naiad. Muskgrass and slender water naiad were both found at 33 and 34 survey points respectively. Water celery, sago pondweed, spiny naiad, and variable-leaf pondweed are also important components of the Simonton Lake submerged community. There were fewer plants identified during the May survey, but there were four species identified during the May survey that were not found during the August survey. Also, there were five species identified during the August survey that were not found during the May survey. See Table 18 for these species.

Rare Species Presence

White-stem pondweed *(Potamogeton praelongus)* was found at two survey points during the summer survey (Figure 21). This plant has been listed as threatened in the state of Indiana (IDNR 2010). White-stem pondweed prefers clear and neutral to alkaline waters (Flora of North America). It is fairly easy to identify by its clasping leaf base and leaf tip. This is the only pondweed species that has these two characteristics. If found, please leave it undisturbed. No other rare aquatic plant species were collected during the survey.

Figure 21. White-stem pondweed *(Potamogeton praelongus)* a state threatened submersed plant species found on Simonton Lake, August 27, 2010. Photo from http://plants.usda.gov/java/profile?symbol=POPR5

Table 18. Aquatic plant species observed in Simonton Lake during the spring and summer surveys completed May 27 and August 27, 2010.

Scientific Name	Common Name	Stratum	Spring	Summer
Chara spp.	Musk grass	Submergent	X	X
Elodea canadensis	Common waterweed	Submergent	X	X
Myriophyllum sibiricum	Northern watermilfoil	Submergent	X	
Myriophyllum heterophyllum	Variable watermilfoil	Submergent	X	X
Myriophyllum spicatum [I]	Eurasian watermilfoil [I]	Submergent	X	X
Najas minor [I]	Brittle naiad [I]	Submergent	X	
Nitella spp.	Nitella spp.	Submergent	X	
Potamogeton crispus [I]	Curly-leaf pondweed [I]	Submergent	X	
Potamogeton gramineus	Variable-leaf pondweed	Submergent	X	X
Stukenia pectinata	Sago pondweed	Submergent	X	X
Vallisneria americana	Water celery	Submergent	X	X
Potamogeton illinoensis	Illinois pondweed	Submergent		X
*Potamogeton praelongus**	White-stem pondweed*	Submergent		X
Najas flexilis	Slender water nymph	Submergent		X
Najas guadalupensis	Southern water nymph	Submergent		X
Ceratophyllum demersum	Coontail	Submergent	X	X
Nuphar advena	Spatterdock	Floating-leaf	X	X
Nymphaea tuberosa	White water lily	Floating-leaf	X	X
Sagittaria latifolia	Broadleaf arrowhead	Emergent	X	X
Scirpus pungens	Chairmakers rush	Emergent	X	X
Scirpus validus	Soft stem bulrush	Emergent	X	X
Typha angustifolia	Narrow-leaf cattail	Emergent	X	X
Typha latifolia	Broad-leaf cattail	Emergent	X	X
Iris spp.	Iris	Emergent	X	X
Juncus spp.	Rush	Emergent	X	X
Najas marina	Spiny naiad	Submersed		X

* indicates State threatened species
[I] indicates invasive species

2.6.4 Exotic (Invasive) Species Mapping

No areas of invasive species were mapped on Simonton Lake. All invasive species observed were found to be sparsely populated and, therefore, no aquatic plant beds were mapped. However, invasive species presence was noted and detailed in Table 19.

Eurasian watermilfoil was discovered at eight points around the lake with the majority of detections on the east side of the east basin (Figure 22). Curly-leaf pondweed was found at four survey points in the western basin. Three of the points were near the south-southwest side of the lake and one point was on the north side of the western basin (Figure 23). Brittle naiad was discovered at seven points with the majority of detections found in and near the channel between the two basins and on the east side of the eastern basin (Figure 24). Curly-leaf pondweed was only found in the May survey and all but one survey point of Eurasian watermilfoil was found during the May survey. There were no IDNR permitted herbicide treatments in the main body of the lake in 2010; however, the channels in the east basin were treated in June. It is possible that private landowners treated additional areas around the lake.

Table 19. Invasive plant species observed in Simonton Lake during surveys completed on May 27 and August 27, 2010.

Scientific Name	Common Name	Stratum	May	August
Myriophyllum spicatum	Eurasian watermilfoil	Submersed	X	X
Potamogeton crispus	Curly-leaf pondweed	Submersed	X	
Najas minor	Brittle Naiad	Submersed	X	
Najas marina	Spiny Naiad	Submersed		X

Tier II Survey General Description

Tier II surveys are usually completed in order to document changes in the plant community resulting from aquatic herbicide treatment. The spring survey serves as a pre-herbicide treatment survey and the summer survey serves as a post-treatment survey. Two Tier II surveys were completed on Simonton Lake even though there were no DNR permitted treatments on the two main basins of the lake. The only treatments that were permitted for 2010 were for 9.3 acres in the channels in the eastern basin. This treatment would not have affected this survey. The data collected is however, useful for documenting seasonal variation in the native plant community and creating baseline data for future surveys. This information is also used to make better management decisions for the future. Also, by conducting the spring survey in May, we were able to collect data for curly-leaf pondweed during the peak growing season for this particular species.

Spring Tier II Survey Details

JFNew conducted the spring Tier II survey on Simonton Lake on May 27, 2010. Transparency was 8.5 feet (4.4 m) at the deepest spot in the lake as measured with a Secchi disc prior to the sampling event. Plants were sampled to a maximum depth of 15 feet (4.6 m) at seventy randomly selected sites within the littoral zone. Results of the sampling are listed in Table 20 and Appendix A.

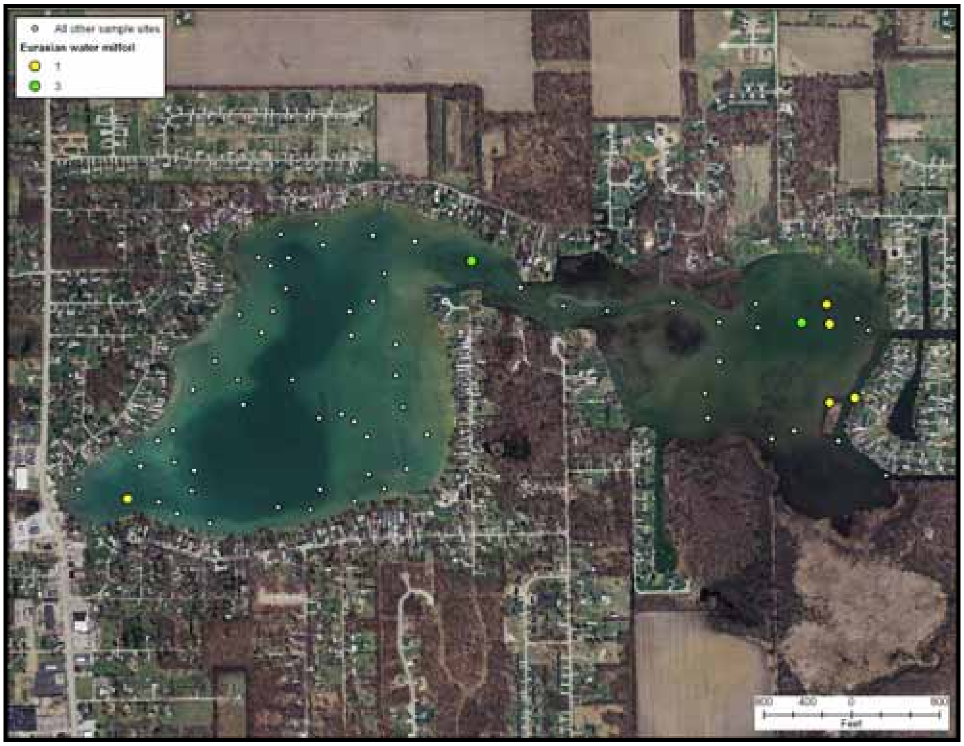


Figure 22. Complete map of all locations sampled during the Simonton Lake spring Tier II survey which occurred on May 27, 2010 also showing locations and density of Eurasian watermilfoil.

Table 20. Simonton Lake spring Tier II survey metrics and data as collected May 27, 2010.

Occurrence and abundance of submersed aquatic plants in Simonton Lake								
County:	Elkhart	Sites with plants:		64	Mean species/site:			1.69
Date:	5/27/2010	Sites with native plants:		64	Standard error (ms/s):			0.13
Secchi (ft):	8.5	Number of species:		11	Mean native species/site:			1.53
Maximum plant depth (ft):	15.0	Number of native species:		9	Standard error (mns/s):			0.11
Trophic status:	Mesotrophic	Maximum species/site:		5	Species diversity:			0.82
Total sites:	70.0				Native species diversity:			0.78
All depths (0-15 feet)			**Frequency of**	**Rake score fequency per species**				**Plant**
Scientific Name	**Common Name**		**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Chara spp.	Muskgrass		55.7	44.3	35.7	20.0	0.0	19.1
Stukenia pectinata	Sago pondweed		34.3	65.7	34.3	0.0	0.0	6.9
Vallisneria americana	Water celery		20.0	80.0	20.0	0.0	0.0	4.0
Nitella spp.	Nitella spp.		12.9	87.1	12.9	0.0	0.0	2.6
Najas minor	Najas minor		10.0	90.0	10.0	0.0	0.0	2.0
Myriophyllum spicatum	Eurasian watermilfoil		10.0	90.0	7.1	2.9	0.0	3.1
Elodea canadensis	Common waterweed		7.1	92.9	5.7	1.4	0.0	2.0
Potamogeton gramineus	Variable-leaf pondweed		5.7	94.3	5.7	0.0	0.0	1.1
Potamogeton crispus	Curly-leaf pondweed		5.7	94.3	4.3	1.4	0.0	1.7
Myriophyllum heterophyllum	Variable-leaf watermilfoil		4.3	95.7	2.9	1.4	0.0	1.4
Myriophyllum sibiricum	Northern watermilfoil		2.9	97.1	2.9	0.0	0.0	0.6
Filamentous algae	Filamentous algae		17.10					

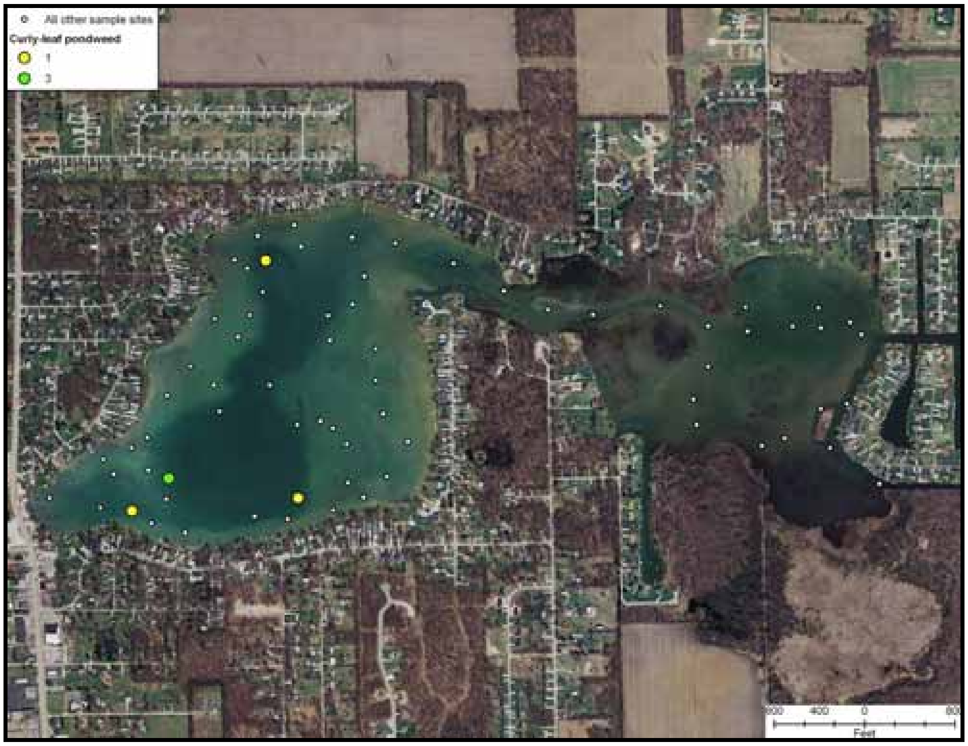


Figure 23. Curly-leaf pondweed locations in Simonton Lake as sampled during the spring Tier II survey which occurred on May 27, 2010.

Figure 24. Brittle Naiad locations in Simonton Lake as sampled during the spring Tier II surveys which occurred on May 27, 2010.

The spring survey revealed that Simonton Lake supports an extensive plant community. The community extends throughout the entire east basin, which is entirely within the littoral zone, and from the lake's shoreline to water approximately 15 feet deep in the western basin. This is consistent with the estimated extent of the littoral zone based on the lake's Secchi disc historic Secchi depth of 5.5 feet. A total of nine native submersed species were recorded during this survey along with three invasive species. The dominant plant species found were muskgrass and sago pondweed. Muskgrass was identified at 56% of the survey sites. The invasive species (curly-leaf pondweed, Eurasian watermilfoil, brittle naiad, and spiny naiad) were found in low abundance throughout the entire lake. The curly-leaf pondweed data is very important because the survey was completed during the peak growing season for the species. The low abundance of this species may be an encouraging sign that the population is being controlled.

Summer Tier II Survey

JFNew conducted the summer Tier II survey on Simonton Lake on August 27, 2010. Transparency was 6.2 feet (1.9 m at the deepest spot in the lake prior to the sampling event. Plants were again sampled to a depth of 15 feet (4.6 m) at 70 randomly selected sites within the littoral zone. Results of the sampling are listed in Table 21 and Appendix A.

Table 21. Simonton Lake summer Tier II survey metrics and data as collected August 27, 2010.

Occurrence and abundance of submersed aquatic plants in Simonton Lake								
County:	Elkhart	Sites with plants:		62	Mean species/site:			2.36
Date:	8/27/2010	Sites with native plants:		62	Standard error (ms/s):			0.16
Secchi (ft):	6.2	Number of species:		12	Mean native species/site:			2.34
Maximum plant depth (ft):	15.0	Number of native species:		0	Standard error (mns/s):			0.16
Trophic status:	Mesotrophic	Maximum species/site:		5	Species diversity:			0.84
Total sites:	70.0				Native species diversity:			0.84
All depths (0-15 feet)		Frequency of Occurrence	Rake score fequency per species					Plant Dominance
Scientific Name	Common Name		0	1	3	5		
Najas flexilis	Slender naiad	48.6	51.4	20.0	18.6	10.0		25.1
Chara spp.	Muskgrass	47.1	52.9	35.7	10.0	1.4		14.6
Vallisneria americana	Water celery	34.3	65.7	24.3	7.1	2.9		12.0
Najas marina	Spiny naiad	34.3	65.7	14.3	7.1	12.9		20.0
Potamogeton gramineus	Variable-leaf pondweed	34.3	65.7	30.0	4.3	0.0		8.6
Stuckenia pectinata	Sago pondweed	21.4	78.6	14.3	5.7	1.4		7.7
Myriophyllum heterophyllum	Variable-leaf watermilfoil	4.3	95.7	4.3	0.0	0.0		0.9
Elodea canadensis	Common waterweed	2.9	97.1	2.9	0.0	0.0		0.6
Najas guadalupensis	Southern naiad	2.9	97.1	1.4	1.4	0.0		1.1
Potamogeton praelongus	White-stem pondweed	2.9	97.1	2.9	0.0	0.0		0.6
Potamogeton illinoensis	Illinois pondweed	1.4	98.6	1.4	0.0	0.0		0.3
Myriophyllum spicatum	Eurasian watermilfoil	1.43	98.57	1.43	0.00	0.00		0.29
Filamentous algae		2.86						

The Secchi disc depth reading dropped slightly to 6.2 feet in the summer survey, which did not appear to affect species diversity. A total of eleven native species were observed during this survey along with only one invasive species. Muskgrass and slender naiad dominated the plant community with each species identified at about 50% of the survey sites. There were an additional five plant species identified during the summer survey (three naiad species and two pondweed species) that were not found in the spring. Several species from the spring survey that were not found in this survey included two invasive species (curly-leaf pondweed and brittle naiad). Eurasian watermilfoil was found in only one location compared to seven locations in the spring (Figure 25). One Indiana state threatened species, white-stem pondweed, was also identified during the summer survey. This plant was identified at two locations, one in each basin.

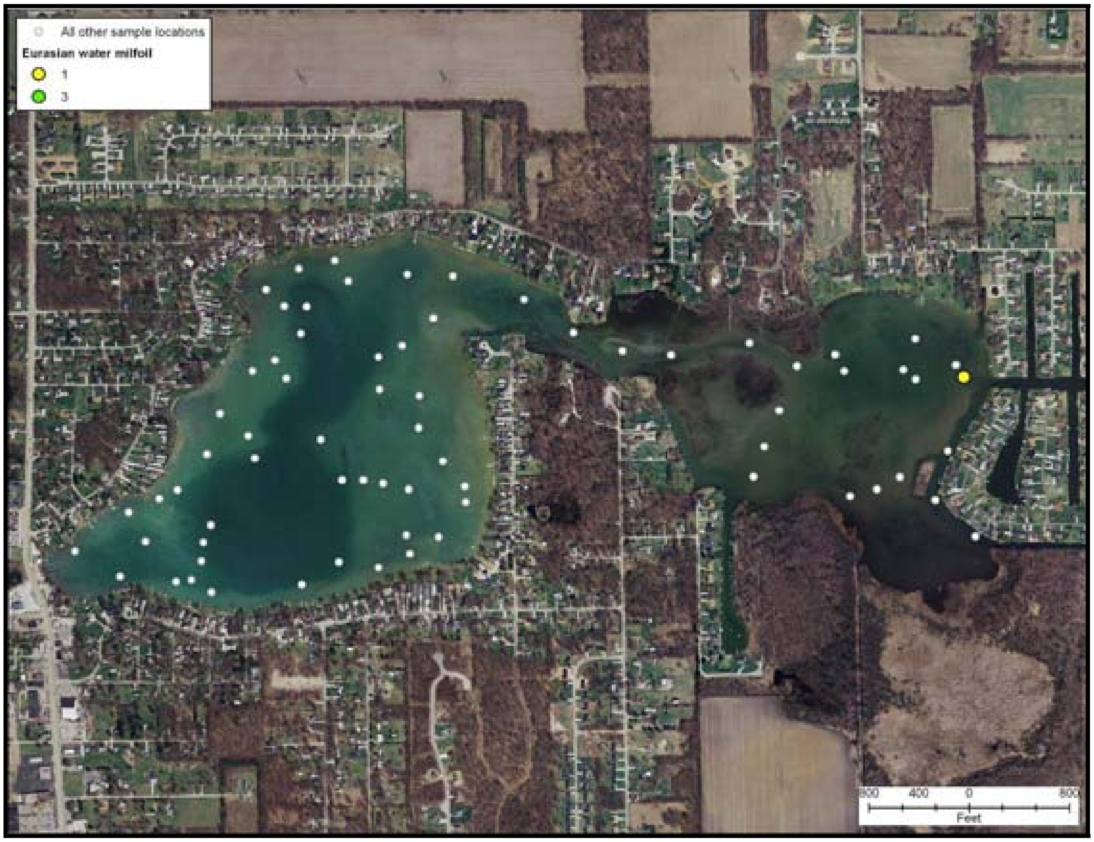


Figure 25. Locations sampled during the Simonton Lake summer Tier II survey which occurred on August 27, 2010 also showing the locations of Eurasian watermilfoil.

Comparison
Simonton Lake possessed a greater number of native species than northern Indiana lakes surveyed by Pearson (2004; Table 22). In addition, Simonton Lake had better native rake diversity than the lakes surveyed by Pearson (2004). Overall, Simonton Lake contained higher native species diversity and native species richness than the lakes surveyed by Pearson (2004).

Table 22. A comparison of the aquatic plant communities in Simonton Lake to the average values for plant community metrics found by Pearson (2004) in his survey of 21 northern Indiana lakes.

Metric	May 2010	August 2010	Indiana Average (2004)
Number of species collected	**11**	**12**	8
Number of native species collected	**9**	**11**	7
Species Richness (Avg. # species/site)	**1.69**	**2.36**	1.61
Native Species Richness	**1.53**	**2.34**	1.33
Rake Diversity (SDI)	**0.82**	**0.84**	0.62
Native Rake Diversity (SDI)	**0.78**	**0.84**	0.5

2.6.4 Macrophyte Inventory Discussion

As noted earlier in this section, the composition and structure of the lake's rooted plant community often reflect the long-term health of a lake. In some cases, problematic aquatic plant conditions indicate a larger and potentially more serious problem in a lake. Rooted aquatic plant data could be used to better understand the results of a chemical analysis of a lake as well as the overall health of the lake. This data may also help in confirming trends observed in historical data. Simonton Lake's historical rooted aquatic plant data prior to 2007 were not available for this study. Yet, these data serve as a baseline by which future variations in the plant community can be compared. Additionally, these data should allow for some determination of future changes in the plant community due to herbicide treatment or other factors (i.e. climate). With this limited data set, we can provide only a limited assessment of the plant communities in Simonton Lake.

Secchi disc transparency depths measured as part of the study indicated that Simonton Lake possessed good water clarity. The Secchi disc transparency depth recorded during the rooted plant survey was 8.5 feet in the spring and 6.2 feet in the summer. The plant community reflects the relatively stable water clarity documented in 2007 and in 2010. Several submersed aquatic plant species, white-stem pondweed, Illinois pondweed, and northern watermilfoil thrive in clear water (Boreman et al., 1997). Many of the other species found in Simonton Lake can tolerate more turbid conditions. Their presence is not necessarily an indication of turbid water, however, the combination of plants that cannot tolerate turbid water and others that can, may indicate a lake with good water clarity.

In general, Simonton Lake has good native plant diversity compared to other lakes in northern Indiana. The large littoral zone of the lake, especially in the east basin coupled with good Secchi depth readings should allow for this diversity to persist. However, the presence of invasive species and heavy recreational use may threaten the diversity in the future. Considering the number of spatial variables that impact the plant community such as boat-traffic and changes in nutrient availability or temporal variables such as climatic conditions, we cannot easily summarize the cause and effect for changes in the plant communities within Simonton Lake. Still, general trends emerge from the data that are useful for the purpose of management decisions. Table 23 details changes in the site frequency and dominance of Eurasian watermilfoil, curly-leaf pondweed, and brittle naiad in 2010 within Simonton Lake. Since we do not have any previous survey information for Simonton Lake other than 2007, we can only compare the 2010 spring and summer results to each other and to the 2007 results. Multiple years of aquatic macrophyte surveys are needed to accurately determine whether the water quality may be changing with time.

Table 23. Variation in site frequency and dominance of Eurasian watermilfoil, curly-leaf pondweed, and Brittle naiad within Simonton Lake during all assessments.

	Eurasian watermilfoil		Curly-leaf pondweed		Brittle naiad	
Date	Site Frequency	Dominance Index	Site Frequency	Dominance Index	Site Frequency	Dominance Index
5/27/2010	10.0	3.1	5.7	1.7	10.0	2.0
8/27/2010	1.43	.29	N/A	N/A	N/A	N/A
8/01/2007	13	3.8	2.9	.6	N/A	N/A

Muskgrass is the dominate macrophyte of Simonton Lake and is very beneficial to many organisms and functions associated with the lake. For one, muskgrass' reproductive structure is an excellent food source for waterfowl. Also many different fish species use muskgrass beds for cover and for a food source. Its structure also slows the movement of water and stabilizes the lake bottom, which therefore, helps the water quality and clarity of the lake (Boreman et al., 1997).

Four invasive species were discovered during the spring survey. In the summer survey, only Eurasian watermilfoil and spiny naiad were documented. It is uncertain why this happened. It is understandable that curly-leaf pondweed was not found because it dies back in the summer. However, it is strange that brittle naiad wasn't found, and that only one patch of Eurasian watermilfoil was found. One explanation could be the patchiness of the populations. The same GPS data points were surveyed on each survey date in 2010; however, precision sampling is difficult from a boat and the patches could be very small. Continued monitoring for the presence of these invasive species in the future summers is recommended.

The only other complete aquatic plant survey for Simonton Lake on record was made in 2007 during an IDNR fisheries survey. For this survey the IDNR conducted one Tier II survey in August. The fish management report for Simonton Lake, which documented this survey, identifies seven native aquatic species and two invasive species (Eurasian watermilfoil and curly-leaf pondweed). The Secchi disc reading was 6.0 feet, which is comparable to our summer Secchi disc reading of 6.2 feet.

Into the Future

Changes in a lake's rooted plant communities over time can illustrate unseen chemical changes in the lake. As mentioned in the previous paragraphs, historical data are rather sparse; however, it is important to note that as early as 2007, curly-leaf pondweed and Eurasian watermilfoil species were present in the lake, while brittle and spiny naiad were not. This is the first official record of brittle and spiny naiad in the lake but both these species are becoming naturalized and some biologists do not consider them as invasive as they are becoming another part of the normal plant communities found in our lakes. These species should continue to be monitored as they could potentially grow to nuisance levels in the lake if left untreated. The current presence of the other two invasive species is not a new introduction into Simonton Lake, but should also continue to be monitored.

Invasive (also called exotic) Plants

Although they are not currently at the levels observed on many other regional lakes, Eurasian watermilfoil and curly-leaf pondweed are present in Simonton Lake (Figure 26). As invasive species, these species have the potential to continue to proliferate if left unmanaged, so data collected during the plant survey will be outdated quickly and should not be used to precisely locate individual plants or even stands. These two species are known to occur in the channels and are likely to spread to the lake if left uncontrolled. Treatment of these two species in particular should be considered a priority to prevent the continued spread into other parts of the lake.

Eurasian watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) was not widespread in Simonton Lake. Also, when found, it had low biomass. This may be the result of multiple years of herbicide treatment. Our spring data showed that Eurasian watermilfoil had a frequency occurrence of 10 in May and then only 1.4 in August. A 2007 survey conducted by the IDNR Division of Fish and Wildlife found that Eurasian watermilfoil had a frequency of 13. This small decrease may be a positive sign that the species is being controlled.

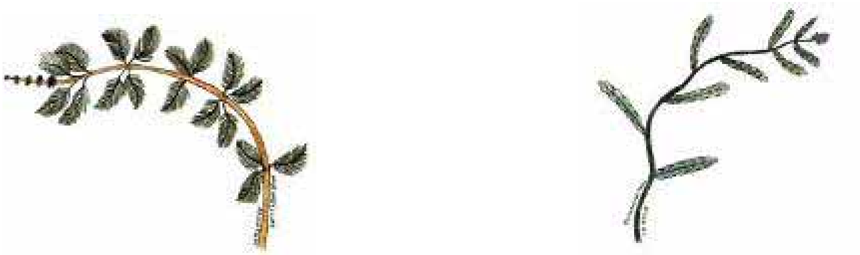
Curly-leaf pondweed

Curly-leaf pondweed (*Potamogeton crispus*) was also not widespread throughout the lake. The low occurrence was coupled with low biomass. Curly-leaf pondweed grows early in the year and then dies back throughout the summer. Our data backs this knowledge. In the May survey curly-leaf pondweed had a frequency occurrence of 5.7 and was not found in the August survey. The IDNR in 2007 had a frequency occurrence of 2.9. The IDNR was collected in August and low numbers would be expected. These numbers are positive signs that this species may be under control as well.

Brittle naiad and Spiny Naiad

Brittle Naiad (*Najas minor*) and Spiny Naiad (*Najas marina)* were identified but not widespread in the lake. They can both be considered an invasive species due to their tendency to become densely populated; however both are native to North America. Spiny naiad has become naturalized to the point where many biologists no longer consider it to be an invasive species. The frequency of occurrence of the more aggressive brittle naiad was only 10%; however, this species needs to be monitored in order to know if treatment is necessary to keep it from spreading farther in the future. Spiny naiad was found at a frequency of 34% with up to 20% dominance in the summer survey. Many of the observations were in shallow water in the area between the two basins and in the eastern basin. This species can spread throughout a lake by vegetative reproduction (fragments break off a parent plant and float and colonize elsewhere in the lake). Special care should be taken on the lake and boat ramp to clean aquatic vegetation off all boats and water gear.

It is important not to underestimate the generally low frequency of occurrence for all of these invasive species. Continuing to monitor the lake is important to stay one step in front of a potential heavy growth for these three species. It is nearly impossible to eradicate invasive species once they are established. However, they can be controlled to reduce their negative impact on the lake.



Eurasian watermilfoil Curly-leaf pondweed

Figure 26. Invasive aquatic plant species found in Simonton Lake during 2010 Tier II aquatic macrophyte surveys.

Although it was not identified in Simonton Lake during the aquatic plant survey, another exotic, invasive species, *Hydrilla verticillata*, was identified for the first time in Indiana at Lake Manitou in Fulton County in 2006. Hydrilla is a submergent plant that resembles common waterweed. However, Hydrilla can tolerate lower light levels and higher nutrient concentrations than most native aquatic species. Because of its special adaptations, Hydrilla can live in deeper water and photosynthesize earlier in the morning than other aquatic species. Because of these factors, Hydrilla is often present long before it becomes readily apparent. It often grows quickly below the water and becomes obvious only after out-competing other species and forming a monoculture. Dense mats of Hydrilla often cause pH imbalances, temperature and DO fluctuations. This allows it to out-compete other aquatic plants and can cause imbalances in the fish community.

The presence of Eurasian watermilfoil, curly-leaf pondweed, and other invasive species is typical in northern Indiana lakes. Of the lakes surveyed by Aquatic Control consultants and IDNR fisheries biologists, nearly every lake supported at least one invasive species (White, 1998a). In fact, White (1998a) notes the absence of invasive plants in only seven lakes in the 15 northern counties in Indiana. These 15 counties include all of the counties in northeastern Indiana where most of Indiana's natural lakes are located. Of the northern lakes receiving permission to treat aquatic plants in 1998, Eurasian watermilfoil was listed as the primary target in those permits (White, 1998b). Despite the ubiquitous presence of invasive species, lakeshore property owners and watershed stakeholders should continue management efforts to limit invasive species populations. Management options are discussed in Section 3 of this report.

2.7 Lake Use

2.7.1 Perceived Problems

A public meeting was held May 10, 2010 to discuss aquatic plant survey results and to distribute a lake use survey to lake residents to fill out regarding their concerns about the lake. Appendix A contains detailed results from the user survey. Figure 27 details the responses of users in regard to perceived problems in Simonton Lake. Thirty-three lake users responded to the survey this year. The main concern of Simonton Lake users are overuse by nonresidents (78%). Concerns about too many boats accessing the lake (70%) and the need for dredging in the lake (70%) are an issue for lake users as well. 42% of lake users think there are too many aquatic plants and too many jets skis, while 18% think there is a fish population problem. Only 9% listed a pier/funneling problem and 6% and 3% think there is a water quality problem and over-fishing problem.

Twelve lake users who submitted a survey made specific comments about the problems concerning the lakes. Those comments are included with the detailed results in Appendix A. Of the lake users that commented, many specifically mentioned too many boats on the lake by non-residents. The one lake user who commented specifically about aquatic plant issues in the lake noted that there were too many plants in the channels. We observed this during our survey, however, the channels are not part of the official survey, and therefore, could not be quantified.

Individuals who responded to the survey were asked to note their primary use of the lake. The majority of people who responded, use Simonton Lake for swimming (85%) and boating (100%). The next highest use category (58%) use Simonton Lake for fishing and 24% use it for irrigation. Only 9% use Simonton Lake for drinking water and the remaining 6% responded with "other" activities as their primary use. The public access site for Simonton Lake is located in between the two lake basins on the south side of the waterway.

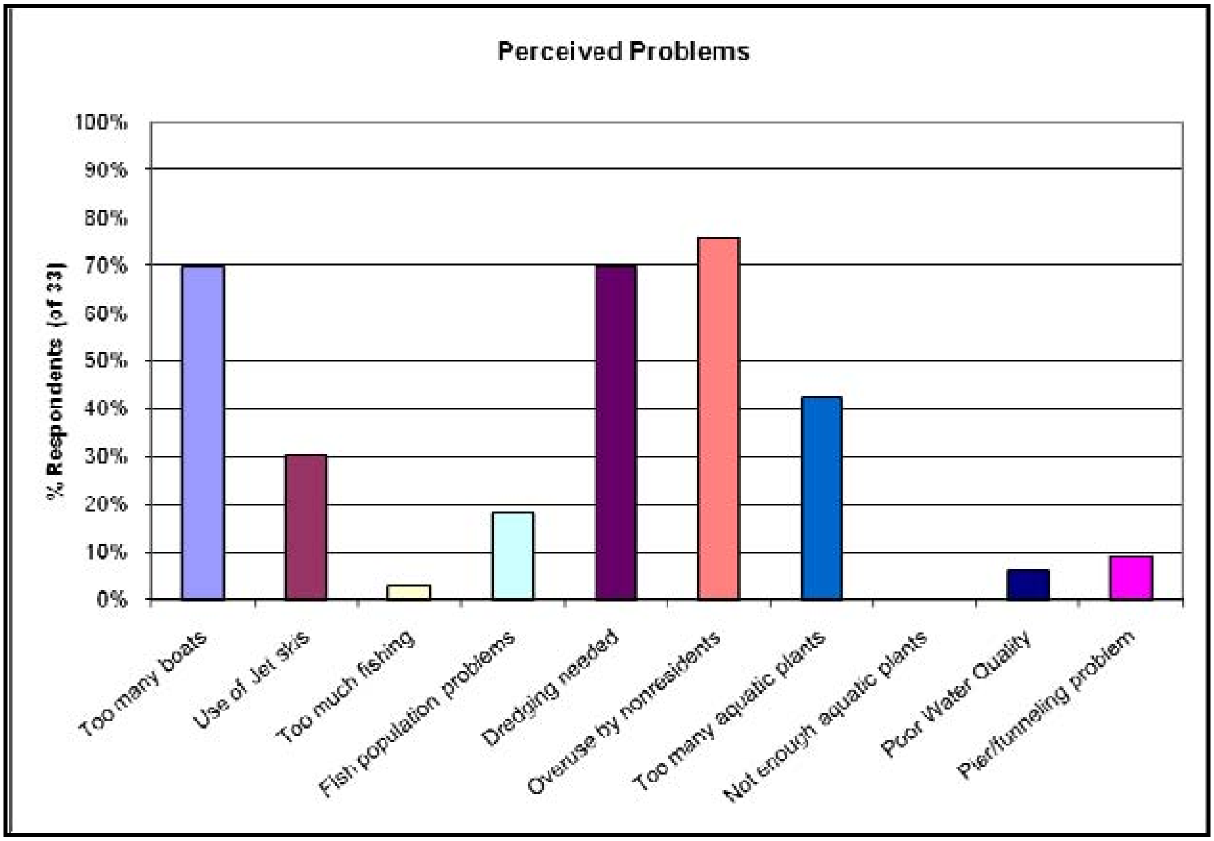


Figure 27. Perceived problems from Simonton Lake users based on survey results obtained May 10, 2010.

Subsequent discussions and non-public meetings were held with Simonton Lake Area Homeowners Association members regarding other issues on the lake. Other concerns brought up at these meeting included lake level issues (no lake level control and potentially blocked inlets to the lake), and a lack of potential fish spawning areas due to the loss of plants. These subjects will be discussed in the Management Recommendations (Section 3) and within the Project Feasibility Section (Section 4) of this report. However, we feel it is important to address the issue of crowding on the lake in this section with the discussion below.

2.7.2 Boating Survey

Boat counts were conducted by residents of Simonton Lake on July 3 (Saturday), August 3 (Tuesday), and August 15 (Sunday), 2010. Boat counts were conducted once every two hours from 7am to 9pm in each basin of the lake. During each survey, watercraft were counted in each of the five categories of 1) fishing boats, 2) pontoons, 3) speedboat, 4) paddle boats, and 5) personal watercraft (wave runner). The number of watercraft for each of the five categories and for each two hour block of the day, were totaled for each lake basin (Appendix A).

Pontoon boats are the most popular boats on Simonton Lake for all days (Figure 28). On weekdays, fishing boats are the second most common boat followed by speedboats. On the weekend (excluding July 3), fishing boats, speedboats and wave runners have similar numbers on Simonton Lake. Non-motorized craft were noted infrequently on Simonton Lake, with the exception of July 3. The maximum number of watercraft using the lake at any one time occurred on July 3 at 3pm (Figure 29). A total of 324 watercraft were counted on the two basins, 300 in the west basin alone. Excluding July 3 the average number of boats on the lake in the other two surveys was 15.6 during any one counting period. Approximately half that many were present in the morning hours with peak use occurring between 5pm and 7pm on the weekday and around 3pm on the weekend.

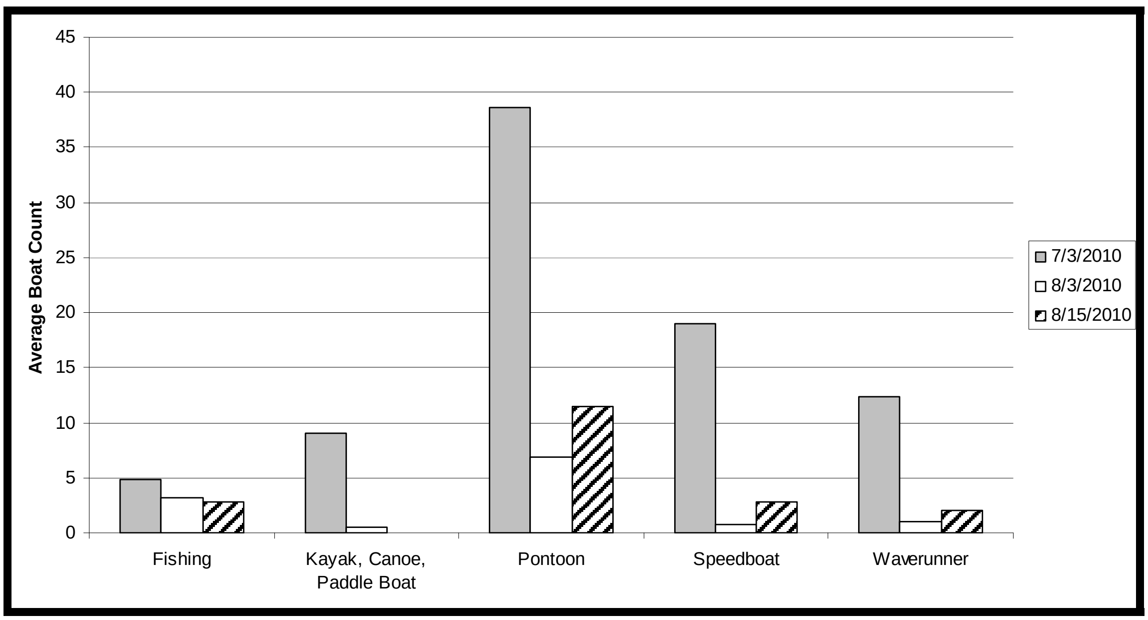


Figure 28. Use of Simonton Lake by different watercraft types.

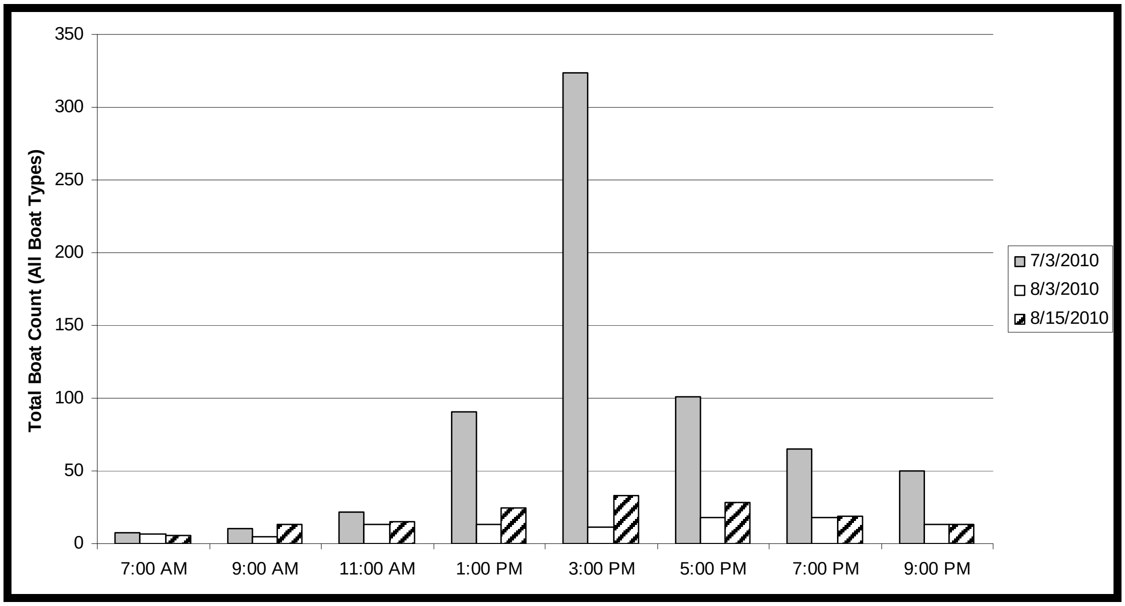


Figure 29. Use of Simonton Lake during different time periods.

Lakes are finite resources which are in high demand. As residential development increases around lakes, boating and other on-lake recreational activities increase as well. This increased use coupled with increases in boat size and speed has brought lake over-crowding to the forefront in many communities. Balancing lake use with ecological, economical, and aesthetic impacts is paramount in arriving at balanced, sustainable use levels. Mahoney and Stynes (1995) noted that recreational carrying capacity is based as much on science as it is on user perception. Other researchers agree that every waterbody has a carrying capacity; however, what that capacity is determined to be depends on a number of factors including the waterbody's size, shape, depth, shoreline development, and most importantly the aesthetic preference of the lake's user group. Wagner (1990) suggests that there is not one true carrying capacity for each waterbody; rather each lake user has their own perception. This results in there being no single boating densities that will satisfy all users at all times. Jaakson et al. (1994) may state recreational carrying capacity best by indicating that carrying capacity is more a value judgment than a technical decision.

One of the most common impacts associated with motorized watercraft is a decrease in water clarity. As motor boats travel through shallow water, the energy from movement of the boat propeller may be sufficient to resuspend sediment from the lake bottom, decreasing the lake's water clarity. Several researchers have documented either an increase in turbidity or a decrease in Secchi disc transparency during and following motor boat activity (Wagner, 1990; Asplund, 1996; Yousef et al., 1980). Crisman (1986) reports a decrease in Secchi disc transparency following holiday weekend use of Lake Maxinkuckee in Culver, Indiana. Asplund (1996) also observed poorer water clarity in his study of lakes following weekend boating and that this decrease in water clarity is more pronounced in lakes with generally better water clarity. This finding is particularly significant for many lakes throughout the watershed as they generally exhibit better water clarity than the typical Indiana lake.

The ability of a motor boat to resuspend sediment from the lake bottom depends on several factors. Some of these factors, such as boat length, motor size, and boat speed, are related to the boat itself and the boat's operator. Yousef et al. (1978) found that 10 horsepower (hp) motors were capable of mixing the water column to a depth of 6 feet (1.8 m), while 50 hp motors were capable of mixing the water column to a depth of 15 feet (4.6 m). While larger motor sizes have a greater potential to resuspend sediments than smaller motors, longer boats and higher speeds do not automatically translate to a greater ability to resuspend sediments. Boats that are ‘planing’ on the water actually have little impact on the lake’s bottom. This is because the velocity of water at the lake bottom created by a motor boat depends on the boat’s displacement, which is a function of boat length and speed. Beachler and Hill (2003) suggest that boat speeds in the range of 7 to 12 mph may have the greatest potential to resuspend sediment from the lake bottom (based on typical recreational boat length).

Certain characteristics of lakes also influence the ability of motor boats to resuspend sediments. Shallow lakes are obviously more prone to water clarity degradation associated with motorized watercraft than deeper lakes. Studies indicate that shallow areas (0-10 feet) are extremely susceptible to negative impacts due to boating activities (Asplund, 1996). Wagner (1990) suggests little impacts from motorized boating in water deeper than 10-15 feet (3.0-4.6 m). Lakes with soft fine sediments are more likely to suffer from sediment resuspension than lakes with coarser substrates. Lakes with extensive rooted plant coverage throughout the littoral zone are less prone to motor boat related resuspension problems than lakes with sparse vegetation since plants help hold the lake’s bottom substrate in place.

It is important to note that the decrease in water clarity is not usually permanent. Once motor boating activity ceases, resuspended materials will sink to the lake bottom again. However, this process can take several days. Wagner (1990) found that while turbidity levels steadily decreased following boating activity in his shallow study lakes, the turbidity had not returned to baseline levels even two days after the activity. Crisman (1986) found similar lags on Lake Maxinkuckee.

In addition to a decrease in water clarity, several other potential ecological impacts from motorized boating exist. Various researchers have documented increased phosphorus concentrations, damage to rooted plants, changes in rooted plant distribution, and increased shoreline erosion associated with motor boating activity (Asplund, 1996; Asplund and Cook, 1997; Schloss, 1990; Yousef et al., 1980). Less commonly studied concerns include potential increases in heavy metal and hydrocarbon pollution, changes in algal populations, and impacts to lake fauna.

Just as the potential impact of motor boating on a lake’s water clarity depends in large part on the specific characteristics of the lake, the potential for other ecological impacts associated with motor boating often depend on characteristics of the specific lake (Wagner, 1990). For example, Yousef et al. (1980) found increases in total phosphorus concentrations associated with motor boating activity in all his study lakes. However, only one of Wagner’s study lakes showed an increase in phosphorus concentrations associated with motor boating activity. This lake possessed a nutrient rich, fine particle substrate. Similarly, Schloss (1990) reported greater increases in phosphorus concentrations due to motor boat activities in those New Hampshire lakes with high levels of internal phosphorus loading. New Hampshire lakes with lower levels of internal phosphorus loading were less likely to see large increases in phosphorus concentration associated with motor boat activity.

Finally, boating activities can cause negative impacts to the aquatic plant community. Vermaat and Bruyne (1993) noted that boat-generated waves were the key factor in determining the distribution of aquatic plants. This is likely due to the potential impacts of boat motors through uprooting, dragging, and tearing of plant material. Figure 30 details the mechanisms and impacts that watercraft can have on aquatic plant communities. All of these factors lead to the ecological carrying capacity of a lake or the maximum level of use before an unacceptable or irreversible decline in the ecosystem occurs (Pigram, 1983).

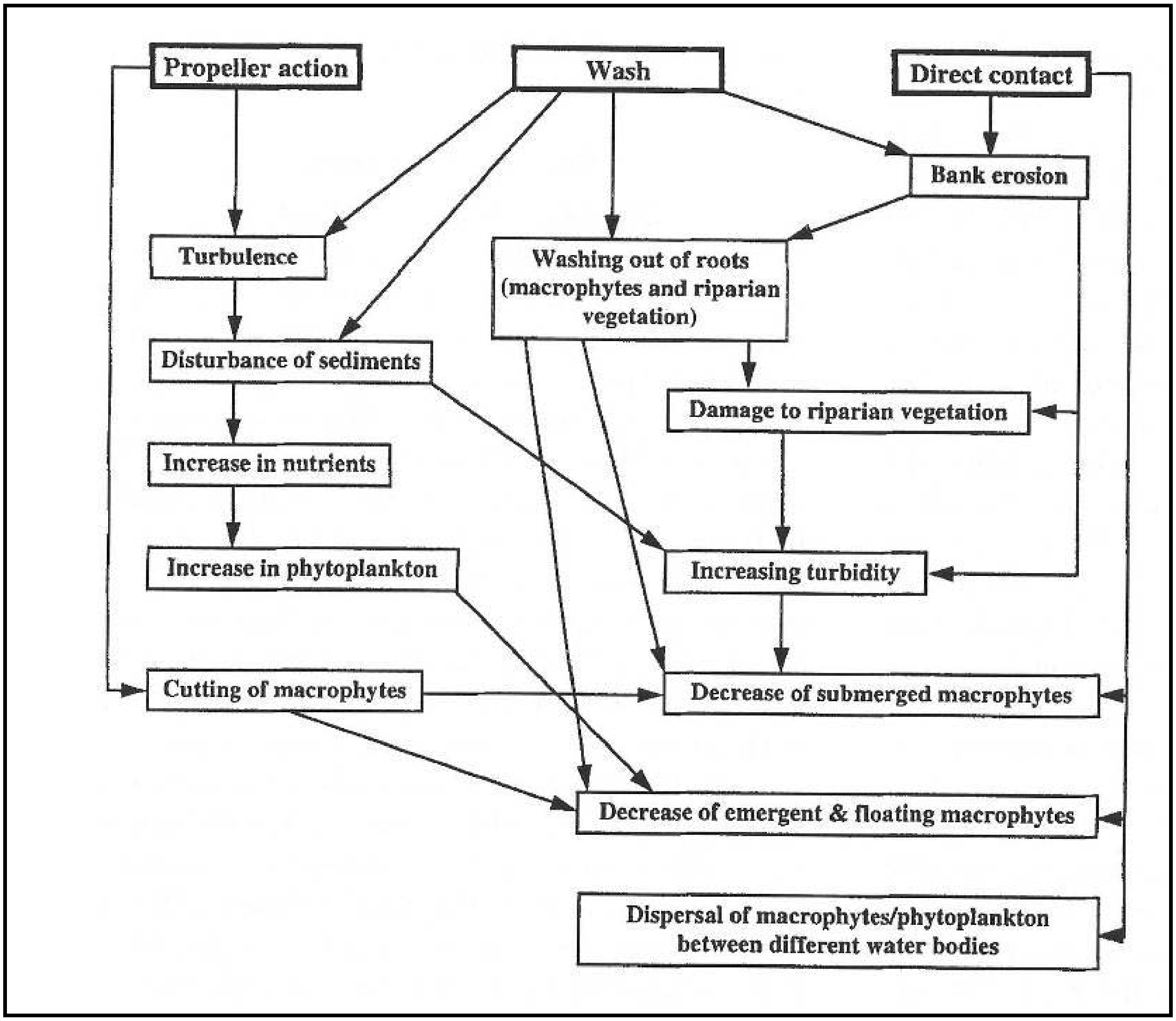


Figure 30. Impacts of watercraft to aquatic plant communities. Source: Morisch and Arthington, 1998.

There has been much research completed which details the optimum spatial requirement for various watercraft and their associated uses (JFNew, 2007). Despite the basis for these determinations, no single density standard will satisfy all lake users in all situations. Some researchers looked at multiple user groups and the space required for each to interact safely, while other researchers identified space needs associated with just one user group. Because of the mixed uses that typically occur on Simonton Lake two methodologies were selected. The first was developed by the Steuben County Lakes Council and Lagrange

County Lakes Council (2005) and relies specifically upon the calculation of space required for the physical watercraft itself and for the activity in which the watercraft is engaged. The second methodology was developed by the Lake Ripley Management District (2003) and utilizes Theiren's (1964) idea theory that a watercraft's space requirements are directly proportional to the speed at which the watercraft is traveling. Under this scenario, activities that involve passive recreation, like canoeing, kayaking, or paddle boating, require less space than those that are more active or aggressive, such as speed boating, skiing, tubing, or engaging in personal watercraft use. Following this guidance, a low spatial requirement (10 acres/boat) is required when all users are engaged in passive (stationary or idle speed) activities. A lower density (30 acres/boat) is required when all users are engaged in aggressive (fast-moving watercraft) activities. An equal mix of passive and aggressive uses results in a mid-point density of 20 acres/boat. Table 24 details the optimal space requirements based on the above research.

Table 24. Optimum spatial requirements for watercraft by Boat Type (SCLC and LCLC, 2005) and by watercraft use rates (LRMD, 2003).

Boat Type	Optimal Area	Lake Usage	Optimal Area
Pontoon/Motor boat	14.85 acres/boat	All uses: 100% idle	10 acres/boat
Sailboat/Canoe/Kayak	13.05 acres/boat	All uses: 75% idle; 25% fast users	15 acres/boat
Water ski/Wake board boat	20.7 acres/boat	All uses: 50% idle; 50% fast users	20 acres/boat
Personal watercraft	16.65 acres/boat	All uses: 25% idle; 75% fast users	25 acres/boat
		All uses: 100% fast users	30 acres/boat

Given the 301 acres of Simonton Lake, and assuming all acres are available to boat use, and assuming, based on the boat count totals above, and an average of the two optimal use rates, 20-25 pontoon boats or 14 speed boats would be an acceptable number of users on Simonton Lake. However, with the shallow nature of Simonton Lake (86% of the lake's surface area is less than 10 feet deep) and its extensive shoreline (46,072 feet) the area available for high speed boating outside a 200-foot idle zone is only 89 acres. Therefore, a more realistic number of actively moving pontoons on the lake which would give everyone adequate space may be something closer to 6 to 8 boats and a more comfortable and safe number of high speed boats is probably 3-4 actively moving at any one time. Based on the survey results, it appears that week days and weekends mostly fall within those ranges except for the fourth of July weekend and likely other holidays.

3.0 MANAGEMENT IMPLICATIONS

The water quality of Simonton Lake is much better than most other Indiana's lakes. The lake can be considered as mesotrophic based upon the 2010 data which was taken immediately following the fourth of July weekend when the water quality would have been at its worst. The low volume of surface runoff into the lake reduces the delivery of nutrients into the lake, thus limiting the algae production. Because of the extremely limited input of surface water runoff to the lake, the most likely source of new phosphorus additions to the lake other than natural rainfall will come from lake side lawn and garden maintenance and animal waste. Some of the phosphorus that does reach the lake settles out of the water column into the deeper waters, where it doesn't contribute to algae growth unless disturbed by mixing of the water column. Motor boat traffic on the lake will continue to recycle the phosphorus from the deeper waters, where it naturally settles, back into the upper levels of the lake where algae production occurs in warm weather. Preserving and encouraging aquatic macrophyte growth reduces the potential for algae blooms because the plants take up phosphorus and their roots bind and hold the sediments. While the data presented in this report show no alarming patterns of water quality degradation they do however, show some areas of concern that drive the following management recommendations.

1. Limit the phosphorus that enters the lake by establishing an education program for lake residents and those who live off the lake to limit the use of phosphorus based fertilizers. Phosphorous is often a limiting nutrient for plants in aquatic systems and most suppliers now offer phosphorus free fertilizers.

2. Educate the residents about proper disposal of pet waste and waste produced by geese. If possible this waste must be removed from areas where rainfall can wash it into the lake to limit bacterial contamination and nutrient loading.

3. Encourage County government to require mandatory sewer system hookups for any new developments or home renovations on the area north of the lake from which ground water flows toward the lake.

4. Establish and enforce an ecozone in the southeast corner of the east basin to promote aquatic macrophytes (plants) that consume nutrients during the summer which would otherwise be utilized by algae.

5. Protect existing aquatic plants in the west basin from damage by boat traffic.

6. Educate lakeshore residents on the importance of aquatic plants and natural shoreline benefits for fish and the human enjoyment of the lake. Encourage or promote the use of stone and native plants to protect shorelines from erosion instead of steel and concrete.

7. Educate lake residents about the invasive aquatic species present in Simonton Lake and implement a program to monitor and control these invasive species.

8. Limit motor use to idle speed in shallow water (especially the channels) to prevent recycling the phosphorus that is in the sediments on the lake bottom.

9. Consider dredging areas of shallow water where continued motor boat traffic stirs up the sediments allowing the recycling of nutrients contained in those sediments. This includes the channel between the east and west basins of the lake which is currently less than two feet deep most of the time.

10. Consider native landscaping of lawn edges along the lakeshore to include taller grasses and forbs that are capable of filtering runoff water better than turf grass.

11. Continue to pursue a water level control structure at the outlet of the lake. This will help keep lake levels more consistent and help in identifying and regulating boat speeds in the shallow water areas to reduce phosphorus recycling.

4.0 FEASIBILITY

4.1 Project 1 – Ecozone Development

Background

Legislation enacted in 2000 amended Indiana Code 14-15-7-3 to allow for the establishment of zones on public waters where the use of watercraft may be limited or prohibited for the purposes of fish, wildlife, or botanical resource management, or for the protection of users. Regulations in 312 IAC 5-6-1 allow for the establishment of zones on specified public freshwater lakes to govern the operation of watercraft for any of the following purposes:

a. Addressing unusual conditions or hazards
b. Fish, wildlife or botanical resource management
c. The protection of users

In order to be effective, a zone established under this rule must be identified on site by buoys placed in accordance with 312 IAC 5-4. Watercraft operation may be restricted on specified lakes and reservoirs with state or federal funding under 312 IAC 5-10-1. The Ecozone's boundaries are fixed geographic points and additional rule-making would need to be undertaken to adjust any future boundaries. Therefore; boundary lines should be made as straight as possible in order to minimize the number of buoys needed to mark the designated area and to minimize boater confusion.

Ecozones are established through the IDNR's rulemaking process and are unique to a given lake and geographic area. Ecozone establishment is initiated by local interests petitioning the IDNR to begin the rule making process. Prior to a petition, lake groups are encouraged to hold public outreach meetings and have at least one meeting with IDNR staff responsible for lake management issues. After IDNR staff review the petition, it is submitted to the Natural Resources Commission (NRC) which is the rulemaking body for the IDNR. The petition must include appropriate maps with geographic reference points and a short description of the need, purpose and specific regulation the petition is seeking. For example, the petition for Simonton Lake might request "idle speed only" within the proposed ecozone versus "no boat traffic". The petition should also include information about the organization that is seeking the petition.

The Petition is reviewed by the NRC for preliminary approval. If the petition obtains this preliminary approval, the NRC directs the IDNR hearing officer to hold public hearings. Upon completion of the public hearings the hearing officer reports back to the NRC with his or her recommendation based upon the facts and opinions presented at the hearings. The NRC can either: 1) adopt into final rule the proposed zone boundaries, or 2) make modifications to the zone boundaries, 3) elect not to proceed with the rule making on the proposed zone. Once the zone is adopted by the NRC, IDNR staff then coordinates with the petitioning organization regarding the purchase and installation of the regulation buoys to mark the zone as appropriate. (IDNR 2006)

Method
To summarize the feasibility of what needs to be accomplished for establishing an ecozone in the southeast corner of the east basin of Simonton Lake the following outline was developed:

1) Build a case for the need to protect the bay
    a. Review historical photos to document vegetation loss in the Area of Interest (AOI) as well as the rest of the lake
    b. Conduct quantitative vegetation sampling in AOI
    c. Identify other ecological benefits (wildlife and fish) that may benefit from the ecozone
2) Develop potential alternatives for the ecozone boundaries and restrictions
3) Develop emergent plant restoration or protection plan
4) Receive local public input on alternatives to achieve strong support
5) Submit petition with specifics of purpose, ecozone boundaries, regulations within ecozone, maps showing proposed area and regulations

The case for ecozone development
Establishing an ecozone in Simonton Lake can improve water quality, fish habitat, and increase shoreline protection. The proposed boundary, described below, is a shallow part of the eastern basin of Simonton Lake that has excellent submersed plants and an intact wetland on the shoreline. At less then 10 feet deep the substrate is vulnerable to disturbance from motor boat traffic. If the sediment is disturbed it would increase turbidity by resuspending debris and sediment into the water column, and it may lower water quality by resuspending nutrients into the water column which promotes algal growth. Also, at shallow depths, the submersed vegetation is especially sensitive to watercraft use. Submersed as well as emergent vegetation is easily shredded or destroyed by watercraft, which exposes the sediment to even more disturbance.

To protect the shoreline from erosion, it is also important to keep the shoreline intact. The proposed ecozone area has a wetland that is very important to the Simonton Lake ecosystem. It not only holds the shoreline together, but also filters runoff that would otherwise directly enter into the lake. Also, by looking at old aerial photos (Figures 31, 32, &, 33) it appears this wetland has been decreasing in size in the past 50 years. This loss reduces wildlife habitat, fish production, and nutrient absorption.

Figure 31. 1951 aerial photo of Simonton Lake.

Figure 32. 1965 aerial photo of Simonton Lake.

Figure 33. 1973 aerial photo of Simonton Lake.

As mentioned earlier in the document, aquatic plants play an important role in the health of a lake. Simonton Lake is no exception. With a diverse, healthy community of submersed and emergent plants, Simonton Lake will continue to support good water quality for wildlife and the lake's users. The ecozone helps ensure healthy aquatic plants will remain in that portion of the lake. Simonton Lake contains one state listed threatened species (white-stem pondweed) and one species that mostly grows in lakes with good water quality (northern watermilfoil). This ecozone may help sustain both of these species. This protected area may also be an ideal place for fish habitat and or spawning locations.

Proposed boundary

The proposed ecozone is in the southeast corner of Simonton Lake (Figure 34). The northern boundary of the ecozone would extend from the south point of the small island directly west approximately 850 feet (259 m) to the tip of the adjacent point. The eastern boundary is 125 feet (38 m) from the developed shoreline, giving property owners ample room to operate their watercraft. The southern and western boundaries are the respective shorelines.

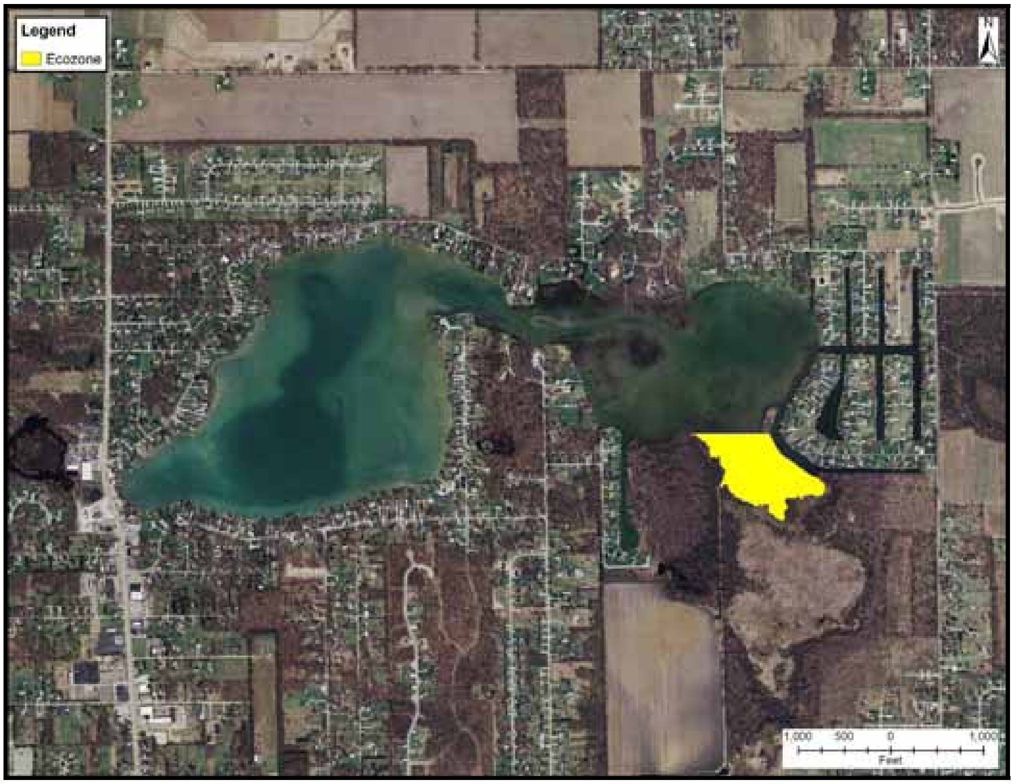


Figure 34. Proposed ecozone location.

Proposed plant restoration/Protection plan

JFNew recommends implementing an ecozone in the area specified above to restore habitat for wildlife and increase ecosystem services. The area proposed has a diverse group of native plants already present; therefore, no additional plants are necessary for restoration. However, in order for the native plants to recover, we recommend making watercraft regulations such as: no motorized watercraft allowed, no watercraft allowed, or only idle speeds allowed. With one of these regulations in place, the wetland and submersed plant communities will be able to recover. The zone should be clearly marked with buoys.

Summary

As seen when comparing photographs from the 1950's to today, the emergent vegetation in the south eastern portion of Simonton Lake has been decreasing (Figures 31, 32, &, 33). Today, the shallow water in this area still contains many submersed and emergent species; however, constant wave action from watercraft has damaged this area. If protected, this area should recover. This will help not only the fish and wildlife, but also benefit the entire lake and its users. It will help provide better fishing, aesthetics, and increase water quality. JFNew recommends the Simonton Lake Area Home Owners Association create a petition to the IDNR to create an ecozone on Simonton Lake.

4.2 Shoreline Improvements – West end of West Basin

Background

A parking area, a small outbuilding, and demolished building site make up the west end of Simonton Lake adjacent to State Road 19. These parcels sit at a low point on the landscape with adjacent properties and State Road 19 rising in elevation to the north and south. In the 1990's, State Road 19 was reconstructed to drain runoff from the road to a constructed basin west of SR 19, instead of into Simonton Lake. There is no surface water connection between the constructed basin on the west side of SR 19 and Simonton Lake on the east side of the road. The 50-75 foot wide lots on the east side of State Road 19 that slope directly into the lake, are mostly paved, and have a three to five foot buffer of grass between the paved area and the lakeshore. The lakeshore has minor erosion issues approximately six inches to a foot above the water line. This area is mostly vegetated, but is also armored with various rocks and debris (Figure 35).

Figure 35. Lakeshore along west end of Simonton Lake

We identified an opportunity to improve the shoreline and filter or trap some of the sediment that washes to the lake from the paved areas as shown in Figure 36. We assumed that landowners would be interested in having the SLAHOA cost share with the LARE program to design and implement a project in this location. The proposed improvements that were never fully developed included adding glacial stone and native grasses and forbs to the shoreline to develop a fully vegetated shoreline approximately 2-3 feet high and constructing a berm and swale catchment on the uphill side of the shoreline treatment to intercept any sediments coming from the parking area. The captured sediments would have to be periodically removed from the site to maintain any structure

Figure 36: Parking area at west end of Simonton Lake

Considerations

1) The land is private; there is no way to complete a project at this location without the landowner’s cooperation.
2) A shoreline stabilization project utilizing bioengineering would have maximum public exposure at this location.
3) A shoreline stabilization project at this location would have a limited affect on improving the water quality of Simonton Lake as the contributing drainage area to the proposed shoreline work site was less than ½ acre.
4) The project would have more value for its aesthetic improvements to the shoreline while demonstrating a technique for others to implement.

Method

1) Contact landowner and ascertain whether they are interested
2) Develop conceptual drawings of potential projects for approval by owner
3) Seek tentative regulatory approval
4) Develop final designs
5) Obtain Permits
6) Obtain funding
7) Construct
8) Maintain

Summary

A letter of inquiry was sent November 12, 2010 to the owners of the property (Appendix D). No response was received. No further attempts to contact the owner were made.

4.3 Project 3: Inlet improvement North side of channel between the basins

Background

During the watershed tour and in a subsequent meeting with SLAHOA there were several suggestions made to the effect that a ditch across North Shore Drive had been blocked and was not allowing water to flow to the lake. Upon initial investigations with LARE staff we noted the existing inlet to the lake was barely visible in the woods to the north of North Shore Drive. The depth of the channel is approximately one foot with a top width of approximately two feet. The channel was dry and had very little evidence of flow. Upon inspection on the south side of North Shore Drive we noted a shallow drainage beginning approximately 50 feet from the road and heading to the lake (Figure 37). The drainage on average was approximately two feet below grade and had a top of bank width of 8-20 feet. There appeared to be some water in the lower part of the channel initiating from under an old stump part way down the channel. After meeting with the landowners of the two lots and obtaining permission to survey, we suspected there may be a connection, but it is not readily apparent. While the intent of the SLAHOA may have been for us to see about having the channel cleaned, it is JFNew's opinion that cleaning it would not help the lake in any manner, however; improving it to be a fully vegetated channel would help reduce the organic matter input to the lake and provide a pollution filter. With that in mind we sought and obtained permission to proceed with conceptual drawings for a potential project.

Figure 37: Facing Southeast(left) and northwest(right) at inlet drainage from North Shore Drive, Simonton Lake

Considerations

1) The land is held privately by two separate property owners, there is no way to complete a project at this location without the landowner's cooperation.
2) While surface water is apparently blocked from freely flowing into the lake, ground water infiltration on the north side of North Shore Drive filters any water that does reach the lake from this drainage.
3) This drainage flows quite well during rain events
4) Improvements to this drain would be more aesthetic than functional in improving water quality in Simonton Lake

Method

1) Contact landowner and ascertain whether they are interested
2) Develop conceptual drawings of potential projects for approval by owner

3) Seek tentative regulatory approval
4) Develop final designs
5) Obtain permits
6) Obtain funding
7) Construct
8) Maintain

Summary

JFNew sent an initial letter of inquiry in November 2010. Upon talking with the owner we were given permission to survey and make a proposal for a potential project. The survey work was completed in December 2010. We collected grade information on the drainage and at various inlet structures. We also documented the width of the bottom and top of the existing channel. We located a portion of the culvert that comes underneath North Shore Drive emptying into the channel that crosses the property, but did not have the tools to excavate the entire opening of the culvert and determine its actual size (estimated 12" metal pipe). We located and surveyed elevations at two additional inlets to this system on the south side of North Shore Drive (a four inch diameter tile runs down the south edge of North Shore Drive). We utilized this survey information to create two conceptual drawings of proposed optional work at the site (Appendix E).

We proposed that the blocked culvert be exposed by lowering the bottom of the existing channel. At that point we proposed either enclosing the channel completely in a culvert all the way to the lake or clean the entire channel and convert it to a vegetated swale to the lake. JFNew recommended converting the drainage to a vegetated swale for the following reasons. Putting the drainage into a pipe would require State and Federal permits (Section 401 and 404 of the Clean Water Act), which would be very difficult to obtain and would require mitigation (fixing a stream some place else). In addition, the piping project would not likely be funded by the Lake and River Enhancement (LARE) program. The vegetated swale would be granted a permit without any requirements and could be funded by the state LARE program, provided the funds are available. Both methods would increase the flow of surface water to the lake immediately following storm events, but the vegetated swale would trap nutrients and sediment, thereby helping keep Simonton Lake clean.

We provided the drawings to the two landowners that would be involved in the project and gave them a month to review the options. We received a call from one of the owners a month later declining to move forward with the project.

4.4 Project 4: Dredging the channel between the lake

Background

During various conversations with residents and on the survey taken May 10, 2010 many people expressed interest in dredging the channel between the two lake basins to promote more accessibility and reduce bottom disturbance from direct contact with outboard motor propellers. Dredging has other benefits including removal of phosphorus enriched sediments from lake bottoms, thereby reducing the likelihood of phosphorus release from the sediments. Dredging also deepens lakes for recreational purposes and limits the growth area for rooted macrophytes. Because this technique is capital-intensive, it can only be justified in small lakes or in lakes where the sediment-bound phosphorus is limited to a small, identifiable area. Dredging is not effective in lakes where additional sediment loading cannot be controlled; however, that is not the case in Simonton Lake. Furthermore, the use of dredging as a plant control technique may not be completely effective considering that dredged areas may be recolonized by nuisance invasive species.

Dredging may be a viable option to deepen the channel between the two basins on Simonton Lake. This area is very narrow and in the past, it has hindered watercraft movement. Also, dredging would keep aquatic vegetation biomass down in the area that was dredged. The channel has been dredged previously as evidenced in the historical photographs between 1958 and 1967 and as related to me by a SLAHOA member who stated that the channel was dredged in 1960 by “Cowles”. The current passage between the lakes is often less than two feet deep and results in most boats churning up the sediment with their props as they pass through this frequently traveled area,

Considerations

1) Cost and funding sources must be evaluated before deciding whether to pursue a dredging project. Generally the cost of hydraulic dredging in Indiana lakes in the last five years has been from $0.75 to $1.25 per square foot of surface area dredged or between $15.00 and $20.00 per cubic yard of material removed. Fuel costs are directly related to the cost of hydraulic dredging. At the lower end of the cost estimate above, you must also include the cost of obtaining and developing a disposal site. Adding in the cost of a consulting engineer for the project will add 20 percent or more to the total cost.

2) Sediment disposal options include developing a settling basin or pumping the material into large perforated sacks that contain the spoils, but allow the water to seep out. Hydraulic dredge spoils are about 90% water and therefore large surface areas are required on which to place or pump the spoils. Spoil areas should be within 3000 feet of the dredge site.

3) Any dredging activities in a freshwater public lake will require permits from the Indiana Department of Natural Resources. If water or spoils are placed or allowed to go back into the lake or stream a permit is also required from the US Army Corps of Engineers, and the Indiana Department of Environmental Management.

4) A potentially troublesome consequence of dredging is the resuspension of sediments during the dredging operation and the possible release of toxic substances bound loosely to sediments. Because of this, sediment cores must be analyzed prior to dredging to determine sediment composition if an IDEM 401 Certification for the return water is required.

5) The center of the channel between the lakes is within 200 feet of either shoreline, meaning that this is an idle speed only zone. Deepening of the channel may make it more difficult to enforce the idle speed zone to the detriment of adjacent shorelines which would likely see increased erosion with larger or more watercraft at greater speeds.

Method

To move forward with the dredging project in the channel between the basins on Simonton Lake the following plan of action should be followed:

1) Build local support for the project through discussions at public meetings around the lake and set up an account for funds to pay for engineering plans, permits, construction administration and supervision, and dredging (estimates below).
2) Review historical photos to document previous dredging limits.

3) Hold meeting(s) with IDNR permitting biologist and seek opinion on what would be allowed (30 foot wide channel based on preliminary discussions held)
4) Conduct sediment depth measurements to figure out how much material will be removed.
5) Develop alternative sediment removal methods and final cost estimates.
6) Identify a spoils area and design the spoils area containment.
7) Obtain written agreement with spoils site owner (purchase, lease or rent).
8) Obtain required permits.
9) Obtain funding (IDNR LARE funding is the only grant source for lake dredging)
10) Bid out dredging or employ an engineer to bid out and oversee the work.
11) Follow up surveys of dredged area.
12) Close out spoils basin site (1 or 2 years post dredging)

Simonton Lake Specifics

Proposed area of dredging: 2000 feet by 30 feet = 60,000 sq ft.	Cost: $75,000
Engineering plan and surveys, specifications, permits	Cost: $15,000
Construction administration/inspections	Cost: $15,000
Total	$105,000

The planning and implementation of a public lake dredging project can be funded through the Lake and River Enhancement (LARE) program of the IDNR. Steps 1 through 8 described above are often completed in a "Sediment Removal Plan" that can be funded at a 80% cost share with a maximum of $7,500 for each lake. These plans include the engineering of the sediment removal and spoils basin, along with permits or regulatory coordination and landowner agreements and may cost in excess of $20,000 if completed by a consulting engineer. The sediment removal plans can also be completed by lake association members with the assistance of the LARE staff. Therefore, minimal cash from the lake sponsor is necessary to start the planning process. There are no guarantees once the Sediment Removal Plan is completed that the LARE program will fund the 80% cost share available for the actual dredging project; however, at least 12 lakes in northern Indiana have gone through this process successfully and completed their dredging projects.

Alternative Method

The above approach describes the steps necessary and cost estimates for a LARE sponsored dredging project. The alternative is to fund the project directly through your lake association which would likely result in the project being completed sooner and at a greater cost to the lake association but less overall costs. The LARE program retains a list of hydraulic dredging companies available to complete this work directly. The SLAHOA would only need to call these companies directly and seek a quote for the area and the depth they want dredged. The dredging company would then be responsible to locate a spoils site, obtain the permits and perform any surveys necessary. The cost to complete the project in this manner may be 30% less than the estimated cost provided above, although the entire cost of the project would be paid for by the lake association.

Summary

The channel between the basins at Simonton Lake can be hydraulically dredged to improve recreational access between the lakes as it has been completed in the past. The primary reasons for dredging this channel should be to reduce the amount of lake bottom sediments that are resuspended into the water column by constant boat traffic through this shallow water zone. Enforcement of the idle speed only law through this area will be harder if this channel is dredged as watercraft will be able to move through the channel at greater speeds. Permits could be obtained for dredging an area of approximately 1.37 acres or 2000 feet long by 30 feet wide to a depth of six feet below the water line at the center and sloping gradually to the edges.

Setting up and implementing a dredging project is a difficult and expensive project but one that more than a dozen northern Indiana Lakes have undertaken utilizing LARE funding with a local cash match. The estimated cost to complete the proposed channel dredging project is $105,000. The amount of time required to plan and fully implement the project is three years, and as many as six years, depending upon the funding source and the drying time for the dredge spoils. Currently, the LARE program is considering new sediment removal grant applications that would grant 80% of the project costs.

5.0 DIAGNOSTIC/FEASIBILITY SUMMARY

Simonton Lake is a 301 acre (121.8 hectares) lake located in the northwest portion of Elkhart County Indiana. The Simonton Lake watershed extends north of the lake into Cass County Michigan and encompasses approximately 5,233 acres (8.2 square miles or 2,177.7 ha), and makes up the northern finger of the 040500012202 HUC watershed. Simonton Lake drains south through the Osolo Township Ditch into the St. Joseph River, which drains to Lake Michigan. The watershed is extremely flat draining from a high elevation of 920 feet (280.4 m) above mean sea level to 772.86 feet (235.57 m) above mean sea level at the lake. Simonton Lake possesses a watershed area to lake area ratio of approximately 18.5:1.

The movement, stagnation, and melting of the Saginaw Lobe of the Wisconsin glacial age is largely responsible for the landscape covering the Simonton Lake watershed. The dominant soils left behind by the glacier are within the Oshtemo-Kalamazoo-Houghton association (56%), Riddles-Hillsdale-Gilford association (36%), and open water (6%). The remainder of the watershed is made up of Coloma-Spinks-Oshtemo (1%) and Houghton-Adrian-Carlisle (<1%). The dominant soil type in the watershed is well drained by sandy substratum with no surface water streams. Thus, the lake level and water quality is heavily influenced by ground water levels and not by surface water runoff. There are three listed highly erodible soils in the watershed, Kalamazoo Loam (5-10% slopes), Oshtemo sandy loam (6-12% slopes), and Riddles Fine sandy loam (12-18% slopes), as well as one potentially highly erodible soil unit, Tyner Loamy sand (5-10% slopes); however, these soil units make up less then 1% of the landscape and do not border any surface waters, so erosion is not an issue.

The lake's watershed lies within Homoya's Northern Lakes Natural Region and Omernik and Gallant's Southern Michigan/Northern Indiana Drift Plains Ecoregion (Omernik and Gallant, 1988). It also lies in Petty and Jackson's Oak-Hickory Climax Forest Association (Petty and Jackson, 1966). The region was a mixture of numerous natural community types, including bog, fen, marsh, prairie, sedge meadow, swamp, seep spring, lake, and deciduous forest.

Agricultural land use dominates the Simonton Lake watershed, accounting for approximately 60% of the landscape. Most of the remaining land use is open space or low intensity residential development. The area surrounding the lake has been serviced by sewers since 1999-2000. A review of aerial photographs dating back to 1939 tracks the residential development of the lake. There were 20 structures visible on the lake in 1939, with most of those on the south side of the west basin. North Shore Drive extended only part way around the west basin from what is now State Road 19, but only had six to eight homes along the lake. The east basin was predominantly wetland which drained out the southeast corner of the lake. By 1951, North Shore Drive had been extended to the narrows with over 30 homes built along the northern lakeshore and on the south side, CR 9 (Johnson Street) was developed up to what is now the public landing with approximately 30 homes. Development of the channels on the east end of the east basin began in 1957. By this time as many as 100 structures existed on the south side of the west basin. The channel between the two basins was dredged in 1960 to improve access between the basins. In 1965 homes were being constructed on the east end of the east basin and a channel on the south side of the east basin adjacent to Forest Avenue was completed. The lakes shoreline was nearly 100% developed except for the southeast corner of the east basin by 1973.

Simonton Lake has a volume of 2,686 acre-ft (3,313,132 m^3) with a maximum depth of 24 feet (7.3 m) and a mean depth of 12.1 ft (3.7 m). Approximately 84% of the lake surface area is less than 10-feet deep with less than 6 acres (2.4 ha) deeper than 20 feet The length of the shoreline is 46,170 ft (14,073 m). The shoreline development ratio is 3.6:1.

The Simonton Lake fishery is dominated by bluegill and largemouth bass. Additional species available to anglers include redear sunfish, yellow perch, black crappie, walleye and northern pike. Walleye have been stocked in Simonton Lake off and on since 1988 by the Simonton Lake Sportsmen Club and Indiana Department of Natural Resources (IDNR). Results of the general surveys from 1964-2007 indicate the Simonton fishery has remained relatively consistent in regards to dominant fish species composition and relative growth rates and condition factors (length/weight) of those species. In general, bluegill is the most abundant species followed by largemouth bass and redear sunfish. Bluegills have exhibited average to above average growth rates and condition. Largemouth bass during all survey events have exhibited average to above average condition and growth rates, but tend to be smaller than most anglers desire due to heavy fishing pressure.

Since 1988, the west basin of Simonton Lake has been sampled five times by the Indiana Clean Lakes Program. While the concentration of soluble reactive phosphorus has decreased somewhat, the concentration of total phosphorus has decreased steadily over the years from a mean of 0.055 mg/L in 1988 to under 0.030 mg/L. This is an encouraging trend because algae production is driven by phosphorus. The concentration of total nitrogen has also declined since 1988. Much of this decline was due to declines in ammonia and nitrate. Both ammonia and nitrate are soluble forms of nitrogen that are used by algae and aquatic plants for growth. One minor area of concern is that since 2000, blue-green algae have become the dominant type of algae in Simonton Lake, although at low densities.

Temperature, oxygen, and light penetration measurements were made on July 6, 2010. Temperature and oxygen profiles for Simonton Lake show that the lake was thermally stratified. The surface water of the west basin was well-mixed down to a depth of 16.4 feet (5 m) as indicated by the steady water temperatures. Below 16 feet, the temperature decreased steadily to the lake bottom which indicates there was no *hypolimnion* present at the time of sampling. The eastern basin was well-mixed to the bottom as the temperature and dissolved oxygen measurements were uniform. Simonton Lake had adequate dissolved oxygen in the well-mixed epilimnion of both basins. Dissolved oxygen (DO) decreased rapidly below 16.4 feet (5 m) in the western basin. At 20 to 23 feet (6 to 7 m) depths the concentration of DO was less than 1 mg/L, which is insufficient to support fish.

The 1% light level, extended to 21.5 ft (~7 m). Based on the depth-area curve and the depth volume curve, approximately 99% of the lake surface area and volume lies above the 21.5-foot 1% light level and can support plant or algae growth.

Phosphorus and nitrogen are the primary plant nutrients in lakes and drive the plankton populations that we see as algae. Phosphorus concentrations were similar for all samples in both basins during sampling conducted July 6, 2010. In the western basin, nitrate-nitrogen was 0.420 mg/L in the epilimnion and 0.291 mg/L in the deep water sample. Ammonia in the epilimnion was 0.039 mg/L and 0.317 mg/L in the deep water. In the east basin, nitrate-nitrogen was only 0.22 mg/L. The eastern basin's ammonia concentration was similar to the west basin's epilimnetic sample. Values for pH were within the normal range for Indiana lakes. The alkalinity values of 135 mg/L and 149 mg/L, for the epilimnion and deep water, indicate that Simonton Lake is a well-buffered system. The west basin had a higher density of plankton than the west basin, but east basin's plankton density was still fairly low. Overall, there was a nice mix of phytoplankton and zooplankton in both basins and this resulting balance is important for a healthy lake ecosystem.

Overall, the water quality of Simonton Lake is much better than most of Indiana's lakes. Simonton Lake current water quality parameters place the lake in the mesotrophic range for total phosphorus, total nitrogen and chlorophyll *a* with an Indiana TSI score of 22. The total nitrogen to total phosphorus ratios of 40N:1P for the west basin and 35N:1P for east basin show strong phosphorus limitation in Simonton Lake. This means that if more phosphorus is added to Simonton Lake, it may stimulate the growth of more algae. Therefore, phosphorus management and control should be a central part of any management plan.

No phosphorus budget was developed for Simonton Lake because phosphorus inputs are generally associated with flowing waters and there is no inlet stream that can be measured for Simonton Lake. A water budget was developed using a HYMAPS-OWL on-line model to estimate a hydraulic residence time of 1.2 years. This means that on average, water entering the lake stays in the lake for just over one year before it flows out. This hydraulic residence time is shorter than other glacial lakes in this part of the country; however, without accurate groundwater data, this water budget should be considered as very preliminary.

The Simonton Lake plant community was surveyed on May 27 and August 27, 2010 according to the Indiana Department of Natural Resources sampling protocols. A total of seventy points were surveyed throughout the littoral zone on each survey date. Aquatic plants were found at all 70 sites. Muskgrass was by far the most dominant submersed species found in each survey. Eleven different aquatic submersed species were collected in May and twelve different submersed aquatic species were collected in August. In all, 16 different submersed aquatic species were collected from the two surveys. Of the species collected, four are considered invasive: Eurasian watermilfoil, curly-leaf pondweed, brittle naiad, and spiny naiad; however, they were all found in sparse populations. Also, the state listed threatened species, white-stem pondweed, was documented. Floating leaf and emergent vegetation data was also collected during this survey. Seven emergent species were noted bordering Simonton Lake's edge. The most common emergent species include two cattail species and arrowhead. The two floating leaf species were spatterdock and white water lily. Water celery, sago pondweed, and variable-leaf pondweed are also important components of the Simonton Lake submerged community. Secchi disc transparency depths measured during the aquatic plant survey indicated that Simonton Lake possessed good water clarity ranging from 8.5 feet in the spring to 6.2 feet in the summer.

Concerns addressed at various meetings with lake residents included overuse of the lake by nonresidents, too many boats accessing the lake, lake level control, too many aquatic plants in the channels, a decline in the fisheries, pier and funneling issues, water quality and the need for dredging the channel between the lake basins. The majority of people who responded to the survey listed swimming and boating as their primary use of the lake. The next highest use was for fishing and then irrigation. The public access site for Simonton Lake is located in between the two lake basins on the south side of the waterway. A boat count conducted by lake volunteers documented that pontoon boats were the most popular watercraft on Simonton Lake. On weekdays, fishing boats are the second most common watercraft followed by speedboats. On the weekend (excluding July 3), fishing boats, speedboats and wave runners/jet skis have similar numbers on Simonton Lake. Non-motorized watercrafts were noted infrequently on Simonton Lake, with the exception of July 3. The maximum number of watercraft using the lake at any one time occurred on July 3 when a total of 324 watercraft were counted on the two basins, 300 in the west basin alone. Excluding July 3, the average number of boats on the lake in the other two surveys was 15.6 during any one counting period. Approximately half that many were present in the morning hours with peak use occurring between 5pm and 7pm on the weekday and around 3pm on the weekend. A review of the literature on tolerance compared with the non-idle zone available for boating suggests Simonton Lake can support 6-8 pontoon boats or 3-4 high speed boats operating at the same time and still maintain safe and comfortable distances between boaters. At least twice that number of non-motorized or non-moving craft would be an acceptable density to most lake users according to the research. This research suggests Simonton Lake may be at or close to its socially acceptable carrying capacity for watercraft during most of the summer.

Based on all the information gathered during this study the following management recommendations are suggested:

1) Limit phosphorus inputs by education of residents about fertilizer and animal waste
2) Encourage continued sewer system hookups
3) Establish and enforce an ecozone in the southeast corner of the east basin
4) Protect existing aquatic plants from damage by boat traffic
5) Encourage natural vegetated shorelines as alternatives to seawalls
6) Educate residents on invasive aquatic plants and implement monitoring & control
7) Consider dredging the channel between the basins to reduce sediment resuspension

Two projects were selected as being feasible to implement and which may help in improving the water quality of Simonton Lake. The projects were the establishment of an ecozone and the dredging of the channel between the two lakes. Two other projects involving lakeshore bioengineering and inlet channel improvements were determined not to be feasible at this time due to landowner concerns and lack of local support.

An ecozone is an area set aside in a public freshwater lake for addressing unusual conditions or hazards, improving fish, wildlife or botanical resource management or for the protection of lake users. Within this zone, special watercraft regulations can be established to either restrict access to boats or keep them at idle speeds. Established zones must be identified on site by buoys whose boundaries are fixed geographic points. Ecozones are established through the IDNR's rulemaking process, they are initiated by a group representing the lake, and are unique to a given lake and geographic area. They are initiated by local interests petitioning the IDNR to begin the rule making process. The petition must include appropriate maps with geographic reference points and a short description of the need, purpose and specific regulation the petition is seeking. The petition is reviewed by the NRC for preliminary approval. If the petitioning organization obtains this preliminary approval, the NRC directs the IDNR hearing officer to hold public hearings. Upon completion of the public hearings the hearing officer reports back to the NRC with his or her recommendation based upon the facts and opinions presented at the hearings. The NRC can either: 1) adopt into final rule the proposed zone boundaries, or 2) make modifications to the zone boundaries, 3) elect not to proceed with the rule making on the proposed zone. Once the zone is adopted by the NRC, IDNR staff then coordinates with the petitioning organization regarding the purchase and installation of the regulation buoys to mark the zone as appropriate.

Establishing an ecozone in Simonton Lake can improve water quality and fish habitat. The proposed ecozone is in the southeast corner of Simonton Lake. The area proposed has a diverse group of native plants already present; therefore, no additional plants are necessary for restoration. However, in order for the native plants to recover, we recommend watercraft restrictions that allow for idle speeds only. JFNew recommends the Simonton Lake Area Home Owners Association begin the petition process to the IDNR to create the proposed ecozone in the southeast corner of the east basin.

Dredging of the channel between the two basins is also a possibility. Dredging of an access channel between the lake basins will reduce sediment resuspension from watercraft motoring between the two lakes. The suspended sediment that results from prop wash results in making phosphorus more available for plant and algae growth. Because the only practical method to dredge this channel is hydraulic, which is a relatively expensive process, it can only be justified in small areas of the lake. JFNew has proposed a maximum extent of 60,000 square feet of dredging based on a channel length of 2000 feet and a channel width of 30 feet. The estimated cost for engineering, permitting, and implementation of the dredging project is $105,000 of which potentially 80% could be paid for through the LARE program. The primary reasons for dredging this channel should be to reduce the amount of lake bottom sediments that are resuspended into the water column by constant boat traffic through this shallow water zone. Enforcement of the idle speed only law through this area may be more difficult if this channel is dredged.

In conclusion, Simonton Lake has relatively good water quality when compared to other Midwestern lakes and the data obtained and collected suggest that the water quality has improved in the last 10 years. This trend should continue with attention to management of phosphorus inputs from the vicinity of the lake through continued sewerage of adjacent residents, education of residents on the use of phosphorus free fertilizers, and enforcing idle speed limits in the shallow areas of the lake. Implementing the two feasible projects of an ecozone and the dredging are not critical to preserving the water quality of the lake, but would play an important role in controlling phosphorus resuspension.

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APPENDIX A

RAW DATA

SIMONTON LAKE DIAGNOSTIC/FEASIBILITY STUDY

ELKHART COUNTY, INDIANA

Appendix A: Data

Raw Plant Survey Data

Simonton Lake spring survey raw data 5/27/10

DEPTH	FILALG	CHARA	ELOCAN	MYREXA	MYRHET	MYRSPI	NAJMIN	NITELLA	POTCRI	POTGRA	POTPEC	VALAME	Lat	Long
1		3											41.7490	-85.9509
1		1											41.7492	-85.9501
2		3								1			41.7509	-85.9526
2		3										1	41.7501	-85.9531
2		1								1		1	41.7495	-85.9530
3		1		1								1	41.7480	-85.9471
3			3	1		1		1				1	41.7499	-85.9489
3		1											41.7519	-85.9526
3					1								41.7524	-85.9541
3					3								41.7522	-85.9563
3					1		1	1					41.7524	-85.9578
3		1											41.7540	-85.9627
3		3											41.7545	-85.9660
3													41.7491	-85.9713
3		1											41.7476	-85.9648
3													41.7479	-85.9638
3		1											41.7492	-85.9624
3											1		41.7524	-85.9514
4		1									1		41.7489	-85.9487
4	p												41.7517	-85.9476
4		1					1					1	41.7528	-85.9592
4		1									1		41.7542	-85.9672
4											1		41.7537	-85.9679
4											1		41.7522	-85.9686
4		3											41.7511	-85.9694
4		1											41.7504	-85.9702
4											1		41.7489	-85.9723
4		1											41.7479	-85.9740
4		1											41.7515	-85.9634
5			1			1		1				1	41.7500	-85.9481
5	p	1								1	1		41.7473	-85.9707
5	p	1									1		41.7471	-85.9696
5	p										1		41.7482	-85.9643
5	p	1									1		41.7492	-85.9644
5		3									1		41.7484	-85.9631
5	p	1									1		41.7499	-85.9632
5	p									1	1	1	41.7507	-85.9634
5		1									1	1	41.7532	-85.9637
5						1					1	1	41.7523	-85.9490
5			1									1	41.7520	-85.9480
6		3					1						41.7518	-85.9513
6						3	1				1		41.7535	-85.9608
6	p		1				1						41.7542	-85.9641
6		1											41.7540	-85.9658
6	p	1											41.7534	-85.9675
6		1											41.7518	-85.9678
6		3											41.7523	-85.9675
6													41.7506	-85.9686
6		3											41.7494	-85.9708
6	p	1									1		41.7495	-85.9648
6		3											41.7497	-85.9652
6											1		41.7517	-85.9649
6	p	1									1		41.7525	-85.9641
7			1			1	1				1	1	41.7518	-85.9489
7		3											41.7486	-85.9708
7		1											41.7473	-85.9663
7		3											41.7496	-85.9660
8						3	1				1	1	41.7519	-85.9498
10		3											41.7485	-85.9719
10						1		1				1	41.7477	-85.9724
11		3									1	1	41.7523	-85.9649
11								1					41.7506	-85.9668
12													41.7500	-85.9685
14								1	1		1		41.7536	-85.9669
14	p	1											41.7529	-85.9670
14									3		1		41.7484	-85.9701
14								1	1				41.7476	-85.9713
15								1					41.7479	-85.9702
15													41.7474	-85.9674
15								1	1				41.7479	-85.9660

Simonton Lake summer survey raw data 8/27/10

DEPTH	FILALG	CHARA	ELOCAN	MYRHET	MYRSPI	NAJFLE	NAJGUA	NAJMAR	POTGRA	POTILL	POTPRA	STUPEC	VALAME	Long	Lat
2														-85.9623	41.7491
2		1												-85.9623	41.7494
2														-85.9632	41.7531
2		3						1						-85.9531	41.7510
2		3						1						-85.9535	41.7502
2		3				1			1					-85.9538	41.7496
2														-85.9510	41.7491
2												1		-85.9502	41.7493
2		1												-85.9496	41.7495
3		3											1	-85.9474	41.7482
3		1				3		1						-85.9525	41.7520
3		1							1			1		-85.9539	41.7525
3		1		1		1			1					-85.9562	41.7523
3		1	1	1		3			3					-85.9576	41.7524
3		1												-85.9626	41.7541
3		1				1				1				-85.9661	41.7544
3		1				5			1				1	-85.9681	41.7538
3						3			1					-85.9722	41.7489
3						5						1		-85.9738	41.7481
3							3	5				1	3	-85.9725	41.7475
3														-85.9649	41.7477
3						3			1				1	-85.9640	41.7479
4		3			1			1	1					-85.9477	41.7517
4		3						1	1				1	-85.9479	41.7520
4		1						1	3				1	-85.9485	41.7490
4		1						3					1	-85.9514	41.7522
4				1		3		1				1	1	-85.9591	41.7528
4						3			1				1	-85.9671	41.7543
4						1								-85.9678	41.7523
4		1				1			1					-85.9685	41.7520
4		1				1			1					-85.9695	41.7511
4		1												-85.9713	41.7492
4		1												-85.9671	41.7473
4														-85.9640	41.7484
4		1				3			1					-85.9631	41.7483
4						5			1					-85.9630	41.7500
4						1								-85.9636	41.7507
4														-85.9636	41.7514
5		1											3	-85.9481	41.7501
5								5					1	-85.9512	41.7519
5		1										5	3	-85.9605	41.7535
5	p	1				1			1					-85.9657	41.7540
5		1				5			1				1	-85.9675	41.7534
5		1				3			1			1		-85.9675	41.7519
5		1												-85.9687	41.7506
5	p													-85.9699	41.7502
5						1								-85.9640	41.7494
5		1				1			1					-85.9647	41.7495
5						3			1					-85.9648	41.7516
6								5			1	1	1	-85.9491	41.7526
6		1				3			1				1	-85.9639	41.7541
6		3				5								-85.9707	41.7494
6						3			3					-85.9653	41.7496
6		1						5				3		-85.9659	41.7496
6						3		1						-85.9641	41.7525
7								3				3	1	-85.9494	41.7519
7								3				3	1	-85.9685	41.7501
7								3					5	-85.9704	41.7474
7						3		1	1					-85.9698	41.7472
7		5				5		5				1	1	-85.9665	41.7505
7						1		1					5	-85.9648	41.7523
8			1					3					3	-85.9491	41.7517
8							1	5						-85.9698	41.7486
9						1		5					1	-85.9708	41.7474
10						5							1	-85.9669	41.7534
11									1		1	3	3	-85.9671	41.7528
13						1		5				1		-85.9717	41.7483
15														-85.9701	41.7478
15								5				1		-85.9700	41.7483
15						1								-85.9660	41.7478

Simonton Lake Spring Survey Summary Results

Occurrence and abundance of submersed aquatic plants in Simonton Lake					
County:	Elkhart	Sites with plants:	64	Mean species/site:	1.69
Date:	5/27/2010	Sites with native plants:	64	Standard error (ms/s):	0.13
Secchi (ft):	8.5	Number of species:	11	Mean native species/site:	1.53
Maximum plant depth (ft):	15.0	Number of native species:	9	Standard error (mns/s):	0.11
Trophic status:	Mesotrophic	Maximum species/site:	5	Species diversity:	0.82
Total sites:	70.0			Native species diversity:	0.78

All depths (0-5 feet)		Frequency of Occurrence	Rake score fequency per species				Plant Dominance
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Chara spp.	Muskgrass	60.0	40.0	45.0	15.0	0.0	18.0
Stukenia pectinata	Sago pondweed	37.5	62.5	37.5	0.0	0.0	7.5
Vallisneria americana	Water celery	25	75.0	25.0	0.0	0.0	5.0
Potamogeton gramineus	Variable-leaf pondweed	10	90.0	10.0	0.0	0.0	2.0
Elodea canadensis	Common waterweed	7.5	92.5	5.0	2.5	0.0	2.5
Myriophyllum heterophyllum	Variable-leaf watermilfoil	7.5	92.5	5.0	2.5	0.0	2.5
Nitella spp.	Nitella spp.	7.5	92.5	7.5	0.0	0.0	1.5
Myriophyllum spicatum	Eurasian watermilfoil	7.5	92.5	7.5	0.0	0.0	1.5
Myriophyllum sibiricum	Northern water milfoil	5	95.0	5.0	0.0	0.0	1.0
Najas minor	Najas minor	5	95.0	5.0	0.0	0.0	1.0
Potamogeton crispus	Curly leaf pondweed	0	100.0	0.0	0.0	0.0	0.0
Filamentous algae	Filamentous algae	17.5					

All depths (5-10 feet)		Frequency of Occurrence	Rake score fequency per species				Plant Dominance
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Chara spp.	Muskgrass	65.0	35.0	30.0	35.0	0.0	27.0
Stukenia pectinata	Sago pondweed	30.0	70.0	30.0	0.0	0.0	6.0
Najas minor	Najas minor	25.0	75.0	25.0	0.0	0.0	5.0
Myriophyllum spicatum	Eurasian watermilfoil	20.0	80.0	10.0	10.0	0.0	8.0
Vallisneria americana	Water celery	15.0	85.0	15.0	0.0	0.0	3.0
Elodea canadensis	Common waterweed	10.0	90.0	10.0	0.0	0.0	2.0
Nitella spp.	Nitella spp.	5.0	95.0	5.0	0.0	0.0	1.0
Myriophyllum sibiricum	Northern water milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum heterophyllum	Variable-leaf watermilfoil	0.0	100.0	0.0	0.0	0.0	0.0
Potamogeton gramineus	Variable-leaf pondweed	0.0	100.0	0.0	0.0	0.0	0.0
Potamogeton crispus	Curly leaf pondweed	0.0	100.0	0.0	0.0	0.0	0.0
Filamentous algae	Filamentous algae	20					

All depths (10-15 feet)		Frequency of Occurrence	Rake score fequency per species				Plant Dominance
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Nitella spp.	Nitella spp.	50.0	50.0	50.0	0.0	0.0	10.0
Potamogeton crispus	Curly leaf pondweed	40.0	60.0	30.0	10.0	0.0	12.0
Stukenia pectinata	Sago pondweed	30.0	70.0	30.0	0.0	0.0	6.0
Chara spp.	Muskgrass	20.0	80.0	10.0	10.0	0.0	8.0
Vallisneria americana	Water celery	10.0	90.0	10.0	0.0	0.0	2.0
Elodea canadensis	Common waterweed	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum sibiricum	Northern water milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum heterophyllum	Variable-leaf watermilfoil	0.0	100.0	0.0	0.0	0.0	0.0
Najas minor	Najas minor	0.0	100.0	0.0	0.0	0.0	0.0
Potamogeton gramineus	Variable-leaf pondweed	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum spicatum	Eurasian watermilfoil	0.0	100.0	0.0	0.0	0.0	0.0
Filamentous algae	Filamentous algae	10.0					

Simonton Lake Summer Survey Summary Results

Occurrence and abundance of submersed aquatic plants in Simonton Lake					
County:	Elkhart	Sites with plants:	62	Mean species/site:	2.36
Date:	8/27/2010	Sites with native plants:	62	Standard error (ms/s):	0.16
Secchi (ft):	6.2	Number of species:	12	Mean native species/site:	2.34
Maximum plant depth (ft):	15.0	Number of native species:	0	Standard error (mns/s):	0.16
Trophic status:	Mesotrophic	Maximum species/site:	5	Species diversity:	0.84
Total sites:	70.0			Native species diversity:	0.84

All depths (0-5 feet)		**Frequency of Occurrence**	**Rake score fequency per species**				**Plant Dominance**
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Chara spp.	Muskgrass	59.18	40.8	46.9	12.2	0.0	16.7
Najas flexilis	Slender naiad	46.94	53.1	20.4	18.4	8.2	23.3
Potamogeton gramineus	Variable-leaf pondweed	40.82	59.2	36.7	4.1	0.0	9.8
Vallisneria americana	Water celery	26.53	73.5	20.4	6.1	0.0	7.8
Najas marina	Spiny naiad	20.41	79.6	14.3	2.0	4.1	8.2
Stuckenia pectinata	Sago pondweed	14.29	85.7	12.2	0.0	2.0	4.5
Myriophyllum heterophyllum	Variable-leaf milfoil	6.12	93.9	6.1	0.0	0.0	1.2
Elodea canadensis	Common waterweed	2.04	98.0	2.0	0.0	0.0	0.4
Najas guadalupensis	Southern naiad	2.04	98.0	0.0	2.0	0.0	1.2
Potamogeton illinoensis	Illinois pondweed	2.04	98.0	2.0	0.0	0.0	0.4
Myriophyllum spicatum	Eurasian water milfoil	2.04	98.0	2.0	0.0	0.0	0.4
Potamogeton praelongus	White-stem pondweed	0.00	100.0	0.0	0.0	0.0	0.0
Filamentous algae		4.08					

All depths (5-10 feet)		**Frequency of Occurrence**	**Rake score fequency per species**				**Plant Dominance**
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Najas marina	Spiny naiad	75.0	25.0	18.8	25.0	31.3	50.0
Vallisneria americana	Water celery	62.5	37.5	43.8	6.3	12.5	25.0
Najas flexilis	Slender naiad	56.3	43.8	12.5	25.0	18.8	36.3
Stuckenia pectinata	Sago pondweed	31.3	68.8	12.5	18.8	0.0	13.8
Chara spp.	Muskgrass	25.0	75.0	12.5	6.3	6.3	12.5
Potamogeton gramineus	Variable-leaf pondweed	18.8	81.3	12.5	6.3	0.0	6.3
Elodea canadensis	Common waterweed	6.3	93.8	6.3	0.0	0.0	1.3
Najas guadalupensis	Southern naiad	6.3	93.8	6.3	0.0	0.0	1.3
Potamogeton praelongus	White-stem pondweed	6.3	93.8	6.3	0.0	0.0	1.3
Myriophyllum heterophyllum	Variable-leaf milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Potamogeton illinoensis	Illinois pondweed	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum spicatum	Eurasian water milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Filamentous algae		0					

All depths (10-15 feet)		**Frequency of Occurrence**	**Rake score fequency per species**				**Plant Dominance**
Scientific Name	**Common Name**		**0**	**1**	**3**	**5**	
Stuckenia pectinata	Sago pondweed	60.0	40.0	40.0	20.0	0.0	20.0
Najas flexilis	Slender naiad	40.0	60.0	40.0	0.0	0.0	8.0
Najas marina	Spiny naiad	40.0	60.0	0.0	0.0	40.0	40.0
Vallisneria americana	Water celery	20.0	80.0	0.0	20.0	0.0	12.0
Potamogeton gramineus	Variable-leaf pondweed	20.0	80.0	20.0	0.0	0.0	4.0
Potamogeton praelongus	White-stem pondweed	20.0	80.0	20.0	0.0	0.0	4.0
Chara spp.	Muskgrass	0.0	100.0	0.0	0.0	0.0	0.0
Elodea canadensis	Common waterweed	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum heterophyllum	Variable-leaf milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Najas guadalupensis	Southern naiad	0.0	100.0	0.0	0.0	0.0	0.0
Potamogeton illinoensis	Illinois pondweed	0.0	100.0	0.0	0.0	0.0	0.0
Myriophyllum spicatum	Eurasian water milfoil	0.0	100.0	0.0	0.0	0.0	0.0
Filamentous algae		0.0					

IDNR Lake and River Enhancement – Lake Use Survey

Lake Name: Simonton Lake

Are you a lake property owner? Yes 100% No 0%

Are you currently a member of your lake association? Yes 97% No 0%

How many years have you been at the lake?
<2 yrs 3%   2 – 5 yrs 18%   5-10 yrs 9%   > 10 years 70%

How do you use the lake (mark all that apply)
85% Swimming   24% Irrigation   100% Boating   9% Drinking water
58% Fishing   6% Other

Do you have aquatic plants at your shoreline in nuisance quantities?
Yes 24% No 76%

Do you currently participate in a weed control project on the lake?
Yes 24% No 76%

Does aquatic vegetation interfere with your use or enjoyment of the lake?
Yes 64% No 36%

Does the level of vegetation in the lake affect your property values?
Yes 30% No 64%

Are you in favor of continuing efforts to control vegetation on the lake?
Yes 91% No 6%

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded?
Yes 61% No 39%

Mark any of these you think are problems on your lake:
70% Too many boats access the lake
30% Use of jet skis on the lake
3% Too much fishing
18% Fish population problem
70% Dredging needed
78% Overuse by nonresidents
42% Too many aquatic plants
0% Not enough aquatic plants
6% Poor water quality
9% Pier/funneling problem

Comments:
• Too many boats access the lake by non residents, problem with jet skis brought in by non residents, limit public access
• Way too many boats. Does not meet standard for boats per acre of lake
• Dredging needed on west coast
• The channel between the two lakes is too shallow
• Lake cleanup - annually. Old shacks in high weed area. Narrow passage and shallow between lakes
• Very interested in controlling outside use of the lake and potential for dredging
• Too many boats access the lake from easement - non-lake people
• Sand bar out of control on weekends
• High water, no control of water levels - often to high with weir control
• Zebra mussels, too many plants in channels
• Matted oscillatoria - north end of channel off CR #11
• People have drains going into the lake from their homes

Boat Survey Results

		Time							
Date	**Boat Type**	**7:00 AM**	**9:00 AM**	**11:00 AM**	**1:00 PM**	**3:00 PM**	**5:00 PM**	**7:00 PM**	**9:00 PM**
7/3/2010	**Fishing**	4	5	3	3	18	0	2	4
	Kayak, Canoe, Paddle Boat	2	1	2	1	64	1	1	0
	Pontoon	1	2	7	58	122	48	42	29
	Speedboat	1	2	6	23	65	31	14	10
	Waverunner	0	0	4	6	55	21	6	7
8/3/2010	**Fishing**	5	4	4	0	0	3	6	3
	Kayak, Canoe, Paddle Boat	0	0	0	0	2	2	0	0
	Pontoon	2	1	7	11	8	9	7	10
	Speedboat	0	0	1	2	0	2	1	0
	Waverunner	0	0	1	0	1	2	4	0
8/15/2010	**Fishing**	6	6	3	1	0	2	3	1
	Kayak, Canoe, Paddle Boat	0	0	0	0	0	0	0	0
	Pontoon	0	6	8	16	21	17	13	11
	Speedboat	0	1	0	3	7	7	3	1
	Waverunner	0	0	4	5	5	2	0	0

APPENDIX B

SOURCES OF ADDITIONAL INFORMATION

SIMONTON LAKE DIAGNOSTIC/FEASIBILITY STUDY

ELKHART COUNTY, INDIANA

Appendix B: Additional Information

PSD Explained

Proportional stock density (PSD) is an easily calculated statistic used by fisheries biologists when determining if a species population is balanced. Anderson (1976) developed PSD and its use is generally applicable to water bodies less than 500 acres. PSD relates the number of individuals in a population stock size or larger to the number of those individuals that are of quality size or larger. Stock size is generally defined as the minimum size at which a species becomes available to anglers, while quality size is generally defined as the minimum size anglers consider the species harvestable. Generally, PSDs indicative of balance in a target species population are based on sustainable harvest of sizes preferred by anglers (Hubert and Kohler, 1999). Therefore, balance depends on the density of fish of various sizes in the population; both adequate numbers of catchable size fish and sufficient numbers of smaller fish to provide replacement (Hubert and Kohler, 1999).

Ranges of PSD values indicating balanced populations have been developed for a number of different fish species. For example, largemouth bass populations with PSD values between 40 and 70 and bluegill populations with PSD values between 20 and 40 are characteristic of balanced populations (Anderson, 1980). If a species PSD value is low it would suggest the population has a disproportionate number of small individuals. Conversely, if a species PSD is high it would suggest the population has a disproportionate number of large individuals. It is important to note that desired PSD values can vary depending on the management goal of a fishery. For example, a largemouth bass oriented fishery would support a low PSD value in the bluegill population and a high PSD value in the largemouth bass population. The low bluegill PSD value would provide an abundance of edible size prey demanded by the large largemouth bass population. It is important to note PSD values are usually calculated for a single collection method, such as electro-fishing; however, due to the absence of data provided on the number of individuals collected by method in historic fishery management reports, an overall PSD was calculated for each given survey year. Additionally, it is important to recognize that PSD is not an all inclusive statistic which always correlates with the overall state of a population; rather, PSD should be used in series with other population statistics such as recruitment, mortality, growth and condition, and density, just to name a few. The PSD value should be viewed as a general assessment of the population structure.

Aquatic Vegetation Survey:

To find the IDNR Tier II survey protocol visit: http://www.in.gov/dnr/fishwild/files/fw-LARE_TierII_Procedure_Manual_Dec2010.pdf

IDNR ECOZONE Handout

http://www.in.gov/dnr/fishwild/files/DNR_Ecozones_brochure_revised_4-4-07.pdf

Potential additional Funding

Clean Water Act Section 319 Nonpoint Source Pollution Management Grant
The 319 Grant Program is administered by the Indiana Department of Environmental Management (IDEM), Office of Water Management, Watershed Management Section. 319 is a federal grant made available by the Environmental Protection Agency (EPA). 319 grants fund projects that target nonpoint source water pollution. Nonpoint source pollution (NPS) refers to pollution originating from general sources rather than specific discharge points (Olem and Flock, 1990). Sediment, animal and human waste, nutrients, pesticides, and other chemicals resulting from land use activities such as mining, farming, logging, construction, and septic fields are considered NPS pollution. According to the EPA, NPS pollution is the number one contributor to water pollution in the United States. To qualify for funding, the water body must meet specific criteria such as being listed in the state's 305(b) report as a high priority water body or be identified by a diagnostic study as being impacted by NPS pollution. Funds can be requested for up to $300,000 for individual projects. There is a 25% cash or in-kind match requirement. To qualify for implementation projects, there must be a watershed management plan for the receiving waterbody. This plan must meet all of the current 319 requirements. This diagnostic study serves as an excellent foundation for developing a watershed management plan since it satisfies several, but not all, of the 319 requirements for a watershed management plan. More information about the Section 319 program can be obtained from http://www.in.gov/idem/nps/2524.htm

Section 205(j) Water Quality Management Planning Grants
Funds allocated by Section 205(j) of the Clean Water Act are granted for water quality management planning and design. Grants are given to municipal governments, county governments, regional planning commissions, and other public organizations for researching point and non-point source pollution problems and developing plans to deal with the problems. According to the IDEM Office of Water Quality website: "The Section 205(j) program provides for projects that gather and map information on non-point and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and implement watershed management plans. No match is required. For more information on and 205(j) grants, please see the IDEM website at:
http://www.in.gov/idem/nps/2525.htm

Other Federal Grant Programs
The USDA and EPA award research and project initiation grants through the U.S. National Research Initiative Competitive Grants Program and the Agriculture in Concert with the Environment Program.

Watershed Protection and Flood Prevention Program
The Watershed Protection and Flood Prevention Program is funded by the U.S. Department of Agriculture and is administered by the Natural Resources Conservation Service. Funding targets a variety of watershed activities including watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in small watersheds (250,000 or fewer acres). The program covers 100% of flood prevention construction costs or 50% of construction costs for agricultural water management, recreational, or fish and wildlife projects.

APPENDIX C

MEETINGS DOCUMENTATION AND CORRESPONDENCE

SIMONTON LAKE DIAGNOSTIC/FEASIBILITY STUDY

ELKHART COUNTY, INDIANA

MEMO TO FILE

File: Simonton Lake 08-12-096.00

Date: May 20, 2010

Subject: Public meeting to discuss diagnostic/feasibility study

Present at meeting: John Richardson, Betsy Ewoldt, Brett Peters, Simonton Lake Association board members, and approximately 60 people from the public.

1) The public meeting began with board member introductions.
2) The safety committee posted new signs near the boat launch and at Lakeshore Grill noting DNR guidelines and rules.
3) A main concern for homeowners around Simonton Lake continues to be the water level and issues such as water in basements, pier damage, and seawall erosion are associated with the need for a weir structure at the outlet.
4) Funding is still being sought for construction of the weir structure.
5) JFNew handed out the lake use surveys for people to fill out during the meeting. 33 surveys were completed and returned to JFNew employees that evening.
6) John Richardson presented the group with goals for the study and the work to be completed in the coming year.

Date: May 23, 2011

Subject: Final Meeting Presentation of Study

Present: Approximately 80 members of the Simonton Lake Area Homeowners Association and the full Board Presentation by John Richardson of Cardno-JFNew

1) The presentation was well received,

2) Questions about FEMA floodway mapping

3) Questions about dredging

4) Approximately six folks signed up to be on a dredging committee

5) Only one person signed up to be on the ecozone implementation committee

MEMO TO FILE

File: Simonton Lake 08-12-096.00

Date: November 4, 2010

Subject: Meeting to review feasibility tasks

Present at meeting: John Richardson, Rod Edgell, Bob Putnam, Bob Evans, Bill Broderick, and Jim Flemming

1) We briefly reviewed where we were at with the Diagnostic-Feasibility Study (data collection nearly complete, feasibility work and report to go).
2) Summarized the state of the lake, (better water quality and less invasive aquatic plants than most Indiana Lakes).
3) Presented the purpose of the meeting (to target which projects we could work on for feasibility of implementation of which two will be fully pursued).
4) Discussed the following potential projects:
   - A: The shoreline at the west end of the lake (infiltration and shoreline clean up)
   - B: Dredging the channel between the lake basins
   - C: Flooding or potential flooding issues caused by infilling of the inlet channel on the north side of the lake (adjacent to the new cell tower)
   - D: Filling and blockage of drainage in the northeast corner of the little lake
   - E: The outlet of the lake and a potential water level control structure
   - F: Planting of the lake with additional fish friendly plants
   - G: The development of an Ecozone in the SE corner of the little lake and potentially in the channel between the two lakes (An Ecozone can provide for a no wake zone outside of the 200-foot zone currently allowed and would allow for establishment of vegetation in shallow areas that currently receive too much boat traffic).

5) All of the above issues will be discussed and presented within the Diagnostic Study.
6) The two issues that will be pursued for feasibility include improvements to the shoreline on the west end of the lake and the eco-zone development in conjunction with dredging of the channel between the lakes.
7) Feasibility includes project development to a point that JFNew perform or obtain:
   - A: Limited survey work and concept designs for presentation
   - B: Landowner and/or lake association agreements to implement the project
   - C: DNR and if necessary IDEM and Corps approval to implement the project
   - D: Cost estimates for proposed project
   - E: A discussion of any issues that may prevent project implementation
8) We briefly discussed the application for additional grants to implement these potential projects and it was agreed that we would apply for the next round of LARE grants (applications due in early January) with the understanding that LARE grants may not be available again this year due to budget cuts at the state level.

APPENDIX D

PROPERTY OWNER CORRESPONDENCE

SIMONTON LAKE DIAGNOSTIC/FEASIBILITY STUDY

ELKHART COUNTY, INDIANA

November 12, 2010

Richard and Sally Hobson &
Lynn Companion
51415 Lake Drive
Elkhart, IN 46514

RE: Simonton Lake

Dear Mr. and Mrs. Hobson and Ms. Companion:

JFNew is working with the Simonton Lake Area Home Owners Association (SLAHOA) on a DNR funded study to improve water quality in Simonton Lake. Recently, we met and discussed opportunities for several projects around the lake that we hope will contribute to cleaner water and better fishing. We need your help.

You own a parcel at the west end of Simonton Lake adjacent to the Lakeside Grill. We would like to talk to you about using available grant funds to improve the shoreline on this parcel while reducing some of the sediment that washes to the lake from the paved areas. We have not developed any specific plans to date but would like to share some ideas with you before taking any further action.

Would you be willing to sit down with me and a representative of the SLAHOA to discuss the possibilities for this parcel? There is no cost to you associated with any potential project. JFNew is being paid by the SLAHOA utilizing a DNR Lake and River Enhancement grant received last year and will pursue grants for any projects that become feasible as part of the current study. Please contact me at the email or phone number above, or if you prefer, you may contact Bill Broderick (SLAHOA Board member) at 574-264-4161.

Sincerely,

John Richardson

C: William Broderick
JFNew File 0812096

November 17, 2010

Ms. Ola Crain
25552 N. Shore Drive
Elkhart, IN 46514

RE: Simonton Lake Projects

Dear Ms Crain:

Thank you for taking time to meet with the DNR representatives and me last Monday. As we mentioned, JFNew is working with the Simonton Lake Area Home Owners Association (SLAHOA) on a DNR funded study to improve water quality in Simonton Lake. This letter is intended to summarize our discussion regarding your property.

The DNR representatives felt that improvements to the channel on your parcel could be funded using Lake and River Enhancement money, provided we come up with some plans that are acceptable to you and the lake association. Improvements would likely include armoring the channel banks and bottom to increase the flow of clean water to the lake. Additionally, we will be looking for the outlet of the 12 inch diameter culvert that crosses from the north side of North Shore Drive toward the lake and investigating where the tile drain along the south side of North Shore Drive outlets. There is no cost to you for any of this work. Your cooperation is all that is required to complete this feasibility study.

We hope to complete this work and come to an agreement with you on a practical project yet this fall. Therefore, I was hoping we could come out early next week to perform the survey work required to develop some sketches. We will call this Friday to confirm a mutually agreeable time for us to perform the work.

Thank you,

John Richardson

C: William Broderick
JFNew File 0812096

December 22, 2010

Ms. Ola Crain
25552 N. Shore Drive
Elkhart, IN 46514

RE: Simonton Lake Projects

Dear Ms. Crain:

We appreciated being able to survey and investigate the drainage crossing your property last month on behalf of the Simonton Lake Area Homeowners Association. I apologize for the month long delay in getting you the attached information.

To summarize, we collected grade information on the drainage and at the various inlet structures we found as well as documented the width of the bottom and at the top of the existing channel. We also located a portion of the culvert that comes underneath North Shore Drive emptying into the channel that crosses your parcel, but did not have the tools to excavate the entire opening to the culvert and determine its actual size (estimated 12" metal pipe). Please review the attached plan view drawing to see that it adequately represents the existing conditions on the property (Page 1).

What we propose for a future project is that the blocked culvert be exposed, which may involve lowering the bottom of the existing channel. At that point the project could take two directions as shown on Page 2 of the attached drawing: 1) enclose the channel completely in a culvert all the way to the lake or 2) clean the entire channel and convert it to a vegetated swale to the lake. JFNew would like to convert it to a vegetated swale for the following reasons. Putting the drainage into a pipe would require State and Federal permits (Section 401 and 404 of the Clean Water Act) which would be very difficult to obtain and would require mitigation (fixing a stream some place else). In addition, the piping project would not likely be funded by the Lake and River Enhancement (LARE) program. The vegetated swale would be granted a permit without any requirements and could be funded by the state LARE program, provided the funds are available. Both methods would increase the flow of surface water to the lake immediately following storm events, but the vegetated swale would trap nutrients and sediment thereby helping keep Simonton Lake clean.

Please consider this project over the next several weeks. Again, there is no cost to you. We are only requesting your cooperation and permission to potentially complete the project in the future. If you approve of the proposed project we will document your approval in our Engineering Feasibility report to the lake association.

Unless the project is completed entirely on your own accord, the SLAHOA board would also have to approve of and obtain funding to construct the project. JFNew would help the organization seek grant funds to construct the project. To the best of our knowledge this project would not likely be constructed in 2011 due to state budget shortfalls; however, we are hoping the LARE grant program will be available in 2012.

Please do not hesitate to contact me if you have any concerns or questions in the next few weeks. We will contact you again in mid-January to see if you are still interested.

Thank you,

John Richardson

C: William Broderick
Rod Edgell – DNR LARE
JFNew File 0812096

November 17, 2010

Mr. Shaylor King
25570 N. Shore Drive
Elkhart, IN 46514

RE: Simonton Lake Projects

Dear Mr. King:

Thank you for taking time to meet with the DNR representatives and me last Monday. As we mentioned, JFNew is working with the Simonton Lake Area Home Owners Association (SLAHOA) on a DNR funded study to improve water quality in Simonton Lake. This letter is intended to summarize our discussion regarding your property.

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Thank you,

John Richardson

C: William Broderick
JFNew File 0812096

December 22, 2010

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25570 N. Shore Drive
Elkhart, IN 46514

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Please do not hesitate to contact me if you have any concerns or questions in the next few weeks. We will contact you again in mid-January to see if you are still interested.

Thank you,

John Richardson

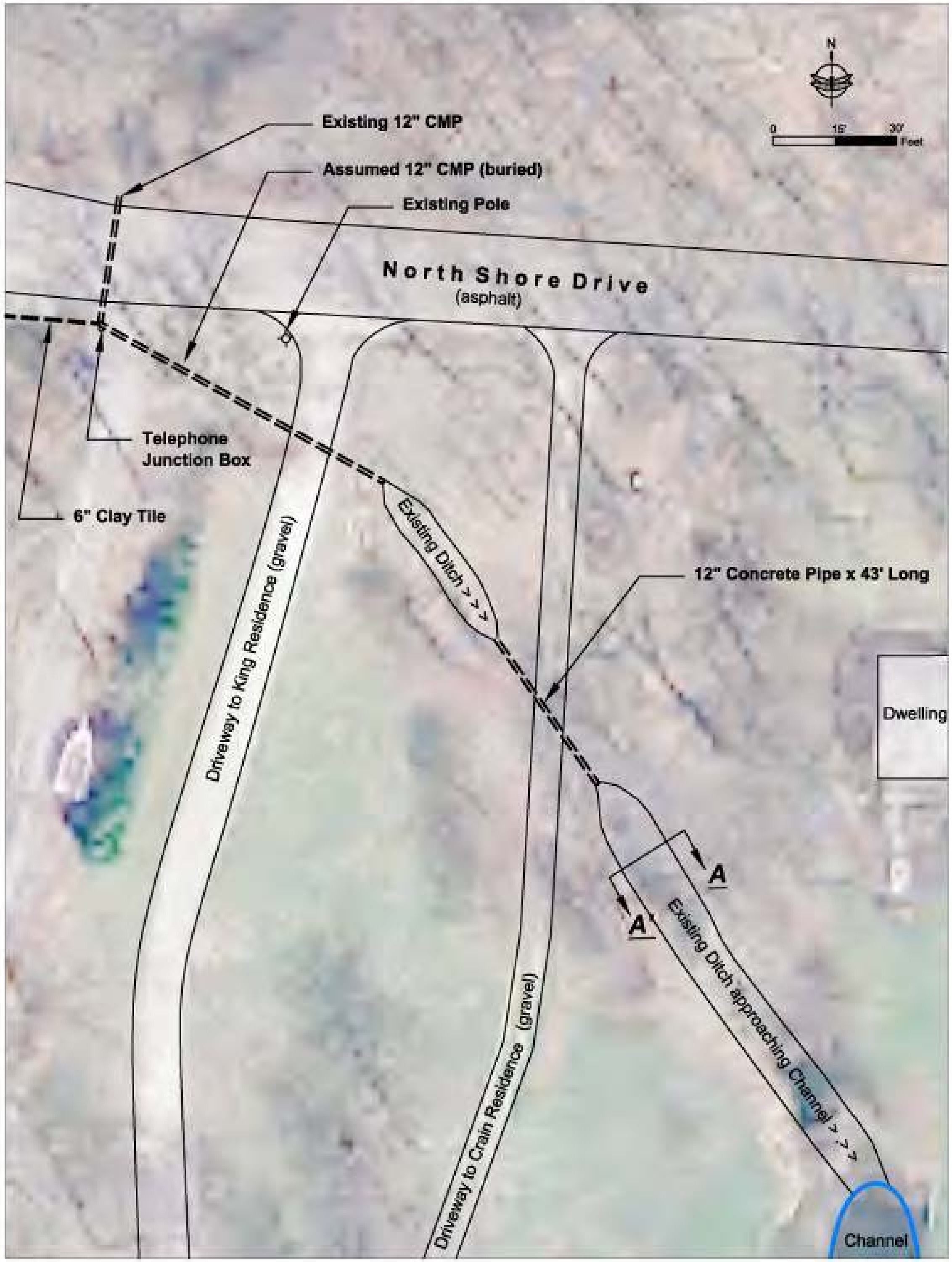
C: William Broderick
Rod Edgell - DNR LARE
JFNew File 0812096

APPENDIX E

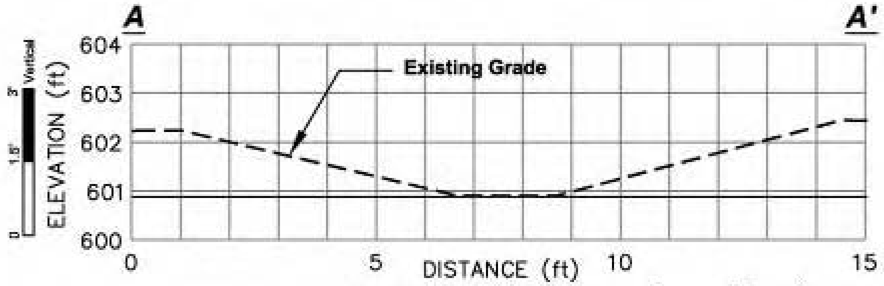
PROJECT PLANS

SIMONTON LAKE DIAGNOSTIC/FEASIBILITY STUDY

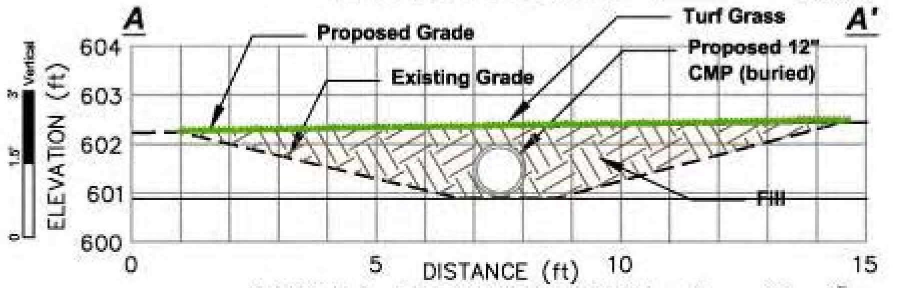
ELKHART COUNTY, INDIANA



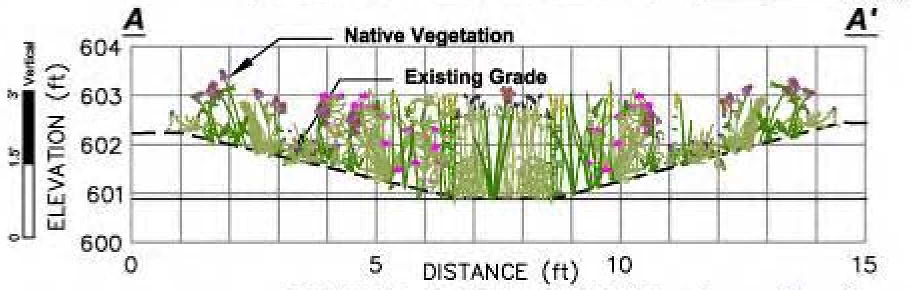
N
0
15'
30'
Feet
Existing 12" CMP
Assumed 12" CMP (buried)
Existing Pole
North Shore Drive
(asphalt)
Telephone
Junction Box
6" Clay Tile
Existing Ditch > > >
12" Concrete Pipe x 43' Long
Dwelling
A
A'
Driveway to King Residence (gravel)
Existing Ditch approaching Channel > > >
Driveway to Crain Residence (gravel)
Channel



EXISTING CONDITIONS



OPTION A - PIPE IN FILLED DITCH



OPTION B - VEGETATED SWALE

VEGETATED SWALE