Lotus Lake Management Plan, 2018-2022

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We would like to thank the following for their contributions to this project. Asterisks indicate members of the Lake Planning Committee.

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Purpose of the Study

In 2013, the Polk County Land and Water Resources Department applied for a two phase Wisconsin Department of Natural Resources Lake Planning Grant on behalf of the Lotus Lake Association. The grant was awarded and data collection occurred in 2014, 2015, and 2016.

The main purpose of the grant was to determine the impacts of carp removal on water quality and biological indicators and to develop a Lake Management Plan for Lotus Lake. Carp removal efforts were scheduled and attempted numerous times over the study period but were largely unsuccessful.

Methods and activities completed through this grant award include:

- ✓ In-lake physical and chemical data
- ✓ Tributary monitoring
- ✓ Phytoplankton
- ✓ Zooplankton
- ✓ Spring and fall aquatic macrophyte surveys
- ✓ Lake resident survey
- ✓ Lake level and precipitation monitoring data
- ✓ Watershed delineation and boundaries
- ✓ Phosphorus loads
- ✓ Shoreline inventory
- ✓ Shoreline restoration workshop

The following report details the methods and activities completed through the two phase grant.

Background Information on Lakes, Studies, and Management Plans

Lakes are a product of the landscape they are situated in and of the actions that take place on the land which surrounds them. Factors such as lake size, lake depth, water sources, and geology all cause inherent differences in lake quality. As a result, lakes situated within feet of others can differ profoundly in the uses they support.

A landscape can be divided into watersheds and subwatersheds. These areas define the land that drains to a particular lake, flowage, stream, or river. Watersheds that preserve native vegetation and minimize impervious surfaces (cement, concrete, and other materials that water can't permeate) are less likely to cause negative impacts on lakes, rivers, and streams. This arises because rain and melting snow eventually end up in lakes and streams through surface runoff or groundwater infiltration. Rain and melting snow entering a waterbody is not inherently problematic. However, water has the ability to carry nutrients, bacteria, sediments, and chemicals into a waterbody. These inputs can impact aquatic organisms such as insects, fish, and wildlife and—especially in the case of the nutrient phosphorus—fuel problematic algae blooms.

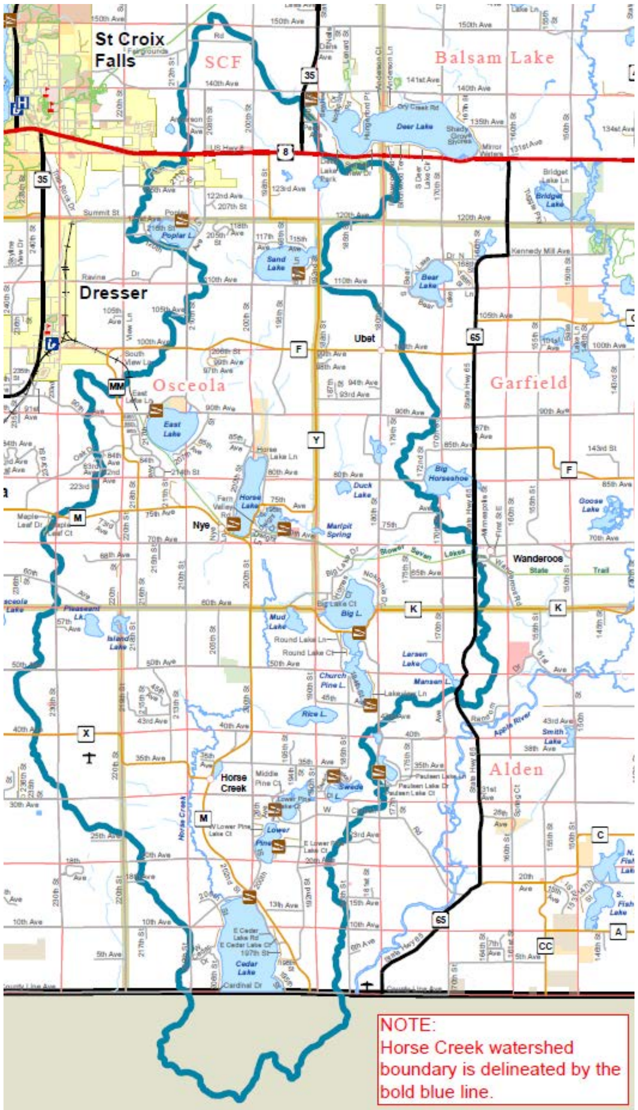
Lake studies often examine the underlying factors that impact a lake's health, such as lake size, depth, water sources, and the land use in a lake's watershed. Many forms of data can be collected and analyzed to gauge a lake's health including: physical data (oxygen, temperature, etc.), chemical data (including nutrients such a phosphorus and nitrogen), biological data (algae, zooplankton, and aquatic plants), geological data (soils, glacial till, and sediment chemistry) and land use within a lake's watershed. Additionally, sediment cores can be used to determine how a lake has changed over the course of hundreds of years

Lake studies identify challenges and threats to a lake's health along with opportunities for improvement. These studies identify practices already being implemented by watershed residents to improve water quality and areas providing benefits to a lake's ecosystem. Additionally, these studies quantify practices or areas on the landscape, or within the lake, which have the potential to negatively impact the health of a lake and identify best management practices for improvement.

The end product of a lake study is a **Lake Management Plan** which identifies goals, objectives, and action items to either maintain or improve the health of a lake. These goals should be realistic based on inherent lake and watershed characteristics (lake size, depth, land use, etc.) and should align with the goals of watershed residents.

Lake management plans are designed to be working documents that are used to guide the actions which take place to manage a specific lake.

Introduction to Lotus (East) Lake



NOTE:
Horse Creek watershed boundary is delineated by the bold blue line.

Lotus (East) Lake[1] is a 237 acre lake located in the Town of Osceola[2] in Polk County, Wisconsin, approximately 50 miles northeast of the Twin Cities metropolitan area. The area of land that drains to a lake is called a watershed. Lotus Lake is situated within the Horse Creek Watershed, which is part of the St. Croix River Basin. The Horse Creek Watershed drains 54 square miles of land in Polk and St. Croix Counties.

On a smaller scale, the area of land that drains to Lotus Lake, or the Lotus Lake watershed, is 2,825 acres in size.[3] The drainage basin: lake area ratio (DB: LA) compares the size of a lake's watershed to the size of a lake. If a lake has a relatively large DB: LA then surface water inflow (containing nutrients and sediments) occurs from a large area of land relative to the area of the lake. The DB: LA for Lotus Lake is approximately 12:1.

Horse Creek is the largest stream in the Horse Creek watershed and measures 16 miles in length. It flows into Lotus Lake on the northeast side of the lake and exits to Horse Lake on the south side of Lotus Lake before emptying into Cedar Lake.[4]

Lakes are classified according to their primary source of water and how that water enters and leaves the system. Lotus Lake is defined as a drainage lake, or a lake with an inlet and an outlet. Drainage lakes receive most of their water from the surrounding watershed in the form of stream drainage, have a prominent inlet and outlet that move water through the system, and commonly have high nutrient levels due to inputs from the watershed.

Significant public access and use opportunities are available on Lotus Lake. A public boat landing and County Park are located on the north side of the lake in addition to State of Wisconsin Land. Additionally, the Stower Seven Lakes State Trail, a silent trail maintained by the County, runs alongside

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[1] Waterbody ID (WBIC) 2616900

[2] T33N, R19-18 W, Sec. 15, 16, 21, 22

[3] Nonpoint Source Control Plan for the Horse Creek Priority Watershed Project, June 2001

[4] Ibid

the east and south sides of Lotus Lake. A platted access site is also owned by The Town of Osceola on the southeast side of the lake.

Lotus Lake has known populations of two aquatic invasive species: curly leaf pondweed and purple loosestrife.

The trophic state is a measure of a lakes health which relates to the amount of algae in the water. Using secchi data, the average summer trophic state for the past five years was hypereutrophic, which is considered poor for a shallow lowland lake. [5]

Lotus Lake has been monitored by members of the Lotus Lake Association since 2011.

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[5] http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2616900&page=waterquality

Lake Classification

Lake classification in Polk County is a relatively simple model that considers:

- ✓ Lake surface area
- ✓ Maximum depth
- ✓ Lake type
- ✓ Watershed area
- ✓ Shoreline irregularity
- ✓ Existing level of shoreline development

These parameters are used to classify lakes as class one, class two, or class three lakes. Lotus Lake is classified as a class two lake.

Class one lakes are large and highly developed.
Class two lakes are less developed and more sensitive to development pressure.
Class three lakes are usually small, have little or no development, and are very sensitive to development pressure.

Lotus Lake Characteristics

Lotus Lake [6]
Area: 237 Acres
Maximum depth: 15 feet
Mean depth: 7 feet
Bottom: 0% sand, 0% gravel, 0% rock, and 99% muck
Hydrologic lake type: Drainage [7]
Total shoreline: 3.29 miles
Invasive species: Curly-leaf pondweed, purple loosestrife
Fish: Panfish, largemouth bass, and northern pike
Boat landings: 1
Trophic Status: Hypereutrophic

Oligotrophic lakes are generally clear, deep, and free of plants and large algae blooms.

Mesotrophic lakes lie between oligotrophic and eutrophic lakes. They usually have productive fisheries, healthy plant life, and occasional algae blooms.

Eutrophic lakes are generally high in nutrients and support a large number of plant and animal populations. They are usually very productive and subject to frequent algae blooms.

Hypereutrophic lakes are characterized by dense algae communities and can experience heavy blooms throughout the summer.

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[6] http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2616900&page=facts

[7] A drainage lake is fed by streams, groundwater, precipitation, and runoff and drained by a stream

Designated Waters and Sensitive Areas

A designated water is a waterbody with special designations that affect permit requirements.

Lotus Lake is not designated as a priority navigable waterway (PNW, ASNRI, PRF).

Lotus Lake is listed as a water whose harvest of wild rice is date regulated. However, rice has not been known to exist on Lotus Lake since the 1990's. The Wisconsin Ceded Territory Manoomin Inventory recommends Lotus Lake no longer be considered a wild rice water. [8]

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[8] Wisconsin Ceded Territory Manoomin Inventory, GLIFWC Project Report, Peter David, 2010

Impaired Waters

Wisconsin lakes, rivers, and streams are managed to determine if their conditions are meeting state and federal water quality standards. Water samples are collected through monitoring studies and results are compared to guidelines designed to evaluate conditions as compared to state standards. General assessments place waters in four different categories: poor, fair, good, and excellent. The results of assessments can be used to determine which actions will ensure that water quality standards are being met (anti-degradation, maintenance, or restoration).

If a waterbody does not meet water quality standards, it is placed on Wisconsin's Impaired Waters List under the Federal Clean Water Act, Section 303(d). Every two years the State of Wisconsin is required to submit list updates to the United States Environmental Protection Agency for approval.

Waterbodies can be listed as impaired based on pollutants such as total phosphorus, total suspended solids, and metals. Wisconsin waters are each assigned four uses (fish and aquatic life, recreation, public health and welfare, and wildlife) that carry with them a set of goals.

Impairment thresholds vary for each use and vary based on lake characteristics such as whether a waterbody is shallow or deep and whether a waterbody is a drainage or seepage lake. Lotus Lake is classified as a shallow drainage lake that does not stratify. [9]

Lotus Lake was assessed during the 2016 listing cycle. Total phosphorus sample data exceeded the 2016 Wisconsin's Consolidated Assessment and Listing Methodology (WisCALM) listing thresholds for recreation (40 µg/L) but not for fish and aquatic life (100 µg/L). Chlorophyll sample data exceeded the 2016 WisCALM listing thresholds for recreation (30% of days in the sampling season have nuisance algal blooms with chlorophyll values greater than 20 µg/L) but not for fish and aquatic life (60 µg/L).[10] The impairment listed is excess algal growth based on the pollutant total phosphorus. The general condition is poor.

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[9] Listing thresholds can be found in: Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting, Wisconsin Department of Natural Resources, September 2013

[10] http://dnr.wi.gov/water/waterDetail.aspx?key=16558

Previous Lake Studies

Past studies on Lotus Lake include:

- ✓ Lotus Lake, Phase 1 and 2, Water Quality and Biological Assessment/Education and Riparian Survey Project, Land and Water Resources Department, 2004
- ✓ Lotus Lake, Phase 3 and 4, Water Quality and Biological Assessment/Historical Changes, Land and Water Resources Department, 2006
- ✓ Paleolimnologic Analysis of Horse Lake and Lotus Lake, Polk County, Wisconsin, St. Croix Watershed Research Station, 2008

Lotus Lake, Phase 1 and 2, Water Quality and Biological Assessment/Education and Riparian Survey, 2004

Land and Water Resources Department

Activities funded through the first phase of this WDNR grant included: water quality monitoring, critical habitat survey, riparian vegetation assessment, lake sediment survey, algae assessment, zooplankton assessment, fish tissue sampling, and a benthic macroinvertebrate assessment. The second phase included: watershed delineation and a land use inventory, exotic species inventory, macrophyte diversity survey, sociological landowner survey, lake level and precipitation monitoring, and phosphorus loading modeling.

Key findings of this study include:

- ✓ In 2005 the average secchi depth was 1.25 feet, the average summer phosphorus concentration was 131 µg/L, the average summer growing season soluble reactive phosphorus concentration was 21 µg/L, and the average growing season chlorophyll a concentration was 52.9 µg/L
- ✓ The average Trophic State Index for Lotus Lake was 72.6 which indicated a hypereutrophic state
- ✓ The average total phosphorus concentration was 183 µg/L at the inlet and 136 µg/L at the outlet
- ✓ Lotus Lake is phosphorus limited, with a TN:TP ratio of 22:1
- ✓ Water level fluctuations on Lotus Lake were closely related to the amount of precipitation received
- ✓ Lead concentration in the sediments near the inlet measured 129 µg/L which is below the threshold of 130 µg/L for a probable effect of impact to benthic organisms but above the 83 µg/L threshold for some probability of effect to benthic organisms
- ✓ Lead concentrations in carp tissue were below the EPA healthy advisory set for waterfowl
- ✓ Green algae were dominate in May; whereas, blue green algae were the dominant algae class in June through September
- ✓ Four blue green algae species present in the lake were capable of producing toxins
- ✓ Of the one hundred random points where plants were sampled, only 13 had plants in June and only 14 had plants in August
- ✓ Seven species of plants were identified in Lotus Lake: coontail, curly-leaf pondweed, sago pondweed, elodea, American lotus, white water lily, and yellow water lily

- ✓ Cladocera made up the majority of the zooplankton community early in the season; whereas, rotifers predominated late in the season
- ✓ Macroinvertebrate sampling indicated that shredders and scrapers were only present in native riparian environments
- ✓ Purple loosestrife dotted the shoreline of Lotus Lake and was prolific on the north end of the lake
- ✓ Management strategies suggested included: limiting motorized activity on the lake, controlling carp, expanding plant coverage to at least a 5 foot rooting depth, and enhancing native riparian environments
- ✓ Watershed modeling indicated a watershed phosphorus load of 398-2,112 pounds with a water column phosphorus concentration of 30-128 µg/L
- ✓ Modeling indicated that internal loading comprises 31% of the total phosphorus in the water column
- ✓ A lake resident survey indicated that scenic beauty and financial investment are the top two reasons for owning property on or near Lotus Lake

Lotus Lake, Phase 3 and 4, Water Quality and Biological Assessment/Historical Changes, Land and Water Resources Department, 2006

Land and Water Resources Department

A comprehensive study of Lotus Lake was continued with additional phased studies. Phase three project activities included: water quality monitoring (in lake and tributary), tributary flow monitoring, groundwater monitoring, algal community assessment and toxin analysis, zooplankton community assessment, macrophyte mapping, macroinvertebrate assessment, and coarse wood habitat inventory. The fourth phase included: paleolimnoligical core collection, land use history, and a determination of the impact and timing of watershed disturbances on water quality. This information will be used to assist with the determination of a stable ecosystem state and to develop water quality goals.

Key findings of this study include:

- ✓ In 2007 the average secchi depth was just over 1 foot, the average summer phosphorus concentration was 188 µg/L, the average summer soluble reactive phosphorus concentration was 21 µg/L, and the average chlorophyll a concentration was 86.3 µg/L
- ✓ The average total phosphorus concentration was 219 µg/L at the inlet and 235 µg/L at the outlet
- ✓ The average instantaneous load of total phosphorus was 194 pounds/year at the inlet and 79 pounds/year at the outlet
- ✓ Groundwater in the Horse Creek Watershed is relatively high in phosphorus
- ✓ Watershed modeling indicated that the annual watershed load of phosphorus to Lotus Lake was 757.3 pounds
- ✓ The annual internal phosphorus load was calculated as 611 pounds (or 44.6% of the total nutrient load to the lake)
- ✓ The algae community was similar in both 2005 and 2007, with blue green algae dominating the community throughout the summer

- ✓ Blue green algae concentrations were above the threshold where toxin production is likely to occur in July and August
- ✓ Cladocerans were a major component of the Lotus Lake zooplankton community early in the growing season; whereas, rotifers became more prevalent later in the growing season
- ✓ Of the one hundred forty five littoral points where plants were sampled, 46 had plants in July
- ✓ Seven species of plants were identified in Lotus Lake: coontail, curly-leaf pondweed, sago pondweed, soft-stem bulrush, American lotus, white water lily, and yellow water lily
- ✓ Management recommendations included: carp removal and barriers, biological monitoring, limiting impervious surfaces, minimizing recreational boating, partnerships with local organizations, purple loosestrife control, and steps to prevent aquatic invasive species

Paleolimnological Analysis of Horse Lake and Lotus Lake, Polk County, Wisconsin, 2008

St. Croix Watershed Research Station

This project was completed through the Phase 4 grant applied for by the Polk County Land and Water Resources Department. A sediment core was used to reconstruct the trophic and sedimentation history of Lotus Lake and Horse Lake. Piston and Livingston cores were collected from Lotus Lake and were dated using lead-210. The cores were analyzed for changes in magnetic susceptibility, loss-on-ignition, and diatom community composition. Findings were similar for Lotus and Horse Lake.

Key findings of this study include:

- ✓ The sediment cores indicated an increase in sedimentation rate beginning in the 1900's with a more rapid rate of increase in the most recent 10-20 years.
- ✓ Samples dating prior to European settlement have a higher percentage of benthic diatoms which indicate higher water clarity; whereas, recent core samples show a shift to an increased abundance of planktonic diatoms which indicate more turbid and eutrophic conditions.
- ✓ The sediment cores also show increases in diatom-inferred total phosphorus values at the time of European settlement.

Fisheries[11]

The most recent fisheries survey conducted on Lotus Lake was in 2012. The survey consisted of early spring fyke netting for northern pike and late spring electrofishing that targeted bass, panfish, and other species. Fyke nets were fished from March 20, 2012 to March 23, 2012 and the effort amounted to 15 net-nights. The catch rate of northern pike was good (8.50 fish/net night) and their size structure was excellent, with many fish >30 inches and the largest at 37 inches.

Largemouth bass and panfish were assessed by boat electrofishing at night along the shoreline. There was one 1.5-mile gamefish transect in which only gamefish were collected, and two 0.5-mile index transects in which all species were collected. Bluegill were the most common species collected during the electrofishing survey. The catch rate of bluegill was 140 fish/mile, which is considered average. The size structure of bluegill was low. Black crappie was the second most common species, and had a catch rate of 26 fish/mile, which is considered a good electrofishing catch rate for crappie. Crappie had respectable size structure and fish up to 11 inches were present. Pumpkinseed and yellow perch were the other panfish species collected in lower numbers. Largemouth bass were collected in low numbers (4 fish/mile), but had good size structure, with fish up to 18.5 inches present.

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[11] Information provided by Aaron Cole, Fisheries Biologist, Wisconsin DNR

Impacts of Carp on Lotus Lake

Common carp (*Cyprinus carpio)* are an invasive species introduced from Eurasia. Numerous studies have documented the negative impacts common carp cause to lake ecosystems. Carp can survive a wide range of conditions but they seem to reach their greatest densities in shallow eutrophic systems such as Lotus Lake. The fisheries of Lotus Lake must tolerate shallow depths, which create warm conditions and low dissolved oxygen in the summer, and high blue green algae concentrations, which provide low food value. Carp tolerate these conditions and dominate the fisheries of Lotus Lake.

When carp are introduced to a waterbody, studies have documented declines in submerged aquatic vegetation and increases in total phosphorus and total suspended solids. Carp cause a shift from a clear water state with submerged aquatic plants to a turbid, algae dominated state. Common carp increase nutrients in a waterbody through their foraging and spawning behavior which re-suspends nutrients from the sediment into the water column. Additionally, the foraging behavior of carp creates more flocculent sediment which is more prone to re-suspension by wind action. In a shallow lake like Lotus Lake, this effect is expounded by the fact that wind is able to hold sediment in suspension.

The current aquatic macrophyte community in Lotus Lake is suppressed and dominated by floating leaf species. The paleolimnological record shows that Lotus Lake historically had submerged aquatic vegetation. This is supported by the 1961 report Surface Water Resources of Polk County (Wisconsin Conservation Department) which notes the presence of nesting species of mallards, bluewing teal, and wood ducks on Lotus Lake. These are species which rely on the presence of a submerged aquatic macrophyte community. The paleolimnological record shows evidence of carp in Lotus Lake as early as the 1950's, which correlates with the timeframe during which plants began to disappear.

The University of Minnesota has identified that when carp biomass exceeds 100 pounds per acre, severe negative impacts occur to the lake ecosystem. Population estimates for 2013 and 2014 exceed this threshold (189 pounds per acre and 163 pounds per acre, respectively).

A study completed in 1975 by LaMarra estimated that 1 pound of carp produced 0.11 pounds of phosphorus per year. Extrapolating these numbers to Lotus Lake, it can be estimated that carp contributed 4,927 pounds of phosphorus to Lotus Lake in 2013 and 4,249 pounds of phosphorus in 2014. [12]

Options for carp management include: barriers that limit fish movement, stocking of bluegills in wetlands that serve as nursery grounds for carp, water level manipulations, fish removal by commercial fishermen (pheromones can be used to attract carp to a concentrated areas for netting or netting can be done with natural population aggregates form in winter), and chemical piscides such as rotenone to non-selectively kill fish. Additional management options such as altering the gene makeup of fish and using viruses are largely experimental at this time.

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[12] Using a lake acreage of 237

Carp Population Estimates [13]

Carp from Lotus Lake were marked in the spring of 2013, 2014, and 2015. Typically, carp were shocked with two boats for two days. WDNR marked 1,275 carp in 2013, 644 carp in 2014, and 696 carp in 2015. Fin clipping was used to determine the initial population size of the carp in Lotus Lake and to determine the exploitation rate of carp from removal efforts. Each year a different fin clip was used so that the years could be differentiated. As fins were clipped, any previous fin clips were recorded.

Over the four year course of this project, there were not enough carp removed from Lotus Lake to determine the exploitation rate. However, population estimates were determined for 2013 and 2014. The 2013 carp population was estimated at 10,688 carp[14] (45 fish/acre, 189 pounds/acre); whereas, the 2014 population was estimated at 7,886[15] carp (33 fish/acre, 163 pounds/acre). Population estimates show a slight decline in number of carp in Lotus Lake; however, the decline is not statistically significant or significant enough to show biological differences within the lake. This decline is not a result of removal efforts. Although carp removal efforts were planned multiple times over the course of this study, the only successful removal effort occurred in 2016.

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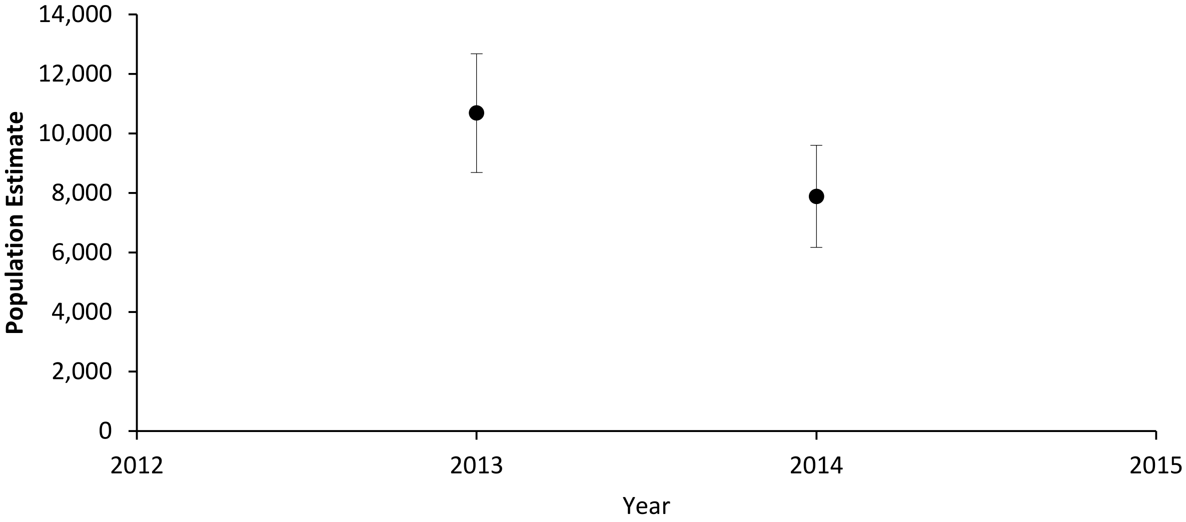
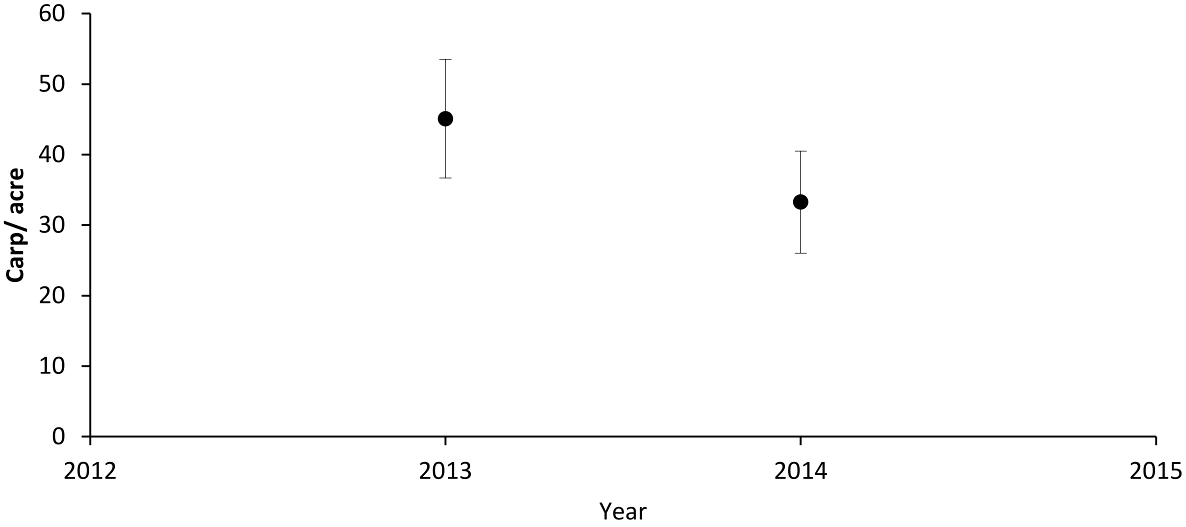
[13] Information and graphs from Aaron Cole, Fisheries Biologist, Wisconsin DNR

[14] 95% C.I. = 8,691 - 13,357

[15] 95% C.I. = 7,899 – 10,591

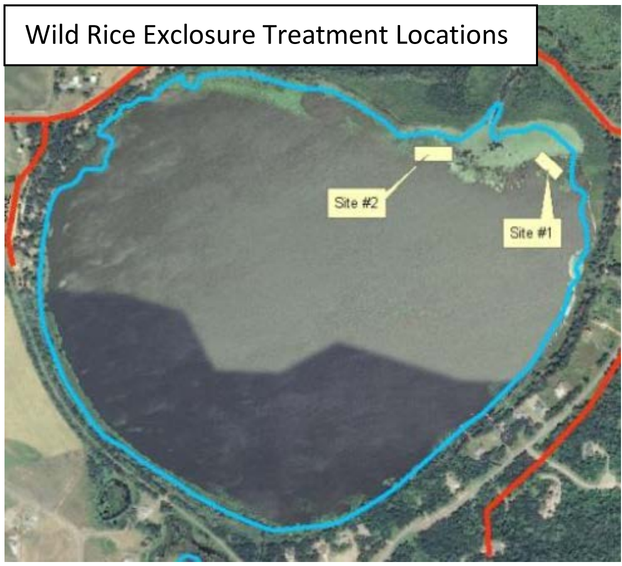
The first carp netting attempt occurred in December 2013. The net got stuck and no carp were removed. No netting attempts occurred in 2014 or 2015. In 2016, an open water seining attempt occurred in April and approximately 70 carp were removed. Another attempt was made in June 2016 when the contract fisherman used a large mesh gill net. There were 100-150 carp removed with the gill net.





Wild Rice Restoration Project [16]

The Lotus Lake Wild Rice Restoration Project was carried out under the Bureau of Indian Affairs-Circle of Flight. With the assumption that carp were responsible for the low diversity and density of aquatic plants on Lotus Lake, exclosures and open marked areas were set up at two sites on Lotus Lake on April 23rd, 2014. Both sites were seeded with wild rice at a rate greater than 50 pounds/acre to determine the capability of Lotus Lake to support wild rice in the absence of herbivory and disturbance. Both sites were located in areas assumed to support wild rice populations. The exclosures and open marked areas were 12 feet x 12 feet x 5 feet with fencing pushing into the sediment approximately 1 foot to prevent burrowing from muskrats and carp.


Wild Rice Exclosure Treatment Locations

On May 29th, 2014, Polk County Land and Water Resources Department staff observed that wild rice within the exclosures had germinated and advanced to floating leaf stage, whereas no wild rice was observed in the open marked areas (photos below).

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[16] Information and graphics from Tony Havranek, Senior Environmental Scientist, WSB & Associates

The St. Croix Tribe surveyed the sites on July 30th, 2014. By this time water levels had dropped substantially, with only 1-2 inches of water remaining at site 1 and approximately 18 inches of water remaining at site 2. Within the exclosures the wild rice was growing well (no yellowing/red stems, thick stems, seed and flower development, and multiple tillers). In the middle of the exclosure at site 2, there was a large patch of dead wild rice which was assumed to be from heavy growth within the exclosure.

At both sites, dense floating leaf vegetation was noted. The primary species present was yellow water lily, with white water lily and American lotus also present. Although wild rice can be suppressed by dense plant growth, it seemed to be competing favorably in Lotus Lake.

Within the exclosures, average stem density was 46 stems per square meter (site 1) and 88 stems per square meter (site 2). At site 1, two wild rice plants were observed outside of the exclosure. At site 2, no wild rice plants were observed outside of the exclosures.

This survey indicated that wild rice can successfully grow in Lotus Lake, in the absence of disturbance. It is assumed that carp are the major disturbance limiting wild rice growth in Lotus Lake. Although waterfowl can limit the growth of wild rice, a large scale seeding (at least 3 acres) could negate the effects of waterfowl. Additionally, competition with floating leaf vegetation could limit wild rice growth in Lotus Lake. A large scale seeding effort is not recommended until the carp biomass in Lotus Lake has been substantially reduced.

In support of the ultimate goal of reintroducing wild rice to the lake, ten adult carp were implanted with high frequency radio transmitters on September 17th, 2014. Radio tags were monitored 1-2 times per week from November to December. In the winter, carp aggregate within a lake, making large scale removal efforts more successful. It was determined that an aggregate of seven of the ten fish would likely allow for a successful removal effort on Lotus Lake. Over the course of the winter, an aggregation of seven fish never occurred. The carp seemed to prefer the eastern shoreline and the western shoreline between the landing and the land house along the west shore.

In 2015, an additional ten fish were radio tagged in Horse Lake to determine if the carp from Horse Lake were moving between the two lakes. Fish locations were monitored from winter 2015 through spring 2016, with only 1 fish moving from Lotus Lake to the wetlands between Horse and Lotus Lakes. In the spring, carp from Horse Lake were found in the creek near the wetland.

In April 2016, on the same day that the netting occurred, 12 acres of rice were seeded. At this time, 5 of the 9 tagged carp were in the seine net so a good portion of the carp population was assumed to be in the net. Unfortunately, the net snagged on a number of logs so the carp were not captured and removed as expected.

Lake Resident Survey

A Wisconsin Department of Natural Resources approved survey was mailed to two hundred twenty-four property owners on and around Lotus Lake in June 2014. Ninety surveys were returned (40% response rate) and data was entered and analyzed.

Survey respondents have owned their property on Lotus Lake for an average of 14 years. The majority of respondents use their property as a year round residence (84%). This is rather unique for Polk County lakes, where most lake surveys indicate that their property owners primarily use their property as a seasonal or weekend residence. However, the high percentage of full time residents is related to the fact that less than a quarter of respondents (20%) own lakefront property. The remaining majority of respondents (83%) own property near Lotus Lake. On average, properties on Lotus Lake are used 289 days per year and occupied by 2.7 people.

The survey asked respondents to describe the area measuring 35 feet inland (beginning at the water's edge, shoreland towards the road). Approximately two-thirds of respondents indicated that this area of their property contained un-mowed vegetation (67%), and woods (60%). Fewer respondents indicated that this area of their property contained shrubs (47%) and a minority indicated that this area contained mowed lawn (20%). Nearly half of the property owners answering this question indicated that they had a dock or pier (47%).

The survey asked respondents which activities they enjoy on Lotus Lake. The most popular activities enjoyed on Lotus Lake include: scenic view (71%), peace and tranquility (51%), observing birds/wildlife (36%), fishing (25%) and non-motorized boating (canoe/kayak) (25%). Survey respondents were also asked how often they use the Lotus Lake County Park, Lotus Lake boat landing, and the Stower Seven Lakes Trail during the open water season and during the ice on season. Of these three public resources, more people use the Lotus County Park (54% open water, 16% ice on) as compared to the Stower Seven Lakes Trail (45% open water, 13% ice on) and the Lotus Lake boat landing (38% open water, 11% ice on). Taking into consideration only the people using each of these resources, the Stower Seven Lakes Trail is used an average of 6 days per month during the open water season and 5 days per month during the ice on season, the Lotus County Park is used an average of 4 times per month year-round, and the Lotus Lake boat landings is used an average of 3 times per month year-round.

Over half of survey respondents (54%) do not keep watercraft on their property for use on Lotus Lake. Over a quarter of respondents keep canoes/kayaks on their property (28%), with fewer respondents keeping motorboats/pontoons that are 1-20 HP (10%), motorboats/pontoons that are 21-50 HP (10%), motorboats/pontoons that are greater than 50 HP (10%), rowboats/paddleboats (6%) and jet skis (5%).

In an effort to quantify risk of spreading aquatic invasive species, survey respondents were asked if the watercrafts they use on Lotus Lake are used on other waterbodies. Approximately two-thirds (62%) of boats used on Lotus Lake are used on other waterbodies.

Respondents were asked to rank their degree of concern with fifteen issues as high, medium, low, issue exists but isn't a concern, and issue doesn't exist. Responses for this question were analyzed using a point system. Each issue ranked as high received 4 points, as medium received 3 points, as low received

2 points, as exists but not a concern 1 point, and as not an issue received 0 points. Total points were averaged to determine a final rank.

Issues with a final ranking of medium concern included: decrease in overall lake health, excessive algae blooms, lack of water clarity or quality, and presence of common carp in the lake. The remaining issues ranked as low concerns. Excessive noise level on the lake and disregard for slow-no-wake zones ranked as exists but not a concern.

What is your degree of concern with each issue listed below?	Rank
Decrease in overall lake health	3.2
Excessive algae blooms	3.1
Lack of water clarity or quality	3.1
Presence of common carp in the lake	3.0
Excessive aquatic plant growth	2.9
Decreased fisheries	2.8
New invasive species entering the lake	2.7
Increased nutrient pollution	2.7
Loss of natural scenery/beauty	2.5
Decreased wildlife populations	2.5
Decreased property values	2.3
Increased development	2.2
Unsafe use of motorized watercraft	2.1
Excessive noise level on the lake	1.8
Disregard for slow-no-wake zones	1.5

Lake levels on Lotus Lake do vary over the course of the year and from year to year on Lotus Lake. Over half of respondents (53%) described the current lake level as just right, nearly one third were unsure how to describe the lake level, and a minority (15%) described the lake level as too low.

When asked to describe the current water quality on Lotus Lake, the most common response was poor (41%), flowed by fair (22%), and good (10%). Over a quarter (27%) of respondents were unsure how to describe the current water quality. Survey respondents were fairly divided in describing how the water quality has changed since they've lived on or near Lotus Lake, with close to half of respondents either unsure how to describe the change (29%) or not being able to notice a change due to the short time they have owned their property (12%). Nearly a quarter of respondents (22%) described the water quality as unchanged. However, more respondents described the lake as degraded (severely 11%, somewhat 16%) as compared to improved (somewhat 9%, greatly 0%).

The survey also asked a variety of questions regarding algae and aquatic plants. Respondents were asked to describe the amount of aquatic plants in Lotus Lake, what months during the open water season algae and aquatic plants are a problem, and what uses are impaired as a result of algae and aquatic plants.

Respondents consider algae to be most problematic in August (56%), July (40%), and September (26%). Approximately three quarters of respondents indicated that swimming (76%) and overall enjoyment of the lake (73%) are impaired by algae. Around half of respondents indicated that fishing (54%), dogs/animals using the water (50%), and boating (44%) are impaired by algae. Nearly a quarter of respondents indicated that navigation (27%) is impaired by algae.

Approximately half of respondents described the amount of aquatic plants as too many (51%). Fewer respondents described a healthy amount of plants (35%) and too few plants (14%). Less than half of respondents considered aquatic plant growth to be problematic during the open water season. Months with the greatest number of respondents indicating problematic plant growth included: August (45%), July (43%), and September (28%).

Approximately two-thirds of respondents indicated that swimming (63%) was limited by aquatic plants. Around half of respondents felt that boating (53%) fishing (51%), and overall enjoyment of the lake (51%) were limited by aquatic plants. One third felt that navigation was limited by aquatic plants.

Earlier in the survey, 20% of respondents indicated that the area 35 feet back from their shoreline contained mowed lawn. Later, the survey asked respondents to describe the current amount of mowed lawn across the entire shoreline of Lotus Lake. Nearly a third of respondents described the amount of lawn as just right (30%). Fewer respondents indicated that the amount of lawn was too much (10%) and not enough (5%). Over half of respondents (56%), were unsure how to describe the amount of lawn. This likely results because many respondents do not own lakeshore property on Lotus Lake.

The survey asked respondents what impact, if any, that landowner landscaping practices such as shoreline buffers, rain gardens, and native plants have on the water quality of Lotus Lake. Respondents were rather divided in their answers with a third of respondents indicating a positive impact only if all property owners participate (30%), a third of respondents indicating a positive impact regardless of how many property owners participate (34%), and a third of respondents indicating no impact (32%).

On a positive note, over half of respondents do not use fertilizer on their property (57%) and another quarter use zero phosphorus fertilizer (27%). A small minority of respondents are unsure if they use fertilizer (11%), use fertilizer but are unsure of its phosphorus content (2%) or use multiple types of fertilizer that contain varying amounts of phosphorus (2%).

The survey asked respondents to indicate which actions should be completed by the Lotus Lake Association to manage Lotus Lake. Over three-fourths of respondents supported programs to prevent and monitor invasive species (71%) and practices to enhance fisheries (70%). Over half of respondents supported offering incentives for upgrades to non-conforming septic systems (63%) and the installation of shoreline buffers/rain gardens (57%). Fewer respondents supported offering incentive for property owners to install farm land conservation practices (43%), lake fairs and workshops to share information (41%), and the enforcement of slow-no-wake-zones (41%).

The survey also asked respondents if they would support or oppose the removal of carp from Lotus Lake. A third of respondents were unsure if they would support or oppose the removal of carp from Lotus Lake (33%). More respondents supported the removal of carp (definitely support 40%, probably support 10%) as compared to opposing the removal of carp (probably oppose 17%, definitely oppose 0%).

Lotus Lake has an Association whose purpose is to preserve and protect Lotus Lake and its surroundings and to enhance the water quality, fishery, and aesthetic values of Lotus Lake, as a public recreational facility for today and for future generations. Membership is optional, with dues costing $10 per year. Almost a third of survey respondents are members of the Association (29%) and over half are not members (53%). Remaining respondents weren't aware that the association exists (18%). The survey also asked respondents which activities they were aware that the Association had completed to benefit Lotus Lake. The majority of respondents weren't aware of any of the listed activities (58%). Approximately a third of respondents were aware of roadside cleanups (38%). Around a quarter of respondents were aware that the Association completes invasive species removal projects (26%), completes invasive species education projects (22%), and conducts monthly beach sampling for fecal coliform bacteria (17%).

Survey respondents were asked how they prefer to receive information from the Lotus Lake Association. Respondents indicated that the most preferred method of communication was the newsletter (49%), followed by email (32%). Fewer respondents preferred the annual meeting (14%) and a website (11%). Nearly a quarter of respondents would prefer not to receive information (22%).

The survey asked respondents which activities they were interested in participating in to improve Lotus Lake. Around a quarter of respondents were interested in learning how to monitor water quality (30%) and learning how to identify invasive species (26%). Fewer respondents were interested in learning how to monitor for aquatic invasive species (18%), serving on a committee to develop an action plan for improving Lotus Lake (14%), installing a rain garden on their property (14%), and installing a buffer on their property (7%). Approximately half of respondents were not interested in participating in any of the listed projects (49%).

Lake Level and Precipitation Monitoring

Lake water-level fluctuations are important to lake managers, lakeshore property owners, developers, and recreational users because they can have significant impacts on lake water quality and usability. Although lake levels naturally change from year to year, extreme high or low levels can present problems such as restricted water access, flooding, shoreline and structure damage, and changes in near shore vegetation.

Records of lake water elevations can be very useful in understanding changes that may occur in lakes. While some lakes respond almost immediately to precipitation, other lakes do not reflect changes in precipitation until months later.

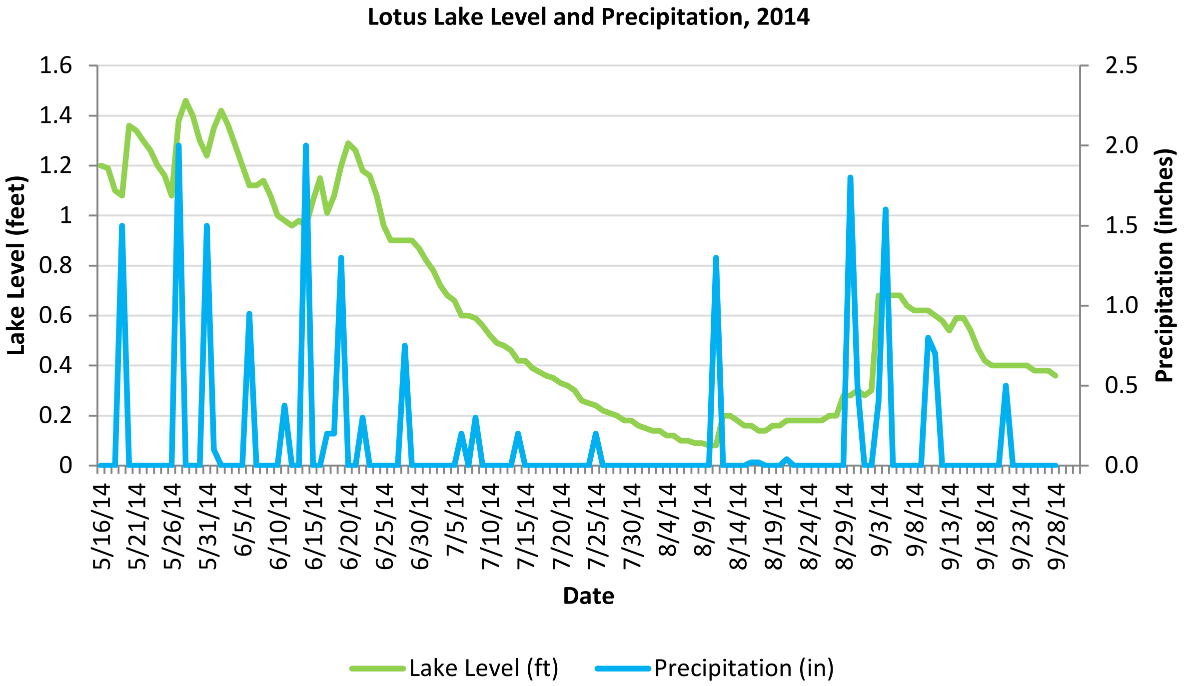
Volunteers monitored lake level and precipitation on Lotus Lake in 2014, 2015, and 2016. Polk County Land and Water Resources Department provided training on data collection methods and installed staff and rain gauges. The Polk County Land Information Division of Surveyor Department calibrated the staff gauge by referencing the numbered height on the gage to the surveyed elevation of the water when the gauge was installed in the spring and prior to removal in the fall in 2015 and 2016. As a result, the 2015 and 2016 data can be tied back to actual elevation. Monitoring began in May/June and continued through September in all three years.

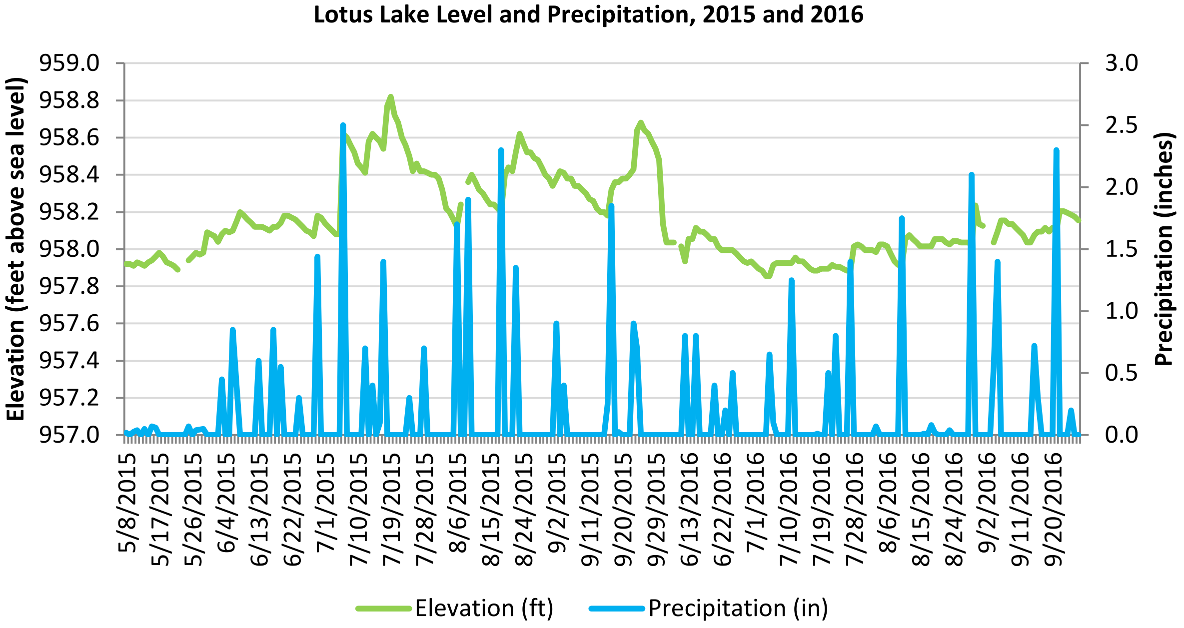
Seasonal precipitation on Lotus Lake totaled 19.8 inches in 2014, 24.3 inches in 2015, and 17.0 inches in 2016. Lake level did respond to precipitation events, with levels increasing following rainfall events.

In 2014, lake level was greatest in the spring and dropped through July and August. Lake level dropped a total of 1.38 feet from its highest level on May 28th to its lowest level on August 10th and 11th.

In 2015, lake level was lowest in the spring and increased throughout the growing season. Lake level increased a total of 0.93 feet from its lowest level on May 22nd to its highest level on July 19th.

In 2016, lake level was greatest in the spring and fall. Lake level remained the most constant during 2016, differing only 0.38 feet from the highest to lowest level. Lake level was the lowest on July 4th and 5th and the highest on August 30th.


Lotus Lake Level and Precipitation, 2014
Lake Level (feet)
Precipitation (inches)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2.5
2.0
1.5
1.0
0.5
0.0
5/16/14
5/21/14
5/26/14
5/31/14
6/5/14
6/10/14
6/15/14
6/20/14
6/25/14
6/30/14
7/5/14
7/10/14
7/15/14
7/20/14
7/25/14
7/30/14
8/4/14
8/9/14
8/14/14
8/19/14
8/24/14
8/29/14
9/3/14
9/8/14
9/13/14
9/18/14
9/23/14
9/28/14
Date
Lake Level (ft)
Precipitation (in)


Lotus Lake Level and Precipitation, 2015 and 2016
Elevation (feet above sea level)
Precipitation (inches)
959.0
958.8
958.6
958.4
958.2
958.0
957.8
957.6
957.4
957.2
957.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5/8/2015
5/17/2015
5/26/2015
6/4/2015
6/13/2015
6/22/2015
7/1/2015
7/10/2015
7/19/2015
7/28/2015
8/6/2015
8/15/2015
8/24/2015
9/2/2015
9/11/2015
9/20/2015
9/29/2015
6/13/2016
6/22/2016
7/1/2016
7/10/2016
7/19/2016
7/28/2016
8/6/2016
8/15/2016
8/24/2016
9/2/2016
9/11/2016
9/20/2016
Elevation (ft)
Precipitation (in)

Lake Mixing and Stratification: Background Information

Water quality is affected by the degree to which the water in a lake mixes. Within a lake, mixing is most directly impacted by the temperature-density relationship of water. When comparing why certain lakes mix differently than others, lake area, depth, shape, and position in the landscape become important factors to consider.

Water reaches its greatest density at 3.9°C (39°F) and becomes less dense as temperatures increase and decrease. Compared to other liquids, the temperature-density relationship of water is unusual: liquid water is more dense than water in its solid form (ice). As a result, ice floats on liquid water.

When ice melts in the early spring, the temperature and density of the water will be constant from the top to the bottom of the lake. This uniformity in density allows a lake to completely mix. As a result, oxygen is brought to the bottom of a lake, and nutrients are re-suspended from the sediments. This event is termed **spring turnover**.

As the sun's rays warm the surface waters in the spring, the water becomes less dense and remains at the surface. Warmer water is mixed deeper into the water column through wind and wave action. However, these forces can only mix water to a depth of approximately twenty to thirty feet. Generally, in a shallow lake, the water may remain mixed all summer. However, a deeper lake usually experiences layering based on temperature differences, called **stratification**.

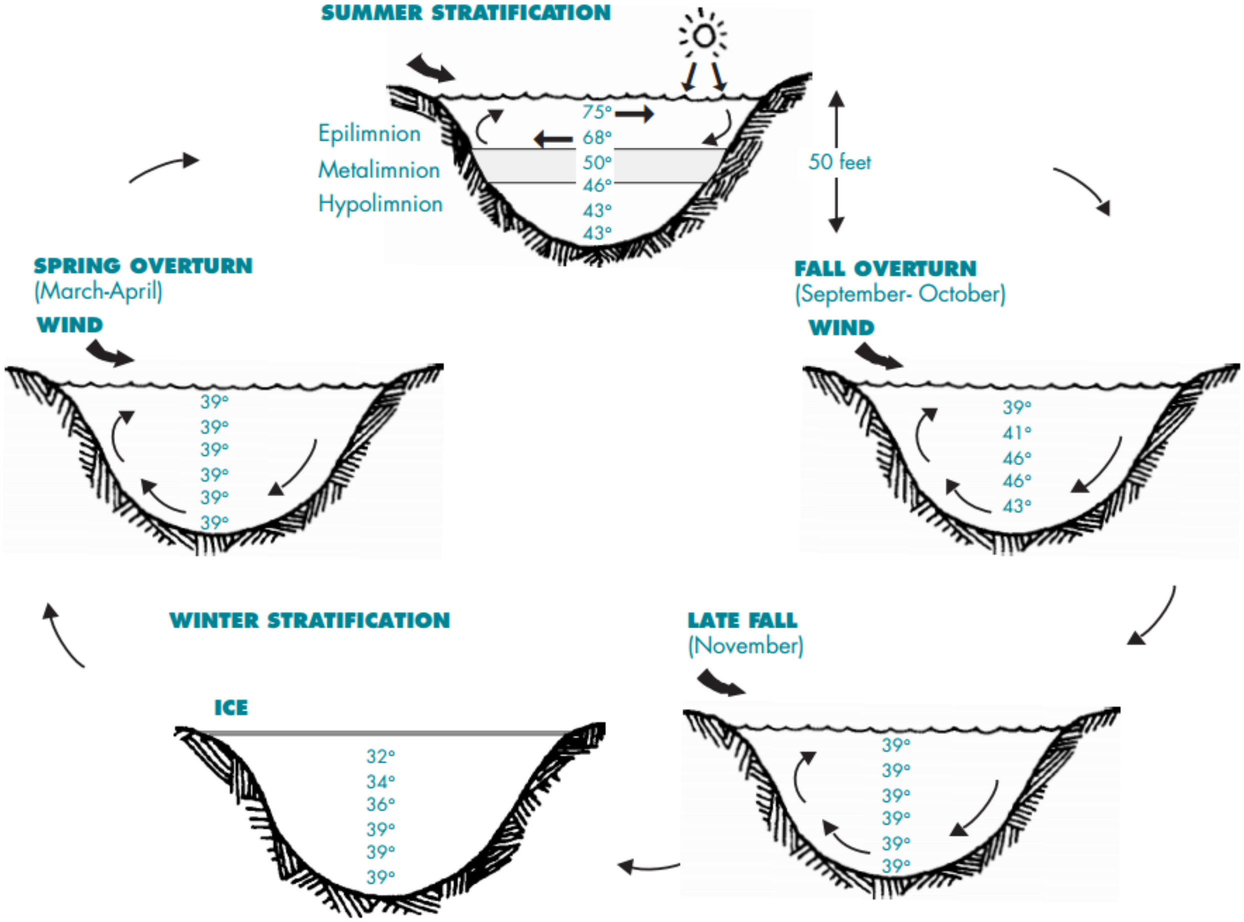
During the summer, lakes have the potential to divide into three distinct zones: the **epilimnion**, **thermocline** or **metalimnion**, and the **hypolimnion**. The epilimnion describes the warmer surface layer of a lake and the hypolimnion describes the cooler bottom area of a lake. The thermocline, or metalimnion, describes the transition area between the epilimnion and hypolimnion.

As surface waters cool in the fall, they become more dense and sink until the water temperature evens out from top to bottom. This process is called **fall turnover** and allows for a second mixing event to occur. Occasionally, algae blooms can occur at fall turnover when nutrients from the hypolimnion are made available throughout the water column.

Variations in density arising from differences in water temperatures can prevent warmer water from mixing with cooler water. As a result, nutrients released from the sediments can become trapped in the hypolimnion of a lake that stratifies. Additionally, since mixing is one of the main ways oxygen is distributed throughout a lake, lakes that don't mix have the potential to have very low levels of oxygen in the hypolimnion.

The absence of oxygen in the hypolimnion can have adverse effects on fisheries. Species of cold water fishes require the cooler waters that result from stratification. Cold water holds more oxygen as compared to warm water. As a result, the cooler waters of the hypolimnion can provide a refuge for cold water fisheries in the summer as long as oxygen is present. Respiration by plants, animals, and especially bacteria is the primary way oxygen is removed from the hypolimnion. A large algae bloom can cause oxygen depletion in the hypolimnion as algae die, sink, and decay.

In the winter, stratification remains constant because ice cover prevents mixing by wind action.



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[17] Figure from Understanding Lake Data (G3582), UW-Extension, Byron Shaw, Christine Mechenich, and Lowell Klessig, 2004

Deep Hole Sampling Procedure

In-lake data were collected by the Polk County Land and Water Resources Department at the deep hole of Lotus Lake at spring and fall turnover events and bi-weekly between the months of May through September from 2014-2016.

Lake profile monitoring

Dissolved oxygen, temperature, conductivity, specific conductance, and pH were recorded at meter increments with a Hanna Instruments 9828 multi-parameter probe.

Secchi depth

Secchi depth was recorded with an eight inch diameter round disk with alternating black and white quadrants called a secchi disk. To record secchi depth, the disk was lowered into the lake on the shady side of a boat until just before it disappeared from sight. This depth was measured in feet and recorded as the secchi depth. Data were collected bi-weekly to correspond with lake profile monitoring readings.

Chemistry and chlorophyll a

Top samples were collected once monthly with a composite sampler and analyzed at the Wisconsin State Lab of Hygiene. Top samples were analyzed for total phosphorus, soluble reactive phosphorus, nitrate/nitrite, ammonium, total Kjeldahl nitrogen, total suspended solids, and chlorophyll a.

Dissolved Oxygen

Oxygen is required by all aquatic organisms for survival. The amount of oxygen dissolved in water depends on: temperature, the amount of wind mixing that brings water into contact with the atmosphere, the biological activity that consumes or produces oxygen within a lake, and the composition of groundwater and surface water entering a lake.

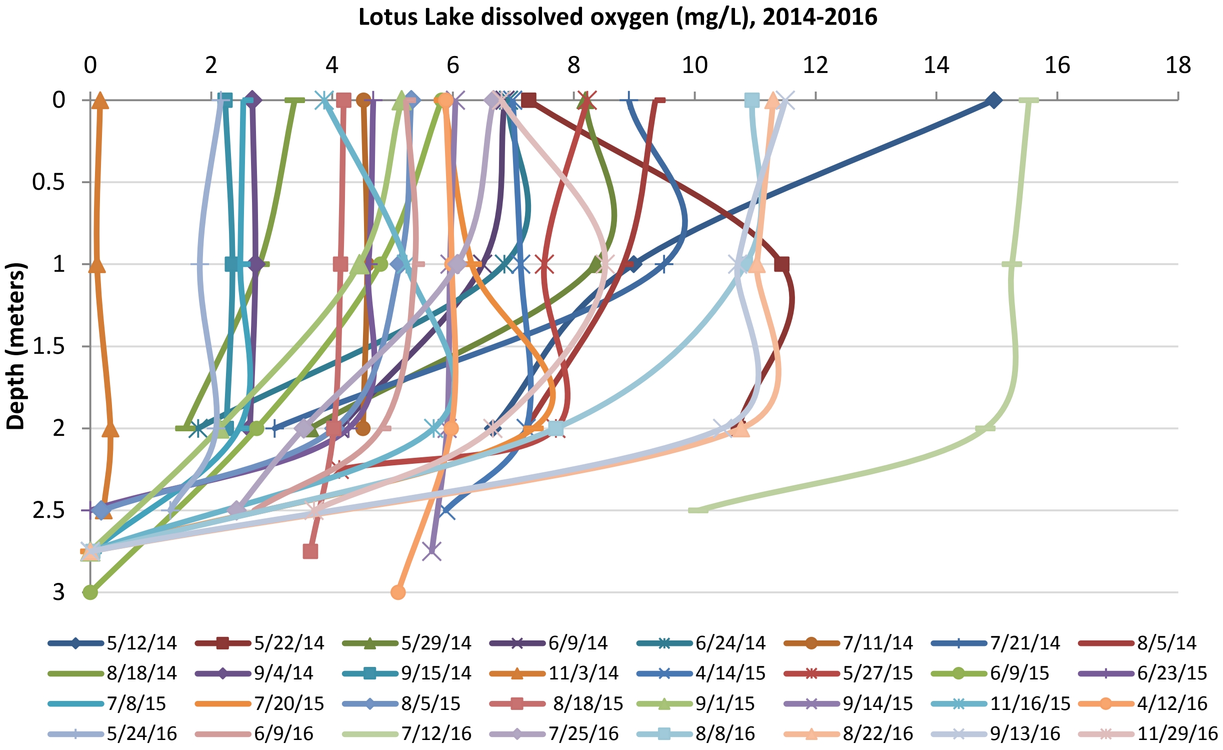
In a process called photosynthesis, plants use carbon, water, and the sun's energy to produce simple sugars and oxygen. Chlorophyll, the pigment in plants that captures the light energy necessary for photosynthesis, is the site where oxygen is produced. Since photosynthesis requires light, the oxygen producing process only occurs during the daylight hours and only at depths where sunlight can penetrate. Plants and animals also use oxygen in a process called respiration. During respiration, sugar and oxygen are used by plants and animals to produce carbon dioxide and water.

Cold water has a higher capacity for oxygen than warm water. Although temperatures are coolest in the deepest part of a lake, these waters often do not contain the most oxygen. This arises because in the deepest parts of lakes, oxygen producing photosynthesis is not occurring, mixing is unable to introduce oxygen, and the only reaction occurring is oxygen consuming respiration. Therefore, it is not uncommon for oxygen depletion to occur in the hypolimnion.

During the sunlight hours, when photosynthesis is occurring, dissolved oxygen levels at a lake's surface may be quite high. Conversely, at night or early in the morning (when photosynthesis is not occurring), the dissolved oxygen values can be expected to be lower.

A water quality standard for dissolved oxygen in warm water lakes and streams is set at 5 mg/L. This standard is based on the minimum amount of oxygen required by fish for survival and growth. For cold water lakes supporting trout, the standard is set even higher at 7 mg/L.

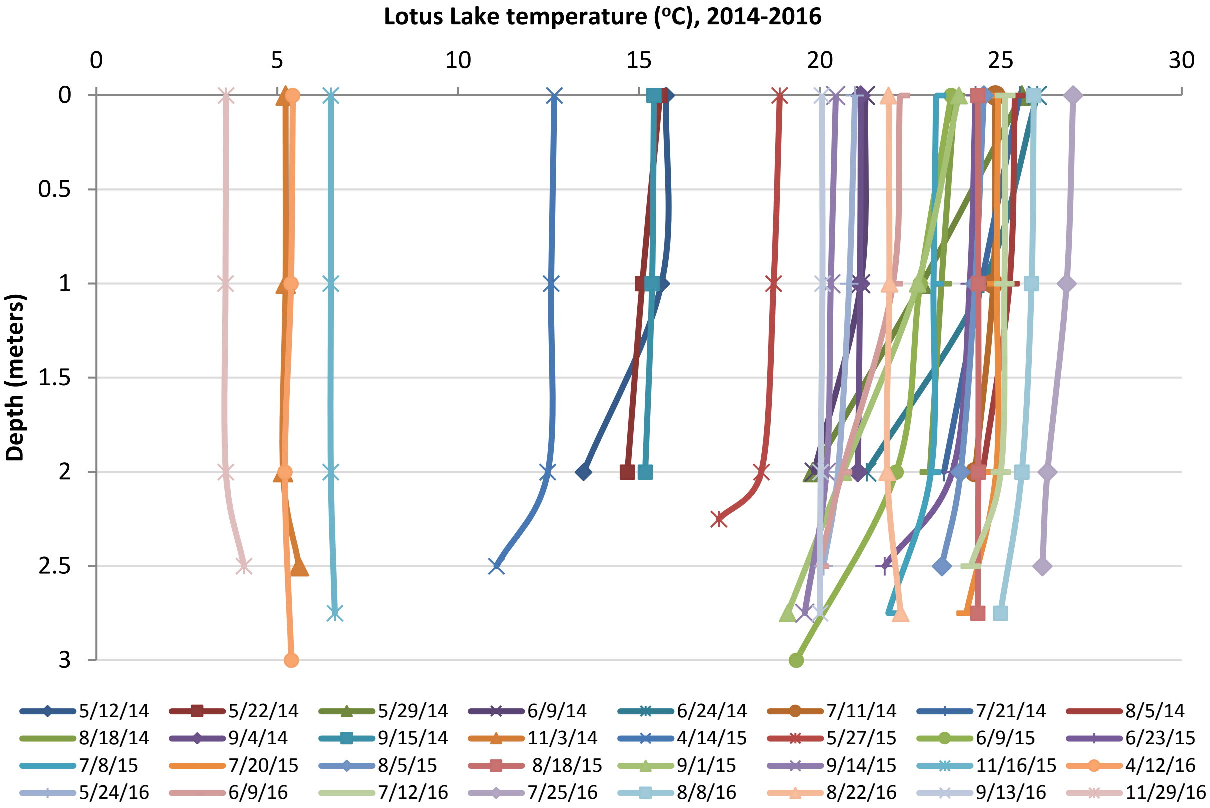
Dissolved oxygen levels at the surface of Lotus Lake were below 5 mg/L on 10 of the 32 days data was collected. In June 2016, the dissolved oxygen sensor on the probe malfunctioned and was sent off for repairs.


Lotus Lake dissolved oxygen (mg/L), 2014-2016
0
2
4
6
8
10
12
14
16
18
0
0.5
1
1.5
2
2.5
3
Depth (meters)
5/12/14
5/22/14
5/29/14
6/9/14
6/24/14
7/11/14
7/21/14
8/5/14
8/18/14
9/4/14
9/15/14
11/3/14
4/14/15
5/27/15
6/9/15
6/23/15
7/8/15
7/20/15
8/5/15
8/18/15
9/1/15
9/14/15
11/16/15
4/12/16
5/24/16
6/9/16
7/12/16
7/25/16
8/8/16
8/22/16
9/13/16
11/29/16

Temperature

Lotus Lake reached its warmest surface temperature (27°C) on July 25th, 2016.

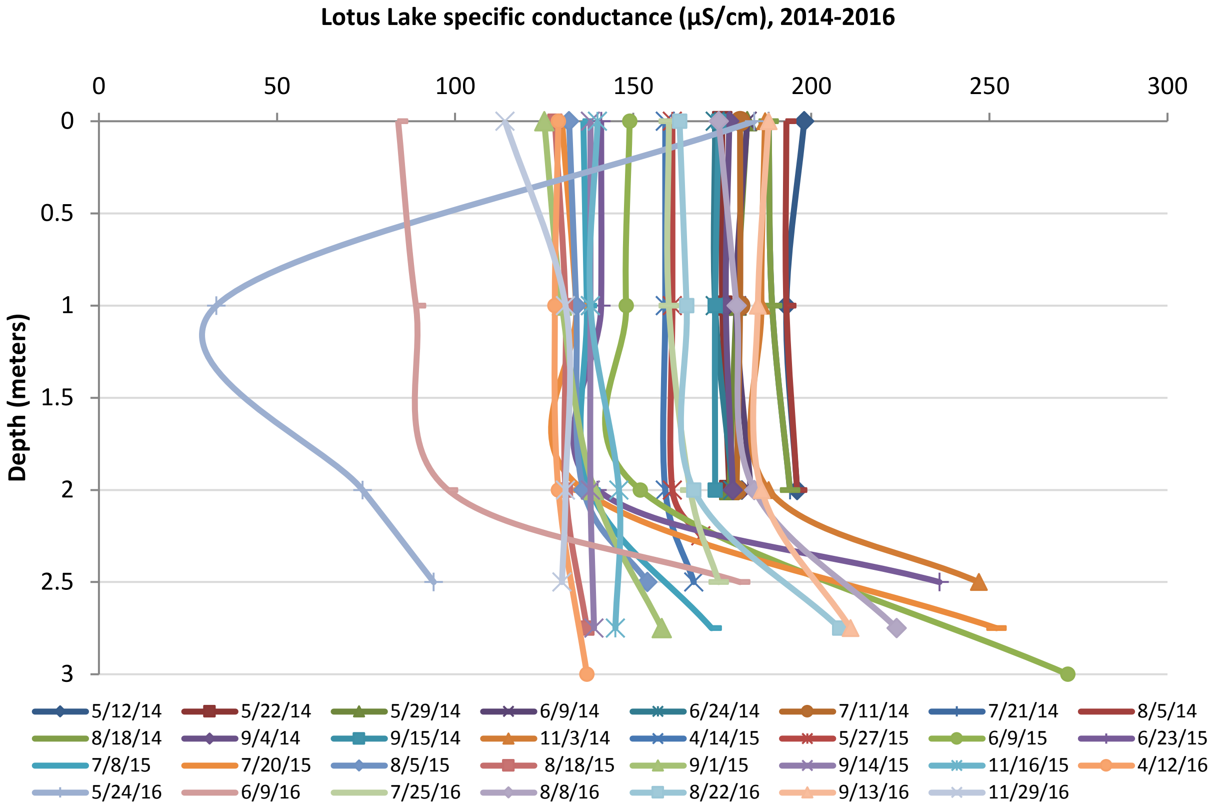
Lotus Lake did not stratify, or set up density dependent layers, during the study. Very weak stratification at the very bottom of the lake occurred in May, June, and July of 2015.



Specific Conductance (Conductivity)

Conductivity is the measure of the ability of water to conduct an electrical current and serves as an indicator of the concentration of total dissolved inorganic chemicals in the water. Since conductivity is temperature related, reported values are normalized at 25°C and termed specific conductance. Specific conductance increases as the concentration of dissolved minerals in a lake increase.

In general, specific conductance values at the surface were between 170 and 200 µS/cm in 2014 and between 120 and 160 µS/cm in 2015, and ranged from 80 and 190 µS/cm in 2016. However, in 2015 specific conductance values were much lower, falling between 130 and 180 µS/cm. Values generally increased towards the bottom of the lake.



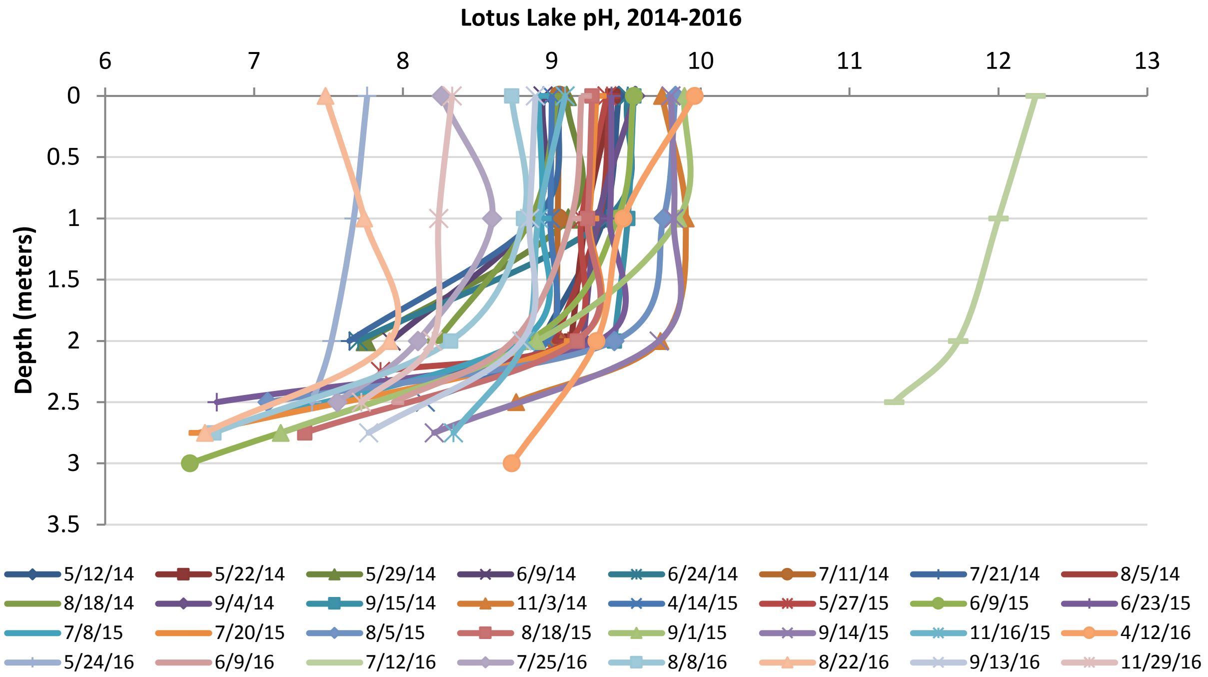
pH

An indicator of acidity, pH is the negative logarithm of the hydrogen ion (H+) concentration. Lower pH waters have more hydrogen ions and are more acidic, and high pH waters have less hydrogen ions and are less acidic.

A pH value of seven is considered neutral. Values less than seven indicate acidic conditions; whereas, values greater than seven indicate alkaline conditions. A single pH unit change represents a tenfold change in the concentration of hydrogen ions. As a result, a lake with a pH value of eight is ten times less acidic than a lake with a pH value of seven. Across Wisconsin lakes, pH values can range from 4.5 (acid bog lakes) to 8.4 (hard water, marl lakes).

Through the removal of CO_2 from the water column, photosynthesis has the effect of increasing pH. As a result, pH generally increases during the day and decreases at night. Under conditions such as high temperature, high nutrients, and dense algae blooms, pH levels can increase.

In general pH levels on Lotus Lake were between 7 and 10, with values decreasing towards the bottom of the lake. The July 12th extreme reading was collected using a backup probe.



Secchi Depth

The depth which light can penetrate into lakes is affected by suspended particles, dissolved pigments, and absorbance by water. Often, the ability of light to penetrate the water column is determined by the abundance of algae or other photosynthetic organisms in a lake.

One method of measuring light penetration is with a secchi disk. A secchi disk is an eight inch diameter round disk with alternating black and white quadrants that is used to provide a rough estimate of water clarity. The depth at which the secchi disk is just visible is defined as the secchi depth. A greater secchi depth indicates greater water clarity.

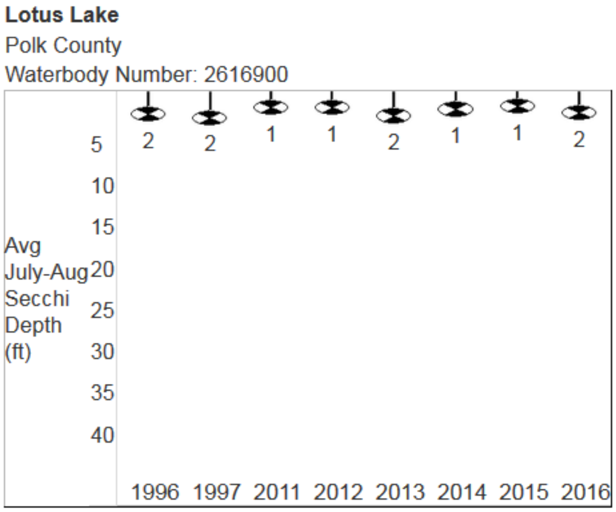
Secchi depth ranged from a low of half a foot on September 4th, 2014 and August 18th, 2015 to a high of three feet at fall turnover in 2014 and 2016.

Growing season average secchi depth (May-September) was 1.3 feet in 2014, 1.0 foot in 2015, and 1.6 feet in 2016.

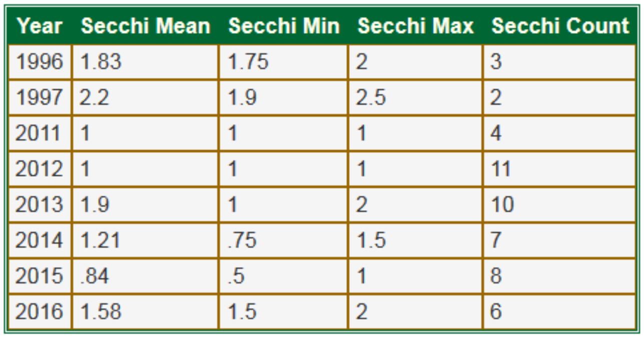
Summer index period average secchi depth (July 15-September 15) was 0.9 feet in 2014, 0.8 feet in 2015, and 1.4 feet in 2016.

The Wisconsin Department of Natural Resources website provides historic secchi depth averages for the months of July and August. This data exists for Lotus Lake for 1996, 1997, and 2011-2016. Over this timeframe, secchi depth has consistently measured between one and two feet. The highest secchi depth recorded measured 2.5 feet and the lowest secchi depth recorded measured 0.5 feet.

Over the three years this study took place, average summer secchi depth (July-August) was 1.2 feet in 2014, 0.8 feet in 2015, and 1.6 feet in 2016.

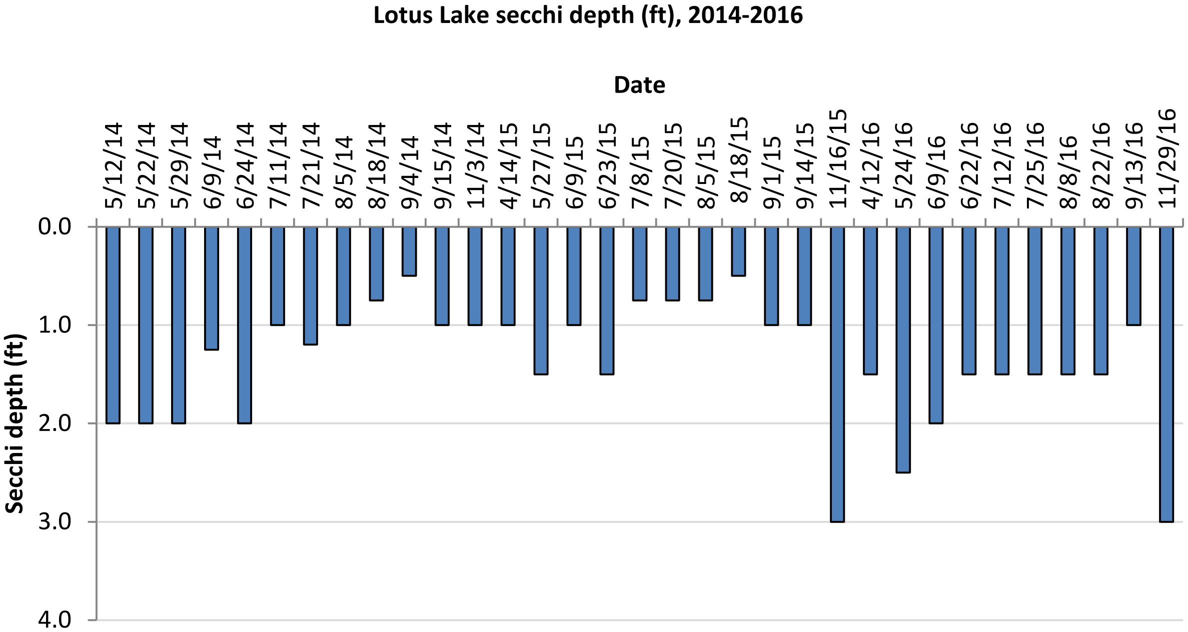


Past secchi averages in feet (July and August only).



Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1996	1.83	1.75	2	3
1997	2.2	1.9	2.5	2
2011	1	1	1	4
2012	1	1	1	11
2013	1.9	1	2	10
2014	1.21	.75	1.5	7
2015	.84	.5	1	8
2016	1.58	1.5	2	6

The average summer secchi depth (July and August) for the Northwest geo-region was 8.6 feet in 2013, 8.5 feet in 2014, and 8.4 feet in 2015. In all three years, secchi depth for Lotus Lake was well below the Northwest geo-region average.



Phosphorus

Phosphorus is an element present in lakes which is necessary for plant and algae growth. It occurs naturally in soil and rocks and in the atmosphere in the form of dust. Phosphorus can make its way into lakes through groundwater and human induced disturbances such as soil erosion. Additional sources of phosphorus inputs into a lake can include external sources such as fertilizer runoff from urban and agricultural settings and internal sources such as release from lake bottom sediments.

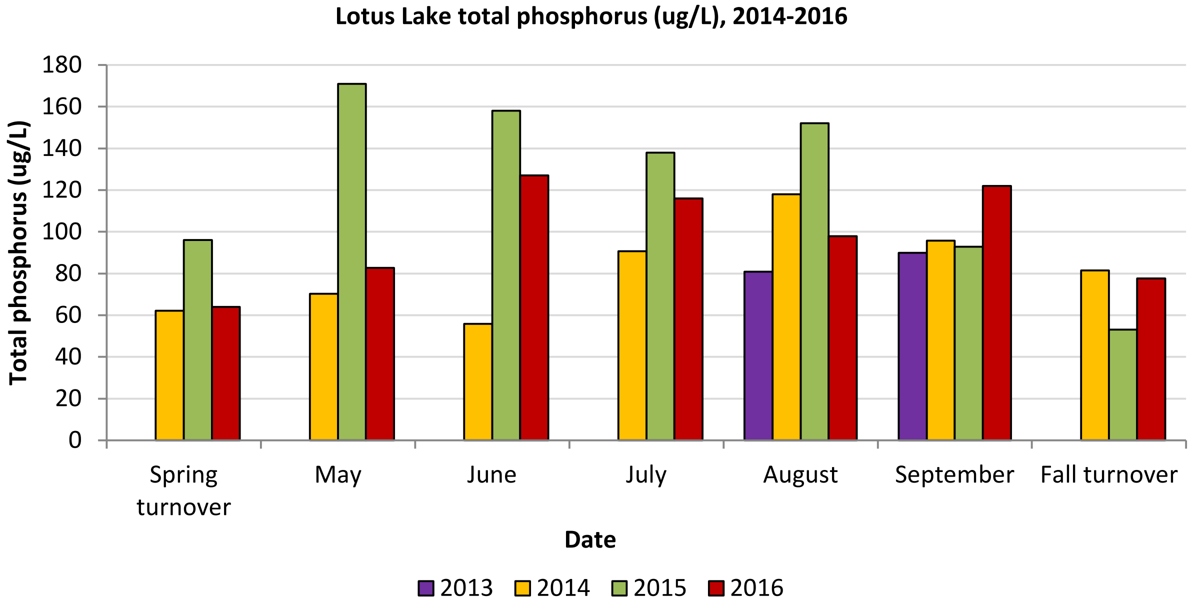
Phosphorus does not readily dissolve in water, instead it forms insoluble precipitates with calcium, iron, manganese, sulfur, and aluminum. If oxygen is available in the hypolimnion, iron forms sediment particles that store phosphorus in the sediments. However, when lakes lose oxygen in the winter or when the hypolimnion becomes anoxic in the summer, these particles dissolve and phosphorus is redistributed throughout the water column with strong wind action or turnover events.

Phosphorus is necessary for plant and animal growth. Excessive amounts can lead to an overabundance of growth which can decrease water clarity and lead to nutrient pollution in lakes.

Total phosphorus (TP) is a measure of all the phosphorus in a sample of water. In many cases total phosphorus is the preferred indicator of a lake's nutrient status because it remains more stable than other forms over an annual cycle.

In lakes, a healthy limit of total phosphorus is set at 20 µg/L. If a value is above the healthy limit it is more likely that a lake could support nuisance algae blooms. Total phosphorus concentrations were above 20 µg/L in Lotus Lake on all twenty sampling dates.

Growing season average (excludes turnover) surface total phosphorus exceeded the healthy limit in 2014 (86.12 µg/L), 2015 (142.36 µg/L), and 2016 (109.12 µg/L). Summer index period average surface total phosphorus (July 15-September 15) exceeded the healthy limit in 2014 (101.47 µg/L), 2015 (127.60 µg/L), and 2016 (109.95 µg/L).

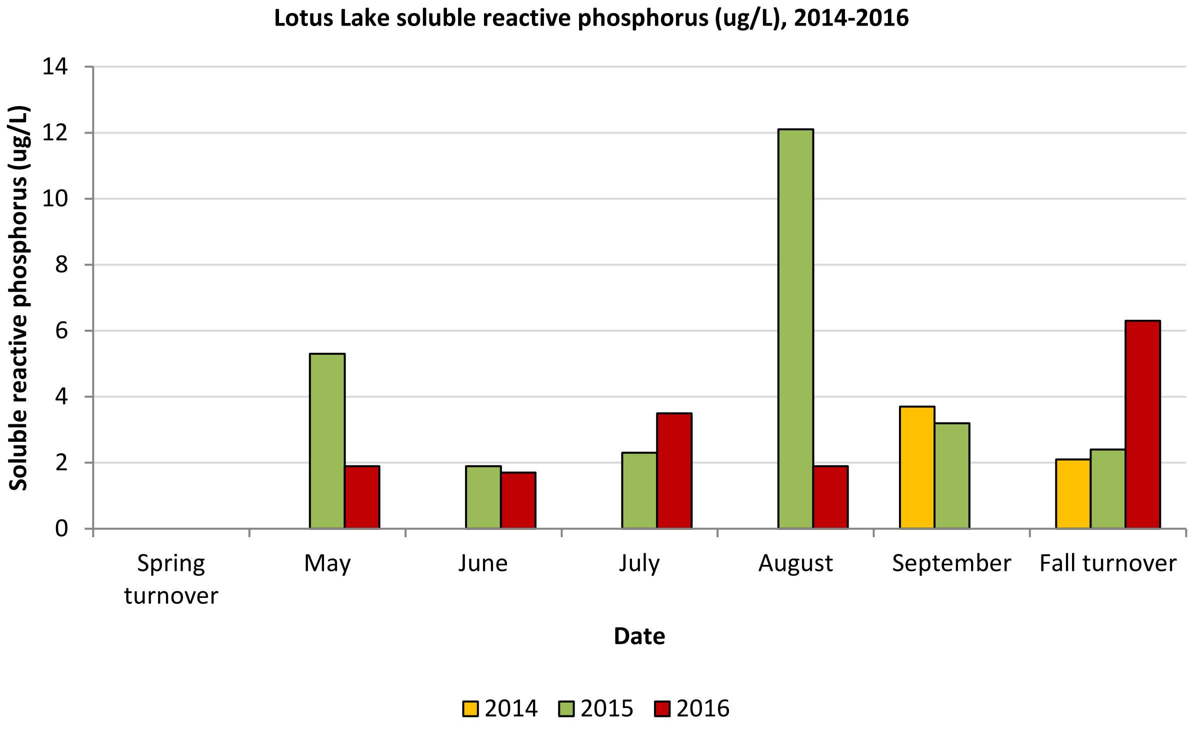


Soluble reactive phosphorus (SRP) includes forms of phosphorus that are dissolved in the water and are readily available for uptake by algae and aquatic plants.

In lakes, a healthy limit of soluble reactive phosphorus is set at 10 µg/L. If a value is above the healthy limit it is more likely that a lake could support nuisance algae blooms.

Surface soluble reactive phosphorus concentrations were below 10 µg/L on all sampling dates with the exception of August 18th, 2015. On eight of the twenty-one dates where samples were taken (38%), soluble reactive phosphorus was below the limit of detection.[18] Soluble reactive phosphorus concentrations were lowest in 2014, with only two of the seven samples being above the limit of detection.

Growing season average (excludes turnover) surface soluble reactive phosphorus was within the healthy limit in 2014 (3.7 µg/L), 2015 (5.0 µg/L), and 2016 (2.25 µg/L). Summer index period average surface total phosphorus (July 15-September 15) was within the healthy limit in 2014 (3.7 µg/L), 2015 (5.9 µg/L), and 2016 (1.9 µg/L).



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[18] Averages were not calculated for surface soluble reactive phosphorus because over half the samples were below the limit of detection

[19] Values of zero represent data points where soluble reactive phosphorus was below the limit of detection

Tributary Phosphorus Budget

Data was collected on the inlet and outlet of Lotus Lake. Flow data was collected bi-weekly at each tributary with a March McBirney Flo-Mate ™ velocity flowmeter. At each foot interval across each of the tributaries, depth (ft) and velocity (m/s) were measured. Grab samples were collected once monthly on each tributary. Samples were analyzed at the State Lab of Hygiene for total phosphorus, soluble reactive phosphorus, nitrate/nitrite, ammonium, total Kjeldahl nitrogen, and total suspended solids.

The phosphorus data collected is specific to date and location and can be used to theoretically determine how much phosphorus is entering and leaving Lotus Lake through tributaries. Values for phosphorus influxes are established by multiplying the phosphorus concentration at a specific location by the volume of water that moves through a specific location, or the discharge in cubic feet per second. To determine the average instantaneous load of phosphorus (in mg/s), the average phosphorus concentration is multiplied by the average seasonal discharge. Units are then converted and expressed as lb/yr.

The analysis of this data allows for areas of phosphorus loading to be identified. Once areas of phosphorus loading are identified, the land use and geology of these areas can be investigated for their total phosphorus contribution and best management recommendations can be made.

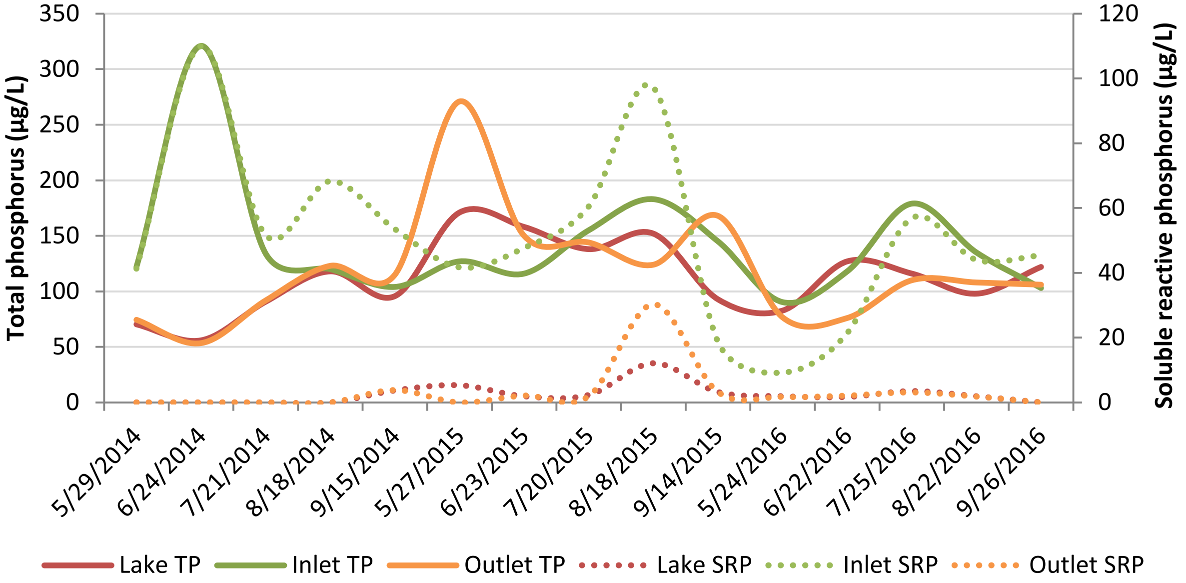
Site	Total phosphorus (µg/L)	Inlet and Outlet Area (m2)	Discharge (L/s)	Total Phosphorus (lb/yr)
2014 Inlet	160.20	1.216	280	3,121
2015 Inlet	145.20	1.104	166	1,677
2016 Inlet	125.06	1.260	189	1,644
2014 Outlet	91.52	0.846	465	2,961
2015 Outlet	171.40	0.576	242	2,886
2016 Outlet	95.32	0.336	118	783

The pounds of phosphorus entering Lotus Lake through the inlet were nearly twice as high in 2014 as in 2015 and 2016. This is partially due to a higher total phosphorus concentration and partially due to a higher discharge or flow through the inlet in 2014. An averaged over the three years, 2,147 pounds of phosphorus are entering Lotus Lake through the inlet.

The pounds of phosphorus leaving Lotus Lake through the outlet were nearly four times as high in 2014 and 2015 as compared to 2016. The increase in 2014 is due primarily to elevated flow through the outlet; whereas, the increase in 2015 is due primarily to an elevated total phosphorus concentration. In 2015 the in-lake total phosphorus concentration was elevated, which explains the increased total phosphorus concentration at the outlet in that year. An averaged over the three years, 2,210 pounds of phosphorus are leaving Lotus Lake through the outlet.

Year	Lotus Lake deep hole total phosphorus (µg/L)
2014	86.12
2015	142.36
2016	109.12

Lotus Lake, inlet, and outlet total phosphorus and soluble reactive phosphorus, 2014-2016



Nitrogen

Nitrogen, like phosphorus, is an element necessary for plant growth. Nitrogen sources in a lake can vary widely. Nitrogen does not occur naturally in soil minerals; however, it is a major component of all plant and animal matter. The decomposition of plant and animal matter releases ammonia, which is converted to nitrate in the presence of oxygen. This reaction accelerates when water temperatures increase. Nitrogen can also be introduced to a lake through rainfall, in the form of nitrate and ammonium, and through groundwater in the form of nitrate.

In most instances, the amount of nitrogen in a lake corresponds to land use. Nitrogen can enter a lake from surface runoff or groundwater sources as a result of fertilization of lawns and agricultural fields, animal waste, or human waste from septic systems or sewage treatment plants. During spring and fall turnover events, nitrogen is recycled back into the water column, which can cause spikes in ammonia levels. Under low oxygen circumstances, nitrogen can be lost from a lake system through a process called denitrification. Under these conditions nitrate is converted to nitrogen gas. Additionally, nitrogen can be lost through permanent sedimentation.

Nitrogen comprises the majority (78%) of the gases in the Earth's atmosphere. As with other gases, nitrogen is more soluble in cooler water as compared to warmer water. Nitrogen gas is not readily available to most aquatic plants, with the exception of blue green algae.

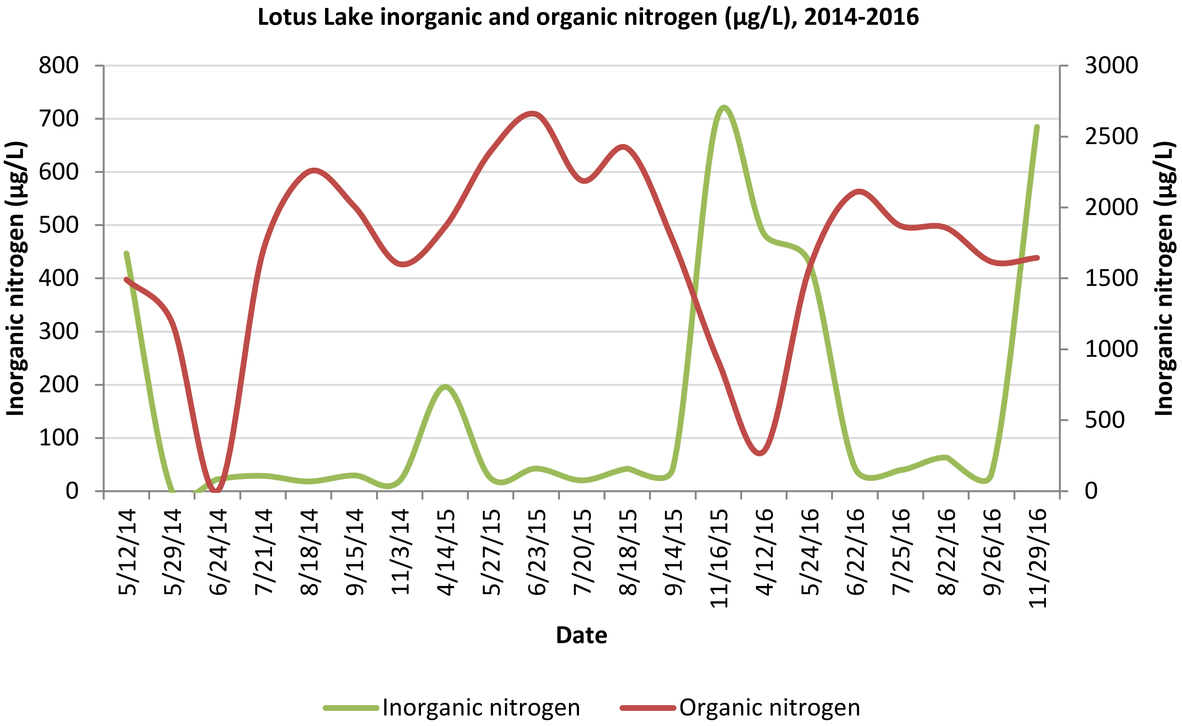
Similar to phosphorus, nitrogen is divided into many components. In this study nitrate/nitrite (NO_3 and NO_2), ammonium (NH_4), and total Kjeldahl nitrogen (TKN) were analyzed.

Nitrate/nitrite and ammonium are all inorganic forms of nitrogen which can be used by aquatic plants and algae. Inorganic nitrogen concentrations above 300 µg/L can support summer algae blooms.

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen plus ammonium. By subtracting the ammonium concentration from TKN, the organic nitrogen concentration found in plants and algal material can be found.

Nitrate/nitrite concentrations were below the limit of detection on all sampling dates with the exception of spring turnover (2014-2016) and fall turnover (2015). Inorganic nitrogen was above the healthy limit of 300 µg/L at spring turnover in 2014, fall turnover in 2015, and both turnover events and the May sampling date in 2016.

Growing season average (excludes turnover) surface organic nitrogen was highest in 2015 (2,286 µg/L) as compared to 2016 (1,804 µg/L) and 2014 (1,786 µg/L). Summer index period average surface organic nitrogen (July 15-September 15) was also highest in 2015 (2,125 µg/L) as compared to 2016 (1,864 µg/L) and 2014 (1,985 µg/L).


Lotus Lake inorganic and organic nitrogen (µg/L), 2014-2016
Inorganic nitrogen (µg/L)
800
700
600
500
400
300
200
100
0
Inorganic nitrogen (µg/L)
3000
2500
2000
1500
1000
500
0
5/12/14
5/29/14
6/24/14
7/21/14
8/18/14
9/15/14
11/3/14
4/14/15
5/27/15
6/23/15
7/20/15
8/18/15
9/14/15
11/16/15
4/12/16
5/24/16
6/22/16
7/25/16
8/22/16
9/26/16
11/29/16
Date
Inorganic nitrogen
Organic nitrogen

Tributary Nitrogen

Over all three sampling years, growing season average inorganic nitrogen, or the nitrogen available for plants and algae, was greatest at the inlet of Lotus Lake. Inorganic nitrogen decreased in-lake and at the outlet as available nitrogen was taken up by plants and algae. Values for inorganic nitrogen were similar in the lake and in the outlet. Nitrate/nitrite concentrations were below the limit of detection on all sampling dates at the outlet of Lotus Lake. As a result, inorganic nitrogen at the outlet is equal to the ammonium concentration.

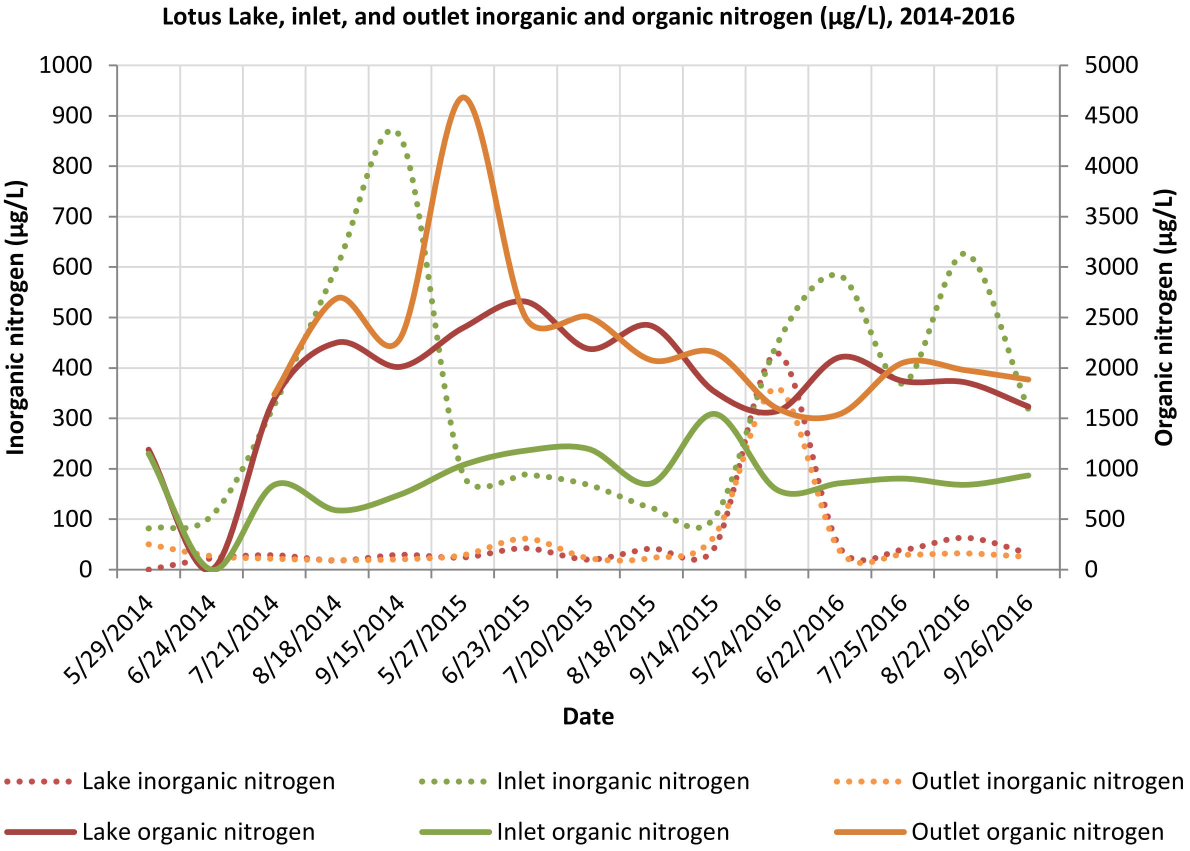
Over all three sampling years, growing season average organic nitrogen, or the nitrogen in plants and algae, was greatest in the lake and in the outlet as compared to the inlet. This indicates that the lake is exporting plants and algae downstream.

Growing season average inorganic nitrogen (µg/L)

	2014	2015	2016
Surface of Lotus Lake	20	34	122
Inlet	395	154	469
Outlet	28	40	97

Growing season average organic nitrogen (µg/L)

	2014	2015	2016
Surface of Lotus Lake	1,786	2,286	1,804
Inlet	830	1,163	865
Outlet	2,002	2,784	1,811


Lotus Lake, inlet, and outlet inorganic and organic nitrogen (µg/L), 2014-2016
Inorganic nitrogen (µg/L)
1000
900
800
700
600
500
400
300
200
100
0
Organic nitrogen (µg/L)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
5/29/2014
6/24/2014
7/21/2014
8/18/2014
9/15/2014
5/27/2015
6/23/2015
7/20/2015
8/18/2015
9/14/2015
5/24/2016
6/22/2016
7/25/2016
8/22/2016
9/26/2016
Date
Lake inorganic nitrogen
Inlet inorganic nitrogen
Outlet inorganic nitrogen
Lake organic nitrogen
Inlet organic nitrogen
Outlet organic nitrogen

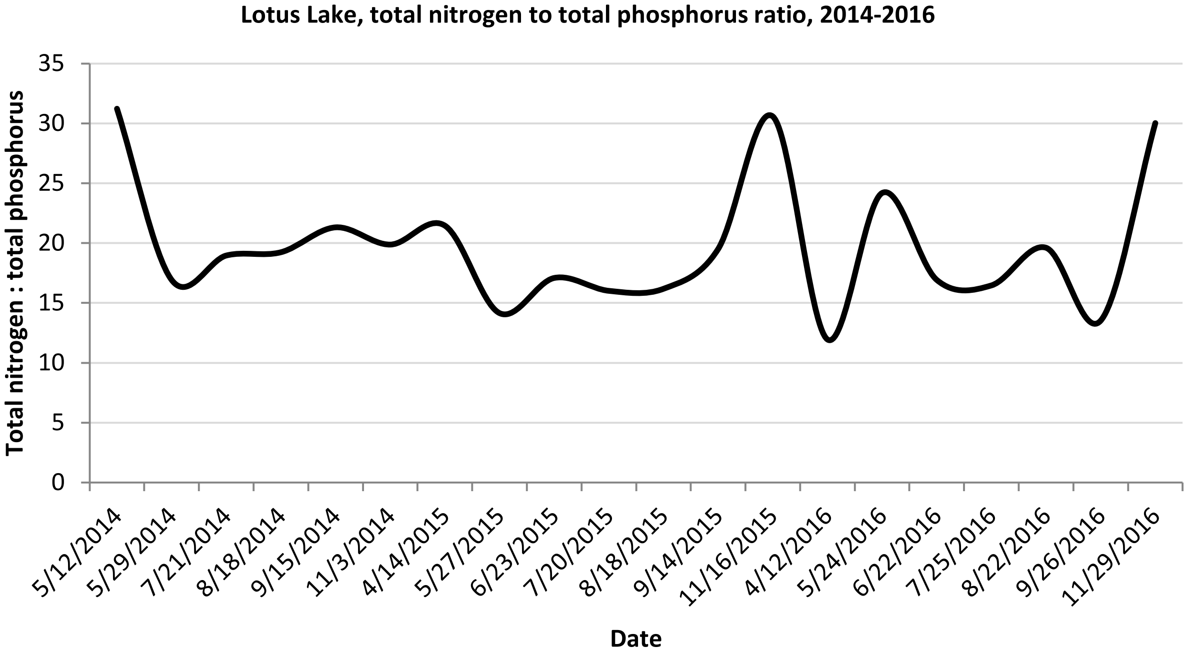
Total Nitrogen to Total Phosphorus Ratio

The total nitrogen to total phosphorus ratio (TN:TP) is a calculation that depicts which nutrient limit algae growth in a lake.

Lakes are considered nitrogen limited, or sensitive to the amount of nitrogen inputs, when TN:TP ratios are less than 10. Only about 10% of Wisconsin lakes are limited by nitrogen. In contrast, lakes are considered phosphorus limited, or sensitive to the amount of phosphorus inputs into a lake, when the TN:TP ratio is above 15. Lakes with values between 10 and 15 are considered transitional. In transitional lakes it is impossible to determine which nutrient, either nitrogen or phosphorus, is limiting algae growth.

Total nitrogen is found by adding nitrate/nitrite to total Kjeldahl nitrogen. As previously mentioned, nitrate/nitrite concentrations were below the limit of detection on all sampling dates with the exception of spring turnover (2014-2016) and fall turnover (2015). As a result, total nitrogen is largely reflective of total Kjeldahl nitrogen.

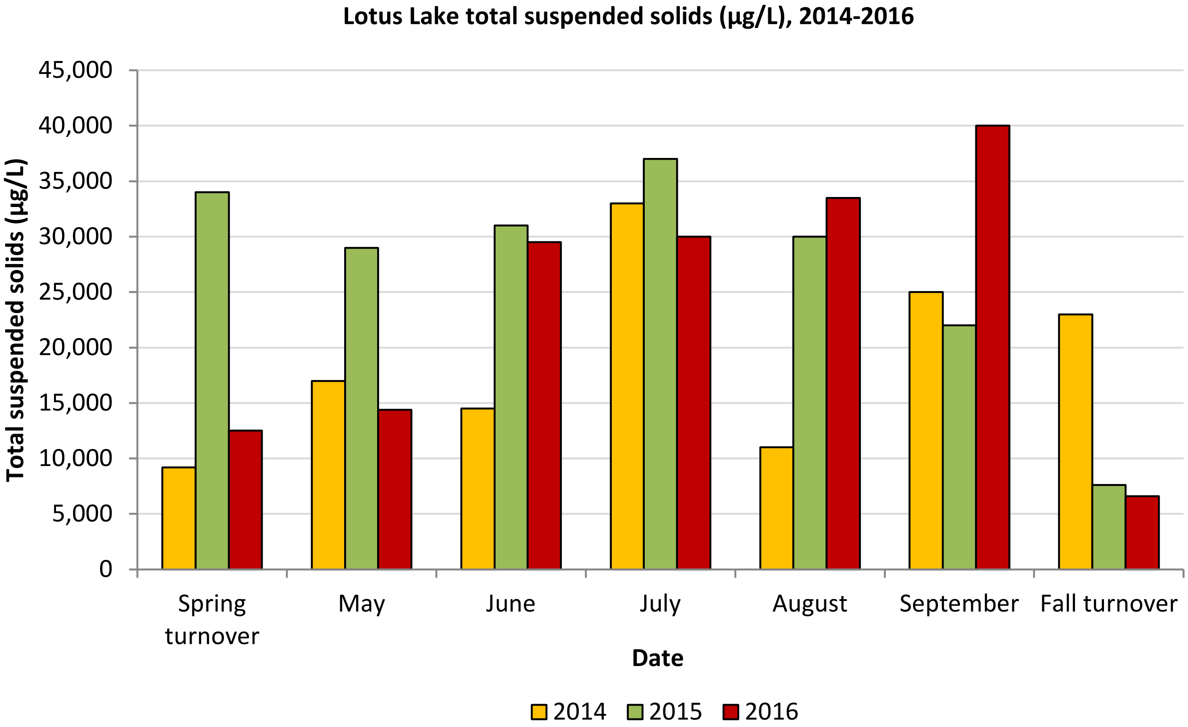
The majority of the sample dates indicate a phosphorus limited state in Lotus Lake. A transitional state existed during May 2015, April 2016 (spring turnover), and September 2016.



Total Suspended Solids

Total suspended solids (TSS) quantify the amount of inorganic matter that is floating in the water column. Wind, waves, boats, and even some fish species can stir up sediments from the lake bottom re-suspending them in the water column. Fine sediments, especially clay, can remain suspended in the water column for weeks. These particles scatter light and decrease water transparency.

Growing season (excludes turnover) average surface total suspended solids were highest in 2016 (36,750 µg/L) followed by 2015 (29,667 µg/L), and 2014 (23,000 µg/L). Summer index period average surface total suspended solids (July 15-September 15) were highest in 2015 (29,800 µg/L) followed by 2016 (29,480 µg/L), and 2014 (20,100 µg/L).

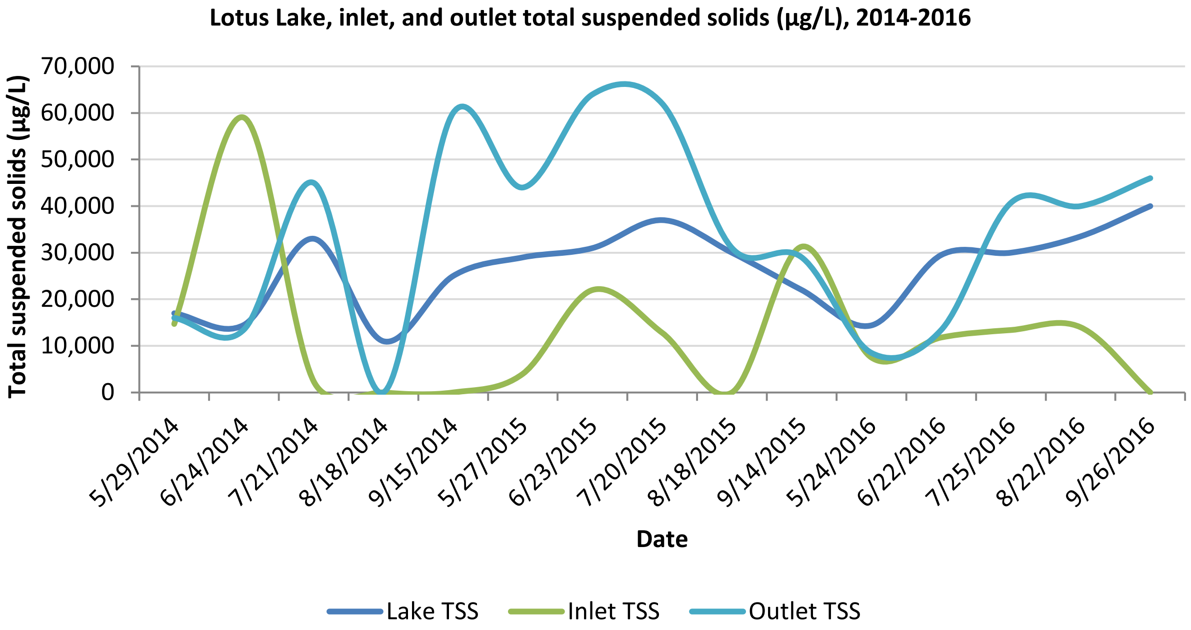


Tributary Total Suspended Solids

In all three sampling years, growing season average total suspended solids were highest at the outlet. In 2016, average total suspended solids were similar in-lake as compared to in the outlet. However, in 2015 total suspended solids were substantially higher in the outlet as compared to in-lake.

Growing season average total suspended solids (µg/L)

	2014	2015	2016
Surface of Lotus Lake	20,100	29,800	29,480
Inlet	15,220	14,020	9,340
Outlet	26,900	46,000	29,720



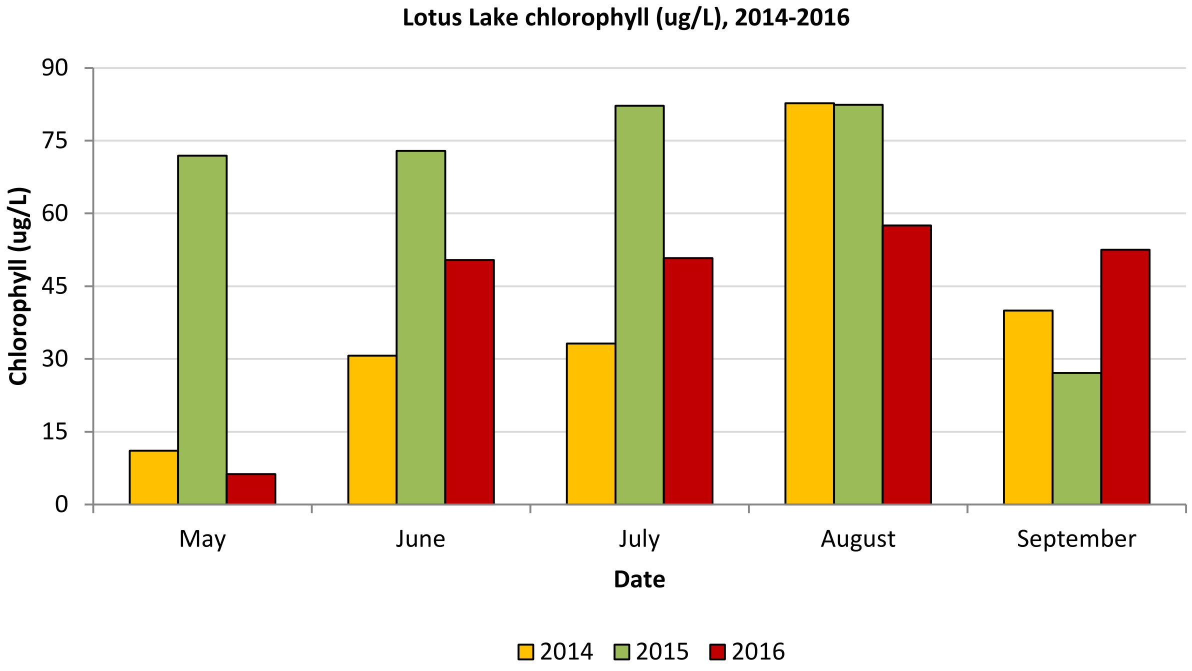
Chlorophyll

Chlorophyll is a pigment in plants and algae that is necessary for photosynthesis and is an indicator of water quality in a lake. Chlorophyll gives a general indication of the amount of algae growth in a lake, with greater values for chlorophyll indicating greater amounts of algae. However, since chlorophyll is present in sources other than algae— such as decaying plants— it does not serve as a direct indicator of algae biomass.

Chlorophyll seems to have the greatest impact on water clarity when levels exceed 30 µg/L. Lakes which appear clear generally have chlorophyll levels less than 15 µg/L.

Growing season average (excludes turnover) surface chlorophyll exceeded the healthy limit in 2014 (40 µg/L), 2015 (67 µg/L), and 2016 (43 µg/L). Summer index period average surface chlorophyll (July 15-September 15) exceeded the healthy limit in 2014 (52 µg/L), 2015 (64 µg/L) and 2016 (55 µg/L).

Chlorophyll levels were below 15 µg/L on the May 2014 and May 2016 sample date and below 30 µg/L on the September 2015 sample date.



Trophic State Index

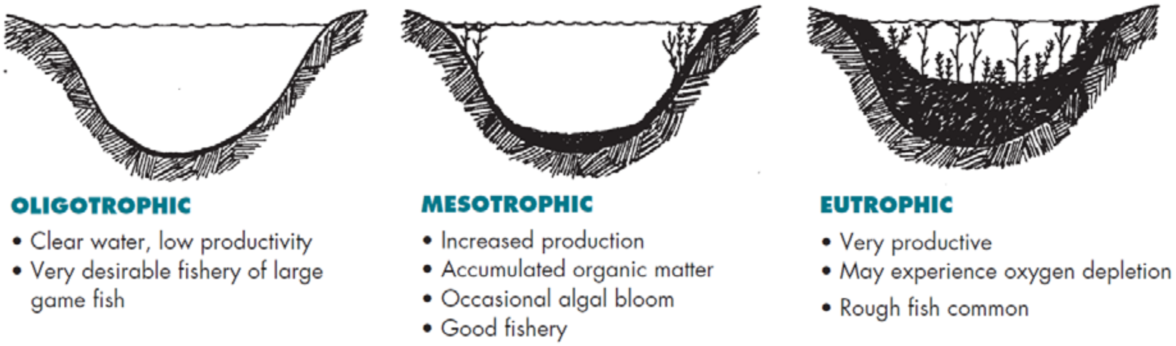
Lakes are divided into three categories based on their trophic states: oligotrophic, eutrophic, and mesotrophic. These categories reflect a lake's nutrient and clarity level and serve as an indicator of water quality. Each category is designed to serve as an overall interpretation of a lake's primary productivity.

Oligotrophic lakes are generally clear, deep, and free of weeds and large algae blooms. These types of lakes are often poor in nutrients and are unable to support large populations of fish. However, oligotrophic lakes can develop a food chain capable of supporting a desirable population of large game fish.

Eutrophic lakes are generally high in nutrients and support a large number of plants and animals. They are usually very productive and subject to frequent algae blooms. Eutrophic lakes often support large fish populations, but are susceptible to oxygen depletion.

Mesotrophic lakes lie between oligotrophic and eutrophic lakes. They usually have good fisheries and occasional algae blooms.

All lakes experience a natural aging process which causes a change from an oligotrophic to a eutrophic state. Human influences that introduce nutrients into a lake (agriculture, lawn fertilizers, and septic systems) can accelerate the process by which lakes age and become eutrophic.



[20]

A common method of determining a lake's trophic state is to compare total phosphorus (important for algae growth), chlorophyll (an indicator of the amount of algae present), and secchi disk readings (an indicator of water clarity). Although many factors influence these relationships, the link between total phosphorus, chlorophyll, and secchi disk readings is the basis of comparison for the trophic state index (TSI).

TSI is determined using a mathematic formula and ranges from 0 to 110. Lakes with the lowest numbers are oligotrophic and lakes with the highest values are eutrophic.

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[20] Figure from Understanding Lake Data (G3582), UW-Extension, Byron Shaw, Christine Mechenich, and Lowell Klessig, 2004

Three equations for summer index period TSI were examined for Lotus Lake.

$TSI (P) = 14.42 * Ln [TP] + 4.15$ (where TP is in µg/L)
$TSI (C) = 30.6 + 9.81 Ln [Chlor\text{-}a]$ (where the chlorophyll is in µg/L)
$TSI (S) = 60\text{-}14.41 * Ln [Secchi]$ (where the secchi depth is in meters)

<u>Lotus Lake 2014</u>
Average summer index period TSI (total phosphorus) = 71
Average summer index period TSI (chlorophyll) = 69
Average summer index period TSI (secchi depth) = 79
Average summer index period TSI = 73 = hypereutrophic

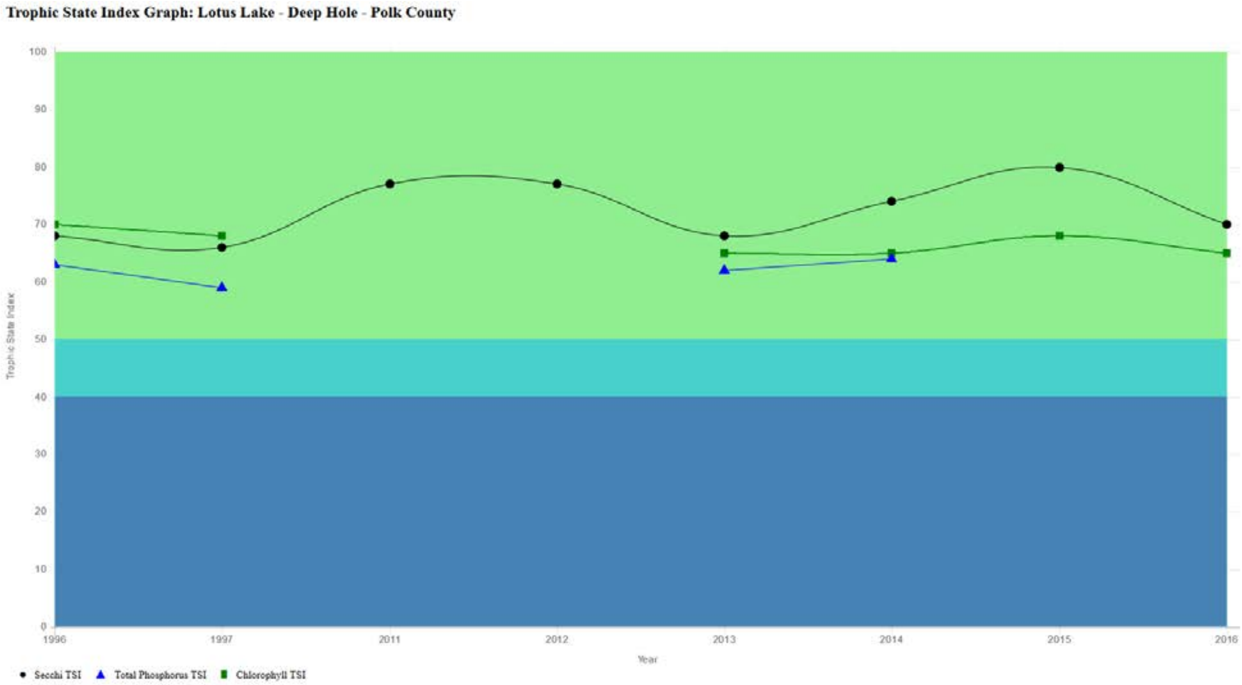
<u>Lotus Lake 2015</u>
Average summer index period TSI (total phosphorus) = 74
Average summer index period TSI (chlorophyll) = 71
Average summer index period TSI (secchi depth) = 80
Average summer index period TSI = 75 = hypereutrophic

<u>Lotus Lake 2016</u>
Average summer index period TSI (total phosphorus) = 72
Average summer index period TSI (chlorophyll) = 70
Average summer index period TSI (secchi depth) = 72
Average summer index period TSI = 71 = hypereutrophic

TSI	**General Description**
<30	Oligotrophic: clear water, high dissolved oxygen throughout the year/lake
30-40	Oligotrophic: clear water, possible periods of oxygen depletion in the lower depths of the lake
40-50	Mesotrophic: moderately clear water, increasing chance of anoxia near the bottom of the lake in summer, fully acceptable for all recreation/aesthetic uses
50-60	Mildly eutrophic: decreased water clarity, anoxic near the bottom, may have macrophyte problem, warm-water fisheries only
60-70	Eutrophic: blue-green algae dominance, scums possible, prolific aquatic plant growth, full body recreation may be decreased
70-80	Hypereutrophic: heavy algal blooms possible throughout the summer, dense algae and macrophytes
>80	Algal scums, summer fish kills, few aquatic plants due to algal shading, rough fish dominate

Monitoring the trophic state index of a lake gives stakeholders a method by which to gauge lake productivity over time. TSI secchi data exists for 1996-2016; TSI data for phosphorus exist for 1996, 1997, 2013, and 2014; and TSI data for chlorophyll exist for 1996, 1997, and 2013-2016.

Historic TSI data falls between 60 and 80, indicating a eutrophic to hypereutrophic state.



Phytoplankton

Algae, also called phytoplankton, are microscopic plants and autotrophic bacteria that convert sunlight and nutrients into biomass. They can live on bottom sediments and substrate, in the water column, on wave-swept shorelines, and on aquatic macrophytes. Algae are the primary producers in an aquatic ecosystem and can vary in form (filamentous, colonial, unicellular, etc.). They form the base of the aquatic food web. Zooplankton, are small aquatic organisms that feed on algae. The size and shape of algae determine which types of zooplankton—if any—can consume them.

Algae have generally short life cycles. As a result, changes in water quality are often reflected by changes in the algal community within a few days or weeks. The number and types of algae in a waterbody can provide useful information for environmental monitoring programs, impairment assessments, and the identification of best management strategies.

The types of algae in a lake will change over the course of a year. Typically, there is less algae in winter and spring because of ice cover and cold temperatures. As a lake warms up and sunlight increases, algae communities begin to increase, particularly diatoms. Their short life span quickly cycles the nutrients in a lake and affects nutrient dynamics through a number of different mechanisms.

The types of algae present in a lake are influenced by environmental factors like climate, phosphorus, nitrogen, silica and other nutrient content, carbon dioxide, grazing, substrate, and other factors in the lake. When high levels of nutrients are available, blue-green algae (cyanobacteria) often become predominant and create light limited conditions for other groups of algae. Additionally, under nitrogen limited conditions blue green algae have a competitive advantage over other algae because of their unique ability to fix nitrogen from the atmosphere.

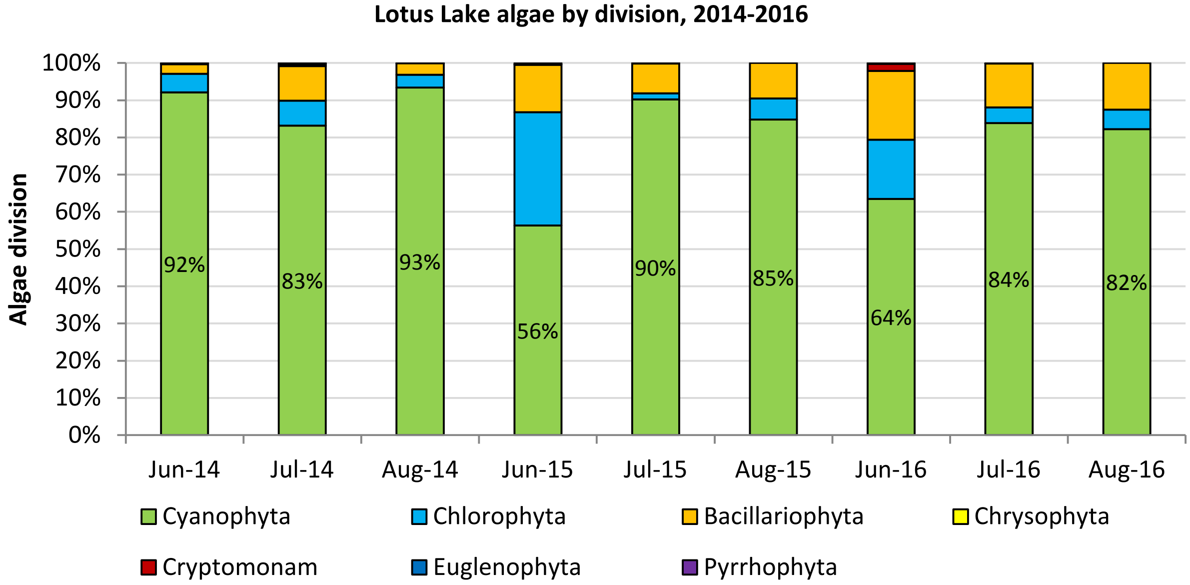
Chlorophyll is a pigment in plants and algae that is necessary for photosynthesis. Chlorophyll gives a general indication of the amount of algae growth in the water column; however, it is not directly correlated with algae biomass. To obtain accurate algae data, composite samples from a two meter water column were collected monthly, preserved with glutaraldehyde, placed on ice, and sent to the University of Wisconsin-Oshkosh for identification and enumeration of algae species. Sampling was conducted in 2014, 2015, and 2016.

Algae were identified to the lowest taxonomic level, and a relative concentration and cell count was made to describe the algae community throughout the growing season. This method of sampling also allows the identification of any species of concern which might be present.

There are 12 divisions of algae found in typical lakes of Wisconsin. Seven divisions were found in Lotus Lake. The division Pyrrhophyta was only present in Lotus Lake in 2014.

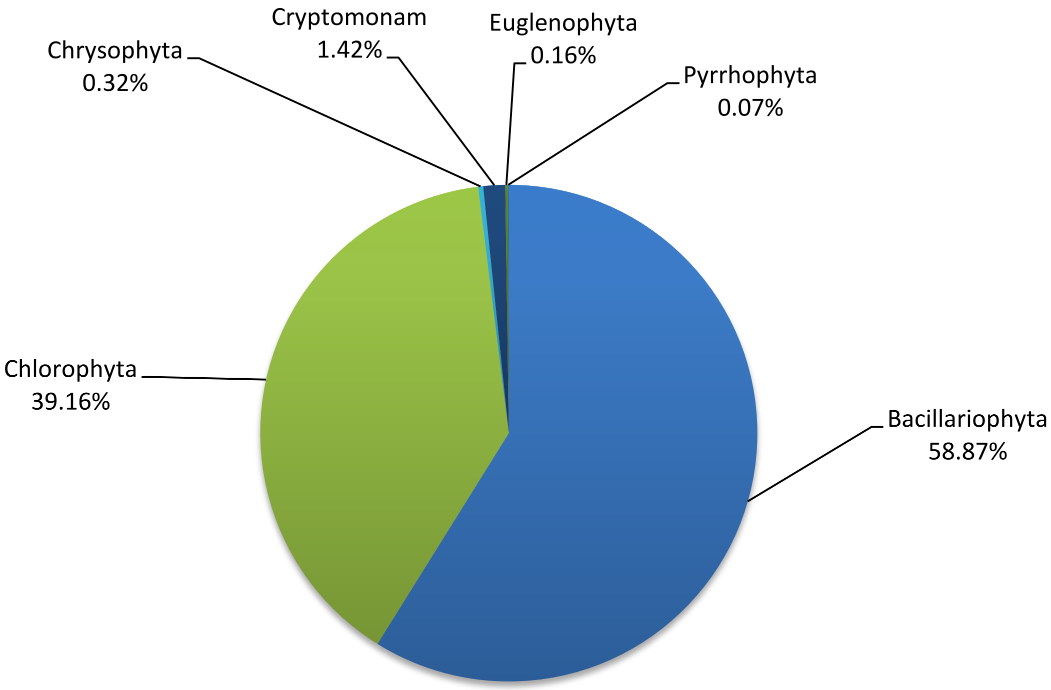
Algal Division	**Common Name**	**Characteristics**
Bacillariophyta	Diatoms	Sensitive to chloride, pH, color, and total phosphorus in water. As total phosphorus increases, diatoms decrease. Generally larger in size. Tend to be highly present in spring and late spring.
Chlorophyta	Green algae	Provide high nutritional value to consumers. Can be filamentous and intermingle with macrophytes.
Chrysophyta	Golden brown algae	A genus of single-celled algae in which the cells are ovoid. Contain chlorophyll *a*, c_1 and c_2, generally masked by abundant accessory pigment, fucoxanthin, imparting distinctive golden color to cells.
Cryptomonam	Cryptomonads	Bloom forming, are not known to produce any toxins, and feed small zooplankton. Cryptomonads frequently dominate the phytoplankton assemblages of the Great Lakes.
Cyanophyta	Blue green algae	Prevail in nutrient-rich standing waters. Blooms can be toxic to zooplankton, fish, livestock, and humans. Can be unicellular, colonial, planktonic, or filamentous. Can live on almost any substrate. More prevalent in late to mid-summer.
Euglenophyta	Euglenoids	Commonly found in freshwater that is rich in organic materials. Most are unicellular.
Pyrrhophyta	Dinoflagellate	Have starch food reserves and serve as food for grazers.

On all of the sampling dates, blue-green algae (cyanophyta) were the most abundance division of algae in Lotus Lake, comprising from 56-93% of the algal community.



Of the other groups of algae present in Lotus Lake, the diatoms (bacillariophyta) and the green algae (chlorophyta) formed the largest components of the non-cyanobacteria algal community at 58.87% and 39.16% respectively. All other groups comprised less than 1.5% of the non-cyanobacterial algal community.

Lotus Lake non-cyanobacterial algal community, totals for 2014-2016



Of the diatoms present in the system, *Aulacoseira granulata* had the highest cell density count. *A. granulata* is a common diatom found in high nutrient, eutrophic systems. *Fragilaria crotonensis* and *Synedra spp*. were the most commonly sampled species and are also indicative of a eutrophic system.

The most common green algae present in Lotus Lake were *Pediastrum spp*. and *Scenedesmus spp*. Both are common species found in freshwater all over the world. *Pediastrum spp*. is non-motile and forms colonies of 2 to 128 cells. In high nutrient water *Pediastrum spp*. can form blooms. *Scenedesmus spp*. also forms colonies of 4, 8, or 16 cells in a row and is a common component of freshwater plankton. *Scenedesmus spp*. is able to compete with cyanobacteria through allelochemicals and morphological adaptations such as spines. *Scenedesmus spp*. is also a common bio-indicator of physical and chemical changes in environmental conditions. The genus is commonly used to detect the presence of nutrients or toxins resulting from anthropogenic inputs to aquatic systems.

Blue Green Algae

Blue-green algae or cyanobacteria have been around for billions of years and typically bloom during the summer months. However, blue-green algae blooms become more frequent as a result of increased nutrient concentrations. In addition to the negative aesthetics posed by algae, blue green algae are of specific concern because some have the ability to produce toxins, which when ingested or inhaled, can cause short and long term health effects. Effects range from tingling, burning, numbness, drowsiness, and dermatitis to liver or respiratory failure possibly leading to death. Toxin producing groups such as *Dolichospermum crissum*, *Aphanizomenon flos-aquae*, *Microcystis aeruginosa*, and *Planktolyngbya spp.* were common during the sampling season. Toxin data was not collected as part of this study.

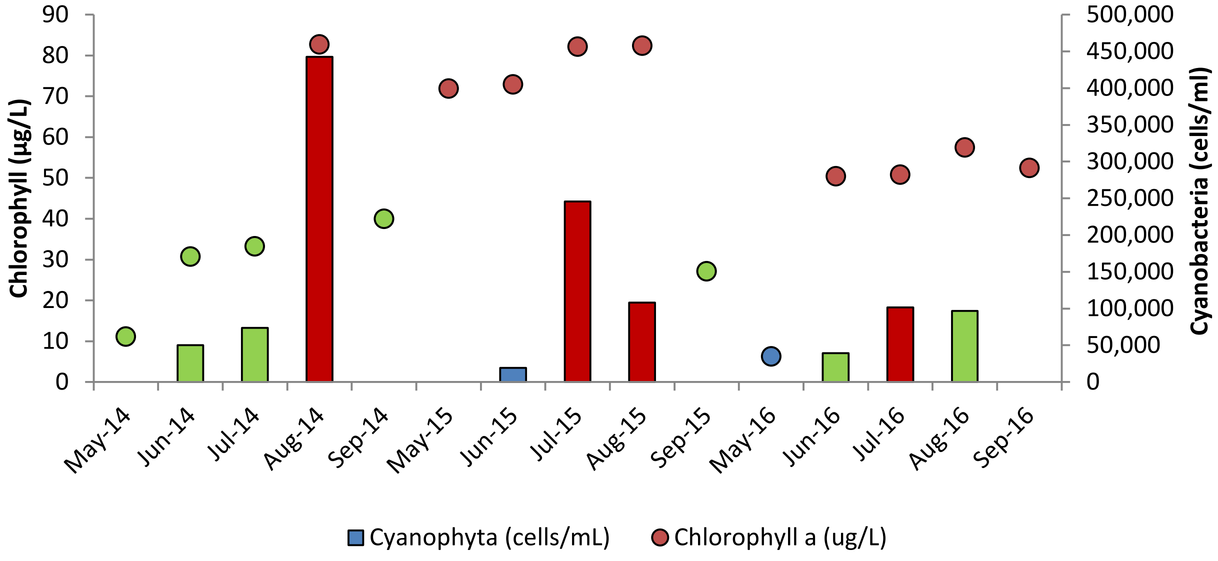
It is not known which environmental conditions cause the production of cyanotoxins, but scientists have found that when blue green algae is present at concentrations over 100,000 cells/mL toxin production is more likely to occur.

Federal guidelines for blue green algae cell densities and chlorophyll concentrations do not exist. The Wisconsin Harmful Algal Bloom (HAB) Surveillance Program uses guidelines of the World Health Organization to determine risks from blue green algae.

Blue green algae cell density (cells/mL)	Chlorophyll a (µg/L)	Risk
Less than 20,000	Less than 10	**Low**
20,000 to 100,000	10 to 50	**Moderate**
Greater than 100,000	Greater than 50	**High**

Based on chlorophyll data, toxin risk was high on 60% of the sample dates and moderate on 33% of the sample dates. Based on cyanobacteria cell density data, toxin risk was high on 44% of the sample dates and moderate on 44% of the sample dates.

Lotus Lake cyanobacteria and chlorophyll toxin risk, 2014-2016



Zooplankton

Zooplankton are small aquatic animals that feed on algae and are eaten by fish. They are divided into three main components: rotifers, copepods, and cladocerans.

Rotifers eat algae, other zooplankton, and sometimes each other. Due to their small size, rotifers are not capable of significantly reducing algal biomass although they are able to shift the algae community to favor larger species.

Copepods feed on algae and other plankton. They are eaten by larger plankton and are preyed heavily upon by pan fish, minnows, and the fry of larger fish.

Cladocerans are filter feeders that play an important part in the food web. Species of cladocerans (particularly daphnia) are well known for their ability to reduce algal biomass and help maintain clear water in lake ecosystems.

Zooplankton are often overlooked as a component of aquatic systems, but their role in a lake is extremely important. Lake systems are valued primarily for water clarity, fishing, or other recreation, all of which are strongly linked to water quality and ecosystem health. Zooplankton are the primary link between the bottom up processes and top down processes of a lake ecosystem.

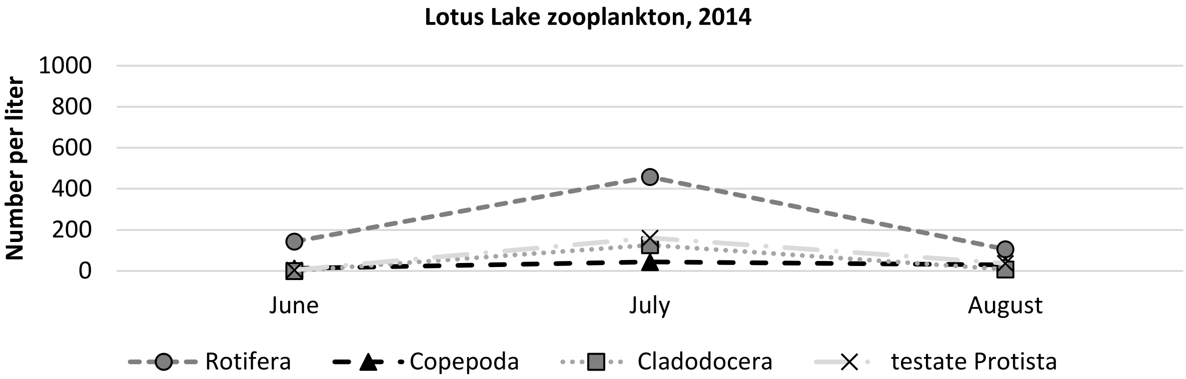
Bottom up processes include factors such as increased nutrients, which can cause noxious algal blooms. Zooplankton have the ability to mediate algae blooms by heavy grazing. Conversely, shifts in algal composition, which can be caused by increased nutrients, can change the composition of the zooplankton community. If the composition shifts to favor smaller species of zooplankton, for example, algal blooms can be intensified, planktivorous fish can become stressed, and the development of fry can be negatively impacted.

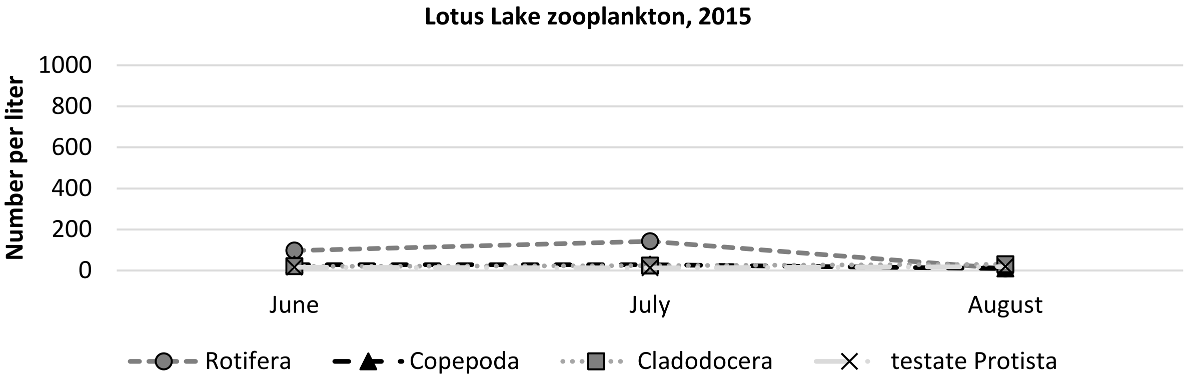
Top down processes include factors such as increased fish predation. Increases in planktivorous fishes (pan fish) can dramatically reduce zooplankton populations and lead to algal blooms. In some lakes, biomanipulation is utilized to manage this effect and improve water clarity. Piscivorous fish (fish that eat other fish) are used to reduce planktivorous fish. This in turn increases zooplankton populations and ultimately reduces algae populations.

Changes in the aquatic plant community and shoreland habitat can impact zooplankton populations. This occurs especially in shallow lakes where zooplankton are more likely to have the ability to migrate horizontally to avoid predation from fish and other invertebrates. In general, a diverse shoreland habitat (substrate, plant species, and woody debris) will support a diverse zooplankton community.

Composite samples from a two meter water column were collected monthly, preserved with denatured ethanol, placed on ice, and sent to Dr. Toben Lafrancois for identification and enumeration of zooplankton species. This analysis shows the abundance of the major zooplankton groups—cladocera, copepoda, and rotifer—in Lotus Lake. Testate protozoa are also included in this analysis. It is unclear if testate protozoa correlate to the total protozoan community or if they increase at the expense of soft protozoan that leave no trace in preserved samples.

Lotus Lake produced a curious crash in 2016 for all groups except rotifers in June. In 2014 and 2015 there was a bump in zooplankton populations in July. One particularly notable spike of rotifers in June 2016 is primarily due to *B. angularis*, *F. longiseta*, and *Collotheca* sp. (probably *C. mutabilis*). The first two rotifer species are indicators of eutrophic conditions. Combined with *Collotheca* sp. in this spike, it would appear to relate to a bacterial bloom related to high nutrients and/or high temperatures.[21]





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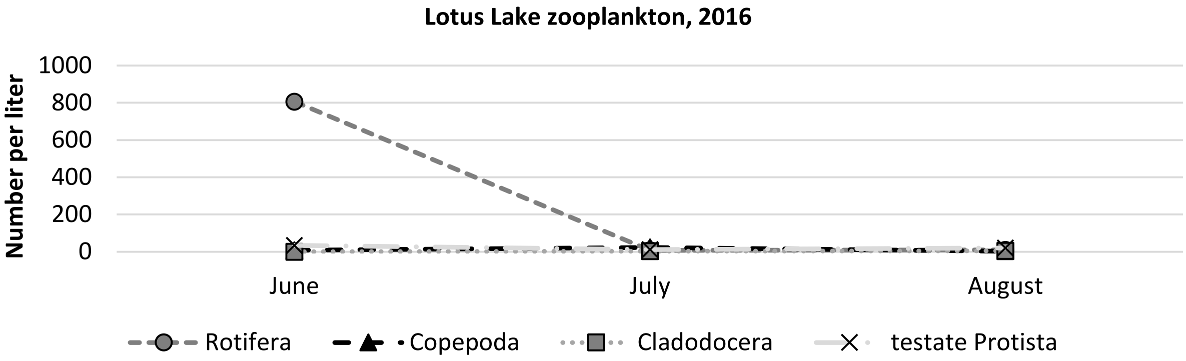
[21] Text and graphs from Lafrançois, T. 2016. Zooplankton of Big Blake and Lotus Lakes, Polk County, 2013-2016.


Lotus Lake zooplankton, 2016
Number per liter
1000
800
600
400
200
0
June
July
August
Rotifera
Copepoda
Cladodocera
testate Protista

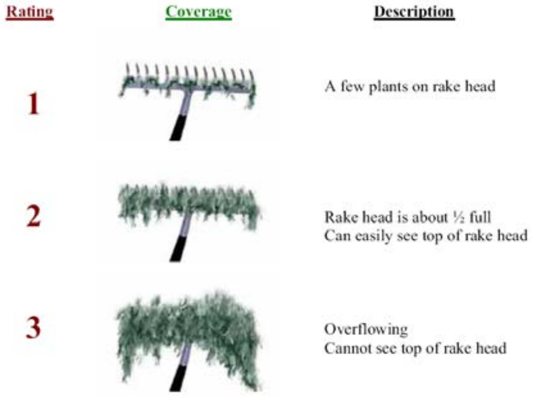
Point Intercept Aquatic Macrophyte Surveys

Spring and fall aquatic macrophyte surveys were conducted on Lotus Lake in 2014, 2015, and 2016 using the Jessen and Lound Rake Method.

Three hundred and thirteen sampling points were established in and around the lake using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total lake acres. Points were generated in ArcView, downloaded to a GPS unit, and sampled in field.

During the aquatic macrophyte survey, each sampling point was located using a handheld mapping GPS unit. The depth at each sampling point was recorded using a depth finder. At each sampling point a pole rake was used to sample the plant community of an approximately 1 meter section of the benthos.

All plants on the rake, as well as any that were dislodged by the rake, were identified to species and assigned a rake fullness value of 1 to 3 to estimate abundance. Visual sightings of plants within six feet of the sample point were also recorded. The lake bottom type, or substrate, was also assigned at each sampling point where the bottom was visible or it could be reliably determined using the rake. Data was collected at each sampling point, with the exception of those that were too shallow or terrestrial. Shallow communities were characterized visually.



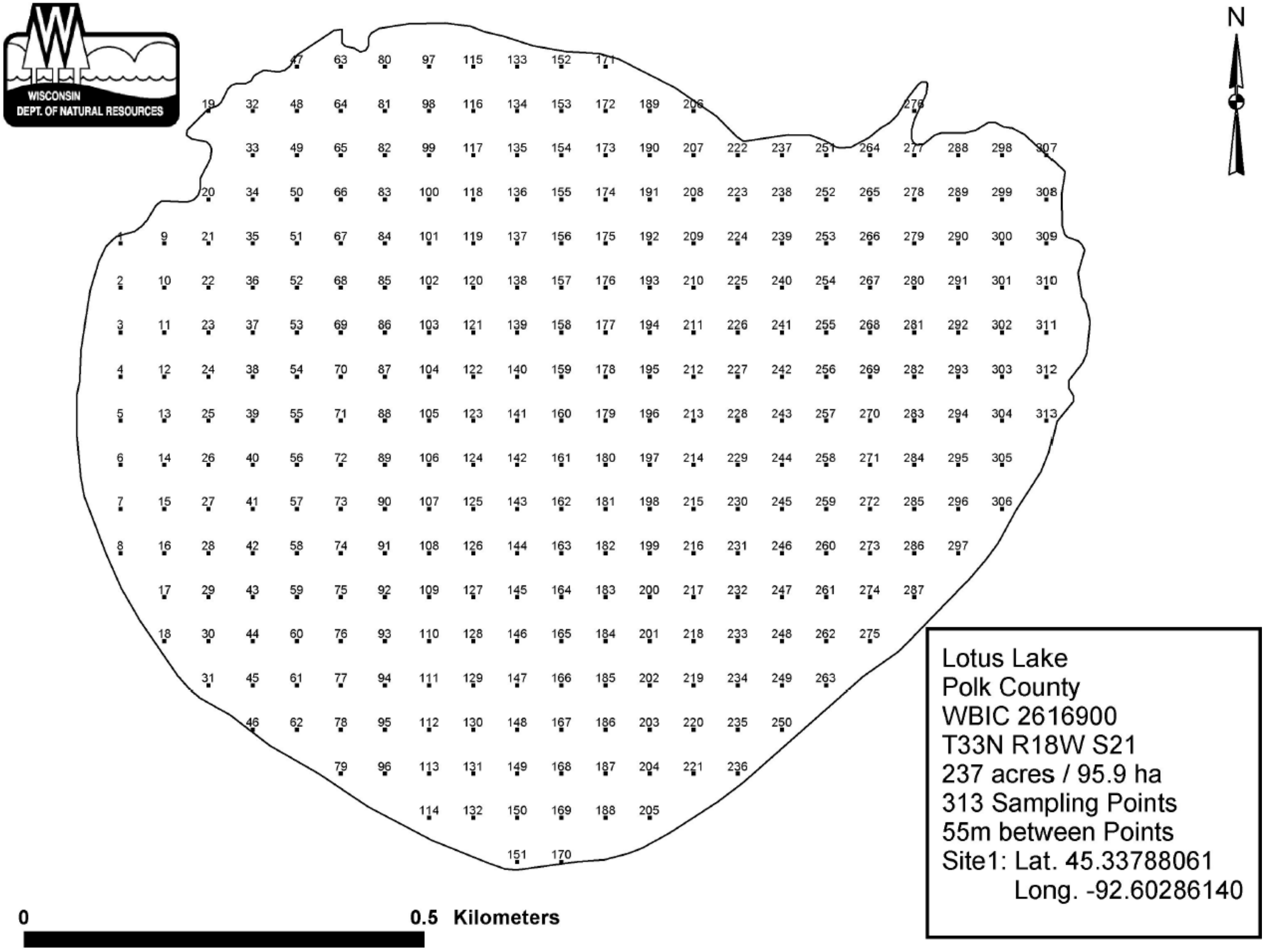
Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

Although three hundred and thirteen sampling points were established in Lotus Lake, it was not possible to reach all sampling points (some were terrestrial).

Data collected was entered into a spreadsheet for analysis. The following statistics were generated from the spreadsheet:

- Maximum depth of plants
- Frequency of occurrence
- Relative frequency
- Sample points with vegetation
- Species richness
- Simpson's Diversity Index
- Floristic Quality Index

Following are explanations of the various analysis values with data from Lotus Lake.


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Lotus Lake
Polk County
WBIC 2616900
T33N R18W S21
237 acres / 95.9 ha
313 Sampling Points
55m between Points
Site1: Lat. 45.33788061
Long. -92.60286140
0
0.5 Kilometers
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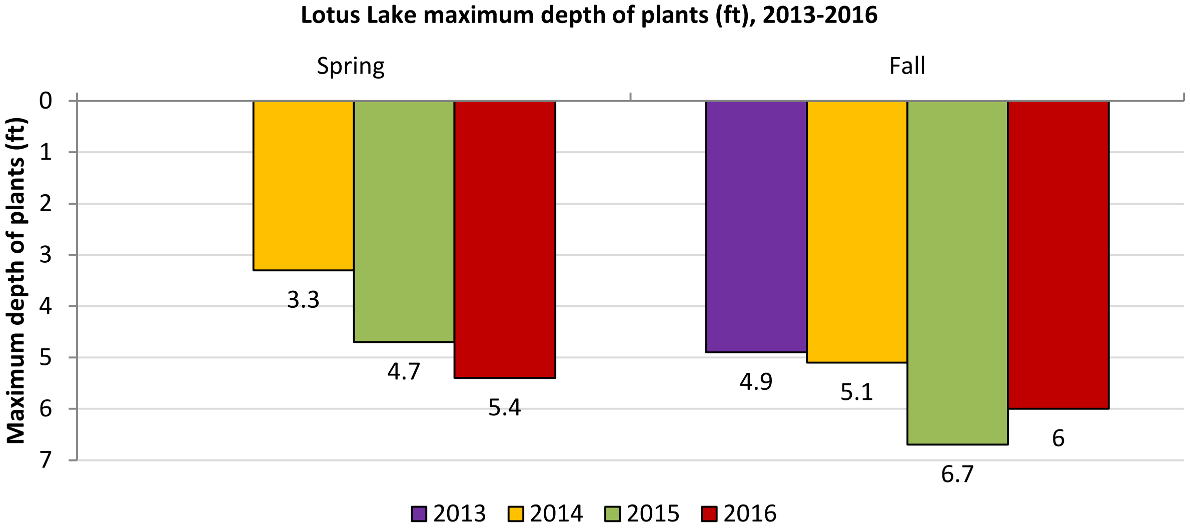
Maximum Depth of Plants

In lakes, plant growth is limited to certain depths based on availability of light. With greater water clarity, light can penetrate to greater depths and be used by plants for growth. In Lotus Lake the maximum depth of plants was greater in the fall as compared to the spring. The maximum depth of plants ranged from a low of 3.3 feet to a high of 6.7 feet.



Frequency of Occurrence

Two values are computed for frequency of occurrence: the frequency of occurrence within vegetated areas and the frequency of occurrence at sites shallower than the maximum depth of plants. The maximum depth of plants is the depth of the deepest site sampled at which vegetation was present (maximum depth of plants).

Frequency of occurrence within vegetated areas is defined as the number of times a species was seen in a vegetated area divided by the total number of vegetated sites. This value shows how often the plant would be encountered everywhere vegetation was found in the lake. The greater the value, the more frequently the plant would be encountered in the lake.

In the spring, within vegetated areas, the most frequently encountered species were white water lily, spatterdock, and coontail. American lotus was frequently encountered in spring of 2016.

In the fall, within vegetated areas, the most frequently encountered species was American lotus, followed by spatterdock and white water lily.

Frequency of occurrence within vegetated areas (%)	**Fall 2013**	**Spring 2014**	**Fall 2014**	**Spring 2015**	**Fall 2015**	**Spring 2016**	**Fall 2016**
Ceratophyllum demersum, Coontail	6.3	35.3	4.7	26.3	5.5	31.8	6.0
Elodea canadensis, Common waterweed					1.8		2.0
Lemna minor, Small duckweed	3.1				1.8		
Nelumbo lutea, American lotus	62.5		65.1	10.5	74.5	45.5	78.0
Nuphar variegata, Spatterdock	9.4	35.3	23.3	42.1	10.9	18.2	8.0
Nymphaea odorata, White water lily	21.9	47.1	11.6	42.1	10.9	9.1	14.0
Potamogeton natans, Floating-leaf pondweed					1.8	4.5	
Schoenoplectus tabernaemontani, Softstem bulrush	6.3						
Stuckenia pectinata, Sago pondweed	3.1		2.3	5.3		4.5	
Wolffia sp.	3.1						
Filamentous algae		5.9				18.2	

<u>Frequency of occurrence at sites shallower than the maximum depth of plants</u> is defined as the number of times a species was seen divided by the total number of sites shallower than the maximum depth of plants. This value shows how often the plant would be encountered within the depths plants can potentially grow (maximum depth of plants). The greater the value, the more frequently the plant would be encountered in the lake.

In the spring, at sites shallower than the maximum depth of plants, the most frequently encountered plants were white water lily, spatterdock, and coontail. Spring frequency of occurrence values for these species were greater in 2014. In the fall, at sites shallower than the maximum depth of plants, American lotus was the most frequently encountered plant.

The most frequently encountered plants were still only found at 25% of the sites were plants can potentially grow in Lotus Lake.

Frequency of occurrence at sites shallower than maximum depth of plants	**Fall 2013**	**Spring 2014**	**Fall 2014**	**Spring 2015**	**Fall 2015**	**Spring 2016**	**Fall 2016**
Ceratophyllum demersum, Coontail	1.4	18.8	1.3	4.3	1.6	4.3	1.9
Elodea canadensis, Common waterweed					0.5		0.6
Lemna minor, Small duckweed	0.7				0.5		
Nelumbo lutea, American lotus	13.5		17.9	1.7	21.9	6.2	24.8
Nuphar variegata, Spatterdock	2.0	18.8	6.4	6.9	3.2	2.5	2.5
Nymphaea odorata, White water lily	4.7	25.0	3.2	6.9	3.2	1.2	4.5
Potamogeton natans, Floating-leaf pondweed					0.5	0.6	
Schoenoplectus tabernaemontani, Softstem bulrush	1.4						
Stuckenia pectinata, Sago pondweed	0.7		0.6			0.6	
Wolffia sp.	0.7						
Filamentous algae		3.1		0.9		2.5	

Relative Frequency

Relative frequency is the frequency of a particular plant species relative to other plant species. This value is independent of the number of points sampled. Relative frequency can be used to show which plants are the dominant species in a lake. The higher the value a species has for relative frequency, the more common the species is compared to others. The relative frequency of all plants will always add up to 100%. If species A had a relative frequency of 30%, this species occurred 30% of the time compared to all the species sampled or makes up 30% of all species sampled.

Relative frequency example:
Suppose we were sampling 10 points in a very small lake and got the following results:
Plant A present at 3 of 10 sites
Plant B present at 5 of 10 sites
Plant C present at 2 of 10 sites
Plant D present at 6 of 10 sites

Plant D is the most frequently sampled at all points, with 60% (6/10) of the sites having plant D. However, the relative frequency allows us to see what the frequency of Plant D is compared to other plants, without taking into account the number of sites. This value is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If we add all frequencies (3+5+2+6), we get a sum of 16. We can calculate the relative frequency by dividing by the individual frequency.

Plant A = 3/16 = 0.1875 or 18.75%
Plant B = 5/16 = 0.3125 or 31.25%
Plant C = 2/16 = 0.125 or 12.5%
Plant D = 6/16 = 0.375 or 37.5%

Now we can compare the plants to one another. Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because, although we sampled Plant D at 6 of 10 sites, we were sampling many other plants too, thereby giving a lower frequency when compared to those other plants. This then gives a true measure of the dominant plants present.

In the spring of 2014 and 2015, the dominant plants in Lotus Lake as indicated by relative frequency were spatterdock, white water lily, and coontail. In 2016, the plant community was dominated by American Lotus and coontail. In the fall, the most dominant plant in Lotus Lake as indicated by relative frequency was American lotus which comprised from 54-72% of the plant community.

American Lotus has increased from year to year, becoming increasing dominant over the course of this study.

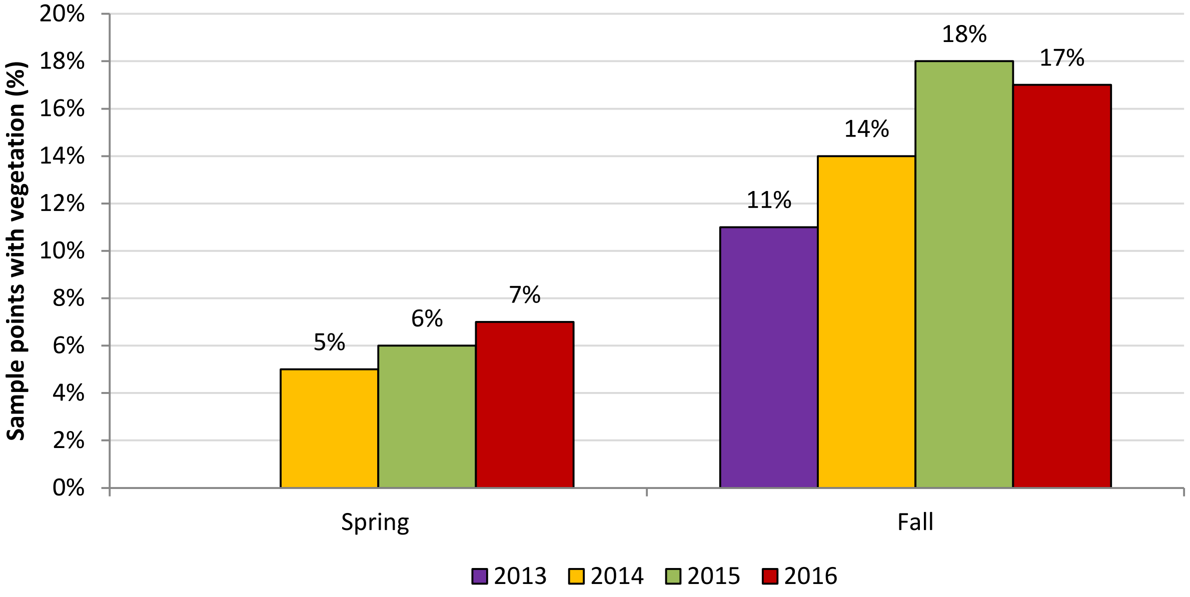
Relative frequency (%)	**Fall 2013**	**Spring 2014**	**Fall 2014**	**Spring 2015**	**Fall 2015**	**Spring 2016**	**Fall 2016**
Ceratophyllum demersum, Coontail	5.4	30.0	4.3	21.7	5.1	28.0	5.6
Elodea canadensis, Common waterweed					1.7		1.9
Lemna minor, Small duckweed	2.7				1.7		
Nelumbo lutea, American lotus	54.1		60.9	8.7	69.5	40.0	72.2
Nuphar variegata, Spatterdock	8.1	30.0	21.7	34.8	10.2	16.0	7.4
Nymphaea odorata, White water lily	18.9	40.0	10.9	34.8	10.2	8.0	13.0
Potamogeton natans, Floating-leaf pondweed					1.7	4.0	
Schoenoplectus tabernaemontani, Softstem bulrush	5.4						
Stuckenia pectinata, Sago pondweed	2.7		2.2			4.0	
Wolffia sp.	2.7						

Sample Points with Vegetation

This value shows the number of sites where plants were actually collected and gives an approximation of the plant coverage of a lake. If 10% of all sample points had vegetation, then it is implied that approximately 10% of the lake is covered with plants.

In all sample years the percent of Lotus Lake that is covered with plants was greater in fall as compared to spring. In the fall the presence of American lotus is much more pronounced. Overall, plant coverage increased each year of the study. A small percentage of Lotus Lake has plant growth and the community is dominated by floating leaf species (lilies).

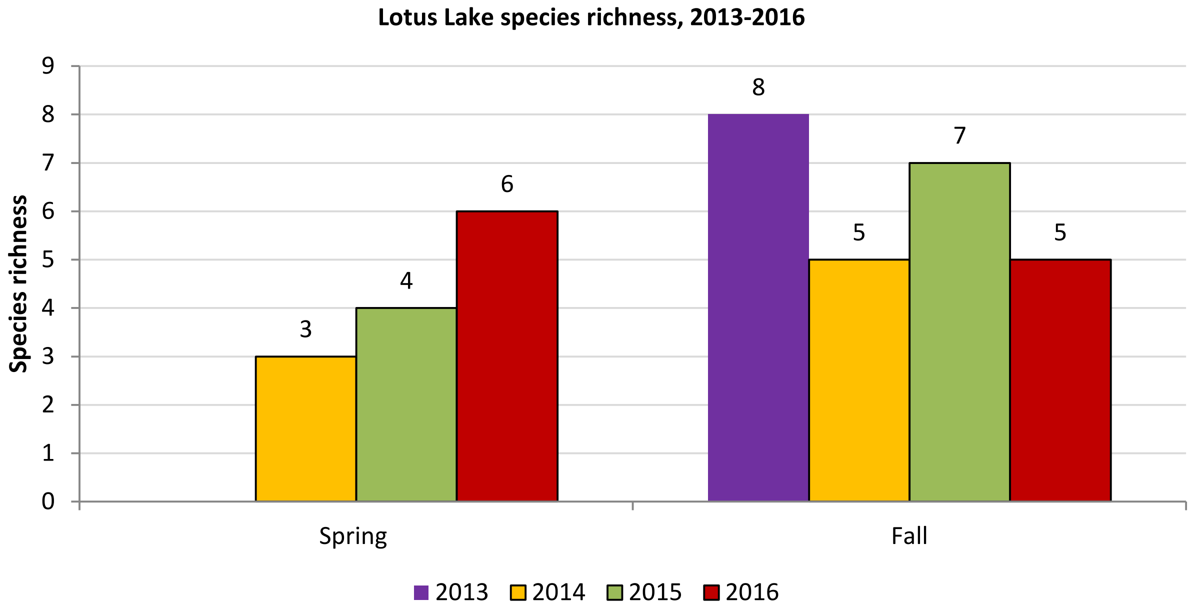
Lotus Lake sample points with vegetation (%), 2013-2016



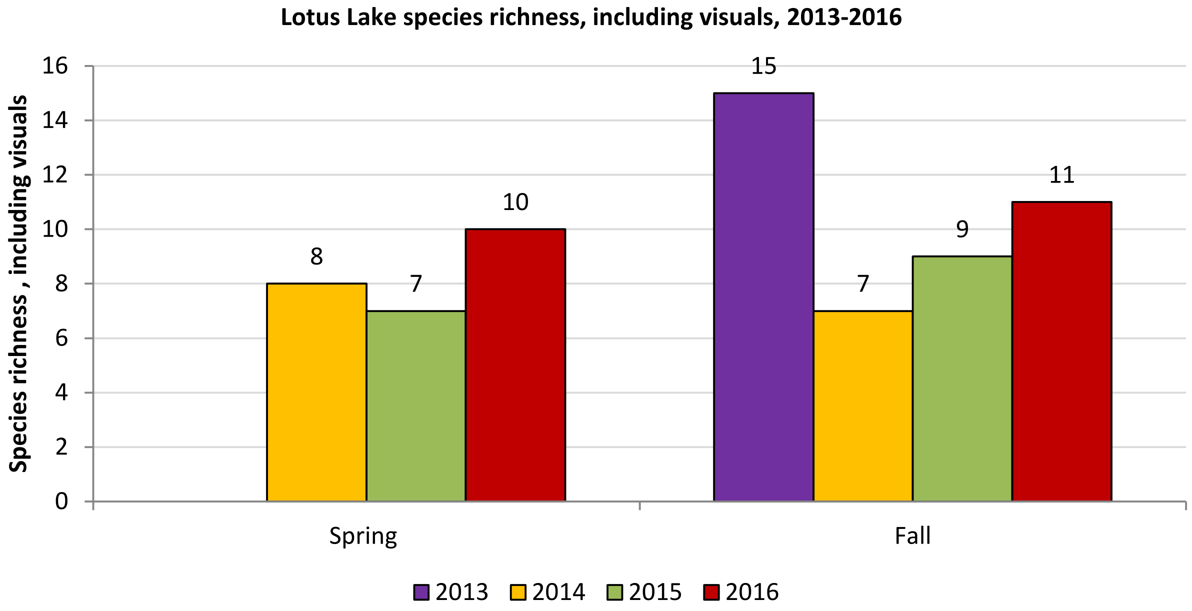
Species Richness

Species richness is a measure of the number of different individual species found in a lake. Species richness can be computed based on plants sampled or based on plants sampled/visually seen during the survey.

Very few species of plants are found in Lotus Lake. In all sampling years, species richness was greater in the fall as compared to the spring. The greatest number of species was found in the fall of 2013.



Species richness was slightly greater when including visuals, with a high of 15 species found in the fall of 2013.



Simpson's Diversity Index

Simpson's Diversity Index (D) is used to determine how diverse the plant community in a lake is by measuring the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). This value ranges from zero to one, with greater values representing more diverse plant communities. In theory, the value for Simpson's Diversity Index is the chance that two species that are sampled will be different. An Index of one means that the two plants sampled will *always* be different (very diverse) and an Index of zero means that the two plants sampled will *never* be different. Simpson's Diversity Index can be calculated by using the equation

$$D = \frac{\sum n(n-1)}{N(N-1)};$$

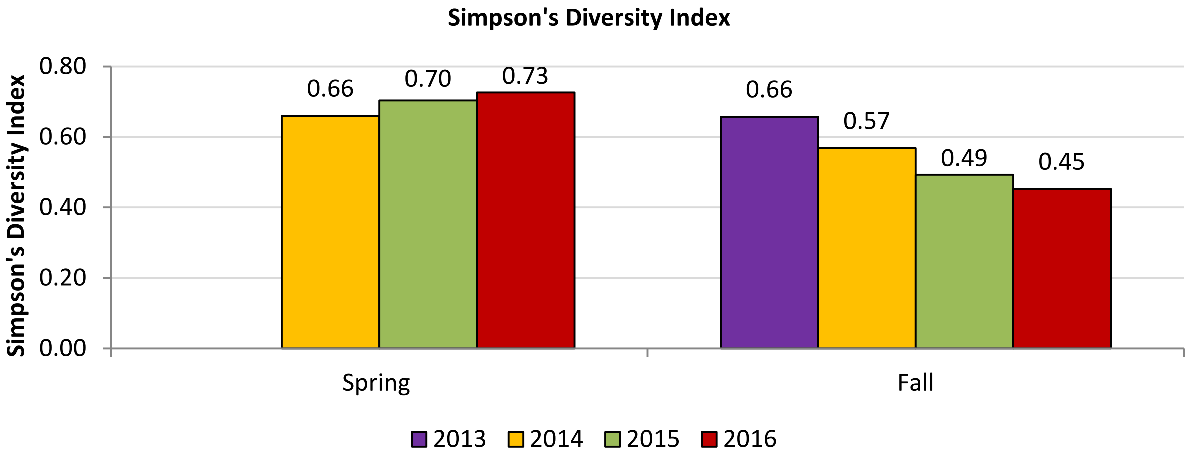
Where: D = Simpson's Diversity Index;
n= the total number of organisms of a particular species; and
N=the total number of organisms of all species.

Simpson's Diversity Index example:
If one went into a lake and found just one plant, the Simpson's Diversity Index would be "0." This is because if two plants were sampled randomly, there would be a 0% chance of them being different, since there is only one plant.

If every plant sampled were different, then the Simpson's Diversity Index would be "1." This is because if two plants were sampled randomly, there would be a 100% chance they would be different since every plant is different.

These are extreme and theoretical scenarios, but they do make the point. The greater the Simpson's Diversity Index is for a lake, the greater the diversity since it represents a greater chance of two randomly sampled plants being different.

Diversity in Lotus Lake was always greatest in the spring as compared to the fall. Spring diversity increased over the course of the study; whereas fall diversity decreased over the course of the study.



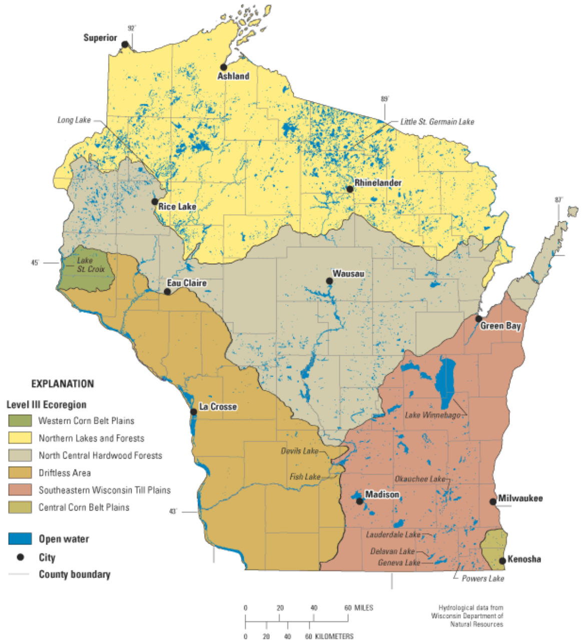
Floristic Quality Index

The Floristic Quality Index (FQI) is designed to evaluate the closeness of the flora in an area to that of an undisturbed condition. It can be used to identify natural areas, compare the quality of different sites or locations within a single lake, monitor long-term floristic trends, and monitor habitat restoration efforts. This is an important assessment in Wisconsin because of the demand by the Department of Natural Resources (DNR), local governments, and riparian landowners to consider the integrity of lake plant communities for planning, zoning, sensitive area designation, and aquatic plant management decisions.

The FQI takes into account the species of aquatic plants found and their tolerance for changing water quality and habitat modification using the equation $I = \overline{C}\sqrt{N}$

Where I is the Floristic Quality Index;
$\overline{C}$ is the average coefficient of conservation (http://www.botany.wisc.edu/wisflora/FloristicR.asp);
and $\sqrt{N}$ is the square root of the number of species.

The Index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant of change while a lower value indicates a plant is tolerant of change. Those plants with higher values are more apt to respond adversely to water quality and habitat changes. The FQI is calculated using the number of species and the average conservatism value of all species used in the Index. Therefore, a higher FQI indicates a healthier lake plant community. It should be noted that invasive species have a conservatism value of 0.



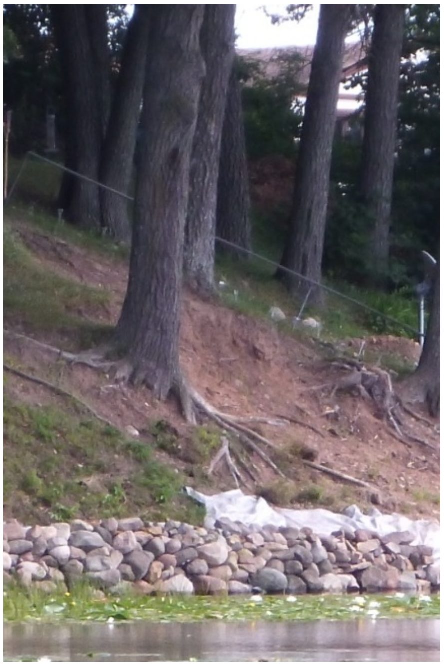
Summary of North Central Hardwood Forest values for Floristic Quality Index

Mean species richness = 14
Mean average conservatism = 5.6
Mean Floristic Quality = 20.9*

**Floristic Quality has a significant correlation with area of lake (+), alkalinity (-), conductivity (-), pH (-) and secchi depth (+). With a positive correlation, as that value rises, so will FQI. With a negative correlation, as a value rises, the FQI will decrease.*

Using data from 2013-2016, the mean species richness for Lotus Lake is 5, which is below the mean value for the North Central Hardwood Forest. The mean average conservatism value for Lotus Lake is 5, which is below the mean value for the North Central Hardwood Forest. The mean Floristic Quality value for Lotus Lake is 11 which is below the mean value for the North Central Hardwood Forest.

Land Use and Water Quality

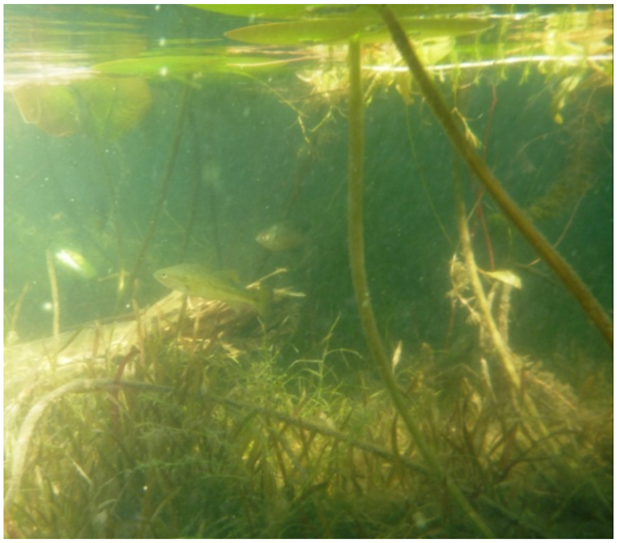


The health of water resources depends largely on the decisions that landowners make on their properties. When waterfront lots are developed, a shift from native plants and trees to impervious surfaces and lawn often occurs. Impervious surfaces are hard, man-made surfaces such as rooftops, paved driveways, and concrete patios that make it impossible for rain to infiltrate into the ground.

By making it impossible for rainwater to infiltrate into the soil, impervious surfaces increase the volume of rainwater that washes over the soil surface and runs off directly into lakes and streams. Rainwater runoff can carry pollutants such as sediment, lawn fertilizers, and car oils directly into a lake. Native vegetation can slow the speed of rainwater, giving it time to soak into the soil where it is filtered by soil microbes.

In extreme precipitation events erosion and gullies can result. The signs of erosion are unattractive and can cause decreases in property values. Sediment can also have negative impacts on aquatic life: fish eggs will die when covered with sediment and sediment influxes to a lake can decrease water clarity making it difficult for predator fish species to locate food.

Increases in impervious surfaces and lawns cause a loss of habitat for birds and other wildlife. Over ninety percent of all lake life is born, raised, and fed in the area where land and water meet. Overdeveloped shorelines remove critical habitat which species such as loons, frogs, songbirds, ducks, otters, and mink depend on. Impervious surfaces and lawns can be thought of as biological deserts which lack food and shelter for birds and wildlife. Nuisance species such as Canada geese favor lawns over taller native grasses and flowers. Lawns provide geese with a ready food source (grass) and a sense of security from predators (open views).



Additionally, fish species depend on the area where land and water meet for spawning. The removal of coarse woody habitat, or trees and braches that fall into a lake, cause decreases in fisheries habitat.

Common lawn species, such as Kentucky bluegrass, are often dependent on chemical fertilizers and require mowing. Excess chemical fertilizers are washed directly into the adjacent water during precipitation events. The phosphorus and other nutrients in fertilizers, which produce lush vegetative growth on land, are the same nutrients which fuel algae blooms and decrease water clarity in a lake. Additionally, since common lawn species have very shallow root systems, when lawns are located on steep slopes, soil capacity is reduced and the impacts of erosion can be intensified.

Avoiding establishing lawns can provide direct positive impacts on lake water quality. The creation of a buffer zone of native grasses, wildflowers, shrubs, and trees where the land meets the water can provide numerous benefits for water quality and restore valuable bird and wildlife habitat.

In Polk County, all new constructions on lakeshore properties require that a shoreland protection area be in place. A shoreland protection area is required to be 35 feet in depth as measured from the ordinary high water mark, which is defined as the point on the bank or shore up to which the water leaves a distinct mark (erosion, change in vegetation, etc.). These rules are in place largely to protect water quality and also provide benefits in terms of natural beauty, and bird and wildlife viewing opportunities. Additionally, shoreline protection areas allow for a 35 feet per 100 feet of shoreline viewing corridor which can be established as lawn.

Shoreline Inventory

The shoreline inventory was completed using methodology developed by the University of Wisconsin Stevens Point Center for Watershed Science and Education. Land and Water Resources Department, with assistance from two volunteers, completed the Shoreland Vegetation Survey and Shoreland Disturbance Survey Above and Below the Ordinary High Water Mark on September 9th, 2015.

In the Shoreland Vegetation Survey, the general shoreline condition was characterized as disturbed or undisturbed; the dominant short vegetation ground condition was determined[22]; the presence or absence of each short shoreland vegetation ground condition was characterized; and it was established if tall shoreland vegetation was present or absent.

Using the Shoreland Vegetation Survey and Shoreland Disturbance Survey Above and Below the Ordinary High Water Mark, the survey established the presence of shoreland alterations[23]; determined presence of erosion (undercut banks/slumping and furrows/gullies); documented culvert size, shape, and material; and characterized the areas below the ordinary high water mark[24].

---

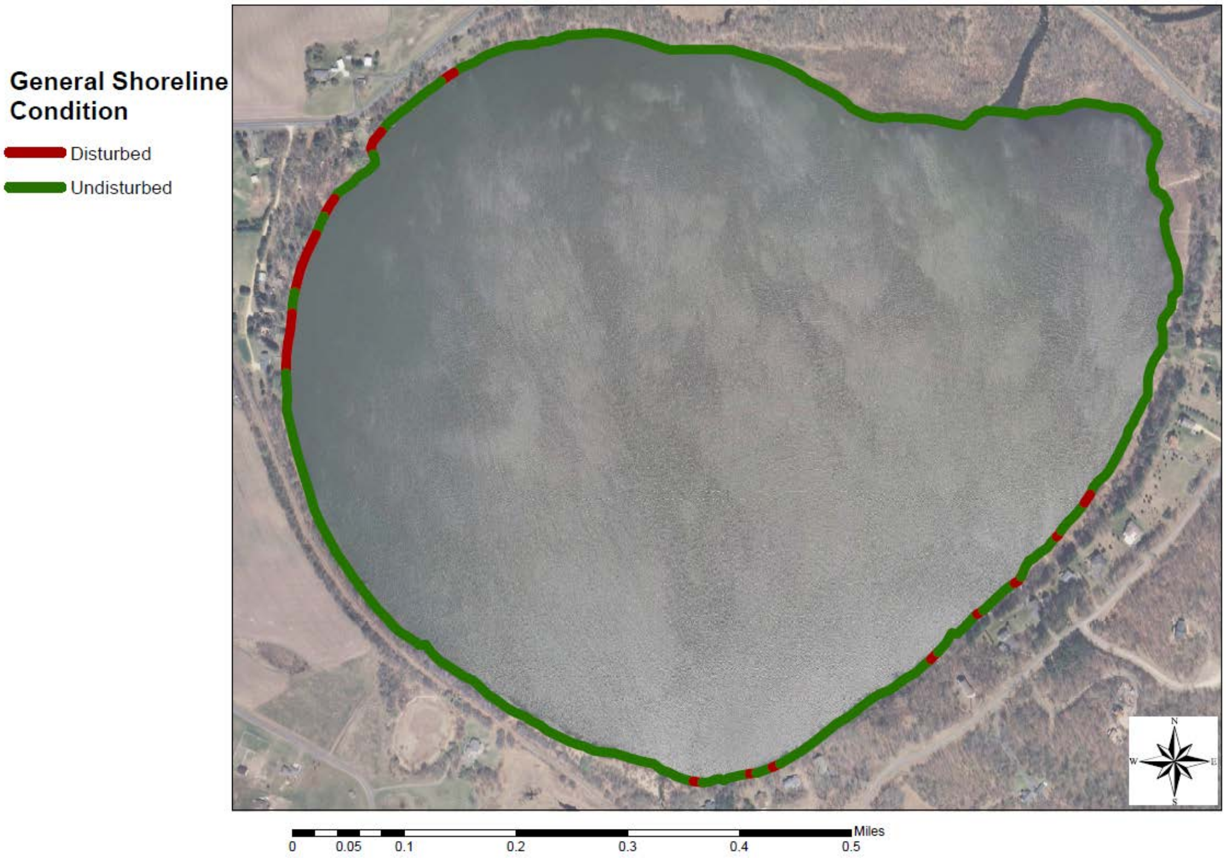
[22] Short shoreland vegetation ground conditions include: organic-leaf pack/needles, barren/bare dirt (erosion), new shoreland restoration, mowed vegetation, short un-mowed vegetation < 3 feet tall, and impervious surface

[23] Shoreland alterations include: dock/pier, seawall, rip-rap, artificial beach, boat landing, and dam/spillway

[24] The presence of the following were characterized for the area below the ordinary high water mark: cut/mowed area >30 feet wide, tilled/erosion, motor vehicle tire imprints, and woody structure

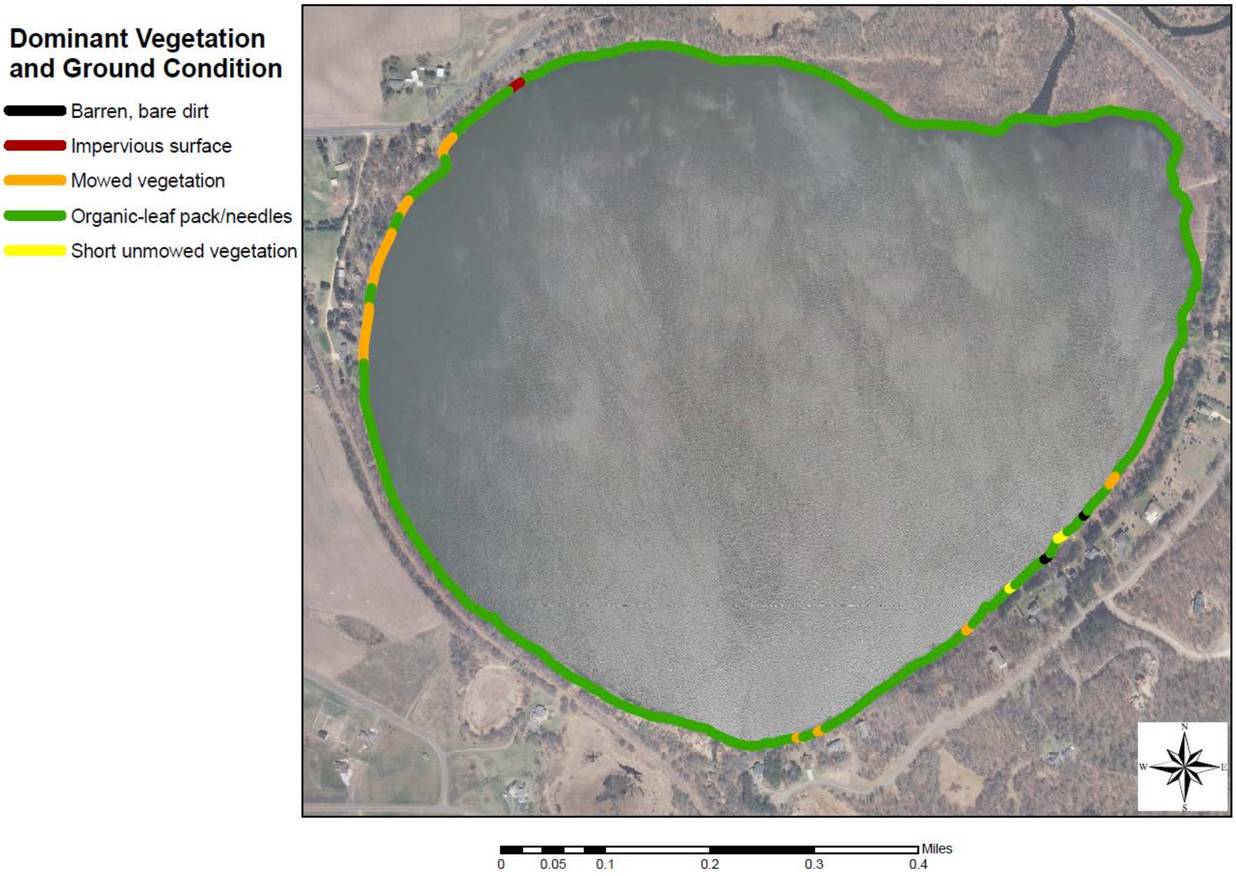
The general shoreline condition of Lotus Lake is largely undisturbed. Approximately one-tenth (11%) of the shoreline of Lotus Lake was characterized as disturbed, as compared to undisturbed (89%). Areas of disturbance exist on the north west and south east side of the lake.

Lotus Lake General Shoreline Condition Within 35 feet



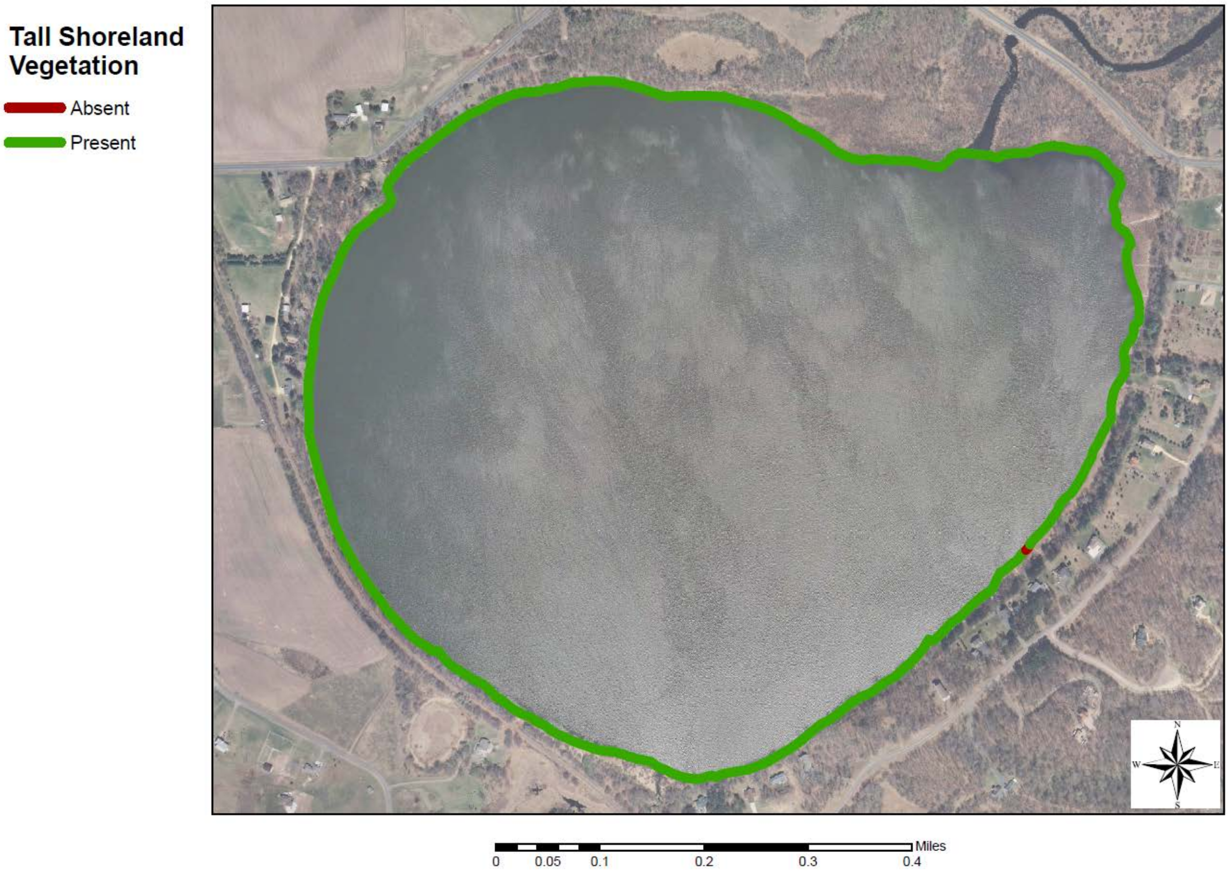
The dominant short shoreland vegetation and ground cover on Lotus Lake was organic-leaf pack/needles (90%). About one tenth of the short shoreland vegetation and ground cover was mowed vegetation (8%). The remaining ground conditions (barren/bare dirt, impervious surface, and short unmowed vegetation less than 3 feet tall) each made up less than 1% of the dominant vegetation along the shoreline of Lotus Lake.

Lotus Lake Dominant Shoreland Vegetation and Ground Conditions

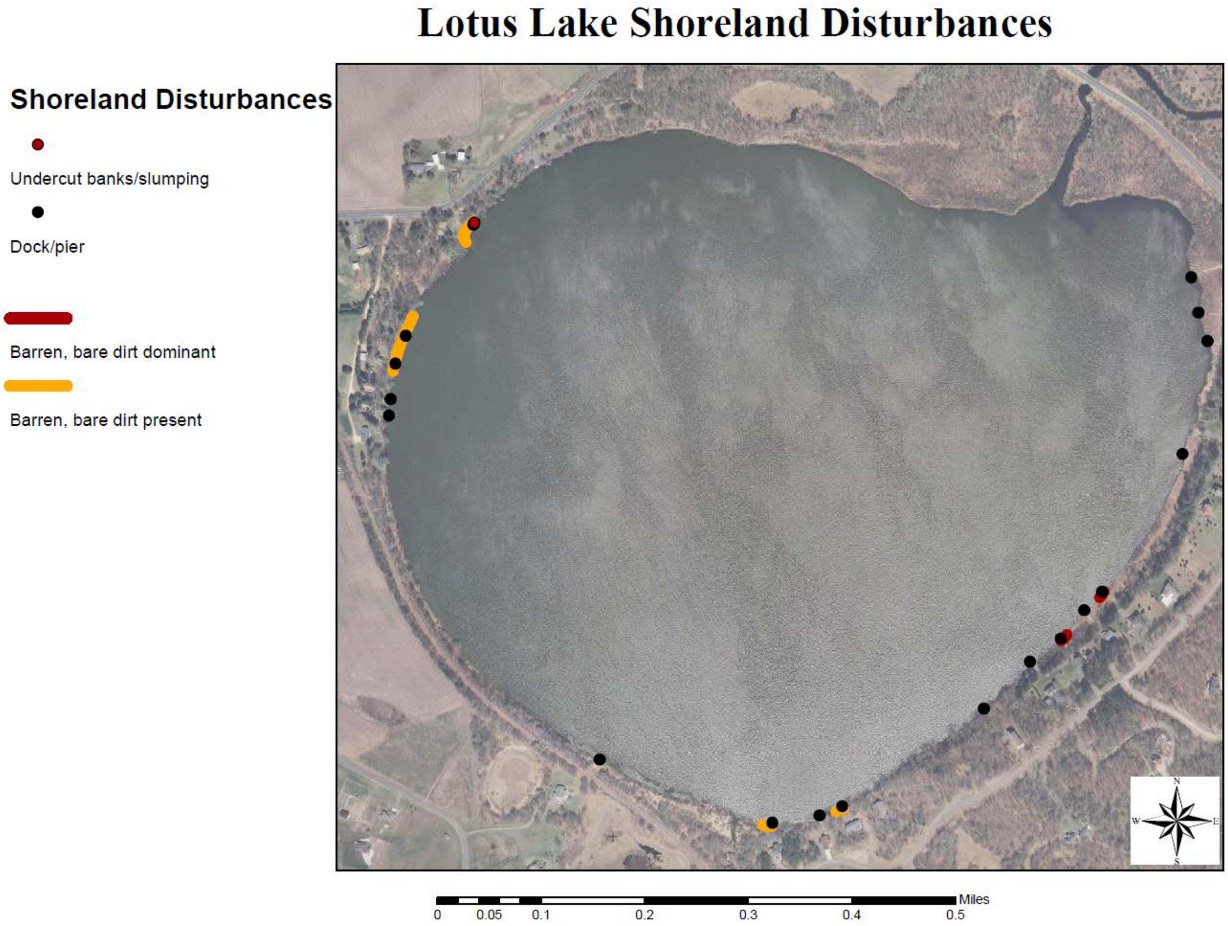


The vast majority of shoreline on Lotus Lake (99%) includes the presence of tall shoreland vegetation (trees/shrubs). An area without tall shoreland vegetation exists on the east side of the lake.

Lotus Lake Tall Shoreland Vegetation

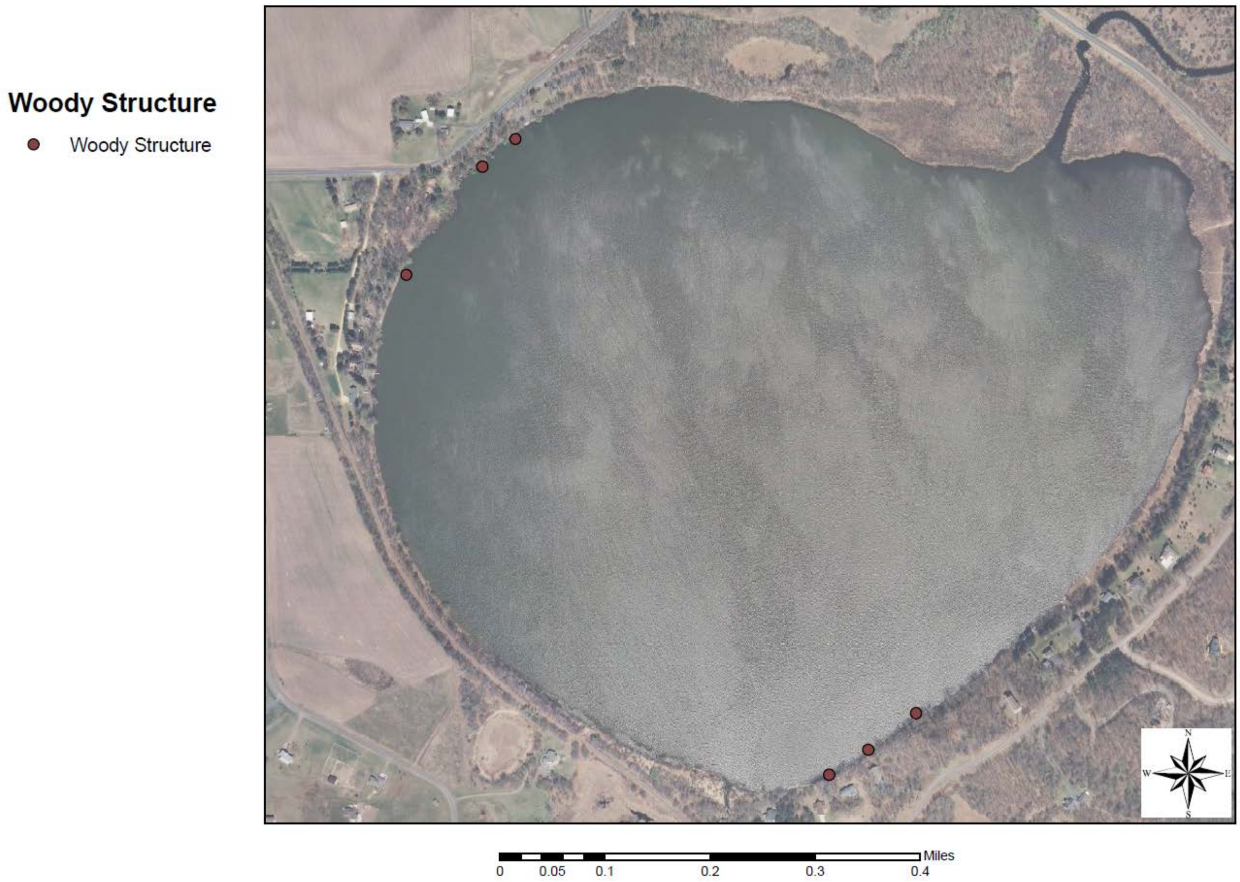


The shoreline inventory also characterized disturbances around Lotus Lake. There were a total of 18 docks/piers and 1 undercut bank. Two shoreline segments were dominated by bare dirt and four segments had bare dirt present, although it was not dominant.



There were 6 areas along the shoreline of Lotus Lake that included coarse woody structure. These areas provide important benefits for fish and wildlife. Sites including coarse woody structure occur on the northwest and south side of Lotus Lake.

Lotus Lake Woody Structure Below the Ordinary High Water Mark



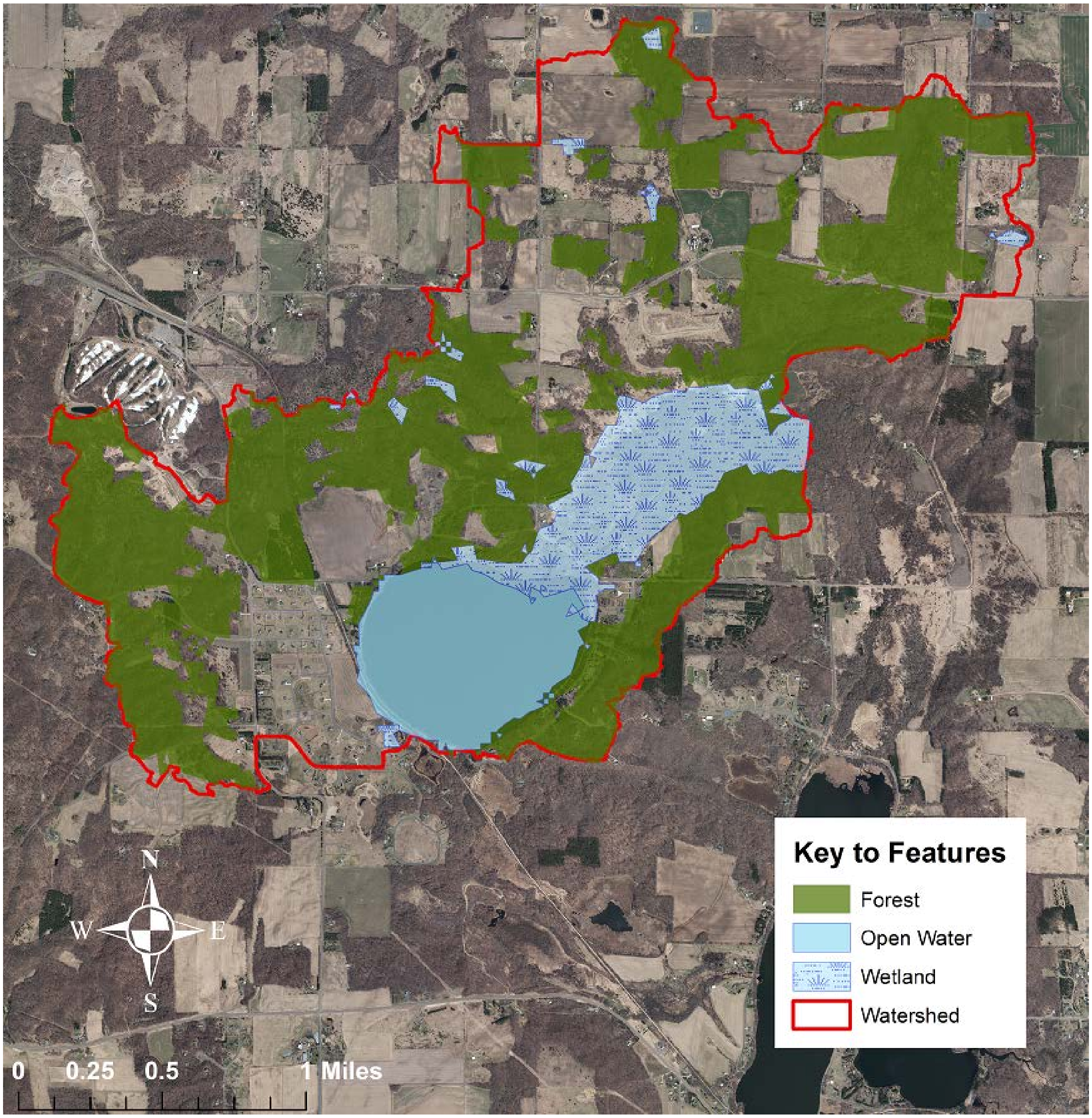
Shoreline Restoration and Rain Garden Workshop

A shoreline restoration and rain garden workshop was held for Lotus Lake stakeholders on Monday, July 11th, 2016. Only one participant attended. Topics discussed included the Healthy Lakes grant program, the importance and benefits of native plantings, site evaluation, how to install a practice, and resources for native plantings.

LWRD staff provided site visits at three properties on Friday, July 22nd, 2016. At two of the three sites visited, invasive species (buckthorn and garlic mustard) were discussed. One property had a very natural shoreline and was interested in filling in areas with additional native plants. Another property was not located on the lakeshore and was interested in rain gardens and infiltration pits to catch runoff from rooftops. The third property was interested in a rain garden and native plantings. A site visit was also completed at the Lotus Lake County Park, including the boat landing. Designs can be found in Appendix I.

Areas Providing Water Quality Benefits to Lotus Lake

Natural areas such as forests, grasslands, and wetlands allow for more infiltration of precipitation when compared with row cropped fields and developed residential sites containing lawns, rooftops, sidewalks, and driveways. This occurs because dense vegetation lessens the impact of raindrops on the soil surface, thereby reducing erosion and allowing for greater infiltration of water. Additionally, wetlands provide extensive benefits through their ability to filter nutrients and allow sediments to settle out before reaching lakes and rivers.



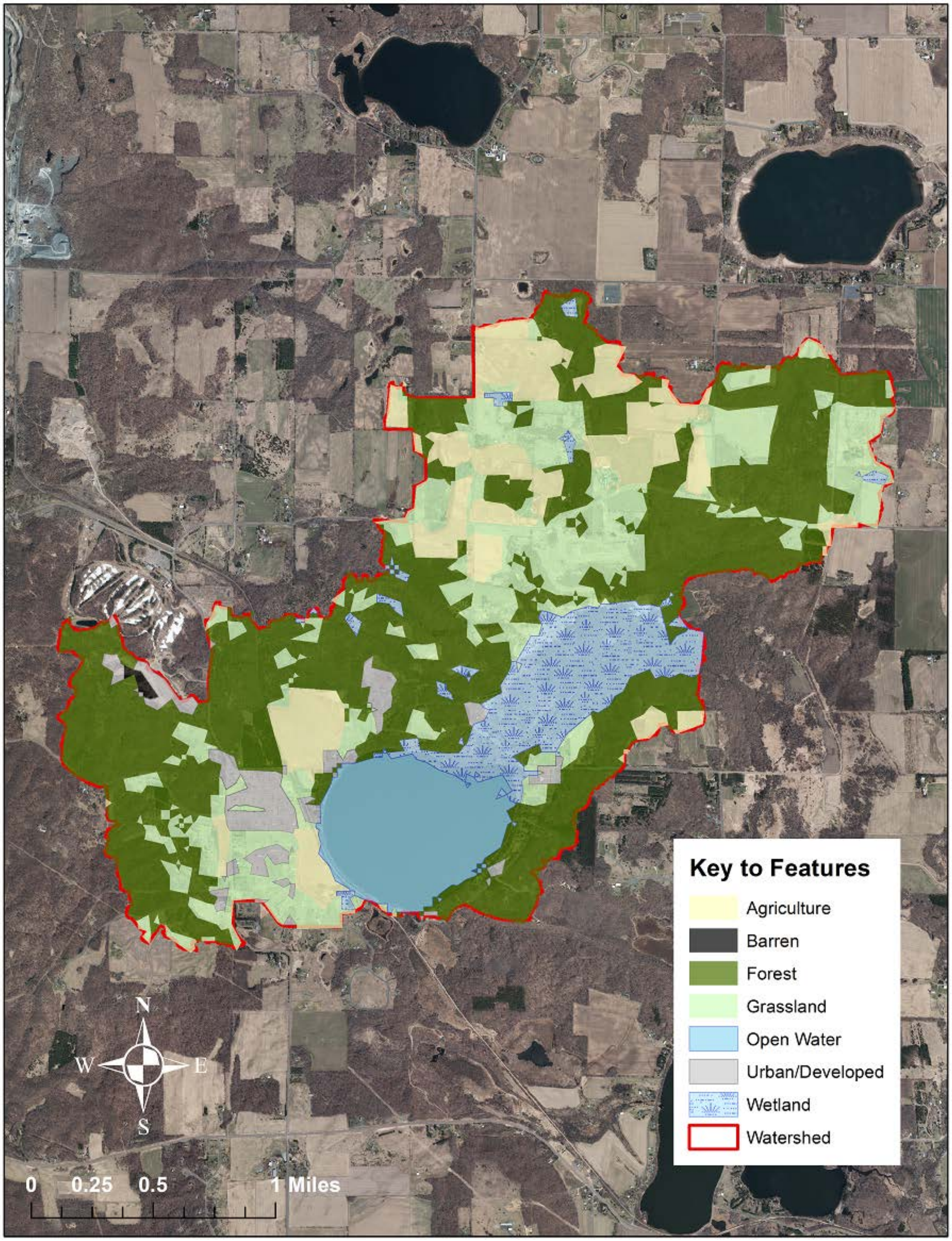
Land Use in the Lotus Lake Watershed

The area of land that drains to a lake is called a watershed. Land use in the Lotus Lake watershed was delineated using WISLAND 2 satellite derived data and aerial photos from 2014. The Wisconsin Lakes Modeling Suite (WiLMS) was used to model historic and current conditions for Lotus Lake, verify monitoring, and estimate land use nutrient loading for the watershed. Phosphorus is the key parameter in the modeling scenarios used in WiLMS because it is the limiting nutrient for algal growth in most lakes.

The most common land use in the Lotus Lake watershed is forest (44.8%), followed by pasture/grass (21%), row crop (12.7%), wetland (9.1%), and rural residential (3.9%). The largest contributor of phosphorus to Lotus Lake based on land use was row crop (44%), followed by pasture/grass (21.7%), forest (13.9%), precipitation to the lake surface (8.8%), septic (7%), wetlands (3.1%), and rural residential (1.4%).

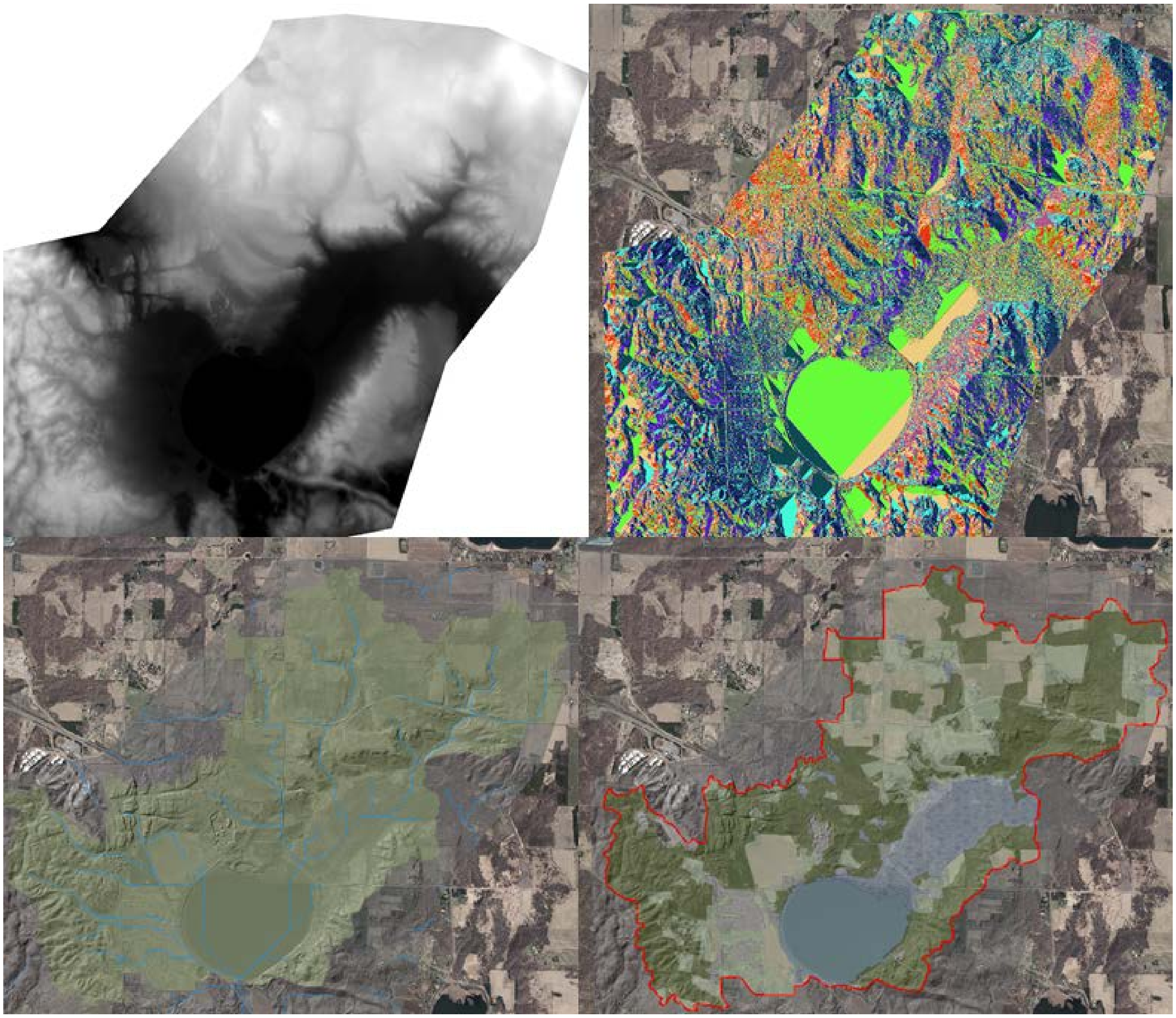
2014 Land Use and Nutrient Loading

	Total Acres	Percent Acres (%)	Total Loading (lb P/yr)	Loading %
Agriculture	371.4	12.7%	331	44.0%
Grassland	611.5	21.0%	163	21.7%
Urban/developed/barren	115.1	3.9%	11	1.4%
Wetland	265.7	9.1%	24	3.1%
Forest	1305.7	44.8%	106	13.9%
Lake surface	248	8.5%	66	8.8%
Septic			53	7%


Key to Features
Agriculture
Barren
Forest
Grassland
Open Water
Urban/Developed
Wetland
Watershed
N
W
E
S
0
0.25
0.5
1 Miles

Watershed and In-lake Modeling

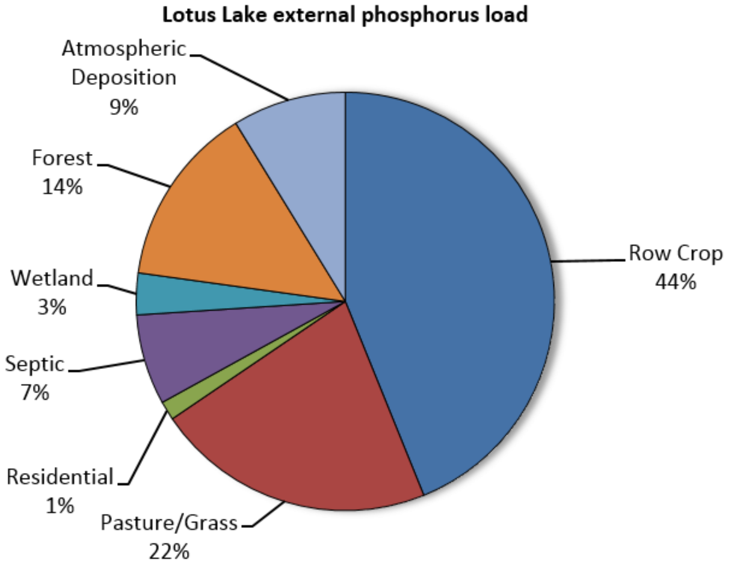
In order to delineate the watershed for Lotus Lake, the ArcGIS Spatial Analyst Toolbox was used to manipulate LiDAR data and satellite derived land cover to model the hydrological conditions and flow patterns entering Lotus Lake. The Wisconsin Lake Modeling Suite (WiLMS) was then used to model current conditions for Lotus Lake, verify monitoring, and estimate land use nutrient loading for the watershed. Phosphorus is the key parameter in the modeling scenarios used in WiLMS because it is the limiting nutrient for algal growth in most lakes.



Watershed modeling can be used to estimate the external (or land based) inputs of phosphorus to a lake and the internal (or lake based) sediment inputs of phosphorus to a lake. However, because models can only make estimates, the outputs from modeling scenarios need to be compared with actual in-lake water quality data.

Based on average evaporation, precipitation, and runoff coefficients for Polk County soils and land use, WiLMS determined the annual nonpoint source load of phosphorus to Lotus Lake under several scenarios for each year of the study and the combined three years of data. The combined data seemed to “fit” the lake condition best and WiLMS determined the annual nonpoint source load of phosphorus to Lotus Lake as 341.5 kilograms per year (752.9 lbs).

Lotus Lake external phosphorus	
Source	**Load kg/yr**
Row Crop	150
Pasture/Grass	74
Residential	5
Septic	23.89
Wetland	11
Forest	48
Atmospheric Deposition	30



The internal load for Lotus Lake was estimated using *in-situ* data. Four methods were used to estimate internal loading under different scenarios over the study period.

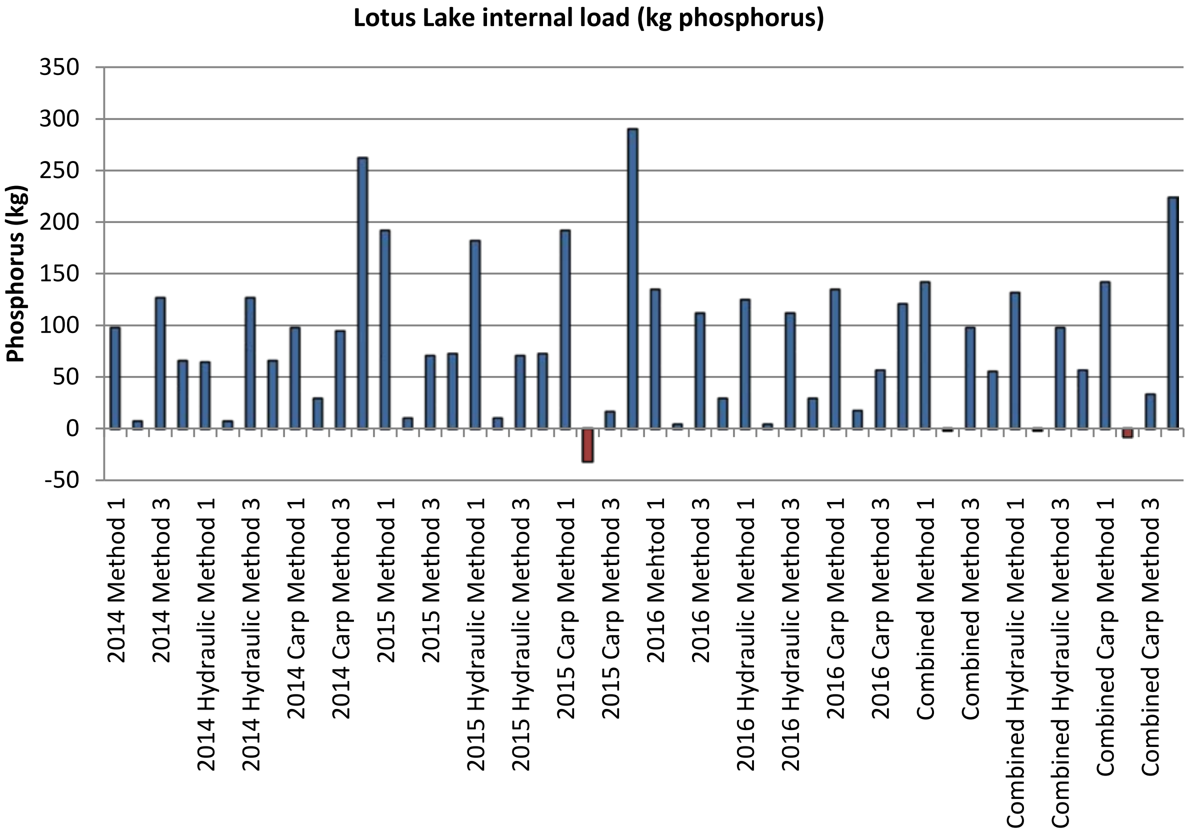
The first method was a complete total phosphorus mass budget. Using this method the internal load varied from 65 kg phosphorus per year to 192 kg phosphorus per year. The average of all scenarios was 136.5 kg phosphorus per year.

In the second method the internal load was estimated from growing season *in situ* phosphorus increases. This method predicted the internal load to be between -35 kg phosphorus per year (or burying phosphorus in the sediment) to 30 kg phosphorus per year. The average of all scenarios was 4.33 kg phosphorus per year.

The third method estimated the internal load from in situ phosphorus increases in the fall. Utilizing this method the internal load was estimated to be between 17 kg phosphorus per year to 127 kg phosphorus per year. The average of all scenarios was 84.9 kg phosphorus per year.

The fourth method used the average of the calculated phosphorus release rates (7.1 mg/m^2-day) and anoxic sediment area. Employing this method the internal load was predicted to be between 30 kg phosphorus per year to 290 kg phosphorus per year. The average of all scenarios was 112 kg phosphorus per year.

Overall the internal load is predicted to be significant and is likely a controlling factor in both the nutrient and phytoplankton dynamics of Lotus Lake. While controlling the internal load can be a difficult endeavor and cost prohibitive it is probably the most useful way to improve the water quality of Lotus Lake.



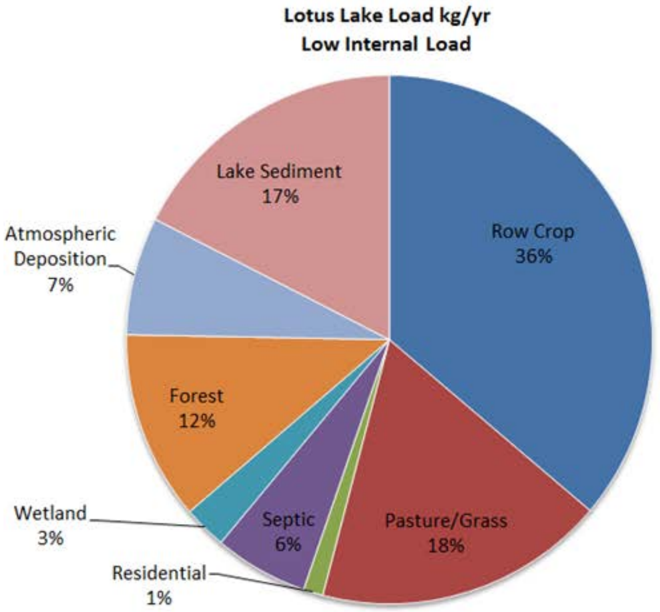
Because the internal load of phosphorus is calculated to be a significant portion of the total phosphorus entering Lotus Lake, nutrient budgets need to be recalculated. This was done using several different internal loading scenarios, and generally, the complete mass budget method of calculating the internal load. A modified version of the Nürnberg total phosphorus model is in agreement with this conclusion. The Nürnberg model is as follows:

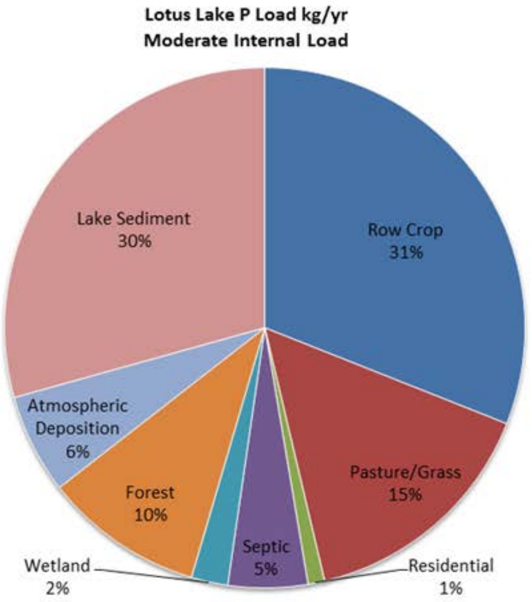
$$\mathrm{P} = \frac{\mathrm{L_{Ext}}}{\mathrm{q_s}}(1 - \mathrm{R}) + \frac{\mathrm{L_{Int}}}{\mathrm{q_s}}\text{; where}$$

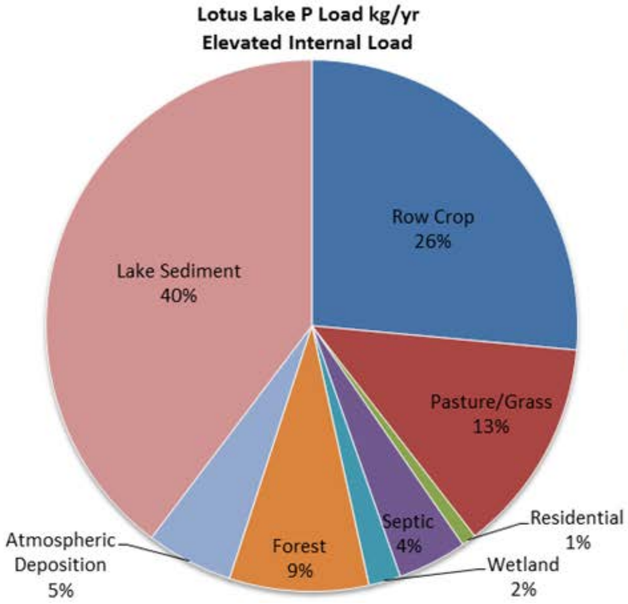
$\mathrm{R} = \frac{15}{18+\mathrm{q_s}}$,
P = the predicted mixed lake total phosphorus concentration,
L_{ext} = external loading,
L_{int} = internal loading,
qs = areal water loading or surface overflow rate, and
z = the lakes mean depth.

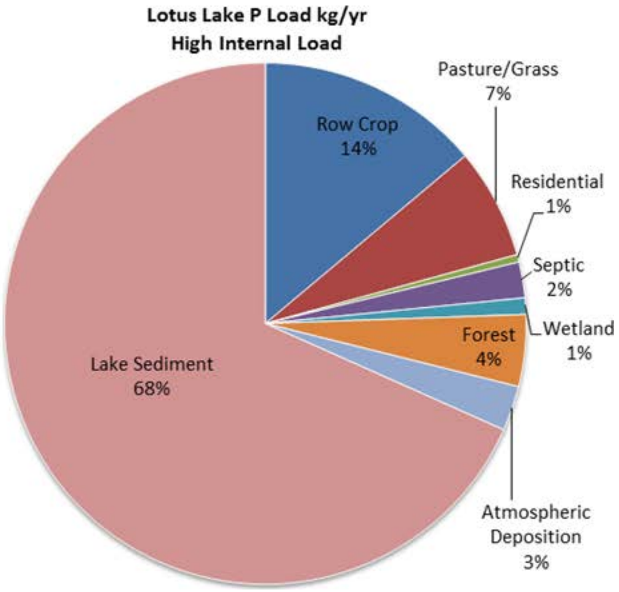
The Osgood Lake Mixing Index ($\mathrm{OI} = \mathrm{z}/\sqrt{\mathrm{km}^2}$) predicts the lake is polymictic and likely has strong sediment/water interactions.

The nutrient budget for Lotus Lake was recalculated using a low, moderate, elevated, and high internal loading scenario. Even with a low estimated internal load the sediment contributes a significant amount of phosphorus to the water column. The internal load increases with each scenario (low: 72 kg, moderate: 142 kg, elevated: 225 kg, and high: 738 kg).









The data generated from the different scenarios can be used to model the likely phosphorus content of a lakes water column.

The data was used to select the Canfield-Bachmann 1981 natural lake model:

$$P = \frac{0.8L}{\left(z(0.0569(L/z)^{0.422}\right)+p} \text{ ; where}$$

P = the predicted mixed lake total phosphorus concentration in µg/L,
L = the areal total phosphorus load in mg/m^2 of lake,
z = the lake mean depth in meters, and
p = the lake flushing rate in yr^{-1}.

This model was used to estimate the total phosphorus content of the water column under many different scenarios.

The first modeling scenario used land use phosphorus coefficients and did not take into account the calculated internal loading. In this scenario the Canfield-Bachmann model calculated the total phosphorus concentration as 110.5 µg/L; which is reasonable as the lake does regularly reach values of 100 µg/L phosphorus and above. However, there is intense interaction at the sediment water interface, especially in shallow lakes so other scenarios were computed.

In the second scenario an internal load of 47.6 mg/m^2 of lake surface area internal loading rate were applied in addition to land use phosphorus coefficients. In this scenario the model predicted the mixed lake water column phosphorus concentration to be 122.69 µg/l phosphorus. Lotus Lake experiences concentrations this high approximately 30% of the time.

The third scenario predicted the water column phosphorus concentration to be 145.97 µg/l. In this scenario an internal loading rate of 141 mg per meter squared of lake surface area was applied to the model. Lotus Lake has experienced concentrations this high at 20.5% of all sampling dates between 2005 and present day. The concentrations were never this high from 1996 (when sampling began) to 2005.

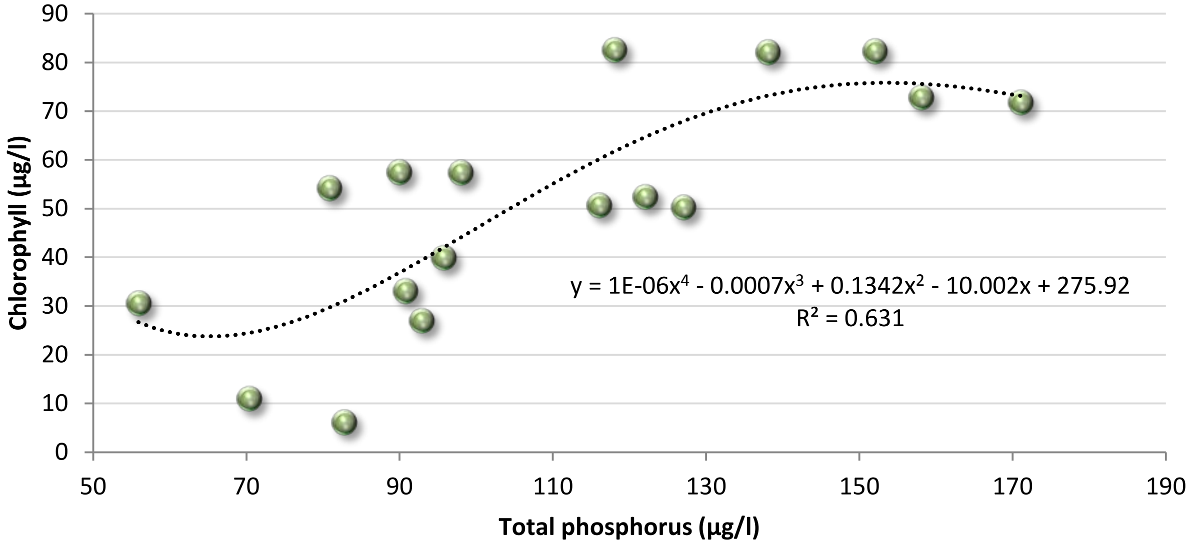
The concentration of phosphorus calculated by the model in the fourth scenario was 165.33 µg/l. In this case an internal loading rate of 223.11 mg per meter squared of lake surface area was applied. This concentration has been observed in 9.1% of sampling date on Lotus Lake.

Finally, in the fifth scenario an internal loading rate of 733.46 mg/m^2 of lake surface area was applied. In this case the Canfield-Bachmann model calculated the total phosphorus concentration to be 272.12 µg/l phosphorus which is approximately 8 µg/l phosphorus less than the highest concentration from a water sample taken from Lotus Lake July 2nd, 2007.

In reality the internal load of Lotus Lake is probably very seasonal and changes annually depending on the spring diatom maximum and nutrient recycling, carp phenology, and self-shading by cyanobacterial blooms that cause anoxia in the deeper regions of the lake near the sediment-water interface.

Chlorophyll and total primary productivity were also modeled to assess the biological response of phytoplankton based on nutrient loading relationships because pelagic chlorophyll is usually closely related to phosphorus concentrations in the water column. In Lotus Lake the water column phosphorus concentration accounts for 63.1% of the variability in the concentration of chlorophyll.

Lotus Lake chlorophyll versus total phosphorus, 2013-2016



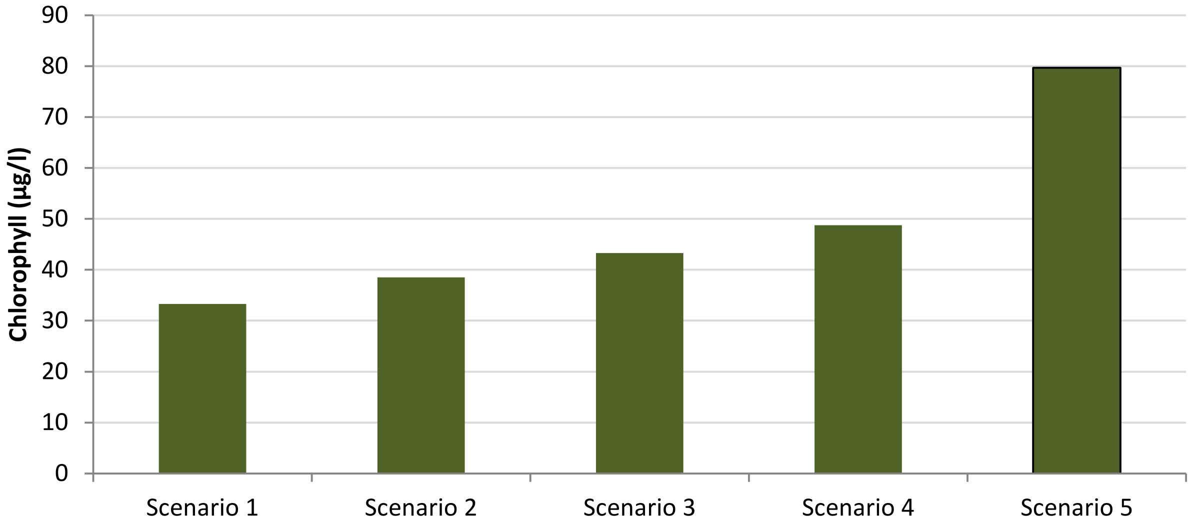
Chlorophyll *a* concentration was modeled based on the above scenarios using the equation:

$$[chl.\mathrm{a}] = \ 0.55\{[P]_i/(1+\sqrt{T_w})\}^{0.76}$$; where

$[P]_i$= incoming phosphorus to the lake, and
T_w = lake hydraulic retention time

In all but two samples the in situ chlorophyll was at or above modeled values.

Lotus Lake modeled chlorophyll

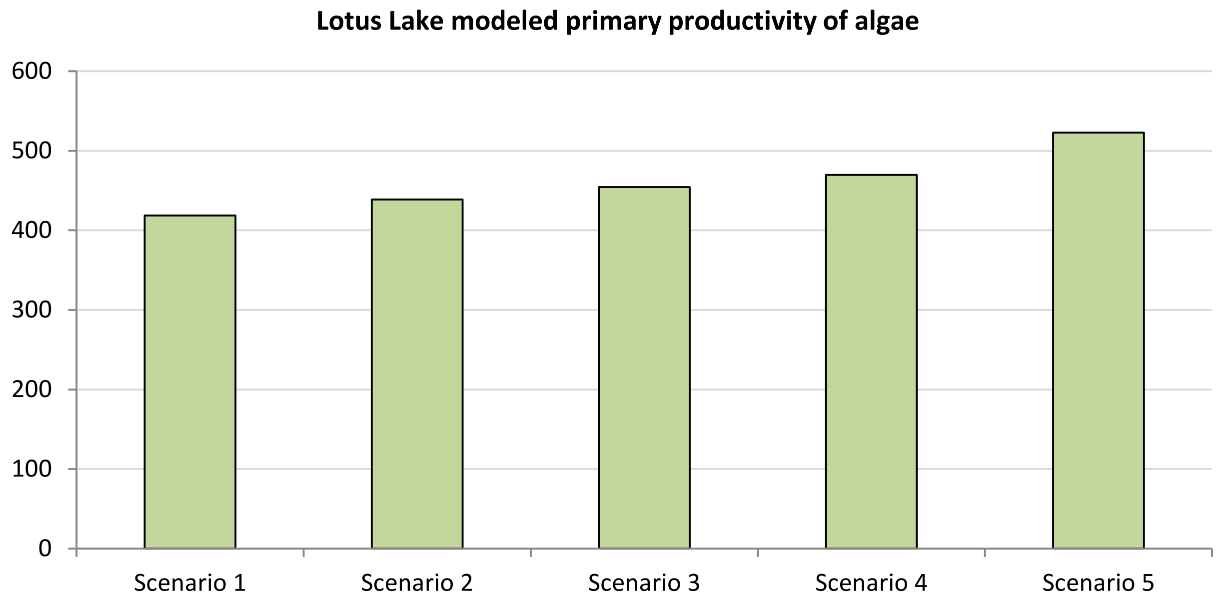


The annual rate of primary productivity of algae has also been related to the predicted phosphorus concentrations modeled for Lotus Lake. The nonlinearity of the data results from the light-reducing, self-shading effects of dense algae populations. This well-known relationship can be represented by:

$$\sum C\ (gm^{-2}yr^{-1}) = \left[\frac{\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}{0.3+0.011\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}\right]; \text{where}$$

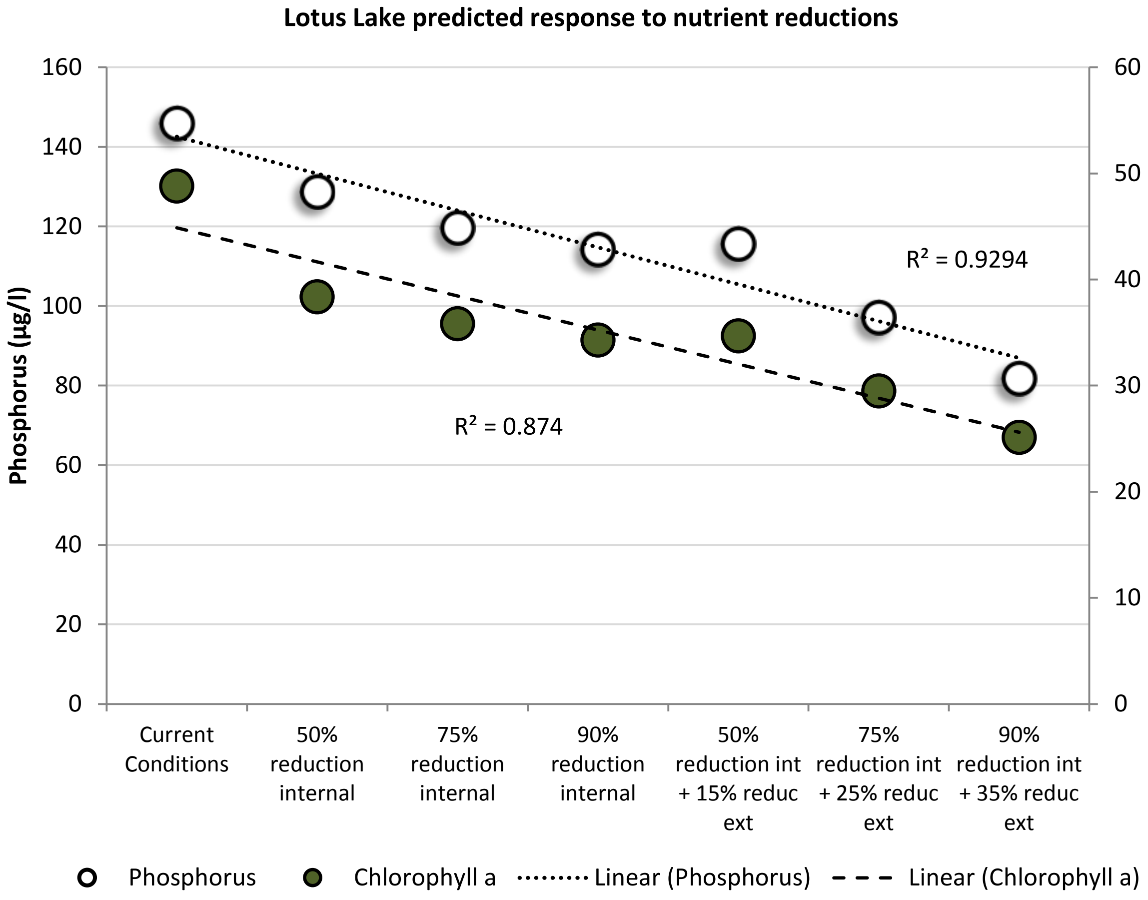
c = carbon
$[P]_i$= incoming phosphorus to the lake, and
T_w = lake hydraulic retention time

The relationship operates similarly to that of daily photosynthesis and is based on average chlorophyll concentrations and light extinction due to turbidity, dissolved organic substances, and re-suspended sediment.



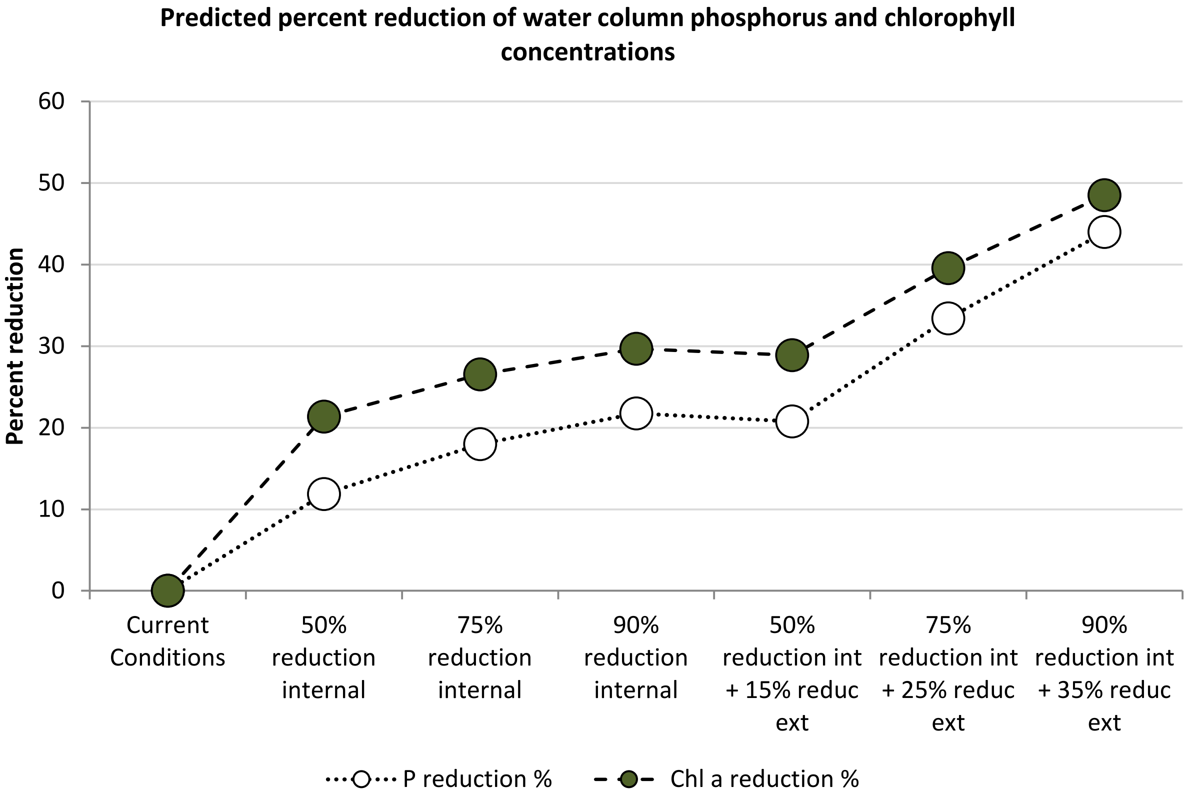
Models can be used to predict many different scenarios and can be useful to guide management decisions. The Canfield-Bachmann model was used to predict the lake response to nutrient reductions in Lotus Lake. The fourth modeling scenario (elevated internal load) was used to model the reductions as both the *in situ* phosphorus and chlorophyll samples matched most closely with the measured data during the growing season.

The lake was modeled under current conditions and a 50%, 75%, and 90% reduction in internal loading. Moreover, additional external reductions were made of 15%, 25%, and 35%. There is a very strong linear correlation in the lake's chemical and biological response with R^2 values of 0.9294 and 0.874 for phosphorus and chlorophyll respectively.



The modeling suggests that a reduction in the internal load would change the biological and chemical properties of the lakes water. Additional reductions on the land have a rather large impact on the water properties once a 25% watershed reduction is met.

When the data is plotted as a percent reduction in the concentration of phosphorus and chlorophyll, it is easy to see that even a 50% reduction of the internal load would elicit a significant response in the algal community of Lotus Lake.



Larger reductions could likely be met by removing a large biomass of common carp (*Cyprinus carpio*). Nonpoint sources can be reduced by applying best management practices to properties; and as agricultural practices change large reductions can be met.

Summary of Rules and Legislation

Comprehensive Land Use Planning

The Polk County Comprehensive Land Use Plan was adopted in 2009. The plan includes an analysis of population, economy, housing, transportation, recreation, and land use trends. It also reports the physical features of Polk County. The purpose of the land use plan is to provide general guidance to achieve the desired future development of the county and direction for development decisions. The lakes classification outlines restriction on development according to lake features.

Plan information is available online at http://www.co.polk.wi.us <Departments < Land Information < Comprehensive Plan

Town, City and Village Comprehensive Plans are available at:
http://www.co.polk.wi.us < Departments < Land Information < Comprehensive Plan < City, Village, and Town Comprehensive Plans

Smart growth is a state mandated planning requirement to guide land use decisions and facilitate communication between municipalities. Wisconsin's Comprehensive Planning Law (Statute 66.1001, Wis. Stats.) was passed as part of the 1999 Budget Act. The law requires that if a local government engages in zoning, subdivision regulations, or official mapping, those local land use regulations must be consistent with that unit of local government's comprehensive plan beginning on January 1, 2010. The law defines a comprehensive plan as having at least the following nine elements:

- ✓ Issues and opportunities
- ✓ Housing
- ✓ Transportation
- ✓ Utilities and community facilities
- ✓ Agricultural, natural, and cultural resources
- ✓ Economic development
- ✓ Intergovernmental cooperation
- ✓ Land use
- ✓ Implementation
- ✓ Polk County added "Energy and Sustainability"

Polk County Comprehensive Land Use Ordinance

On September 15th, 2015, Polk County adopted a new zoning ordinance, including the comprehensive zoning ordinance and the shoreland zoning ordinance. These rules were rewritten for several reasons, including a newly adopted comprehensive plan for the county and newly adopted changes to the State of Wisconsin's administrative rule on shorelands (NR 115). The Polk County Comprehensive Land Use Ordinance applies to the unincorporated portions of the county where the towns adopted the ordinance. The Polk County Shoreland Zoning Ordinance applies to all areas within 1000 feet of a lake, pond or flowage and within 300 feet from rivers or streams. Zoning of shorelands is required by the State of Wisconsin and covers impervious surface limits and setbacks from surface waters.

The current Comprehensive Zoning Ordinance is available at:
http://www.co.polk.wi.us < Departments < Land Information < Ordinances (Zoning)

Subdivision Ordinance

The subdivision ordinance, adopted in 1996 and updated in 2005, requires a recorded certified survey map for any parcel less than 19 acres. The ordinance requires most new plats to incorporate storm water management practices with no net increase in runoff from development.

The ordinance is available online at:
http://www.co.polk.wi.us < Departments < Land Information < Ordinances (Zoning)

Animal Waste

A policy manual established minimum standards and specifications for animal waste storage facilities, feedlots, degraded pastures, and active livestock operations greater than 300 animal units for livestock producers regulated by the ordinances. Revisions of the Polk County Manure and Water Quality Management Ordinance began in 2016. The ordinance was reviewed by Corporation Counsel and WDNR. Publication of the ordinance and a public hearing took take place in April 2017. The ordinance was brought to the Polk County Board for review in May 2017 and adoption in June 2017. Generally, the ordinance is a little less restrictive than the past ordinance. The ordinance regulates manure piles and manure storage.

The ordinance is available online at:
http://www.co.polk.wi.us < Departments < Land & Water Resources < Ordinances.

Storm Water and Erosion Control

This ordinance, passed in December 2005, establishes planning and permitting requirements for erosion control on disturbed sites greater than 3,000 square feet, where more than 400 cubic yards of material is cut or filled, or where channels are used for 300 feet more of utility installation (with some exceptions). Storm water plans and implementation of best management practices are required for subdivisions, survey plats, and roads where more than ½ acre of impervious surface will result. The Polk County Land and Water Resources Department administers the ordinance. The ordinance is a local mechanism to implement the Wisconsin Non-agricultural Runoff Performance Standards found in NR 151.

The ordinance is available online at:
http://www.co.polk.wi.us < Departments < Land & Water Resources < Ordinances.

WI Non-Agricultural Performance Standards (NR 151)

Construction Sites >1 acre – must control 80% of sediment load from sites

Storm water management plans (>1 acre)
- Total suspended solids
- Peak discharge rate
- Infiltration
- Buffers around water

Developed urban areas (>1000 persons/square mile)
- Public education
- Yard waste management
- Nutrient management
- Reduction of suspended solids

Amended Illegal Transport of Aquatic Plants and Invasive Animals

The purpose of this ordinance, passed in June 2011, is to prevent the spread of aquatic invasive species in Polk County and surrounding water bodies by prohibiting the transport of boats, trailer, personal watercraft, and equipment if aquatic invasive plants or invasive animals are attached.

The ordinance is available online at:
http://www.co.polk.wi.us < Departments < Land & Water Resources < Ordinances.

Polk County Land and Water Resources Management Plan

The Polk County Land and Water Resources Management Plan describes the strategy the Land and Water Resources Department (LWRD) will employ from 2010-2018 to address agriculture and non-agriculture runoff management, stormwater discharge, shoreline management, soil conservation, invasive species and other environmental degradation that affects the natural resources of Polk County. The plan specifies how the LWRD will implement NR 151 (Runoff Management). It involves identifying critical sites, offering cost-share and other programs, identifying best management practices, monitoring and evaluating projects for compliance, conducting enforcement activities, tracking progress, and providing information and education.

Polk County has local shoreland protection, zoning, subdivision, animal waste, and non-metallic mining ordinances. Enforcing these rules and assisting other agencies with programs are part of LWRD's ongoing activities. Other activities to implement the NR 151 Standards include implementing information and education strategies, writing nutrient management plans, providing technical assistance to landowners and lakeshore owners, performing lake studies, collaborating with other agencies, working on a rivers classification system, setting up demonstration sites of proper BMP's, controlling invasive species, and revising ordinances to offer better protection of resources.

WI Agricultural Performance Standards (NR 151)

For farmers who grow agricultural crops

- ✓ Meet tolerable soil loss (T) on cropped fields
- ✓ Starting in 2005 for high priority areas such as impaired or exceptional waters, and 2008 for all other areas, follow a nutrient management plan designed to limit entry of nutrients into waters of the state

For farmers who raise, feed, or house livestock

- ✓ No direct runoff from feedlots or stored manure into state waters
- ✓ No unlimited livestock access to waters of the state where high concentrations of animals prevent the maintenance of adequate or self-sustaining sod cover
- ✓ Starting in 2005 for high priority areas, and 2008 for all other areas, follow a nutrient management plan when applying or contracting to apply manure to limit entry of nutrients into waters of the state

For farmers who have or plan to build a manure storage structure

- ✓ Maintain a structure to prevent overflow, leakage, and structural failure
- ✓ Repair or upgrade a failing or leaking structure that poses an imminent health threat or violates groundwater standards
- ✓ Close a structure according to accepted standards
- ✓ Meet technical standards for a newly constructed or substantially-altered structure

For farmers with land in a water quality management area (defined as 300 feet from a stream, or 1,000 feet from a lake or areas susceptible to groundwater contamination)

- ✓ Do not stack manure in unconfined piles
- ✓ Divert clean water away from feedlots, manure storage areas, and barnyards located within this area

Implementation Plan Development

Lake management plans help protect natural resource systems by encouraging partnerships between concerned citizens, lakeshore residents, watershed residents, agency staff, and diverse organizations. They identify concerns of importance and set realistic goals, objectives, and action items to address each concern. Additionally, lake management plans identify roles and responsibilities for meeting each goal and provide a timeline for implementation.

Lake management plans are living documents which are under constant review and adjustment depending on the condition of a lake, available funding, level of volunteer commitments, and the needs of lake stakeholders.

The vision statement, guiding principles, and lake management plan goals presented below were created through collaborative efforts using current and past water quality data, a 2014 sociological survey regarding the needs of Lotus Lake residents, and a series of five meetings by the Lotus Lake Management Plan Committee. Key study details were presented at the annual Lotus Lake Picnic over the course of the project.

The draft plan was posted on the Polk County Land and Water Resources Department website and opened for a 30 day public comment period ending on November 20th, 2017. A notice of public comment was published in the Osceola Sun on October 11th and October 18th, 2017. One public comments was received. The plan was approved by the Lotus Lake Association Board on Friday, December 1st, 2017. The board approved the incorporation of the public comments into the plan. The specific activities that were added are bolded in the following implementation plan. The plan was approved by the Wisconsin Department of Natural Resources on March 29th, 2018.

Implementation Plan

VISION an overall statement for what you want Lotus Lake to look like

Lotus Lake is a multi-use lake that supports recreation, a viable fishery, and aquatic plants such as wild rice

GUIDING PRINCIPLE provides guidance on how the lake management plan will be implemented

Lake users and homeowners on or near Lotus Lake understand the purpose of the Lotus Lake Association, are engaged in actions to improve Lotus Lake, and are willing to participate in implementing the lake management plan

Actions to improve Lotus Lake are implemented with partner support and knowledge

An understanding of data drives lake management decisions and what is best for the resource

Communication with lake users and homeowners regarding lake management is easy to understand, concise, and frequent

Goal 1: Implement multiple integrated strategies to actively manage the carp population in Lotus Lake

A. Reduce the carp population to less than 89 pounds/acre (100 kg/hectare)
    1. Remove carp through commercial fishing **or contracted seining**
    2. Remove carp through targeted harvesting **(electrofishing/box netting)** as allowed by regulations
        i. **Electrofishing**
        ii. **Box netting**
        iii. **Carcass disposal**
    3. Organize a carp fishing tournament on Lotus Lake
    4. Consider experimental options including: species specific pathogens/viruses, poisoned corn, pheromone lure traps, water level manipulations, modified fish genes, etc.
    5. Eradicate carp with chemical piscicides such as rotenone
    6. **Build a modified seine for use in Horse and Lotus Lakes to eliminate the potential spread of invasive species (modify mesh size, roller size, density, and weight)**

B. Monitor carp locations to increase the likelihood of successful management efforts
    1. Radio tag/monitor carp to determine locations and formation of population aggregates **(10 high frequency radio tags, monitoring weekly for 12 wks/yr)**
    2. Determine spawning locations for the Lotus Lake carp population
    3. Determine movement of carp between Horse Lake, Lotus Lake, and surrounding wetlands
    4. Determine locations for the installation of carp barriers

C. Maintain reduced carp populations in Lotus Lake
    1. Install carp barriers to limit carp movement into and out of Lotus Lake **(cost for fixed grate barrier at the culverts crossing the Stowers Trail)**
    2. **PIT (passive integrated transponder) tag carp and northern pike to confirm movement observed anecdotally and through radio telemetry to dictate timing and location of barrier installation**
    3. **Install a rotating drum or vertical barrier at the Lotus Lake outlet and a fixed grate at the Horse Lake Inlet**
    4. Stock bluegill and gamefish to sustain a reduced carp population and/or replenish the Lotus Lake fishery in the case of rotenone
    5. Stock bluegill in wetlands that serve as nursery ground for spawning carp
    6. Maintain the aerator to prevent winterkill of bluegills and gamefish **(solar)**

D. Assess carp population following reduction efforts
    1. Determine number of marked fish removed from Lotus Lake to estimate population reductions **and develop a mark recapture population estimate**
    2. Determine carp population estimates if suspected carp population changes **using the electrofishing catch per unit effort**

3. Use existing population data to inform the need for future removal efforts to keep carp populations below 89 pounds/acre (100 kg/hectare)
4. **Complete late summer/early fall trap netting to confirm nursery sites on Lotus Lake, Horse Lake, and in the wetlands (3 sites with 3 net nights/site)**

E. Effectively communicate project goals and results to the broader community
    1. Use multiple methods of communication: website, Facebook, press releases, lake fair, etc.
    2. Attend local town, village, sportsman's club, lake organization, Polk County Association of Lakes and Rivers, and other community group meetings and events to share project goals and results
    3. Evaluate a carp-proof exclosure to provide a pilot demonstration of what Lotus Lake could look like without carp

Goal 2. Reduce internal and external phosphorus loading to Lotus Lake to levels where water quality improves, algae growth decreases, and recreation is possible

Lotus Lake is on the Impaired Waters List for total phosphorus and chlorophyll. Nutrient pollution will be managed to remove Lotus Lake from the Impaired Waters List. Total phosphorus will be reduced to below 40 µg/L and chlorophyll will be reduced to below 20 µg/L for at least 30% of days in the sampling season

Internal phosphorus loading

A. Implement multiple strategies to actively manage the carp population in Lotus Lake

B. Conduct a study of water aerators to determine the most effective system for Lotus Lake (efficiency, cost, placement)

C. Re-establish wild rice and additional submerged aquatic plants in Lotus Lake

D. Research the costs and benefits of installing a dam at the outlet of Lotus Lake to maintain water levels

External phosphorus loading

E. Install best management practices including: native plantings, diversion, rock infiltration, and rain gardens using the Healthy Lakes Grant program
    1. Identify a person or committee responsible for the grant application and implementation
    2. Provide information to homeowners regarding each practice and how it relates to improved water quality and decreased algae growth
    3. Identify homeowners interested in installing grant eligible best practices
    4. Include the county owned boat landing and park as a Healthy Lakes site
    5. Apply for and implement a Healthy Lakes Grant application
    6. Install WDNR signage at Healthy Lakes project sites
    7. Organize a tour of properties where successful practices have been installed

F. Support the work of the Horse Creek Farmer Led Council

G. Design new homeowner packets that highlight the impact of shoreline development on water quality

H. Participate in meetings on the proposed quarry and share concerns for Lotus Lake

I. If plant growth becomes problematic for recreation and navigation, develop an aquatic plant management plan which is mindful of the benefits of submerged aquatic plants

Goal 3. Restore the Lotus Lake ecosystem to support wildlife, fisheries, wild rice, and submerged aquatic plants

A. Implement multiple strategies to actively manage the carp populations in Lotus Lake

B. Re-establish wild rice and additional submerged aquatic plants in Lotus Lake

C. Install best management practices including: native plantings, rain gardens, and fish sticks using the Healthy Lakes Grant program
    1. For fish sticks: work with fisheries biologist to determine locations for fish sticks and other habitat improvements

D. Promote practices to restore the fishery of Lotus Lake
    1. Determine if natural reproduction of northern pike and other species of fish is occurring
    2. Stock northern pike and other species of fish if natural reproduction is not occurring
    3. Improve natural reproduction by enhancing habitat for spawning

E. Reduce populations of purple loosestrife
    1. Map purple loosestrife locations on Lotus Lake
    2. Volunteers partner with contractor to spray for purple loosestrife
    3. Determine effectiveness of contracted removal efforts
    4. Follow up herbicide treatment with volunteer removal of flowers and/or spot herbicide treatment
    5. Contact Polk County LWRD to implement a bio-control program

F. Prevent the introduction of aquatic invasive species into Lotus Lake and contain newly introduced invasive species
    1. Develop an active base of educated volunteers to participate in WDNR statewide AIS efforts: Clean Boat, Clean Waters; Landing Blitz; Drain Campaign; Bait Dealer Initiative; Citizen Lake Monitoring Network for AIS
    2. Ensure that signage at the boat landing is in place and updated as necessary
    3. Conduct professional level AIS monitoring at public boat landing and likely areas of introduction
    4. Conduct professional level whole lake point intercept plant surveys
    5. Maintain a contingency fund for rapid response to newly introduced invasive species
    6. Develop an Aquatic Invasive Species Rapid Response Plan

Goal 4. Sustain the implementation of the plan

A. Ensure that the goals of the plan are met through board delegation
    1. Review and document progress made towards plan implementation
    2. Identify actions that weren't completed and identify why they were not completed
    3. Report progress towards goals related to: carp management, water quality, and aquatic invasive species

B. Continue current data collection efforts and expand data collection efforts to evaluate progress
    1. Ensure that a volunteer is in place each year to collect phosphorus, chlorophyll, and secchi data
    2. Continue to collect beach sample for coliform bacteria
    3. Conduct spring and summer aquatic plant point intercept surveys to determine plant community recovery and expansion of American Lotus
    4. Consider collecting algae and toxin data
    5. Repeat the 2014-2016 water quality study in five to ten years
    6. Develop an aquatic plant management plan to address navigation and recreation if plant growth becomes problematic as a result of carp management
    7. Analyze the presence of lead in fish tissues
    8. Determine if the culverts for the trail impacted water levels

C. Evaluate the costs, benefits, and feasibility of forming a District

Acronyms used for partners in the following implementation table:

CON = Consultant
DU = Ducks Unlimited
HCFLWC = Horse Creek Farmer Led Watershed Council
LLA = Lotus Lake Association Board
LLAV = Lotus Lake Association Volunteers
LWRD = Polk County Land and Water Resources Department
ORGC = Osceola Rod and Gun Club
PCSC = Polk County Sportsman’s Club
SCENRD = St. Croix Environmental and Natural Resources Department
WDNR = Wisconsin Department of Natural Resources

Acronyms used for funding sources in the following implementation table:

AEPP = WDNR Aquatic Invasive Species Grant Program
BIA-CoF = Bureau of Indian Affairs - Circle of Flight Program
LPL = WDNR Lake Planning and Protection Grant Program
USFWS-TWG = U.S. Fish and Wildlife Service Tribal Wildlife Grant Program

GOAL 1. IMPLEMENT MULTIPLE INTEGRATED STRATEGIES TO ACTIVELY MANAGE THE CARP POPULATION IN LOTUS LAKE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Reduce the carp population to less than 89 pounds/acre (100 kg/hectare)	Contingent on approval			LLAB, WDNR	
Remove carp through commercial fishing ***or contracted seining***	**2018, as needed**	**$10,000/ yr**	**400**		**BIA-CoF, DU, USFWS-TWG**
Remove carp through targeted harvesting ***(electrofishing/box netting)*** *as allowed by regulations*	2018-future				
Electrofishing	**2018-future**	**$ 10,300**	**40**		**BIA-CoF, DU, USFWS-TWG**
Box netting	**2018-future**	**$ 10,533**	**288**		
Carcass disposal	**2018-future**	**$ 1,500**	**20**		
Organize a carp fishing tournament on Lotus Lake	2018			PCSC, ORGC	
Consider experimental options including: species specific pathogens/viruses, poisoned corn, pheromone lure traps, water level manipulations, modified fish genes, etc.					
Eradicate carp with chemical piscicides such as rotenone	If feasible	$$$$			
Build a modified seine for use in Horse and Lotus Lakes to eliminate the potential spread of invasive species (modify mesh size, roller size, density, and weight)	**2019**	**$ 17,000**			
Monitor carp locations to increase the likelihood of successful management efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Radio tag/monitor carp to determine locations and formation of population aggregates ***(10 high frequency radio tags, monitoring weekly for 12 wks/yr)***	**2018-future**	**$7,180**			**BIA-CoF, DU, USFWS-TWG**
Determine spawning locations for the Lotus Lake carp population	**2018-2020**	**Included above**			**BIA-CoF, DU, USFWS-TWG**
Determine movement of carp between Horse Lake, Lotus Lake, and surrounding wetlands	**2018-2020**	**$ 7,180**			**BIA-CoF, DU, USFWS-TWG**
Determine locations for the installation of carp barriers		**$ 1,500**			**BIA-CoF, DU, USFWS-TWG**
Maintain reduced carp populations in Lotus Lake	Contingent on funding			LLAB	Contingent on removal

Install carp barriers to limit carp movement into and out of Lotus Lake ***(cost for fixed grate barrier at the culverts crossing the Stowers Trail)***	**2019-2020**	**$ 4,000**		DU	
PIT (passive integrated transponder) tag carp and norther pike to confirm movement observed anecdotally and through radio telemetry to dictate timing and location of barrier installation	**2018-2019**	**$ 22,000**			
Install a rotating drum or vertical barrier at the Lotus Lake outlet and a fixed grate at the Horse Lake Inlet	**2019-2020**	**$ 11,000**			
Stock bluegill and gamefish to sustain a reduced carp population and/or replenish the Lotus Lake fishery in the case of rotenone					
Stock bluegill in wetlands that serve as nursery ground for spawning carp		$3000/yr			
Maintain the aerator to prevent winterkill of bluegills and gamefish ***(solar)***	Ongoing	**$ 14,500**	**30**	ORGC	ORGC
Assess carp population following reduction efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Determine number of marked fish removed from Lotus Lake to estimate population reductions ***and develop a mark recapture population estimate***	**2018-future**	**$ 7,665**	**16**		
Determine carp population estimates if suspected carp population ***using the electrofishing catch per unit effort***	**2018-future**	**$ 5,465**	**16**		
Use existing population data to inform the need for future removal efforts to keep carp populations below 89 pounds/acre (100 kg/hectare)	**2018-future**	**Included above**			
Complete late summer/early fall trap netting to confirm nursery sites on Lotus Lake, Horse Lake, and in the wetlands (3 sites with 3 net nights/site)	**2018-2021**	**$ 19,400**			
Effectively communicate project goals and results to the broader community					
Use multiple methods of communication: website, Facebook, press releases, lake fair, etc.	Ongoing	$100-500/yr	40/yr	LLAB	-
Attend local town, village, sportsman's club, lake organization, Polk County Association of Lakes and Rivers, and other community group meetings and events to share project goals and results	Ongoing	$25/yr PCALR membership	40/yr	LLAB	-
Evaluate a carp-proof exclosure to provide a pilot demonstration of what Lotus Lake could look like without carp	2018	**$ 5,200**			

GOAL 2. REDUCE INTERNAL AND EXTERNAL PHOSPHORUS LOADING TO LOTUS LAKE TO LEVELS WHERE WATER QUALITY IMPROVES, ALGAE GROWTH DECREASES, AND RECREATION IS POSSIBLE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
INTERNAL PHOSPHORUS LOADING					
Implement multiple strategies to actively manage the carp population in Lotus Lake	SEE GOAL 1				
Conduct a study of water aerators to determine the most effective system for Lotus Lake (efficiency, cost, placement)	Ongoing	-	20	LLAB	-
Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	Contingent on funding/ removal	**$ 12,000**		LLAB, SCENRD	
Research the costs and benefits of installing a dam at the outlet of Lotus Lake to maintain water levels	2019	-	40	LLAB	-
EXTERNAL PHOSPHORUS LOADING					
Install best management practices including: native plantings, diversion, rock infiltration, and rain gardens using the Healthy Lakes Grant program	2020	Grant: 75%, $1000/ practice	100	LLAB, LWRD	Healthy Lakes
Identify a person or committee responsible for the grant application and implementation			See above		-
Provide information to homeowners regarding each practice and how it relates to improved water quality and decreased algae growth	Ongoing				-
Identify homeowners interested in installing grant eligible best practices					
Include the county owned boat landing and park as a Healthy Lakes site					
Apply for and implement a Healthy Lakes Grant application					
Install WDNR signage at Healthy Lakes project sites					
Organize a tour of properties where successful practices have been installed					
Support the work of the Horse Creek Farmer Led Council	Ongoing	As able	-	LLAB, LWRD, HCFLWC	-
Design new homeowner packets that highlight the impact of shoreline development on water quality	2018	$100	24	LLAB, LLAC	LPL
Participate in meetings on the proposed quarry and share concerns for Lotus Lake	Ongoing	-	3 hrs/yr	LLAB	-
If plant growth becomes problematic for recreation and navigation, develop an aquatic plant management plan which is mindful of the benefits of submerged aquatic plants	If necessary		40	LLAB, LWRD, CON	LPL

GOAL 3. RESTORE THE LOTUS LAKE ECOSYSTEM TO SUPPORT WILDLIFE, FISHERIES, WILD RICE, AND SUBMERGED AQUATIC PLANTS	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Implement multiple strategies to actively manage the carp population in Lotus Lake	SEE GOAL 1				
Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	SEE GOAL 2				
Install best management practices including: native plantings, rain gardens, and fish sticks using the Healthy Lakes Grant program	SEE GOAL 2				
For fish sticks: work with fisheries biologist to determine locations for fish sticks and other habitat improvements	2020	Grant: 75%, $1000/ practice	25	LLAB	Healthy Lakes
Promote practices to restore the fishery of Lotus Lake	Contingent on carp removal			LLAB, WDNR	
Determine if natural reproduction of northern pike and other species of fish is occurring					
Stock northern pike and other species of fish if natural reproduction is not occurring					
Improve natural reproduction by enhancing habitat for spawning					
Reduce populations of purple loosestrife					
Map purple loosestrife locations on Lotus Lake	Ongoing	$200-400	8	LLAB, CON	AEPP
Volunteers partner with contractor to spray for purple loosestrife	Ongoing	$75/hr for contractor	20	CON	AEPP
Determine effectiveness of contracted removal efforts	Ongoing		2	LLAB, CON	AEPP
Follow up herbicide treatment with volunteer removal of flowers and/or spot herbicide treatment	If needed	$50 for herbicide	20	LLAB, LLAV	AEPP
Contact Polk County LWRD to implement a bio-control program	If interest	-	50	LLAB, LWRD	AEPP
Prevent the introduction of aquatic invasive species into Lotus Lake and contain newly introduced invasive species					
Develop an active base of educated volunteers to participate in WDNR statewide AIS efforts: Clean Boat, Clean Waters; Landing Blitz; Drain Campaign; Bait Dealer Initiative; Citizen Lake Monitoring Network for AIS	Ongoing	$100-500	100	LLAB, LLAV, LWRD	AEPP
Ensure that signage at the boat landing is in place and updated as necessary	Ongoing	-	1	LLAB	-
Conduct professional level AIS monitoring at public boat landing and likely areas of introduction	Yearly	$200-400	-	LWRD/CON	LPL/AEPP
Conduct professional level whole lake point intercept plant surveys	Yearly	$800-1,600	-	LWRD/CON	LPL/AEPP
Maintain a contingency fund for rapid response to newly introduced invasive species	2018	If funds available	-	LLAB	-
Develop an Aquatic Invasive Species Rapid Response Plan	2018	-	10	LLAB, LWRD	-

GOAL 4. SUSTAIN THE IMPLEMENTATION OF THE PLAN	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Ensure that the goals of the plan are met through board delegation					
Review and document progress made towards plan implementation	Ongoing	-	10	LLAB	-
Identify actions that weren't completed and identify why they were not completed	Ongoing	-	10	LLAB	-
Report progress towards goals related to: carp management, water quality, and aquatic invasive species	Ongoing	-	10	LLAB	-
Continue current data collection efforts and expand data collection efforts to evaluate progress					
Ensure that a volunteer is in place each year to collect phosphorus, chlorophyll, and secchi data	Contingent on carp removal	$50-60/sample + S&H	10	LLAB, LLAV	LPL
Continue to collect beach sample for coliform bacteria	Yearly	$200	20	LLAB, LWRD	-
Conduct spring and summer aquatic plant point intercept surveys to determine plant community recovery and expansion of American Lotus	As needed	$800-1,600	-	LWRD	LPL
Consider collecting algae and toxin data	As needed	Algae: $65/ sample, toxin: ~$400 + S&H			
Repeat the 2014-2016 water quality study in five to ten years	2019-2024	$25,000		LLAB, LWRD, CON	LPL
Develop an aquatic plant management plan to address navigation and recreation if plant growth becomes problematic as a result of carp management	If needed			LLAB, LWRD, CON	LPL
Analyze the presence of lead in fish tissues	If needed			LWRD, CON	LPL
Determine if the culverts for the trail impacted water levels	2018		10	LLAB	LPL
Evaluate the costs, benefits, and feasibility of forming a District		-	80	LLAB	-

Appendix A

Lake Resident Survey

Lotus Lake Resident Survey, 2014

The following survey is a component of the Lotus Lake Planning grant. The Lotus Lake Association, Polk County Land and Water Resources Department, Polk County Parks Department, Wisconsin Department of Natural Resources, and St. Croix Tribal Environmental Department have partnered to gather data about Lotus Lake in 2014-2016. The ultimate goal of the study is to identify ways to improve water quality on Lotus Lake. Your responses are very important and will help guide the future management of Lotus Lake and its watershed.

The survey should take approximately 5-10 minutes to complete. Responses will remain confidential. Feel free to contact the Polk County Land and Water Resources Department with any questions at 715-485-8699. Surveys should be returned by July 1st to:

LWRD
100 Polk County Plaza- Suite 120
Balsam Lake, WI 54810

____

1. How many years have you owned property on or near Lotus Lake? Note: If you own more than one property, please answer all questions for the property you have owned the longest.
   ______________years

2. Which of the following best describes how you use your property?
   ___Year-round residence
   ___Seasonal residence (continued occupancy for months at a time)
   ___Weekend, vacation, and/or holiday residence
   ___Rental property
   ___Other, please specify______________

3. How many days in a typical year is your property used by you or others? Just provide your best estimate.
   ______________days per year

4. On the average day that your property is occupied, how many people occupy the property?
   ______________people

5. Is the property you own on the shoreline of Lotus Lake?
   ___No, please skip to question 7 ___Yes

6. Which of the following describe the first 35 feet of your shoreline (the area located directly adjacent to the lake)? If you don't own shoreline property, please skip this question. Please check all that apply.
   ___Mowed lawn
   ___Un-mowed vegetation
   ___Shrubs/trees
   ___Undisturbed woods
   ___Stabilizing rock/rip rap
   ___Pier/dock
   ___Buffer zone/shoreline restoration
   ___Rain garden
   ___Other, please describe__________

7. What activities do you enjoy on Lotus Lake? Please check all that apply.

___Swimming
___Peace and tranquility
___Scenic view
___Jet skiing/wakeboarding/waterskiing
___Non-motorized boating (canoe/kayak)
___Motorized boating
___Sailing or wind surfing
___Hunting/trapping
___Observing birds/wildlife
___Open water fishing
___Ice fishing
___Snowmobiling
___Cross country skiing/snowshoeing
___Other, please list______________

8. How many days a month do you use the <u>Lotus County Park</u> during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the park, write zero.

Use Lotus County Park _________days a month during the **open water season**
Use Lotus County Park _________days a month during the **ice on season**

9. How many days a month do you use the <u>Lotus Lake boat landing</u> during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the boat landing, write zero.

Use Lotus Lake boat landing _________ days a month during the **open water season**
Use Lotus Lake boat landing _________ days a month during the **ice on season**

10. How many days a month do you use the <u>Stower Seven Lake Trail</u> during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the trail, write zero.

Use Stower Seven Lake Trail _________ days a month during the **open water season**
Use Stower Seven Lake Trail _________ days a month during the **ice on season**

11. Which of the following watercraft are kept on your property for use on Lotus Lake? Please check all that apply.

___Jet skis
___Motorboats/pontoons (1-20 HP)
___Motorboats/pontoons (21-50 HP)
___Motorboats/pontoons (more than 50 HP)
___Canoes/kayaks
___Paddleboats/rowboats
___Sailboat
___No watercrafts are kept at my property, skip to question 13

12. Are the watercrafts that you use on Lotus Lake used on other waterbodies?

___Yes ___No

13. What is your degree of concern with each issue listed below? If you feel the issue doesn't exist on Lotus Lake check the first column; if you feel the issue exists but is not a concern check the second column; and if the issue concerns you rank your concern as low, medium, or high.

	Issue doesn't exist	Exists, but not a concern	Low concern	Medium concern	High concern
New invasive species entering the lake					
Presence of common carp in the lake					
Excessive aquatic plant growth					
Excessive algae blooms					
Lack of water clarity or quality					
Loss of natural scenery/beauty					
Excessive noise level on the lake					
Decreased wildlife populations					
Decreased fisheries					
Unsafe use of motorized watercraft					
Disregard for slow-no-wake zones					
Decreased property values					
Increased development					
Increased nutrient pollution					
Decrease in overall lake health					

14. How would you describe the current lake level of Lotus Lake?

___Too high ___Just right ___Too Low ___Unsure

15. How would you describe the current water quality of Lotus Lake?

___Poor
___Fair
___Good
___Excellent
___Unsure

16. How has the water quality changed in Lotus Lake in the time you've lived on/near the lake?

___Severely degraded
___Somewhat degraded
___Remained unchanged
___Somewhat improved
___Greatly improved
___Unsure
___ I haven't been on the lake long enough to notice a change

17. Which month(s) of the open water season do you consider <u>algae growth</u> (not including plants) to be a problem on Lotus Lake. Please check all that apply.

___May
___June
___July
___August
___September
___October
___Unsure
___Algae growth is never a problem, **please skip to question 19**

18. Please indicate which of the following uses you believe are impaired by algae (not including plants) on Lotus Lake. If you are unsure, please check the last column.

	Yes	No	Unsure
Swimming			
Fishing			
Boating			
Navigation			
Dogs/animals using the water			
Overall enjoyment of the lake			

19. Overall, how would you describe the amount of aquatic plants (not including algae) in Lotus Lake?

___Too few plants ___Healthy amount of plants ___Too many plants

20. Which month(s) of the open water season do you consider aquatic plant growth (not including algae) to be a problem in Lotus Lake? Please check all that apply.

___May
___June
___July
___August
___September
___October
___Unsure
___Aquatic plants are never a problem, **please skip to question 22**

21. Please indicate which of the following uses you believe are limited by aquatic plants (not including algae) on Lotus Lake. If you are unsure, please check the last column.

	Yes	No	Unsure
Swimming			
Fishing			
Boating			
Navigation			
Overall enjoyment of the lake			

22. How would you describe the current amount of mowed lawn across the entire shoreline of Lotus Lake?

___Too much
___Just right
___Not enough
___Unsure

23. What impact, if any, do you believe landowner landscaping practices such as shoreline buffers, rain gardens, and native plants have on the water quality of Lotus Lake?

___Positive impact, but only if all property owners participate
___Positive impact, regardless of how many property owners participate
___Negative impact, please describe________________________________
___No impact

24. How would you describe the use of fertilizer on your property?
___I don't use any fertilizer on my property
___I use zero phosphorus fertilizer on my property
___I use fertilizer on my property but I'm unsure of its phosphorus content
___I use fertilizer on my property that contains phosphorus
___I use multiple types of fertilizers on my property that contain varying amounts of phosphorus

25. Please indicate which of the following actions should be completed by the Lotus Lake Association to manage Lotus Lake. Most activities are eligible for grant funding.

	Yes	No	Unsure
Offering incentives for property owners to install shoreline buffers and rain gardens			
Offering incentives for property owners to install farmland conservation practices			
Lake fairs and workshops to share information			
Enforcement of slow-no-wake zones			
Practices to enhance fisheries			
Offering incentives for property owners to upgrade non-conforming septic systems			
Programs to prevent and monitor invasive species			

26. Carp dislodge aquatic vegetation while searching for food which leads to decreased water clarity. The removal of carp from Lotus Lake could result in increased aquatic plant growth (possibly to nuisance levels) in Lotus Lake. Would you support or oppose the removal of carp from Lotus Lake?
___Definitely support
___Probably support
___Probably oppose
___Definitely oppose
___Unsure, I need more information

27. Are you currently a member of the Lotus Lake Association?
___Yes ___No ___I was unaware that the Association existed

28. The Lotus Lake Association has completed the following activities to benefit the lake. From the list below, please check the activities that you were aware of.
___Monthly beach sampling for fecal coliform bacteria during the summer months
___Roadside clean-ups
___Invasive species (purple loosestrife) removal projects
___Invasive species education projects (example: Landing Blitz, sign installation, etc.)
___Not aware of any activities above

29. How do you prefer to receive information from the Lotus Lake Association? Please check all that apply.
___Newsletter
___Email
___Website
___Facebook
___Annual Meeting
___Prefer not to receive information
___Other, please specify___________

30. From the list below, which activities might you be interested in participating to improve Lotus Lake? Responses will be considered as a measure of interest rather than a commitment.
    ___Learning to identify aquatic invasive species
    ___Learning how to monitor for aquatic invasive species
    ___Learning how to monitor water quality
    ___Serving on a committee to develop an action plan for improving Lotus Lake
    ___Installing a shoreline buffer on your property
    ___Installing a rain garden on your property
    ___None of the above
    ___Some other activity, please describe____

If you're interested in participating in any of the above activities and would like more information, please list your contact information below. This information will be kept separate from your responses to ensure confidentiality.

____

If you have any comments you would like to make, please use the space below.
Thank you for your time and your answers!

If you'd like to become a member of the Lotus Lake Association, please fill out the membership form below and enclose a check with the survey.

Lotus Lake Association

You are not going to want to miss the opportunity to hear more about our upcoming exciting events so, if you haven't done so already, please send your annual dues of $10 payble to Lotus Lake Association to Deb Goodman, Treasurer, 857 207th Street, Dresser, WI 54009. The dues are due by August 31 for the 2014 fiscal year. *(Please print)*

Name____ Phone____________________
First Last

Address______________________________________ Email____________________
Street or P.O. Box City State Zip

Please provide your email address if you would like to receive updates about Lotus Lake via email.

Thanks for your support!

The purpose of the Association is to preserve and protect Lotus Lake and its surroundings and to enhance the water quality, fishery and aesthetic values of Lotus Lake, as a public recreational facility for today and for future generations.

2014 Lotus Lake Resident Survey Summary

Surveys mailed: 224
Surveys returned: 90
Response Rate: 40%

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1. How many years have you owned property on or near Lotus Lake? Note: If you own more than one property, please answer all questions for the property you have owned the longest.
   88 respondents, 98%
   Average: 14 years

2. Which of the following best describes how you use your property?
   87 respondents, 97%

   Year-round residence **73 respondents, 87%**
   Seasonal residence (continued occupancy for months at a time) **4 respondents, 5%**
   Weekend, vacation, and/or holiday residence **3 respondents, 3%**
   Rental property **2 respondents, 2%**
   Other, please specify **5 respondents, 6%**
      Lot number 4
      I own a 17 lot development, 1 lot has been sold
      Vacant Land
      Hunting land
      Lot

3. How many days in a typical year is your property used by you or others? Just provide your best estimate.
   87 respondents, 97%
   Average 289 days per year

4. On the average day that your property is occupied, how many people occupy the property?
   90 respondents, 100%
   Average 3 people

5. Is the property you own on the shoreline of Lotus Lake?
   90 respondents, 100%

   No **75 respondents, 83%**
   Yes **15 respondents, 17%**

6. Which of the following describe the first 35 feet of your shoreline (the area located directly adjacent to the lake)? If you don't own shoreline property, please skip this question. Please check all that apply.

15 respondents, 17%

Mowed lawn	**3 respondents, 20%**
Un-mowed vegetation	**10 respondents, 67%**
Shrubs/trees	**7 respondents, 47%**
Undisturbed woods	**9 respondents, 60%**
Stabilizing rock/rip rap	**1 respondent, 7%**
Pier/dock	**7 respondents, 47%**
Buffer zone/shoreline restoration	**0 respondents, 0%**
Rain garden	**0 respondents, 0%**
Other, please describe	**0 respondents, 0%**

7. What activities do you enjoy on Lotus Lake? Please check all that apply.
84 respondents, 93%

Swimming	**13 respondents, 15%**
Peace and tranquility	**43 respondents, 51%**
Scenic view	**60 respondents, 71%**
Jet skiing/wakeboarding/waterskiing	**6 respondents, 7%**
Non-motorized boating (canoe/kayak)	**21 respondents, 25%**
Motorized boating	**12 respondents, 14%**
Sailing or wind surfing	**0 respondents, 0%**
Hunting/trapping	**9 respondents, 11%**
Observing birds/wildlife	**30 respondents, 36%**
Open water fishing	**21 respondents, 25 %**
Ice fishing	**8 respondents, 10%**
Snowmobiling	**8 respondents, 10%**
Cross country skiing/snowshoeing	**8 respondents, 10%**
Other, please list	**11 respondents, 13%**

None - 6
Walking trail
Park/playground
Picnic
Dog swims
Don't use

8. How many days a month do you use the Lotus County Park during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the park, write zero.
   87 respondents, 97%

   Use Lotus County Park **2.3** days a month during the **open water season**
   Use Lotus County Park **.7** days a month during the **ice on season**

9. How many days a month do you use the Lotus Lake boat landing during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the boat landing, write zero.
   87 respondents, 97%

   Use Lotus Lake boat landing **1.2** days a month during the **open water season**
   Use Lotus Lake boat landing **.4** days a month during the **ice on season**

10. How many days a month do you use the Stower Seven Lake Trail during the **open water season** and during the **ice on season**. Just provide your best estimate. If you never use the trail, write zero.
    87 respondents, 97%

    Use Stower Seven Lake Trail **4.0** days a month during the **open water season**
    Use Stower Seven Lake Trail **1.2** days a month during the **ice on season**

11. Which of the following watercraft are kept on your property for use on Lotus Lake? Please check all that apply.
    79 respondents, 88%

Jet skis	**4 respondents, 5%**
Motorboats/pontoons (1-20 HP)	**8 respondents, 10%**
Motorboats/pontoons (21-50 HP)	**8 respondents, 10%**
Motorboats/pontoons (more than 50 HP)	**8 respondents, 10%**
Canoes/kayaks	**22 respondents, 28%**
Paddleboats/rowboats	**5 respondents, 6%**
Sailboat	**0 respondents**
No watercrafts are kept at my property, skip to question 13	**43 respondents, 54%**

12. Are the watercrafts that you use on Lotus Lake used on other waterbodies?
    47 respondents, 52%

    Yes – 29 respondents, 62%
    No – 18 respondents, 38%

13. What is your degree of concern with each issue listed below? If you feel the issue doesn't exist on Lotus Lake check the first column; if you feel the issue exists but is not a concern check the second column; and if the issue concerns you rank your concern as low, medium, or high.

Values in the chart represent number of respondents and percentages for each issue listed below, respectively.

	Issue doesn't exist	Exists, but not a concern	Low concern	Medium concern	High concern
New invasive species entering the lake **70 respondents, 78%**	**3, 4%**	**7, 10%**	**22, 31%**	**16, 23$**	**22, 31%**
Presence of common carp in the lake **71 respondents, 79%**	**4, 6%**	**5, 7%**	**11, 15%**	**18, 25%**	**33, 46%**
Excessive aquatic plant growth **74 respondents, 82%**	**4, 5%**	**7, 9%**	**11, 15%**	**25, 34%**	**27, 36%**
Excessive algae blooms **74 respondents, 82%**	**3, 4%**	**3, 4%**	**13, 18%**	**22, 30%**	**33, 45%**
Lack of water clarity or quality **75 respondents, 83%**	**3, 4%**	**3, 4%**	**9, 12%**	**25, 33%**	**35, 47%**
Loss of natural scenery/beauty **72 respondents, 80%**	**11, 15%**	**3, 4%**	**17, 24%**	**18, 25%**	**23, 32%**
Excessive noise level on the lake **71 respondents, 79%**	**23, 32%**	**5, 7%**	**19, 27%**	**8, 11%**	**16, 23%**
Decreased wildlife populations **71 respondents, 79%**	**13, 18%**	**4, 6%**	**13, 18%**	**19, 27%**	**22, 31%**
Decreased fisheries **71 respondents, 79%**	**6, 8%**	**6, 8%**	**10, 14%**	**22, 31%**	**27, 38%**
Unsafe use of motorized watercraft **74 respondents, 82%**	**22, 30%**	**8, 11%**	**20, 27%**	**5, 7%**	**19, 26%**
Disregard for slow-no-wake zones **72 respondents, 80%**	**27, 38%**	**5, 7%**	**23, 32%**	**8, 11%**	**9, 13%**
Decreased property values **73 respondents, 81%**	**14, 19%**	**5, 7%**	**22, 30%**	**11, 15%**	**21, 29%**
Increased development **73 respondents, 81%**	**14, 19%**	**6, 8%**	**25, 34%**	**11, 15%**	**17, 23%**
Increased nutrient pollution **71 respondents, 79%**	**8, 11%**	**5, 7%**	**17, 24%**	**13, 18%**	**28, 39%**
Decrease in overall lake health **74 respondents, 82%**	**5, 7%**	**3, 4%**	**7, 9%**	**16, 22%**	**43, 58%**

14. How would you describe the current lake level of Lotus Lake?
85 respondents, 94%

Too high	**0 respondents, 0%**
Just right	**45 respondents, 53%**
Two Low	**13 respondents, 15%**
Unsure	**27 respondents, 32%**

15. How would you describe the current water quality of Lotus Lake?
86 respondents, 96%

Poor	**35 respondents, 41%**
Fair	**19 respondents, 22%**
Good	**9 respondents, 10%**
Excellent	**0 respondents, 0%**
Unsure	**23 respondents, 27%**

16. How has the water quality changed in Lotus Lake in the time you've lived on/near the lake?
85 respondents, 94%

Severely degraded	**9 respondents, 11%**
Somewhat degraded	**14 respondents, 16%**
Remained unchanged	**19 respondents, 22%**
Somewhat improved	**8 respondents, 9%**
Greatly improved	**0 respondents, 0%**
Unsure	**25 respondents, 29%**
I haven't been on the lake long enough to notice a change	**10 respondents, 12%**

17. Which month(s) of the open water season do you consider algae growth (not including plants) to be a problem on Lotus Lake. Please check all that apply.
82 respondents, 91%

May	**3 respondents, 4%**
June	**11 respondents, 13%**
July	**33 respondents, 40%**
August	**46 respondents, 56%**
September	**21 respondents, 26%**
October	**5 respondents, 6%**
Unsure	**28 respondents, 34%**
Algae growth is never a problem	**4 respondents, 5%**

18. Please indicate which of the following uses you believe are impaired by algae (not including plants) on Lotus Lake. If you are unsure, please check the last column.

Values in the chart represent number of respondents and percentages for each issue listed below, respectively.

	Yes	No	Unsure
Swimming **74 respondents, 82%**	**56, 76%**	**1, 1%**	**17, 23%**
Fishing **70 respondents, 78%**	**38, 54%**	**9, 13%**	**23, 33%**
Boating **72 respondents, 80%**	**32, 44$**	**14, 19%**	**26, 36%**
Navigation **67 respondents, 74%**	**18, 27%**	**17, 25%**	**32, 48%**
Dogs/animals using the water **72 respondents, 80%**	**36, 50%**	**10, 14%**	**26, 36%**
Overall enjoyment of the lake **75 respondents, 83%**	**55, 73%**	**1, 1%**	**19, 25%**

19. Overall, how would you describe the amount of aquatic plants (not including algae) in Lotus Lake?
65 respondents, 72%

Too few plants	**9 respondents, 14%**
Healthy amount of plants	**23 respondents, 35%**
Too many plants	**33 respondents, 51%**

20. Which month(s) of the open water season do you consider aquatic plant growth (not including algae) to be a problem in Lotus Lake? Please check all that apply.
80 respondents, 89%

May	**4 respondents, 5%**
June	**11 respondents, 14%**
July	**34 respondents, 43%**
August	**36 respondents, 45%**
September	**22 respondents, 28%**
October	**11 respondents, 14%**
Unsure	**33 respondents, 41%**
Aquatic plants are never a problem	**8 respondents, 10%**

21. Please indicate which of the following uses you believe are limited by aquatic plants (not including algae) on Lotus Lake. If you are unsure, please check the last column.

Values in the chart represent number of respondents and percentages for each issue listed below, respectively.

	Yes	No	Unsure
Swimming **70 respondents, 78%**	**44, 63%**	**5, 7%**	**21, 30%**
Fishing **68 respondents, 76%**	**35, 51%**	**9, 13%**	**24, 35%**
Boating **68 respondents, 76%**	**36, 53%**	**4, 6%**	**28, 41%**
Navigation **66 respondents, 73%**	**24, 36%**	**11, 17%**	**31, 47%**
Overall enjoyment of the lake **68 respondents, 76%**	**35, 51%**	**7, 10%**	**26, 38%**

22. How would you describe the current amount of mowed lawn across the entire shoreline of Lotus Lake?
84 respondents, 93%

Too much	**8 respondents, 10%**
Just right	**25 respondents, 30%**
Not enough	**4 respondents, 5%**
Unsure	**47 respondents, 56%**

23. What impact, if any, do you believe landowner landscaping practices such as shoreline buffers, rain gardens, and native plants have on the water quality of Lotus Lake?
79 respondents, 88%

Positive impact, but only if all property owners participate **24 respondents, 30%**
Positive impact, regardless of how many property owners participate **27 respondents, 34%**
Negative impact, please describe **3 respondents, 4%**
If too much fertilizers are used and also animal waste
Phosphates
No impact **25 respondents, 32%**

24. How would you describe the use of fertilizer on your property?
81 respondents, 90%

I don't use any fertilizer on my property **46 respondents, 57%**
I use zero phosphorus fertilizer on my property **22 respondents, 27%**
I use fertilizer on my property; I'm unsure of its phosphorus content **9 respondents, 11%**
I use fertilizer on my property that contains phosphorus **2 respondents, 2%**
I use multiple types of fertilizers on my property that contain varying amounts of phosphorus **2 respondents, 2%**

25. Please indicate which of the following actions should be completed by the Lotus Lake Association to manage Lotus Lake. Most activities are eligible for grant funding.

Values in the chart represent number of respondents and percentages for each issue listed below, respectively.

	Yes	No	Unsure
Offering incentives for property owners to install shoreline buffers and rain gardens **81 respondents, 90%**	**46, 57%**	**9, 11%**	**26, 32%**
Offering incentives for property owners to install farmland conservation practices **79 respondents, 88%**	**34, 43%**	**16, 20%**	**29, 37%**
Lake fairs and workshops to share information **80 respondents, 89%**	**33, 41%**	**16, 20%**	**31, 39%**
Enforcement of slow-no-wake zones **79 respondents, 88%**	**18, 23%**	**29, 37%**	**32, 41%**
Practices to enhance fisheries **80 respondents, 89%**	**56, 70%**	**8, 10%**	**16, 20%**
Offering incentives for property owners to upgrade non-conforming septic systems **81 respondents, 90%**	**51, 63%**	**12, 15%**	**18, 22%**
Programs to prevent and monitor invasive species **80 respondents, 89%**	**57, 71%**	**8, 10%**	**15, 19%**

26. Carp dislodge aquatic vegetation while searching for food which leads to decreased water clarity. The removal of carp from Lotus Lake could result in increased aquatic plant growth (possibly to nuisance levels) in Lotus Lake. Would you support or oppose the removal of carp from Lotus Lake?
81 respondents, 90%

Definitely support	**32 respondents, 40%**
Probably support	**8 respondents, 10%**
Probably oppose	**14 respondents, 17%**
Definitely oppose	**0 respondents, 0%**
Unsure, I need more information	**27 respondents, 33%**

27. Are you currently a member of the Lotus Lake Association?
83 respondents, 92%

Yes	**24 respondents, 29%**
No	**44 respondents, 53%**
I was unaware that the Association existed	**15 respondents, 18%**

28. The Lotus Lake Association has completed the following activities to benefit the lake. From the list below, please check the activities that you were aware of.
81 respondents, 90%

Monthly beach sampling for fecal coliform bacteria during the summer months	**14 respondents, 17%**
Roadside clean-ups	**31 respondents, 38%**
Invasive species (purple loosestrife) removal projects	**21 respondents, 26%**
Invasive species education projects (example: Landing Blitz, sign installation, etc.)	**18 respondents, 22%**
Not aware of any activities above	**47 respondents, 58%**

29. How do you prefer to receive information from the Lotus Lake Association? Please check all that apply.
85 respondents, 94%

Newsletter	**42 respondents, 49%**
Email	**27 respondents, 32%**
Website	**9 respondents, 11%**
Facebook	**3 respondents, 4%**
Annual Meeting	**12 respondents, 14%**
Prefer not to receive information	**19 respondents, 22%**
Other, please specify	**2 respondents, 2%**

Relocating in the next year
Letter only as it pertains to the cropland

30. From the list below, which activities might you be interested in participating to improve Lotus Lake? Responses will be considered as a measure of interest rather than a commitment.
76 respondents, 84%

Learning to identify aquatic invasive species **20 respondents, 26%**
Learning how to monitor for aquatic invasive species **14 respondents, 18%**
Learning how to monitor water quality **23 respondents, 30%**
Serving on a committee **11 respondents, 14%**
Installing a shoreline buffer on your property **5 respondents, 7%**
Installing a rain garden on your property **11 respondents, 14%**
None of the above **37 respondents, 49%**
Some other activity, please describe **6 respondents, 8%**
Making the Stower Seven Lakes Trail a motorized trail (multi-use)
I do not live on the lake nor do I use the lake but might if it has fish in it.
Stop housing development
Mailer address, stuffers
I would really like to see it be a good fishing lake
Study how to stop homes from polluting the lake; I was never asked to be in the lake association

If you're interested in participating in any of the above activities and would like more information, please list your contact information below. This information will be kept separate from your responses to ensure confidentiality.

____

If you have any comments you would like to make, please use the space below.
Thank you for your time and your answers!

Appendix B

Lake Level and Precipitation

Date	Lake Level (ft)	Precipitation (in)
5/16/2014	1.20	0
5/17/2014	1.19	0
5/18/2014	1.10	0
5/19/2014	1.08	1.5
5/20/2014	1.36	0
5/21/2014	1.34	0
5/22/2014	1.30	0
5/23/2014	1.26	0
5/24/2014	1.20	0
5/25/2014	1.16	0
5/26/2014	1.08	0
5/27/2014	1.38	2
5/28/2014	1.46	0
5/29/2014	1.40	0
5/30/2014	1.30	0
5/31/2014	1.24	1.5
6/1/2014	1.35	0.1
6/2/2014	1.42	0
6/3/2014	1.36	0
6/4/2014	1.28	0
6/5/2014	1.20	0
6/6/2014	1.12	0.95
6/7/2014	1.12	0
6/8/2014	1.14	0
6/9/2014	1.08	0
6/10/2014	1.00	0
6/11/2014	0.98	0.375
6/12/2014	0.96	0
6/13/2014	0.98	0
6/14/2014	0.96	2
6/15/2014	1.06	0
6/16/2014	1.15	0
6/17/2014	1.01	0.2
6/18/2014	1.08	0.2
6/19/2014	1.20	1.3
6/20/2014	1.29	0
6/21/2014	1.26	0
6/22/2014	1.18	0.3
6/23/2014	1.16	0
6/24/2014	1.08	0
6/25/2014	0.96	0
6/26/2014	0.90	0
6/27/2014	0.90	0
6/28/2014	0.90	0.75
6/29/2014	0.90	0
6/30/2014	0.87	0
7/1/2014	0.82	0
7/2/2014	0.78	0
7/3/2014	0.72	0
7/4/2014	0.68	0
7/5/2014	0.66	0
7/6/2014	0.60	0.2
7/7/2014	0.60	0
7/8/2014	0.59	0.3
7/9/2014	0.56	0
7/10/2014	0.52	0
7/11/2014	0.49	0
7/12/2014	0.48	0
7/13/2014	0.46	0
7/14/2014	0.42	0.2
7/15/2014	0.42	0
7/16/2014	0.39	0
7/17/2014	0.38	0
7/18/2014	0.36	0
7/19/2014	0.35	0
7/20/2014	0.33	0
7/21/2014	0.32	0
7/22/2014	0.30	0
7/23/2014	0.26	0
7/24/2014	0.25	0
7/25/2014	0.24	0.2
7/26/2014	0.22	0
7/27/2014	0.21	0
7/28/2014	0.20	0
7/29/2014	0.18	0
7/30/2014	0.18	0
7/31/2014	0.16	0
8/1/2014	0.15	0
8/2/2014	0.14	0
8/3/2014	0.14	0
8/4/2014	0.12	0
8/5/2014	0.12	0
8/6/2014	0.10	0
8/7/2014	0.10	0
8/8/2014	0.09	0

8/9/2014	0.09	0
8/10/2014	0.08	0
8/11/2014	0.08	1.3
8/12/2014	0.20	0
8/13/2014	0.20	0
8/14/2014	0.18	0
8/15/2014	0.16	0
8/16/2014	0.16	0.02
8/17/2014	0.14	0.02
8/18/2014	0.14	0
8/19/2014	0.16	0
8/20/2014	0.16	0
8/21/2014	0.18	0.04
8/22/2014	0.18	0
8/23/2014	0.18	0
8/24/2014	0.18	0
8/25/2014	0.18	0
8/26/2014	0.18	0
8/27/2014	0.20	0
8/28/2014	0.20	0
8/29/2014	0.28	0
8/30/2014	0.28	1.8
8/31/2014	0.30	0.5
9/1/2014	0.28	0
9/2/2014	0.30	0
9/3/2014	0.68	0.4
9/4/2014	0.68	1.6
9/5/2014	0.68	0
9/6/2014	0.68	0
9/7/2014	0.64	0
9/8/2014	0.62	0
9/9/2014	0.62	0
9/10/2014	0.62	0.8
9/11/2014	0.60	0.7
9/12/2014	0.58	0
9/13/2014	0.54	0
9/14/2014	0.59	0
9/15/2014	0.59	0
9/16/2014	0.54	0
9/17/2014	0.47	0
9/18/2014	0.42	0
9/19/2014	0.40	0
9/20/2014	0.40	0
9/21/2014	0.40	0.5
9/22/2014	0.40	0
9/23/2014	0.40	0
9/24/2014	0.40	0
9/25/2014	0.38	0
9/26/2014	0.38	0
9/27/2014	0.38	0
9/28/2014	0.36	0

Date	Elevation (ft)	Precipitation (in)
5/8/2015	957.92	0.02
5/9/2015	957.92	0
5/10/2015	957.91	0.0275
5/11/2015	957.93	0.04
5/12/2015	957.92	0
5/13/2015	957.91	0.05
5/14/2015	957.93	0
5/15/2015	957.94	0.07
5/16/2015	957.96	0.06
5/17/2015	957.98	0
5/18/2015	957.96	0
5/19/2015	957.93	0
5/20/2015	957.92	0
5/21/2015	957.91	0
5/22/2015	957.89	0
5/23/2015		0
5/24/2015		0
5/25/2015	957.94	0.07
5/26/2015	957.96	0
5/27/2015	957.98	0.04
5/28/2015	957.97	0.045
5/29/2015	957.98	0.05
5/30/2015	958.09	0
5/31/2015	958.08	0
6/1/2015	958.07	0
6/2/2015	958.04	0
6/3/2015	958.08	0.45
6/4/2015	958.1	0
6/5/2015	958.09	0

6/6/2015	958.1	0.85
6/7/2015	958.15	0.4
6/8/2015	958.2	0
6/9/2015	958.18	0
6/10/2015	958.16	0
6/11/2015	958.14	0
6/12/2015	958.12	0
6/13/2015	958.12	0.6
6/14/2015	958.12	0
6/15/2015	958.11	0
6/16/2015	958.1	0
6/17/2015	958.12	0.85
6/18/2015	958.12	0
6/19/2015	958.14	0.55
6/20/2015	958.18	0
6/21/2015	958.18	0
6/22/2015	958.17	0
6/23/2015	958.16	0
6/24/2015	958.14	0.3
6/25/2015	958.12	0
6/26/2015	958.1	0
6/27/2015	958.09	0
6/28/2015	958.07	0
6/29/2015	958.18	1.44
6/30/2015	958.17	0
7/1/2015	958.14	0
7/2/2015	958.12	0
7/3/2015	958.1	0
7/4/2015	958.08	0
7/5/2015	958.08	0
7/6/2015	958.62	2.5
7/7/2015	958.6	0
7/8/2015	958.56	0
7/9/2015	958.52	0
7/10/2015	958.46	0
7/11/2015	958.44	0
7/12/2015	958.41	0.7
7/13/2015	958.58	0
7/14/2015	958.62	0.4
7/15/2015	958.6	0
7/16/2015	958.58	0.1
7/17/2015	958.54	1.4
7/18/2015	958.77	0
7/19/2015	958.82	0
7/20/2015	958.72	0
7/21/2015	958.68	0
7/22/2015	958.6	0
7/23/2015	958.56	0
7/24/2015	958.5	0.3
7/25/2015	958.42	0
7/26/2015	958.46	0
7/27/2015	958.42	0
7/28/2015	958.42	0.7
7/29/2015	958.41	0
7/30/2015	958.4	0
7/31/2015	958.4	0
8/1/2015	958.38	0
8/2/2015	958.32	0
8/3/2015	958.22	0
8/4/2015	958.2	0
8/5/2015	958.16	0
8/6/2015	958.12	1.7
8/7/2015	958.24	0
8/8/2015		0
8/9/2015	958.36	1.9
8/10/2015	958.4	0
8/11/2015	958.36	0
8/12/2015	958.32	0
8/13/2015	958.3	0
8/14/2015	958.27	0
8/15/2015	958.24	0
8/16/2015	958.24	0
8/17/2015	958.22	0
8/18/2015	958.2	2.3
8/19/2015	958.4	0
8/20/2015	958.44	0
8/21/2015	958.42	0
8/22/2015	958.52	1.35
8/23/2015	958.62	0
8/24/2015	958.57	0
8/25/2015	958.52	0
8/26/2015	958.52	0
8/27/2015	958.49	0
8/28/2015	958.48	0
8/29/2015	958.44	0
8/30/2015	958.4	0

8/31/2015	958.38	0
9/1/2015	958.34	0
9/2/2015	958.38	0.9
9/3/2015	958.42	0
9/4/2015	958.41	0.4
9/5/2015	958.38	0
9/6/2015	958.38	0
9/7/2015	958.34	0
9/8/2015	958.34	0
9/9/2015	958.32	0
9/10/2015	958.3	0
9/11/2015	958.27	0
9/12/2015	958.26	0
9/13/2015	958.22	0
9/14/2015	958.2	0
9/15/2015	958.2	0
9/16/2015	958.18	0.25
9/17/2015	958.32	1.85
9/18/2015	958.36	0
9/19/2015	958.36	0.025
9/20/2015	958.38	0
9/21/2015	958.38	0
9/22/2015	958.4	0
9/23/2015	958.43	0.9
9/24/2015	958.64	0.7
9/25/2015	958.68	0
9/26/2015	958.64	0
9/27/2015	958.62	0
9/28/2015	958.58	0
9/29/2015	958.54	0
9/30/2015	958.48	0
6/6/2016	958.135	0
6/7/2016	958.035	0
6/8/2016	958.035	0
6/9/2016	958.035	0
6/10/2016		0
6/11/2016	958.015	0
6/12/2016	957.935	0.8
6/13/2016	958.055	0
6/14/2016	958.055	0
6/15/2016	958.115	0.8
6/16/2016	958.095	0
6/17/2016	958.095	0
6/18/2016	958.075	0
6/19/2016	958.055	0
6/20/2016	958.055	0.4
6/21/2016	958.015	0
6/22/2016	957.995	0
6/23/2016	957.995	0.2
6/24/2016	957.995	0
6/25/2016	957.995	0.5
6/26/2016	957.975	0
6/27/2016	957.955	0
6/28/2016	957.935	0
6/29/2016	957.925	0
6/30/2016	957.935	0
7/1/2016	957.915	0
7/2/2016	957.895	0
7/3/2016	957.885	0
7/4/2016	957.855	0
7/5/2016	957.855	0.65
7/6/2016	957.915	0.1
7/7/2016	957.925	0
7/8/2016	957.925	0
7/9/2016	957.925	0
7/10/2016	957.925	0
7/11/2016	957.925	1.25
7/12/2016	957.955	0
7/13/2016	957.935	0
7/14/2016	957.935	0
7/15/2016	957.915	0
7/16/2016	957.895	0
7/17/2016	957.885	0
7/18/2016	957.885	0.01
7/19/2016	957.895	0
7/20/2016	957.895	0
7/21/2016	957.895	0.5
7/22/2016	957.915	0
7/23/2016	957.905	0.8
7/24/2016	957.905	0
7/25/2016	957.895	0
7/26/2016	957.885	0
7/27/2016	957.885	1.4
7/28/2016	958.015	0
7/29/2016	958.025	0
7/30/2016	958.015	0

7/31/2016	957.995	0
8/1/2016	957.995	0
8/2/2016	957.995	0
8/3/2016	957.985	0.07
8/4/2016	958.025	0
8/5/2016	958.025	0
8/6/2016	958.015	0
8/7/2016	957.975	0
8/8/2016	957.935	0
8/9/2016	957.915	0
8/10/2016	957.915	1.75
8/11/2016	958.055	0
8/12/2016	958.075	0
8/13/2016	958.055	0
8/14/2016	958.035	0
8/15/2016	958.015	0
8/16/2016	958.015	0.01
8/17/2016	958.015	0
8/18/2016	958.015	0.08
8/19/2016	958.055	0.02
8/20/2016	958.055	0
8/21/2016	958.055	0
8/22/2016	958.035	0
8/23/2016	958.025	0.04
8/24/2016	958.045	0
8/25/2016	958.045	0
8/26/2016	958.035	0
8/27/2016	958.035	0
8/28/2016	958.035	0
8/29/2016	958.025	2.1
8/30/2016	958.235	0
8/31/2016	958.135	0
9/1/2016	958.125	0
9/2/2016		0
9/3/2016		0
9/4/2016	958.035	0.55
9/5/2016	958.095	1.4
9/6/2016	958.155	0
9/7/2016	958.155	0
9/8/2016	958.135	0
9/9/2016	958.135	0
9/10/2016	958.115	0
9/11/2016	958.095	0
9/12/2016	958.075	0
9/13/2016	958.035	0
9/14/2016	958.035	0
9/15/2016	958.075	0.72
9/16/2016	958.095	0.3
9/17/2016	958.095	0
9/18/2016	958.115	0
9/19/2016	958.095	0
9/20/2016	958.115	0
9/21/2016	958.105	2.3
9/22/2016	958.205	0
9/23/2016	958.205	0
9/24/2016	958.195	0
9/25/2016	958.185	0.2
9/26/2016	958.175	0
9/27/2016	958.155	0

Appendix C

Chemical Data: In Lake and Tributary

Lotus Lake Deep Hole

*All units mg/L unless otherwise noted

Date	Phosphate Ortho Diss	Total Phosphorus	Nitrogen NO3+NO2 Diss	Nitrogen Kjeldahl Total	Nitrogen NH3-N Diss	Total Suspended Solids	Chlorophyll a (ug/L)
8/19/13		0.0808					54.3
9/10/13		0.0899					57.6
5/12/2014	ND	0.0621	0.159	1.78	0.288	9	
5/29/2014	ND	0.0703	ND	1.19	ND	17	11.1
6/24/2014	ND	0.0559	ND		0.0223	15	30.7
7/21/2014	ND	0.0907	ND	1.72	0.0287	33	33.2
8/18/2014	ND	0.118	ND	2.27	0.0181	11	82.7
9/15/2014	0.0037	0.0957	ND	2.04	0.0295	25	40
11/3/2014	0.0021	0.0815	ND	1.62	0.0192	23	
4/14/2015	ND	0.096	0.0701	1.99	0.126	34	
5/27/2015	0.0053	0.171	ND	2.42	0.0242	29	71.9
6/23/2015	0.0019	0.158	ND	2.7	0.0424	31	72.9
7/20/2015	0.0023	0.138	ND	2.21	0.0201	37	82.2
8/18/2015	0.0121	0.152	ND	2.46	0.042	30	82.4
9/14/2015	0.0032	0.0928	ND	1.81	0.0425	22	27.1
11/16/2015	0.0024	0.0531	0.0238	1.6	0.684	8	
4/12/2016	ND	0.064	0.154	0.611	0.33	13	
5/24/2016	0.0019	0.0827	ND	2	0.429	14	6.25
6/22/2016	0.0017	0.127	ND	2.15	0.0438	30	50.4
7/25/2016	0.0035	0.116	ND	1.91	0.0394	30	50.8
8/22/2016	0.0019	0.0979	ND	1.92	0.0632	34	57.5
9/26/2016	ND	0.122	ND	1.65	0.0327	40	52.5
11/29/2016	0.0063	0.0776	ND	2.33	0.685	7	

Lotus Lake Inlet

*All units mg/L unless otherwise noted

Date	Phosphate Ortho Diss	Total Phosphorus	Nitrogen NO3+NO2 Diss	Nitrogen Kjeldahl Total	Nitrogen NH3-N Diss	Total Suspended Solids	Chlorophyll a (ug/L)
5/29/2014	0.0413	0.122	0.0424	1.19	0.0395	14.7	3.94
6/24/2014	0.11	0.321	0.0467		0.0598	59	
7/21/2014	0.0516	0.134	0.255	0.912	0.0712	2.4	
8/18/2014	0.0683	0.12	0.537	0.653	0.065	ND	
9/15/2014	0.0535	0.104	0.814	0.79	0.0455	ND	
5/27/2015	0.0417	0.127	0.146	1.08	0.0437	4	
6/23/2015	0.0477	0.116	0.159	1.21	0.0296	22	
7/20/2015	0.0605	0.155	0.115	1.25	0.0531	12.8	
8/18/2015	0.0972	0.183	0.0941	0.884	0.0285	ND	
9/14/2015	0.0187	0.145	0.0674	1.58	0.0352	31.3	
5/24/2016	0.0092	0.0903	0.43	0.809	0.0171	7.5	
6/22/2016	0.0214	0.118	0.532	0.908	0.0509	11.8	
7/25/2016	0.0569	0.179	0.242	1.03	0.127	13.4	
8/22/2016	0.044	0.135	0.532	0.936	0.0946	14	
9/26/2016	0.0454	0.103	0.255	0.997	0.063	ND	

Lotus Lake Outlet

*All units mg/L unless otherwise noted

Date	Phosphate Ortho Diss	Total Phosphorus	Nitrogen NO3+NO2 Diss	Nitrogen Kjeldahl Total	Nitrogen NH3-N Diss	Total Suspended Solids	Chlorophyll a (ug/L)
5/29/2014	ND	0.0744	ND	1.34	0.0503	16	19.2
6/24/2014	ND	0.0534	ND		0.0272	13.5	
7/21/2014	ND	0.0918	ND	1.76	0.0217	45	
8/18/2014	ND	0.123	ND	2.71	0.0191		
9/15/2014	0.0038	0.115	ND	2.31	0.0206	60	
5/27/2015	ND	0.271	ND	4.71	0.0287	44	
6/23/2015	0.0021	0.15	ND	2.56	0.0616	64	
7/20/2015	0.0019	0.144	ND	2.53	0.0229	62	
8/18/2015	0.0303	0.124	ND	2.1	0.0232	31	
9/14/2015	0.0032	0.168	ND	2.22	0.0658	29	
5/24/2016	0.0017	0.0766	ND	1.96	0.36	8.5	
6/22/2016	0.0021	0.076	ND	1.58	0.0372	13.4	
7/25/2016	0.0031	0.11	ND	2.08	0.0298	40.7	
8/22/2016	0.0018	0.108	ND	2.01	0.0323	40	
9/26/2016	ND	0.106	ND	1.91	0.0254	46	

Appendix D

Physical Data: In Lake and Tributary

Lotus Lake Deep Hole

Date	Depth (m)	Dissolved oxygen (mg/L)	pH	Temp (oC)	Specific Conductance	Conductivity	Salinity	ORP	TDS	Secchi (ft)
8/19/13	0	7.25	9.03	23.66	214	209	0.10	-67.5		1.0
	1	7.25	8.96	23.52	214	208	0.10	-67.3		
	2	5.39	8.63	23.10	220	212	0.10	-67.5		
9/10/13	0	6.84	9.15	23.08	216	209	0.10	-44.8		1.0
	1	7.58	9.05	22.97	217	208	0.10	-45.5		
	2	2.44	6.87	22.72	278	265	0.14	-48.4		
5/12/14	0	14.95	9.45	15.75	198	163	0.09	23.7		2.0
	1	8.99	9.35	15.62	193	159	0.09	22.8		
	2	6.66	8.93	13.47	196	153	0.09	23.3		
5/22/14	0	7.25	9.41	15.58	175	144	0.08	29.3	88	2.0
	1	11.44	9.23	15.09	175	142	0.08	30.6	88	
	2	10.72	9.13	14.68	177	142	0.08	31.7	89	
5/29/14	0	8.19	9.10	25.58	182	183	0.09	-20.2	91	2.0
	1	8.36	9.11	22.82	179	172	0.08	-19.4	90	
	2	3.64	7.75	19.80	177	155	0.08	-16.2	88	
6/9/14	0	6.86	8.94	21.26	182	168	0.08	-21.4	90	1.3
	1	6.49	8.87	21.13	179	166	0.08	-22.7	90	
	2	4.12	7.92	19.84	183	165	0.09	-22.9	91	
6/24/14	0	6.92	9.51	26.01	173	177	0.08	-15.9	87	2.0
	1	6.85	9.37	24.52	173	171	0.08	-15.7	86	
	2	1.78	7.70	21.29	178	166	0.08	-14.9	89	
7/11/14	0	4.52	9.05	24.85	180	179	0.08	-57.0	90	1.0
	1	4.58	9.04	24.79	180	179	0.08	-54.6	90	
	2	4.51	9.03	24.29	179	177	0.08	-53.7	89	
7/21/14	0	8.91	9.06	25.52	188	190	0.09	-54.3	94	1.2
	1	9.49	8.90	24.46	189	187	0.09	-53.9	94	
	2	3.05	7.64	23.43	194	188	0.09	-57.1	97	

8/5/14	0	9.35	9.39	25.39	193	195	0.09	-31.0	97	1.0
	1	8.82	9.32	25.24	193	194	0.09	-31.6	97	
	2	7.21	9.02	24.50	196	194	0.09	-32.2	98	
8/18/14	0	3.38	9.04	23.73	188	184	0.09	-5.4	94	0.8
	1	2.80	8.86	23.36	189	183	0.09	-7.3	94	
	2	1.57	8.23	23.04	194	187	0.09	-6.7	97	
9/4/14	0	2.68	9.56	21.13	177	164	0.08	-91.9	88	0.5
	1	2.73	9.31	21.11	176	163	0.08	-91.1	88	
	2	2.64	9.21	21.05	178	164	0.08	-89.3	89	
9/15/14	0	2.23	9.55	15.41	174	142	0.08	-64.7	87	1.0
	1	2.35	9.51	15.36	173	141	0.08	-63.8	86	
	2	2.25	9.42	15.17	173	141	0.08	-62.5	87	
11/3/14	0	0.16	9.74	5.23	187	117	0.09	-58.4	94	1.0
	1	0.11	9.90	5.23	186	116	0.09	-57.5	94	
	2	0.33	9.73	5.16	188	117	0.09	-58.5	94	
	2.5	0.22	8.76	5.60	247	156	0.12	-59.6	125	
4/14/15	0	6.99	9.00	12.66	159	122	0.08	40.1	79	1.0
	1	7.12	8.99	12.57	159	122	0.08	40.6	80	
	2	7.21	8.97	12.48	159	121	0.08	41.0	79	
	2.5	5.88	8.15	11.06	167	123	0.08	41.2	83	
5/27/15	0	8.22	9.37	18.89	161	143	0.08	12.0	81	1.5
	1	7.51	9.20	18.72	161	142	0.08	13.5	81	
	2	7.70	9.11	18.38	161	141	0.08	15.6	81	
	2.25	4.12	7.85	17.21	169	144	0.08	12.9	84	
6/9/15	0	5.81	9.55	23.63	149	145	0.07	13.1	74	1.0
	1	4.80	9.44	22.77	148	142	0.07	15.0	74	
	2	2.75	8.84	22.11	152	144	0.07	13.1	76	
	3	0.00	6.57	19.35	272	244	0.13	2.8	137	
6/23/15	0	4.68	9.40	24.30	141	139	0.07	19.8	70	1.5
	1	4.60	9.39	24.14	141	138	0.07	20.5	70	
	2	4.27	9.31	23.66	140	137	0.07	22.3	70	
	2.5	0.00	6.75	21.79	236	222	0.11	6.1	118	
7/8/15	0	2.53	8.91	23.21	136	131	0.06	29.7	68	0.8

	1	2.48	8.93	23.14	137	132	0.06	29.5	68	
	2	2.46	8.79	23.07	138	133	0.06	30.4	69	
	2 3/4	0.02	6.66	21.89	172	162	0.09	-113.7	99	
7/20/15	0	5.85	9.30	24.92	130	129	0.06	24.2	65	0.8
	1	6.31	9.25	24.89	134	134	0.06	23.2	67	
	2	7.33	9.15	24.87	136	135	0.06	27.5	68	
	2 3/4	0.00	6.63	24.05	252	247	0.11	2.9	118	
8/5/15	0	5.31	9.83	24.53	132	131	0.06	35.5	66	0.8
	1	5.12	9.75	24.29	134	132	0.06	36.5	67	
	2	4.04	9.42	23.89	136	133	0.06	39.4	68	
	2 1/2	0.18	7.09	23.37	154	149	0.07	39.1	77	
8/18/15	0	4.19	9.27	24.36	128	126	0.06	-28.8	64	0.5
	1	4.14	9.24	24.38	131	129	0.06	-28.1	65	
	2	4.03	9.17	24.38	131	129	0.06	-26.3	65	
	2 3/4	3.64	7.34	24.36	137	136	0.06	-29.5	69	
9/1/15	0	5.15	9.89	23.84	125	123	0.06	-53.4	63	1.0
	1	4.45	9.85	22.70	130	125	0.06	-45.2	65	
	2	2.13	8.90	20.65	139	128	0.07	-50.3	70	
	2 3/4	0.00	7.18	19.11	158	140	0.07	-194.9	79	
9/14/15	0	6.04	9.80	20.44	138	126	0.06	-94.1	69	1.0
	1	5.95	9.82	20.30	138	126	0.06	-75.0	69	
	2	5.90	9.72	20.18	138	125	0.06	-65.0	69	
	2 3/4	5.65	8.21	19.58	139	125	0.07	-75.1	70	
11/16/15	0	3.87	9.09	6.48	140	91	0.07	-1.1	70	3.0
	1	5.23	8.91	6.48	138	90	0.07	7.8	70	
	2	5.68	8.82	6.48	146	95	0.07	10.1	74	
	2 3/4	0.00	8.34	6.59	145	95	0.07	4.4	73	
4/12/16	0	5.88	9.96	5.43	129	81	0.06	-5.9	65	1.5
	1	5.98	9.48	5.38	128	81	0.06	4.5	64	
	2	5.97	9.30	5.21	129	80	0.06	13.0	64	
	3	5.09	8.73	5.39	137	86	0.06	15.2	68	
5/24/16	0	2.16	7.76	20.97	184	77	0.03	11.0	38	2.5
	1	1.81	7.67	20.81	33	30	0.01	15.1	16	

	2	2.08	7.52	20.50	74	68	0.03	19.8	38	
	2 1/2	1.32	7.39	20.10	94	85	0.04	18.9	43	
6/9/16	0	5.22	9.20	22.21	84	80	0.04	20.6	42	2.0
	1	5.37	9.13	22.02	89	84	0.04	27.1	44	
	2	4.81	8.74	20.61	98	90	0.05	30.3	49	
	2 1/2	2.71	7.94	19.98	180	163	0.09	28.4	90	
6/22/16										1.5
					Sp./Con.	NTU				
7/12/16	0	15.53	12.25	25.12	0.173	-51.40			1.5	
	1	15.25	12.00	25.10	0.174	-51.40				
	2	14.81	11.73	25.00	0.174	-51.40				
	2.5	10.06	11.30	24.17	0.210	-51.30				
7/25/16	0	6.67	8.26	27.00	160	167	0.07	72.2	80	1.5
	1	6.07	8.60	26.82	160	166	0.07	62.7	80	
	2	3.53	8.10	26.29	166	171	0.08	51.5	83	
	2.5	2.42	7.56	26.15	174	178	0.08	47.1	87	
8/8/16	0	10.95	8.73	25.91	174	177	0.08	30.9	87	1.5
	1	10.84	8.81	25.85	179	182	0.08	24.2	89	
	2	7.70	8.32	25.58	184	187	0.09	14.1	92	
	2.75	0.04	6.73	24.99	224	224	0.10	-15.3	109	
8/22/16	0	11.30	7.48	21.90	163	154	0.08	24.0	82	1.5
	1	11.03	7.74	21.92	165	155	0.08	19.7	82	
	2	10.77	7.91	21.86	167	157	0.08	21.2	84	
	2.75	0.00	6.67	22.23	208	197	0.10	-71.4	104	
9/13/16	0	11.50	8.89	20.06	188	171	0.09	-35.5	94	1.0
	1	10.71	8.85	20.07	185	168	0.09	-31.1	92	
	2	10.46	8.80	20.02	186	168	0.09	-29.5	93	
	2.75	0.00	7.77	20.00	211	191	0.09	-36.2	101	
11/29/16	0	6.80	8.33	3.59	114	68	0.05	-106.0	57	3.0
	1	8.52	8.24	3.57	131	78	0.06	-97.4	66	
	2	6.66	8.20	3.58	131	78	0.06	-93.4	66	
	2.5	3.70	7.72	4.08	130	78	0.06	-92.6	65	

Lotus Lake Inlet

Inlet Date	Feet	Depth (ft)	Flow(m/s)	Comments
5/22/14	0	2.9	0.29	
	1	3.1	0.29	
	2	3.0	0.09	
	3	3.0	0.11	
	4	2.8	0.15	
	5	2.8	0.20	
	6	2.0	0.24	
5/29/14	0	2.8	0.19	
	1	3.0	0.30	
	2	3.1	0.30	
	3	3.0	0.25	
	4	2.9	0.22	
	5	2.9	0.16	
	5.5	3.0	0.19	
6/9/14	0	2.6	0.11	
	1	2.6	0.33	
	2	2.7	0.14	
	3	2.6	0.15	
	4	2.6	0.16	
	5	2.6	0.16	
	5.5	2.7	0.14	
6/24/14	0	2.5	0.12	
	1	3.0	0.11	
	2	3.1	0.12	
	3	3.1	0.07	
	4	3.3	0.14	
	5	3.1	0.18	
7/11/14	0	2.0	0.03	
	1	2.3	0.14	
	2	2.5	0.11	
	3	2.4	0.12	
	4	2.4	0.09	
	5	2.4	0.15	
	5.5	2.5	0.06	
7/21/14	0	1.9	0.14	
	1	2.0	0.19	
	2	2.2	0.15	
	3	2.1	0.10	
	4	2.2	0.15	
	5	2.2	0.16	
	6	2.2	0.08	
8/5/14	0	1.7	0.13	
	1	2.0	0.14	
	2	2.1	0.15	
	3	2.0	0.12	
	4	2.1	0.12	
	5	2.1	0.09	
8/18/14	0	1.8	0.11	
	1	2.0	0.13	
	2	2.2	0.14	
	3	2.1	0.14	
	4	2.1	0.18	
	5	2.1	0.10	
	5.5	2.1	0.04	
9/4/14	0	2.3	0.43	
	1	2.6	1.28	
	2	2.7	1.37	
	3	2.6	1.08	
	4	2.5	1.19	
	5	2.6	0.49	
9/15/14	0	2.1	0.15	
	1	2.4	0.20	

	2	2.4	0.17	
	3	2.5	0.13	
	4	2.5	0.10	
	5	2.6	0.10	
5/27/15	0	1.8	0.07	
	1	2.0	0.30	
	2	2.2	0.27	
	3	2.2	0.22	
	4	2.3	0.18	
	5	2.2	0.15	
6/9/15	0	2.1	0.16	
	1	2.2	0.23	
	2	2.2	0.22	
	3	2.2	0.27	
	4	2.2	0.23	
	5	2.2	0.14	
	6	2.3	0.09	
6/23/15	1	2.0	0.08	
	2	2.2	0.04	
	3	2.3	0.09	
	4	2.3	0.09	
	5	2.2	0.06	
	6	2.3	0.11	
7/8/15	0	2.4	0.21	
	1	2.6	0.30	
	2	2.6	0.31	
	3	2.5	0.31	
	4	2.5	0.27	
	5	2.5	0.27	
7/20/15	0	2.6	0.14	
	1	2.7	0.20	
	2	2.8	0.23	
	3	2.7	0.27	
	4	2.6	0.29	
	5	2.6	0.25	
8/5/15	0	2.1	0.07	
	1	2.2	0.13	
	2	2.2	0.14	
	3	2.2	0.09	
	4	2.2	0.08	
	5	2.1	0.06	
8/18/15	0	2.1	0.07	
	1	2.2	0.13	
	2	2.2	0.14	
	3	2.2	0.12	
	4	2.2	0.11	
	5	2.1	0.10	
	6	2.2	0.07	
9/1/15	0	2.4	0.08	
	1	2.4	0.10	
	2	2.5	0.09	
	3	2.2	0.10	
	4	2.1	0.08	
	5	2.2	0.07	
9/14/15	0	2.2	0.08	Beavers
	1	2.2	0.09	
	2	2.2	0.07	
	3	2.2	0.07	
	4	2.1	0.06	
	5	2.2	0.05	
5/24/16	0	1.9	0.06	Barrier on Culvert
	1	2.1	0.05	
	2	3.2	0.05	
	3	3.2	0.06	
	4	3.2	0.05	
	5	3.3	0.06	

6/9/16	0	1.8	0.07
	1	2.0	0.06
	2	3.1	0.05
	3	3.0	0.19
	4	3.1	0.18
	5	2.8	0.05
	6	2.3	0.08
6/21/16	0	1.8	0.06
	1	2.2	0.01
	2	3.1	0.11
	3	3.0	0.13
	4	3.0	0.09
	5	2.8	0.05
	6	2.2	0.00
6/22/16	0	2.0	0.07
	1	2.2	0.09
	2	3.0	0.11
	3	3.1	0.16
	4	3.0	0.09
	5	2.8	0.15
	6	1.8	0.03
7/12/16	0	1.7	0.04
	1	2.4	0.44
	2	2.2	0.43
	3	2.5	0.23
	4	2.4	0.48
	5	2.5	0.31
	6	1.9	0.10
7/25/16	0	2.0	0.07
	1	2.1	0.10
	2	2.8	0.13
	3	2.5	0.21
	4	2.2	0.23
	5	1.6	0.09
	6	1.7	0.05
8/8/16	0	1.6	0.13
	1	2.2	0.11
	2	2.6	0.13
	3	2.8	0.13
	4	2.7	0.16
	5	2.5	0.07
	6	1.6	0.05
8/22/16	0	1.4	0.09
	1	2.0	0.15
	2	2.8	0.07
	3	3.0	0.05
	4	2.8	0.08
	5	2.7	0.08
	6	1.9	0.11
9/13/16	0	1.8	0.08
	1	2.0	0.12
	2	2.7	0.07
	3	2.8	0.10
	4	2.8	0.08
	5	2.8	0.08
	6	1.5	0.07
9/26/16	0	0.1	0.00
	1	0.3	0.03
	2	0.5	0.01
	3	0.5	0.24
	4	0.6	0.82
	5	0.5	1.07
	6	0.5	1.24
	7	0.4	0.90
	8	0.3	0.46
	9	0.3	0.06

10	0.3	0.03
11	0.2	0.00
12	0.2	0.00
13	0.2	0.00
14	0.2	0.00
15	0.2	0.00
16	0.1	0.00

Lotus Lake Outlet

Outlet Date	Feet	Depth (ft)	Flow(m/s)	Comments
5/22/14	0	0.5	0.11	
	1	0.5	0.13	
	2	0.5	0.13	
	3	0.5	0.12	
	4	0.8	0.13	
	5	0.9	0.13	
	6	0.7	0.11	
	7	0.6	0.09	
	8	0.5	0.03	
	9	0.6	0.01	
	10	1.0	0.20	
	11	1.3	0.31	
	12	1.3	0.88	
	13	1.3	1.12	
	14	1.2	1.38	
	15	1.2	1.23	
	16	1.0	1.02	
	17	0.8	0.81	
	18	0.6	0.67	
	19	0.6	0.56	
	20	1.0	0.32	
	21	1.2	0.63	
	22	1.3	0.36	
	23	1.1	0.11	
	24	1.1	0.09	
	25	1.0	0.19	
	26	0.8	0.12	
	27	0.8	0.10	
	28	0.5	0.12	
	29	0.4	0.12	
5/29/14	0	1.0	0.18	
	1	1.1	0.08	
	2	1.1	0.17	
	3	1.2	0.29	
	4	1.2	0.31	
	5	1.4	0.89	
	6	1.4	1.44	
	7	1.4	1.41	
	8	1.3	1.44	
	9	1.2	1.55	
	10	1.2	1.28	
	11	0.9	0.94	
	12	0.8	0.52	
	13	1.1	0.94	
	14	1.1	0.75	
	15	1.0	0.17	
	16	1.0	0.26	
	17	0.9	0.28	
	18	0.9	0.34	
	19	0.8	0.44	
	20	0.6	0.13	
	21	0.5	0.12	
6/9/14	0	0.2	0.07	
	1	0.7	0.21	
	2	1.0	0.37	
	3	1.1	0.66	
	4	1.1	1.34	
	5	1.1	1.43	
	6	0.9	1.42	
	7	0.9	1.39	
	8	0.8	1.12	
	9	0.5	0.86	

	10	0.5	0.81
	11	0.9	0.57
	12	1.0	0.72
	13	0.8	0.36
	14	0.8	0.22
	15	0.7	0.25
	16	0.7	0.13
	17	0.6	0.04
	18	0.5	0.15
	19	0.4	0.12
	20	0.3	0.13
6/24/14	0	0.3	0.23
	1	0.6	0.25
	2	1.0	0.75
	3	1.0	0.88
	4	0.9	1.20
	5	0.9	1.35
	6	0.9	1.52
	7	0.8	1.55
	8	0.6	1.21
	9	0.5	1.08
	10	0.4	1.09
	11	0.5	0.96
	12	0.8	0.69
	13	0.8	0.56
	14	0.7	0.19
	15	0.6	0.43
	16	0.6	0.54
	17	0.5	0.29
	18	0.4	0.21
	19	0.3	0.10
	20	0.2	0.08
7/11/14	0	0.2	0.12

	1	0.4	0.55	
	2	0.5	0.56	
	3	0.5	0.88	
	4	0.4	1.20	
	5	0.4	1.13	
	6	0.3	0.95	
	7	0.2	0.73	
	8	0.2	0.77	
	9	0.2	0.58	
	10	0.2	0.38	
	11	0.2	0.17	
	12	0.3	0.69	
	13	0.2	0.16	
	14	0.1	0.09	
7/21/14	0	0.2	0.22	12:15PM
	1	0.3	0.84	
	2	0.3	0.89	
	3	0.3	1.04	
	4	0.2	0.98	
	5	0.2	0.18	
	6	0.1	0.36	
	7	0.1	0.32	
8/5/14	0	0.1	0.18	
	1	0.2	0.71	
	2	0.2	0.91	
	3	0.1	0.37	
	4	0.05	0.00	
8/18/14	0	0.0	0.00	
	1	0.05	0.35	
	2	0.2	0.52	
	3	0.2	0.83	
	4	0.2	0.78	
	5	0.1	0.54	

	6	0.05	0.22
9/4/14	0	0.2	0.06
	1	0.4	0.17
	2	0.6	0.37
	3	0.8	0.54
	4	0.8	0.99
	5	0.7	1.46
	6	0.7	1.59
	7	0.6	1.25
	8	0.6	1.11
	9	0.5	0.78
	10	0.5	0.60
	11	0.4	0.55
	12	0.5	0.33
	13	0.5	0.24
	14	0.4	0.18
	15	0.4	0.13
	16	0.4	0.14
	17	0.2	0.05
9/15/14	0	0.05	0.02
	1	0.3	0.23
	2	0.4	0.38
	3	0.6	0.52
	4	0.5	0.98
	5	0.5	1.31
	6	0.4	1.05
	7	0.4	0.98
	8	0.3	0.87
	9	0.3	0.73
	10	0.2	0.27
	11	0.2	0.33
	12	0.2	0.29
	13	0.2	0.09
	14	0.1	0.02
	15	0.2	0.03
	16	0.1	0.05
5/27/15	0	0.05	0.00
	1	0.1	0.17
	2	0.2	0.43
	3	0.5	0.88
	4	0.5	1.28
	5	0.3	0.97
	6	0.2	0.45
	7	0.1	0.23
	8	0.05	0.00
6/9/15	0	0.4	0.09
	1	0.6	0.21
	2	0.6	0.43
	3	0.5	0.81
	4	0.9	0.85
	5	0.3	0.96
	6	0.4	0.96
	7	0.3	0.60
	8	0.2	0.84
	9	0.2	0.55
	10	0.2	0.23
	11	0.2	0.42
	12	0.1	0.05
	13	0.1	0.04
	14	0.1	0.00
6/23/15	1	0.03	0.09
	2	0.04	0.03
	3	0.05	0.31
	4	0.04	0.52
	5	0.04	0.81
	6	0.04	0.85

	7	0.05	1.08
	8	0.03	0.77
	9	0.02	0.42
	10	0.01	0.26
	11	0.01	0.03
	12	0.01	0.30
	13	0.01	0.30
	14	0.01	0.05
7/8/15	0	0.5	0.01
	1	0.6	0.06
	2	0.6	0.33
	3	0.9	0.61
	4	1.0	1.02
	5	0.9	1.15
	6	0.8	1.31
	7	0.8	1.13
	8	0.7	0.90
	9	0.6	0.79
	10	0.5	0.46
	11	0.5	0.22
	12	0.5	0.20
	13	0.5	0.13
	14	0.5	0.14
	15	0.5	0.10
	16	0.4	0.10
	17	0.3	0.09
	18	0.2	0.05
	19	0.1	0.00
	20	0.1	0.00
7/20/15	0	0.6	0.10
	1	1.0	0.09
	2	0.8	0.08
	3	0.9	0.27
	4	1.0	0.65
	5	1.2	0.76
	6	1.0	1.20
	7	0.8	1.51
	8	0.8	1.39
	9	0.7	1.20
	10	0.8	1.05
	11	0.7	0.85
	12	0.7	0.58
	13	0.6	0.36
	14	0.7	0.17
	15	0.6	0.17
	16	0.6	0.09
	17	0.6	0.13
	18	0.5	0.09
	19	0.4	0.12
	20	0.2	0.00
	21	0.2	0.00
	22	0.1	0.00
8/5/15	0	0.03	0.05
	1	0.50	0.02
	2	0.50	0.17
	3	0.50	0.37
	4	0.50	0.62
	5	0.50	0.85
	6	0.50	0.83
	7	0.40	0.69
	8	0.30	0.64
	9	0.20	0.41
	10	0.20	0.42
	11	0.10	0.09
	12	0.10	0.01
	13	0.10	0.00

	14	0.10	0.00
8/18/15	0	0.40	0.10
	1	0.50	0.07
	2	0.50	0.26
	3	0.50	0.45
	4	0.50	0.79
	5	0.50	0.93
	6	0.40	0.98
	7	0.30	0.89
	8	0.30	0.66
	9	0.20	0.16
	10	0.20	0.34
	11	0.20	0.08
	12	0.20	0.04
	13	0.20	0.00
	14	0.10	0.00
	15	0.10	0.00
	16	0.10	0.00
9/1/15	0	0.4	0.08
	1	0.4	0.06
	2	0.7	0.01
	3	0.7	0.21
	4	0.7	0.54
	5	0.7	0.84
	6	0.7	1.16
	7	0.7	1.37
	8	0.6	1.02
	9	0.4	0.92
	10	0.4	0.86
	11	0.3	0.30
	12	0.3	0.18
	13	0.3	0.10
	14	0.3	0.08
	15	0.3	0.05
	16	0.2	0.02
	17	0.1	0.00
9/14/15	0	0.3	0.04
	1	0.4	0.03
	2	0.5	0.13
	3	0.6	0.39
	4	0.5	0.62
	5	0.5	1.04
	6	0.5	0.97
	7	0.4	0.85
	8	0.3	0.73
	9	0.2	0.57
	10	0.2	0.22
	11	0.2	0.05
	12	0.2	0.05
	13	0.2	0.07
	14	0.1	0.04
	15	0.1	0.00
5/24/16	0	0.1	0.00
	1	0.3	0.01
	2	0.4	0.19
	3	0.6	0.56
	4	0.5	0.78
	5	0.4	0.96
	6	0.4	1.03
	7	0.2	0.68
	8	0.2	0.00
	9	0.2	0.00
	10	0.2	0.00
	11	0.1	0.00
6/9/16	0	0.1	0.00
	1	0.3	0.20

	2	0.5	0.40
	3	0.5	0.72
	4	0.3	0.89
	5	0.3	0.95
	6	0.2	0.93
	7	0.1	0.10
6/22/16	0	0.2	0.00
	1	0.3	0.12
	2	0.4	0.58
	3	0.4	0.73
	4	0.4	0.62
	5	0.2	0.44
	6	0.2	0.16
	7	0.1	0.00
7/12/16	0	0.1	0.03
	1	0.1	0.59
	2	0.2	0.48
	3	0.3	0.79
	4	0.3	0.73
	5	0.3	0.41
	6	0.2	0.25
	7	0.1	0.02
7/25/16	0	0.1	0.00
	1	0.3	0.33
	2	0.4	0.42
	3	0.3	0.41
	4	0.3	0.56
	5	0.2	0.42
	6	0.1	0.33
	7	0.1	0.00
8/8/16	0	0.1	0.00
	1	0.2	0.02
	2	0.3	0.27
	3	0.3	0.39
	4	0.3	0.51
	5	0.3	0.53
	6	0.2	0.28
	7	0.2	0.18
8/22/16	0	0.1	0.02
	1	0.2	0.01
	2	0.3	0.02
	3	0.4	0.38
	4	0.4	0.73
	5	0.4	1.10
	6	0.3	0.97
	7	0.2	0.64
	8	0.2	0.43
	9	0.1	0.00
	10	0.1	0.00
9/13/16	0	0.2	0.00
	1	0.3	0.01
	2	0.4	0.09
	3	0.4	0.53
	4	0.4	0.75
	5	0.4	0.97
	6	0.4	0.72
	7	0.2	0.56
	8	0.2	0.04
9/26/16	0	1.6	0.05
	1	2.4	0.16
	2	2.8	0.11
	3	2.8	0.11
	4	2.8	0.13
	5	2.7	0.10
	6	1.8	0.06

Appendix E

Phytoplankton

Lake		**Lotus**	**Lotus**	**Lotus**	**Lotus**	**Lotus**	**Lotus**	**Lotus**	**Lotus**	**Lotus**
year		**2014**	**2014**	**2014**	**2015**	**2015**	**2015**	**2016**	**2016**	**2016**
date		**24-Jun**	**21-Jul**	**14-Aug**	**23-Jun**	**20-Jul**	**18-Aug**	**22-Jun**	**25-Jul**	**22-Aug**
Division	**Taxa**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**	**cells/ml**
Bacillariophyta	Amphora							0.0	0.0	65.7
Bacillariophyta	Asterionella							249.8	0.0	131.5
Bacillariiophyta	Aulacoseira	854	7,799	14,057	3,552	19,925	11,748	7930.2	13100.9	14396.4
Bacillariiophyta	centric sm		77	163		121				
Bacillariophyta	Cymbella				178					
Bacillariiophyta	Fragilaria crotonensis		77		296	845		1810.8	0.0	0.0
Bacillariiophyta	Gomhonema	41						62.4	71.2	0.0
Bacillariiophyta	Naviculoid	122			59			0.0	71.2	0.0
Bacillariophyta	Nitzschia							124.9	71.2	0.0
Bacillariiophyta	Stephanodiscus		154			604	83	62.4	0.0	197.2
Bacillariiophyta	Synedra	407	154	327	237	242	250	1248.9	925.6	0.0
Bacillariiophyta	**Total**	**1,423**	**8,263**	**14,547**	**4,322**	**21,737**	**12,081**	**11,489**	**14,240**	**14,791**
Chlorophyta	Ankistrodesmus	163	695					0.0	71.2	0.0
Chlorophyta	Chlamydomonas		77		59		250	124.9	0.0	65.7
Chlorophyta	Closterium							0.0	0.0	65.7
Chlorophyta	Coccoid greens	81	77	163				187.3	142.4	197.2
Chlorophyta	Cosmarion		77		355		583	0.0	71.2	65.7
Chlorophyta	Crucigenia					483				
Chlorophyta	Dictyosphaerium							2809.9	0.0	197.2
Chlorophyta	Elactothrix							124.9	71.2	65.7
Chlorophyta	Euastrum							0.0	213.6	0.0
Chlorophyta	Franceia	122						62.4	0.0	0.0
Chlorophyta	Gloeocystis				118	362	83	187.3	0.0	0.0
Chlorophyta	Lagerheimia			163			250			
Chlorophyta	Mougeotia	41								
Chlorophyta	Nephrocytium							124.9	0.0	0.0
Chlorophyta	Oocystis	244	695	1,144	1,006	242	583	2123.0	854.4	1709.2
Chlorophyta	Pediastrum	447	1,776	5,230	1,776	1,691	1,000	312.2	996.8	1972.1
Chlorophyta	Scenedesmus	1,057	2,471	9,480	6,631		4,333	3684.1	2705.6	1643.4
Chlorophyta	Schroederia	244								
Chlorophyta	Staurastrum	163				1,570				

Chlorophyta	Tetraedron	163	77	327	414	121	250	124.9	0.0	131.5
Chlorophyta	**Total**	**2,725**	**5,946**	**16,509**	**10,361**	**4,468**	**7,332**	**9,866**	**5,126**	**6,114**
Chrysophyta	Mallomonas		77		59	121		0.0	71.2	0.0
Chrysophyta	Synura		232							
Chrysophyta	**Total**	**0**	**309**	**0**	**59**	**121**	**0**	**0**	**71**	**0**
Cryptomonam	Cryptomonas		309	327	118			999.1	0.0	0.0
Cryptomonam	Komma caudata	41				362		187.3	142.4	0.0
Cryptomonam	**Total**	**41**	**309**	**327**	**118**	**362**	**0**	**1,186**	**142**	**0**
Cyanophyta	Anabaena	16,673								
Cyanophyta	Aphanizomenon flos-aquae	1,708						0.0	4699.2	0.0
Cyanophyta	Aphanocapsa	41		163		15,457	7,999			
Cyanophyta	Aphanothece	773	1,390	192,220						
Cyanophyta	Chroococcus	895	927	5,067	1,480	2,657		0.0	427.2	7822.7
Cyanophyta	Gloeocystis			327						
Cyanophyta	Gomphosphaeria							6244.3	1424.0	42071.6
Cyanophyta	Merismopedia							0.0	3132.8	0.0
Cyanophyta	Microcystis	7,808	11,892	172,605	17,703	10,989	33,578	9054.2	13528.1	12161.3
Cyanophyta	Phormidia							562.0	0.0	0.0
Cyanophyta	Planktolyngbya	21,635	31,892	56,064		192,369	57,741			
Cyanophyta	Planktothrix					24,152	8,665			
Cyanophyta	Schizothrix	732	27,799	16,182				23603.3	78178.4	34906.3
Cyanophyta	**Total**	**50,264**	**73,900**	**442,628**	**19,183**	**245,624**	**107,983**	**39,464**	**101,390**	**96,962**
Euglenophyta	Euglena	81	77					124.9	0.0	0.0
Euglenophyta	**Total**	**81**	**77**	**0**	**0**	**0**	**0**	**125**	**0**	**0**
Pyrrhophyta	Ceritum	41								
Pyrrhophyta	Peridinium		77							
Pyrrhophyta	**Total**	**41**	**77**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Appendix F

Zooplankton

Zooplankton of Big Blake and Lotus Lakes, Polk County (WI) 2013-2016.

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Figure 1. *Bosmina coregoni* from Big Blake Lake, Polk Co., WI, 2015. Field of view = 0.65 mm. Photo T. Lafrançois.

Suggested citation: Lafrançois, T. 2016. Zooplankton of Big Blake and Lotus Lakes, Polk County (WI) 2013-2016. Final report to Polk County Land & Water Resources Department, Polk Co. WI.

Eighteen samples from Big Blake and Lotus Lakes in Polk County were examined for zooplankton species abundances. Final data and basic community analyses have been sent with this report as an attachment in Microsoft Excel.

Methods

Zooplankton samples were collected by Polk Co. with WI plankton nets using known depths for volumetric calculation and preserved in ETOH. Laboratory methods used a dual counting technique for different size fractions modified from Chick et al. 2006 and Chick et al. 2010. This process has been found to be cost-effective and statistically robust in nearby systems (Lafrancois 2009, Lafrancois 2013, Lafrancois *et al*. 2016). Samples were condensed on a 20 µm filter, transferred to 40 mL centrifuge tubes and diluted to between 20 and 40 ml depending on sample density. This volume was rigorously agitated, sub-sampled with a 1mL Hensen-Stempel pipette, and transferred to a 1mL Sedgwick Rafter counting slide. Organisms of all size fractions were counted on a compound microscope at magnifications of 40x to 100x using an Olympus CX41 compound microscope. Counts of rotifers and protists were tallied row by row (1/20 ml increments) on the Sedgwick Rafter cell until stable variance in taxa diversity was achieved (Colwell & Coddington 1994). Stable variance in taxonomic diversity and total number for these samples was achieved when at least 50 individuals of smaller species were counted (with volume counted between 0.6 and 2 ml out of 20-40 ml). The larger organisms (copepods and cladocerans) were then counted for the entire cell and checked against the entire sample. Insecta were counted from the entire sample, but in this case only one *Chaoborus* sp. was found in one sample. At least two aliquots were counted in this manner for each sample. Standard identification keys were used from Thorp & Covich (2010) to allow cross study comparison. Zooplankton counts were converted from numbers per subsample to number per liter (n/l).

Results and Summary

Thirty-eight species / lowest practically identifiable taxa from Big Blake Lake and thirty seven from Lotus Lake were identified from samples reported here (2013 to 2016), Tables 1 and 2 respectively. Basic diversity measures are presented in Table 3.

Figure 2. *Trichocerca elongata* and *Filinia longiseta* from Lotus Lake, Polk Co., WI (field of view 1mm across).

Community composition baselines are shown in Figures 3 and 4, with numbers per liter of four primary taxonomic groups. Rotifera are small multicellular organisms that generally feed on bacteria and algae. Cladocerans are crustacean plankton that are typically grazers, and copepods are crustacean often size selective omnivores or predators. Testate protozoa are single celled organisms that leave behind a shell used for identification and counting. It is unclear whether testate protozoa correlate to the total protozoan community, or perhaps are inverse (increasing at the expense of other soft protozoa that leave no trace in preserved samples). They are included because they may indicate run-off events and could be important to long term monitoring as knowledge of this group's ecology develops.

Zooplankton occupy an ecologically critical position between top-down (e.g., fish predation) and bottom-up (e.g., eutrophication) processes. Typically zooplankton will increase in abundance over the summer, and peak in August or September, tracking overall productivity. However, patterns can change as the community responds to fish stocking and growth, temperature, algal growth and community change – particularly due to nutrients and eutrophication, and other factors. Looking *just* at the community patterns over time gives some insight into these processes but is most meaningful when coupled with environmental and fish stocking data. That said, some general patterns stick out.

Big Blake Lake shows some interesting patterns in 2013, where a typical phenological pattern appears in June and July with a crash in August (Fig. 3). This crash is someone unexpected since August tends to be a very productive year. Environmental factors need to be analyzed to explain this change, which would typically occur later in October or November. The 2014 trends show a more typical response with an unexpected drop in rotifers in July but otherwise a slow increase into the most productive months. In 2015 there was a major increase in copepods over the summer, with a decline in rotifers that could be associated with copepod predation, and a decrease in cladocerans. The cladoceran decrease could be due to either fish pressure or a change in algal community structure. The concurrent increase in copepods suggests that a bottom-up mechanism is more likely, since planktivorous fish tend to favor cladocerans but also enjoy copepods, being mostly size selective.

Lotus Lake produced an order of magnitude greater density of zooplankton than Big Blake in 2014 and 2015 with a curious crash in 2016 for all groups except rotifers in June (Fig. 4). In 2014 and 2015 there was a bump in zooplankton populations, all groups, in July. One particularly notable spike of rotifers in June 2016, Lotus Lake, is primarily due to *B. angularis*, *F. longiseta*, and *Collotheca* sp. (probably *C. mutabilis*). The first two rotifer specie are indicators of eutrophic conditions, combined with *Collotheca* sp. in this spike it would appear to relate to a bacterial bloom related to high nutrients and/or high temperatures (Pejler 1983, Walz 1993, Mola 2011).

A simple principle components ordination based on Bray-Curtis similarities helps sort out the complex of species level community composition. Environmental factors were not tested at this time. The ordination shows community similarity between lakes and sample periods, both month and year (Figure 5). This ordination confirms that there are differences between the zooplankton communities in Big Blake and Lotus Lake across the x-axis, which explains 66.2% of variation in community similarity. Samples from Lotus Lake also spread out a bit more, showing what look to be important groups of different community patters. All of the patterns pointed out here between and within Big Blake and Lotus Lake will be best explained when these results are compared to the larger data set of all factors from these lakes.

Table 1. Lowest identified taxa from Big Blake Lake, Polk County (WI) 2013-2015 with total percent occurrence.

Rotifera	
Adineta sp.	0.77%
Ascomorpha sp.	0.46%
Collotheca sp.	0.15%
Conochilus unicornis	5.11%
Filinia longiseta	2.01%
Filinia terminalis	0.31%
Gastropus sp.	0.62%
Keratella cochlearis	20.59%
Keratella cochlearis robusta	4.49%
Monostyla bulla	0.15%
Polyarthra sp.	0.31%
Polyarthra dolichoptera	1.08%
Polyarthra euryptera	2.17%
Polyarthra remata	8.98%
Pompholyx sulcata	0.31%
Synchaeta sp.	1.55%
Trichocerca cylindrica	0.62%
Trichocerca pusilla	1.55%
Trichocerca longiseta	0.15%
unidentified rotifer	0.62%

testate Protista	
Difflugia globosa	0.31%
Difflugia lobostoma	0.62%

Insecta	
Chaoborus sp.	0.15%

Cladocera	
Bosmina coregoni	0.15%
Bosmina longirostris	0.77%
Ceriodaphnia sp.	0.15%
Ceriodaphnia quadrangula	0.31%
Chydorus sp.	0.31%
Diaphanosoma sp.	1.86%
Daphnia ambigua	0.46%
Daphnia mendotae	3.72%
Daphnia retrocurva	0.93%
Holopedium gibberum	0.15%

Copepoda	
cyclopoid nauplius	16.25%
cyclopoid copepodid	14.24%
calanoid nauplius	1.08%
calanoid copepodid	2.17%
Diacyclops spp.	2.48%
Megacyclops viridis	0.31%
Mesocyclops sp.	0.31%
Diaptomidae	0.31%
Skistodiaptomus oregonensis	0.93%

Table 2. Lowest identified taxa from Lotus Lake, Polk County (WI) 2013-2016 with total percent occurrence.

Rotifera	
Anuraeopsis fissa	4.58%
Aplanchna priodonta	0.52%
Brachionus angularis	6.15%
Collotheca sp.	3.01%
Conochilus unicornis	0.13%
Filinia longiseta	8.50%
Kellicottia longispina	0.78%
Keratella cochlearis cochlearis	30.09%
Keratella cochlearis hispida	0.13%
Keratella cochlearis robusta	0.26%
Polyarthra euryptera	0.13%
Polyarthra remata	0.92%
Pompholyx sulcata	8.37%
Trichocerca (bicristata)	0.92%
Trichocerca cylindrica	0.65%
Trichocerca elongata	0.13%
Trichocerca pusilla	0.26%
Trichocerca multicrinis	0.13%
Trichocerca similis	0.26%
unidentified rotifer	0.52%

testate protista	
Arcella gibbosa	0.65%
Centropyxis aerophila	0.26%
Codonella sp.	1.57%
Difflugia oblonga	0.13%
Difflugia lobostoma	10.33%
unidentified protist	0.13%

Copepoda	
cyclopoid nauplius	4.84%
cyclopoid copepodid	3.79%
calanoid nauplius	0.52%
calanoid copepodid	0.16%
Diacyclops spp.	1.44%
Paracyclops chiltoni	1.18%
Diaptomidae	0.02%
Skistodiaptomus oregonensis	0.03%

Cladocera	
Bosmina coregoni	0.78%
Bosmina leideri	0.52%
Chydorus sphaericus	1.45%
Daphnia ambigua	0.92%
Daphnia mendotae	3.01%
Daphnia retrocurva	1.80%
Sida sp.	0.01%

Table 3. Diversity indices for Big Blake and Lotus Lakes, 2013 to 2016, Polk Co., WI including S (raw number of species or lowest identified taxa), d (Margaleff Diversity), J' (Pielou's index), Brillouin and Fisher indices, H' (Shannon index, natural log) and in the last column the inverse Simpson index.

Sample	S	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
BBlakeJune2013	13	4.24	0.73	1.20	25.49	1.86	0.79
BBlakeJuly2013	16	4.19	0.82	1.84	11.03	2.27	0.88
BBlakeAug2013	9	3.20	0.95	1.40	15.74	2.09	0.94
BBlakeJune2014	9	2.79	0.91	1.48	7.39	1.99	0.89
BBlakeJuly2014	12	4.49	0.87	1.40	****	2.16	0.93
BBlakeAug2014	14	3.88	0.83	1.70	10.90	2.20	0.89
BBlakeJune2015	18	4.65	0.77	1.84	13.11	2.24	0.86
BBlakeJuly2015	14	3.49	0.79	1.72	7.43	2.09	0.84
BBlakeAug2015	15	3.98	0.72	1.57	10.40	1.95	0.82
LotusJune2014	10	1.77	0.67	1.43	2.36	1.54	0.66
LotusJuly2014	19	2.70	0.75	2.19	3.51	2.22	0.86
LotusAug2014	14	2.50	0.85	2.11	3.53	2.23	0.86
LotusJune2015	21	3.94	0.83	2.35	6.47	2.53	0.90
LotusJuly2015	14	2.44	0.88	2.22	3.40	2.32	0.88
LotusAug2015	14	3.08	0.88	2.00	5.35	2.32	0.88
LotusJune2016	11	1.48	0.57	1.34	1.78	1.36	0.59
LotusJuly2016	12	2.91	0.90	1.92	5.45	2.23	0.89
LotusAug2016	11	2.81	0.78	1.59	5.50	1.86	0.77

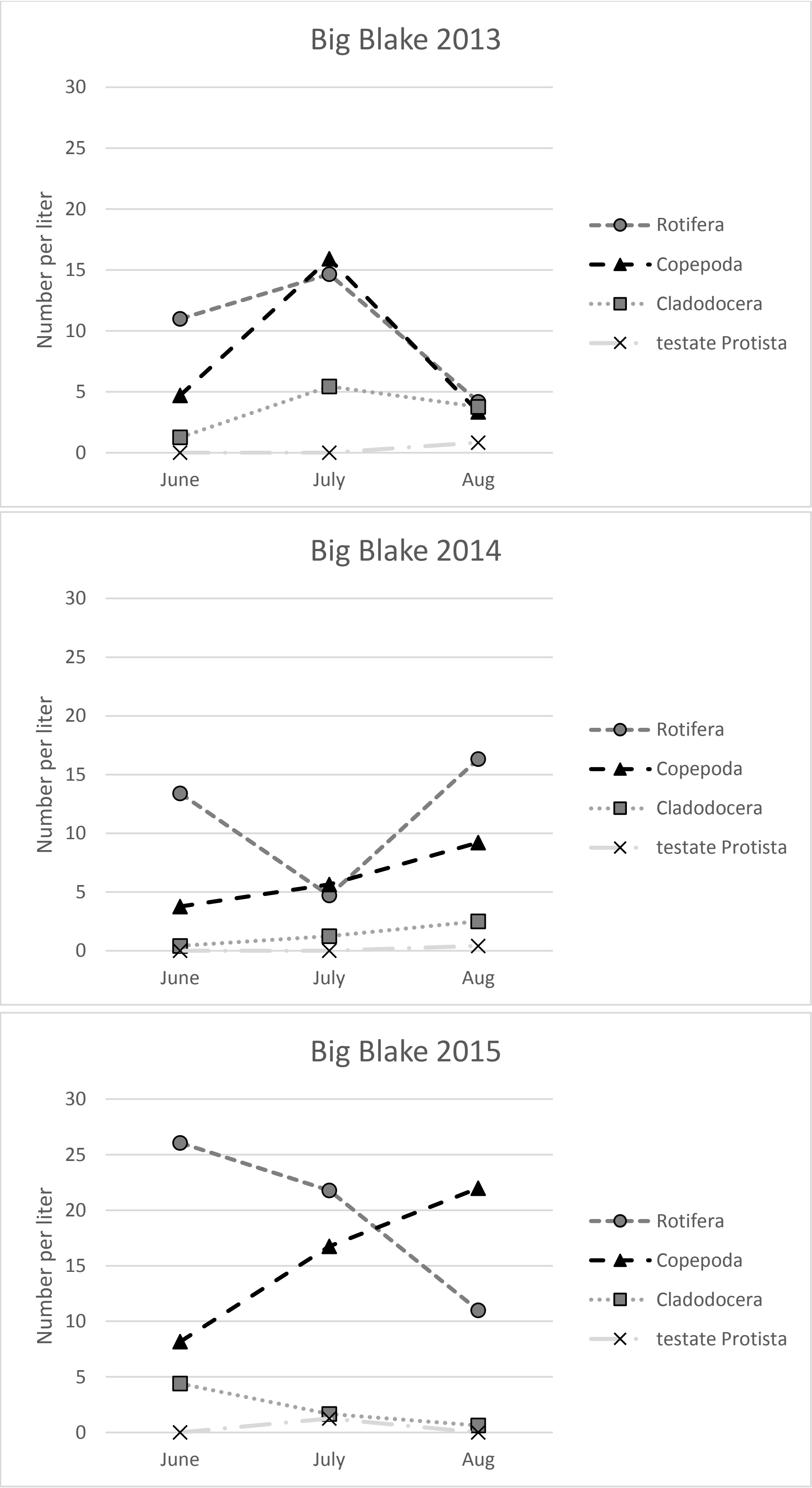

Figure 3. Zooplankton community composition (as total numbers per liter of four primary taxonomic groups) of samples from Big Blake Lake, Polk Co. (WI), 2013 to 2015.

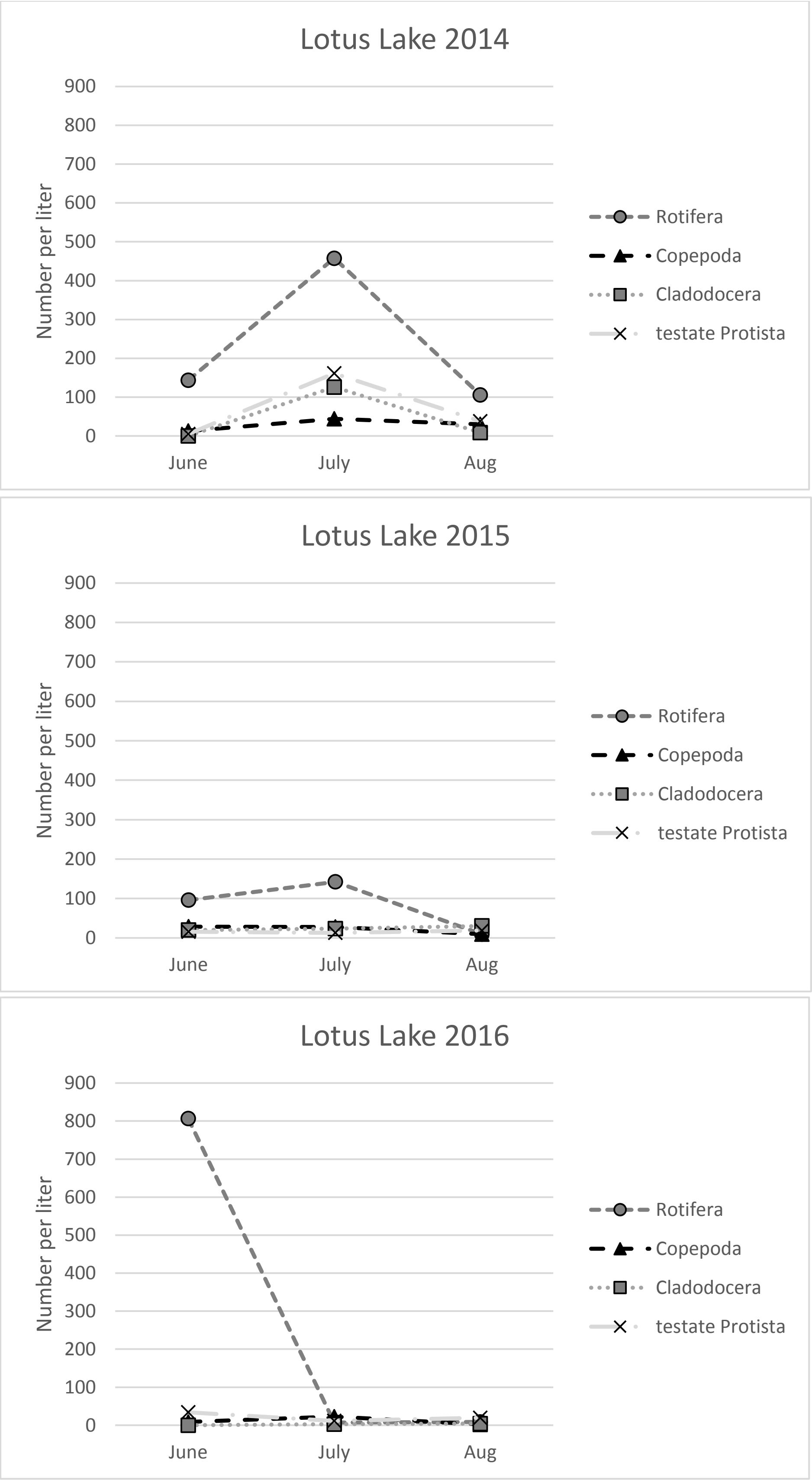

Figure 4. Zooplankton community composition (as total numbers per liter of four primary taxonomic groups) from Lotus Lake, Polk Co. (WI), 2014-2016.

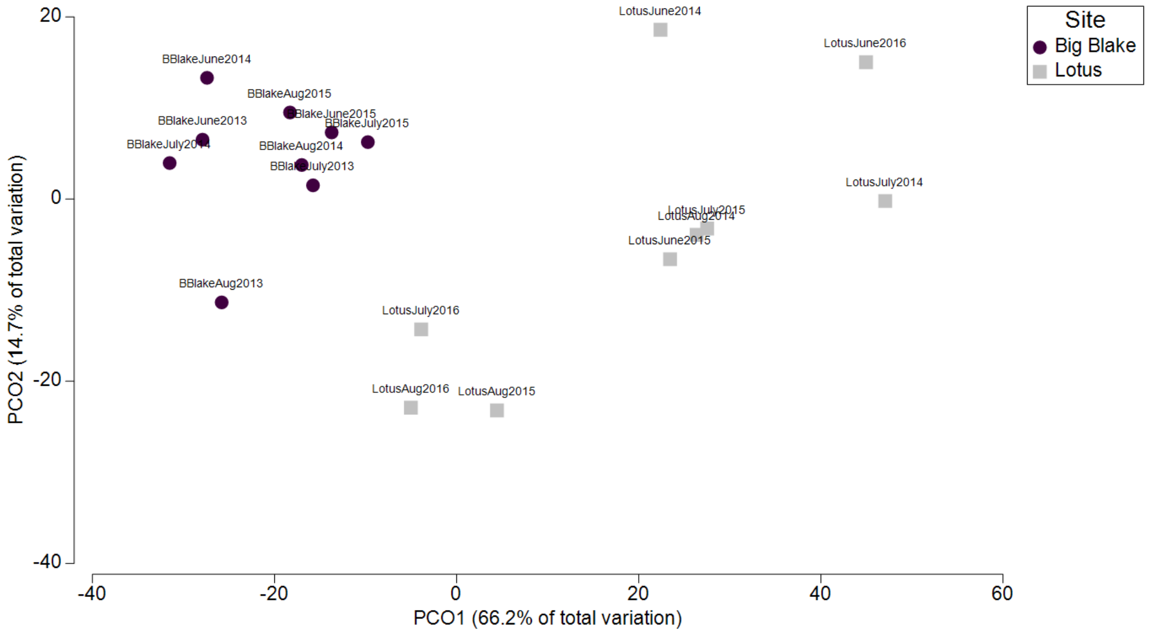

Figure 5. Principal components analysis of zooplankton community composition. Abundances (numbers per liter) were square root transformed before calculating Bray-Curtis resemblance for the ordination. This plot lumped species into major groups to weight the differences between the lakes to show major composition shifts over the more local variations in species. Plot was run in Primer 7 software.

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Sample	S	d	J'	Brillouin	Fisher	H'(loge)	1-Lambda'
	(Raw species diversity)	Margaleff diversity	Pielou's index			Shannon diversity (natural log)	Inverse Simpson
LotusJune2014	10	1.772	0.6696	1.429	2.361	1.542	0.6559
LotusJuly2014	19	2.698	0.7549	2.185	3.505	2.223	0.862
LotusAug2014	14	2.497	0.8453	2.11	3.533	2.231	0.8603
LotusJune2015	21	3.941	0.8316	2.352	6.466	2.532	0.8984
LotusJuly2015	14	2.441	0.8779	2.222	3.399	2.317	0.8781
LotusAug2015	14	3.083	0.8794	1.996	5.353	2.321	0.8803
LotusJune2016	11	1.483	0.5681	1.338	1.784	1.362	0.594
LotusJuly2016	12	2.91	0.8968	1.92	5.451	2.228	0.8881
LotusAug2016	11	2.809	0.7758	1.594	5.496	1.86	0.7679

Number per cubic meter

Site	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus
Month ord	6	7	8	6	7	8	6	7	8
Month	June	July	Aug	June	July	Aug	June	July	Aug
Year	2014	2014	2014	2015	2015	2015	2016	2016	2016
Rotifera	143207	457886	105992	96099	142029	9422	806482	7066	8793
Copepoda	12562	44093	29678	28477	27558	9422	8479	22612	2198
Cladodocera	0	125919	8479	19785	23318	30149	0	2826	4397
testate Protista	5025	161108	38157	15546	12719	18843	33917	11306	19785
Chaoborus sp.	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Adineta sp.	0	0	0	0	0	0	0	0	0
Anuraeopsis fissa	0	0	0	14132	50876	1884	0	0	0
Ascomorpha sp.	0	0	0	0	0	0	0	0	0
Asplanchna brightwelli	0	0	0	0	0	0	0	0	0

Asplanchna herricki	0	0	0	0	0	0	0	0	0
Aplanchna priodonta	0	8479	0	0	0	0	11306	0	0
Brachionus angularis	15074	25438	38157	1413	25438	0	45223	2826	0
Brachionus quadridentatus	0	0	0	0	0	0	0	0	0
Collotheca sp.	17587	0	4240	2826	0	0	30149	2826	1099
Colurella sp.	0	0	0	0	0	0	0	0	0
Conochilus unicornis	0	0	0	1413	0	0	0	0	0
Euchlanis sp.	0	0	0	0	0	0	0	0	0
Filinia longiseta	0	118711	46637	25438	27558	0	33917	0	0
Filinia terminalis	0	0	0	0	0	0	0	0	0
Gastropus sp.	0	0	0	0	0	0	0	0	0
Hexarthra mira	0	0	0	0	0	0	0	0	0
Kellicottia bostoniensis	0	0	0	0	0	0	0	0	0
Kellicottia longispina	0	0	0	0	0	0	22612	0	0
Keratella crassa	0	0	0	0	0	0	0	0	0
Keratella cochlearis cochlearis	90447	118711	4240	33917	25438	1884	516299	1413	3298
Keratella cochlearis hispida	2512	0	0	0	0	0	0	0	0
Keratella cochlearis robusta	0	0	0	0	0	3769	0	0	0
Keratella cochlearis tecta	0	0	0	0	0	0	0	0	0
Keratella earlinae	0	0	0	0	0	0	0	0	0
Lecane luna	0	0	0	0	0	0	0	0	0
Monostyla bulla	0	0	0	0	0	0	0	0	0
Monostyla closterocerca	0	0	0	0	0	0	0	0	0
Monostyla lunaris	0	0	0	0	0	0	0	0	0
Monostyla quadridentata	0	0	0	0	0	0	0	0	0
Notholca squamula	0	0	0	0	0	0	0	0	0
Notholca acuminata var extensa	0	0	0	0	0	0	0	0	0
Notomata sp.	0	0	0	0	0	0	0	0	0
Polyarthra sp.	0	0	0	0	0	0	0	0	0
Polyarthra dolichoptera	0	0	0	0	0	0	0	0	0
Polyarthra euryptera	0	0	0	0	0	0	0	0	1099

Polyarthra major	0	0	0	0	0	0	0	0	0
Polyarthra remata	0	8479	0	8479	0	0	0	0	0
Polyarthra vulgaris	0	0	0	0	0	0	0	0	0
Pompholyx sulcata	12562	169587	0	1413	0	0	143207	0	0
Proales sp.	0	0	0	0	0	0	0	0	0
Synchaeta sp.	0	0	0	0	0	0	0	0	0
Trichocerca (bicristata)	0	8479	0	2826	8479	0	0	0	0
Trichocerca cylindrica	0	0	8479	0	4240	0	3769	0	0
Trichocerca elongata	0	0	4240	0	0	0	0	0	0
Trichocerca pusilla	5025	0	0	0	0	0	0	0	0
Trichocerca lata	0	0	0	0	0	0	0	0	0
Trichocerca longiseta	0	0	0	0	0	0	0	0	0
Trichocerca multicrinis	0	0	0	0	0	1884	0	0	0
Trichocerca similis	0	0	0	2826	0	0	0	0	0
Trichotria tetractis	0	0	0	0	0	0	0	0	0
Trocosphaera sp.	0	0	0	0	0	0	0	0	0
unidentified rotifer	0	0	0	1413	0	0	0	0	3298
cyclopoid nauplius	7537	25438	4240	12719	12719	1884	7537	8479	0
cyclopoid copepodid	2512	8479	16959	8479	8479	5653	0	5653	2198
calanoid nauplius	2512	8479	0	0	0	0	0	1413	0
calanoid copepodid	0	0	0	1413	0	0	942	0	0
Acanthocyclops sp.	0	0	0	0	0	0	0	0	0
Cyclops sp.	0	0	0	0	0	0	0	0	0
Diacyclops spp.	0	0	0	5653	0	1884	0	4240	0
Megacyclops viridis	0	0	0	0	0	0	0	0	0
Mesocyclops sp.	0	0	0	0	0	0	0	0	0
(Metacyclops sp.)	0	0	0	0	0	0	0	0	0
Microcyclops sp.	0	0	0	0	0	0	0	0	0
Paracyclops chiltoni	0	0	8479	0	6360	0	0	2826	0
[Thermocyclops crassus]	0	0	0	0	0	0	0	0	0
Diaptomidae	0	0	0	212	0	0	0	0	0

(Arctodiaptomus arapahoensis)	0	0	0	0	0	0	0	0	0
Heterocope septeptrionalis	0	0	0	0	0	0	0	0	0
(Limnocalanus sp.)	0	0	0	0	0	0	0	0	0
(Osphrantium sp.)	0	0	0	0	0	0	0	0	0
Skistodiaptomus oregonensis	0	1696	0	0	0	0	0	0	0
(Senecella calanoides)	0	0	0	0	0	0	0	0	0
Bosmina coregoni	0	0	0	8479	0	0	0	0	0
Bosmina leideri	0	0	0	2826	0	0	0	1413	0
Bosmina longirostris	0	0	0	0	0	0	0	0	0
Bosmina longispina	0	0	0	0	0	0	0	0	0
Ceriodaphnia sp.	0	0	0	0	0	0	0	0	0
Ceriodaphnia lacustris	0	0	0	0	0	0	0	0	0
Ceriodaphnia laticaudata	0	0	0	0	0	0	0	0	0
Ceriodaphnia pulchella	0	0	0	0	0	0	0	0	0
Ceriodaphnia quadrangula	0	0	0	0	0	0	0	0	0
Chydorus sp.	0	0	0	0	0	0	0	0	0
Chydorus faviformis	0	0	0	0	0	0	0	0	0
Chydorus sphaericus	0	424	0	7066	2120	1884	0	1413	2198
Diaphanosoma sp.	0	0	0	0	0	0	0	0	0
Daphnia ambigua	0	59356	0	0	0	0	0	0	0
Daphnia mendotae	0	59356	4240	1413	8479	18843	0	0	0
Daphnia parvula	0	0	0	0	0	0	0	0	0
Daphnia pulex	0	0	0	0	0	0	0	0	0
Daphnia retrocurva	0	6360	4240	0	12719	9422	0	0	1099
Holopedium gibberum	0	0	0	0	0	0	0	0	0
Leptodora kindtii	0	0	0	0	0	0	0	0	0
Acroperus harpae	0	0	0	0	0	0	0	0	0
Camptocercus sp.	0	0	0	0	0	0	0	0	0
Paralona pigra	0	0	0	0	0	0	0	0	1099
Sida sp.	0	424	0	0	0	0	0	0	0
Simocephalus mirabilis	0	0	0	0	0	0	0	0	0

Arcella gibbosa	0	0	4240	0	0	7537	0	0	0
Centropyxis aerophila	0	0	0	0	0	3769	0	0	0
Codonella sp.	0	8479	12719	0	4240	3769	0	1413	2198
Cyclopyxis arcelloides	0	0	0	0	0	0	0	0	0
Difflugia globosa	0	0	0	0	0	0	0	0	0
Difflugia oblonga	0	8479	0	0	0	0	0	0	0
Difflugia lobostoma	5025	144149	21198	15546	8479	3769	33917	9893	16488
Trinema sp.	0	0	0	0	0	0	0	0	0
unidentified protist	0	0	0	0	0	0	0	0	1099

Number per liter

Site	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus	Lotus
Month ord	6	7	8	6	7	8	6	7	8
Month	June	July	Aug	June	July	Aug	June	July	Aug
Year	2014	2014	2014	2015	2015	2015	2016	2016	2016
Rotifera	143.2	457.9	106.0	96.1	142.0	9.4	806.5	7.1	8.8
Copepoda	12.6	44.1	29.7	28.5	27.6	9.4	8.5	22.6	2.2
Cladodocera	0.0	125.9	8.5	19.8	23.3	30.1	0.0	2.8	4.4
testate Protista	5.0	161.1	38.2	15.5	12.7	18.8	33.9	11.3	19.8
Chaoborus sp.	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Adineta sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anuraeopsis fissa	0.0	0.0	0.0	14.1	50.9	1.9	0.0	0.0	0.0
Ascomorpha sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asplanchna brightwelli	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asplanchna herricki	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aplanchna priodonta	0.0	8.5	0.0	0.0	0.0	0.0	11.3	0.0	0.0
Brachionus angularis	15.1	25.4	38.2	1.4	25.4	0.0	45.2	2.8	0.0
Brachionus quadridentatus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Collotheca sp.	17.6	0.0	4.2	2.8	0.0	0.0	30.1	2.8	1.1

Colurella sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conochilus unicornis	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Euchlanis sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Filinia longiseta	0.0	118.7	46.6	25.4	27.6	0.0	33.9	0.0	0.0
Filinia terminalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gastropus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hexarthra mira	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kellicottia bostoniensis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kellicottia longispina	0.0	0.0	0.0	0.0	0.0	0.0	22.6	0.0	0.0
Keratella crassa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Keratella cochlearis cochlearis	90.4	118.7	4.2	33.9	25.4	1.9	516.3	1.4	3.3
Keratella cochlearis hispida	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Keratella cochlearis robusta	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0
Keratella cochlearis tecta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Keratella earlinae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lecane luna	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostyla bulla	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostyla closterocerca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostyla lunaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monostyla quadridentata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Notholca squamula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Notholca acuminata var extensa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Notomata sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polyarthra sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polyarthra dolichoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polyarthra euryptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Polyarthra major	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polyarthra remata	0.0	8.5	0.0	8.5	0.0	0.0	0.0	0.0	0.0
Polyarthra vulgaris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pompholyx sulcata	12.6	169.6	0.0	1.4	0.0	0.0	143.2	0.0	0.0
Proales sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Synchaeta sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichocerca (bicristata)	0.0	8.5	0.0	2.8	8.5	0.0	0.0	0.0	0.0
Trichocerca cylindrica	0.0	0.0	8.5	0.0	4.2	0.0	3.8	0.0	0.0
Trichocerca elongata	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0
Trichocerca pusilla	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichocerca lata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichocerca longiseta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichocerca multicrinis	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0
Trichocerca similis	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0
Trichotria tetractis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trocosphaera sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
unidentified rotifer	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	3.3
cyclopoid nauplius	7.5	25.4	4.2	12.7	12.7	1.9	7.5	8.5	0.0
cyclopoid copepodid	2.5	8.5	17.0	8.5	8.5	5.7	0.0	5.7	2.2
calanoid nauplius	2.5	8.5	0.0	0.0	0.0	0.0	0.0	1.4	0.0
calanoid copepodid	0.0	0.0	0.0	1.4	0.0	0.0	0.9	0.0	0.0
Acanthocyclops sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclops sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diacyclops spp.	0.0	0.0	0.0	5.7	0.0	1.9	0.0	4.2	0.0
Megacyclops viridis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mesocyclops sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Metacyclops sp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Microcyclops sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paracyclops chiltoni	0.0	0.0	8.5	0.0	6.4	0.0	0.0	2.8	0.0
[Thermocyclops crassus]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diaptomidae	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
(Arctodiaptomus arapahoensis)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heterocope septeptrionalis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Limnocalanus sp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Osphrantium sp.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Skistodiaptomus oregonensis	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(Senecella calanoides)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bosmina coregoni	0.0	0.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0
Bosmina leideri	0.0	0.0	0.0	2.8	0.0	0.0	0.0	1.4	0.0
Bosmina longirostris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bosmina longispina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia lacustris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia laticaudata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia pulchella	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ceriodaphnia quadrangula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chydorus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chydorus faviformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chydorus sphaericus	0.0	0.4	0.0	7.1	2.1	1.9	0.0	1.4	2.2
Diaphanosoma sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daphnia ambigua	0.0	59.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daphnia mendotae	0.0	59.4	4.2	1.4	8.5	18.8	0.0	0.0	0.0
Daphnia parvula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daphnia pulex	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Daphnia retrocurva	0.0	6.4	4.2	0.0	12.7	9.4	0.0	0.0	1.1
Holopedium gibberum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leptodora kindtii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acroperus harpae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Camptocercus sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paralona pigra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Sida sp.	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Simocephalus mirabilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arcella gibbosa	0.0	0.0	4.2	0.0	0.0	7.5	0.0	0.0	0.0
Centropyxis aerophila	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0
Codonella sp.	0.0	8.5	12.7	0.0	4.2	3.8	0.0	1.4	2.2
Cyclopyxis arcelloides	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Difflugia globosa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Difflugia oblonga	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Difflugia lobostoma	5.0	144.1	21.2	15.5	8.5	3.8	33.9	9.9	16.5
Trinema sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
unidentified protist	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1

Appendix G

Point Intercept Aquatic Macrophyte Surveys

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Lotus Lake Polk County WBIC 2616900 **Date:** 6-5-14 **Page 1 of 29**

Observer 1: name and hours: KH JW | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Fil	2 Nym od	3 Nup va	4 SchTa	5 NelLu	6 CerDe	7 Wolfia	8 LemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
1	2.6	S	P	1			1																				
2	4.3	S	P	1			1																				
3	4.8	S	P	1																							
4	5.2	M	P	1																							
5	5.3	M	P	1																							
6	5.3	M	P	1																							
7	5.0	M	P	1																							
8	4.2	S	P	1				V																			
9	5.6	M	P	1																							
10	5.4	M	P	1																							
11	5.7	M	P	1																							
12	5.7	M	P	1																							
13	5.8	M	P	1																							
14	5.9	M	P	1																							
15	5.9	M	P	1																							
16	5.5	M	P	1																							
17	5.3	M	P	1																							
18	3.1	S	P	1				1																			
19	2.1	S	P	1				V	V																		
20	5.6	M	P	1																							
21	5.8	M	P	1																							
22	6.1	M	P	1																							
23	6.4	M	P	1																							
24	6.7	M	P	1																							
25	6.6	M	P	1																							
26	6.7	M	P	1																							
27	6.5	M	P	1																							
28	6.4	M	P	1																							
29	6.3	M	P	1																							
30	5.5	M	P	1																							

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Lotus Lake Polk County WBIC 2616900 Date: **Page 2 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Fil	2 Nym od	3 Nup va	4 Sch ta	5 Nel Lu	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	5.1	S	P	1																							
32	4.0			1				V			V																
33	5.3																										
34	5.4																										
35	5.8																										
36	6.1																										
37	6.4																										
38	6.6																										
39	6.7																										
40	6.6																										
41	6.5																										
42	6.5																										
43	6.3																										
44	6.0																										
45	5.5	M	P	1																							
46	3.5	S	P	1							V																
47	2.6	S	P					1			V																
48	5.4																										
49	5.9																										
50	6.1																										
51	6.5																										
52	6.8																										
53	6.9																										
54	7.0																										
55	7.3																										
56	7.3																										
57	7.3																										
58	7.2																										
59	7.0																										
60	6.5																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 3 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fil	2 NymOd	3 NurVa	4 SchTa	5 NelLy	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	6.2																										
62	5.6																										
63	4.4	S	P					V			V																
64	5.3																										
65	5.4																										
66	6.4																										
67	6.6																										
68	7.0																										
69	7.5																										
70	7.5																										
71	7.7																										
72	7.9																										
73	7.6																										
74	7.5																										
75	7.3																										
76	7.2																										
77	6.4																										
78	5.8																										
79	3.7	S	P							V																	
80	4.3	M	P																								
81	5.5																										
82	6.0																										
83	6.6																										
84	7.2																										
85	7.5																										
86	7.9																										
87	8.2																										
88	8.4																										
89	8.6																										
90	8.4																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 4 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fil	2 Nymod	3 NupVa	4 SchTa	5 NelLu	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	8.2																										
92	7.7																										
93	7.1																										
94	6.7																										
95	6.1																										
96	5.7																										
97	4.0							V			V	V															
98	5.0																										
99	6.2																										
100	6.5																										
101	7.1																										
102	7.5																										
103	8.1																										
104	8.0																										
105	8.5																										
106	8.6																										
107	8.9																										
108	8.8																										
109	8.4																										
110	8.0																										
111	7.4																										
112	7.1																										
113	6.0																										
114	4.6	S	P								V																
115	3.7	S	P					V	V		V																
116	5.5																										
117	6.3																										
118	6.5																										
119	7.6																										
120	7.7																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 5 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fl	2 Nymod	3 Nupla	4 SchTa	5 NelLu	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	8.1																										
122	8.3																										
123	9.0																										
124	9.2																										
125	9.6																										
126	9.4																										
127	8.8																										
128	8.2																										
129	7.3																										
130	6.4																										
131	5.8																										
132	5.5																										
133	3.6	S	P					✓	✓		✓																
134	5.3																										
135	6.7																										
136	6.7																										
137	7.0																										
138	6.6																										
139	6.8																										
140	8.2																										
141	7.7																										
142	8.5																										
143	8.6																										
144	9.1																										
145	9.3																										
146	8.6																										
147	8.3																										
148	6.4																										
149	6.1																										
150	5.4																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 6 of 29**

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Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fl	2 Nymod	3 NupVa	4 SchTa	5 NelLu	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	4.3	M	P					✓																			
152	2.4	S	P					✓			✓																
153	4.7																										
154	6.4																										
155	7.1																										
156	7.1																										
157	7.5																										
158	7.9																										
159	8.1																										
160	8.6																										
161	8.1																										
162	9.0																										
163	9.4																										
164	9.1																										
165	8.4																										
166	7.6																										
167	6.5																										
168	5.9																										
169	5.1																										
170	3.3	S	P					✓	1	✓																	
171	2.5	S	P					|																			
172	3.8	M	P					✓																			
173	6.6																										
174	6.7																										
175	7.1																										
176	7.2																										
177	7.5																										
178	7.5																										
179	7.9																										
180	7.5																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 7 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Fl	2 Nymod	3 NupVa	4 SchTa	5 NelLu	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
181	8.0																										
182	8.2																										
183	8.4																										
184	7.7																										
185	7.0																										
186	6.4																										
187	5.9																										
188	5.0	M	P																								
189	3.0	S	P					V																			
190	5.9																										
191	6.5																										
192	7.2																										
193	6.7																										
194	7.1																										
195	7.4																										
196	7.5																										
197	7.5																										
198	7.5																										
199	7.5																										
200	7.5																										
201	6.9																										
202	6.3																										
203	6.1																										
204	5.3																										
205	4.8	M	P																								
206	1.6	S	P					V	1																		
207	4.9																										
208	6.3																										
209	6.5																										
210	6.4																										

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Lotus Lake Polk County WBIC 2616900 Date: **Page 8 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fl	2 Nymod	③ Nupva	4 SchTa	⑤ NelLu	⑥ Cerpe	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
211	6.5																										
212	6.8																										
213	7.0																										
214	6.9																										
215	7.0																										
216	7.0																										
217	6.8																										
218	6.3																										
219	5.5																										
220	5.2																										
221	5.0																										
222	3.6	S	P								V																
223	5.8																										
224	6.3																										
225	6.3																										
226	6.4																										
227	6.8																										
228	6.9																										
229	6.6																										
230	6.8																										
231	6.8																										
232	6.1																										
233	5.9																										
234	5.0																										
235	4.5																										
236	4.1																										
237	2.4	M	P						V		V	1															
238	4.6	M	P								V																
239	4.7																										
240	5.3																										

Lotus Lake Polk County WBIC 2616900

Date:

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Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fl	2 NymOd	3 NupVa	4 SchTa	5 NelLu	6 Cerbe	7 Wolfia	8 LemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
241	5.6																										
242	5.9																										
243	6.5																										
244	6.3																										
245	6.5																										
246	6.5																										
247	6.6																										
248	5.3																										
249	5.0																										
250	4.7																										
251	1.5	M	P				V	V			V																
252	3.3	M	P				V	1																			
253	4.2	M	P																								
254	4.8																										
255	5.4																										
256	5.6																										
257	5.8																										
258	6.0																										
259	6.0																										
260	6.0																										
261	6.0																										
262	5.3																										
263	4.6	M	P																								
264	1.5	M	P				V				1	V	V														
265	2.2	M	P				1	V			1																
266	3.6	M	P				V	V																			
267	4.4	M	P																								
268	4.7																										
269	4.8																										
270	5.0																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 10 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fil	2 Nymod	3 NupVa	4 SchTa	5 NelLu	6 CerDe	7 Wolfia	8 LemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
271	5.2																										
272	5.4																										
273	5.5																										
274	5.3																										
275	4.4	M	P																								
276	1.5	S	P					✓				1	✓	✓													
277	1.5	S	P					✓				1		✓													
278	2.1	M	P					1	1			1		✓													
279	2.9	M	P					✓	✓																		
280	4.0	M	P																								
281	4.6	M	P																								
282	4.8																										
283	5.1																										
284	5.4																										
285	5.6																										
286	5.1																										
87	3.9	M	P																								
38	1.5	M	P					1	✓				✓	✓													
289	1.8	M	P					✓						✓													
290	2.8	M	P					✓	1																		
291	3.4	M	P	depth= 3.4																							
292	3.7	M	P																								
293	4.3	M	P																								
294	4.6	M	P																								
295	4.7																										
296	4.3	M	P																								
297	4.2	M	P																								
298	1.5	M	P					1	✓				✓	✓													
299	2.0	M	P					✓	1																		
300	2.2	M	P					✓																			

Lotus Lake Polk County WBIC 2616900 Date: **Page 11 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 fl	2 Nymod	3 NupVa	4 SchTa	5 NelLu	6 Cerde	7 WolFi	8 LemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
301	3.2	M	P					V																			
302	3.7	M	P																								
303	4.1	M	P																								
304	4.2	M	P																								
305	3.8	M	P																								
306	3.2	M	P																								
307	15	M	P					1	V				V	V													
308	1.5	M	P																								
309	3.1	M	P					V																			
310	3.1	M	P																								
311	3.3	M	P																								
312	3.7	M	P																								
313	2.8	M	P					V																			
314																											
315																											
316																											
317																											
318																											
319																											
320																											
321																											
322																											
323																											
324																											
325																											
326																											
327																											
328																											
329																											
330																											

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Lotus Lake Polk County WBIC 2616900

Date:

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Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NuLLy	2 NymOd	3 NupVa	4 Sago	5 CerDe	6 EloCa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	2.0	S	P				1																				
2	2.9	S	P				1																				
3	3.8	M	P				1																				
4	4.0	M	P				1																				
5	3.9	M	P				1																				
6	3.8	M	P				1																				
7	3.9	S	P				1																				
8	1.9	S	P					V	1	1																	
9	4.2	M	P				2																				
10	4.2	M	P				1																				
11	4.2	M	P				1																				
12	4.5	M	P				1																				
13	4.4	M	P				1																				
14	4.5	M	P				1																				
15	4.4	M	P				1																				
16	4.1	M	P				1																				
17	3.9	M	P				1																				
* 18	2.6	S	P				V		1																		
19	1.2	S	P				1		V																		
20	3.8	M	P				V																				
21	4.4	M	P				1																				
22	4.6	M	P																								
23	4.7																										
24	5.1																										
25	5.0																										
26	5.0																										
27	4.8																										
28	4.6																										
29	4.3																										
30	4.1	M	P																								

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 2 of ~~29~~ 11**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nulu	2 Nymod	3 Nupva	4 Saso	5 Ceve	6 Eloca	7 SchTa	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	3.1	S	PP						2				V														
32	3.8	M	P				1																				
33	3.8						V																				
34	4.5																										
35	4.8																										
36	5.2																										
37	5.4																										
38	5.5																										
39	5.5																										
40	5.6																										
41	5.6																										
42	5.6																										
43	5.1																										
44	4.8																										
45	4.3																										
46	3.4	S	P						1				V														
47	2.1	S	P				V		1																		
48	4.1	m	P				1																				
49	5.6																										
50	4.7																										
51	5.1																										
52	6.5																										
53	6.1																										
54	6.2																										
55	6.5																										
56	6.3																										
57	6.9																										
58	7.0																										
59	6.2																										
60	5.7																										

Lotus Lake Polk County WBIC 2616900 Date: Page 3 of ~~29~~ 11

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nulu	2 Nymod	3 Nupva	4 Sagp	5 Cerde	6 Eloca	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	4.5																										
62	5.3																										
63	3.3	S	P				3																				
64	4.1	M	P				3																				
65	4.8																										
66	5.4																										
67	5.8																										
68	6.2																										
69	6.4																										
70	6.9																										
71	6.8																										
72	7.0																										
73	7.0																										
74	6.7																										
75	6.3																										
76	5.9																										
77	5.6																										
78	4.9																										
79	4.0	S	P				1																				
80	3.0	M	P				2																				
81	5.1	M	P				1																				
82	5.6																										
83	6.1																										
84	6.6																										
85	7.2																										
86	7.5																										
87	7.8																										
88	7.8																										
89	7.9																										
90	7.8																										

KH JW

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 4 of ~~29~~ 11**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NuLu	2 Nymod	3 NupVa	4 Sase	5 CerDe	6 EloCa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	7.6																										
92	7.1																										
93	6.1																										
94	5.9																										
95	5.7																										
96	5.7	M	P				V																				
97	3.1	S	P				3																				
98	4.7	M	P				3																				
99	5.5																										
100	6.0																										
101	7.4																										
102	7.7																										
103	7.9																										
104	8.5																										
105	8.5																										
106	8.7																										
107	9.2																										
108	8.6																										
109	8.3																										
110	7.9																										
111	6.7																										
112	6.1																										
113	5.4																										
114	4.9	S	P				1																				
115	2.4	S	P				2	V																			
116	5.1	M	P				V																				
117	6.2																										
118	6.2																										
119	6.0																										
120	6.6																										

KH JW

Lotus Lake Polk County WBIC 2616900 **Date:** 8/26/14 **Page 5 of** ~~29~~ 11

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nullu	2 Nymod	3 Nupva	4 Saso	5 Cerde	6 Eloca	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	7.1																										
122	7.4																										
123	7.8																										
124	8.0																										
125	8.2																										
126	8.3																										
127	7.9																										
128	7.4																										
129	6.3																										
130	5.6																										
131	4.8						V																				
132	4.2	M	P				V																				
133	1.8	S	P				V	V	1																		
134	4.6	M	P				3																				
135	5.3																										
136	5.3																										
137	5.6																										
138	5.9																										
139	6.5																										
140	7.1																										
141	7.4																										
142	7.7																										
143	8.1																										
144	8.6																										
145	8.4																										
146	7.8																										
147	7.0																										
148	5.6																										
149	4.8																										
150	4.1	M	P				1																				

Lotus Lake Polk County WBIC 2616900 | **Date:** | **Page 6 of ~~29~~ 11**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NuLu	2 NyMod	3 NupVa	4 Sago	5 CerDe	6 EloCa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	3.3	m	P				V	1																			
152	1.4	S	P				1	V																			
153	3.4	m	P				V																				
154	5.4																										
155	5.7																										
156	5.9																										
157	6.3																										
158	6.7																										
159	6.9																										
160	7.1																										
161	6.8																										
162	7.5																										
163	7.9																										
164	8.1																										
165	7.7																										
166	6.7																										
167	5.6																										
168	5.1	M	P				V																				
169	4.1	M	P				V																				
170	3.2	M	P					V																			
171	1.8	mS	P					2	V																		
172	3.0	M	P				3																				
173	5.0																										
174	5.5																										
175	5.8																										
176	5.9																										
177	6.4																										
178	6.5																										
179	6.8																										
180	6.9																										

KH JW

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 7 of ~~29~~ 11**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nully	2 Nymod	3 Nupva	4 Sago	5 Cerde	6 Eloca	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
181	7.0																										
182	7.4																										
183	7.2																										
184	6.6																										
185	6.0																										
186	5.5																										
187	4.8																										
188	3.8	M	P				V																				
189	2.1	m	P				1	V																			
190	4.9	m	P				V																				
191	5.4																										
192	5.6																										
193	5.7																										
194	6.0																										
195	6.1																										
196	6.2																										
197	6.1																										
198	6.2																										
199	6.2																										
200	6.3																										
201	5.7																										
202	5.1																										
203	4.9																										
204	4.6	m	P				2	V																			
205	3.6	m	P				V																				
206	1.0	S	P					1	1																		
207	4.2	m	P				2																				
208	5.8																										
209	5.5																										
210	5.7																										

KH JW 8/26/14

Lotus Lake Polk County WBIC 2616900 Date: Page 8 of ~~29~~ 11

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nulu	2 NyMod	3 NupVa	4 Sago	5 CerDe	6 EloCa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
211	6.1																										
212	6.3																										
213	6.4																										
214	6.3																										
215	6.3																										
216	6.5																										
217	6.1																										
218	5.6																										
219	5.2																										
220	5.1																										
221	4.6	M	P																								
222	2.5	m	P				1																				
223	3.9	m	P				3																				
224	5.1																										
225	4.9																										
226	5.4																										
227	5.7																										
228	5.7																										
229	5.7																										
230	5.6																										
231	5.6																										
232	5.5																										
233	5.1																										
234	4.5																										
235	3.9																										
236	3.6	S	P						1																		
237	2.0	m	P				3																				
238	2.9	m	P				3																				
239	3.2	m	P				V																				
240	4.4																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 9 of ~~29~~ 11**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nully	2 Nymod	3 Nupva	4 Saso	5 Cevde	6 Elola	7 LemMi	8	9	10	11	12	13	14	15	16	17	18	19	20	21
241	4.5																										
242	4.9																										
243	5.1																										
244	5.2																										
245	5.2																										
246	5.1																										
247	5.1																										
248	4.4																										
249	3.9	m	P																								
250	3.6	m	P				1																				
251	1.5	m	P					V			2		V														
252	3.0	S	P				V	V	V																		
253	3.1	m	P																								
254	3.4																										
255	4.4																										
256	4.3																										
257	4.2																										
258	4.6																										
259	4.4																										
260	4.8																										
261	4.5																										
262	4.0	m	P				V																				
263	3.6	m	P				2																				
264	Shallow																										
265	1.2							V			1		V														
266	2.6							2	V																		
267	3.1																										
268	3.4																										
269	3.4																										
270	3.7																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 10 of ~~29~~ 11**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nully	2 Nymod	3 Nupva	4 Sago	5 Cerde	6 Eloca	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
271	4.1																										
272	4.1																										
273	4.5																										
274	4.1	M	P				3																				
275	3.5	M	P				V																				
276	shallow																										
277	shallow																										
278	1.7	M	P					1	1		V																
279	2.5																										
280	3.3																										
281	3.3																										
282	3.3																										
283	3.4																										
284	3.6																										
285	3.9																										
286	2.9																										
287	3.1	M	P																								
288	shallow																										
289	1.2	M	P				V	V	V		V																
290	1.7	M	P					V	1		V																
291	2.2	M	P				V	V																			
292	2.6																										
293	2.9																										
294	3.4																										
295	3.2																										
296	2.9																										
297	2.9	M	P				V																				
298	shallow																										
299	shallow																										
300	shallow																										

mudflats/Lotus

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 11 of ~~29~~ 11**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NulLu	2 Nymod	3 Nupla	4 Sago	5 CerDe	6 EloCa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301	2.1	M	P					✓																			
302	2.1																										
303	2.7	M	P				✓																				
304	2.7																										
305	2.3	M	P				✓																				
306	2.1	M	P				✓																				
307																											
308	Shallow																										
309																											
310	1.7						3	✓																			
311	1.9																										
312	2.2	M	P					✓																			
313	2.0	M	P					✓																			
314																											
315																											
316																											
317																											
318																											
319																											
320																											
321																											
322																											
323																											
324																											
325																											
326																											
327																											
328																											
329																											
330																											

Start time: 9:30 -12:15

6/4/15

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 1 of 29**

Observer 1: name and hours: K.H.

Observer 2: name and hours: J.W.

Observer 3: name and hours: Nick Hodgson

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NUPVA	2 Nymor	3 Nellu	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.3	S																									
2	3.5	S																									
3	4.1																										
4	4.2																										
5	4.1																										
6	3.9																										
7	3.9	S																									
8	2.1	S					V	V																			
9	4.3																										
10	4.5																										
11	4.6																										
12	4.6																										
13	4.7																										
14	4.9																										
15	4.5																										
16	4.2																										
17	4.2																										
18	1.7						V	''																			
19	1.5	S							V																		
20	4.0																										
21	4.7																										
22	4.9																										
23	5.1																										
24	5.2																										
25	5.4																										
26	5.3																										
27	5.1																										
28	4.9																										
29	4.7																										
30	4.3																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 2 of 29**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 Nellu	4 Schta	5 Eloca	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	3.7	S					1/	V/		V/																	
32	3.9	S					V/	V/	V/	V	V/																
33	4.5																										
34	4.8																										
35	5.1																										
36	5.4																										
37	5.6																										
38	5.8																										
39	5.8																										
40	5.7																										
41	5.7																										
42	5.5																										
43	5.4																										
44	5.3																										
45	4.5																										
46	2.7	S					V/	V/		V/																	
47	1.0	S						V/	V/																		
48	4.4																										
49	4.6																										
50	5.1																										
51	5.6																										
52	6.1																										
53	6.2																										
54	6.2																										
55	6.3																										
56	6.2																										
57	6.1																										
58	5.9																										
59	5.7																										
60	5.5																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 3 of 29**

Observer 1: name and hours:
Observer 2: name and hours:
Observer 3: name and hours:
Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 Nellu	4 Scdta	5 Elacx	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	5.1																										
62	4.5																										
63	3.2	S					V	V	V																		
64	4.2																										
65	5.1																										
66	5.5																										
67	6.0																										
68	6.2																										
69	6.5																										
70	6.8																										
71	7.0																										
72	7.1																										
73	6.9																										
74	6.5																										
75	6.1																										
76	5.8																										
77	5.3																										
78	4.9																										
79	3.9	S							V																		
80	3.1																										
81	4.4																										
82	5.1																										
83	5.5																										
84	6.2																										
85	6.6																										
86	6.8																										
87	7.1																										
88	7.4																										
89	7.4																										
90	7.2																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 4 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 Nellu	4 Schta	5 Elocx	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	6.9																										
92	6.7																										
93	6.1																										
94	5.6																										
95	5.3																										
96	4.8								V																		
97	3.7								V																		
98	4.6								V																		
99	5.3																										
100	5.7																										
101	6.4																										
102	6.7																										
103	7.1																										
104	7.5																										
105	7.8																										
106	7.9																										
107	8.2																										
108	8.1																										
109	7.2																										
110	6.6																										
111	6.0																										
112	5.5																										
113	4.2																										
114	4.1																										
115	2.3	S					V	V	V																		
116	4.6																										
117	5.4																										
118	5.7																										
119	6.3																										
120	6.8																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 5 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nup va	2 Nymod	3 Nel u	4 Sch ta	5 Elo ca	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	7.3																										
122	7.5																										
123	7.9																										
124	8.3																										
125	8.4																										
126	8.5																										
127	8.1																										
128	6.9																										
129	6.4																										
130	5.7																										
131	4.8																										
132	4.4								V																		
133	9.0	S					1	V	V																		
134	4.8								V																		
135	5.4																										
136	5.9																										
137	6.1																										
138	6.6																										
139	6.8																										
140	7.3																										
141	7.4																										
142	7.7																										
143	8.0																										
144	8.6																										
145	8.4																										
146	8.1																										
147	6.9																										
148	5.7																										
149	5.2																										
150	4.4																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 6 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 Nellu	4 SchTa	5 FloCa	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	3.4																										
152	1.6	S						1	V																		
153	3.9																										
154	5.4																										
155	5.9																										
156	6.1																										
157	6.5																										
158	6.7																										
159	7.1																										
160	7.2																										
161	7.4																										
162	7.7																										
163	7.7																										
164	8.1																										
165	7.4																										
166	6.4																										
167	5.6																										
168	4.9																										
169	4.0																										
170	3.0						1			V																	
171	1.4	S					1	1																			
172	3.8								1																		
173	5.4																										
174	5.7																										
175	6.0																										
176	6.2																										
177	6.5																										
178	6.6																										
179	6.6																										
180	6.8																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 7 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 NelLu	4 SchTa	5 EloCa	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
181	7.0																										
182	7.2																										
183	7.2																										
184	6.9																										
185	6.3																										
186	5.5																										
187	4.8																										
188	3.9																										
189	1.9	S						✓																			
190	4.8																										
191	5.6																										
192	5.0																										
193	6.0																										
194	6.3																										
195	6.6																										
196	6.5																										
197	6.5																										
198	6.5																										
199	6.5																										
200	6.4																										
201	5.9																										
202	5.5																										
203	5.2																										
204	4.5								✓																		
205	3.8																										
206	1.3	S					✓																				
207	4.5	S							✓																		
208	5.4																										
209	5.7																										
210	5.6																										

Lotus Lake Polk County WBIC 2616900 **Date:**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 NelLu	4 SchTa	5 FloCa	6 Filamentous Algae	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
211	5.9																										
212	6.1																										
213	6.1																										
214	6.1																										
215	6.1																										
216	6.1																										
217	5.9																										
218	5.5																										
219	5.1																										
220	4.9																										
221	4.4								V																		
222	2.3							✓	V																		
223	4.7								1																		
224	5.3																										
225	5.3																										
226	5.6																										
227	5.7																										
228	5.8																										
229	5.4																										
230	5.9																										
231	5.8																										
232	5.6																										
233	5.3																										
234	5.1																										
235	4.8																										
236	4.9																										
237	5.2	S					V	V																			
238	5.8							V	V			1															
239	4.1							V	V																		
240	4.8																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 9 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 Nellu	4 Schta	5 EloCa	6 Cerde	7 lemmi	8	9	10	11	12	13	14	15	16	17	18	19	20	21
241	5.0																										
242	5.4																										
243	5.1																										
244	5.1																										
245	5.4																										
246	5.2																										
247	5.1																										
248	4.6																										
249	4.3																										
250	3.5								✓																		
251	1.5							✓				1	✓														
252	3.1						1	✓																			
253	3.7																										
254	4.2																										
255	4.6																										
256	4.2																										
257	4.8																										
258	4.4																										
259	5.2																										
260	5.1																										
261	4.8																										
262	4.2																										
263	3.5																										
264	shallow																										
265	3.0							✓				1															
266	3.1							✓																			
267	3.4																										
268	4.1																										
269	4.2																										
270	4.3																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 10 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nupva	2 Nymod	3 NelLu	4 SchTa	5 EloCa	6 Cerde	7 filamentous algae	8	9	10	11	12	13	14	15	16	17	18	19	20	21
271	4.7																										
272	4.6																										
273	4.8																										
274	4.7																										
275	3.2																										
276	shallow																										
277	↓																										
278	↓																										
279	2.0	S					1✓	V✓																			
280	3.0																										
281	3.5																										
282	3.7																										
283	3.9																										
284	4.1																										
285	4.6																										
286	4.1																										
287	3.1																										
288	shallow																										
289	↓						1✓	1✓				1✓															
290	↓						1	1				1✓															
291	2.4							1✓				1✓															
292	3.1																										
293	3.3																										
294	3.6																										
295	3.9																										
296	3.3																										
297	3.0																										
298	shallow																										
299	.5						V✓	V✓																			
300	2.4																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 11 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NupVa	2 NymOd	3 NelLu	4 SchTa	5 EloCa	6 CerDe	7 Filamentous algae	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301																											
302	2.7																										
303	2.6																										
304	3.0																										
305	2.5								✓																		
306	2.1							✓																			
307	shallow																										
308	1							✓																			
309	1.5							↓																			
310	1.9								✓																		
311	2.3																										
312	2.3																										
313	2.1																										
314																											
315																											
316																											
317																											
318																											
319																											
320																											
321																											
322																											
323																											
324																											
325																											
326																											
327																											
328																											
329																											
330																											

KH, JW

10:00AM

Lotus Lake Polk County 2616900 Date: 8/27/15 **Page 1 of 29**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8 Pot Na	9 Lem Mi	10	11	12	13	14	15	16	17	18	19	20	21
1	2.6	S	P				V																				
2	4.1	S	P		—																						
3	5.0	M	P		—																						
4	5.1	M	P		—																						
5	5.0	M	P		—																						
6	5.0	M	P		—																						
7	4.9	M	P		—																						
8	4.4	S	P		—			V	1																		
9	5.1	S	P				1																				
10	5.3	M	P		—																						
11	5.4	M	P		—																						
12	5.6	M	P																								
13	5.5	M	P												V												
14	5.7	M	P		—																						
15	5.4	M	P		—																						
16	5.0	M	P		—																						
17	4.7	M	P		—																						
18	3.3	S	P	—				V	1																		
19	1.2	S	P				1																				
20	4.9	M	P		—																						
21	6.5	M	P		—																						
22	6.6	M	P		—																						
23	6.9	M	P		—																						
24	7.0	M	P		—																						
25	7.6																										
26	7.2																										
27	7.0																										
28	6.4																										
29	6.4																										
30	5.7																										

Lotus Lake Polk County 2616900 Date: **Page 2 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NeILy	2 NyMOd	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	5.5																										
32	4.9	M	P				1																				
33	5.5	M	P						V																		
34	6.3																										
35	6.7																										
36	7.0																										
37	7.3																										
38	7.4																										
39	7.7																										
40	7.7																										
41	7.6																										
42	7.5																										
43	6.8																										
44	6.4																										
45	5.9																										
46	4.7	S	P						1			V															
47	1.9	S	P				2	V			V																
48	6.6	M	P				V	[illegible]																			
49	6.3																										
50	7.2																										
51	7.5																										
52	8.1																										
53	8.3																										
54	8.3																										
55	8.5																										
56	8.3																										
57	7.8																										
58	8.2																										
59	7.4																										
60	6.9																										

Lotus Lake Polk County 2616900 **Date:** **Page 3 of 29**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nellu	2 Nymod	3 Nupva	4 Eloca	5 Cerde	6 Stcpe	7 Scata	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	6.7																										
62	6.2																										
63	5.1	S					2																				
64	5.2	S					2																				
65	5.5	S					2																				
66	6.8																										
67	7.3																										
68	7.9																										
69	8.1																										
70	7.5																										
71	8.2																										
72	9.3																										
73	8.9																										
74	8.0																										
75	7.9																										
76	6.9																										
77	6.9																										
78	6.8																										
79	5.3	S	P				1																				
80	4.0		P				2																				
81	6.7	M	P				1																				
82	7.3																										
83	8.3																										
84	8.3																										
85	8.5																										
86	9.7																										
87	10.0																										
88	10.2																										
89	9.8																										
90	10.1																										

Lotus Lake Polk County 2616900 Date: **Page 4 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 Nymod	3 NupVa	4 EloCa	5 Cerde	6 Stepe	7 Schta	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	9.3																										
92	8.9																										
93	8.4																										
94	7.7																										
95	7.4																										
96	5.3	m	P				1																				
97	4.1	S	P				2																				
98	5.3	m	P				2																				
99	5.7																										
100	6.3																										
101	6.9																										
102	7.4																										
103	7.7																										
104	8.1																										
105	8.4																										
106	8.8																										
107	8.9																										
108	8.4																										
109	8.2																										
110	7.4																										
111	6.6																										
112	6.2																										
113	5.7																										
114	3.9	S	P				1		V																		
115	3.2	S	P				1	V																			
116	5.9	m	r				V																				
117	6.6																										
118	7.0																										
119	7.4																										
120	7.9																										

Lotus Lake Polk County 2616900 **Date:** **Page 5 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 Nymod	3 Nupla	4 Eloca	5 CerDe	6 Stepe	7 Scnta	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	8,2																										
122	8.6																										
123	9.0																										
124	9,4																										
125	9.6																										
126	9.6																										
127	9.3																										
128	8,2																										
129	7.3																										
130	6.5																										
131	5.8																										
132	5.4	M	P				1																				
133	2.9	S	P				V	1																			
134	5.3	M	P				2																				
135	5,9																										
136	6.5																										
137	6,7																										
138	7.3																										
139	7.7																										
140	7.8																										
141	8.2																										
142	8.5																										
143	8.7																										
144	9.4																										
145	9.5																										
146	8.6																										
147	7,8																										
148	7.0																										
149	6.4																										
150	5.6	M	P				2																				

Lotus Lake Polk County 2616900 Date: **Page 6 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 Nellu	2 Nymod	3 Nupva	4 Eloca	5 Cerde	6 Stepe	7 Schta	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	4.1	M	R				1																				
152	2.9	S	P				V	V																			
153	4.9	M	P				2																				
154	6.6																										
155	6.4																										
156	6.7																										
157	7.2																										
158	7.5																										
159	7.7																										
160	7.8																										
161	7.1																										
162	8.4																										
163	8.6																										
164	8.8																										
165	8.3																										
166	7.3																										
167	6.4																										
168	5.7	M	P				V																				
169	5.3	M	P				2																				
170	4.1	S	P				2		V																		
171	2.4	S	P					1	V																		
172	4.0	S	P				1																				
173	5.7																										
174	6.4																										
175	6.6																										
176	6.6																										
177	6.8																										
178	7.2																										
179	7.4																										
180	7.3																										

Lotus Lake Polk County 2616900 **Date:** **Page 8 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 MymOd	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8 PotNa	9	10	11	12	13	14	15	16	17	18	19	20	21
211	6.6																										
212	6.9																										
213	6.8																										
214	6.8																										
215	6.8																										
216	6.8																										
217	6.6																										
218	6.1																										
219	6.1																										
220	5.7																										
221	5.3	m	p				V																				
222	2.7	s	p				1							1													
223	6.5	M	p				2																				
224	7.4																										
225	6.8																										
226	6.7																										
227	6.5																										
228	6.5																										
229	6.4																										
230	6.4																										
231	6.3																										
232	5.8																										
233	5.6																										
234	5.2																										
235	4.8	M	P					V																			
236	1.9	S	P						V																		
237	2.4	S	P				2																				
238	3.9						3																				
239	4.4	S	P				1																				
240	4.2																										

Lotus Lake Polk County 2616900 Date: **Page 9 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8 lemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
241	4.9																										
242	5.8																										
243	5.8																										
244	6.2																										
245	5.2																										
246	6.0																										
247	5.5																										
248	5.3																										
249	4.6																										
250	4.2	m	P				V																				
251	3.0	m	P					V	V		1			V													
252	3.6	m	P				V	V																			
253	4.2																										
254	4.2																										
255	5.2																										
256	5.5																										
257	5.6																										
258	5.3																										
259	5.6																										
260	5.5																										
261	5.3																										
262	4.6	M	P				V																				
263	4.0	m	P				1																				
264	shore/shallow																										
265	2.0	m	P					V	2	1	1			1													
266	3.0	m	P					L	V																		
267	4.1																										
268	4.2																										
269	4.2																										
270	4.5																										

Lotus Lake Polk County 2616900 **Date:** **Page 10 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 Nymod	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8 LemMi	9	10	11	12	13	14	15	16	17	18	19	20	21
271	4.6																										
272	5.0																										
273	5.6																										
274	6.3	M	P				V																				
275	4.1	M	P				1																				
276	Shallow																										
277	shallow																										
278	2.3	M	P					V			1			V													
279	2.8	M	P					2	V																		
280	3.7																										
281	4.4																										
282	4.2																										
283	4.5																										
284	4.6																										
285	4.8																										
286	5.2	M	P				V																				
287	4.1	M	P				V																				
288	Shallow																										
289	shallow																										
290	2.3	M	P						2																		
291	3.1	M	P				1																				
292	3.3																										
293	3.6																										
294	3.8																										
295	4.3																										
296	4.2																										
297	3.8	M	P				1																				
298	Shallow																										
299	3.0	M	P				2																				
300	2.2	M	P				V	V																			

Lotus Lake Polk County 2616900 **Date:**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NyMOd	3 NupVa	4 EloCa	5 CerDe	6 StePe	7 SchTa	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301	3.1	m	P				1																					
302	3.5																									
303	3.7																									
304	3.5																									
305	3.9	m	P				2																					
306	3.0	m	P					V																		
307	Shallow																									
308	1.5	m	P				V	1				V														
309	1.7	m	P					1				V														
310	2.3	m	P				2																					
311	2.9	m	P				1																					
312	2.9																									
313	3.0	m	P																							
314																										
315																										
316																										
317																										
318																										
319																										
320																										
321																										
322																										
323																										
324																										
325																										
326																										
327																										
328																										
329																										
330																										

6/9/16 Start - 11:00 am

Lotus Lake Polk County WBIC 2616900 JW/KA/KF StuPe POTNA, CLP **Date:** **Page 1 of 29**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft) m	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NeLLy American lotus	2 NyMOd white pondlily	3 NupVa yellow spatterdock	4 SchTa softstem bulrush	5 CerDe coontail	6 FilAl algae	7S	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.7m	S																									
2	3.9	m																									
3	4	m																									
4	4.1	m																									
5	4.0	m																									
6	4.0	m																									
7	4.0	m																									
8	2.2	S							V		V																
9	4.3						1																				
10	4.4	m																									
11	4.7	m																									
12	4.6	m																									
13	4.8	m																									
14	3.9	m																									
15	4.7	m																									
16	4.2	m																									
17	4.0	m																									
18	1.5	S							V			V															
19	Terrestrial																										
20	4.2																										
21	5.0																										
22	5.3																										
23	5.7																										
24	5.9																										
25	5.8																										
26	5.9																										
27	5.7																										
28	5.4																										
29	5.2																										
30	4.6																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 2 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NeLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 FilAl	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	3.7	S					1			V																	
32	4.3	m					V																				
33	4.9	m					V																				
34	5.3																										
35	5.7																										
36	6.2																										
37	6.4																										
38	6.5																										
39	6.4																										
40	6.6																										
41	6.5																										
42	6.3																										
43	6.0																										
44	5.5																										
45	4.9																										
46	2.7	S							V	V																	
47	2	S							V		1	1															
48	5.1	m																									
49	5.1																										
50	5.5																										
51	6.1																										
52	6.5																										
53	6.8																										
54	7.1																										
55	7.1																										
56	7.1																										
57	7.2																										
58	6.8																										
59	6.5																										
60	6.1																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 3 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NyMod	3 NupVa	4 SchTa	5 CerDe	6 FlAl	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	5.5																										
62	5.2	m																									
63	3.4						1		V																		
64	4.4						1																				
65	5.4	m																									
66	6.0																										
67	6.5																										
68	6.7																										
69	6.9																										
70	7.3																										
71	7.4																										
72	7.5																										
73	7.6																										
74	7.2																										
75	6.9																										
76	6.5																										
77	6.1																										
78	5.1																										
79	2.7	S							1	V	V																
80	2.9	m					1																				
81	4.5	m					1																				
82	4.9																										
83	5.6																										
84	6.2																										
85	6.4																										
86	6.8																										
87	7.2																										
88	7.4																										
89	7.4																										
90	7.4																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 4 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NyMod	3 NupVa	4 SchTa	5 CerDe	6 FilAl	7 PotNa	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	7.1																										
92	6.8																										
93	6.2																										
94	5.8																										
95	5.3																										
96	4.9						1																				
97	2.7	S																									
98	4.6	M					1				1		V														
99	5.2	m					1																				
100	5.5																										
101	5.7																										
102	6.2																										
103	6.7																										
104	6.9																										
105	7.4																										
106	7.6																										
107	7.8																										
108	7.8																										
109	7.7																										
110	7.3																										
111	6.8																										
112	6.0																										
113	5.0																										
114	4.2						V																				
115	3	m					V																				
116	4.7	m					V																				
117	5.4																										
118	5.8																										
119	6.2																										
120	6.7																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 5 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NyMod	3 NupVa	4 SchTa	5 CerDe	6 FilAl	7 Pot Na	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	7.1																										
122	7.5																										
123	7.7																										
124	8.1																										
125	8.3																										
126	8.2																										
127	7.9																										
128	7.2																										
129	6.6																										
130	5.7																										
131	5.2																										
132	4.3	m					✓																				
133	2.1	S					✓	1	✓																		
134	4.6	m					✓																				
135	5.2																										
136	5.6																										
137	5.9																										
138	6.6																										
139	6.8																										
140	7.3																										
141	7.5																										
142	7.8																										
143	8.1																										
144	8.3																										
145	8.2																										
146	7.8																										
147	6.8																										
148	6.0																										
149	5.2	m																									
150	4.3	m					1																				

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 6 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NyMod	3 NupVa	4 SchTa	5 CerDe	6 FilAl	7 PotNa	8 ZizPa	9	10	11	12	13	14	15	16	17	18	19	20	21
151	3.0	m					V	V	V																		
152	2.5	S					V	V																			
153	4.2						V																				
154	5.4																										
155	5.9																										
156	6.0																										
157	6.4																										
158	6.6																										
159	6.9																										
160	7.2																										
161	7.1																										
162	7.4																										
163	7.9																										
164	7.7																										
165	7.6																										
166	6.6																										
167	5.7																										
168	5.2						V																				
169	4.4						V																				
170	3.2								V	V																	
171	1.3							V	1			V															
172	3.4						V							V													
173	3.1																										
174	5.7																										
175	5.9																										
176	6.0																										
177	6.3																										
178	6.7																										
179	6.6																										
180	6.4																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 7 of 29**

Observer 1: name and hours: | Observer 2:.name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 FilAl	7 PotNa	8 StePe	9	10	11	12	13	14	15	16	17	18	19	20	21
181	6.9																										
182	7.1																										
183	7.1																										
184	6.2																										
185	6.1																										
186	5.5																										
187	4.8																										
188	4.1	S					V																				
189	2.0	S					V	V																			
190	5.1																										
191	5.5																										
192	5.9																										
193	5.8																										
194	6.2																										
195	6.4																										
196	6.3																										
197	6.3																										
198	6.3																										
199	6.3																										
200	6.2																										
201	6.0																										
202	5.6																										
203	5.4																										
204	4.7						V																				
205																											
206	1.3	S						V	V																		
207	4.6	S					V	V						V													
208	5.3																										
209	5.6																										
210	5.7																										

Lotus Lake Polk County WBIC 2616900 **Date:** **Page 8 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 fil algae	7 PotNa	8	9	10	11	12	13	14	15	16	17	18	19	20	21
211	5.9																										
212	6.0																										
213	5.9																										
214	6.1																										
215	5.9																										
216	5.9																										
217	5.7																										
218	5.2																										
219	5.2																										
220	4.8																										
221	4.3	S					V																				
222	2.0	S					V	V	no			1	1														
223	4.8						V																				
224	5.1																										
225	5.0																										
226	5.2																										
227	5.6																										
228	5.8																										
229	5.7																										
230	5.5																										
231	5.5																										
232	5.3																										
233	5.0																										
234	4.8																										
235	4.1																										
236	2.3	S						V	V																		
237	1.3						V	V				V															
238	3.3						V				V																
239	4.3						V																				
240	4.3																										

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Lotus Lake Polk County WBIC 2616900

Date:

Observer 1: name and hours:
Observer 2: name and hours:
Observer 3: name and hours:
Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 fil algae	7 PotNa	8 ~~Sta~~ StuPe	9 Chara	10 ZizPa	11 duckweed	12	13	14	15	16	17	18	19	20	21
241	5.0																										
242	5.1																										
243	5.1																										
244	5.2																										
245	5.4																										
246	5.1																										
247	5.1																										
248	4.7																										
249	3.9																										
250	2.4						V	V																			
251	1.2							V			1	1		1													
252	3.3							1			1				v												
253	3.7															V											
254	4.2																										
255	4.8																										
256	4.7																										
257	4.8																										
258	5.1																										
259	5.1																										
260	5.4																										
261	5.7																										
262	4.1						V																				
263	3.8						V																				
264	too shallow																										
265	2.0							V	V		V	V		V		V	V										
266	2.7							V	1																		
267	3.3																										
268	3.6																										
269	3.9																										
270	4.1																										

Lotus Lake Polk County WBIC 2616900 Date: **Page 10 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 FLalgae	7 PotNa	8 CerPe	9 StuPe	10 Duckweed	11 ZizPa	12	13	14	15	16	17	18	19	20	21
271	4.3																										
272	4.8																										
273	5.3																										
274	5.4						V				|																
275	39						V																				
276	Shallow																										
277	Shallow																										
278	2.0								V					|													
279	2.3							V	|																		
280	2.8																										
281	3.3																										
282	2.6																										
283	3.8																										
284	4.2																										
285	4.2																										
286	4.2																										
287	3.0						V																				
288	too shallow																										
289	19							V	V						V	V											
290	1.9							V																			
291	2.7						V				|																
292	3.1																										
293	3.2																										
294	3.6																										
295	3.8																										
296	3.8																										
297	3.1																										
298	too shallow																										
299	1.5						V	V			V																
300	2.5						V	V									V										

Lotus Lake Polk County WBIC 2616900 Date: **Page 11 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NymOd	3 NupVa	4 SchTa	5 CerDe	6 Filalga	7 PotNa	8 ZizPa	9 Stab	10	11	12	13	14	15	16	17	18	19	20	21
301	2.7						✓	✓						✓													
302	2.8													✓													
303	3.0																										
304	3.1																										
305	2.8						✓	✓																			
306	2.4						✓								✓												
307	too	shallow																									
308	too	shallow																									
309	2.0							✓				✓															
310	1.3						✓	✓				|															
311	2.2						✓																				
312	2.3																										
313	1.9							✓																			
314																											
315																											
316																											
317																											
318																											
319																											
320																											
321																											
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Lotus Lake Polk County WBIC 2616900 10:03 **Date:** 8/31/16 **Page 1 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 Sch ta	5 Stu pe	6 Pot	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.6	S					V				V																
2	4	S																									
3	5.3	M																									
4	5.2	M																									
5	5.2	M																									
6	5.4	M																									
7	4.9	S																									
8	3.0	S						V			V																
9	4.9	M					1																				
10	5.1																										
11	5.6																										
12	5.6																										
13	5.9																										
14	5.9																										
15	5.7																										
16	5.2																										
17	5.1	M																									
18	4.1	S						1	1			V															
19	2.0	S					1	V	V																		
20	4.9						V																				
21	6.1																										
22	6.1																										
23	6.3																										
24	5.8																										
25	6.0																										
26	6.1																										
27	5.6																										
28	5.7																										
29	5.1																										
30	5.1																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 Page 2 of 29

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
31	4.8							V	V																		
32	3.2	M					2																				
33	5.8	M					1																				
34	5.7																										
35	6.0																										
36	6.3																										
37	6.5																										
38	6.6																										
39	6.5																										
40	6.8																										
41	6.8																										
42	6.6																										
43	6.2																										
44	6.0																										
45	5.5																										
46	3.8	S						1	V	V																	
47	2.0	S					V	2	V																		
48	5.5	M					2																				
49	6.1																										
50	6.3																										
51	6.4																										
52	6.8																										
53	6.6																										
54	7.1																										
55	7.1																										
56	7.2																										
57	7.0																										
58	6.7																										
59	6.7																										
60	6.1																										

Lotus Lake Polk County WBIC 2616900 **Date:** 8/31/16 **Page 3 of 29**

Observer 1: name and hours: Observer 2: name and hours: Observer 3: name and hours: Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
61	5.7																										
62	5.9						V																				
63	5.3	m					2																				
64	5.6						3																				
65	6.1																										
66	5.8																										
67	6.4																										
68	7.3																										
69	7.3																										
70	7.8																										
71	7.5																										
72	8.1																										
73	8.1																										
74	7.6																										
75	6.9																										
76	6.8																										
77	6.7																										
78	6.0																										
79	4.8	S					V																				
80							2																				
81	5.6	m					2																				
82	6.4																										
83	6.4																										
84	7.3																										
85	7.5																										
86	8.1																										
87	8.1																										
88	8.1																										
89	8.2																										
90	8.4																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 **Page 4 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
91	7.7																										
92	7.0																										
93	6.8																										
94	6.2																										
95	5.6																										
96	5.4																										
97							2																				
98	5.9						2																				
99	6.2																										
100	6.5																										
101	6.9																										
102	7.5																										
103	7.9																										
104	8.2																										
105	8.8																										
106	8.6																										
107	8.9																										
108	8.6																										
109	8.1																										
110	7.4																										
111	6.7																										
112	6.1																										
113	5.7	M																									
114	2.8	S					1	V																			
115	2.6						2		V			V															
116	5.7						1																				
117	6.0																										
118	6.3																										
119	6.8																										
120	7.2																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 **Page 5 of 29**

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 Schta	5 StuPe	6 potNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
121	7.7																										
122	7.9																										
123	8.2																										
124	8.5																										
125	8.7																										
126	8.7																										
127	8.4																										
128	7.8																										
129	6.6																										
130	5.8																										
131	5.5	M					V																				
132	5.1	M					1																				
133	2.6	S					V		1																		
134	5.3	M					1																				
135	5.8																										
136	6.2																										
137	6.6																										
138	7.0																										
139	7.5																										
140	7.9																										
141	7.9																										
142	8.4																										
143	8.4																										
144	9.1																										
145	8.9																										
146	8.4																										
147	7.5																										
148	6.7																										
149	6.0	M					1																				
150	4.5	M					V																				

Lotus Lake Polk County WBIC 2616900 **Date:** 8/31/16 **Page 6 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
151	2.0	S					1	V	V																		
152	2.5	S					1		V		V																
153	5.5	M					1																				
154	8.0																										
155	8.4																										
156	8.4																										
157	9.9																										
158	9.7																										
159	10.3																										
160	10.7																										
161	10.3																										
162	11.3																										
163	11.3																										
164	11.7																										
165	10.2																										
166	6.7																										
167	5.6																										
168	5.0	M					3																				
169	4.5	M					1																				
170	2.3	M					V	V	V	V																	
171	1.2	S						V	1																		
172	3.4	S					V																				
173	5.4																										
174	5.7																										
175	5.9																										
176	6.1																										
177	6.5																										
178	6.6																										
179	6.8																										
180	6.9																										

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Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 Page 7 of 29

Observer 1: name and hours:

Observer 2: name and hours:

Observer 3: name and hours:

Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
181	7.0																										
182	7.1																										
183	7.0																										
184	6.7																										
185	6.6																										
186	6.8																										
187	5.8						V																				
188	4.6						1		V																		
189	2.7						1		V																		
190	6.2	M																									
191	6.8																										
192	6.7																										
193	7.0																										
194	7.3																										
195	7.4																										
196	7.4																										
197	7.3																										
198	7.3																										
199	7.6																										
200	7.5																										
201	6.8																										
202	6.4																										
203	3.9																										
204	5.1						3																				
205	4.5						V																				
206	1.3							1			V																
207	4.7						1																				
208	6.9						V																				
209	6.2																										
210	6.2																										

Lotus Lake Polk County WBIC 2616900 **Date:** 8/31/16 **Page 8 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NymOd	4 SchTa	5 StuPe	6 PotNa	7 LemMi	8 ZizPa	9	10	11	12	13	14	15	16	17	18	19	20	21
211	6.4																										
212	6.7																										
213	6.8																										
214	7.1																										
215	6.7																										
216	6.9																										
217	6.9																										
218	6.2																										
219	6.0																										
220	5.8																										
221	5.6						1						V														
222	1.5						1		V			V		V													
223	6.2						3																				
224	6.2																										
225	5.2																										
226	5.5																										
227	5.8																										
228	5.8																										
229	6.0																										
230	5.7																										
231	5.8																										
232	5.4																										
233	5.2																										
234	4.8																										
235	4.4																										
236	3.6							V	V																		
237	–						2																				
238	–						3																				
239	4.1						1																				
240	4.5																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 **Page 9 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NypVa	3 NyMod	4 SchTa	5 StuPe	6 PotNa	7 CerDe	8 LemMi	9 EloCa	10	11	12	13	14	15	16	17	18	19	20	21
241	4.7																										
242	5.2																										
243	5.2																										
244	5.2																										
245	5.4																										
246	5.2																										
247	5.1																										
248	5.3																										
249	4.8	M																									
250	4.1	S					V																				
251	2.0	M							V				I	V													
252	3.1	M					V		V																		
253	3.3	M																									
254	3.8																										
255	4.5																										
256	4.5																										
257	4.6																										
258	4.8																										
259	5.0																										
260	5.1																										
261	5.0																										
262	4.2	M																									
263	3.4						I																				
264	too	shallow																									
265	2.0								V				V	V	I												
266	3.5																										
267	3.8																										
268	3.9																										
269	4.1																										
270	4.2																										

Lotus Lake Polk County WBIC 2616900 Date: 8/31/16 **Page 10 of 29**

Observer 1: name and hours:	Observer 2: name and hours:	Observer 3: name and hours:	Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMOd	4 SchTa	5 StuPe	6 PotNa	7 LemMi	8 CerDe	9 ZizPa	10	11	12	13	14	15	16	17	18	19	20	21
271	4.8																										
272	4.9																										
273	5.8																										
274	4.9						1		V			V															
275	4.1						1					V															
276	too shallow																										
277																											
278	2.0					V			1		V	V	1														
279	2.2							V	1			V	V	V													
280	3.4																										
281	3.3																										
282	3.4																										
283	3.7																										
284	4.0																										
285	4.2																										
286	4.2						V																				
287	3.5	M																									
288	too shallow																										
289																											
290	2.0							V	2			V		V													
291	2.9						1					V															
292	3.1																										
293	3.5																										
294	4.0																										
295	4.4						1																				
296	3.9						V																				
297	3.5						V																				
298																											
299	thick lotus																										
300																											

Lotus Lake Polk County WBIC 2616900 **Date:** 8/31/16 **Page 11 of 29**

Observer 1: name and hours: | Observer 2: name and hours: | Observer 3: name and hours: | Total hours worked:

Site #	Depth (ft)	Dominant sediment type (M, S, R)	Rake pole (P) or rake rope (R)?	Total Rake Fullness	EWM 1,2,3	CLP 1,2,3	1 NelLu	2 NupVa	3 NyMod	4 SchTa	5 StuPe	6 PotNa	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
301	too thick lotus																										
302	2.9																										
303	3.4																										
304	3.4																										
305	3.1						3																				
306	2.7						2																				
307																											
308																											
309	too thick lotus beds																										
310																											
311																											
312	3.3	m																									
313	3.2	m						✓	✓																		
314																											
315																											
316																											
317																											
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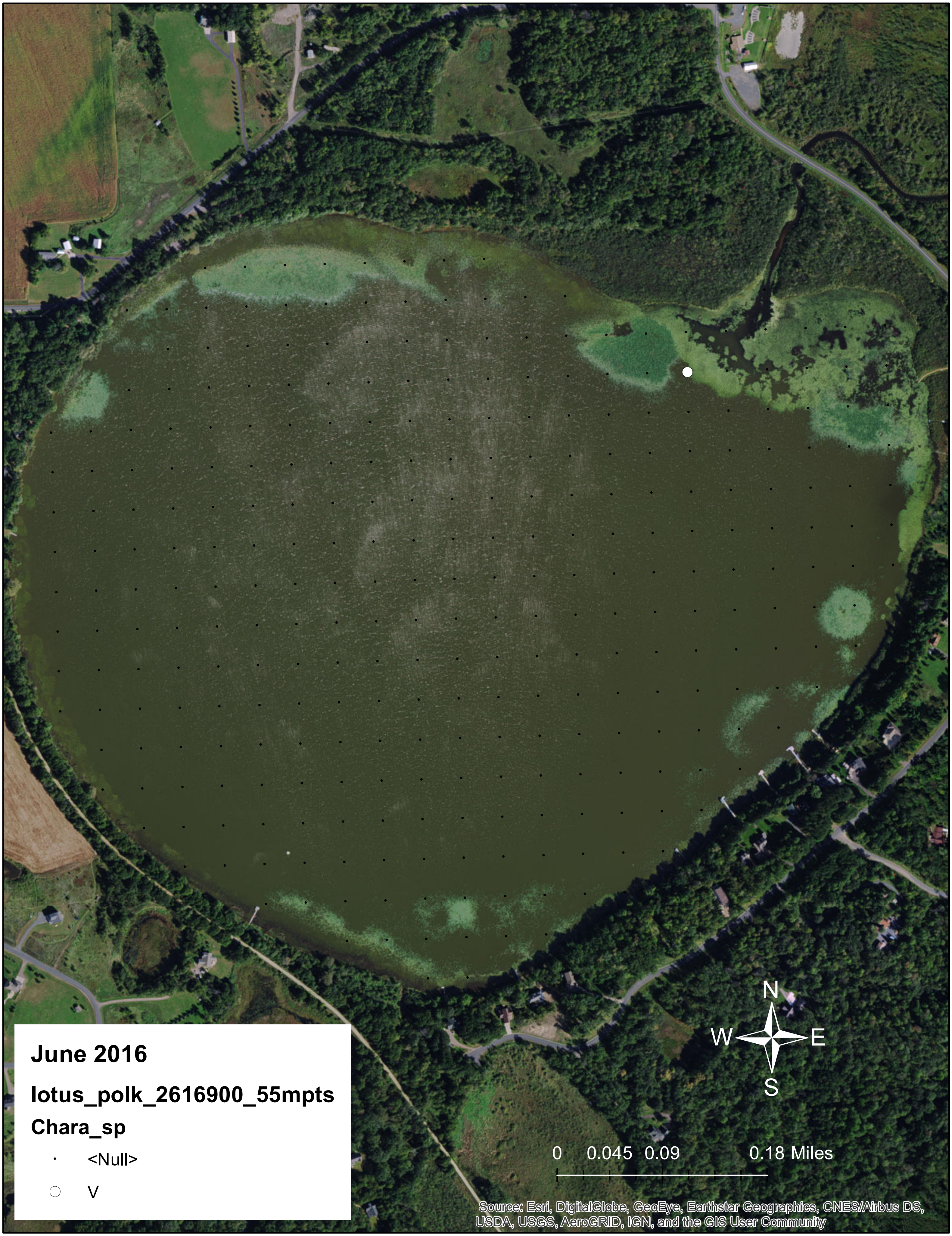
329																											
330																											



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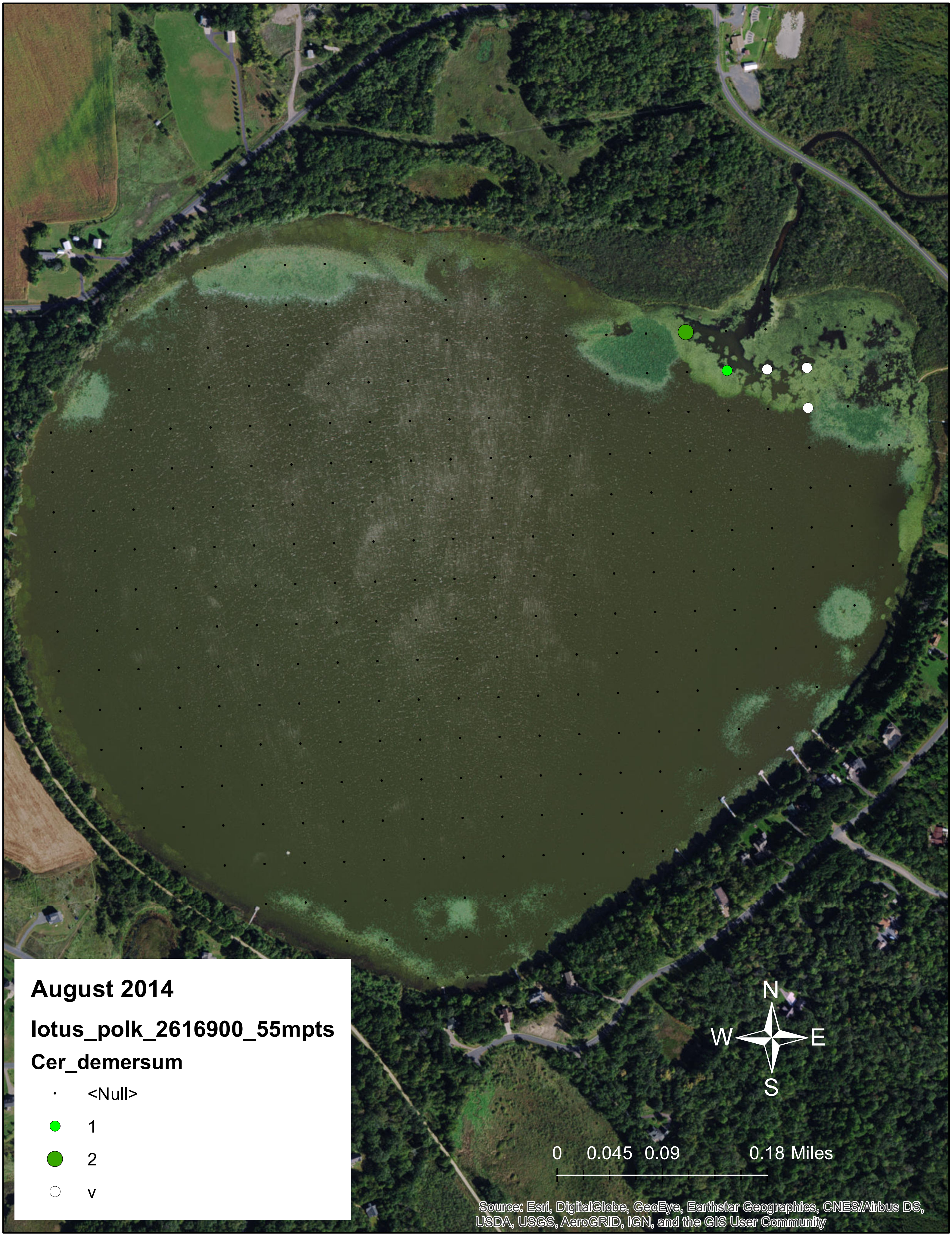
August 2014
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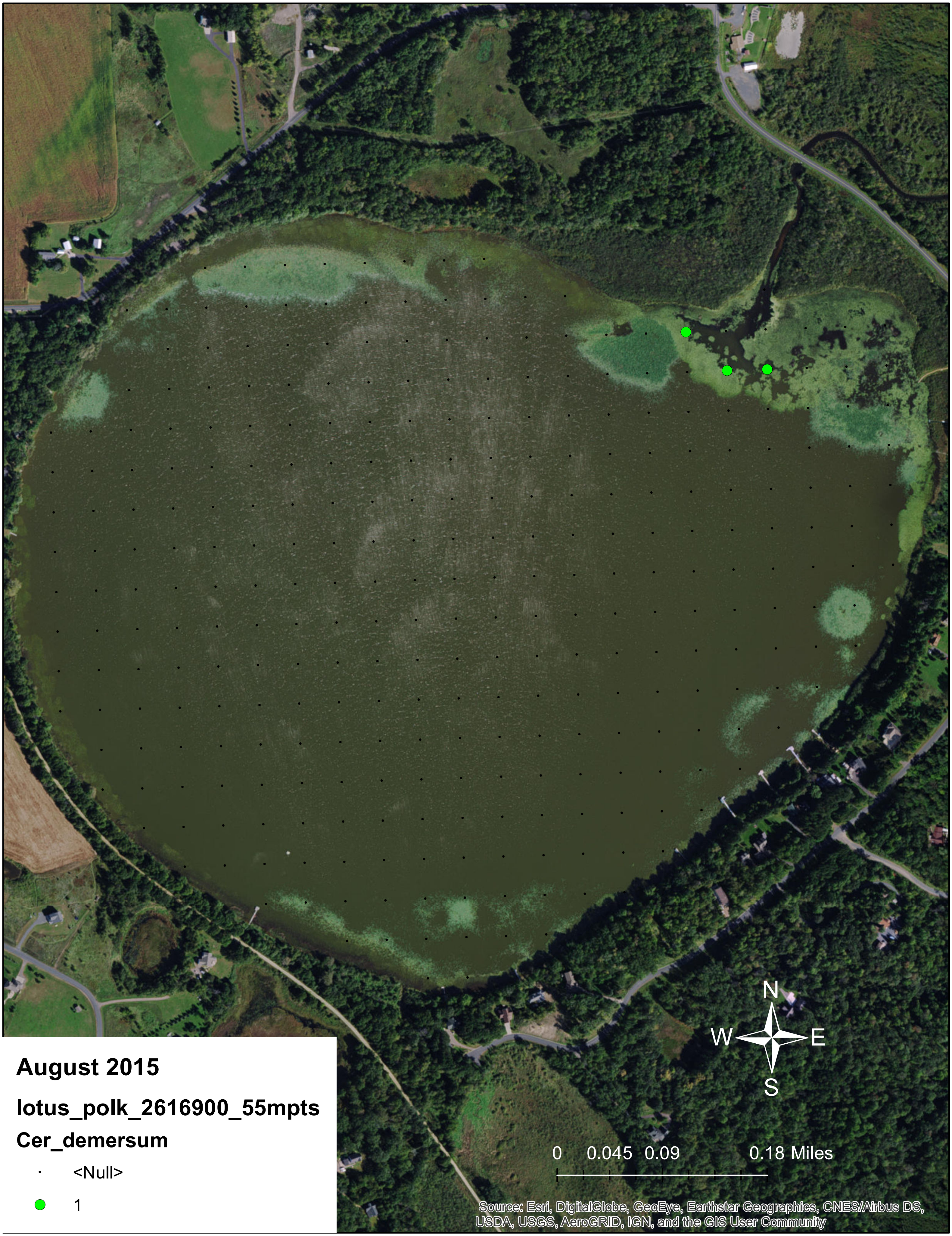

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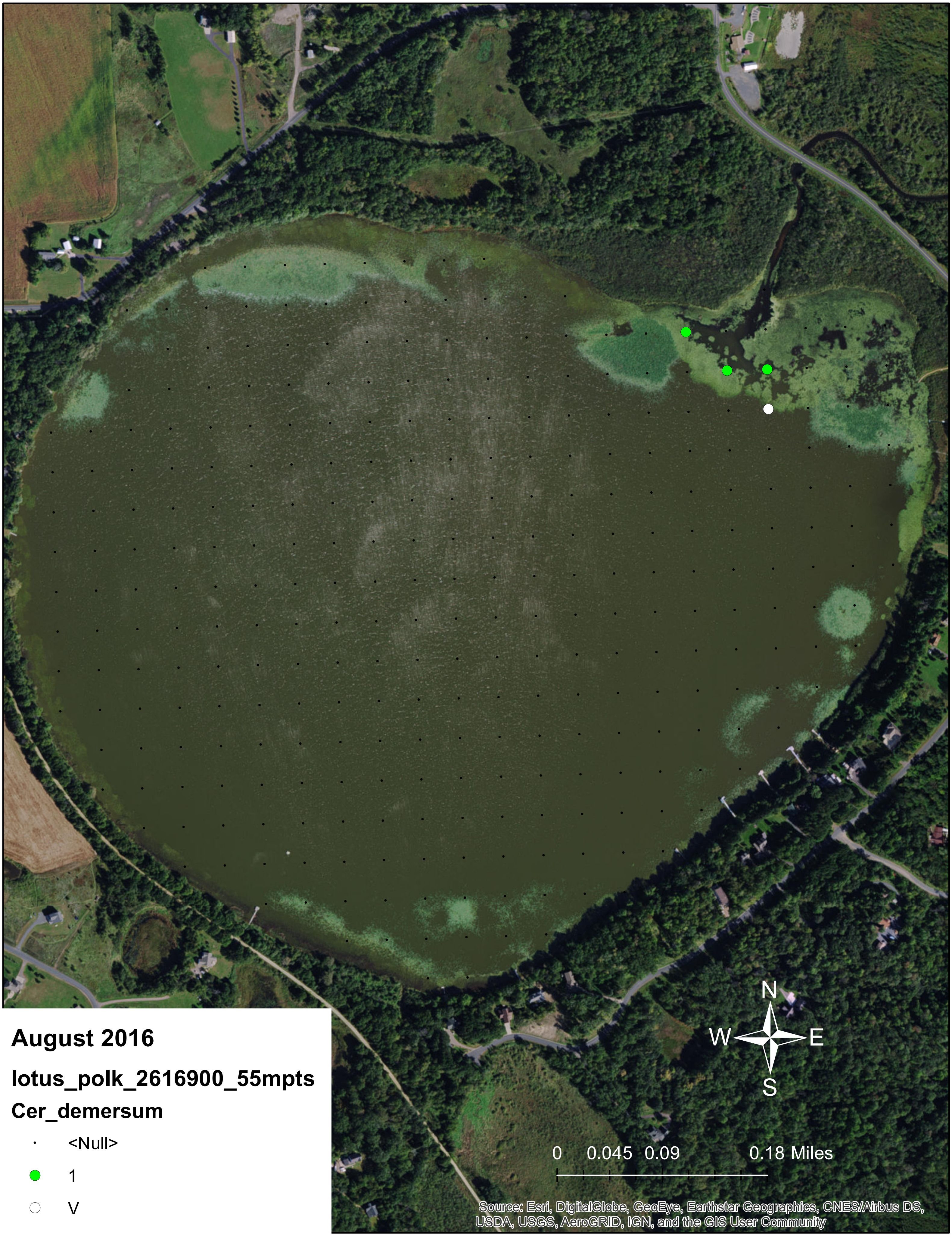

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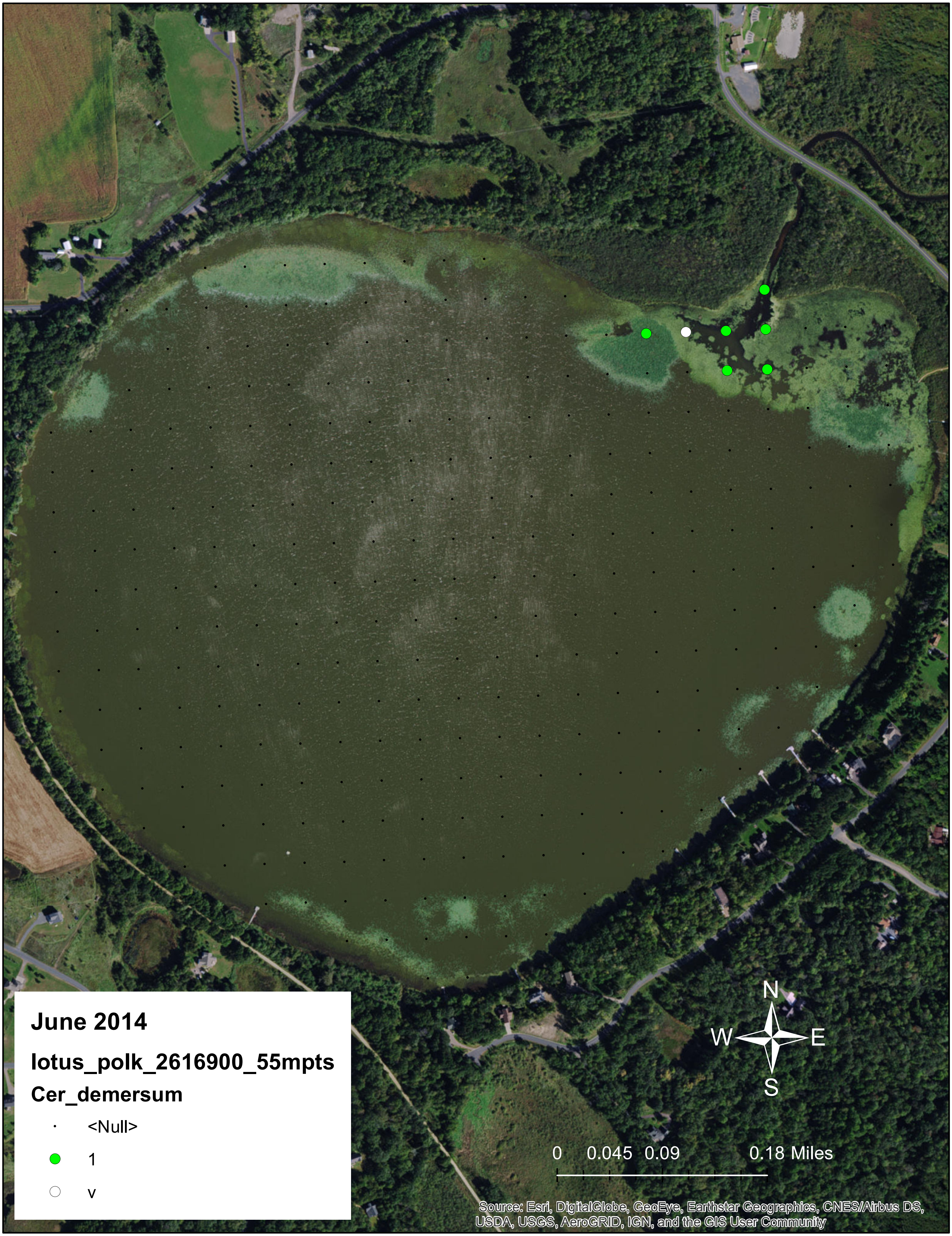

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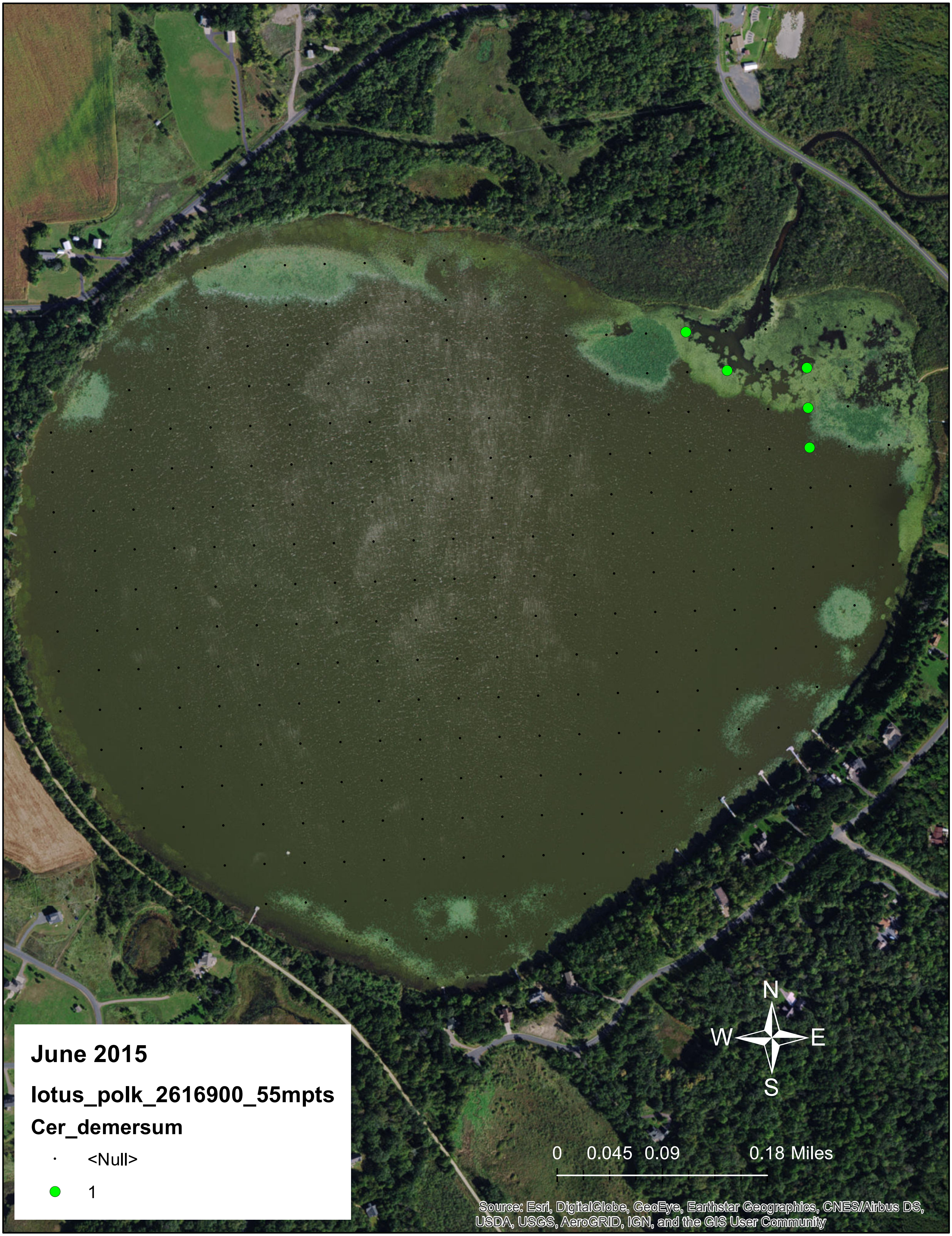

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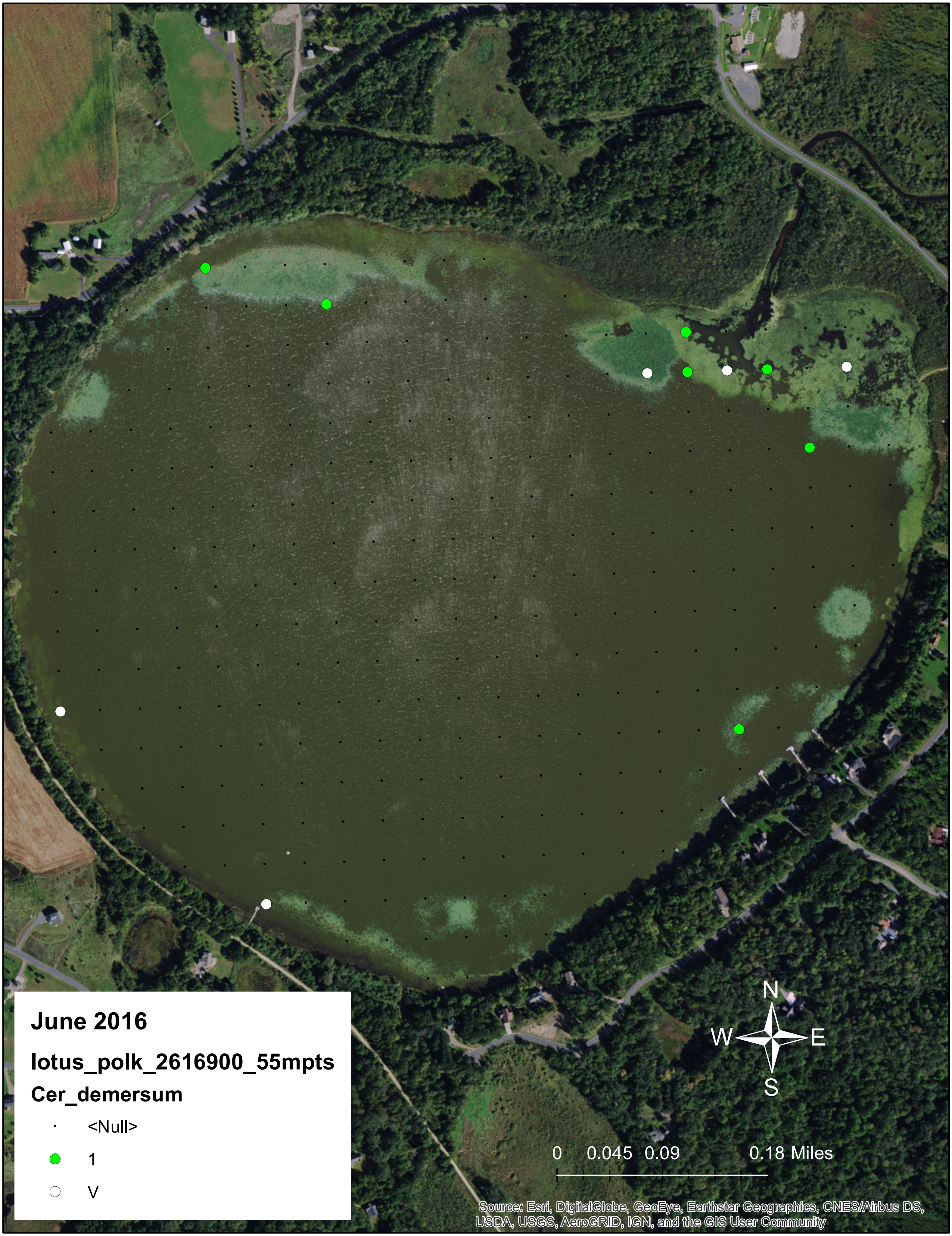

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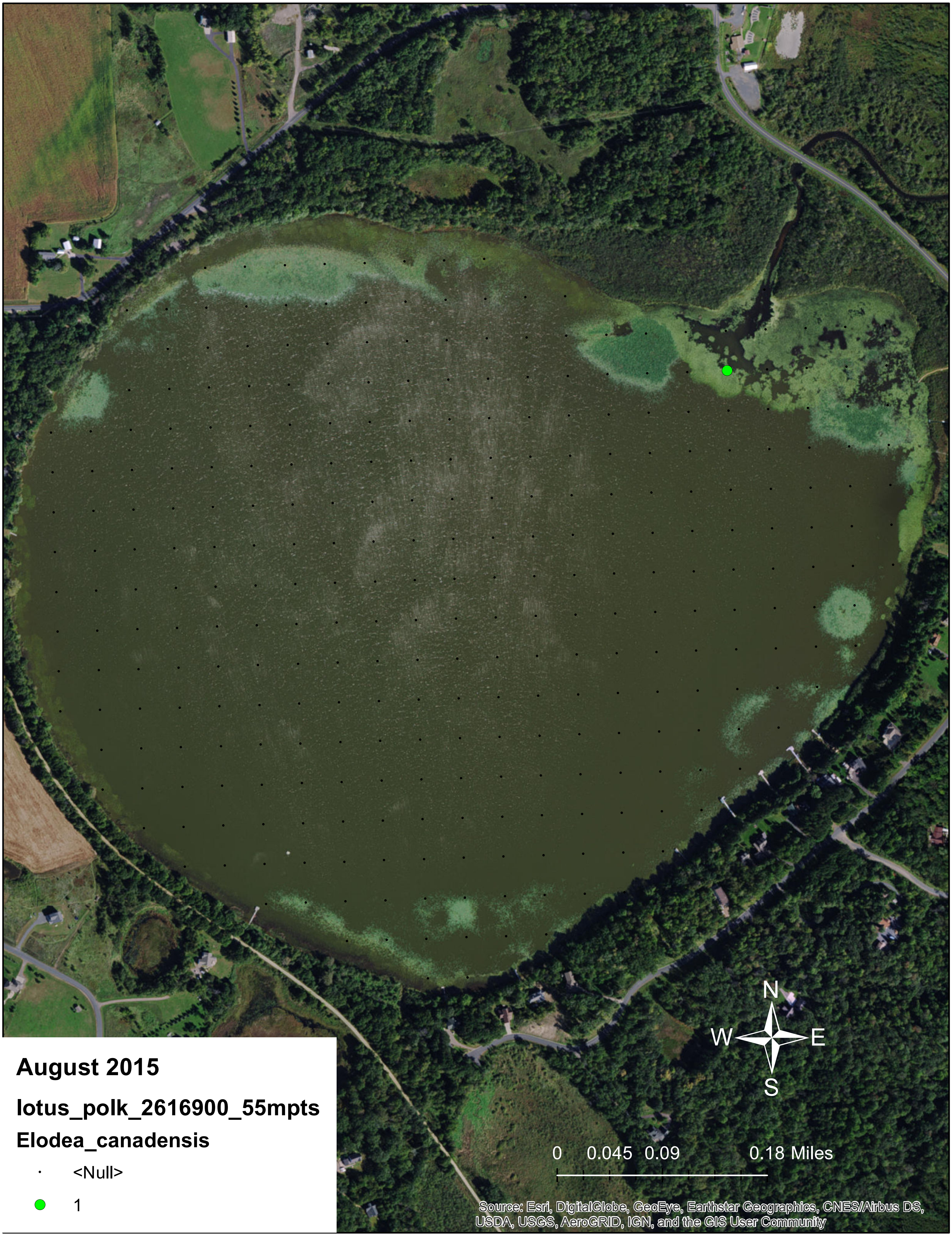

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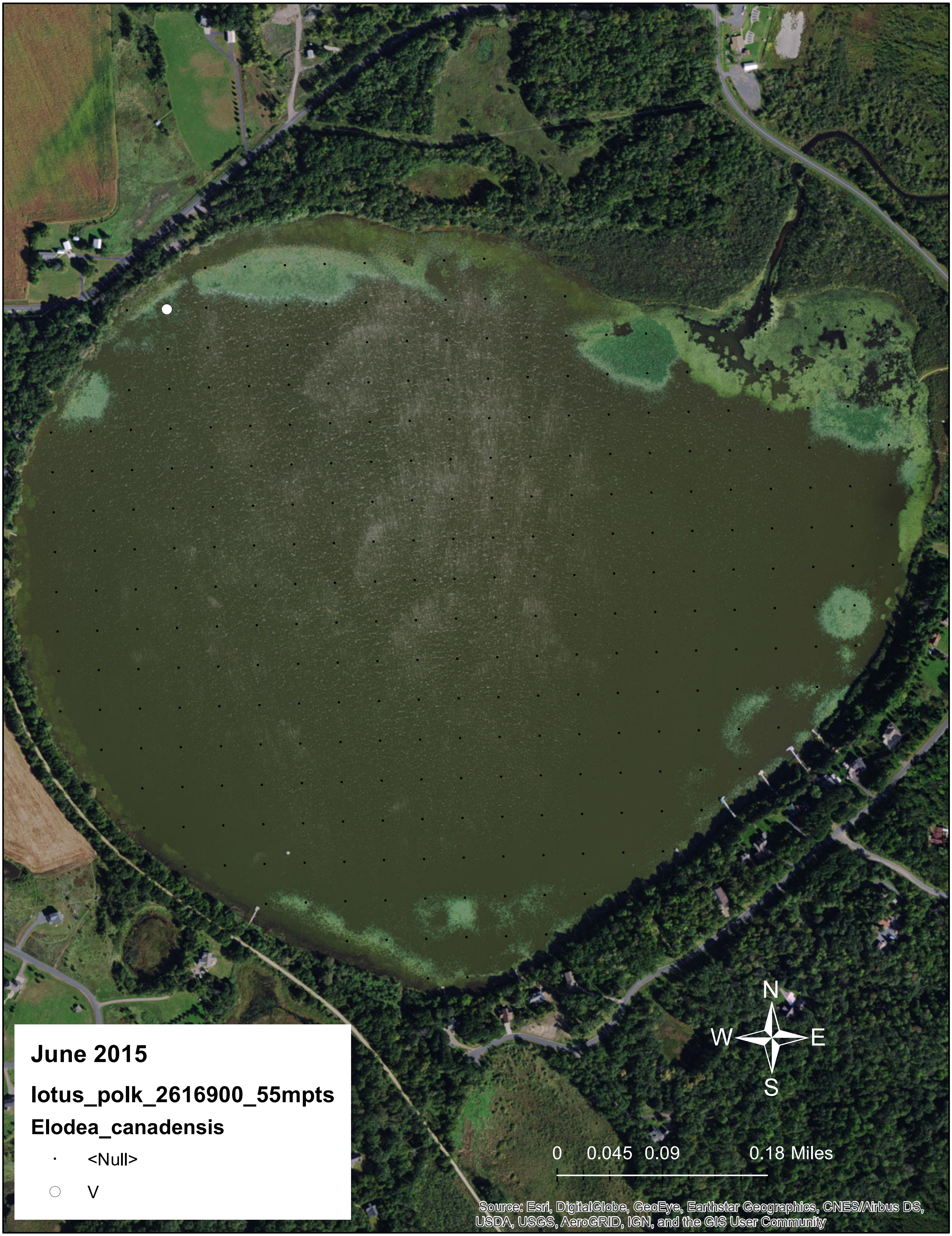

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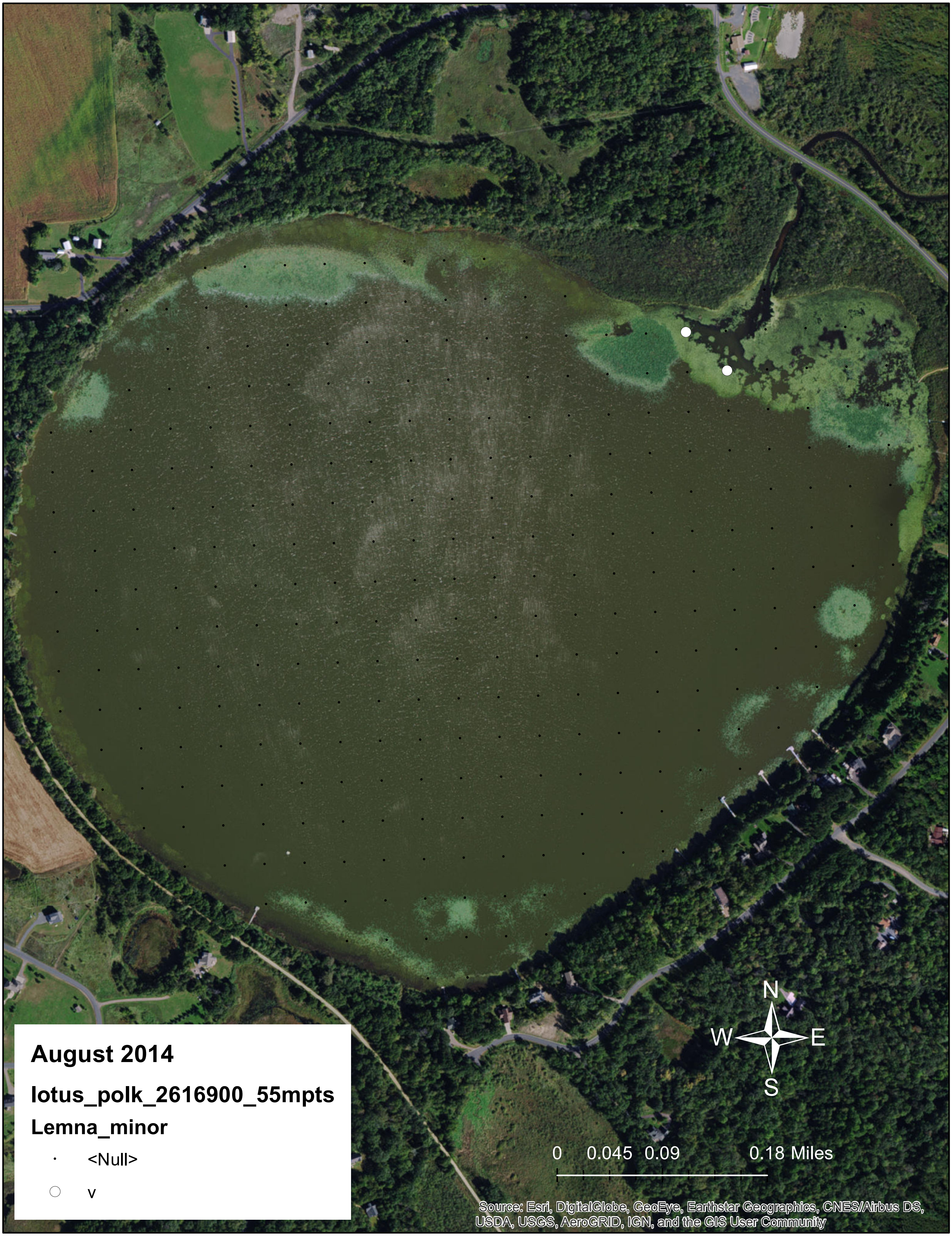
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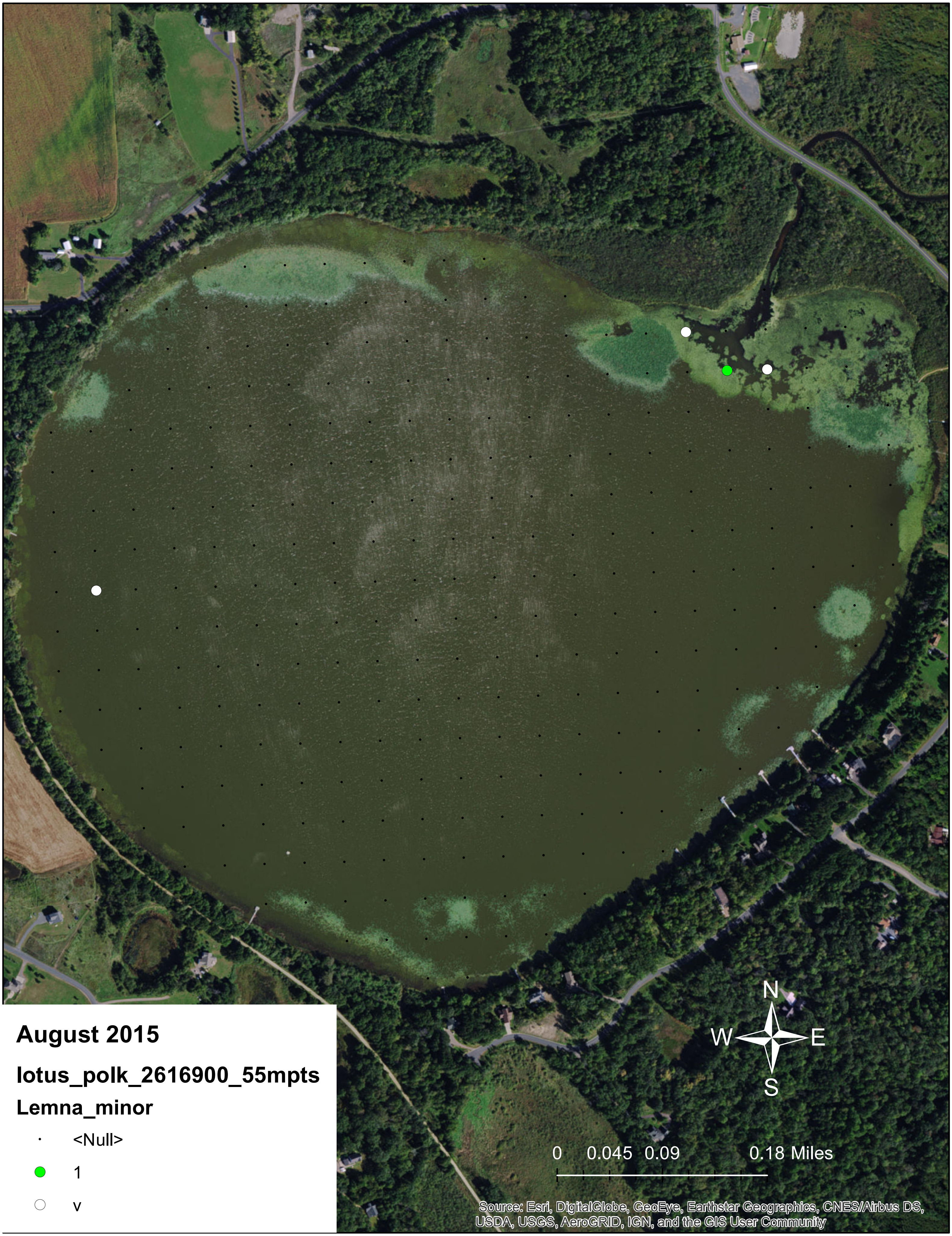

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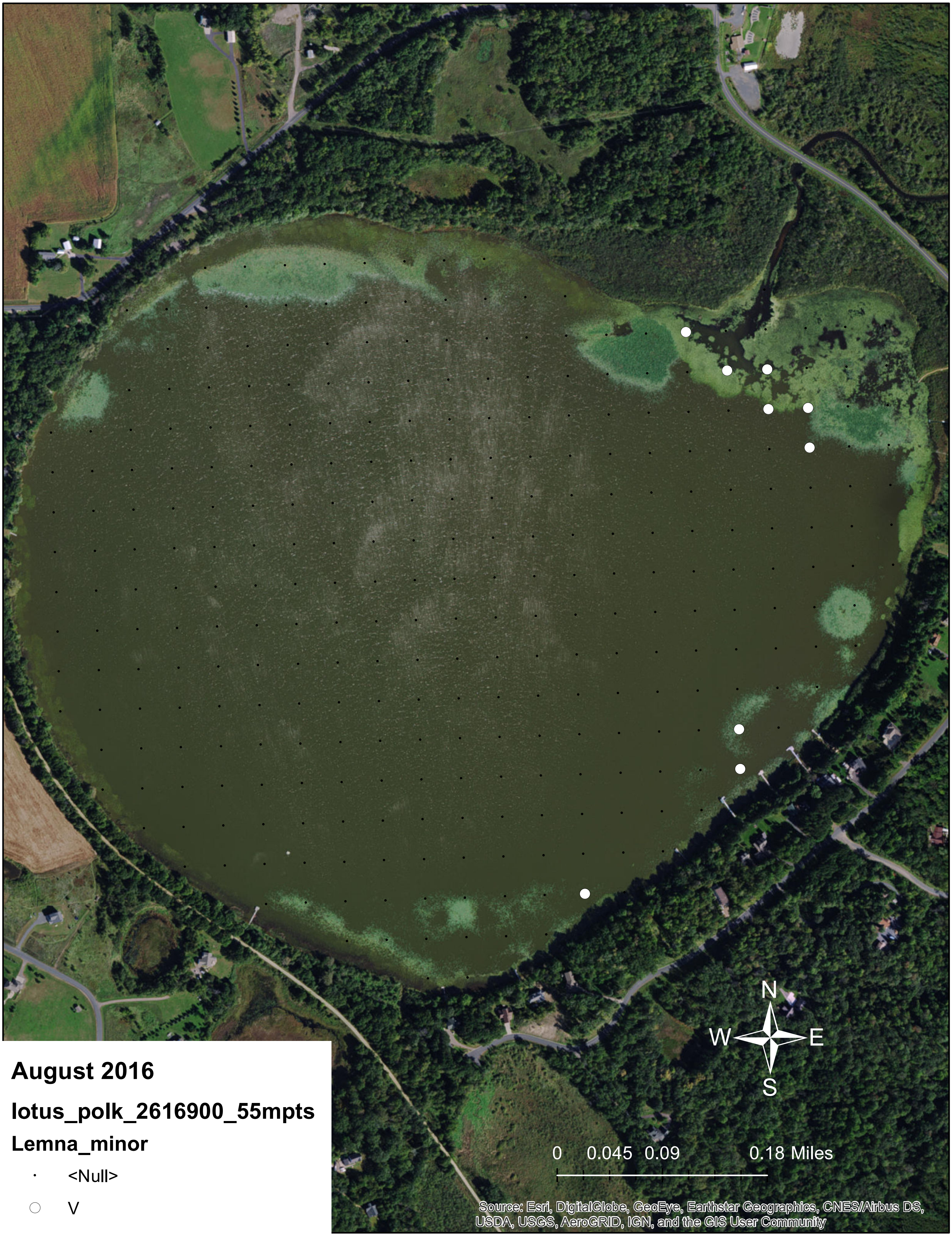

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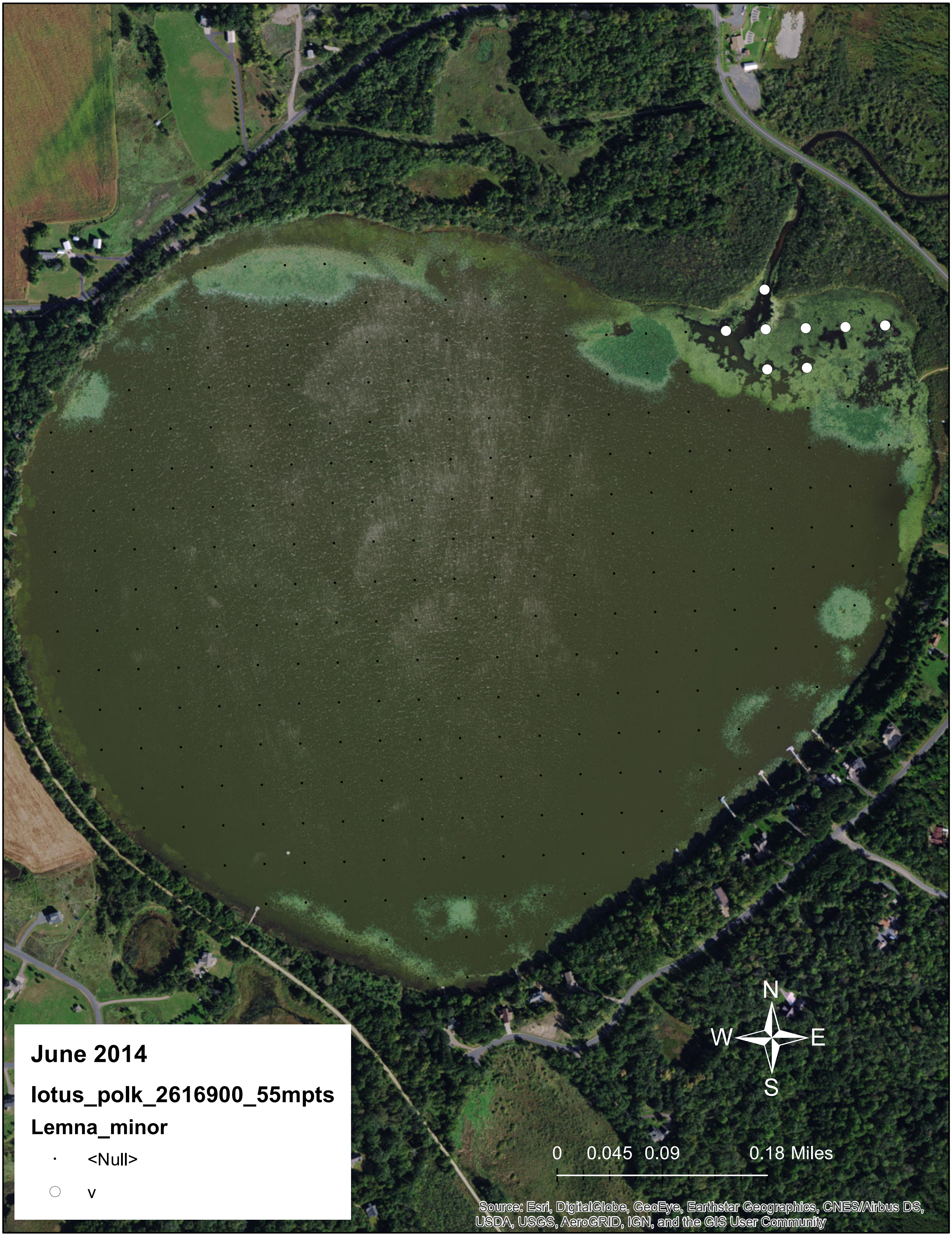

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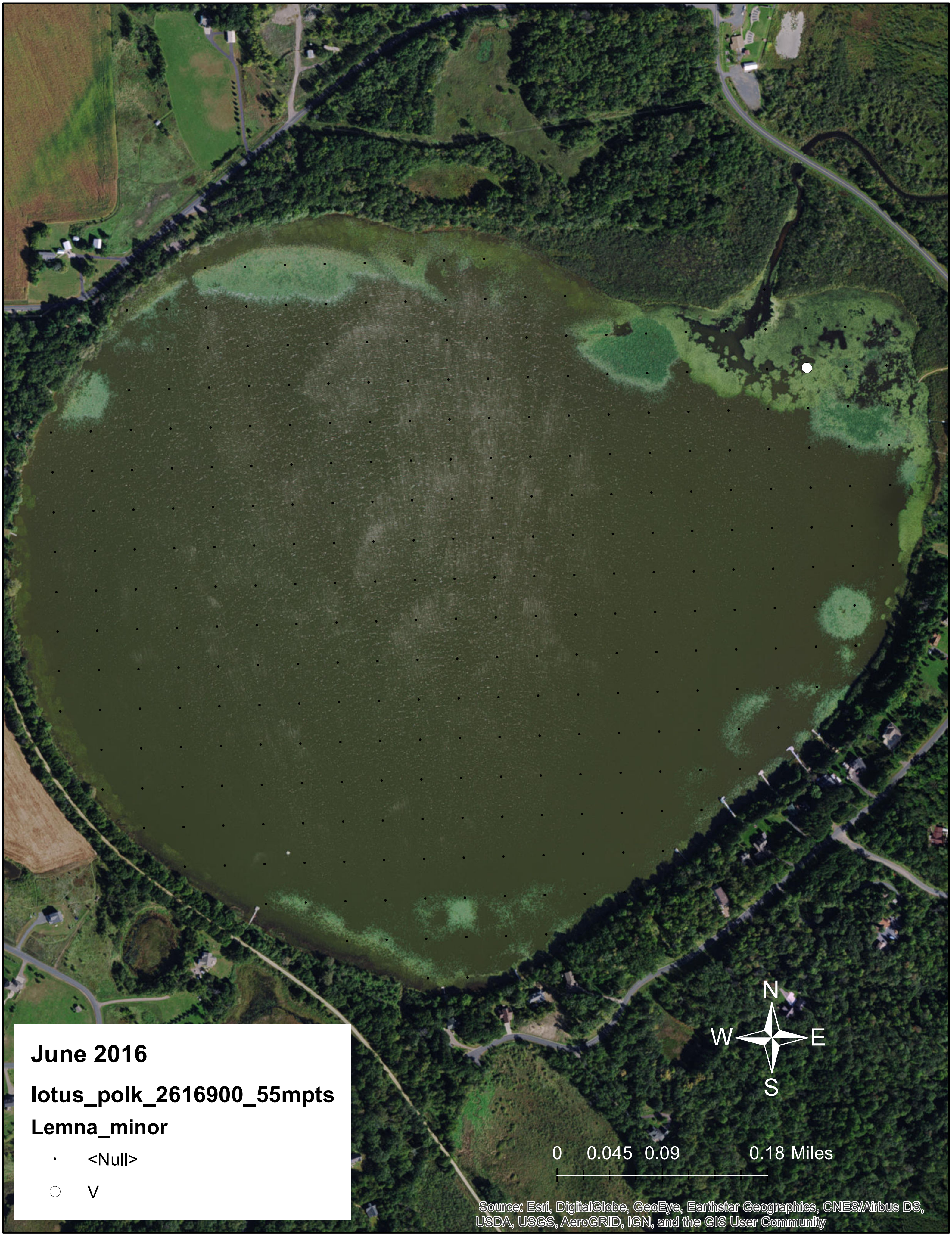

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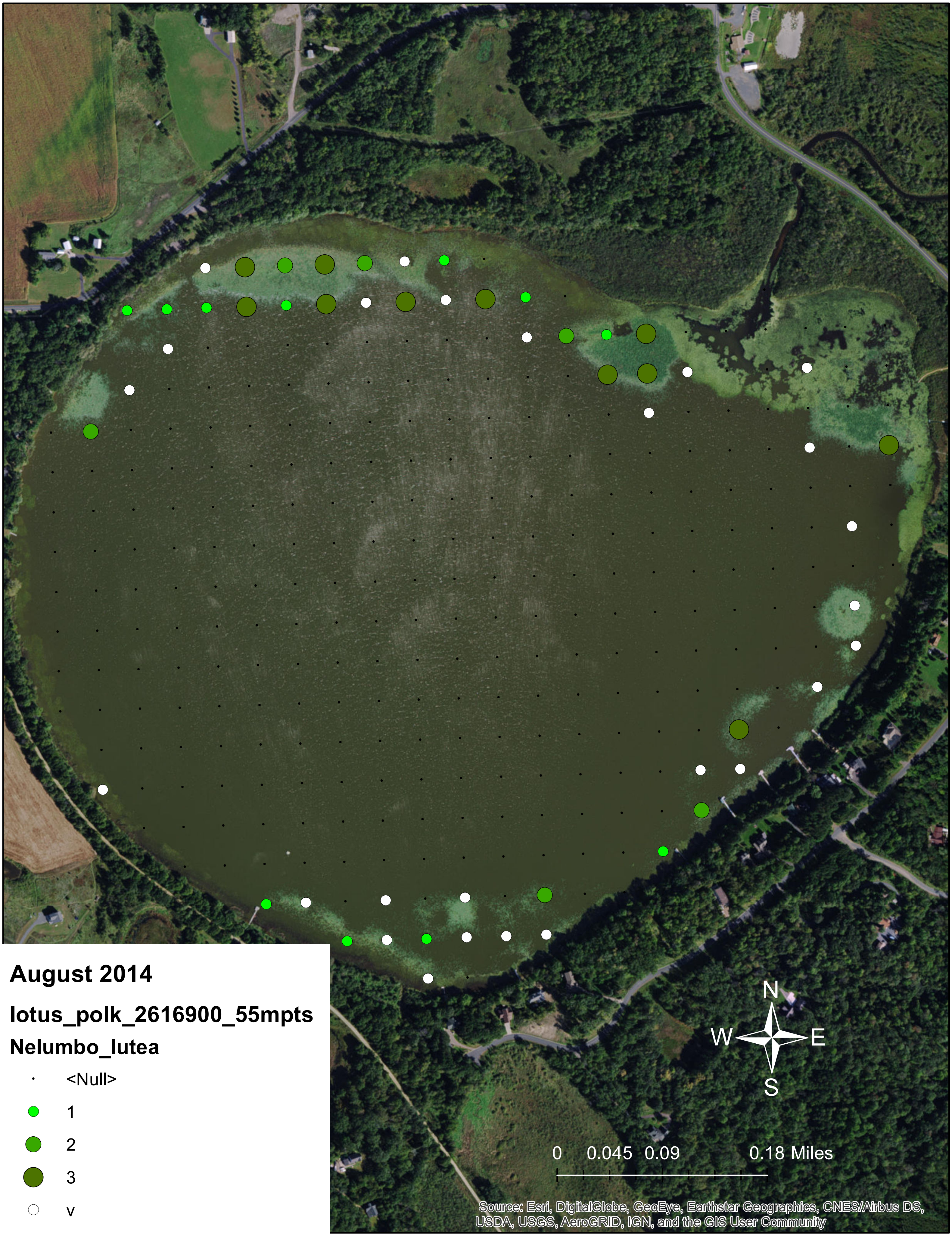

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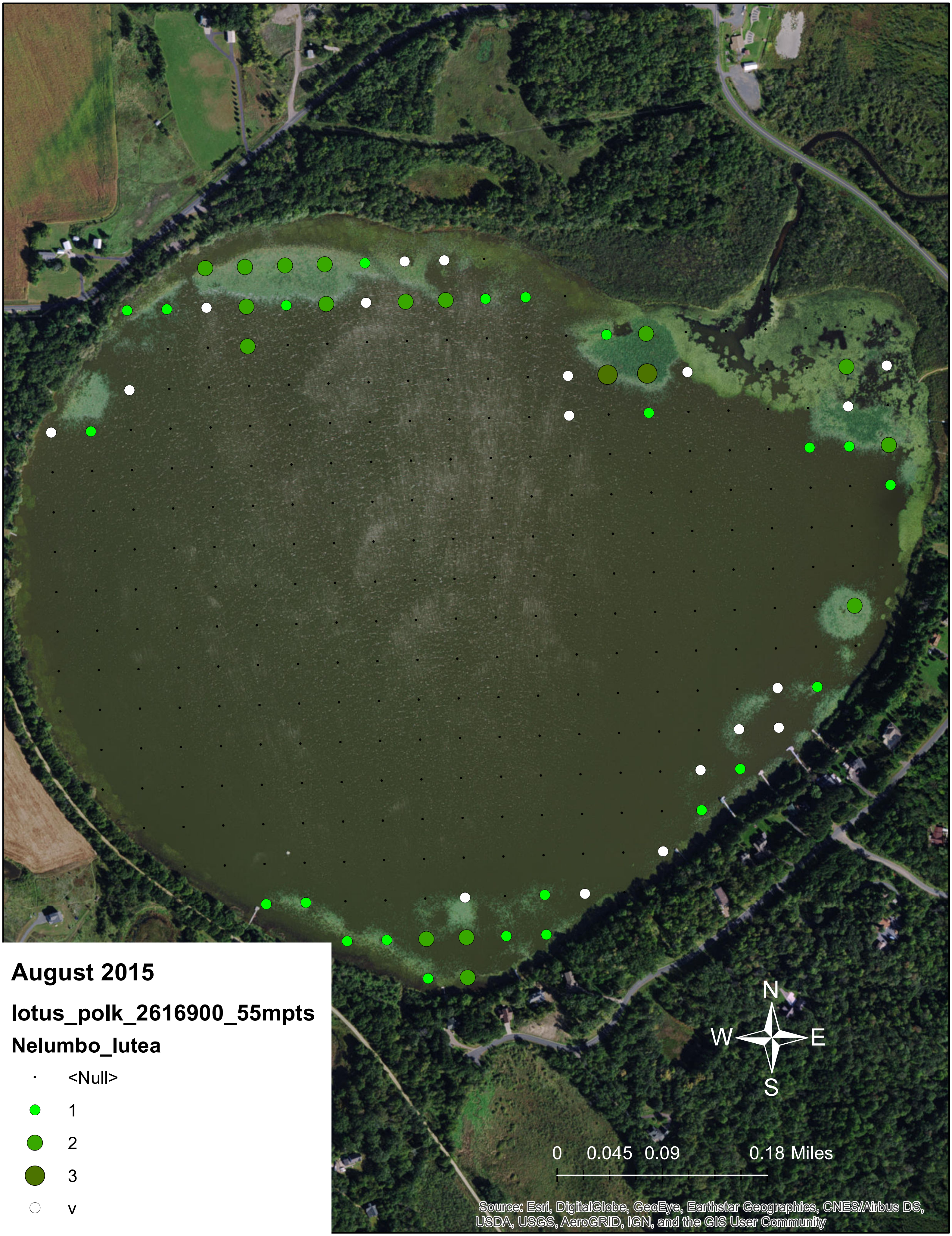

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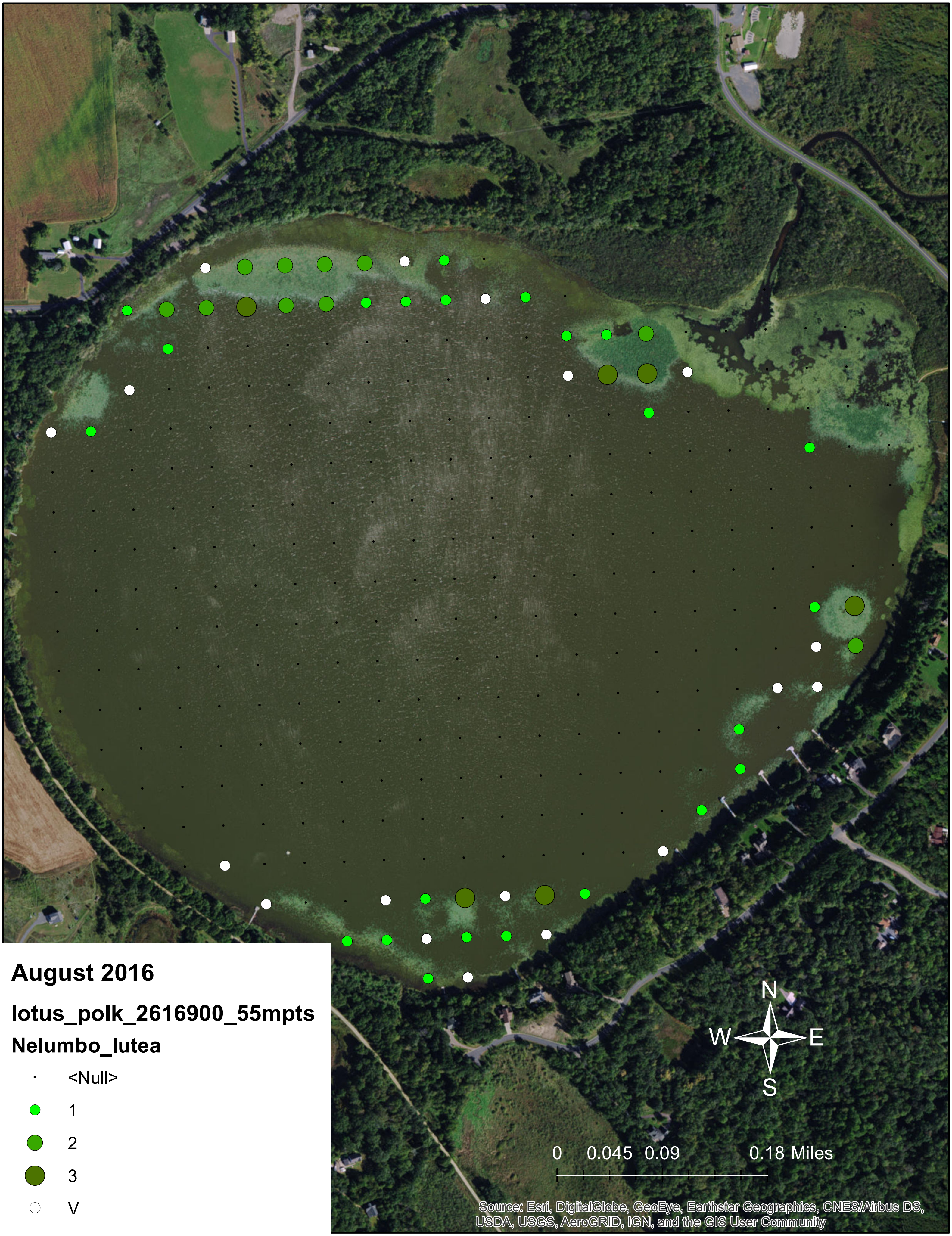

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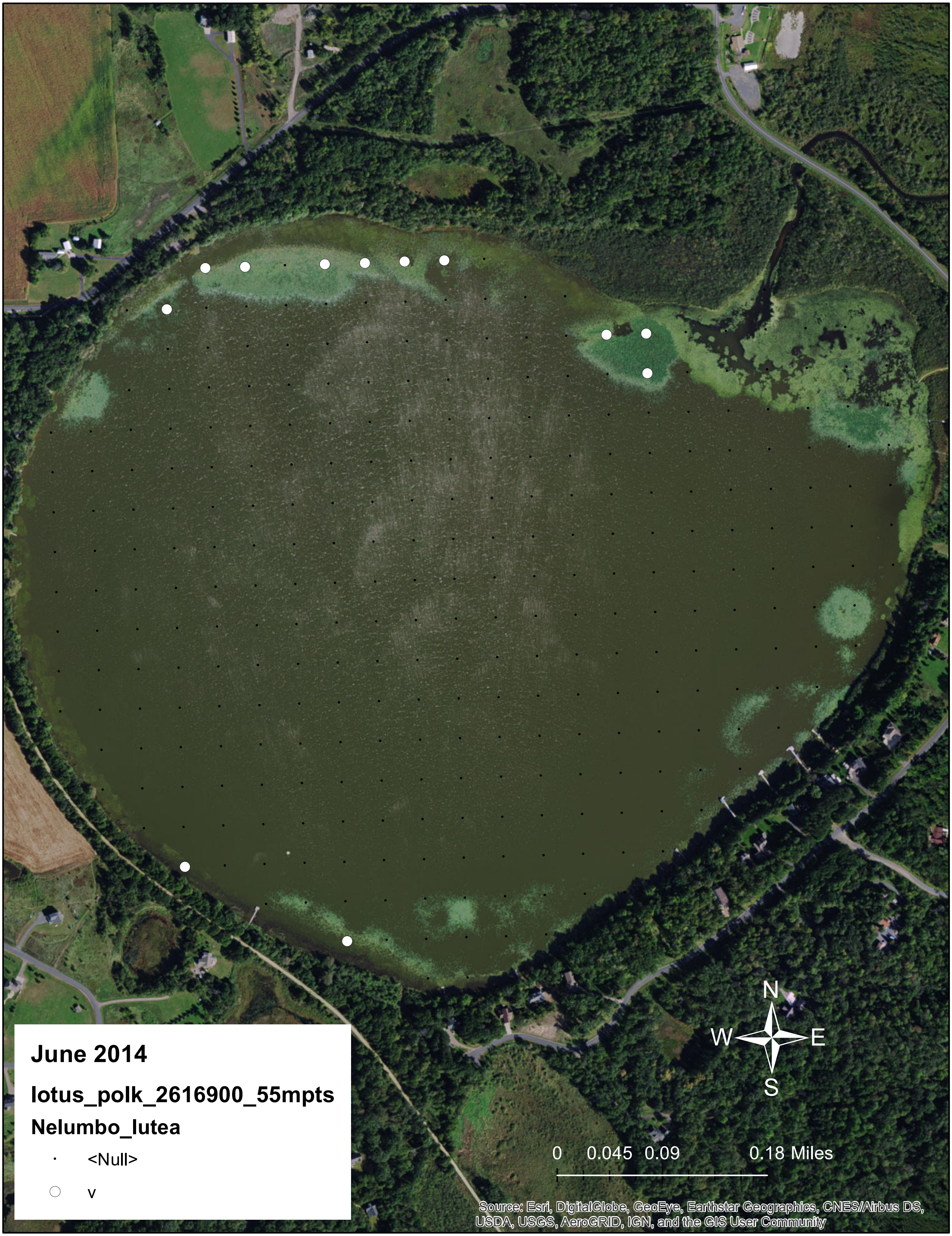

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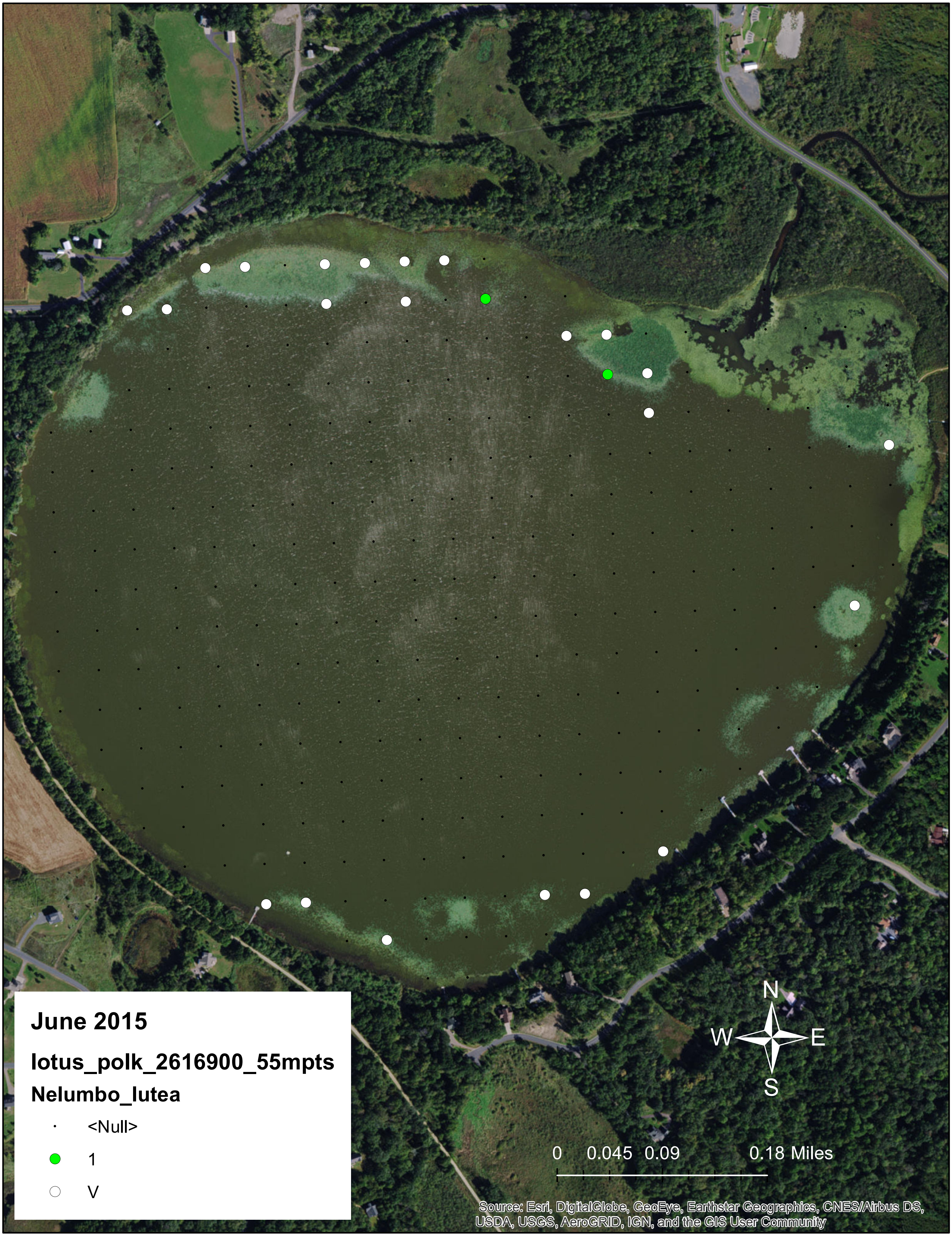
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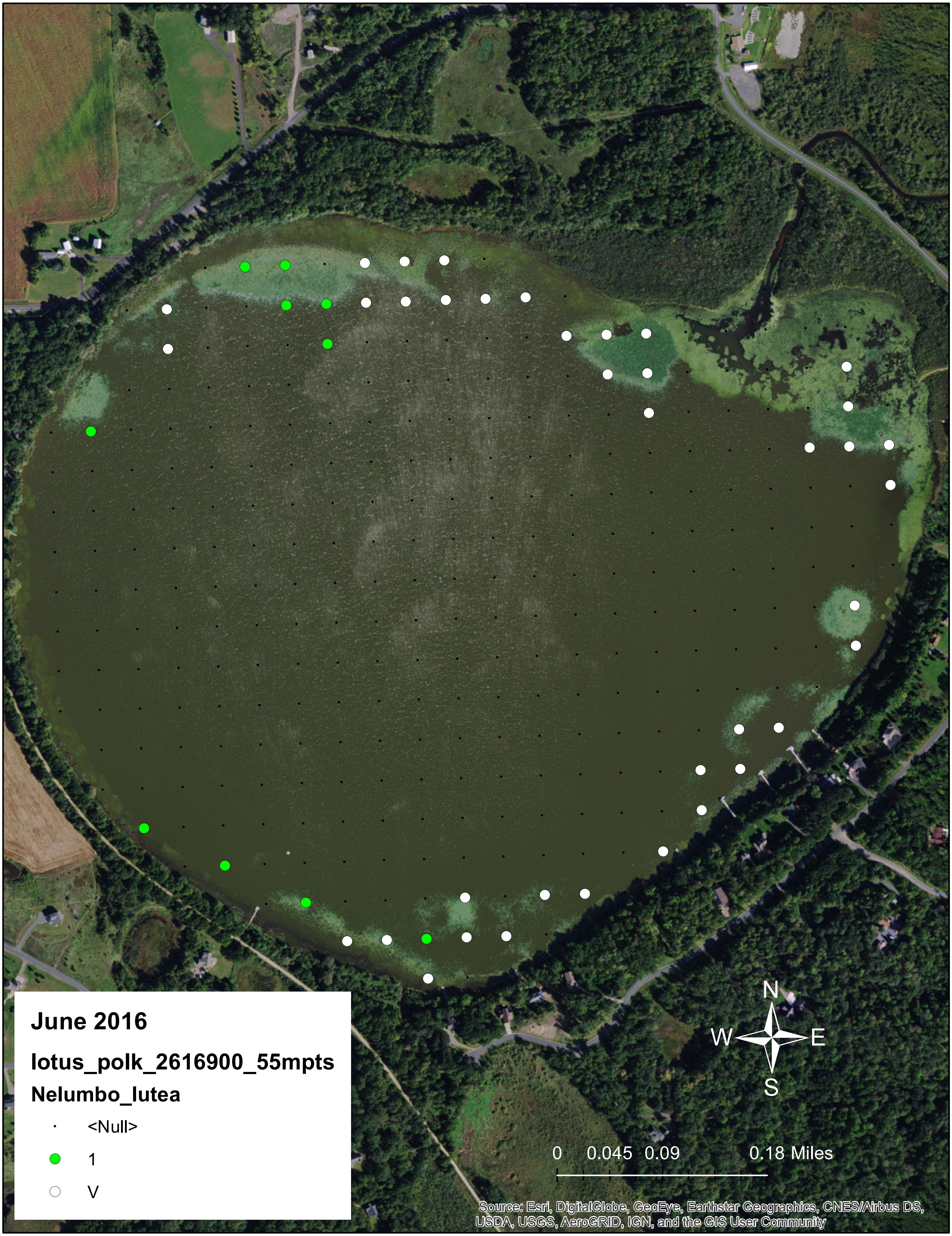
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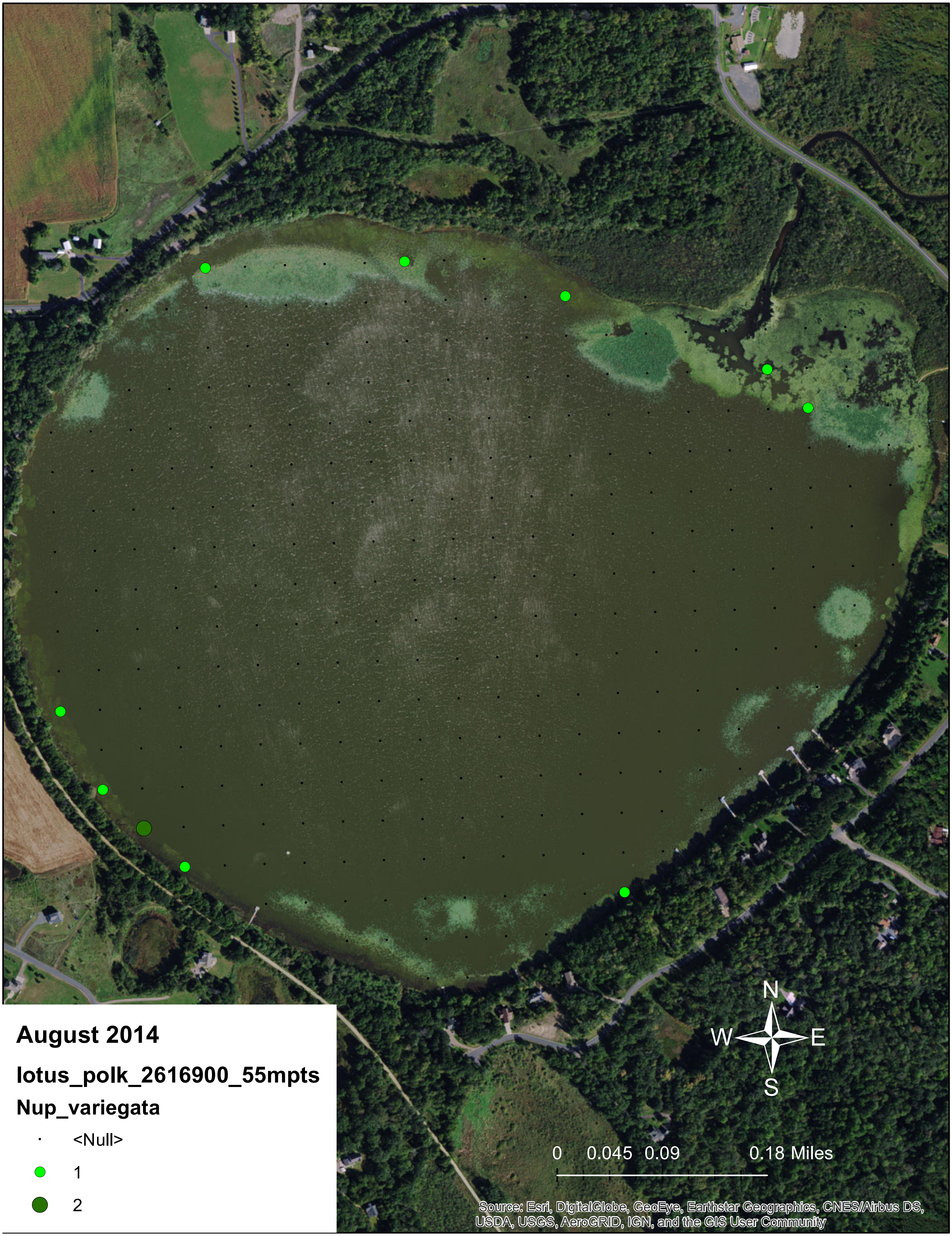

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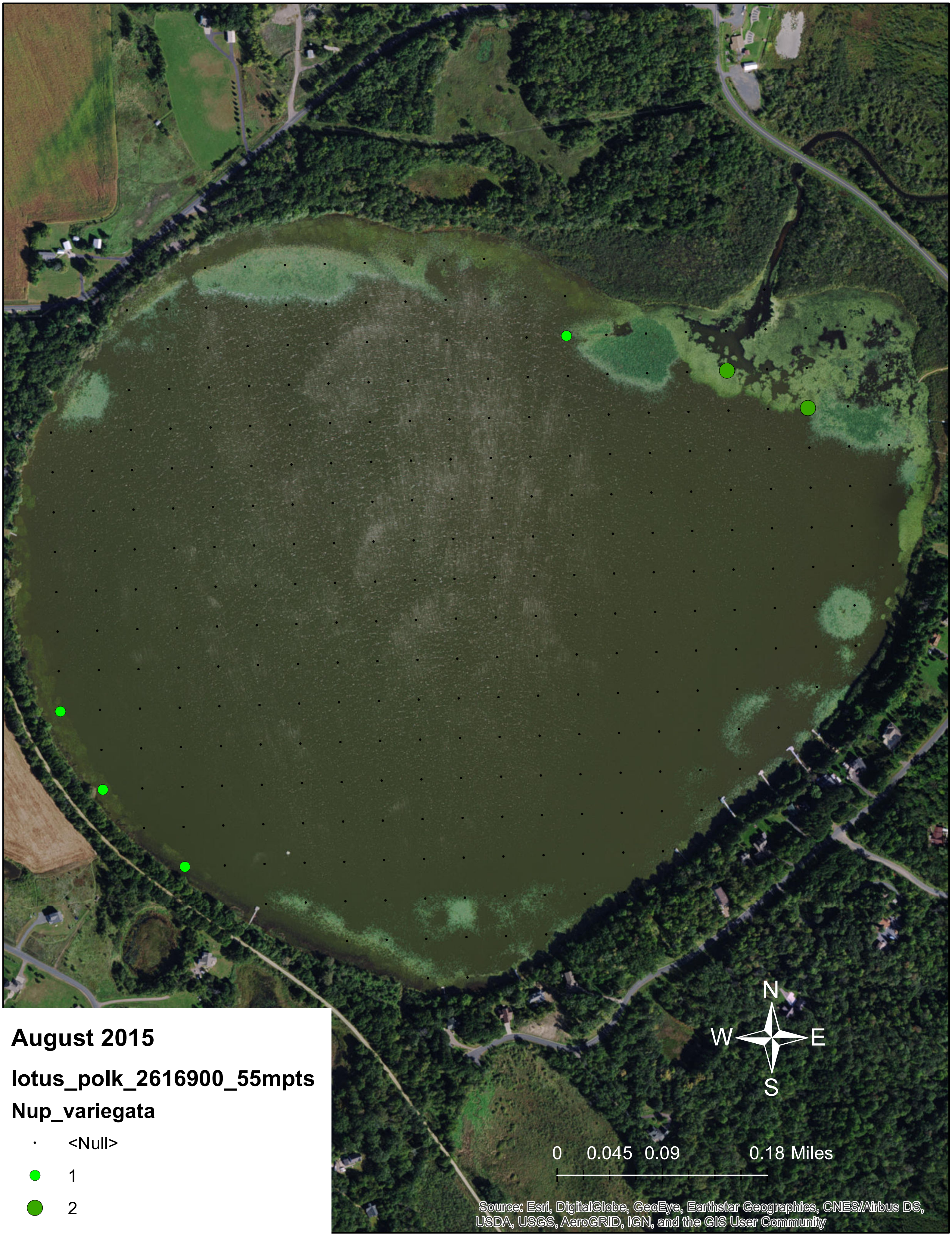

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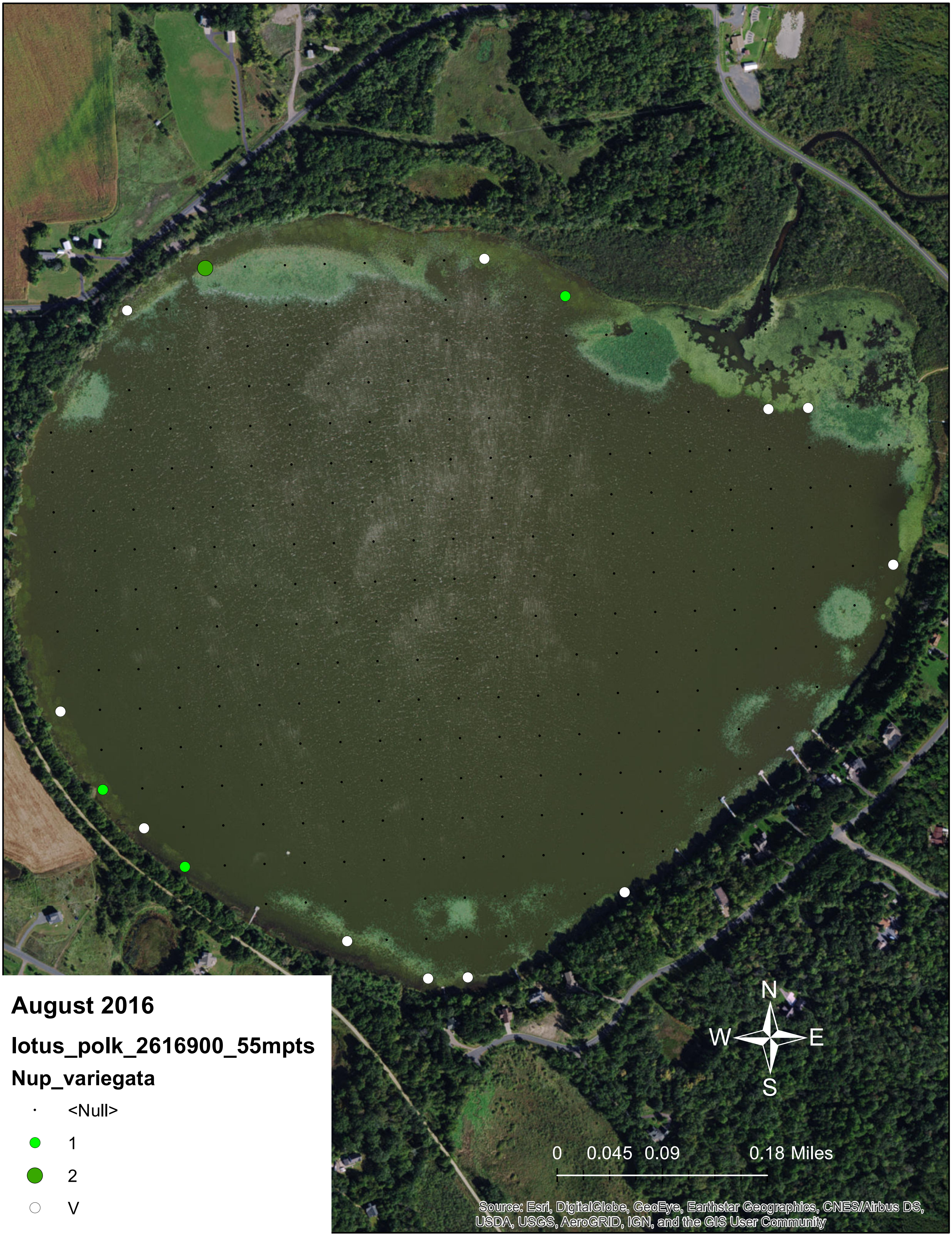

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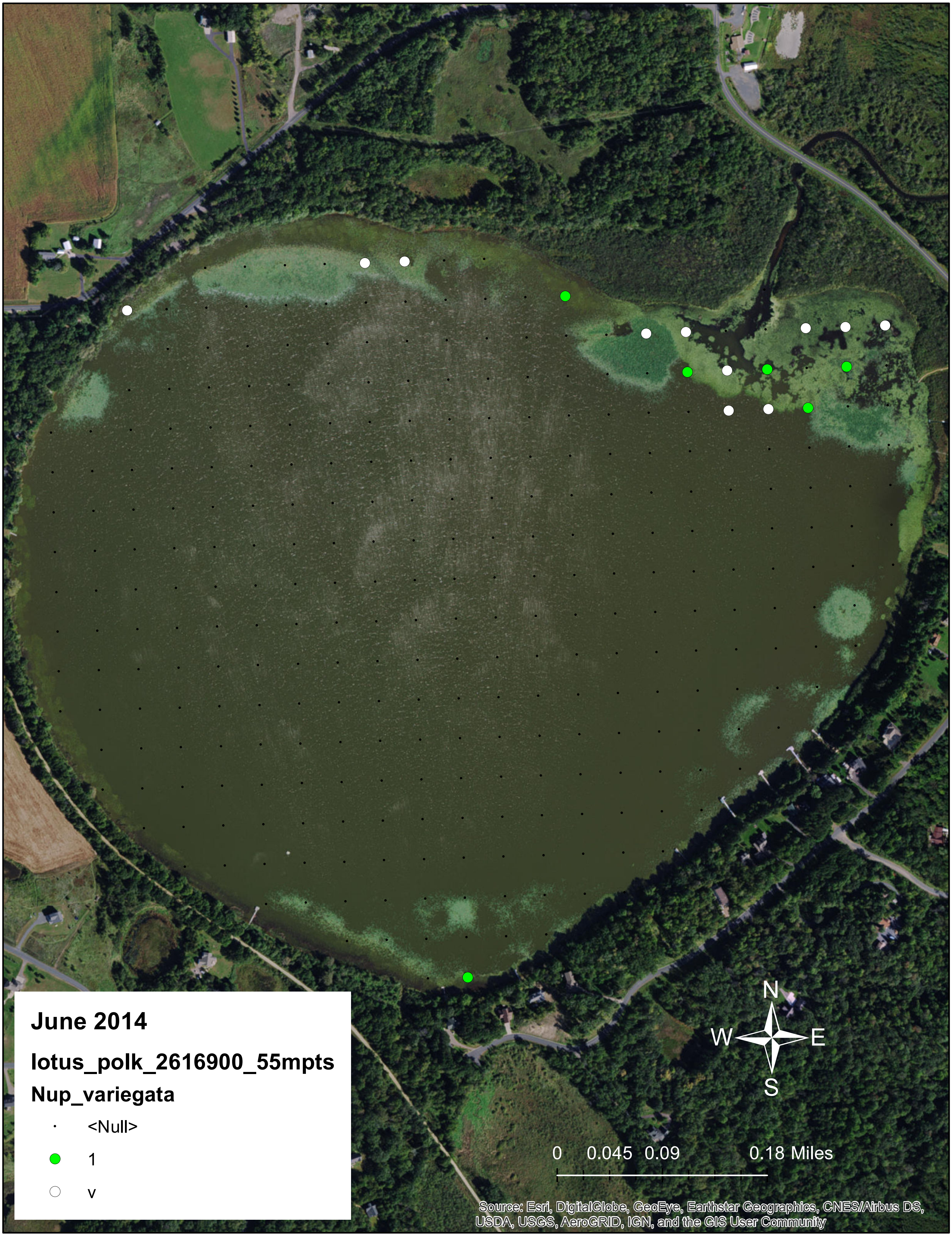
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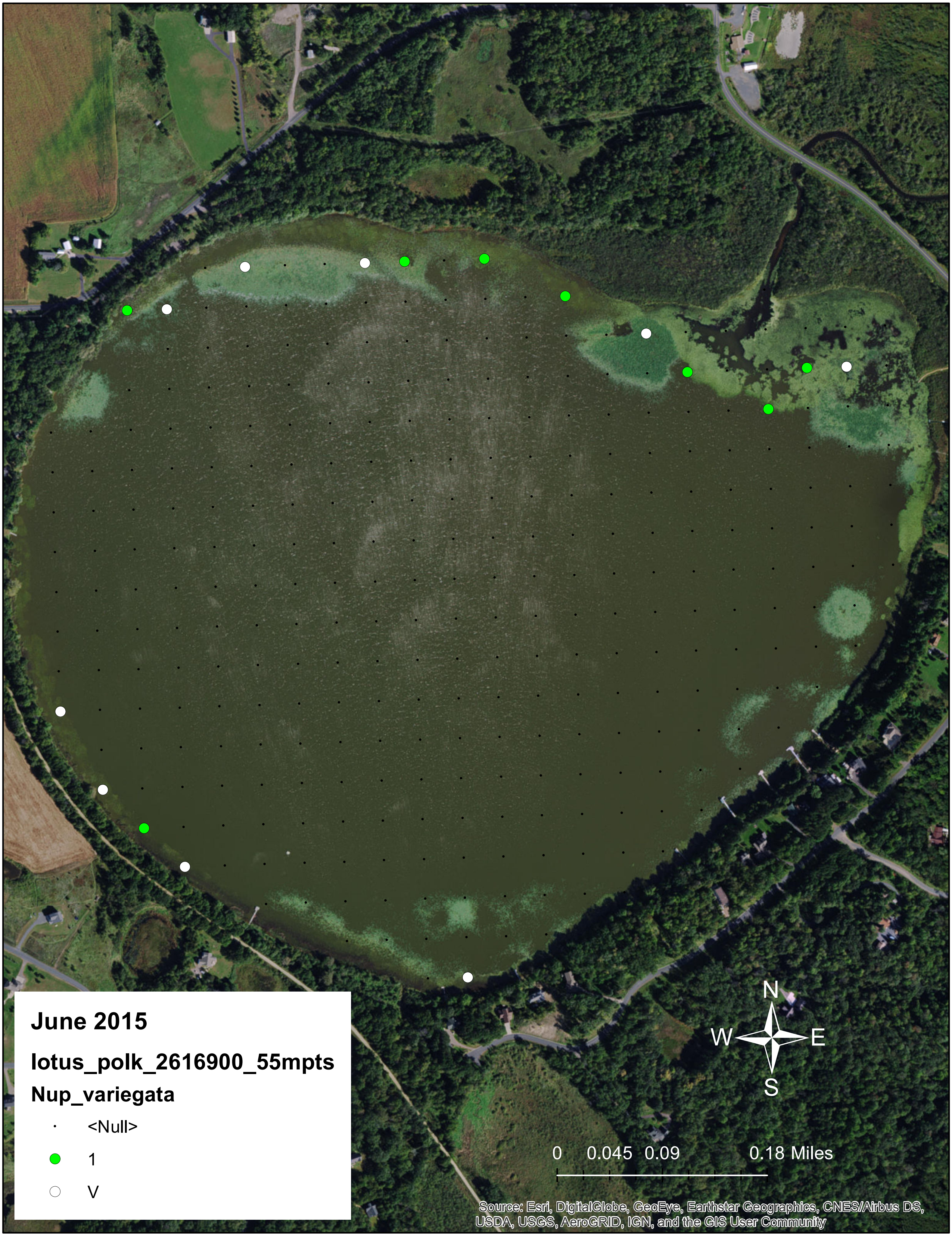

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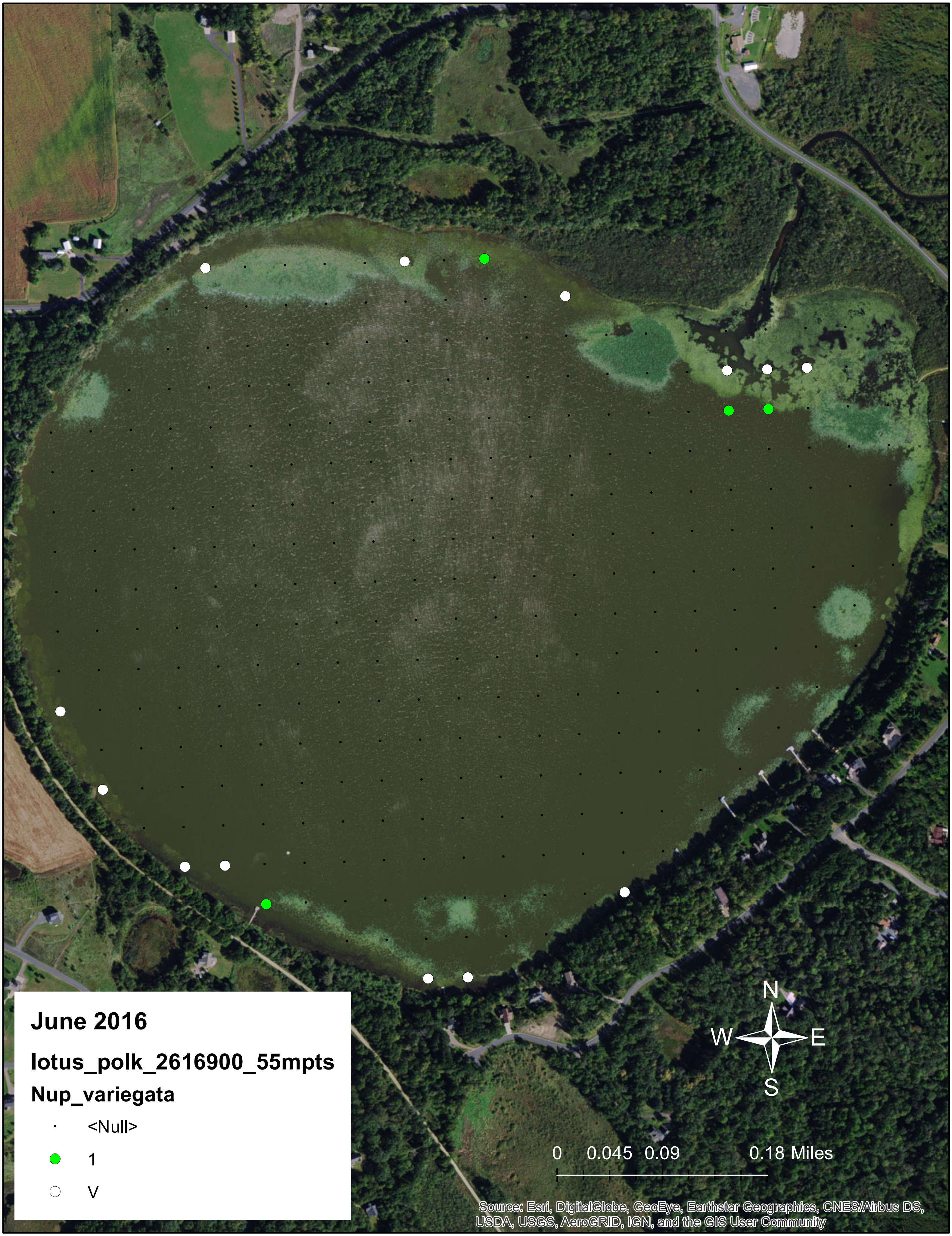

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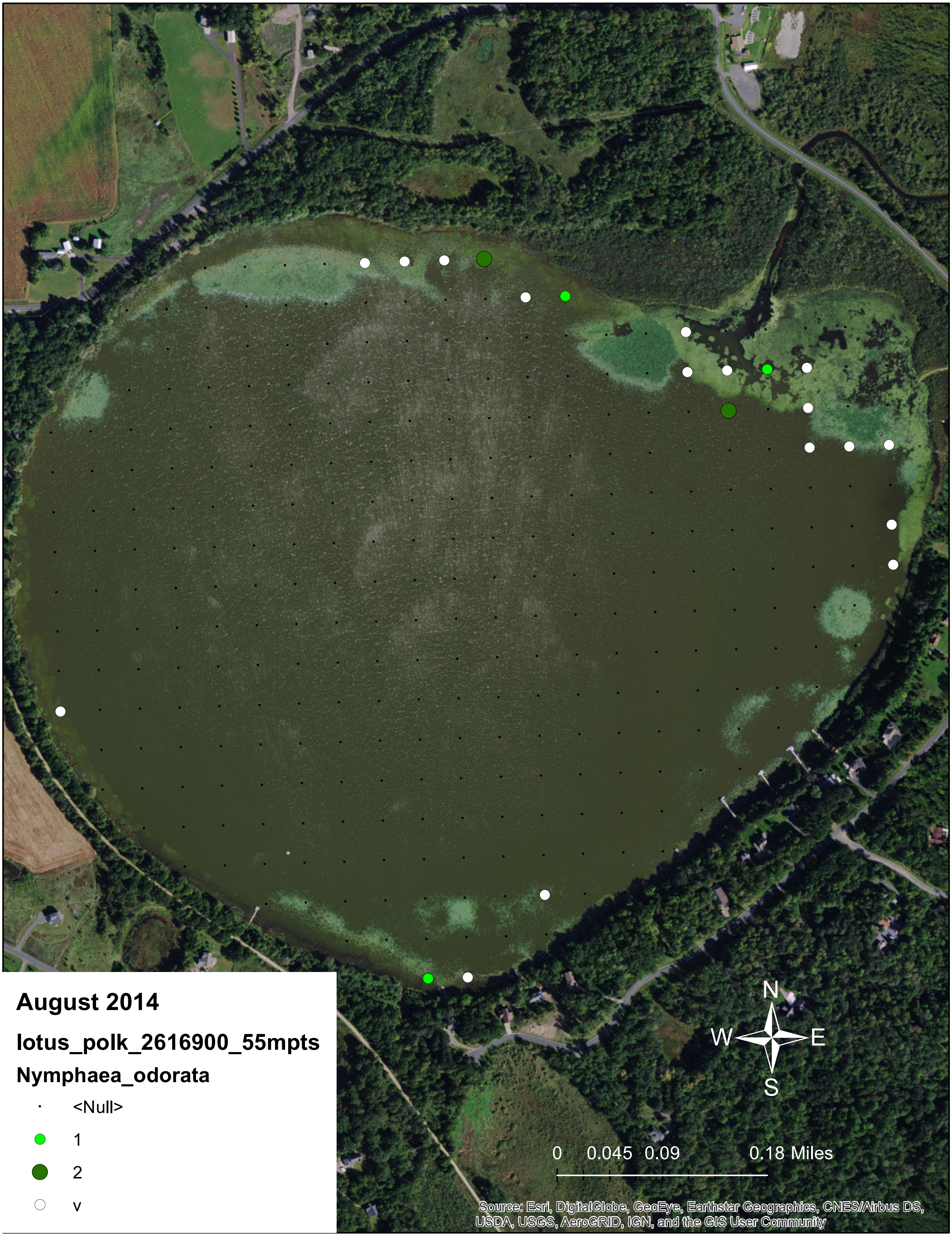

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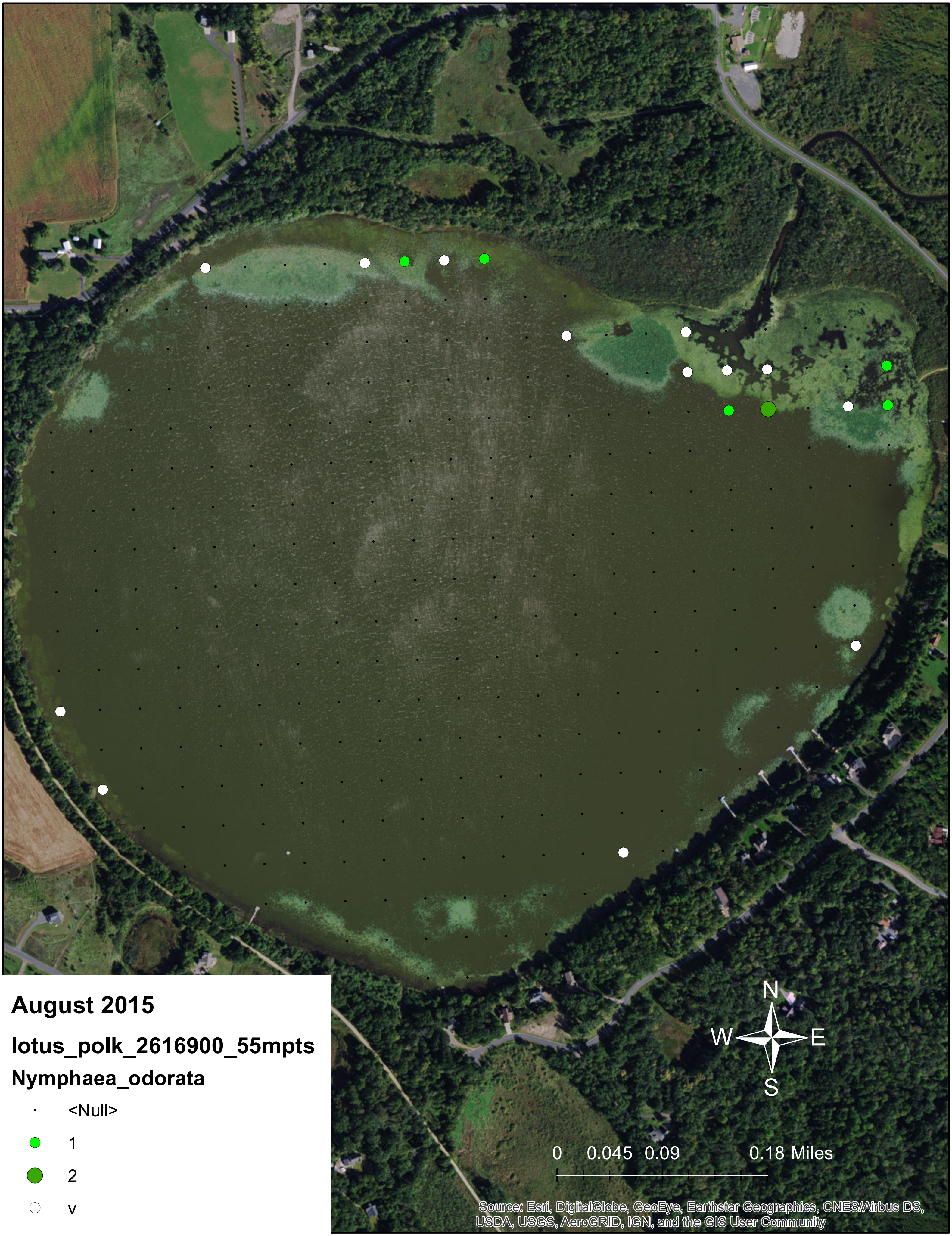
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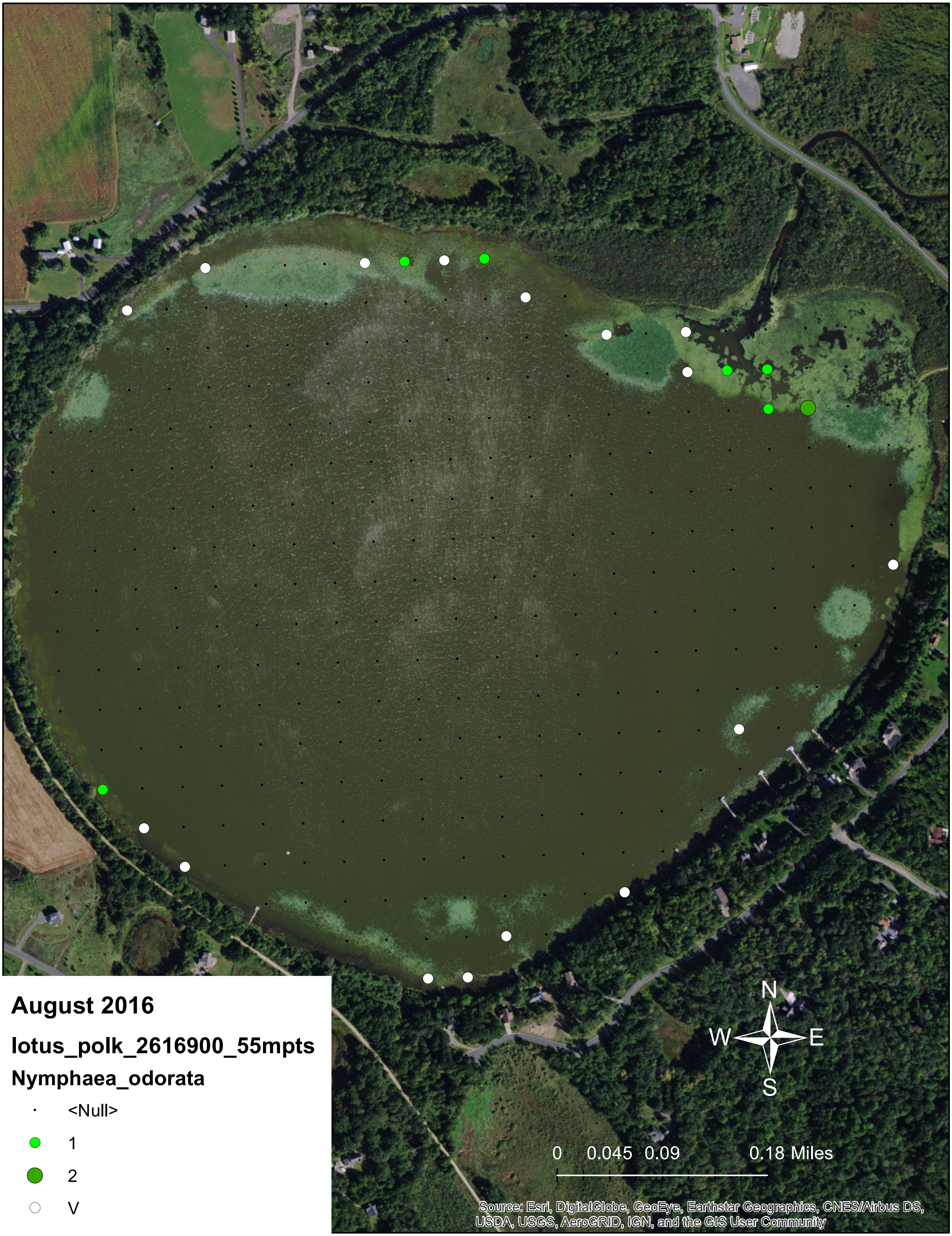
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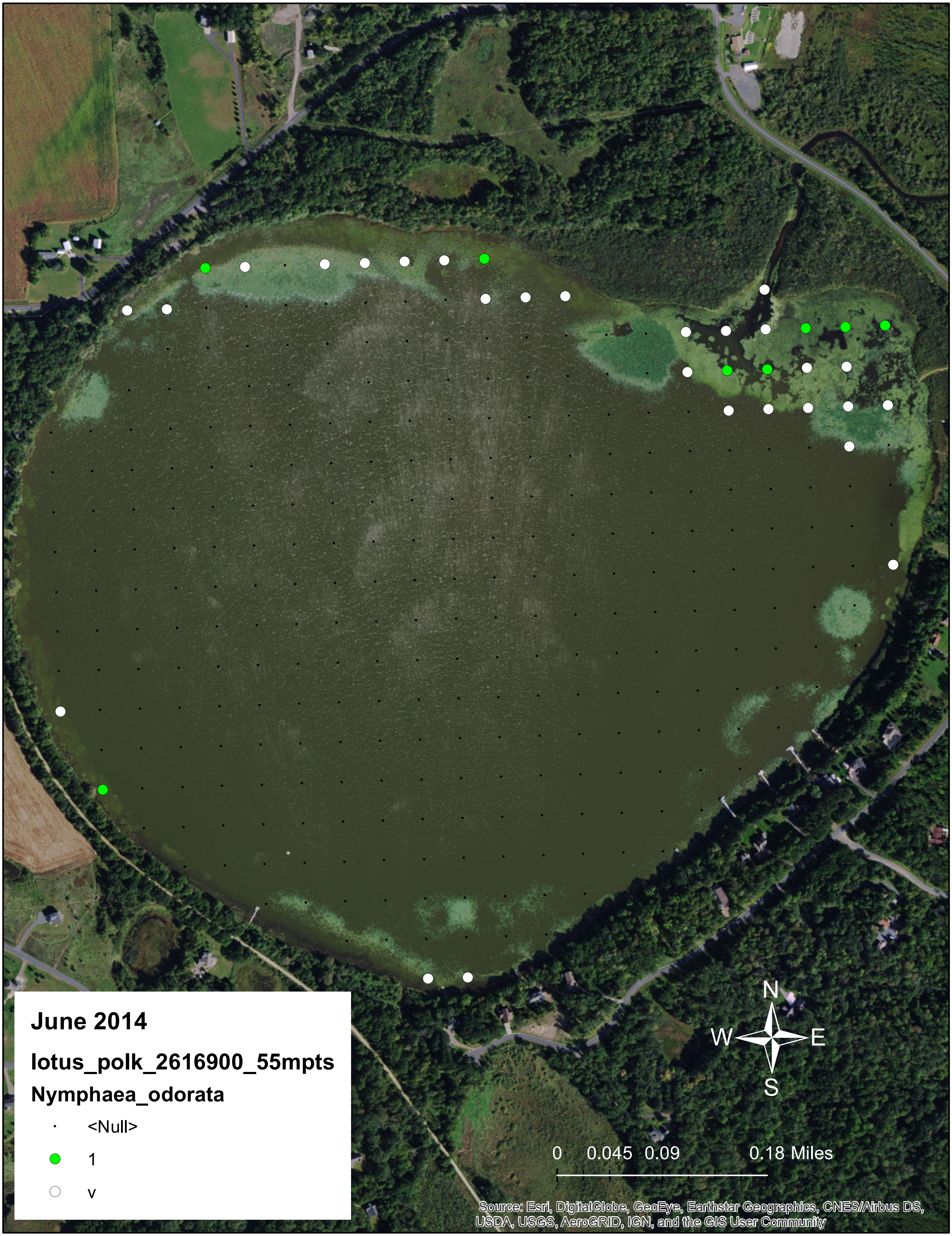

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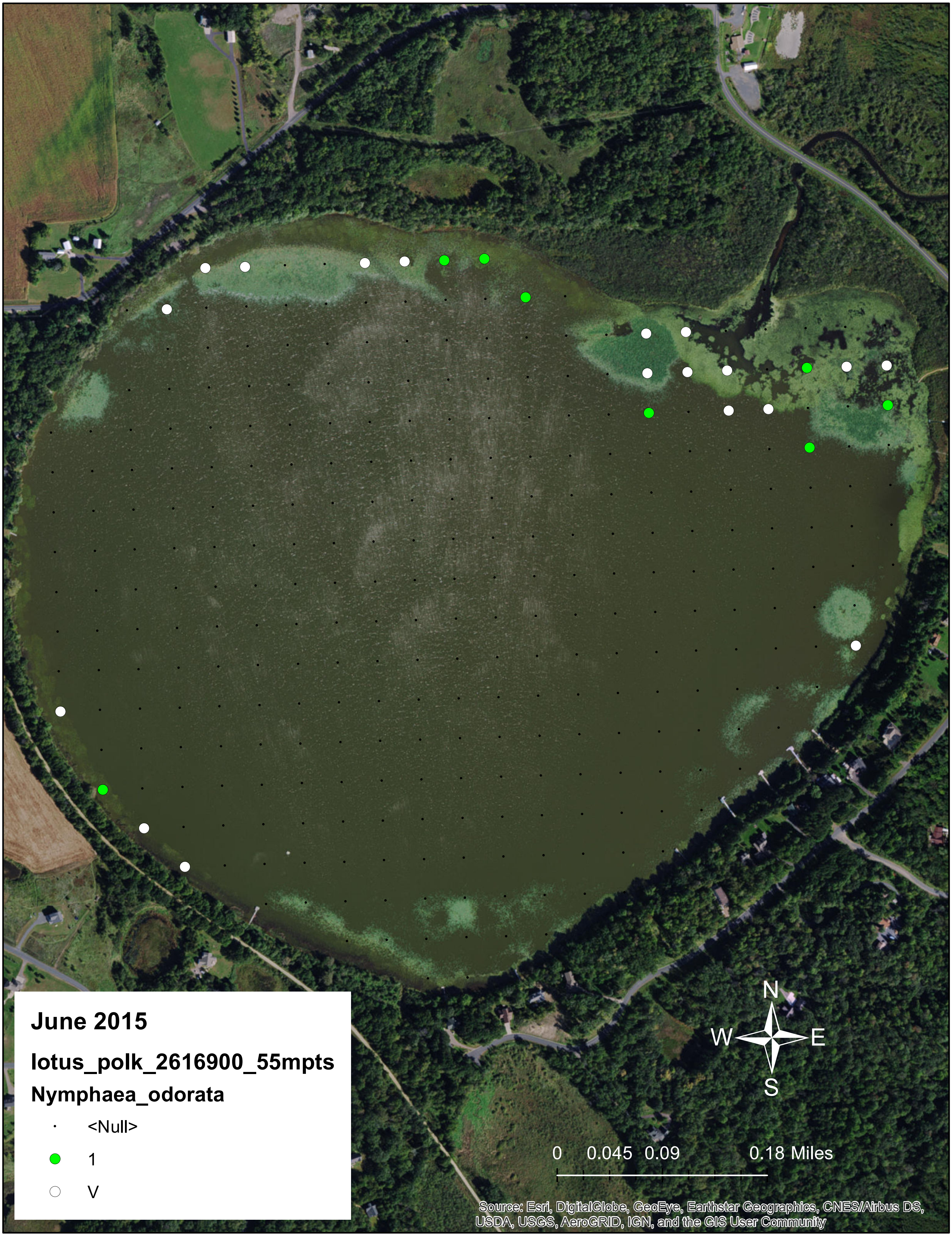

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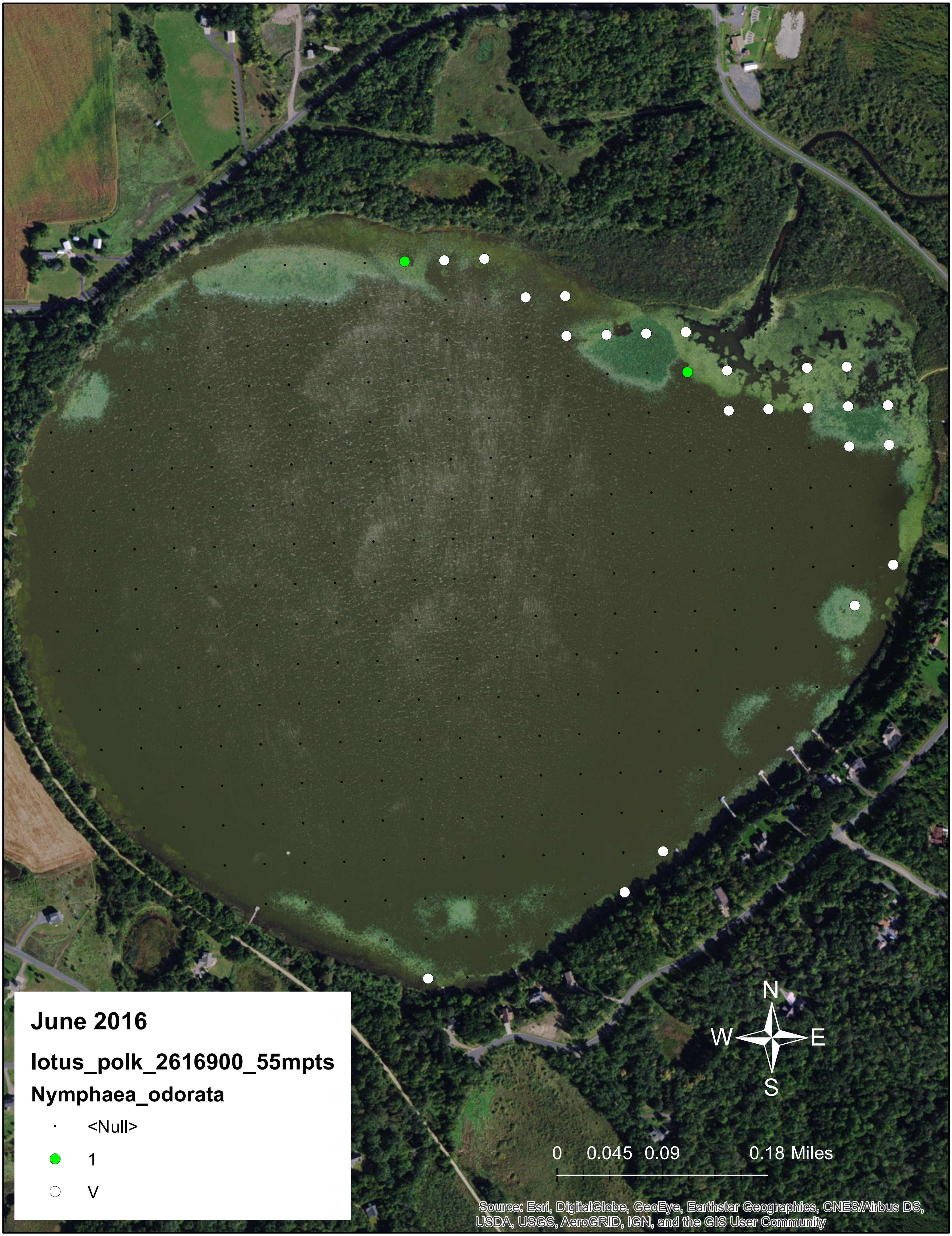

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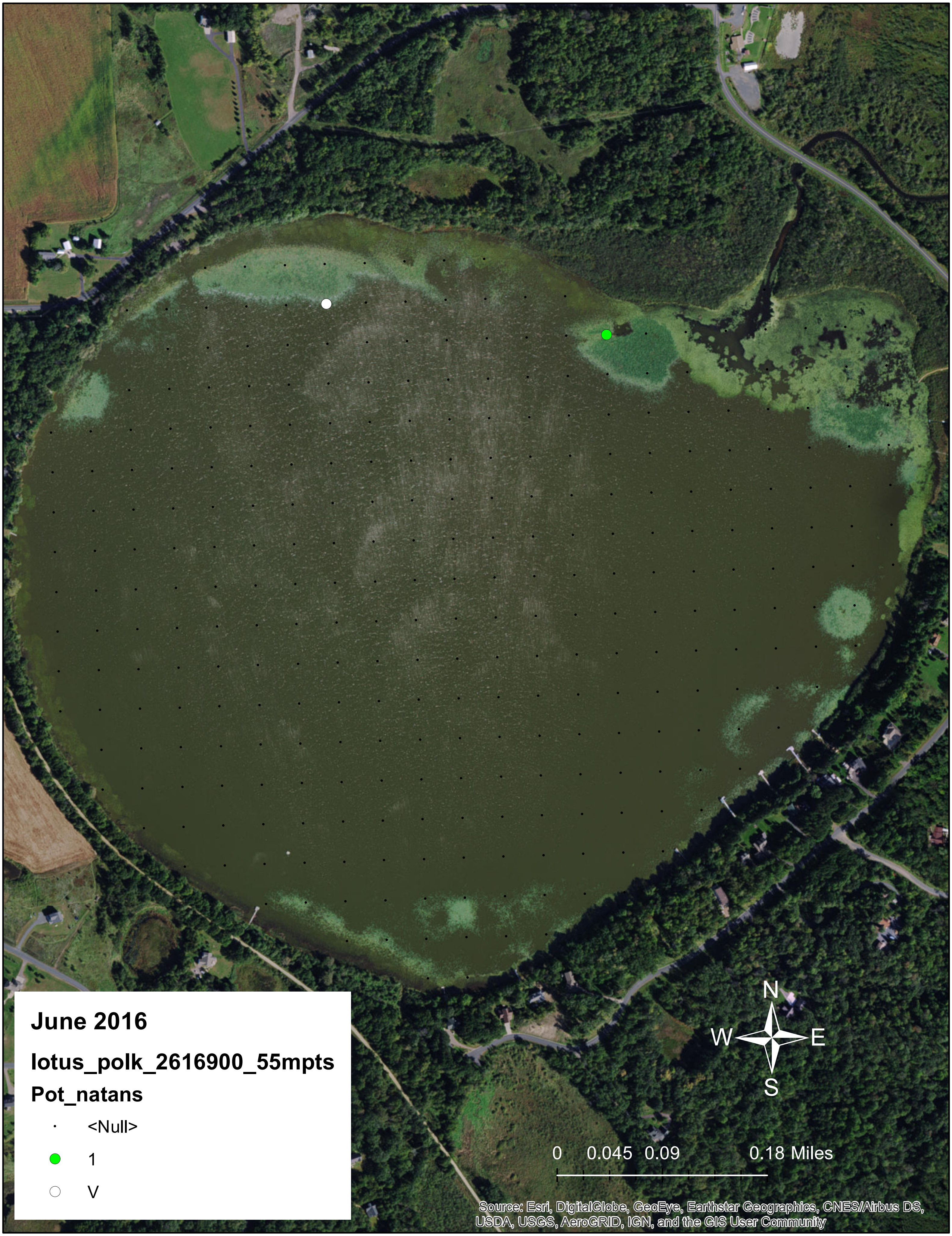
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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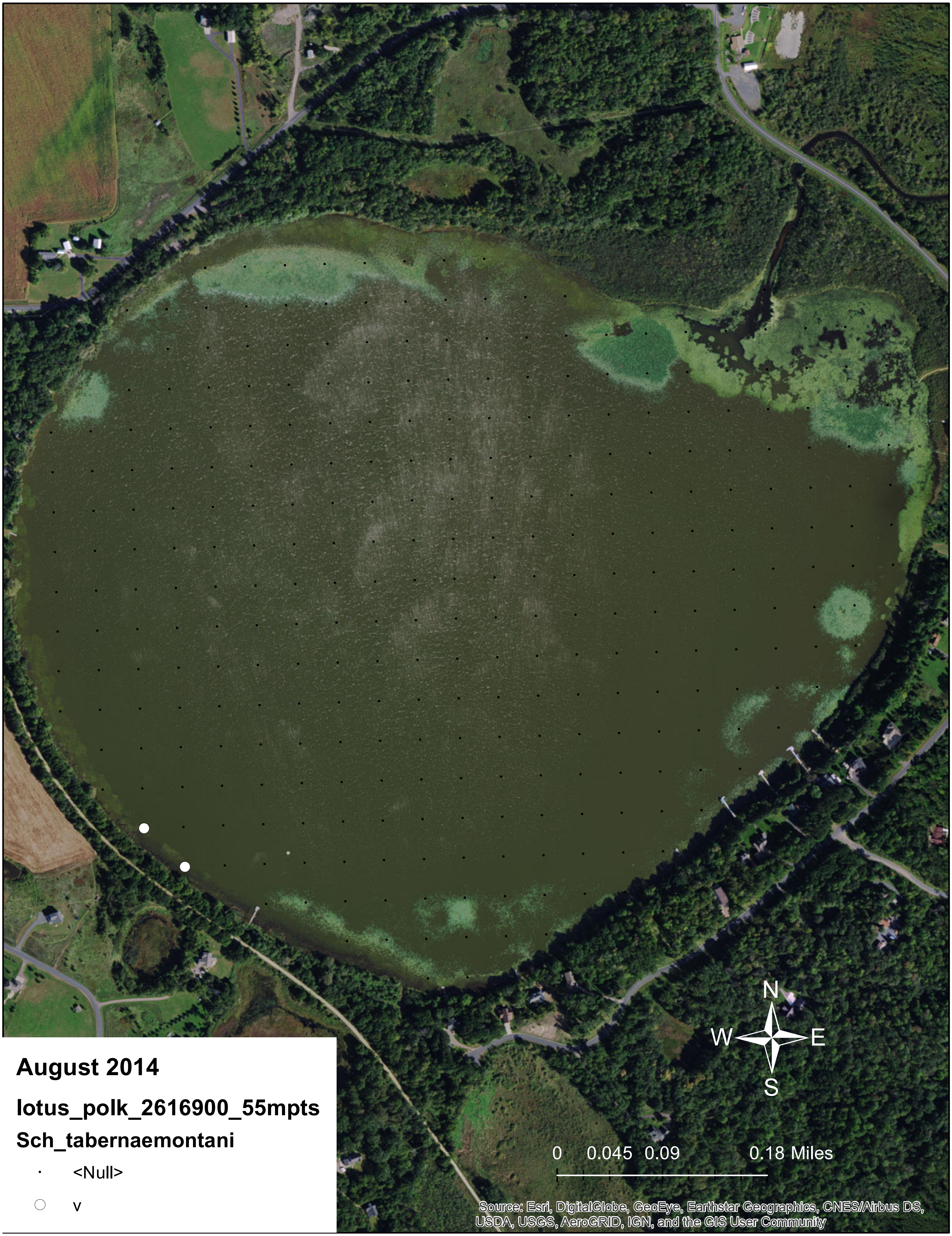

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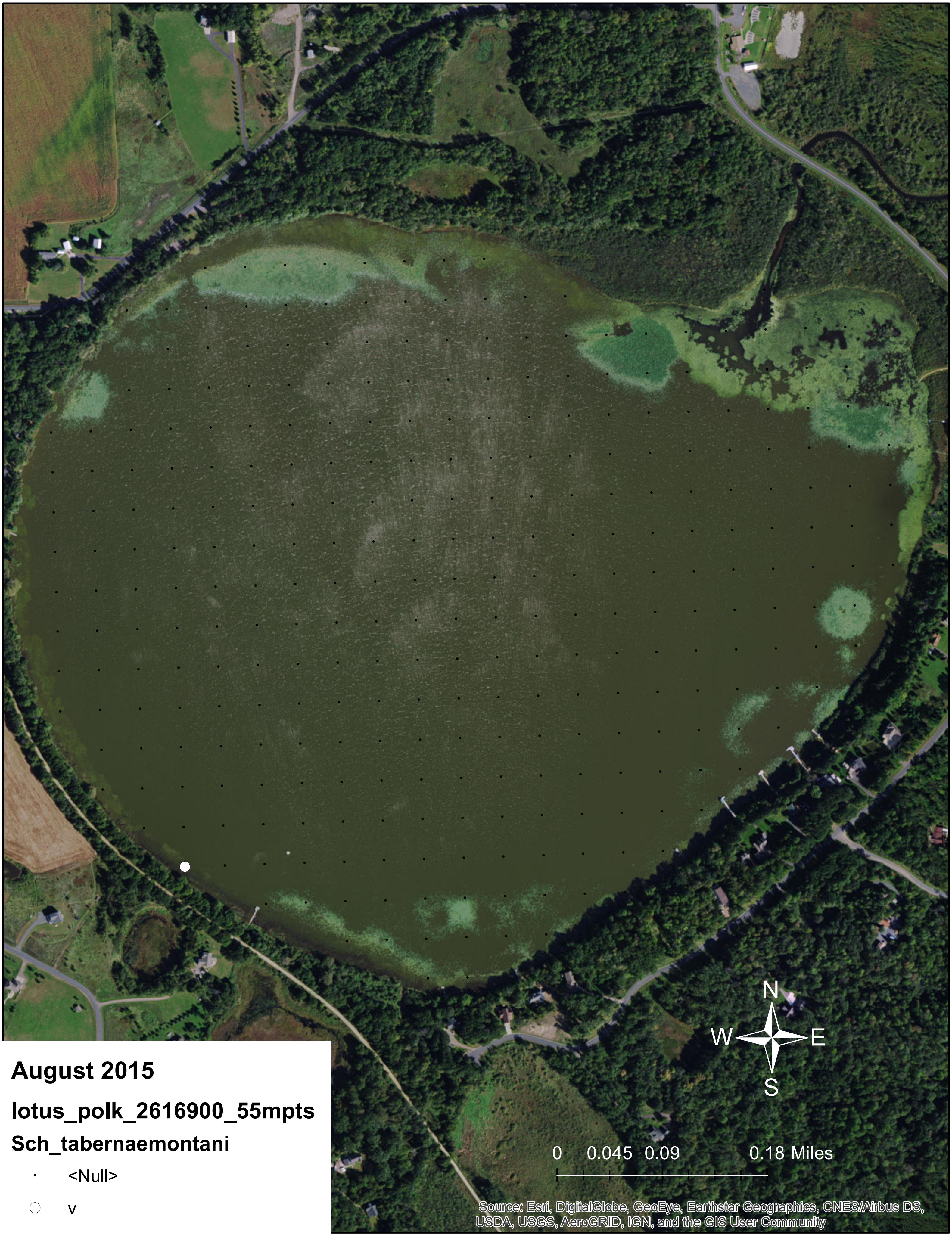

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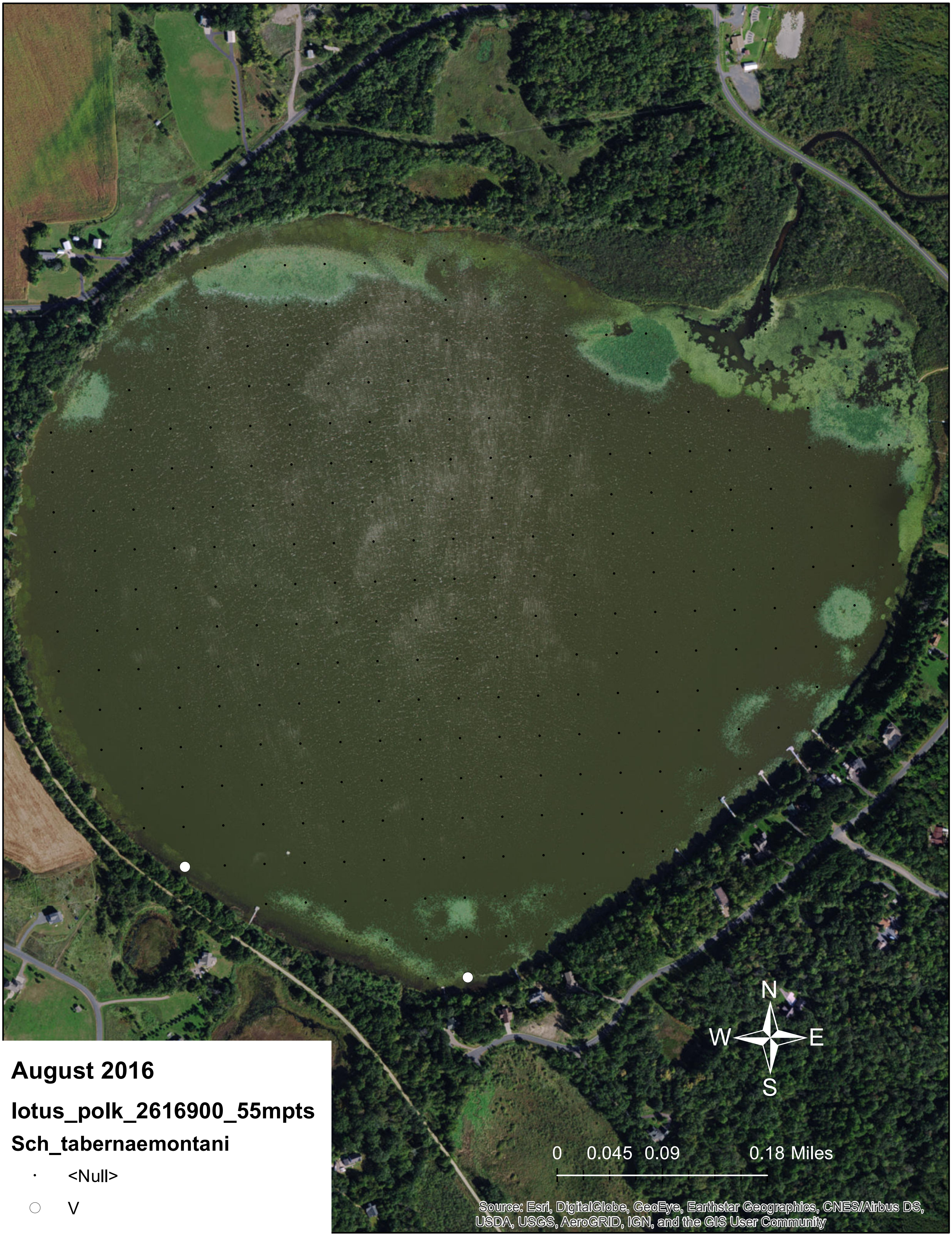

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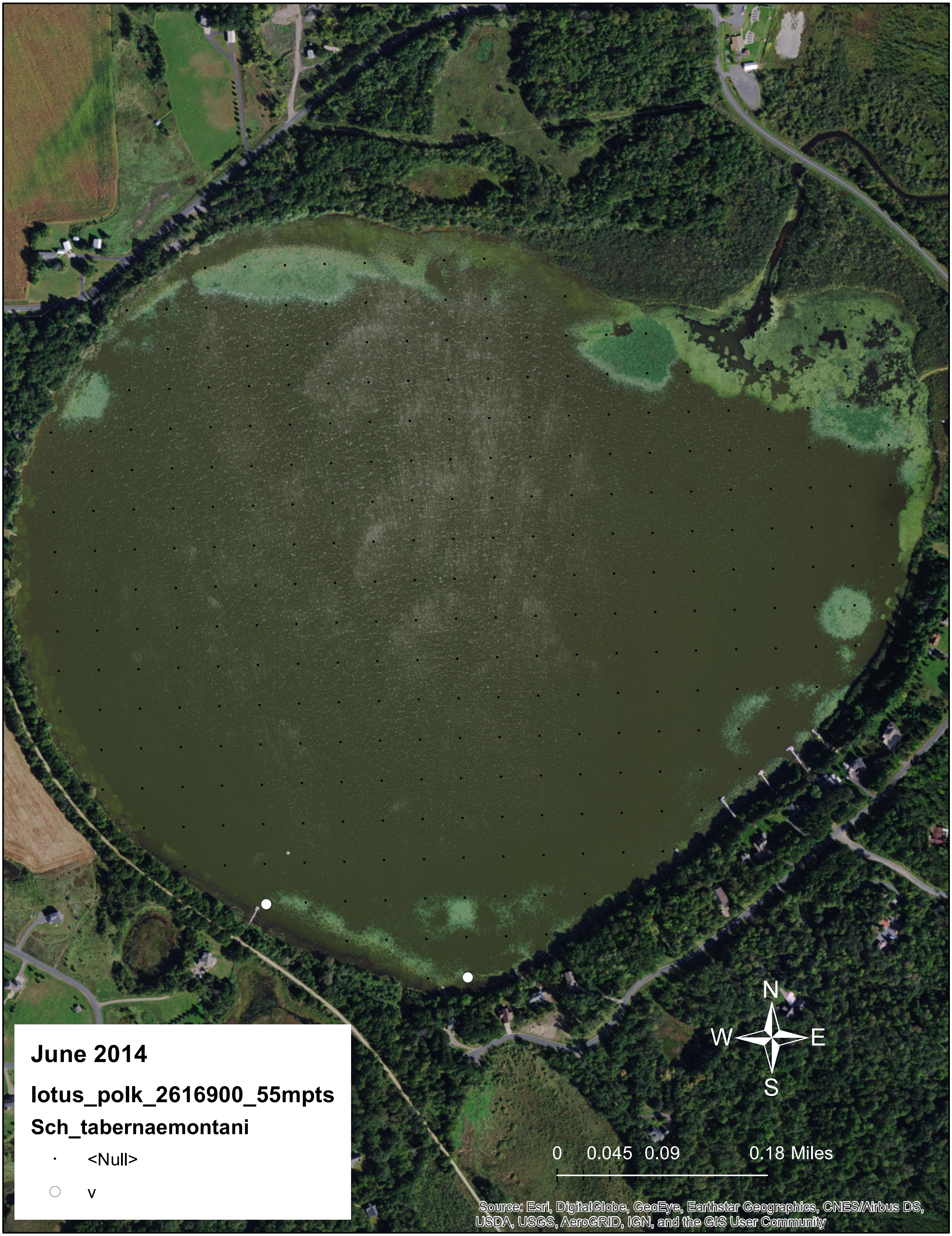

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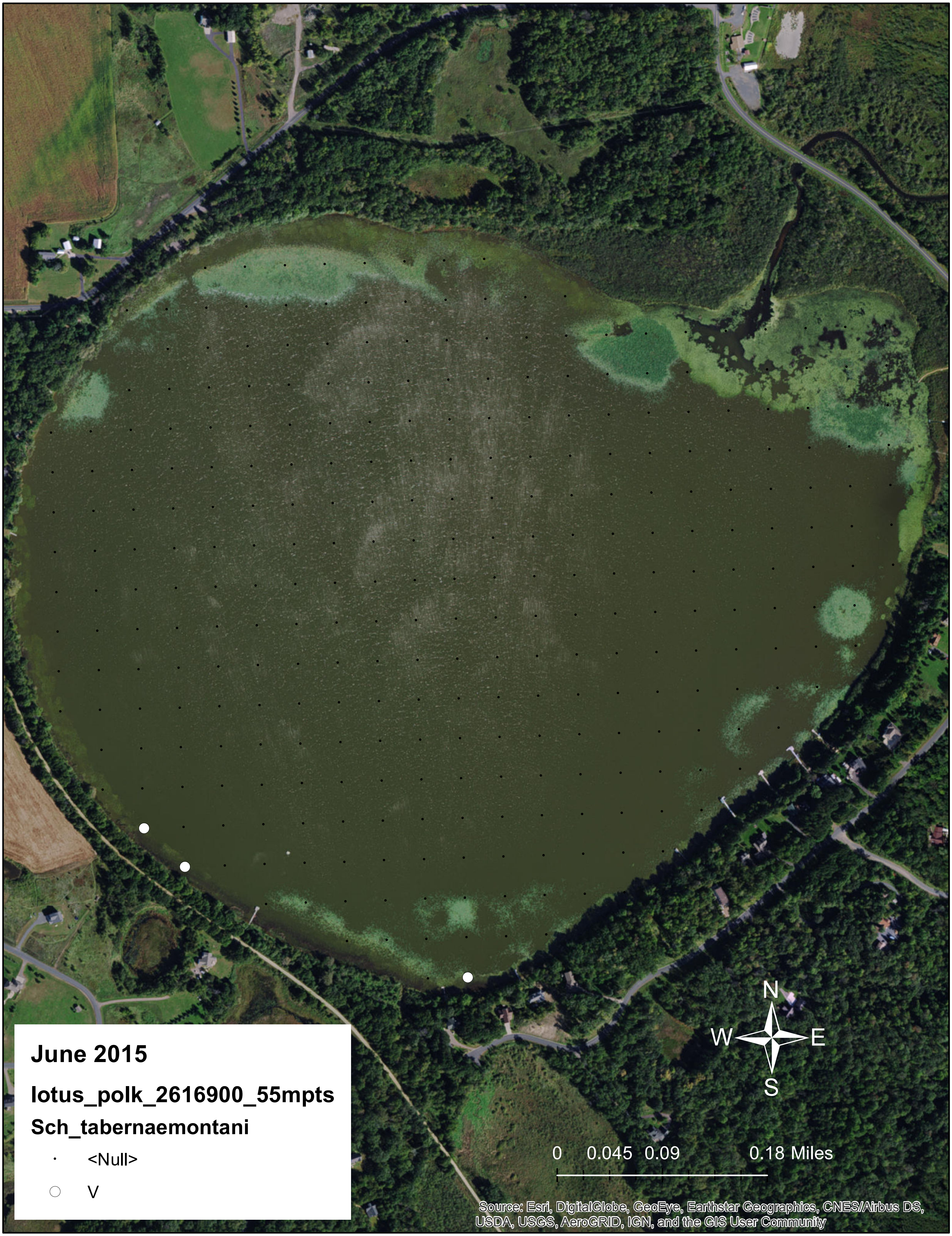

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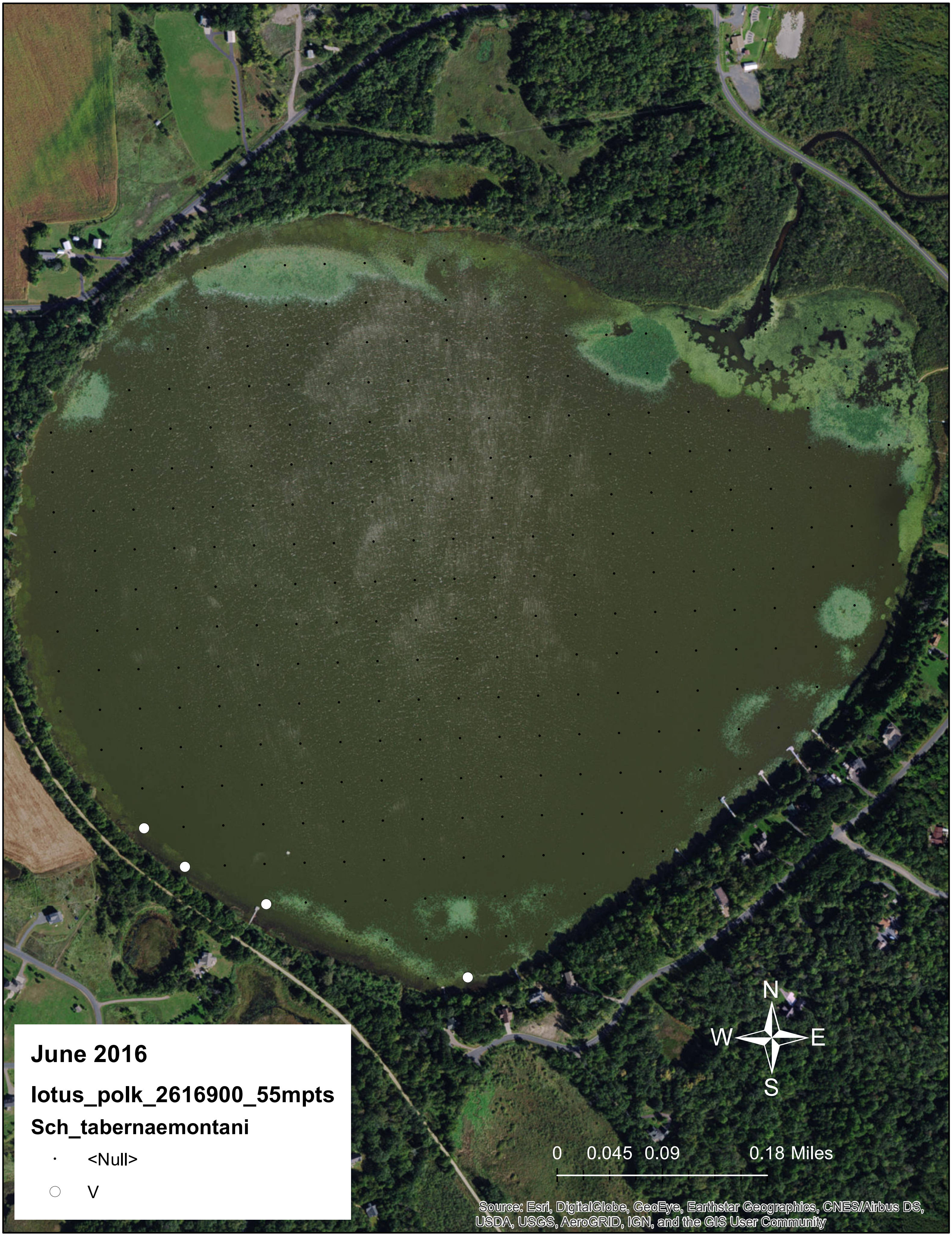

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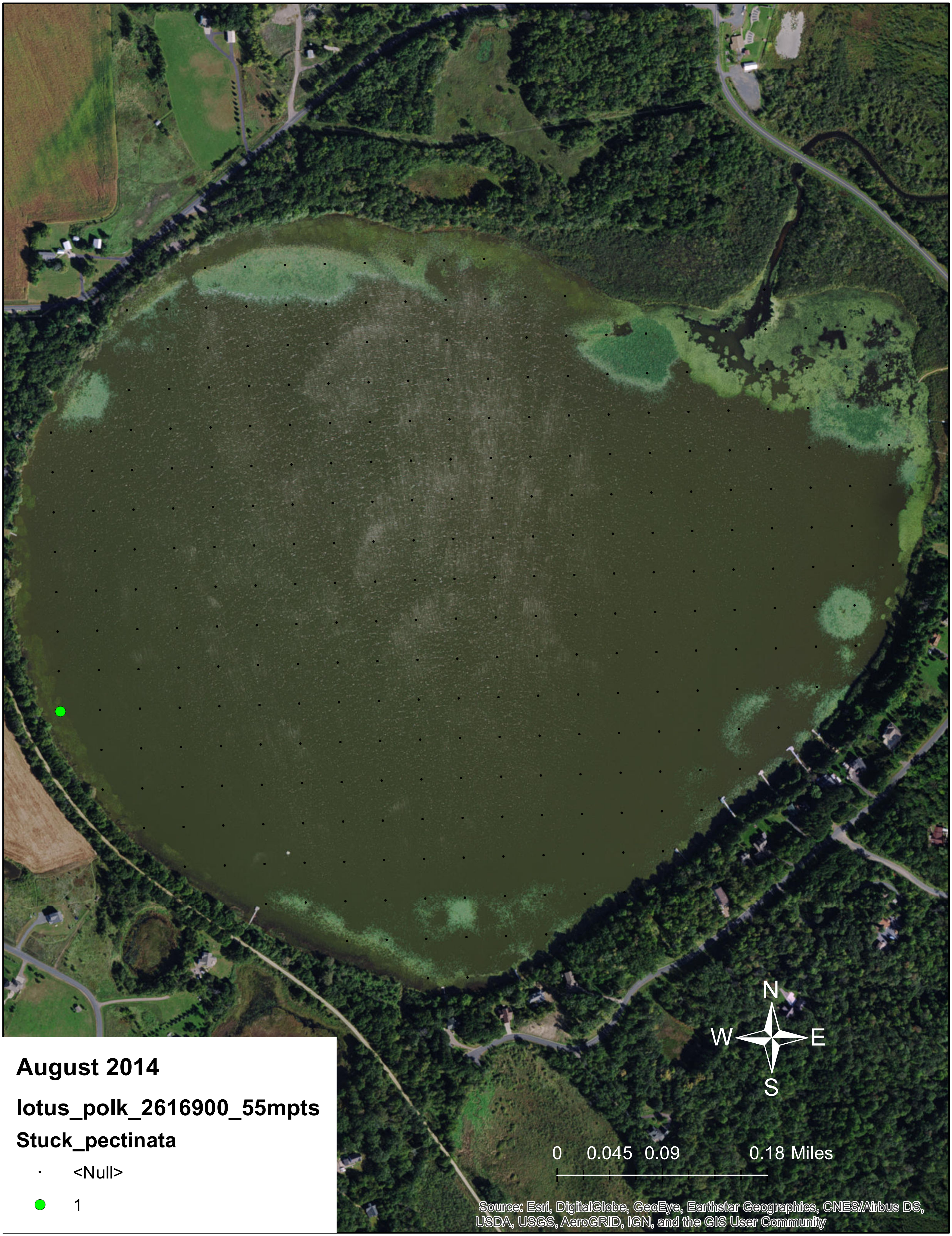

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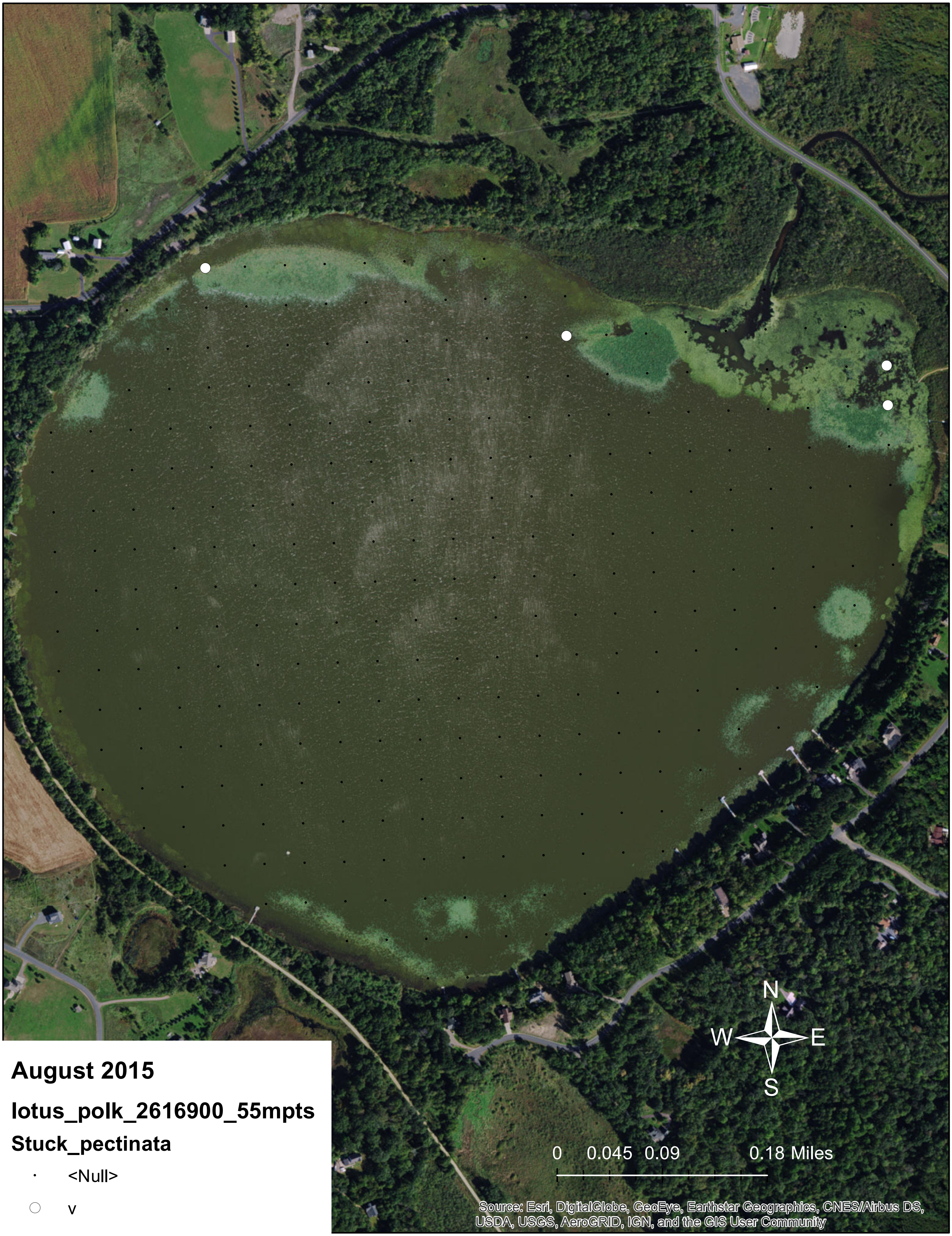

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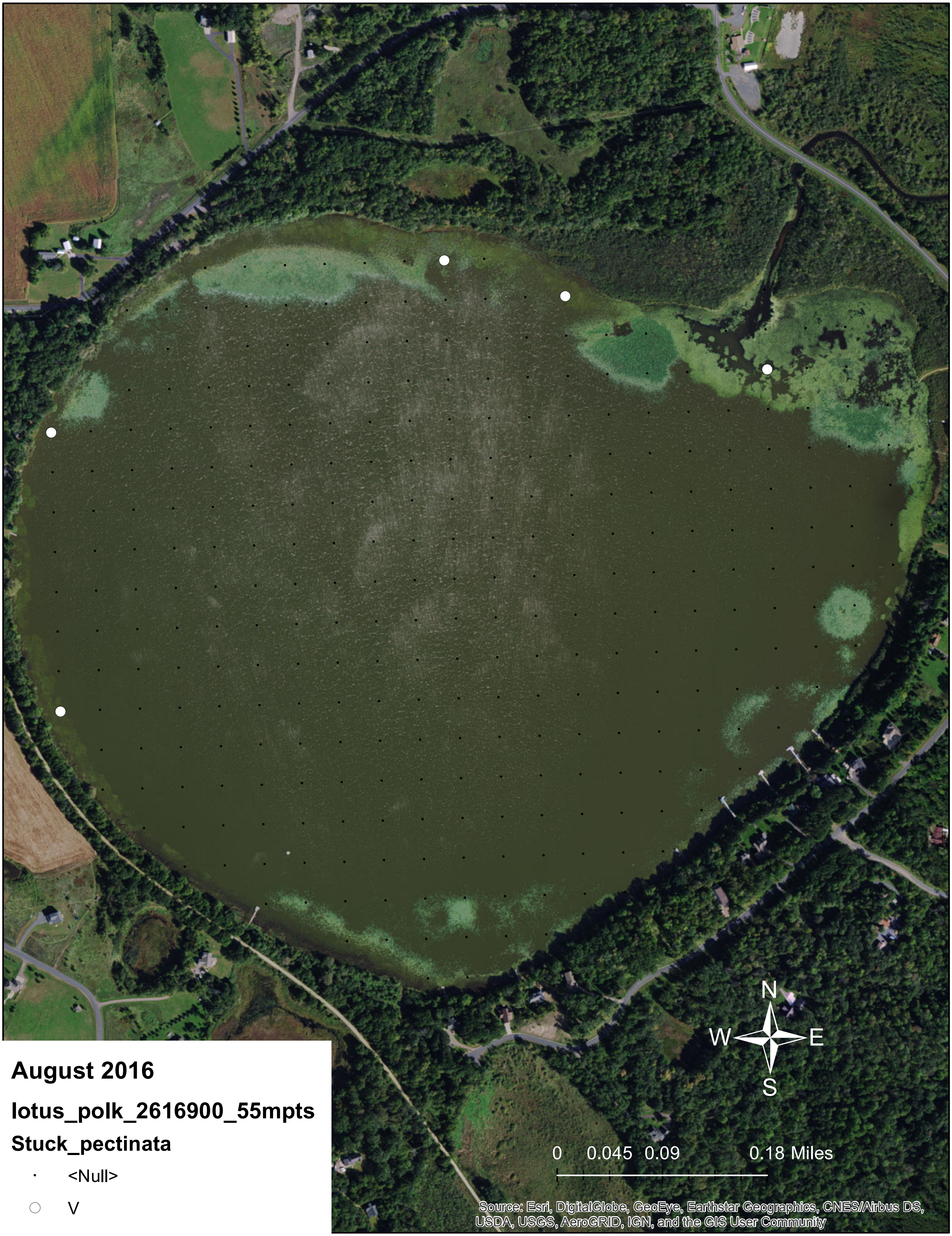

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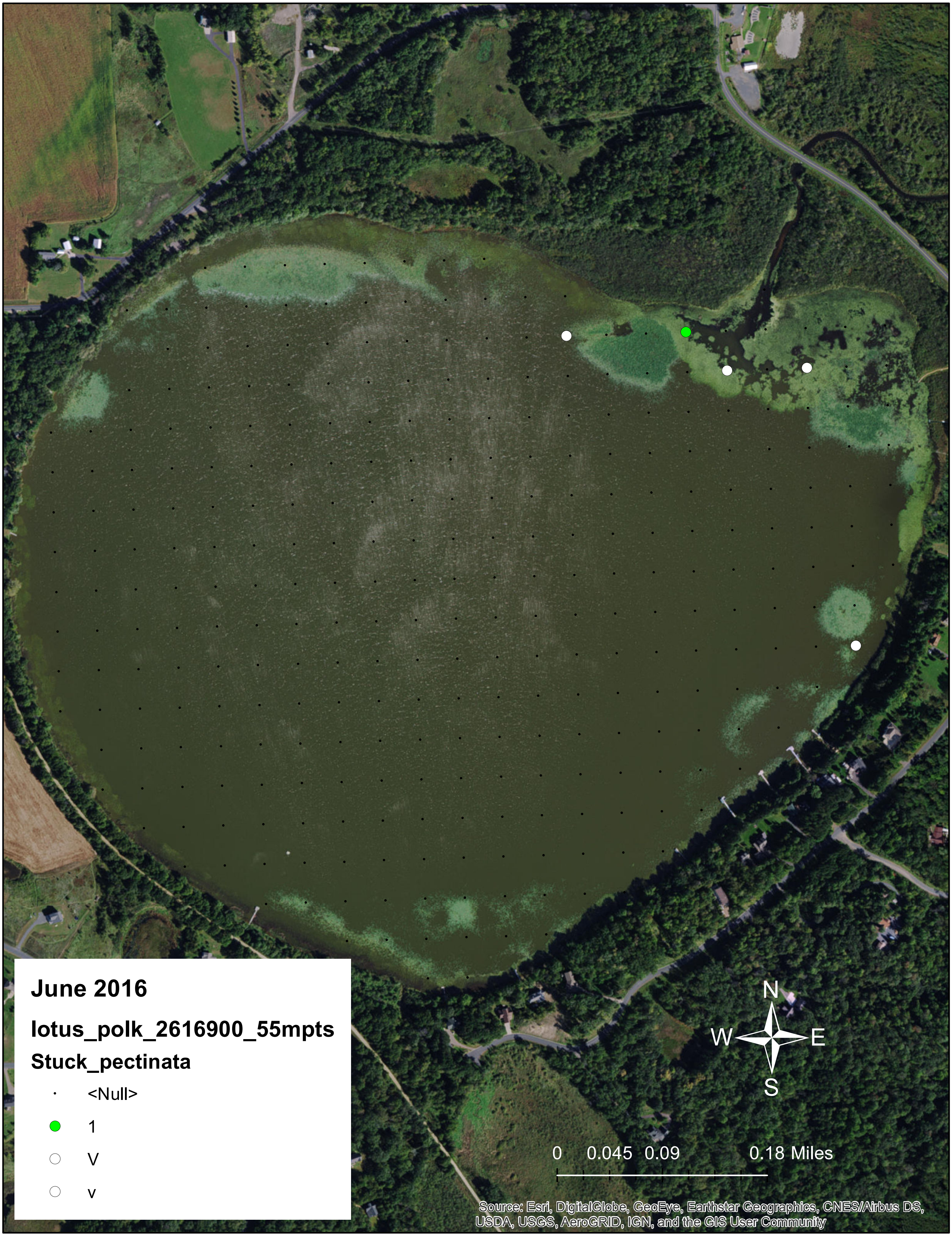
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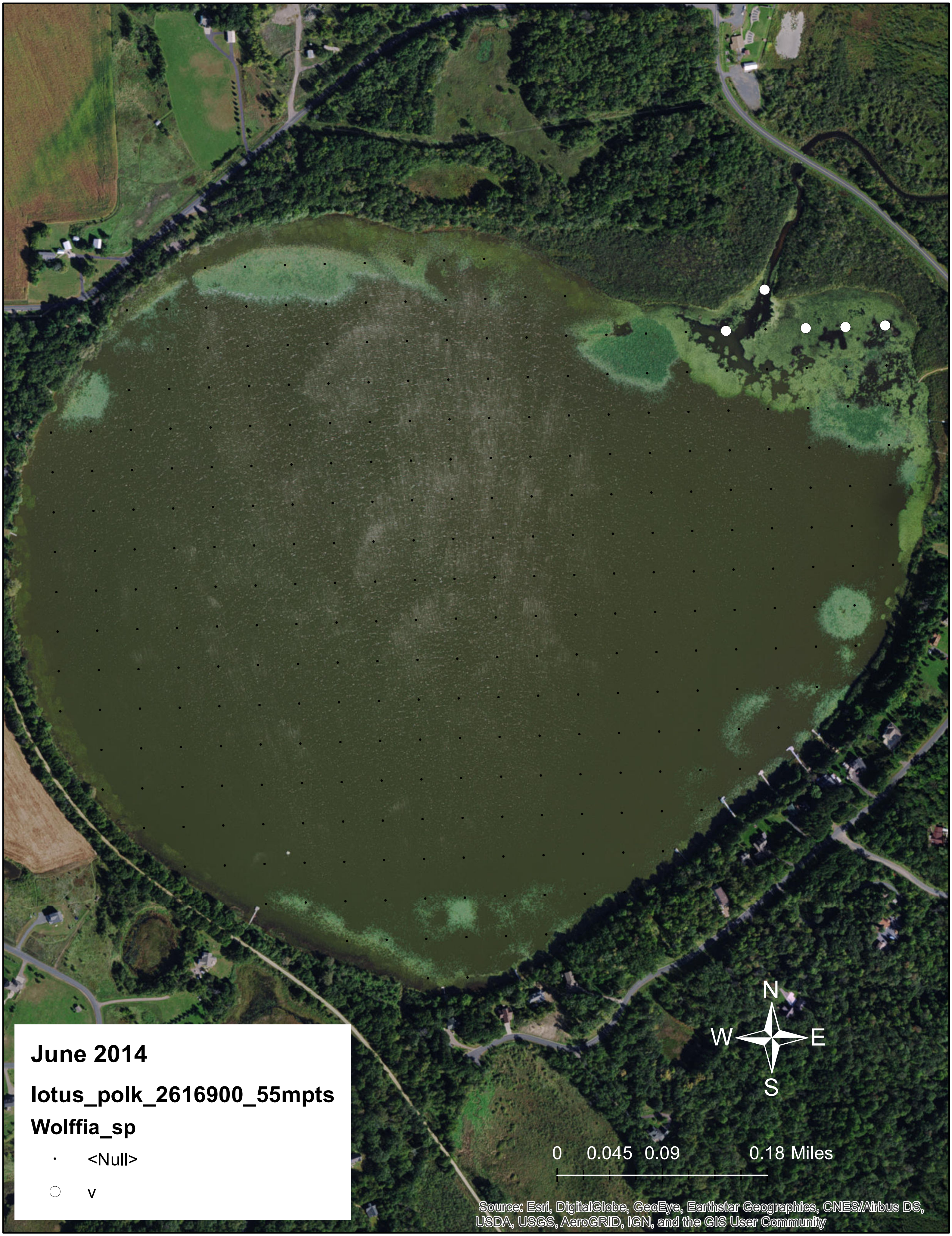

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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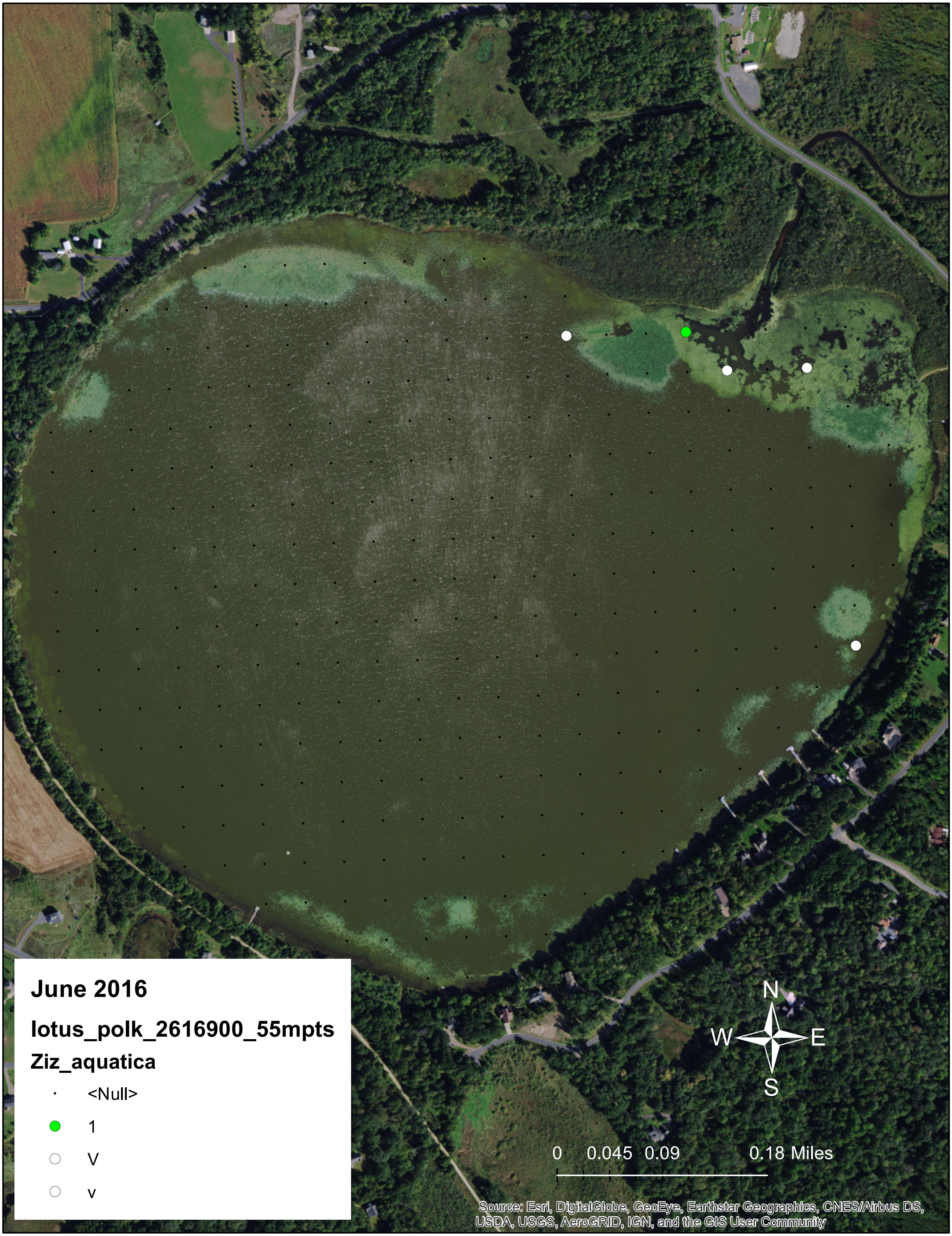
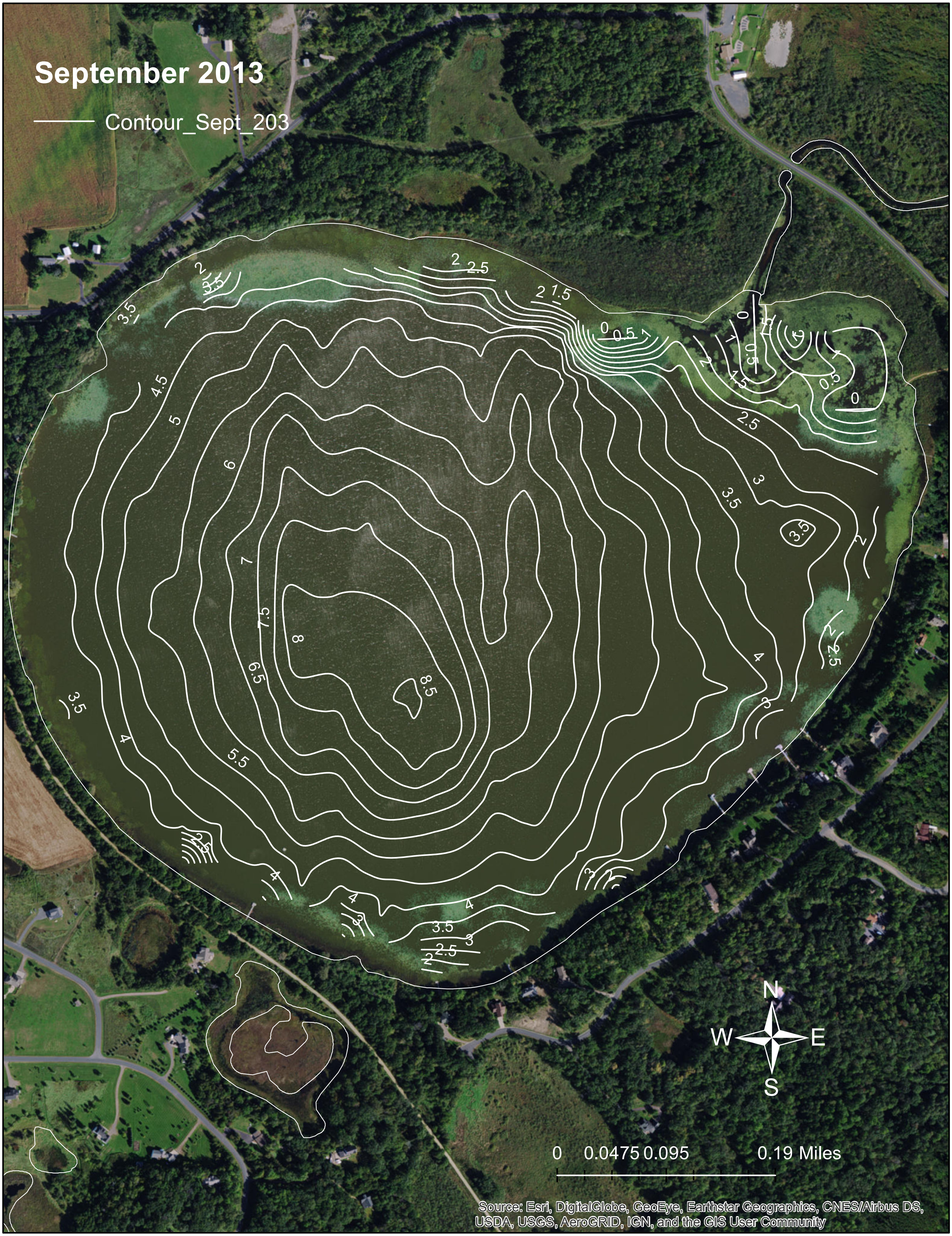


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

September 2013



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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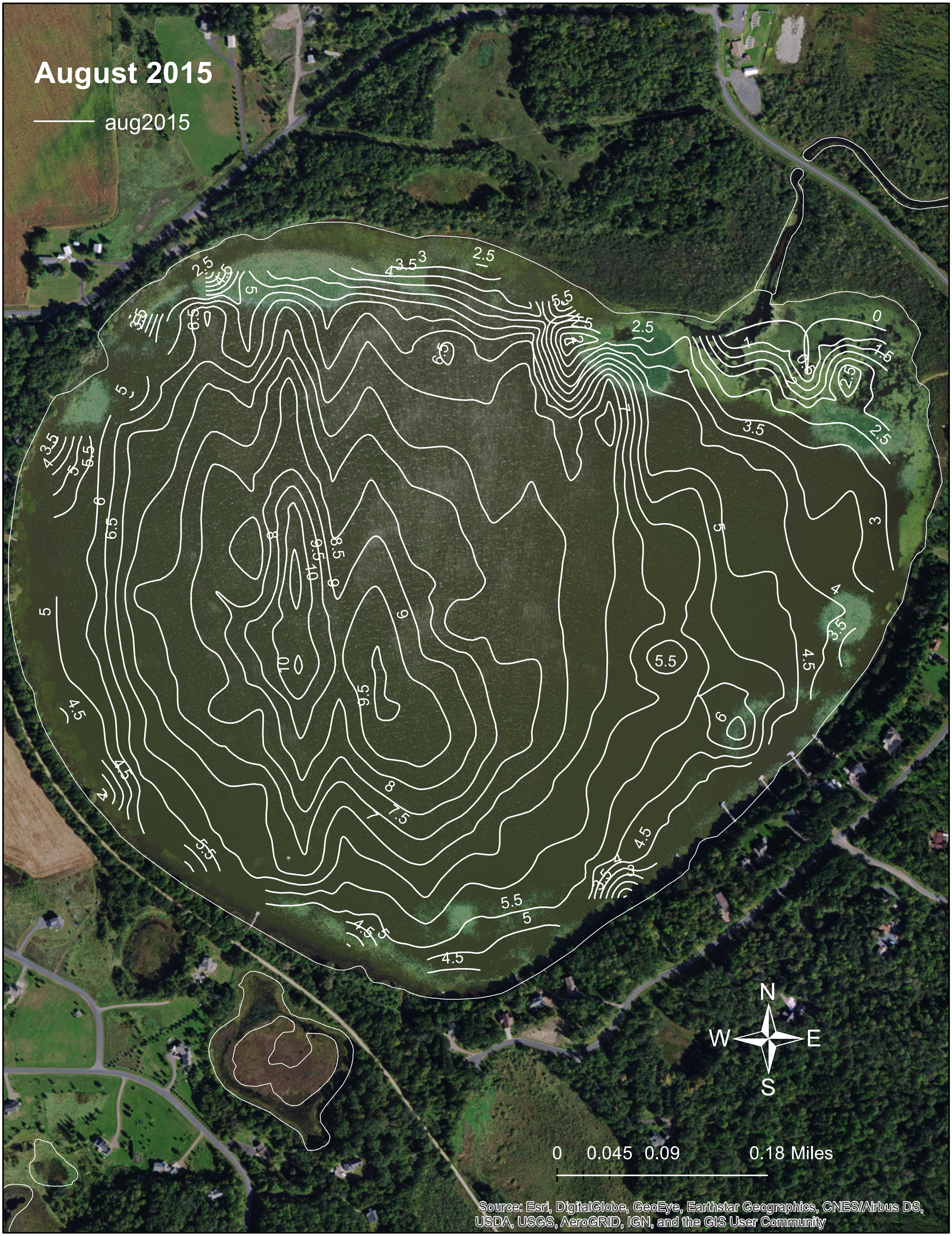
June 2015

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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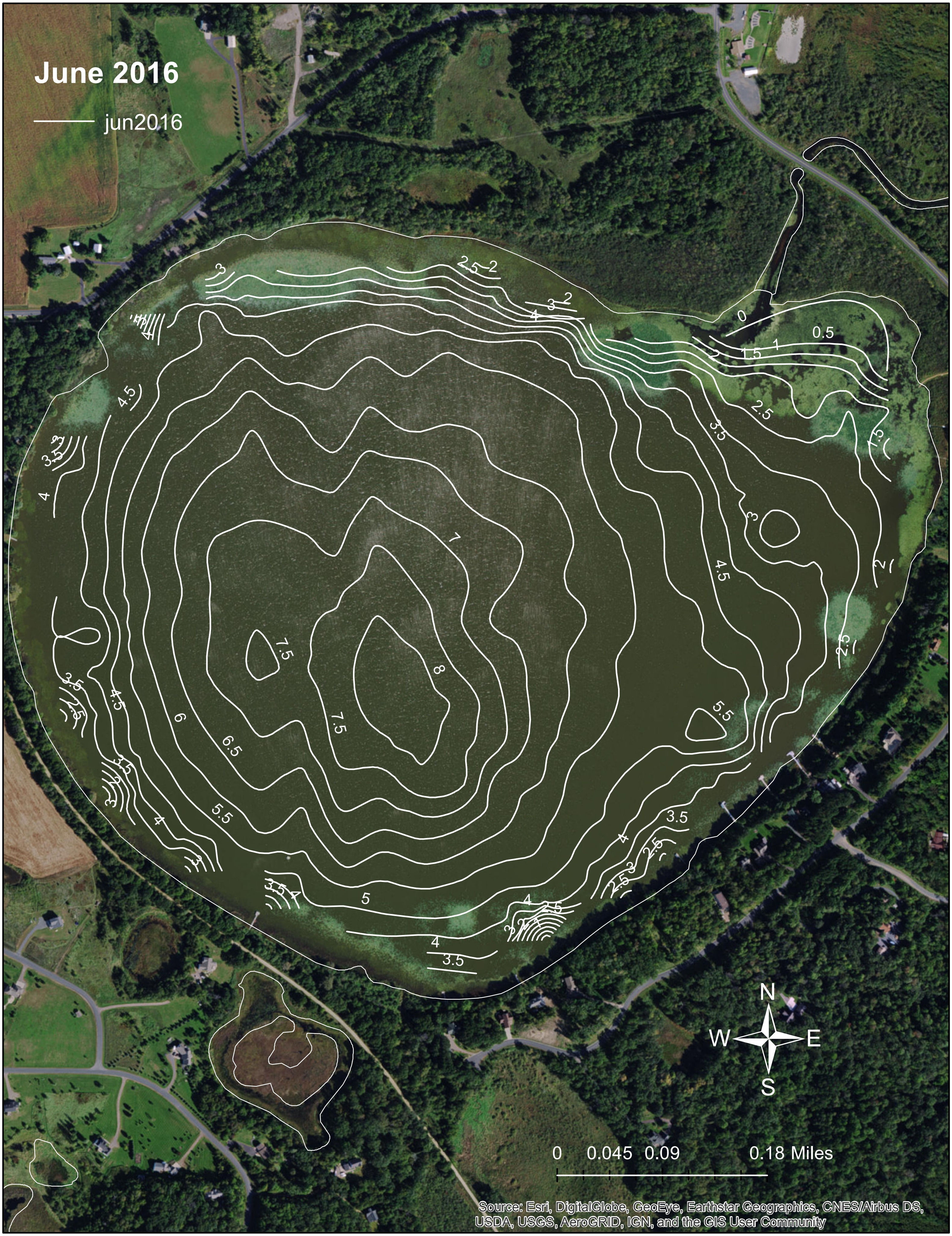

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix H

Shoreline Inventory

GPS points

FID	ident	Latitude	Longitude	y_proj	x_proj
0	093	45.33983	-92.600621	45.33983	-92.600621
1	094	45.339224	-92.60167	45.339224	-92.60167
2	095	45.33902	-92.601736	45.33902	-92.601736
3	096	45.338335	-92.602351	45.338335	-92.602351
4	097	45.338063	-92.602508	45.338063	-92.602508
5	098	45.337923	-92.602811	45.337923	-92.602811
6	099	45.337187	-92.603163	45.337187	-92.603163
7	100	45.336932	-92.603224	45.336932	-92.603224
8	101	45.336176	-92.603347	45.336176	-92.603347
9	102	45.331072	-92.596135	45.331072	-92.596135
10	103	45.331075	-92.596	45.331075	-92.596
11	104	45.331205	-92.595128	45.331205	-92.595128
12	105	45.331228	-92.595065	45.331228	-92.595065
13	106	45.331312	-92.594801	45.331312	-92.594801
14	107	45.331348	-92.594714	45.331348	-92.594714
15	108	45.332673	-92.592037	45.332673	-92.592037
16	109	45.332763	-92.591905	45.332763	-92.591905
17	110	45.333329	-92.591181	45.333329	-92.591181
18	111	45.333382	-92.591086	45.333382	-92.591086
19	112	45.333678	-92.590466	45.333678	-92.590466
20	113	45.333733	-92.590397	45.333733	-92.590397
21	114	45.333948	-92.590143	45.333948	-92.590143
22	115	45.33407	-92.590005	45.33407	-92.590005
23	116	45.334264	-92.589692	45.334264	-92.589692
24	117	45.3343	-92.589605	45.3343	-92.589605
25	118	45.334672	-92.589299	45.334672	-92.589299
26	119	45.334747	-92.589236	45.334747	-92.589236
27	120	45.340207	-92.599159	45.340207	-92.599159
28	121	45.33999	-92.600445	45.33999	-92.600445

Shoreland Vegetation Survey

FID	Id	Waypoint	Gen_distu	Dom_veg	Tall_shore	Barren__ba	shoreline_
0	0	119-120a	Undisturbed	Organic-leaf pack/needles	Present		2760.16
1	0	119-120b	Undisturbed	Organic-leaf pack/needles	Present		2313.51
2	0	120-121	Undisturbed	Organic-leaf pack/needles	Present		365.09
3	0	121-93	Disturbed	Impervious surface	Present		73.4123
4	0	93-94	Undisturbed	Organic-leaf pack/needles	Present		369.377
5	0	94-95	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	128.21
6	0	95-96	Undisturbed	Organic-leaf pack/needles	Present		301.88
7	0	96-97	Disturbed	Mowed vegetation	Present		98.2201
8	0	97-98	Undisturbed	Organic-leaf pack/needles	Present		90.1293
9	0	98-99	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	296.844
10	0	99-100	Undisturbed	Organic-leaf pack/needles	Present		97.704
11	0	100-101	Disturbed	Mowed vegetation	Present		285.349
12	0	101-102	Undisturbed	Organic-leaf pack/needles	Present		2967.01
13	0	102-103	Disturbed	Organic-leaf pack/needles	Present	Barren, bare dirt present	44.2171
14	0	103-104	Undisturbed	Organic-leaf pack/needles	Present		232.646
15	0	104-105	Disturbed	Mowed vegetation	Present		32.1294
16	0	105-106	Undisturbed	Organic-leaf pack/needles	Present		80.1389
17	0	106-107	Disturbed	Mowed vegetation	Present	Barren, bare dirt present	40.6155
18	0	107-108	Undisturbed	Organic-leaf pack/needles	Present		871.018
19	0	108-109	Disturbed	Mowed vegetation	Present		47.0592
20	0	109-110	Undisturbed	Organic-leaf pack/needles	Present		270.814
21	0	110-111	Disturbed	Short unmowed vegetation <3 feet tall	Present		34.6981
22	0	111-112	Undisturbed	Organic-leaf pack/needles	Present		197.056
23	0	112-113	Disturbed	Barren, bare dirt	Present	Barren, bare dirt dominant	44.1769
24	0	113-114	Undisturbed	Organic-leaf	Present		84.2868

FID	Id	Waypoint	Gen_distu	Dom_veg	Tall_shore	Barren__ba	shoreline_
				pack/needles			
25	0	114-115	Undisturbed	Short unmowed vegetation <3 feet tall	Present		59.8427
26	0	115-116	Undisturbed	Organic-leaf pack/needles	Present		115.127
27	0	116-117	Disturbed	Barren, bare dirt	Absent	Barren, bare dirt dominant	35.9883
28	0	117-118	Undisturbed	Organic-leaf pack/needles	Present		171.798
29	0	118-119	Disturbed	Mowed vegetation	Present		48.1438

Dock/pier

FID	type	ident	Latitude	Longitude	y_proj	x_proj
0	WAYPOINT	124	45.339211	-92.601605	45.339211	-92.601605
1	WAYPOINT	126	45.337662	-92.602871	45.337662	-92.602871
2	WAYPOINT	127	45.3373	-92.603167	45.3373	-92.603167
3	WAYPOINT	128	45.336824	-92.603212	45.336824	-92.603212
4	WAYPOINT	129	45.336567	-92.603228	45.336567	-92.603228
5	WAYPOINT	130	45.332099	-92.59919	45.332099	-92.59919
6	WAYPOINT	131	45.331305	-92.595998	45.331305	-92.595998
7	WAYPOINT	132	45.331344	-92.595107	45.331344	-92.595107
8	WAYPOINT	133	45.331476	-92.594951	45.331476	-92.594951
9	WAYPOINT	137	45.332877	-92.592136	45.332877	-92.592136
10	WAYPOINT	138	45.333381	-92.591181	45.333381	-92.591181
11	WAYPOINT	139	45.333742	-92.590559	45.333742	-92.590559
12	WAYPOINT	140	45.334041	-92.590018	45.334041	-92.590018
13	WAYPOINT	141	45.334317	-92.589731	45.334317	-92.589731
14	WAYPOINT	142	45.33626	-92.588953	45.33626	-92.588953
15	WAYPOINT	143	45.337669	-92.587912	45.337669	-92.587912
16	WAYPOINT	144	45.337992	-92.587764	45.337992	-92.587764
17	WAYPOINT	145	45.33832	-92.587815	45.33832	-92.587815

Woody structure

FID	type	ident	Latitude	Longitude	y_proj	x_proj
0	WAYPOINT	122	45.339774	-92.600717	45.339774	-92.600717
1	WAYPOINT	123	45.339407	-92.601383	45.339407	-92.601383
2	WAYPOINT	125	45.337875	-92.602525	45.337875	-92.602525
3	WAYPOINT	134	45.331542	-92.594863	45.331542	-92.594863
4	WAYPOINT	135	45.331734	-92.594187	45.331734	-92.594187
5	WAYPOINT	136	45.332165	-92.5932	45.332165	-92.5932

Appendix I

Shoreline Restoration

Lotus Lake Shoreline Restoration/Rain Garden Workshop

Monday, July 11th
9 -11 AM
Polk County Government Center, Balsam Lake
County Board Room

9:00 Introductions

9:05 Presentation on shoreline restoration and rain gardens

- Healthy Lakes Grants 101
- Importance and benefits of native plantings
- Site evaluation
- How to install a practice
- Moving forward, next steps

11:15 Review resources for native plantings

11:30 Sign up for individual lot site evaluations for project design

11:00 Adjourn

Katelin Anderson
(715) 485-8637
katelin.anderson@co.polk.wi.us

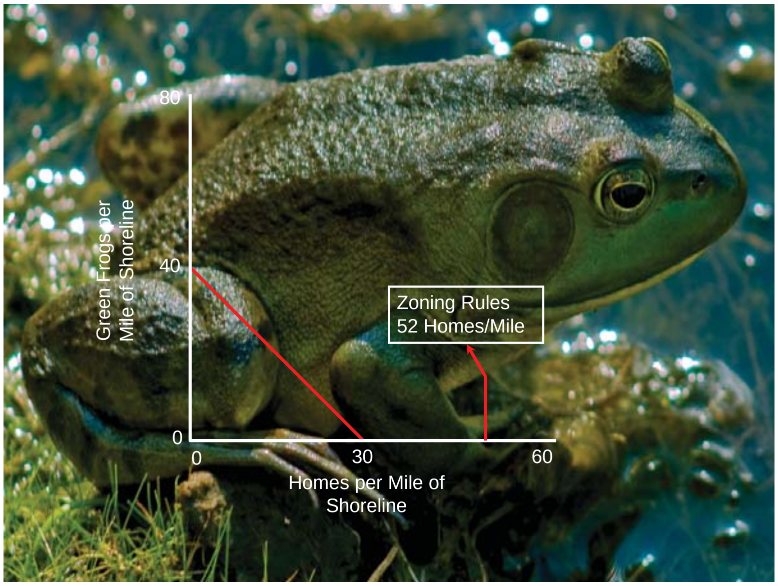
Jeremy Williamson
(715) 485-8639
jeremyw@co.polk.wi.us

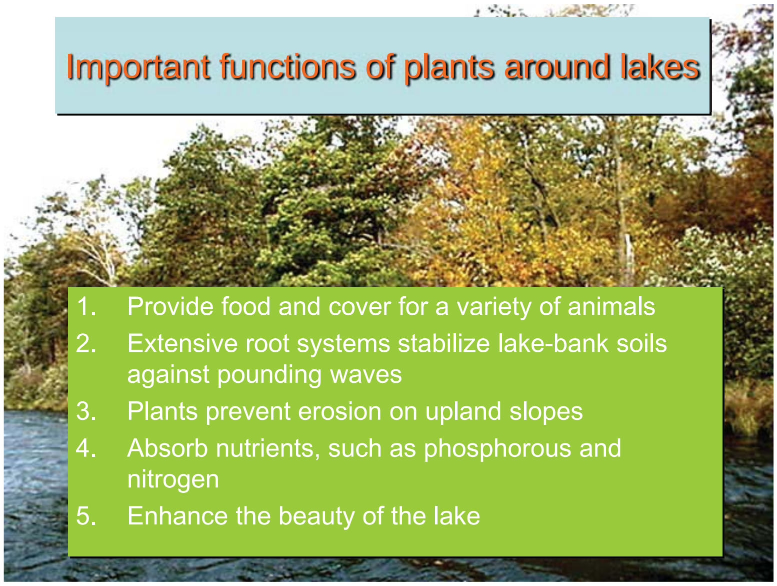
Shoreline Restoration

Improving water quality and wildlife habitat

Problems with Traditional Lakeshores

- Shoreline erosion and sedimentation
- Excessive plant growth and algal blooms
- Loss of wildlife habitat
- Nuisance animals
- Loss of leisure time





Important functions of plants around lakes

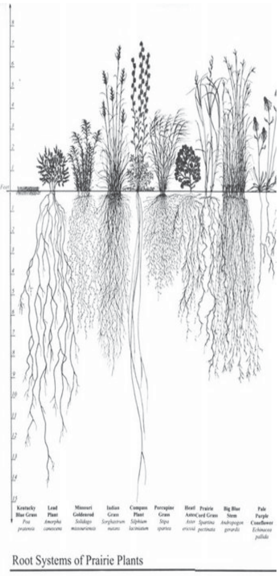
1. Provide food and cover for a variety of animals
2. Extensive root systems stabilize lake-bank soils against pounding waves
3. Plants prevent erosion on upland slopes
4. Absorb nutrients, such as phosphorous and nitrogen
5. Enhance the beauty of the lake

Root Systems

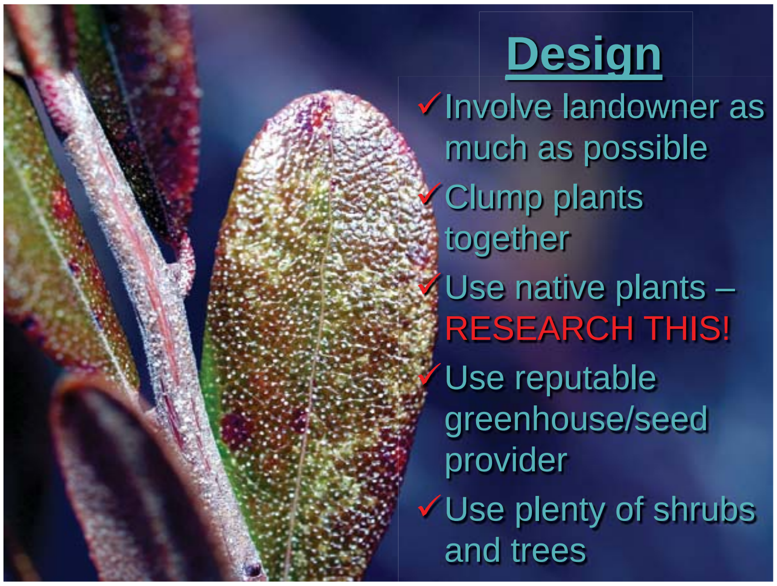
- Stabilize banks
- Stabilize shoreline
- Absorbsion of nutrients
- Absorbsion of water

Why it works

- In turf grass (i. e. lawn) water can only evaporate 0.4 meters out of the soil
- Native vegetation will evapotranspirate water from 2 meters or more from the soil.
- Wet Sponge vs. Dry Sponge



Root Systems of Prairie Plants



Design

- ✓ Involve landowner as much as possible
- ✓ Clump plants together
- ✓ Use native plants – RESEARCH THIS!
- ✓ Use reputable greenhouse/seed provider
- ✓ Use plenty of shrubs and trees

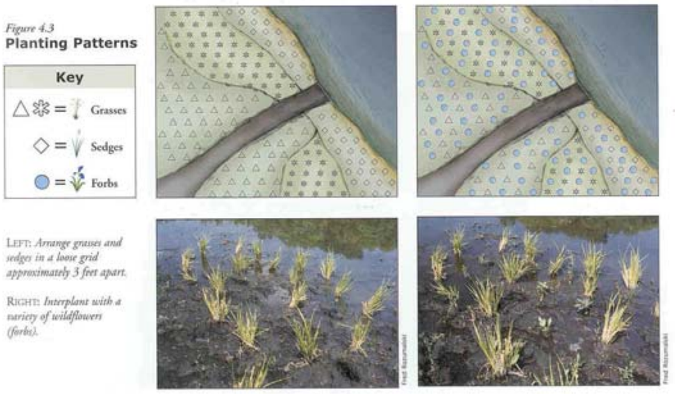


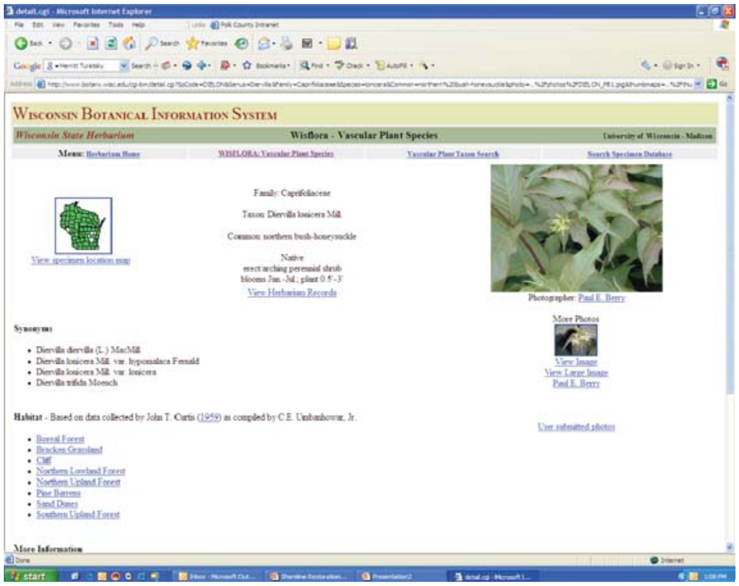
Figure 4.3
Planting Patterns

Key

△ ❋ = Grasses
◇ = Sedges
● = Forbs

LEFT: *Arrange grasses and sedges in a loose grid approximately 3 feet apart.*

RIGHT: *Interplant with a variety of wildflowers (forbs).*



WISCONSIN BOTANICAL INFORMATION SYSTEM

Wisconsin State Herbarium | Wisflora - Vascular Plant Species | University of Wisconsin - Madison

Menu: Herbarium Home | WISFLORA: Vascular Plant Species | Vascular Plant Taxon Search | Search Specimen Database

View specimen location map

Family: Caprifoliaceae

Taxon: Diervilla lonicera Mill.

Common: northern bush-honeysuckle

Native
erect/arching perennial shrub
blooms Jun.-Jul.; plant 0.5'-3'
View Herbarium Records

Photographer: Paul E. Berry

More Photos
View Image
View Large Image
Paul E. Berry

Synonyms

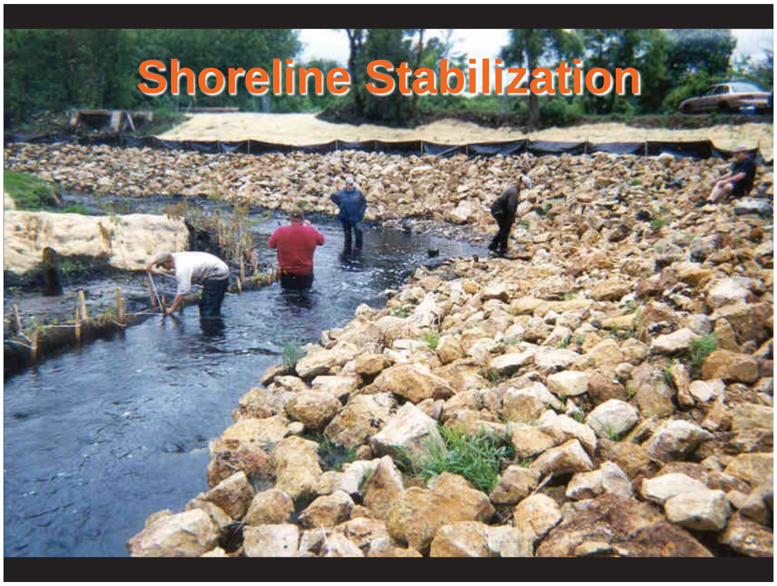
- Diervilla diervilla (L.) MacMill.
- Diervilla lonicera Mill. var. hypomalaca Fernald
- Diervilla lonicera Mill. var. lonicera
- Diervilla trifida Moench

Habitat - Based on data collected by John T. Curtis (1959) as compiled by C.E. Umbanhowar, Jr.

- Boreal Forest
- Bracken Grassland
- Cliff
- Northern Lowland Forest
- Northern Upland Forest
- Pine Barrens
- Sand Dunes
- Southern Upland Forest

User submitted photos

More Information


Shoreline Stabilization

Questions?

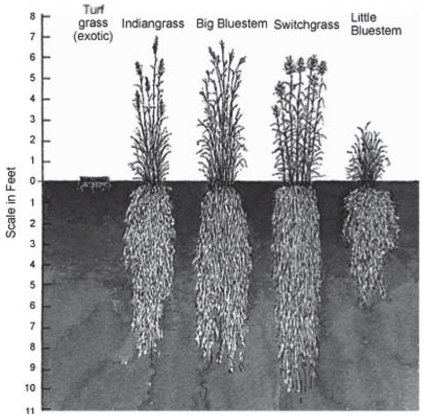
Rain Gardens


Illustration: Rob Dunlavey

Rain Gardens

- Increases the amount of water filtering into ground
- Recharges groundwater
- Provides wildlife habitat
- Enhances beauty of yard and neighborhood
- Protects against flooding and drainage problems
- Protects lakes from damaging flows and reduces erosion
- Reduces the need for costly municipal stormwater treatment structures

Why They Work



Where Should the Rain Garden Go?

- At least 10 feet from house
- Flat area
- Below down spouts
- Not over septic system or sewer lateral
- Not where yard is wet
- Not directly under a large tree
- Not high traffic area

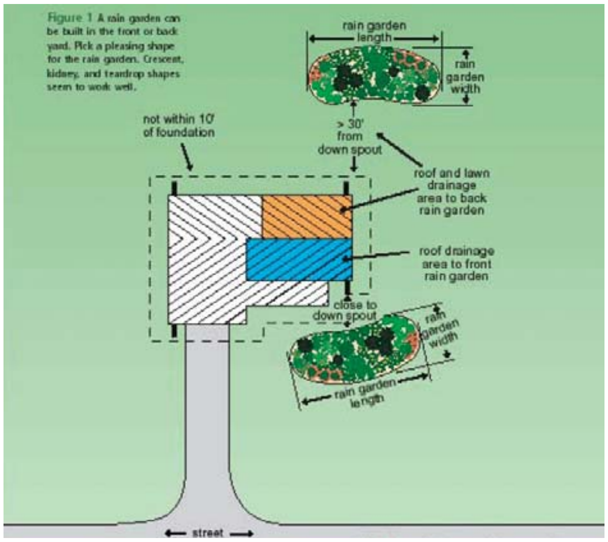


Figure 1 A rain garden can be built in the front or back yard. Pick a pleasing shape for the rain garden. Crescent, kidney, and teardrop shapes seem to work well.

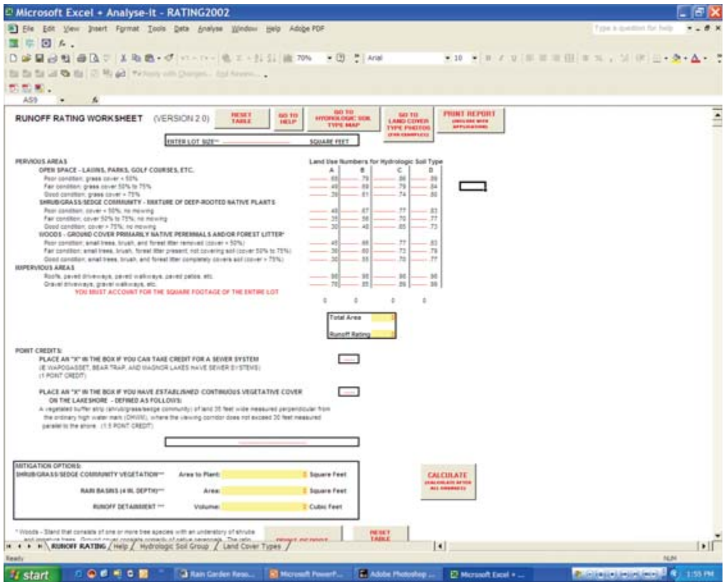
How Big should the Rain Garden Be?

- How deep?
- What type of soil?
- How much roof and lawn drain to it?

Rain Garden Size Factor

	less than 30 ft from down spout			more than 30 ft from down spout
Soil	3-5 in. deep	6-7 in. deep	8 in. deep	All Depths
Sand	0.19	0.15	0.08	0.03
Loamy	0.34	0.25	0.16	0.06
Clayey	0.43	0.32	0.2	0.1

*If the recommended rain garden area is much more than 300 ft. divide it into smaller rain gardens



RUNOFF RATING WORKSHEET (VERSION 2.0)

ENTER LOT SIZE ______ SQUARE FEET

PERVIOUS AREAS

Land Use Numbers for Hydrologic Soil Type A B C D

OPEN SPACE - LAWNS, PARKS, GOLF COURSES, ETC.

SHRUB/GRASS/SEDGE COMMUNITY - MIXTURE OF DEEP-ROOTED NATIVE PLANTS

WOODS - GROUND COVER PRIMARILY NATIVE PERENNIALS AND/OR FOREST LITTER*

IMPERVIOUS AREAS

YOU MUST ACCOUNT FOR THE SQUARE FOOTAGE OF THE ENTIRE LOT

Total Area

Runoff Rating

POINT CREDITS:

PLACE AN "X" IN THE BOX IF YOU CAN TAKE CREDIT FOR A SEWER SYSTEM

(1 POINT CREDIT)

PLACE AN "X" IN THE BOX IF YOU HAVE ESTABLISHED CONTINUOUS VEGETATIVE COVER ON THE LAKESHORE - DEFINED AS FOLLOWS:

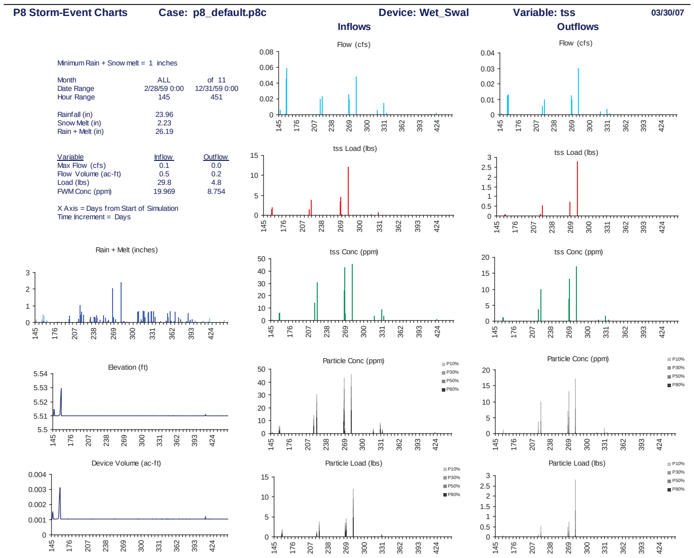
(1.5 POINT CREDIT)

MITIGATION OPTIONS:

SHRUB/GRASS/SEDGE COMMUNITY VEGETATION** Area to Plant: Square Feet

RAIN BASINS (4 IN. DEPTH)** Area: Square Feet

RUNOFF DETAINMENT ** Volume: Cubic Feet



P8 Storm-Event Charts **Case: p8_default.p8c** **Device: Wet_Swal** **Variable: tss** **03/30/07**

Minimum Rain + Snow melt = 1 inches

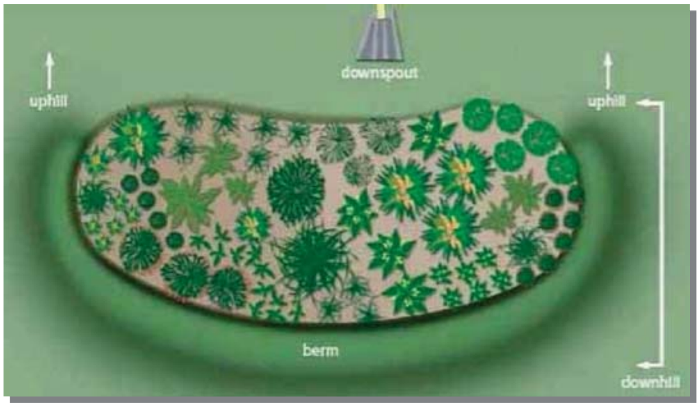
Month	ALL	of 11
Date Range	2/28/59 0:00	12/31/59 0:00
Hour Range	145	451
Rainfall (in)	23.96	
Snow Melt (in)	2.23	
Rain + Melt (in)	26.19	

Variable	Inflow	Outflow
Max Flow (cfs)	0.1	0.0
Flow Volume (ac-ft)	0.5	0.2
Load (lbs)	29.8	4.8
FWM Conc (ppm)	19.969	8.754

X Axis = Days from Start of Simulation
Time Increment = Days

Design

- Water should flow evenly across the entire length
- Length should be perpendicular to slope and downspouts
- Rain gardens should have a maximum length of 15 ft (esp. on 8% slope or more)



Notice Length is Perpendicular

Burnsville

Maplewood

Plant Selection

- **Native**
- **Soil**
- **Sun/Shade**
- **Incorporate plenty of grasses, sedges and, rushes (allows for normal growth patterns)**
- Height of plant
- Bloom time
- Color

Example Plant List: Well Drained Soils

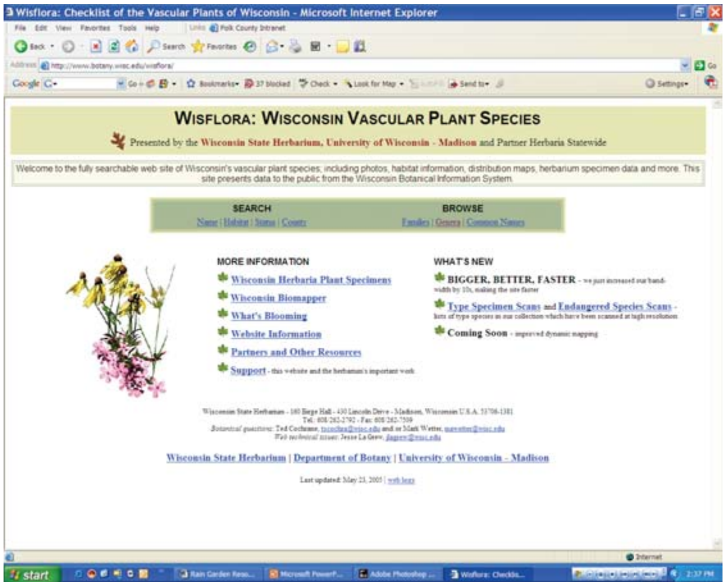
New England aster *Aster novae-angliae*
Spotted Joe-Pye weed *Eupatorium maculatum*
Sneezeweed *Helenium autumnale*
Torrey's rush *Juncus torreyi*
Prairie blazing star *Liatris pycnostachya*
Cardinal flower *Lobelia cardinalis*
Great blue lobelia *Lobelia siphilitica*
Wild bergamot *Monarda fistulosa*
Mountain mint *Pycanthemum virginianum*
Green bulrush *scirpus atrovirens*
Stiff goldenrod *Solidago rigida*
Culver's root *Veronicastrum virginicum*
Golden Alexander *Zizia aurea*

Example Plant List: Clay Soils

Sweet flag *Acorus calamus*
Swamp milkweed *Asclepias incarnata*
Water plantain *Alisma subcordatum*
Bottle brush sedge *Carex comosa*
Fox sedge *Carex vulpinoidea*
Wild blue flag iris *Iris virginica shrevei*
Torrey's rush *Juncus torreyi*
Cardinal flower *Lobelia cardinalis*
False dragon's head *Physostegia virginiana*
Arrowhead *Sagittaria latifolia*
Green bulrush *Scirpus atrovirens*
River bulrush *Scirpus fluviatilis*
Soft-stemmed bulrush *Scirpus validus*

Example Plant List: Shady Areas

Caterpiller Sedge *Carex crinita*
Cardinal Flower* *Lobelia cardinalis*
Ostrich Fern* *Matteuccia struthiopteris*
Virginia Bluebells *Mertensia virginica*
Sensitive Fern *Onoclea sensibilis*
Black Chokeberry *Aronia melanocarpa*
Red Osier Dogwood *Cornus serecia*
Low Bush Honeysuckle *Diervilla lonicera*
Pussy Willow *Salix caprea*
Blue Arctic Willow *Salix purpurea* Nanna



WISFLORA: WISCONSIN VASCULAR PLANT SPECIES

Presented by the Wisconsin State Herbarium, University of Wisconsin - Madison and Partner Herbaria Statewide

Welcome to the fully searchable web site of Wisconsin's vascular plant species; including photos, habitat information, distribution maps, herbarium specimen data and more. This site presents data to the public from the Wisconsin Botanical Information System.

SEARCH
Name | Habitat | Status | County

BROWSE
Families | Genera | Common Names

MORE INFORMATION
- Wisconsin Herbaria Plant Specimens
- Wisconsin Biomapper
- What's Blooming
- Website Information
- Partners and Other Resources
- Support - this website and the herbarium's important work

WHAT'S NEW
- BIGGER, BETTER, FASTER - we just increased our bandwidth by 10x, making the site faster
- Type Specimen Scans and Endangered Species Scans - lots of type species in our collection which have been scanned at high resolution
- Coming Soon - improved dynamic mapping

Wisconsin State Herbarium - 160 Birge Hall - 430 Lincoln Drive - Madison, Wisconsin U.S.A. 53706-1381
Tel: 608/262-2792 - Fax: 608/262-7509
Botanical questions: Ted Cochrane, tscochra@wisc.edu and/or Mark Wetter, mawetter@wisc.edu
Web technical issues: Jesse La Grew, jlagrew@wisc.edu

Wisconsin State Herbarium | Department of Botany | University of Wisconsin - Madison

Last updated: May 23, 2005 | web logs

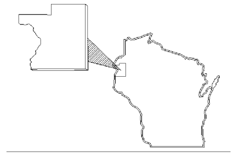
Special Case: Shoreland Area

- Should not replace native shoreland vegetation
- Should help protect riparian veg. from excessive flow and debris

Questions?

Jeremy Williamson
Water Quality Specialist
(715) 485-8639
jeremyw@co.polk.wi.us

		Date
Designed	SEG	12/11/17
Drawn		
Checked		
Approved		



Polk County Land & Water
Resources Department
100 Polk County Plaza - Suite 120
Balsam Lake, WI 54810
715-485-8699
715-485-8601 fax

PROJECT: LOTUS LAKE PARK

COUNTY: POLK

PLAN VIEW

BOAT LANDING PLANTING PLAN

SHEET

Designed SEG Date 12/11/17
Drawn
Checked
Approved

Polk County Land & Water
Resources Department
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PROJECT: Lotus Lake Park
COUNTY: Polk

PLAN VIEW

SHEET

Appendix J

Modeling

Date: 1/5/2017   Scenario: LOTUS 2014

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248 acre
Lake Volume <V>: 1364 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre **(ac)**	Low	Most Likely **|---- Loading (kg/ha-year) ----|**	High	Loading %	Low	Most Likely **|----- Loading (kg/year) ----|**	High
Row Crop AG	371.38	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.47	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.73	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.71	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.3	0.5	0.8	

```
# capita-years                      477.79
% Phosphorus Retained by Soil                   98          90       80
Septic Tank Loading (kg/year)                 2.87       23.89    76.45         7.0

TOTALS DATA
Description                      Low    Most Likely   High     Loading %
Total Loading (lb)               335.8        752.9       1915.7   100.0
Total Loading (kg)               152.3        341.5        869.0   100.0
Areal Loading (lb/ac-year)        1.35         3.04         7.72     0.0
Areal Loading (mg/m^2-year)     151.75       340.27       865.82     0.0
Total PS Loading (lb)              0.0          0.0          0.0     0.0
Total PS Loading (kg)              0.0          0.0          0.0     0.0
Total NPS Loading (lb)           307.3        633.8       1525.9    93.0
Total NPS Loading (kg)           139.4        287.5        692.1    93.0
```

Wisconsin Internal Load Estimator

```
Date: 1/5/2017    Scenario: 27
Method 1 - A Complete Total Phosphorus Mass Budget
Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.45
Internal Load: 216 Lb      98 kg

Method 2 - From Growing Season In Situ Phososphorus Increases
Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day     1.33E-003 lb/acre-day
Internal Load:  17 Lb       8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall
Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
```

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day     6.11E-002 lb/acre-day
Internal Load: 279 Lb     127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           62       145        248
Internal Load: (kg)           28        66        113

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              216         98      22.3
From Growing Season In Situ Phosphorus Increases:          17          8       2.2
From In Situ Phososphorus Increases In The Fall:          279        127      27.0
From Phososphorus Release Rate and Anoxic Area:           145         66      16.1

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              60          68       128
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       216          147.8        145
Internal Load (kg):        98           67.0         66
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	552	901	2061
Total Load (kg):	250	409	935

Phosphorus Prediction and Uncertainty Analysis Module CASE 1

Date: 1/5/2017   Scenario: 24
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 115 mg/m^3
Back calculation GSM phosphorus: 159.5 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 68 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-19	-22
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-23	-27
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-35	-41
Rechow, 1979 General	11	24	60	-62	-72
Rechow, 1977 Anoxic	53	119	304	33	38
Rechow, 1977 water load<50m/year	30	68	172	-18	-21
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	25	40
Vollenweider, 1982 Combined OECD	29	57	122	-17	-23
Dillon-Rigler-Kirchner	17	38	97	-24	-39
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-25	-34
Larsen-Mercier, 1976	36	81	205	19	31
Nurnberg, 1984 Oxic	47	69	129	-17	-20

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	811	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1256	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	2722	GSM
Rechow, 1979 General	13	48	FIT	2293	GSM
Rechow, 1977 Anoxic	68	238	FIT	456	GSM
Rechow, 1977 water load<50m/year	37	137	P	806	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	450	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1006	ANN

Dillon-Rigler-Kirchner	22	76	P	1025	SPO
Vollenweider, 1982 Shallow Lake/Res.	23	98	FIT	1133	ANN
Larsen-Mercier, 1976	48	160	P Pin	487	SPO
Nurnberg, 1984 Oxic	40	120	P	1137	ANN

Phosphorus Prediction and Uncertainty Analysis Module CASE 2

Date: 1/5/2017   Scenario: 25
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 326.84 mg/m^3
Back calculation GSM phosphorus: 453.26 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 128 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-19	-22
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-23	-27
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-35	-41
Rechow, 1979 General	11	24	60	-62	-72
Rechow, 1977 Anoxic	53	119	304	33	38
Rechow, 1977 water load<50m/year	30	68	172	-18	-21
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	25	40
Vollenweider, 1982 Combined OECD	29	57	122	-17	-23
Dillon-Rigler-Kirchner	17	38	97	-24	-39
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-25	-34
Larsen-Mercier, 1976	36	81	205	19	31
Nurnberg, 1984 Oxic	74	95	155	9	10

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	2304	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	6415	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	27108	GSM
Rechow, 1979 General	13	48	FIT	6517	GSM
Rechow, 1977 Anoxic	68	238	FIT	1297	GSM
Rechow, 1977 water load<50m/year	37	137	P	2290	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A

```
 Walker, 1977 General                          42        184          FIT      1280       SPO
 Vollenweider, 1982 Combined OECD              27        112          FIT      3598       ANN
 Dillon-Rigler-Kirchner                        22         76            P      2913       SPO
 Vollenweider, 1982 Shallow Lake/Res.          23         98          FIT      3725       ANN
 Larsen-Mercier, 1976                          48        160        P Pin      1385       SPO
 Nurnberg, 1984 Oxic                           58        156            P      3481       ANN
```

Water and Nutrient Outflow Module

```
Date: 1/5/2017    Scenario: 14
Average Annual Surface Total Phosphorus: 82.03mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading:     394.2 LB =>     178.8 kg
```

Expanded Trophic Response Module

```
Date: 1/5/2017    Scenario: 34
Total Phosphorus:    86.12 mg/m^3
Growing Season
Chorophyll a:        39.54 mg/m^3
Secchi Disk Depth:    0.27 m
```

Carlson TSI Equations:

```
TSI (Total Phosphorus):    68     TSI (Chlorphyll a):    67     TSI (Secchi Disk Depth):    79
```

Expanded Trophic Response Module

```
Date: 1/5/2017    Scenario: 35
Total Phosphorus:    86.12 mg/m^3
Growing Season
Chorophyll a:        39.54 mg/m^3
Secchi Disk Depth:    0.27 m
```

Wisconsin Statewide Prediction Equations:

```
                                             Natural Lakes         Impoundments
                                           Stratified   Mixed      Stratified   Mixed
Secchi Disk Depth using Chlorophyll_a:          1.0       0.8            1.1      0.7
Secchi Disk Depth using Total Phosphorus:       1.1       0.7            0.8      0.8
Chlorphyll_a using Total Phosphorus:           16.4      23.7           45.8     26.0
```

Expanded Trophic Response Module

```
Date: 1/5/2017    Scenario: 36
Total Phosphorus:    86.12 mg/m^3
Growing Season
Chorophyll a:        39.54 mg/m^3
```

```
Secchi Disk Depth:    0.27 m
Wisconsin Regional Prediction Equations:
                                              Stratified                Mixed
                                  Region   Seepage   Drainage    Seepage   Drainage
Use Chlorophyll_a To Predict      South       0.9        0.9        0.7        0.6
Secchi Disk Depth (m)             Central     1.6        0.9        0.3    No Data
                                  North       1.3        0.9        1.0        1.0
Use Total Phosphorus To           South       1.1        0.7        0.5        0.6
Predict Secchi Disk Depth (m)     Central     2.6        0.3        0.5    No Data
                                  North       1.7        0.9        1.0        0.8
Use Total Phosphorus To           South      17.1       57.8       26.2       34.5
Predict Chlorophyll_a (mg/m^3))   Central    15.4      165.5       24.3    No Data
                                  North       8.5       23.4       18.2       12.7

Expanded Trophic Response Module
Date: 1/5/2017    Scenario: 37
Total Phosphorus:    86.12 mg/m^3
Growing Season
Chorophyll a:        39.54 mg/m^3
Secchi Disk Depth:    0.27 m
Cholorphyll a Nuisance Frequency
Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

    Mean    Freq %    ml        z        v        w        x
      5       0.5    1.4      2.546    0.016    0.541    0.005
     10       7.7    2.1      1.428    0.144    0.678    0.077
     15      21.9    2.5      0.774    0.296    0.795    0.219
     20      37.8    2.8      0.310    0.380    0.907    0.378
     25      52.0    3.0     -0.050    0.398    0.984    0.480
     30      63.5    3.2     -0.344    0.376    0.897    0.365
     35      72.3    3.4     -0.593    0.335    0.835    0.277
     40      79.0    3.5     -0.808    0.288    0.788    0.210
     45      84.1    3.6     -0.998    0.242    0.751    0.159
     50      87.9    3.7     -1.168    0.202    0.720    0.121
     55      90.7    3.8     -1.322    0.167    0.695    0.093
     60      92.8    3.9     -1.462    0.137    0.673    0.072
     65      94.4    4.0     -1.591    0.112    0.654    0.056
```

70	95.6	4.1	-1.711	0.092	0.637	0.044
75	96.6	4.1	-1.822	0.076	0.623	0.034
80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

Date: 1/30/2017 Scenario: Lotus Lake 2014 (carp scenario)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading (kg/ha-year) ----|**				**|----- Loading (kg/year) ----|**		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 41

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.45
Internal Load: 216 Lb   98 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 66 Lb   30 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

```
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 4.2 mg/m^2-day     1.15E-002 lb/acre-day
Internal Load: 210 Lb      95 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 2.4 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)          247       577        989
Internal Load: (kg)          112       262        449

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              216        98      22.3
From Growing Season In Situ Phosphorus Increases:          66        30       8.1
From In Situ Phososphorus Increases In The Fall:          210        95      21.8
From Phososphorus Release Rate and Anoxic Area:           577       262      43.4

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              60          66       214
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       216          137.8        577
Internal Load (kg):        98           62.5        262
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	552	891	2493
Total Load (kg):	250	404	1131

Date: 1/26/2017   Scenario: Lotus 2014 Direct

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 7899.7 acre-ft/year
Areal Water Load <qs>: 31.9 ft/year
Lake Flushing Rate <p>: 5.79 1/year
Water Residence Time: 0.17 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading (kg/ha-year) ----|**				**|----- Loading (kg/year) ----|**		
Row Crop AG	84.397	0.50	1.00	3.00	1.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.016	0.10	0.30	0.50	1.0	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.162	0.05	0.10	0.25	0.2	2	4	11
Wetlands	44.488	0.10	0.10	0.10	0.1	2	2	2
Forest	584.2	0.05	0.09	0.18	0.9	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	1.3	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	1.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	5120.8	5762.7	100.0
Total Loading (kg)	53.4	2322.8	2613.9	100.0
Areal Loading (lb/ac-year)	0.47	20.65	23.24	
Areal Loading (mg/m^2-year)	53.17	2314.40	2604.49	
Total PS Loading (lb)	0.0	4815.9	4941.6	94.0
Total PS Loading (kg)	0.0	2184.5	2241.5	94.0
Total NPS Loading (lb)	89.2	185.8	431.2	4.9
Total NPS Loading (kg)	40.5	84.3	195.6	4.9

Wisconsin Internal Load Estimator

Date: 1/26/2017   Scenario: 35

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 238.4 mg/m^3
Areal External Loading: 2314.4 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.54
Observed Phosphorus Retention Coefficient: 0.66
Internal Load: -587 Lb   -266 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 17 Lb   8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day     6.11E-002 lb/acre-day
Internal Load: 279 Lb     127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           62       145        248
Internal Load: (kg)           28        66        113

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 5121 Lb      2323 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                             -587      -266     -12.9
From Growing Season In Situ Phosphorus Increases:          17         8       0.3
From In Situ Phososphorus Increases In The Fall:          279       127       5.2
From Phososphorus Release Rate and Anoxic Area:           145        66       2.8

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                             -25         116       130
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):      -587          147.8        145
Internal Load (kg):      -266           67.0         66
External Load (Lb):       118           5121       5763
External Load (kg):        53           2323       2614
```

```
Total Load (Lb):         -469           5269       5908
Total Load (kg):         -213           2390       2680
```

Date: 1/30/2017 Scenario: Lotus Lake 2014 Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading (kg/ha-year) ----|**				**|----- Loading (kg/year) ----|**		
Row Crop AG	84.4	0.50	1.00	3.00	7.0	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	4.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	0.9	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	4.4	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	6.2	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	4.9

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	1075.4	1611.7	100.0
Total Loading (kg)	53.4	487.8	731.1	100.0
Areal Loading (lb/ac-year)	0.47	4.34	6.50	
Areal Loading (mg/m^2-year)	53.17	486.02	728.42	
Total PS Loading (lb)	0.0	770.5	790.7	71.7
Total PS Loading (kg)	0.0	349.5	358.6	71.7
Total NPS Loading (lb)	89.2	185.8	431.2	23.5
Total NPS Loading (kg)	40.5	84.3	195.6	23.5

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 36

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 82.03 mg/m^3
Phosphorus Inflow Concentration: 207.6 mg/m^3
Areal External Loading: 486.0 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.60
Internal Load: 143 Lb   65 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 95.7 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 82 days
Sediment Phosphorus Release Rate: 0.5 mg/m^2-day   1.33E-003 lb/acre-day
Internal Load: 17 Lb   8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 55.9 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 81.5 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 22.5 mg/m^2-day     6.11E-002 lb/acre-day
Internal Load: 279 Lb     127 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 11.5 mg/m^2-day
Period of Anoxia: 82 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           62       145        248
Internal Load: (kg)           28        66        113

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 1075 Lb      488 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              143        65      11.7
From Growing Season In Situ Phosphorus Increases:          17         8       1.5
From In Situ Phososphorus Increases In The Fall:          279       127      20.6
From Phososphorus Release Rate and Anoxic Area:           145        66      11.9

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              33          83       110
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       143          147.8        145
Internal Load (kg):        65           67.0         66
External Load (Lb):       118           1075       1612
External Load (kg):        53            488        731
```

```
Total Load (Lb):          260           1223       1757
Total Load (kg):          118            555        797
```

Phosphorus Prediction and Uncertainty Analysis Module

```
Date: 1/30/2017    Scenario: 32
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
Back calculation for SPO total phosphorus: 115 mg/m^3
Back calculation GSM phosphorus: 159.5 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 83 kg

           Lake Phosphorus Model              Low   Most Likely   High     Predicted  % Dif.
                                            Total P   Total P    Total P   -Observed
                                            (mg/m^3) (mg/m^3)   (mg/m^3)   (mg/m^3)
 Walker, 1987 Reservoir                          9       83        124         -3        -3
 Canfield-Bachmann, 1981 Natural Lake           15       81        108         -5        -6
 Canfield-Bachmann, 1981 Artificial Lake        14       63         79        -23       -27
 Rechow, 1979 General                            4       34         51        -52       -60
 Rechow, 1977 Anoxic                            18      166        249         80        93
 Rechow, 1977 water load<50m/year               10       95        142          9        10
 Rechow, 1977 water load>50m/year              N/A      N/A        N/A        N/A       N/A
 Walker, 1977 General                           13      122        182         60        97
 Vollenweider, 1982 Combined OECD               12       74        104          0         0
 Dillon-Rigler-Kirchner                          6       53         80         -9       -14
 Vollenweider, 1982 Shallow Lake/Res.            9       65         93         -9       -12
 Larsen-Mercier, 1976                           12      112        169         50        81
 Nurnberg, 1984 Oxic                            41       90        117          4         5

         Lake Phosphorus Model          Confidence Confidence  Parameter    Back       Model
                                           Lower      Upper      Fit?   Calculation   Type
                                           Bound      Bound               (kg/year)
 Walker, 1987 Reservoir                       32        122         FIT       940       GSM
 Canfield-Bachmann, 1981 Natural Lake         25        233         FIT      1273       GSM
 Canfield-Bachmann, 1981 Artificial Lake      20        181         FIT      2745       GSM
 Rechow, 1979 General                         13         52         FIT      2307       GSM
 Rechow, 1977 Anoxic                          66        241         FIT       469       GSM
 Rechow, 1977 water load<50m/year             36        142           P       818       GSM
 Rechow, 1977 water load>50m/year            N/A        N/A         N/A       N/A       N/A
 Walker, 1977 General                         40        202         FIT       461       SPO
 Vollenweider, 1982 Combined OECD             24        127         FIT      1030       ANN
```

```
 Dillon-Rigler-Kirchner                       21         78           P      1053       SPO
 Vollenweider, 1982 Shallow Lake/Res.         21        110         FIT      1159       ANN
 Larsen-Mercier, 1976                         46        160       P Pin       499       SPO
 Nurnberg, 1984 Oxic                          46        140           P      1111       ANN
```

Water and Nutrient Outflow Module

```
Date: 1/30/2017    Scenario: 19
Average Annual Surface Total Phosphorus: 82.03mg/m^3
Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3
Annual Outflow Loading:     406.3 LB =>     184.3 kg
```

```
 Date: 1/5/2017    Scenario: LOTUS 2015
 Lake Id: Lotus Lake 2015
 Watershed Id: 1
Hydrologic and Morphometric Data
Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
 Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 96 mg/m^3
Observed growing season mean phosphorus (GSM): 142.36 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA
     Land Use        Acre       Low    Most Likely    High    Loading %   Low    Most Likely    High
                     (ac)      |---- Loading (kg/ha-year) ----|             |-----  Loading (kg/year) ----|
Row Crop AG          371.4      0.50      1.00      3.00      44.0      75     150     451
Mixed AG               0.0      0.30      0.80      1.40       0.0       0       0       0
Pasture/Grass        611.5      0.10      0.30      0.50      21.7      25      74     124
HD Urban (1/8 Ac)      0.0      1.00      1.50      2.00       0.0       0       0       0
MD Urban (1/4 Ac)      0.0      0.30      0.50      0.80       0.0       0       0       0
Rural Res (>1 Ac)    115.1      0.05      0.10      0.25       1.4       2       5      12
Wetlands             265.7      0.10      0.10      0.10       3.1      11      11      11
Forest              1305.7      0.05      0.09      0.18      13.9      26      48      95
Lake Surface         248.0      0.10      0.30      1.00       8.8      10      30     100

POINT SOURCE DATA
      Point Sources     Water Load     Low    Most Likely    High    Loading %
                        (m^3/year)  (kg/year)  (kg/year)   (kg/year)        _

SEPTIC TANK DATA
Description                                              Low     Most Likely   High     Loading %
Septic Tank Output (kg/capita-year)                      0.30        0.50      0.80
```

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/5/2017   Scenario: 28

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.18
Internal Load: 422 Lb   192 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 152 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.68E-003 lb/acre-day
Internal Load: 23 Lb   11 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 12.6 mg/m^2-day     3.44E-002 lb/acre-day
Internal Load: 157 Lb      71 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 6.6 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           69       161        276
Internal Load: (kg)           31        73        125

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              422        192      35.9
From Growing Season In Situ Phosphorus Increases:          23         11       3.0
From In Situ Phososphorus Increases In The Fall:          157         71      17.3
From Phososphorus Release Rate and Anoxic Area:           161         73      17.6

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                             101          57       131
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       422           90.1        161
Internal Load (kg):       192           40.9         73
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	758	843	2077
Total Load (kg):	344	382	942

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2017   Scenario: 26
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
Back calculation for SPO total phosphorus: 177.78 mg/m^3
Back calculation GSM phosphorus: 263.63 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 101 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-75	-53
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-79	-55
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-91	-64
Rechow, 1979 General	11	24	60	-118	-83
Rechow, 1977 Anoxic	53	119	304	-23	-16
Rechow, 1977 water load<50m/year	30	68	172	-74	-52
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	-9	-9
Vollenweider, 1982 Combined OECD	29	57	122	-62	-52
Dillon-Rigler-Kirchner	17	38	97	-58	-60
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-70	-59
Larsen-Mercier, 1976	36	81	205	-15	-16
Nurnberg, 1984 Oxic	62	83	143	-59	-41

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1340	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	2704	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	7954	GSM
Rechow, 1979 General	13	48	FIT	3790	GSM
Rechow, 1977 Anoxic	68	238	FIT	754	GSM
Rechow, 1977 water load<50m/year	37	137	P	1332	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	696	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1796	ANN

```
 Dillon-Rigler-Kirchner                       22         76           P      1584       SPO
 Vollenweider, 1982 Shallow Lake/Res.         23         98         FIT      1946       ANN
 Larsen-Mercier, 1976                         48        160       P Pin       753       SPO
 Nurnberg, 1984 Oxic                          50        140           P      1922       ANN
```

Water and Nutrient Outflow Module

```
Date: 1/6/2017    Scenario: 15
Average Annual Surface Total Phosphorus: 122.98mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading:     591.1 LB =>     268.1 kg
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 38
Total Phosphorus:    142.4 mg/m^3
Growing Season
Chorophyll a:         67.3 mg/m^3
Secchi Disk Depth:    0.24 m
Carlson TSI Equations:
TSI (Total Phosphorus):    76     TSI (Chlorphyll a):    72     TSI (Secchi Disk Depth):    81
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 39
Total Phosphorus:    142.4 mg/m^3
Growing Season
Chorophyll a:         67.3 mg/m^3
Secchi Disk Depth:    0.24 m
Wisconsin Statewide Prediction Equations:
                                               Natural Lakes            Impoundments
                                             Stratified   Mixed      Stratified   Mixed
Secchi Disk Depth using Chlorophyll_a:            0.8       0.6           1.0       0.6
Secchi Disk Depth using Total Phosphorus:         0.9       0.5           0.6       0.7
Chlorphyll_a using Total Phosphorus:             21.5      32.9          76.5      37.0
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 40
Total Phosphorus:    142.4 mg/m^3
Growing Season
Chorophyll a:         67.3 mg/m^3
Secchi Disk Depth:    0.24 m
Wisconsin Regional Prediction Equations:
```

```
                                              Stratified                Mixed
                                  Region   Seepage   Drainage    Seepage   Drainage
Use Chlorophyll_a To Predict      South       0.7        0.7        0.6        0.5
Secchi Disk Depth (m)             Central     1.3        0.6        0.2    No Data
                                  North       1.1        0.7        0.8        0.9
Use Total Phosphorus To           South       0.9        0.5        0.4        0.5
Predict Secchi Disk Depth (m)     Central     2.6        0.2        0.3    No Data
                                  North       1.5        0.7        0.8        0.6
Use Total Phosphorus To           South      23.7      105.7       38.8       53.2
Predict Chlorophyll_a (mg/m^3))   Central    20.8      350.2       33.6    No Data
                                  North       9.2       35.1       23.8       13.7
```

Expanded Trophic Response Module

Date: 1/6/2017   Scenario: 41

Total Phosphorus: 142.4 mg/m^3

Growing Season

Chorophyll a: 67.3 mg/m^3

Secchi Disk Depth: 0.24 m

Cholorphyll a Nuisance Frequency

Chla Mean Min: 5

Chla Mean Max: 100

Chla Mean Increment: 5

Chla Temporal CV: 0.62

Chla Nuisance Criterion: 20

```
    Mean    Freq %   ml        z        v        w        x
      5       0.5    1.4      2.546    0.016    0.541    0.005
     10       7.7    2.1      1.428    0.144    0.678    0.077
     15      21.9    2.5      0.774    0.296    0.795    0.219
     20      37.8    2.8      0.310    0.380    0.907    0.378
     25      52.0    3.0     -0.050    0.398    0.984    0.480
     30      63.5    3.2     -0.344    0.376    0.897    0.365
     35      72.3    3.4     -0.593    0.335    0.835    0.277
     40      79.0    3.5     -0.808    0.288    0.788    0.210
     45      84.1    3.6     -0.998    0.242    0.751    0.159
     50      87.9    3.7     -1.168    0.202    0.720    0.121
     55      90.7    3.8     -1.322    0.167    0.695    0.093
     60      92.8    3.9     -1.462    0.137    0.673    0.072
     65      94.4    4.0     -1.591    0.112    0.654    0.056
     70      95.6    4.1     -1.711    0.092    0.637    0.044
     75      96.6    4.1     -1.822    0.076    0.623    0.034
```

```
   80      97.3    4.2     -1.926    0.062    0.609    0.027
   85      97.8    4.3     -2.024    0.051    0.598    0.022
   90      98.3    4.3     -2.116    0.043    0.587    0.017
   95      98.6    4.4     -2.203    0.035    0.577    0.014
  100      98.9    4.4     -2.286    0.029    0.568    0.011
```

Summary Trophic Response Module

```
Date: 1/6/2017    Scenario: 2
Average Spring Mixed Total Phosphorus:: 96.0 mg/m^3
Growing Season Chlorophyll_a:: 28.2 mg/m^3
Average Growing Season Chlorophyll_a:: 67.3 mg/m^3
Natural Lake Secchi Depth (m)      Impoundment Secchi Depth (m)
  Mixed     Stratified                  Mixed    Stratified
   0.58         0.81                     0.61         0.95
```

Wisconsin Trophic State Index (TSI)

```
Total Phosphorus::     142.4 mg/m^3          TSI =  67
Chlorophyll a::         67.3 mg/m^3          TSI =  66
Secchi Disc Depth::     0.24 m               TSI =  81
```

```
 Date: 1/30/2017    Scenario: Lotus Lake 2015 (carp scenario)
 Lake Id: Lotus Lake 2015
 Watershed Id: 1
Hydrologic and Morphometric Data
Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
 Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA
     Land Use         Acre        Low    Most Likely    High    Loading %   Low    Most Likely    High
                      (ac)       |---- Loading (kg/ha-year) ----|              |-----  Loading (kg/year) ----|
Row Crop AG            371.4        0.50         1.00         3.00        44.0          75         150         451
Mixed AG                 0.0        0.30         0.80         1.40         0.0           0           0           0
Pasture/Grass          611.5        0.10         0.30         0.50        21.7          25          74         124
HD Urban (1/8 Ac)        0.0        1.00         1.50         2.00         0.0           0           0           0
MD Urban (1/4 Ac)        0.0        0.30         0.50         0.80         0.0           0           0           0
Rural Res (>1 Ac)      115.1        0.05         0.10         0.25         1.4           2           5          12
Wetlands               265.7        0.10         0.10         0.10         3.1          11          11          11
Forest                1305.7        0.05         0.09         0.18        13.9          26          48          95
Lake Surface           248.0        0.10         0.30         1.00         8.8          10          30         100

POINT SOURCE DATA
      Point Sources      Water Load     Low    Most Likely    High    Loading %
                        (m^3/year)  (kg/year)  (kg/year)   (kg/year)         _

SEPTIC TANK DATA
Description                                           Low    Most Likely   High      Loading %
Septic Tank Output (kg/capita-year)                   0.30         0.50    0.80
```

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 42

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.18
Internal Load: 422 Lb   192 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96.00 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 53.1 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: -0.5 mg/m^2-day   -1.29E-003 lb/acre-day
Internal Load: -71 Lb   -32 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96.00 mg/m^3

```
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0.8 mg/m^2-day     2.08E-003 lb/acre-day
Internal Load:  38 Lb      17 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: -0.5 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -0.5 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.1 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)          274       640       1098
Internal Load: (kg)          124       290        498

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              422       192      35.9
From Growing Season In Situ Phosphorus Increases:         -71       -32     -10.4
From In Situ Phososphorus Increases In The Fall:           38        17       4.8
From Phososphorus Release Rate and Anoxic Area:           640       290      46.0

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                             101          36       227
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       422          -16.7        640
Internal Load (kg):       192           -7.6        290
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	758	736	2556
Total Load (kg):	344	334	1159

```
 Date: 1/30/2017    Scenario: Lotus Lake 2015 Direct (modeled hydraulic loading)
 Lake Id: Lotus Lake 2014
 Watershed Id: 1
Hydrologic and Morphometric Data
Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
 Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 96 mg/m^3
Observed growing season mean phosphorus (GSM): 142.36 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA
     Land Use       Acre       Low   Most Likely  High    Loading %  Low   Most Likely  High
                      (ac)     |---- Loading (kg/ha-year) ----|            |-----  Loading (kg/year) ----|
Row Crop AG             84.4       0.50       1.00       3.00        8.4         17         34        102
Mixed AG                 0.0       0.30       0.80       1.40        0.0          0          0          0
Pasture/Grass          186.0       0.10       0.30       0.50        5.6          8         23         38
HD Urban (1/8 Ac)        0.0       1.00       1.50       2.00        0.0          0          0          0
MD Urban (1/4 Ac)        0.0       0.30       0.50       0.80        0.0          0          0          0
Rural Res (>1 Ac)      110.2       0.05       0.10       0.25        1.1          2          4         11
Wetlands                44.5       0.10       0.10       0.10        0.4          2          2          2
Forest                 584.2       0.05       0.09       0.18        5.2         12         21         43
Lake Surface           248.0       0.10       0.30       1.00        7.4         10         30        100

POINT SOURCE DATA
      Point Sources     Water Load     Low    Most Likely    High    Loading %
                        (m^3/year)  (kg/year)  (kg/year)   (kg/year)         _

SEPTIC TANK DATA
Description                                        Low    Most Likely   High     Loading %
Septic Tank Output (kg/capita-year)                0.30        0.50     0.80
```

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	5.9

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	896.3	1421.1	100.0
Total Loading (kg)	53.4	406.6	644.6	100.0
Areal Loading (lb/ac-year)	0.47	3.61	5.73	
Areal Loading (mg/m^2-year)	53.17	405.11	642.28	
Total PS Loading (lb)	0.0	591.5	600.0	66.0
Total PS Loading (kg)	0.0	268.3	272.2	66.0
Total NPS Loading (lb)	89.2	185.8	431.2	28.1
Total NPS Loading (kg)	40.5	84.3	195.6	28.1

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 38

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 122.99 mg/m^3
Phosphorus Inflow Concentration: 173.1 mg/m^3
Areal External Loading: 405.1 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.29
Internal Load: 402 Lb   182 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 152 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 91 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.68E-003 lb/acre-day
Internal Load: 23 Lb   11 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 96 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
```

Just Prior To The End of Stratification

```
Average Water Column Phosphorus Concentration: 53.1 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 12.6 mg/m^2-day     3.44E-002 lb/acre-day
Internal Load: 157 Lb      71 kg
```

Method 4 - From Phososphorus Release Rate and Anoxic Area

```
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 6.6 mg/m^2-day
Period of Anoxia: 91 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           69       161        276
Internal Load: (kg)           31        73        125
```

Internal Load Comparison (Percentanges are of the Total Estimate Load)

```
Total External Load: 896 Lb      407 kg
                                                         Lb        kg         %
From A Complete Mass Budget:                              402       182      30.9
From Growing Season In Situ Phosphorus Increases:          23        11       2.5
From In Situ Phososphorus Increases In The Fall:          157        71      14.9
From Phososphorus Release Rate and Anoxic Area:           161        73      15.2
```

Predicted Water Column Total Phosphorus Concentration (ug/l)

```
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                             84          63       103
Osgood, 1988 Lake Mixing Index: 1.7
```

Phosphorus Loading Summary:

```
                          Low      Most Likely     High
Internal Load (Lb):       402          90.1         161
Internal Load (kg):       182          40.9          73
External Load (Lb):       118           896        1421
External Load (kg):        53           407         645
```

Total Load (Lb):	519	986	1582
Total Load (kg):	236	447	718

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/30/2017   Scenario: 35
Observed spring overturn total phosphorus (SPO): 96.0 mg/m^3
Observed growing season mean phosphorus (GSM): 142.4 mg/m^3
Back calculation for SPO total phosphorus: 177.78 mg/m^3
Back calculation GSM phosphorus: 263.63 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 63 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	10	74	117	-68	-48
Canfield-Bachmann, 1981 Natural Lake	15	71	99	-71	-50
Canfield-Bachmann, 1981 Artificial Lake	14	56	74	-86	-60
Rechow, 1979 General	4	28	45	-114	-80
Rechow, 1977 Anoxic	18	138	219	-4	-3
Rechow, 1977 water load<50m/year	10	79	126	-63	-44
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	101	161	5	5
Vollenweider, 1982 Combined OECD	12	64	94	-55	-46
Dillon-Rigler-Kirchner	6	44	70	-52	-54
Vollenweider, 1982 Shallow Lake/Res.	9	55	83	-64	-54
Larsen-Mercier, 1976	12	94	149	-2	-2
Nurnberg, 1984 Oxic	33	72	99	-70	-49

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	30	111	FIT	1452	GSM
Canfield-Bachmann, 1981 Natural Lake	22	204	FIT	2733	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	7994	GSM
Rechow, 1979 General	11	44	FIT	3812	GSM
Rechow, 1977 Anoxic	57	205	FIT	775	GSM
Rechow, 1977 water load<50m/year	31	122	P	1353	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	171	FIT	713	SPO
Vollenweider, 1982 Combined OECD	22	111	FIT	1839	ANN

```
 Dillon-Rigler-Kirchner                       18         66           P      1627        SPO
 Vollenweider, 1982 Shallow Lake/Res.         19         94         FIT      1992        ANN
 Larsen-Mercier, 1976                         39        137       P Pin       771        SPO
 Nurnberg, 1984 Oxic                          37        113           P      2119        ANN
```

Water and Nutrient Outflow Module

```
Date: 1/30/2017    Scenario: 21
Average Annual Surface Total Phosphorus: 122.99mg/m^3
Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3
Annual Outflow Loading:     609.1 LB =>     276.3 kg
```

Date: 1/6/2017   Scenario: LOTUS 2016

Lake Id: Lotus Lake 2016
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 64 mg/m^3
Observed growing season mean phosphorus (GSM): 109.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre **(ac)**	Low	Most Likely **|---- Loading (kg/ha-year) ----|**	High	Loading %	Low	Most Likely **|----- Loading (kg/year) ----|**	High
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/6/2017   Scenario: 29

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.34
Internal Load: 298 Lb   135 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.73E-003 lb/acre-day
Internal Load: 10 Lb   5 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 19.9 mg/m^2-day     5.41E-002 lb/acre-day
Internal Load: 247 Lb     112 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 10.3 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6         14        24
Internal Load: (Lb)           29         67       115
Internal Load: (kg)           13         30        52

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              298       135      28.3
From Growing Season In Situ Phosphorus Increases:          10         5       1.3
From In Situ Phososphorus Increases In The Fall:          247       112      24.7
From Phososphorus Release Rate and Anoxic Area:            67        30       8.2

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              77          65       112
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       298          128.5         67
Internal Load (kg):       135           58.3         30
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	633	881	1983
Total Load (kg):	287	400	899

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2017   Scenario: 27
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
Back calculation for SPO total phosphorus: 118.52 mg/m^3
Back calculation GSM phosphorus: 202.04 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 65 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-42	-38
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-46	-42
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-58	-53
Rechow, 1979 General	11	24	60	-85	-78
Rechow, 1977 Anoxic	53	119	304	10	9
Rechow, 1977 water load<50m/year	30	68	172	-41	-38
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	23	36
Vollenweider, 1982 Combined OECD	29	57	122	-30	-35
Dillon-Rigler-Kirchner	17	38	97	-26	-41
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-38	-44
Larsen-Mercier, 1976	36	81	205	17	27
Nurnberg, 1984 Oxic	46	67	128	-42	-38

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1027	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1794	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	4467	GSM
Rechow, 1979 General	13	48	FIT	2905	GSM
Rechow, 1977 Anoxic	68	238	FIT	578	GSM
Rechow, 1977 water load<50m/year	37	137	P	1021	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	464	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1216	ANN

```
 Dillon-Rigler-Kirchner                     22         76            P      1056       SPO
 Vollenweider, 1982 Shallow Lake/Res.       23         98          FIT      1352       ANN
 Larsen-Mercier, 1976                       48        160        P Pin       502       SPO
 Nurnberg, 1984 Oxic                        39        118            P      1521       ANN
```

Water and Nutrient Outflow Module

```
Date: 1/6/2017    Scenario: 16
Average Annual Surface Total Phosphorus: 98.17mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading:     471.8 LB =>     214.0 kg
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 42
Total Phosphorus:    109.1 mg/m^3
Growing Season
Chorophyll a:        43.49 mg/m^3
Secchi Disk Depth:    0.42 m
```

Carlson TSI Equations:

```
TSI (Total Phosphorus):    72     TSI (Chlorphyll a):    68     TSI (Secchi Disk Depth):    73
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 43
Total Phosphorus:    109.1 mg/m^3
Growing Season
Chorophyll a:        43.49 mg/m^3
Secchi Disk Depth:    0.42 m
```

Wisconsin Statewide Prediction Equations:

```
                                               Natural Lakes           Impoundments
                                             Stratified   Mixed      Stratified   Mixed
Secchi Disk Depth using Chlorophyll_a:             1.0       0.7            1.1       0.7
Secchi Disk Depth using Total Phosphorus:          1.0       0.6            0.7       0.8
Chlorphyll_a using Total Phosphorus:              18.6      27.7           58.3      30.7
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 44
Total Phosphorus:    109.1 mg/m^3
Growing Season
Chorophyll a:        43.49 mg/m^3
Secchi Disk Depth:    0.42 m
```

Wisconsin Regional Prediction Equations:

```
                                              Stratified                Mixed
                                  Region   Seepage   Drainage    Seepage   Drainage
Use Chlorophyll_a To Predict      South      0.9        0.8        0.6        0.6
Secchi Disk Depth (m)             Central    1.5        0.8        0.3    No Data
                                  North      1.3        0.9        0.9        1.0
Use Total Phosphorus To           South      1.0        0.6        0.5        0.6
Predict Secchi Disk Depth (m)     Central    2.6        0.2        0.4    No Data
                                  North      1.6        0.8        0.9        0.7
Use Total Phosphorus To           South     19.9       76.8       31.5       42.3
Predict Chlorophyll_a (mg/m^3))   Central   17.7      235.4       28.3    No Data
                                  North      8.8       28.3       20.6       13.1
```

Expanded Trophic Response Module

```
Date: 1/6/2017    Scenario: 45
Total Phosphorus:    109.1 mg/m^3
Growing Season
Chorophyll a:        43.49 mg/m^3
Secchi Disk Depth:    0.42 m
Cholorphyll a Nuisance Frequency
Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

    Mean    Freq %    ml        z        v        w        x
      5       0.5    1.4      2.546    0.016    0.541    0.005
     10       7.7    2.1      1.428    0.144    0.678    0.077
     15      21.9    2.5      0.774    0.296    0.795    0.219
     20      37.8    2.8      0.310    0.380    0.907    0.378
     25      52.0    3.0     -0.050    0.398    0.984    0.480
     30      63.5    3.2     -0.344    0.376    0.897    0.365
     35      72.3    3.4     -0.593    0.335    0.835    0.277
     40      79.0    3.5     -0.808    0.288    0.788    0.210
     45      84.1    3.6     -0.998    0.242    0.751    0.159
     50      87.9    3.7     -1.168    0.202    0.720    0.121
     55      90.7    3.8     -1.322    0.167    0.695    0.093
     60      92.8    3.9     -1.462    0.137    0.673    0.072
     65      94.4    4.0     -1.591    0.112    0.654    0.056
     70      95.6    4.1     -1.711    0.092    0.637    0.044
     75      96.6    4.1     -1.822    0.076    0.623    0.034
```

```
     80       97.3    4.2     -1.926    0.062    0.609    0.027
     85       97.8    4.3     -2.024    0.051    0.598    0.022
     90       98.3    4.3     -2.116    0.043    0.587    0.017
     95       98.6    4.4     -2.203    0.035    0.577    0.014
    100       98.9    4.4     -2.286    0.029    0.568    0.011
```

Summary Trophic Response Module

```
Date: 1/6/2017    Scenario: 3
Average Spring Mixed Total Phosphorus:: 64 mg/m^3
Growing Season Chlorophyll_a:: 21.0 mg/m^3
Average Growing Season Chlorophyll_a:: 109.1 mg/m^3
Natural Lake Secchi Depth (m)      Impoundment Secchi Depth (m)
  Mixed     Stratified                  Mixed    Stratified
   0.46          0.65                    0.51          0.82
```

Wisconsin Trophic State Index (TSI)

```
Total Phosphorus::     109.1 mg/m^3          TSI =  65
Chlorophyll a::        43.49 mg/m^3          TSI =  63
Secchi Disc Depth::     0.42 m               TSI =  73
```

Date: 1/30/2017 Scenario: Lotus Lake 2016 (carp scenario)

Lake Id: Lotus Lake 2016
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading**	**(kg/ha-year)**	**----|**		**|-----**	**Loading (kg/year)**	**----|**
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 43

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.34
Internal Load: 298 Lb   135 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.73E-003 lb/acre-day
Internal Load: 40 Lb   18 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

```
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 2.5 mg/m^2-day     6.90E-003 lb/acre-day
Internal Load: 125 Lb      57 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 1.6 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)          115       267        458
Internal Load: (kg)           52       121        208

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                               298       135      28.3
From Growing Season In Situ Phosphorus Increases:           40        18       5.0
From In Situ Phososphorus Increases In The Fall:           125        57      14.3
From Phososphorus Release Rate and Anoxic Area:            267       121      26.2

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              77          55       152
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       298           82.7        267
Internal Load (kg):       135           37.5        121
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	633	836	2183
Total Load (kg):	287	379	990

```
 Date: 1/30/2017    Scenario: Lotus Lake 2016 Direct (modeled hydraulic loading)
 Lake Id: Lotus Lake 2014
 Watershed Id: 1
Hydrologic and Morphometric Data
Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
 Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 64 mg/m^3
Observed growing season mean phosphorus (GSM): 109.12 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA
     Land Use       Acre       Low    Most Likely    High    Loading %   Low    Most Likely    High
                      (ac)       |---- Loading (kg/ha-year) ----|              |-----  Loading (kg/year) ----|
Row Crop AG                84.4       0.50       1.00       3.00        8.5         17         34        102
Mixed AG                    0.0       0.30       0.80       1.40        0.0          0          0          0
Pasture/Grass             186.0       0.10       0.30       0.50        5.6          8         23         38
HD Urban (1/8 Ac)           0.0       1.00       1.50       2.00        0.0          0          0          0
MD Urban (1/4 Ac)           0.0       0.30       0.50       0.80        0.0          0          0          0
Rural Res (>1 Ac)         110.2       0.05       0.10       0.25        1.1          2          4         11
Wetlands                   44.5       0.10       0.10       0.10        0.4          2          2          2
Forest                    584.2       0.05       0.09       0.18        5.3         12         21         43
Lake Surface              248.0       0.10       0.30       1.00        7.5         10         30        100

POINT SOURCE DATA
      Point Sources     Water Load     Low    Most Likely    High    Loading %
                        (m^3/year)  (kg/year)  (kg/year)   (kg/year)         _

SEPTIC TANK DATA
Description                                        Low    Most Likely   High     Loading %
Septic Tank Output (kg/capita-year)                0.30         0.50     0.80
```

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 1/30/2017   Scenario: 40

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 98.17 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.43
Internal Load: 276 Lb   125 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3
Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 122.0 mg/m^3
Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 38 days
Sediment Phosphorus Release Rate: 0.6 mg/m^2-day   1.74E-003 lb/acre-day
Internal Load: 10 Lb   5 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 97.9 mg/m^3

```
Hypolimnetic Volume: 153.9 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 77.6 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 19.9 mg/m^2-day     5.40E-002 lb/acre-day
Internal Load: 247 Lb     112 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0.6 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0.6 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 10.3 mg/m^2-day
Period of Anoxia: 38 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           29        67        115
Internal Load: (kg)           13        30         52

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 885 Lb      401 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              276       125      23.8
From Growing Season In Situ Phosphorus Increases:          10         5       1.1
From In Situ Phososphorus Increases In The Fall:          247       112      21.8
From Phososphorus Release Rate and Anoxic Area:            67        30       7.1

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              59          70        84
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       276          128.5         67
Internal Load (kg):       125           58.3         30
External Load (Lb):       118            885       1402
External Load (kg):        53            401        636
```

Total Load (Lb):	394	1013	1470
Total Load (kg):	179	460	667

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/30/2017   Scenario: 36
Observed spring overturn total phosphorus (SPO): 64.0 mg/m^3
Observed growing season mean phosphorus (GSM): 109.1 mg/m^3
Back calculation for SPO total phosphorus: 118.52 mg/m^3
Back calculation GSM phosphorus: 202.04 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 70 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	10	73	116	-36	-33
Canfield-Bachmann, 1981 Natural Lake	15	70	98	-39	-36
Canfield-Bachmann, 1981 Artificial Lake	14	56	73	-53	-49
Rechow, 1979 General	4	28	44	-81	-74
Rechow, 1977 Anoxic	18	136	216	27	25
Rechow, 1977 water load<50m/year	10	78	124	-31	-28
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	13	100	159	36	56
Vollenweider, 1982 Combined OECD	12	63	93	-24	-28
Dillon-Rigler-Kirchner	6	44	69	-20	-31
Vollenweider, 1982 Shallow Lake/Res.	9	55	82	-32	-37
Larsen-Mercier, 1976	12	93	147	29	45
Nurnberg, 1984 Oxic	36	75	101	-34	-31

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	30	110	FIT	1108	GSM
Canfield-Bachmann, 1981 Natural Lake	22	202	FIT	1816	GSM
Canfield-Bachmann, 1981 Artificial Lake	17	161	FIT	4496	GSM
Rechow, 1979 General	11	43	FIT	2922	GSM
Rechow, 1977 Anoxic	56	202	FIT	594	GSM
Rechow, 1977 water load<50m/year	30	120	P	1037	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	169	FIT	476	SPO
Vollenweider, 1982 Combined OECD	22	109	FIT	1244	ANN

```
 Dillon-Rigler-Kirchner                        18         65           P      1085       SPO
 Vollenweider, 1982 Shallow Lake/Res.          19         94         FIT      1384       ANN
 Larsen-Mercier, 1976                          39        136       P Pin       514       SPO
 Nurnberg, 1984 Oxic                           39        117           P      1541       ANN
```

Water and Nutrient Outflow Module

```
Date: 1/30/2017    Scenario: 22
Average Annual Surface Total Phosphorus: 98.1mg/m^3
Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3
Annual Outflow Loading:     485.9 LB =>     220.4 kg
```

Date: 2/1/2017   Scenario: Lotus Lake Combined

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 74.03 mg/m^3
Observed growing season mean phosphorus (GSM): 112.53 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	371.4	0.50	1.00	3.00	44.0	75	150	451
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	611.5	0.10	0.30	0.50	21.7	25	74	124
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	115.1	0.05	0.10	0.25	1.4	2	5	12
Wetlands	265.7	0.10	0.10	0.10	3.1	11	11	11
Forest	1305.7	0.05	0.09	0.18	13.9	26	48	95
Lake Surface	248.0	0.10	0.30	1.00	8.8	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

```
# capita-years                         477.8
% Phosphorus Retained by Soil                      98.0        90.0     80.0
Septic Tank Loading (kg/year)                      2.87       23.89    76.45        7.0

TOTALS DATA
Description                      Low    Most Likely   High     Loading %
Total Loading (lb)               335.8        752.9      1915.7   100.0
Total Loading (kg)               152.3        341.5       869.0   100.0
Areal Loading (lb/ac-year)        1.35         3.04        7.72
Areal Loading (mg/m^2-year)     151.75       340.27      865.82
Total PS Loading (lb)              0.0          0.0         0.0     0.0
Total PS Loading (kg)              0.0          0.0         0.0     0.0
Total NPS Loading (lb)           307.3        633.8      1525.9    93.0
Total NPS Loading (kg)           139.4        287.5       692.1    93.0

Wisconsin Internal Load Estimator
Date: 2/1/2017    Scenario: 44
Method 1 - A Complete Total Phosphorus Mass Budget
Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.33
Internal Load: 312 Lb     142 kg

Method 2 - From Growing Season In Situ Phososphorus Increases
Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: -10.2 mg/m^2-day     -2.76E-002 lb/acre-day
Internal Load:  -4 Lb      -2 kg

Method 3 - From In Situ Phososphorus Increases In The Fall
Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
```

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 17.3 mg/m^2-day     4.71E-002 lb/acre-day
Internal Load: 215 Lb      98 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: -10.2 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: -10.2 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 3.6 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           53       124        213
Internal Load: (kg)           24        56         97

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              312       142      29.3
From Growing Season In Situ Phosphorus Increases:          -4        -2      -0.6
From In Situ Phososphorus Increases In The Fall:          215        98      22.2
From Phososphorus Release Rate and Anoxic Area:           124        56      14.2

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              79          60       124
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       312          105.4        124
Internal Load (kg):       142           47.8         56
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

Total Load (Lb):	648	858	2040
Total Load (kg):	294	389	925

Phosphorus Prediction and Uncertainty Analysis Module

Date: 2/1/2017 Scenario: 37
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 142 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	30	67	171	-46	-41
Canfield-Bachmann, 1981 Natural Lake	34	63	123	-50	-44
Canfield-Bachmann, 1981 Artificial Lake	30	51	88	-62	-55
Rechow, 1979 General	11	24	60	-89	-79
Rechow, 1977 Anoxic	53	119	304	7	6
Rechow, 1977 water load<50m/year	30	68	172	-45	-40
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	87	222	13	18
Vollenweider, 1982 Combined OECD	29	57	122	-36	-39
Dillon-Rigler-Kirchner	17	38	97	-36	-49
Vollenweider, 1982 Shallow Lake/Res.	24	49	110	-44	-47
Larsen-Mercier, 1976	36	81	205	7	9
Nurnberg, 1984 Oxic	80	101	161	-12	-11

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	38	135	FIT	1059	GSM
Canfield-Bachmann, 1981 Natural Lake	20	181	FIT	1881	GSM
Canfield-Bachmann, 1981 Artificial Lake	16	147	FIT	4772	GSM
Rechow, 1979 General	13	48	FIT	2996	GSM
Rechow, 1977 Anoxic	68	238	FIT	596	GSM
Rechow, 1977 water load<50m/year	37	137	P	1053	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	42	184	FIT	537	SPO
Vollenweider, 1982 Combined OECD	27	112	FIT	1332	ANN

```
 Dillon-Rigler-Kirchner                      22         76           P      1222       SPO
 Vollenweider, 1982 Shallow Lake/Res.        23         98         FIT      1472       ANN
 Larsen-Mercier, 1976                        48        160       P Pin       581       SPO
 Nurnberg, 1984 Oxic                         62        165           P      1281       ANN
```

Water and Nutrient Outflow Module

```
Date: 2/1/2017    Scenario: 23
Average Annual Surface Total Phosphorus: 101.06mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading:     485.7 LB =>     220.3 kg
```

Expanded Trophic Response Module

```
Date: 2/1/2017    Scenario: 54
Total Phosphorus:   101.06 mg/m^3
Growing Season
Chorophyll a:        50.11 mg/m^3
Secchi Disk Depth:    0.42 m
```

Carlson TSI Equations:

```
TSI (Total Phosphorus):    71     TSI (Chlorphyll a):    69     TSI (Secchi Disk Depth):    73
```

Expanded Trophic Response Module

```
Date: 2/1/2017    Scenario: 55
Total Phosphorus:   101.06 mg/m^3
Growing Season
Chorophyll a:        50.11 mg/m^3
Secchi Disk Depth:    0.42 m
```

Wisconsin Statewide Prediction Equations:

```
                                              Natural Lakes            Impoundments
                                            Stratified   Mixed      Stratified   Mixed
Secchi Disk Depth using Chlorophyll_a:            0.9       0.7             1.0       0.7
Secchi Disk Depth using Total Phosphorus:         1.1       0.6             0.8       0.8
Chlorphyll_a using Total Phosphorus:             17.9      26.3            53.9      29.1
```

Expanded Trophic Response Module

```
Date: 2/1/2017    Scenario: 56
Total Phosphorus:   101.06 mg/m^3
Growing Season
Chorophyll a:        50.11 mg/m^3
Secchi Disk Depth:    0.42 m
```

Wisconsin Regional Prediction Equations:

```
                                              Stratified                Mixed
                                  Region   Seepage   Drainage    Seepage   Drainage
Use Chlorophyll_a To Predict      South        0.8        0.8        0.6        0.5
Secchi Disk Depth (m)             Central      1.5        0.8        0.2    No Data
                                  North        1.2        0.8        0.9        1.0
Use Total Phosphorus To           South        1.1        0.7        0.5        0.6
Predict Secchi Disk Depth (m)     Central      2.6        0.3        0.4    No Data
                                  North        1.6        0.8        0.9        0.7
Use Total Phosphorus To           South       19.0       70.0       29.7       39.6
Predict Chlorophyll_a (mg/m^3))   Central     16.9      210.1       27.0    No Data
                                  North        8.7       26.6       19.8       13.0
```

Expanded Trophic Response Module

```
Date: 2/1/2017    Scenario: 57
Total Phosphorus:   101.06 mg/m^3
Growing Season
Chorophyll a:        50.11 mg/m^3
Secchi Disk Depth:    0.42 m
```

Cholorphyll a Nuisance Frequency

```
Chla Mean Min: 5
Chla Mean Max: 100
Chla Mean Increment: 5
Chla Temporal CV: 0.62
Chla Nuisance Criterion: 20

    Mean    Freq %    ml        z        v        w        x
      5       0.5    1.4     2.546    0.016    0.541    0.005
     10       7.7    2.1     1.428    0.144    0.678    0.077
     15      21.9    2.5     0.774    0.296    0.795    0.219
     20      37.8    2.8     0.310    0.380    0.907    0.378
     25      52.0    3.0    -0.050    0.398    0.984    0.480
     30      63.5    3.2    -0.344    0.376    0.897    0.365
     35      72.3    3.4    -0.593    0.335    0.835    0.277
     40      79.0    3.5    -0.808    0.288    0.788    0.210
     45      84.1    3.6    -0.998    0.242    0.751    0.159
     50      87.9    3.7    -1.168    0.202    0.720    0.121
     55      90.7    3.8    -1.322    0.167    0.695    0.093
     60      92.8    3.9    -1.462    0.137    0.673    0.072
     65      94.4    4.0    -1.591    0.112    0.654    0.056
     70      95.6    4.1    -1.711    0.092    0.637    0.044
     75      96.6    4.1    -1.822    0.076    0.623    0.034
```

80	97.3	4.2	-1.926	0.062	0.609	0.027
85	97.8	4.3	-2.024	0.051	0.598	0.022
90	98.3	4.3	-2.116	0.043	0.587	0.017
95	98.6	4.4	-2.203	0.035	0.577	0.014
100	98.9	4.4	-2.286	0.029	0.568	0.011

```
 Date: 2/1/2017    Scenario: Lotus Lake Combined (carp scenario)
 Lake Id: Lotus Lake 2014
 Watershed Id: 1
Hydrologic and Morphometric Data
Tributary Drainage Area: 2669.4 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1779.6 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1847.8 acre-ft/year
Areal Water Load <qs>: 7.5 ft/year
Lake Flushing Rate <p>: 1.35 1/year
 Water Residence Time: 0.74 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA
     Land Use       Acre       Low     Most Likely    High    Loading %   Low    Most Likely    High
                      (ac)     |---- Loading (kg/ha-year) ----|            |-----  Loading (kg/year) ----|
Row Crop AG           371.4       0.50       1.00       3.00       44.0         75        150        451
Mixed AG                0.0       0.30       0.80       1.40        0.0          0          0          0
Pasture/Grass         611.5       0.10       0.30       0.50       21.7         25         74        124
HD Urban (1/8 Ac)       0.0       1.00       1.50       2.00        0.0          0          0          0
MD Urban (1/4 Ac)       0.0       0.30       0.50       0.80        0.0          0          0          0
Rural Res (>1 Ac)     115.1       0.05       0.10       0.25        1.4          2          5         12
Wetlands              265.7       0.10       0.10       0.10        3.1         11         11         11
Forest               1305.7       0.05       0.09       0.18       13.9         26         48         95
Lake Surface          248.0       0.10       0.30       1.00        8.8         10         30        100

POINT SOURCE DATA
      Point Sources     Water Load     Low    Most Likely    High    Loading %
                        (m^3/year)  (kg/year)  (kg/year)   (kg/year)         _

SEPTIC TANK DATA
Description                                        Low    Most Likely    High     Loading %
Septic Tank Output (kg/capita-year)                0.30        0.50     0.80
```

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	7.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	335.8	752.9	1915.7	100.0
Total Loading (kg)	152.3	341.5	869.0	100.0
Areal Loading (lb/ac-year)	1.35	3.04	7.72	
Areal Loading (mg/m^2-year)	151.75	340.27	865.82	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	307.3	633.8	1525.9	93.0
Total NPS Loading (kg)	139.4	287.5	692.1	93.0

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 47

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 149.8 mg/m^3
Areal External Loading: 340.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.33
Internal Load: 312 Lb   142 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: -17 Lb   -8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

```
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
```

Just Prior To The End of Stratification

```
Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 1.5 mg/m^2-day     4.07E-003 lb/acre-day
Internal Load:  74 Lb      34 kg
```

Method 4 - From Phososphorus Release Rate and Anoxic Area

```
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.7 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)          212       495        848
Internal Load: (kg)           96       224        385
```

Internal Load Comparison (Percentanges are of the Total Estimate Load)

```
Total External Load: 753 Lb      342 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              312       142      29.3
From Growing Season In Situ Phosphorus Increases:         -17        -8      -2.3
From In Situ Phososphorus Increases In The Fall:           74        34       8.9
From Phososphorus Release Rate and Anoxic Area:           495       224      39.7
```

Predicted Water Column Total Phosphorus Concentration (ug/l)

```
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              79          45       198
Osgood, 1988 Lake Mixing Index: 1.7
```

Phosphorus Loading Summary:

```
                          Low      Most Likely     High
Internal Load (Lb):       312           28.6        495
Internal Load (kg):       142           13.0        224
External Load (Lb):       336            753       1916
External Load (kg):       152            342        869
```

```
Total Load (Lb):          648            782       2411
Total Load (kg):          294            354       1093
```

Phosphorus Prediction and Uncertainty Analysis Module

```
Date: 2/1/2017    Scenario: 39
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 312 kg

           Lake Phosphorus Model                Low  Most Likely  High     Predicted  % Dif.
                                              Total P   Total P    Total P   -Observed
                                              (mg/m^3) (mg/m^3)   (mg/m^3)   (mg/m^3)
 Walker, 1987 Reservoir                            30        67        171        -46       -41
 Canfield-Bachmann, 1981 Natural Lake              34        63        123        -50       -44
 Canfield-Bachmann, 1981 Artificial Lake           30        51         88        -62       -55
 Rechow, 1979 General                              11        24         60        -89       -79
 Rechow, 1977 Anoxic                               53       119        304          7         6
 Rechow, 1977 water load<50m/year                  30        68        172        -45       -40
 Rechow, 1977 water load>50m/year                 N/A       N/A        N/A        N/A       N/A
 Walker, 1977 General                              39        87        222         13        18
 Vollenweider, 1982 Combined OECD                  29        57        122        -36       -39
 Dillon-Rigler-Kirchner                            17        38         97        -36       -49
 Vollenweider, 1982 Shallow Lake/Res.              24        49        110        -44       -47
 Larsen-Mercier, 1976                              36        81        205          7         9
 Nurnberg, 1984 Oxic                              154       176        236         64        57

         Lake Phosphorus Model           Confidence Confidence  Parameter    Back       Model
                                            Lower      Upper       Fit?   Calculation   Type
                                            Bound      Bound               (kg/year)
 Walker, 1987 Reservoir                        38        135         FIT       1059       GSM
 Canfield-Bachmann, 1981 Natural Lake          20        181         FIT       1881       GSM
 Canfield-Bachmann, 1981 Artificial Lake       16        147         FIT       4772       GSM
 Rechow, 1979 General                          13         48         FIT       2996       GSM
 Rechow, 1977 Anoxic                           68        238         FIT        596       GSM
 Rechow, 1977 water load<50m/year              37        137           P       1053       GSM
 Rechow, 1977 water load>50m/year             N/A        N/A         N/A        N/A       N/A
 Walker, 1977 General                          42        184         FIT        537       SPO
 Vollenweider, 1982 Combined OECD              27        112         FIT       1332       ANN
```

```
 Dillon-Rigler-Kirchner                         22         76           P      1222         SPO
 Vollenweider, 1982 Shallow Lake/Res.           23         98         FIT      1472         ANN
 Larsen-Mercier, 1976                           48        160       P Pin       581         SPO
 Nurnberg, 1984 Oxic                           110        275           P       627         ANN
```

Water and Nutrient Outflow Module

```
Date: 2/1/2017    Scenario: 25
Average Annual Surface Total Phosphorus: 101.06mg/m^3
Annual Discharge: 1.85E+003 AF => 2.28E+006 m^3
Annual Outflow Loading:     485.7 LB =>     220.3 kg
```

Date: 2/1/2017 Scenario: Lotus Lake Combined Direct (modeled hydraulic loading)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre **(ac)**	Low	Most Likely **|---- Loading (kg/ha-year) ----|**	High	Loading %	Low	Most Likely **|----- Loading (kg/year) ----|**	High
Row Crop AG	84.4	0.50	1.00	3.00	8.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.3	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.5	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 45

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.41
Internal Load: 291 Lb   132 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: -4 Lb   -2 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

```
Hypolimnetic Volume: 153.19 acre-ft
Anoxia Sediment Area: 46.42 acres
```

Just Prior To The End of Stratification

```
Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 46.42 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 17.3 mg/m^2-day     4.71E-002 lb/acre-day
Internal Load: 215 Lb      98 kg
```

Method 4 - From Phososphorus Release Rate and Anoxic Area

```
Start of Anoxia Anoxic Sediment Area: 46.42 acre
End of Anoxia Anoxic Sediment Area: 46.42 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 8.6 mg/m^2-day
Period of Anoxia: 70.73 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14         24
Internal Load: (Lb)           54       125        214
Internal Load: (kg)           24        57         97
```

Internal Load Comparison (Percentanges are of the Total Estimate Load)

```
Total External Load: 885 Lb      401 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              291       132      24.8
From Growing Season In Situ Phosphorus Increases:          -4        -2      -0.5
From In Situ Phososphorus Increases In The Fall:          215        98      19.5
From Phososphorus Release Rate and Anoxic Area:           125        57      12.4
```

Predicted Water Column Total Phosphorus Concentration (ug/l)

```
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              62          65        95
Osgood, 1988 Lake Mixing Index: 1.7
```

Phosphorus Loading Summary:

```
                          Low      Most Likely     High
Internal Load (Lb):       291          105.4        125
Internal Load (kg):       132           47.8         57
External Load (Lb):       118            885       1402
External Load (kg):        53            401        636
```

```
Total Load (Lb):          409            990       1527
Total Load (kg):          185            449        693
```

Phosphorus Prediction and Uncertainty Analysis Module

```
Date: 2/1/2017    Scenario: 38
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
Back calculation for SPO total phosphorus: 137.09 mg/m^3
Back calculation GSM phosphorus: 208.39 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 291 kg

           Lake Phosphorus Model              Low   Most Likely   High     Predicted  % Dif.
                                            Total P   Total P    Total P   -Observed
                                            (mg/m^3) (mg/m^3)   (mg/m^3)   (mg/m^3)
 Walker, 1987 Reservoir                         10       73        116        -40       -36
 Canfield-Bachmann, 1981 Natural Lake           15       70         98        -43       -38
 Canfield-Bachmann, 1981 Artificial Lake        14       56         73        -57       -51
 Rechow, 1979 General                            4       28         44        -85       -76
 Rechow, 1977 Anoxic                            18      136        216         24        21
 Rechow, 1977 water load<50m/year               10       78        124        -35       -31
 Rechow, 1977 water load>50m/year              N/A      N/A        N/A        N/A       N/A
 Walker, 1977 General                           13      100        159         26        35
 Vollenweider, 1982 Combined OECD               12       63         93        -30       -32
 Dillon-Rigler-Kirchner                          6       44         69        -30       -41
 Vollenweider, 1982 Shallow Lake/Res.            9       55         82        -38       -41
 Larsen-Mercier, 1976                           12       93        147         19        26
 Nurnberg, 1984 Oxic                           130      169        195         57        51

         Lake Phosphorus Model          Confidence Confidence  Parameter    Back       Model
                                           Lower      Upper      Fit?   Calculation   Type
                                           Bound      Bound              (kg/year)
 Walker, 1987 Reservoir                       30        110         FIT      1143       GSM
 Canfield-Bachmann, 1981 Natural Lake         22        202         FIT      1903       GSM
 Canfield-Bachmann, 1981 Artificial Lake      17        161         FIT      4803       GSM
 Rechow, 1979 General                         11         43         FIT      3014       GSM
 Rechow, 1977 Anoxic                          56        202         FIT       613       GSM
 Rechow, 1977 water load<50m/year             30        120           P      1069       GSM
 Rechow, 1977 water load>50m/year            N/A        N/A         N/A       N/A       N/A
 Walker, 1977 General                         34        169         FIT       550       SPO
 Vollenweider, 1982 Combined OECD             22        109         FIT      1364       ANN
```

```
 Dillon-Rigler-Kirchner                          18          65           P     1255         SPO
 Vollenweider, 1982 Shallow Lake/Res.            19          94         FIT     1507         ANN
 Larsen-Mercier, 1976                            39         136       P Pin      595         SPO
 Nurnberg, 1984 Oxic                            103         258           P      756         ANN
```

Water and Nutrient Outflow Module

```
Date: 2/1/2017    Scenario: 24
Average Annual Surface Total Phosphorus: 101.06mg/m^3
Annual Discharge: 1.90E+003 AF => 2.35E+006 m^3
Annual Outflow Loading:     500.4 LB =>     227.0 kg
```

Date: 2/1/2017 Scenario: Lotau Lake Combined (modeled hydraulic load plus carp)

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1009.3 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 672.9 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1904.7 acre-ft/year
Areal Water Load <qs>: 7.7 ft/year
Lake Flushing Rate <p>: 1.40 1/year
Water Residence Time: 0.72 year
Observed spring overturn total phosphorus (SPO): 74.0 mg/m^3
Observed growing season mean phosphorus (GSM): 112.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	84.4	0.50	1.00	3.00	8.5	17	34	102
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	186.0	0.10	0.30	0.50	5.6	8	23	38
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	110.2	0.05	0.10	0.25	1.1	2	4	11
Wetlands	44.5	0.10	0.10	0.10	0.4	2	2	2
Forest	584.2	0.05	0.09	0.18	5.3	12	21	43
Lake Surface	248.0	0.10	0.30	1.00	7.5	10	30	100

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

# capita-years	477.8				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		2.87	23.89	76.45	6.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.6	884.9	1402.4	100.0
Total Loading (kg)	53.4	401.4	636.1	100.0
Areal Loading (lb/ac-year)	0.47	3.57	5.65	
Areal Loading (mg/m^2-year)	53.17	399.94	633.83	
Total PS Loading (lb)	0.0	580.1	581.4	65.6
Total PS Loading (kg)	0.0	263.1	263.7	65.6
Total NPS Loading (lb)	89.2	185.8	431.2	28.5
Total NPS Loading (kg)	40.5	84.3	195.6	28.5

Wisconsin Internal Load Estimator

Date: 2/1/2017   Scenario: 48

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 101.06 mg/m^3
Phosphorus Inflow Concentration: 170.8 mg/m^3
Areal External Loading: 399.9 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.74
Observed Phosphorus Retention Coefficient: 0.41
Internal Load: 291 Lb   132 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 103.5 mg/m^3
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Time Period of Stratification: 70.33 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: -17 Lb   -8 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 113.6 mg/m^3

```
Hypolimnetic Volume: 609.84 acre-ft
Anoxia Sediment Area: 184.8 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 70.73 mg/m^3
Lake Volume: 1364.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 184.8 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 1.5 mg/m^2-day     4.07E-003 lb/acre-day
Internal Load:  74 Lb      34 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area
Start of Anoxia Anoxic Sediment Area: 184.8 acre
End of Anoxia Anoxic Sediment Area: 184.8 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.7 mg/m^2-day
Period of Anoxia: 70.33 days
Default Areal Sediment Phosphorus Release Rates:
                             Low   Most Likely   High
                               6        14        24
Internal Load: (Lb)          212       495       848
Internal Load: (kg)           96       224       385

Internal Load Comparison (Percentanges are of the Total Estimate Load)
Total External Load: 885 Lb      401 kg
                                                         Lb         kg         %
From A Complete Mass Budget:                              291       132      24.8
From Growing Season In Situ Phosphorus Increases:         -17        -8      -1.9
From In Situ Phososphorus Increases In The Fall:           74        34       7.7
From Phososphorus Release Rate and Anoxic Area:           495       224      35.9

Predicted Water Column Total Phosphorus Concentration (ug/l)
Nurnberg+ 1984 Total Phosphorus Model:      Low    Most Likely   High
                                              62          50       167
Osgood, 1988 Lake Mixing Index: 1.7
Phosphorus Loading Summary:
                          Low      Most Likely     High
Internal Load (Lb):       291           28.6        495
Internal Load (kg):       132           13.0        224
External Load (Lb):       118            885       1402
External Load (kg):        53            401        636
```

```
Total Load (Lb):          409            914       1897
Total Load (kg):          185            414        861
```

Date: 1/30/2017 Scenario: Lotus Lake Inlet 2014

Lake Id: Lotus Lake 2014
Watershed Id: 1

Hydrologic and Morphometric Data

Tributary Drainage Area: 1643.1 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 1095.4 acre-ft
Lake Surface Area <As>: 248.0 acre
Lake Volume <V>: 1364.0 acre-ft
Lake Mean Depth <z>: 5.5 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 1163.6 acre-ft/year
Areal Water Load <qs>: 4.7 ft/year
Lake Flushing Rate <p>: 0.85 1/year
Water Residence Time: 1.17 year
Observed spring overturn total phosphorus (SPO): 62.1 mg/m^3
Observed growing season mean phosphorus (GSM): 86.1 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	**|---- Loading**	**(kg/ha-year)**	**----|**		**|-----**	**Loading (kg/year)**	**----|**
Row Crop AG	284.554	0.50	1.00	3.00	49.7	58	115	345
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	425.086	0.10	0.30	0.50	22.3	17	52	86
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	4.203	0.05	0.10	0.25	0.1	0	0	0
Wetlands	220.769	0.10	0.10	0.10	3.9	9	9	9
Forest	708.52	0.05	0.09	0.18	11.1	14	26	52
Lake Surface	248.0	0.10	0.30	1.00	13.0	10	30	100

POINT SOURCE DATA

Point Sources	Water Load **(m^3/year)**	Low **(kg/year)**	Most Likely **(kg/year)**	High **(kg/year)**	Loading %

SEPTIC TANK DATA

Description	**Low**	**Most Likely**	**High**	**Loading %**
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	

```
# capita-years                          0.0
% Phosphorus Retained by Soil                      98.0        90.0     80.0
Septic Tank Loading (kg/year)                      0.00        0.00     0.00         0.0

TOTALS DATA
Description                      Low    Most Likely   High     Loading %
Total Loading (lb)               238.5       511.0      1307.0   100.0
Total Loading (kg)               108.2       231.8       592.8   100.0
Areal Loading (lb/ac-year)        0.96        2.06        5.27
Areal Loading (mg/m^2-year)     107.79      230.95      590.69
Total PS Loading (lb)              0.0         0.0         0.0     0.0
Total PS Loading (kg)              0.0         0.0         0.0     0.0
Total NPS Loading (lb)           216.4       444.6      1085.7   100.0
Total NPS Loading (kg)            98.1       201.7       492.5   100.0
```

Appendix K

Lake Management Plan Development Meetings

Lotus Lake Management Plan Development
Committee Meeting 1

Wednesday, February 8th, 2017
6-8 PM
Polk County Board Room
Polk County Government Center

6:00 Introductions, roles, and responsibilities (all)

6:15 Schedule future meetings—bring your calendar (all)
  March
  April
  May

6:20 Presentation (Polk County Land and Water Resources Department)
  Purpose of the meeting
  Lotus Lake chemistry results
  Lotus Lake survey results
  Time for questions

7:00 Brainstorming session (Management Plan Committee)
  What do you value about Lotus Lake?
  What concerns/issues do you have for Lotus Lake?

8:00 Adjourn

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(715) 485-8637
katelin.anderson@co.polk.wi.us

Jeremy Williamson
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jeremyw@co.polk.wi.us

Lotus Lake Management Plan Development
Committee Meeting 1 Notes

Wednesday, February 8th, 2017
6-8 PM
Polk County Board Room, Polk County Government Center

Introductions, roles, and responsibilities

Eric Lehman, Brett Stewart, Trish Carlson, Steve Liberda, Kent Stennes, Barb Stennes, Deb Goodman, Denise Kaye, Tony Havranek, Jeremy Williamson, and Katelin Anderson

Discussed roles and responsibilities (see handout)

Schedule future meetings

Wednesdays from 6-8 PM at the Polk County Government Center
- March 8th
- April 12th
- May 10th

Presentation (see slides)
- Purpose of the meeting (see handout with 2007 recommendations)
- Lotus Lake chemistry results
- Lotus Lake survey results

Brainstorming session

<u>What do you value about Lotus Lake?</u>

- Habitat, terrestrial and aquatic
- Quite lake
- Trees surround the lake, undeveloped
- County Park and Stowers Seven Lake Trail
- Lake size—not too big, not too small
- Sand (where it exists) versus muck
- Educational opportunities/outdoor classroom (turtles, plants, duck hunting), the lake experience
- Past conditions—viable fishery (winter fishery is still okay) and water clarity
- Recreation—motorized and non-motorized boating (canoeing), a multi-use lake
- Waterfowl
- Committed residents
- Past and current grant support
- Partner support (past/potential)—Rod and Gun, Polk County, Tribe, Ducks Unlimited

What concerns/issues do you have for Lotus Lake?

Water clarity
Not swimmable (aesthetics, not health concerns)
Algae (toxins?)
Shooting range—lead
Carp
Agriculture (although it's mostly hay)
Invasive plants—purple loosestrife and curlyleaf pondweed
Aquatic plants (especially expansion of lotus), as relates to navigation issues
Proposed quarry
Water level, depth
Access, getting to main part of the lake (related to water level)
Winter dissolved oxygen is unknown
Aerator in the winter—questions regarding placement, efficiency, solar/cheaper options
Weakened environmental policy/standards—as they trickle down to Lotus Lake
Possibility that carp removal could lead to increased algae due to a lack of good plants
Muck
Loss of wild rice
Needs related to carp: teeth in the game, active management, carp barriers, IPM, and consideration of various options (pathogens, poisoned corn, experimental options)
Shoreline development, although there is state/county land there are also open lots
Options for homeowners to enforce shoreline development ordinances
Options for getting more people involved
Dredging as an option (regarding lake depth)
Is there a need to form a District? Are there benefits other than funding?

Adjourn

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Jeremy Williamson
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jeremyw@co.polk.wi.us

Lotus Lake Management Plan Development Rules and Responsibilities

Overall Objective

Develop a Lake Management Plan for Lotus Lake

A management plan outlines goals and actions that everyone can live with

Ground Rules

Listen to what others are saying
Don't interrupt when others are speaking
Input is heard from everyone
Stay on topic and stick to the agenda

Management Plan Committee Responsibilities

Attend all meetings
Share your knowledge and concerns about Lotus Lake
Review background information and draft documents
Develop lake management strategies
Decide when draft document is ready to forward to board for approval

Land and Water Resources Department Responsibilities

Send out agendas and materials prior to meetings
Keep discussion on track, may need to interrupt to keep discussion focused
Summarize key study findings
Write goals, objectives, and action items for the plan using committee input
Write draft and final plan documents
Submit plan for public comment and WDNR review

Association Board Member Responsibilities

Participate as part of the committee
Review draft Management Plan
Approve draft Management Plan to forward to the WI DNR or disapprove draft Management Plan and return to committee

Lotus Lake Planning Meeting

Meeting 1

Wednesday, February 8th, 2017

Purpose of the meetings

Review data

Develop lake management plan, including goals

Grant deliverables

Lake resident survey

Physical and chemical data (deep hole, inlet, outlet)

Lake level and precipitation

Phytoplankton

Zooplankton

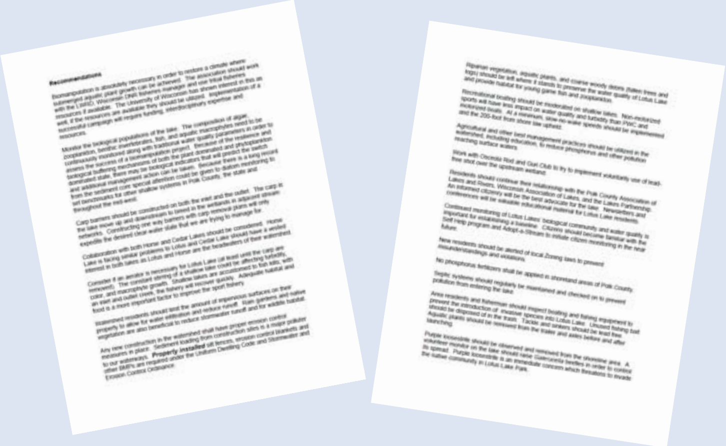
Aquatic plant surveys

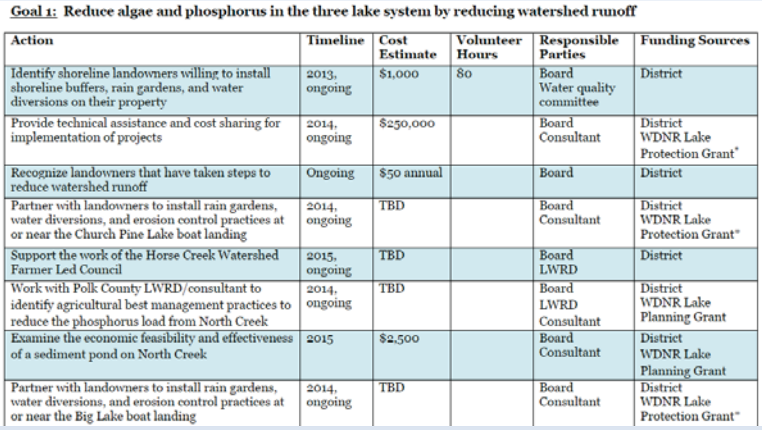
Watershed delineation, land use, and modeling

Shoreline survey and workshop

Lake management plan

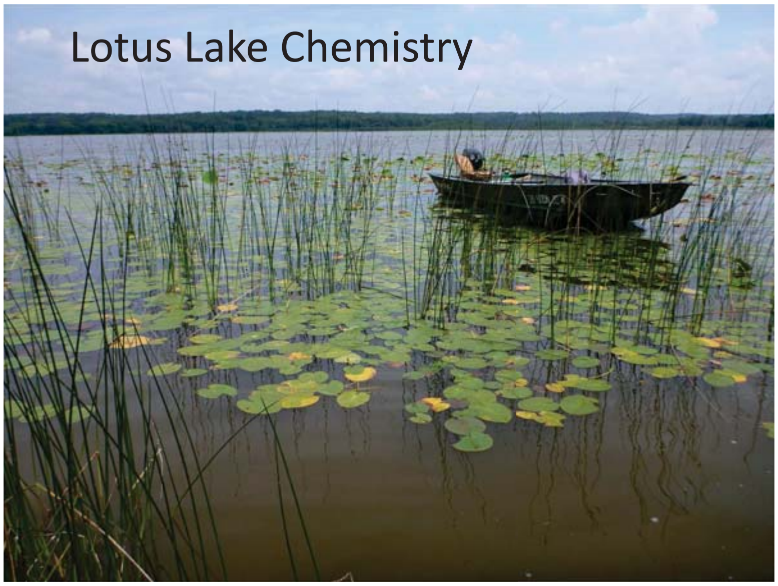
2007 recommendations





Goal 1: Reduce algae and phosphorus in the three lake system by reducing watershed runoff

Action	Timeline	Cost Estimate	Volunteer Hours	Responsible Parties	Funding Sources
Identify shoreline landowners willing to install shoreline buffers, rain gardens, and water diversions on their property	2013, ongoing	$1,000	80	Board Water quality committee	District
Provide technical assistance and cost sharing for implementation of projects	2014, ongoing	$250,000		Board Consultant	District WDNR Lake Protection Grant*
Recognize landowners that have taken steps to reduce watershed runoff	Ongoing	$50 annual		Board	District
Partner with landowners to install rain gardens, water diversions, and erosion control practices at or near the Church Pine Lake boat landing	2014, ongoing	TBD		Board Consultant	District WDNR Lake Protection Grant*
Support the work of the Horse Creek Watershed Farmer Led Council	2015, ongoing	TBD		Board LWRD	District
Work with Polk County LWRD/consultant to identify agricultural best management practices to reduce the phosphorus load from North Creek	2014, ongoing	TBD		Board LWRD Consultant	District WDNR Lake Planning Grant
Examine the economic feasibility and effectiveness of a sediment pond on North Creek	2015	$2,500		Board Consultant	District WDNR Lake Planning Grant
Partner with landowners to install rain gardens, water diversions, and erosion control practices at or near the Big Lake boat landing	2014, ongoing	TBD		Board Consultant	District WDNR Lake Protection Grant*

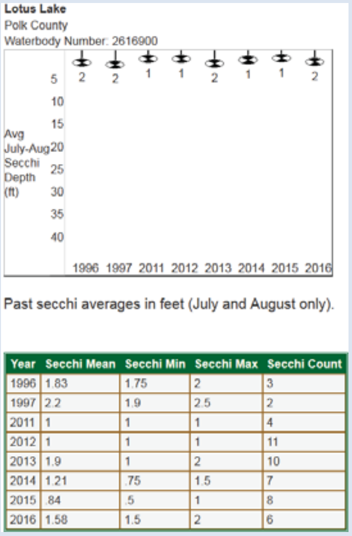


Lotus Lake Chemistry

Secchi depth

Measure of water clarity

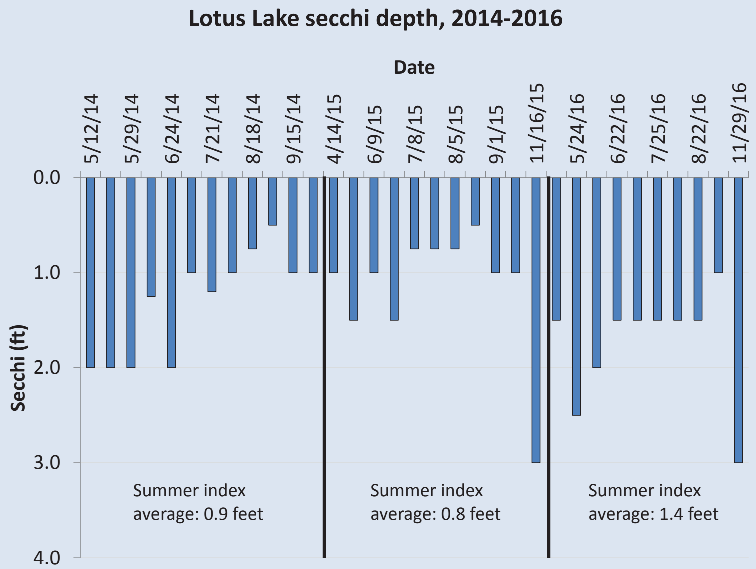
Greater numbers = greater clarity



Lotus Lake
Polk County
Waterbody Number: 2616900

Past secchi averages in feet (July and August only).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1996	1.83	1.75	2	3
1997	2.2	1.9	2.5	2
2011	1	1	1	4
2012	1	1	1	11
2013	1.9	1	2	10
2014	1.21	.75	1.5	7
2015	.84	.5	1	8
2016	1.58	1.5	2	6



Lotus Lake secchi depth, 2014-2016

Summer index average: 0.9 feet

Summer index average: 0.8 feet

Summer index average: 1.4 feet

Phosphorus (P)

Excess amounts cause plant and algae growth

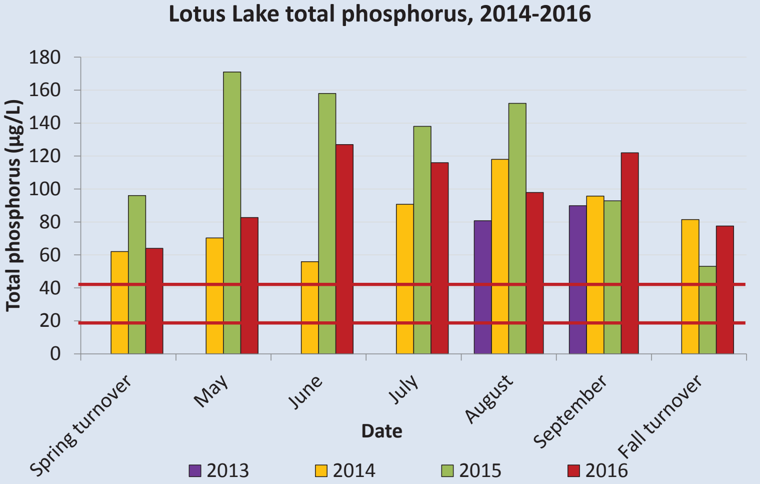
Occurs naturally in soil

Component of fertilizer

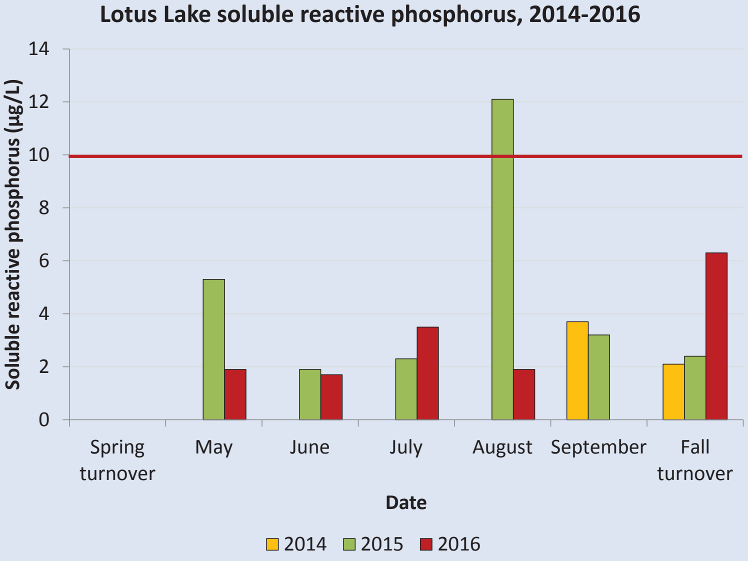
Total P= all P in a water sample

Soluble reactive P = P dissolved in water, ready for uptake by plants and algae

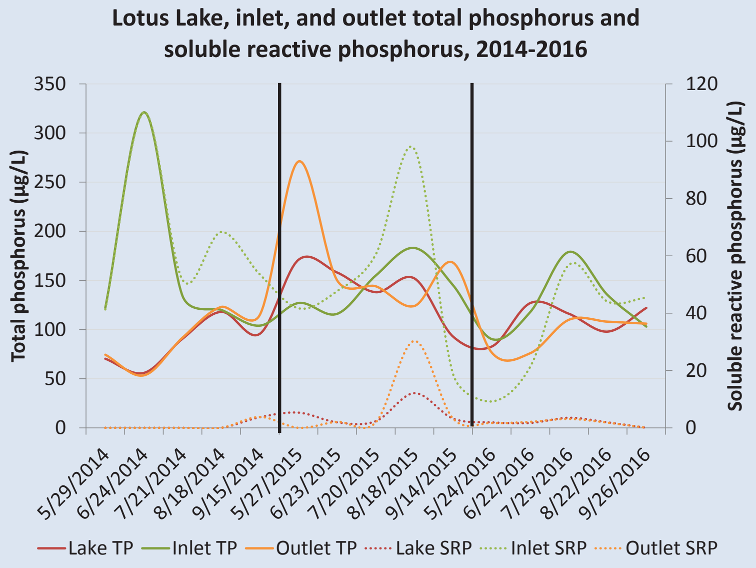
Summer index period averages 2014: 101 µg/L 2015: 128 µg/L 2016: 110 µg/L



Lotus Lake total phosphorus, 2014-2016



Lotus Lake soluble reactive phosphorus, 2014-2016


Lotus Lake, inlet, and outlet total phosphorus and soluble reactive phosphorus, 2014-2016

Site	Total phosphorus (µg/L)	Inlet and Outlet Area (m2)	Discharge (L/s)	Total Phosphorus (lb/yr)
2014 Inlet	160.20	1.216	280	3,121
2015 Inlet	145.20	1.104	166	1,677
2016 Inlet	125.06	1.260	189	1,644
2014 Outlet	91.52	0.846	465	2,961
2015 Outlet	171.40	0.576	242	2,886
2016 Outlet	95.32	0.336	118	783

Year	Lotus Lake deep hole total phosphorus (µg/L)
2014	86.12
2015	142.36
2016	109.12

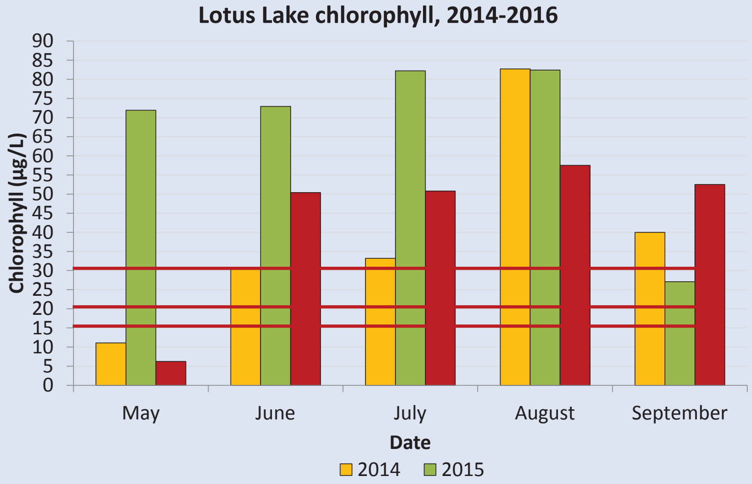
Chlorophyll

Pigment in plants and algae

Provides an indication of the amount of algae in a lake

Higher values = more algae

Summer index period averages 2014: 52 µg/L 2015: 64 µg/L 2016: 55 µg/L


Lotus Lake chlorophyll, 2014-2016

Trophic state index

Serves as an indicator of water quality

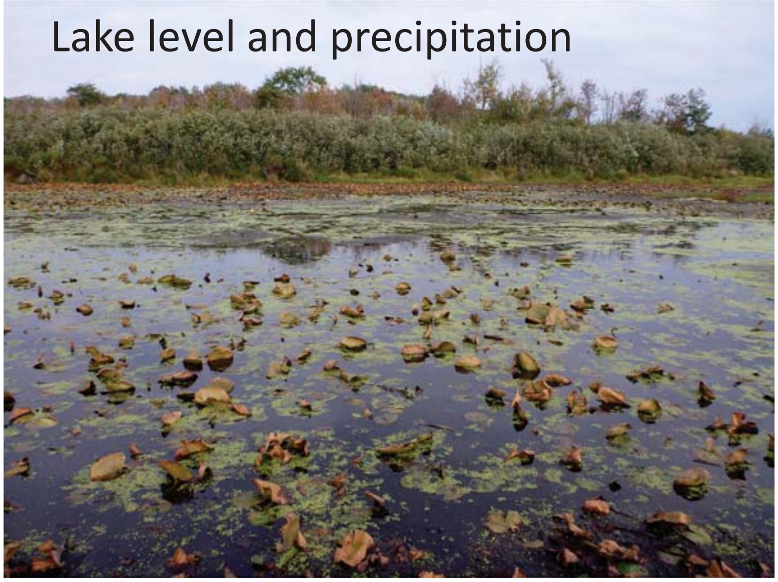
Reflects nutrient and clarity levels

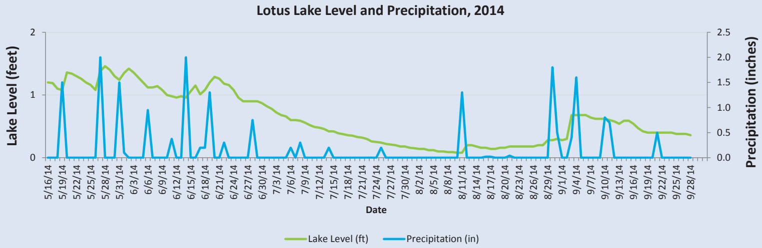
Trophic state index

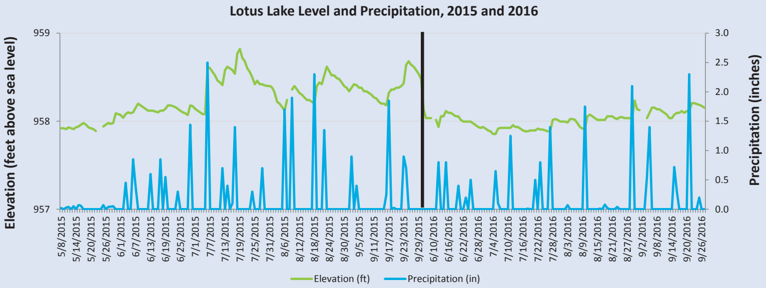
2014: 73 2015: 75 2016: 71

TSI	General Description
<30	Oligotrophic; clear water, high dissolved oxygen throughout the year/lake
30-40	Oligotrophic; clear water, possible periods of oxygen depletion in the lower depths of the lake
40-50	Mesotrophic; moderately clear water, increasing chance of anoxia near the bottom of the lake in summer, fully acceptable for all recreation/aesthetic uses
50-60	Mildly eutrophic; decreased water clarity, anoxic near the bottom, may have macrophyte problem; warm-water fisheries only
60-70	Eutrophic; blue-green algae dominance, scums possible, prolific aquatic plant growth. Full body recreation may be decreased
70-80	Hypereutrophic; heavy algal blooms possible throughout the summer, dense algae and macrophytes
>80	Algal scums, summer fish kills, few aquatic plants due to algal shading, rough fish dominate

Lake level and precipitation







Lotus Lake Resident Survey

Lotus Lake Resident Survey, 2014

The following survey is a component of the Lotus Lake Planning grant. The Lotus Lake Association, Polk County Land and Water Resources Department, Polk County Parks Department, Wisconsin Department of Natural Resources, and St. Croix Tribal Environmental Department have partnered to gather data about Lotus Lake in 2014-2016. The ultimate goal of the study is to identify ways to improve water quality on Lotus Lake. Your responses are very important and will help guide the future management of Lotus Lake and its watershed.

The survey should take approximately 5-10 minutes to complete. Responses will remain confidential. Feel free to contact the Polk County Land and Water Resources Department with any questions at 715-485-8699. Surveys should be returned by July 1st to:

LWRD
100 Polk County Plaza- Suite 120
Balsam Lake, WI 54810

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1. How many years have you owned property on or near Lotus Lake? Note: If you own more than one property, please answer all questions for the property you have owned the longest.
   ____________years
2. Which of the following best describes how you use your property?
   ___Year-round residence
   ___Seasonal residence (continued occupancy for months at a time)
   ___Weekend, vacation, and/or holiday residence
   ___Rental property
   ___Other, please specify____________
3. How many days in a typical year is your property used by you or others? Just provide your best estimate.
   ____________days per year
4. On the average day that your property is occupied, how many people occupy the property?
   ____________people
5. Is the property you own on the shoreline of Lotus Lake?
   ___No, please skip to question 7 ___Yes
6. Which of the following describe the first 35 feet of your shoreline (the area located directly adjacent to the lake)? If you don't own shoreline property, please skip this question. Please check all that apply.
   ___Mowed lawn
   ___Un-mowed vegetation
   ___Shrubs/trees
   ___Undisturbed woods
   ___Stabilizing rock/rip rap
   ___Pier/dock
   ___Buffer zone/shoreline restoration
   ___Rain garden
   ___Other, please describe__________

Mailed 224 surveys in June 2014

90 respondents, 40%

Lotus Lake owners

Property ownership: 14 years

People occupying property: 2.7

Number of days property used: 289 days

Most people are full time residents (84%)

Most don’t own lakefront property (83%)

Activities and public use

Activities Enjoyed

Scenic view (71%)

Peace and tranquility (51%)

Observing birds/wildlife (36%)

Fishing (25%)

Non-motorized boating (25%)

Public resource use

open water, ice on

County Park: 54%, 16%

Stowers Trail: 45%, 13%

Boat landing: 38%, 11%

Degree of concern with each issue listed below?	Rank
Decrease in overall lake health	3.2
Excessive algae blooms	3.1
Lack of water clarity or quality	3.1
Presence of common carp in the lake	3.0
Excessive aquatic plant growth	2.9
Decreased fisheries	2.8
New invasive species entering the lake	2.7
Increased nutrient pollution	2.7
Loss of natural scenery/beauty	2.5
Decreased wildlife populations	2.5
Decreased property values	2.3
Increased development	2.2
Unsafe use of motorized watercraft	2.1
Excessive noise level on the lake	1.8
Disregard for slow-no-wake zones	1.5

Current conditions on Lotus Lake

Water level

Just right (53%), unsure (27%)

Water quality

Poor (41%) or fair (22%), unsure (27%)

Change in water quality

Degraded severely (11%) or somewhat (16%), improved somewhat (9%)

Aquatic plants

Too many (51%), healthy amount (35%)

Months aquatic plants are a problem

August (45%), July (43%)

Months algae is a problem

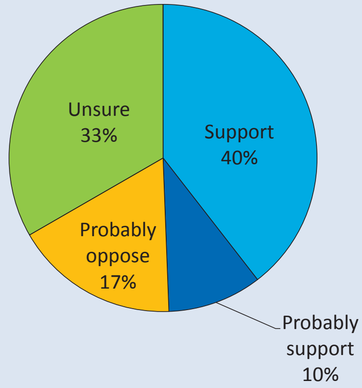
August (56%), July (40%)

Actions to manage Lotus Lake

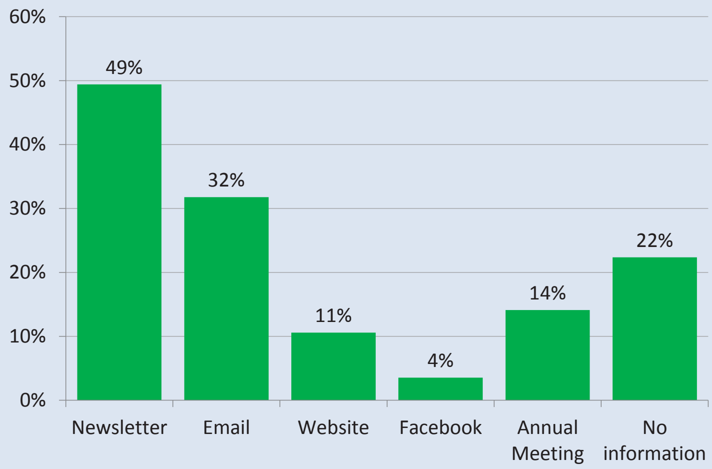
Ranked by priority

Programs to prevent/monitor AIS: 71%
Enhance fisheries: 70%
Upgrade non-conforming septic: 63%
Install shoreline buffers/rain gardens: 57%
Install farmland conservation practices: 43%
Lake fairs and workshops: 41%
Enforce slow no wake zones: 41%

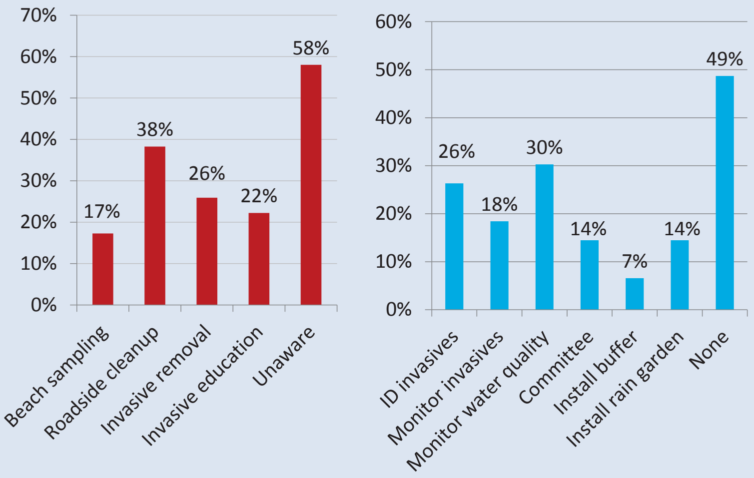
Support for carp removal



Communication



Lake association activities



Recommendations

Biomanipulation is absolutely necessary in order to restore a climate where submerged aquatic plant growth can be achieved. The association should work with the LWRD, Wisconsin DNR fisheries manager and use tribal fisheries resources if available. The University of Wisconsin has shown interest in this as well, if the resources are available they should be utilized. Implementation of a successful campaign will require funding, interdisciplinary expertise and resources.

Monitor the biological populations of the lake. The composition of algae, zooplankton, benthic invertebrates, fish, and aquatic macrophytes need to be continuously monitored along with traditional water quality parameters in order to assess the success of a biomanipulation project. Because of the resilience and biological buffering mechanisms of both the plant dominated and phytoplankton dominated state, there may be biological indicators that will predict the switch and additional management action can be taken. Because there is a long record from the sediment core special attention could be given to diatom monitoring to set benchmarks for other shallow systems in Polk County, the state and throughout the mid-west.

Carp barriers should be constructed on both the inlet and the outlet. The carp in the lake move up and downstream to breed in the wetlands in adjacent stream networks. Constructing one way barriers with carp removal plans will only expedite the desired clear-water state that we are trying to manage for.

Collaboration with both Horse and Cedar Lakes should be considered. Horse Lake is facing similar problems to Lotus and Cedar Lake should have a vested interest in both lakes as Lotus and Horse are the headwaters of their watershed.

Consider if an aerator is necessary for Lotus Lake (at least until the carp are removed). The constant stirring of a shallow lake could be affecting turbidity, color, and macrophyte growth. Shallow lakes are accustomed to fish kills; with an inlet and outlet creek, the fishery will recover quickly. Adequate habitat and food is a more important factor to improve the sport fishery.

Watershed residents should limit the amount of impervious surfaces on their property to allow for water infiltration and reduce runoff. Rain gardens and native vegetation are also beneficial to reduce stormwater runoff and for wildlife habitat.

Any new construction in the watershed shall have proper erosion control measures in place. Sediment loading from construction sites is a major polluter to our waterways. ***Properly installed*** silt fences, erosion control blankets and other BMPs are required under the Uniform Dwelling Code and Stormwater and Erosion Control Ordinance.

Riparian vegetation, aquatic plants, and coarse woody debris (fallen trees and logs) should be left where it stands to preserve the water quality of Lotus Lake and provide habitat for young game fish and zooplankton.

Recreational boating should be moderated on shallow lakes. Non-motorized sports will have less impact on water quality and turbidity than PWC and motorized boats. At a minimum, slow-no-wake speeds should be implemented and the 200-foot from shore law upheld.

Agricultural and other best management practices should be utilized in the watershed, including education, to reduce phosphorus and other pollution reaching surface waters.

Work with Osceola Rod and Gun Club to try to implement voluntarily use of lead-free shot over the upstream wetland.

Residents should continue their relationship with the Polk County Association of Lakes and Rivers, Wisconsin Association of Lakes, and the Lakes Partnership. An informed citizenry will be the best advocate for the lake. Newsletters and conferences will be valuable educational material for Lotus Lake residents.

Continued monitoring of Lotus Lakes' biological community and water quality is important for establishing a baseline. Citizens should become familiar with the Self Help program and Adopt-a-Stream to initiate citizen monitoring in the near future.

New residents should be alerted of local Zoning laws to prevent misunderstandings and violations.

No phosphorus fertilizers shall be applied in shoreland areas of Polk County.

Septic systems should regularly be maintained and checked on to prevent pollution from entering the lake.

Area residents and fisherman should inspect boating and fishing equipment to prevent the introduction of invasive species into Lotus Lake. Unused fishing bait should be disposed of in the trash. Tackle and sinkers should be lead free. Aquatic plants should be removed from the trailer and axles before and after launching.

Purple loosestrife should be observed and removed from the shoreline area. A volunteer monitor on the lake should raise *Galerucella* beetles in order to control its spread. Purple loosestrife is an immediate concern which threatens to invade the native community in Lotus Lake Park.

Lotus Lake Management Plan Development
Committee Meeting 2

Wednesday, March 8th, 2017
6-8 PM
Polk County Government Center, AB Room

6:00	Introductions
6:05	Presentation (Jeremy Williamson) Phosphorus modeling Algae
6:30	Presentation (Aaron Cole) Lotus Lake fisheries update Carp population estimates
7:00	Presentation (Tony Havranek and Jeremy Bloomquist) Wild rice restoration project Carp radio-tagging Options for carp management Carp case studies
7:30	Brainstorm goals for carp management (all)
8:00	Adjourn

Next meeting Wednesday, April 12th
6-8 PM
Polk County Government Center, AB Room

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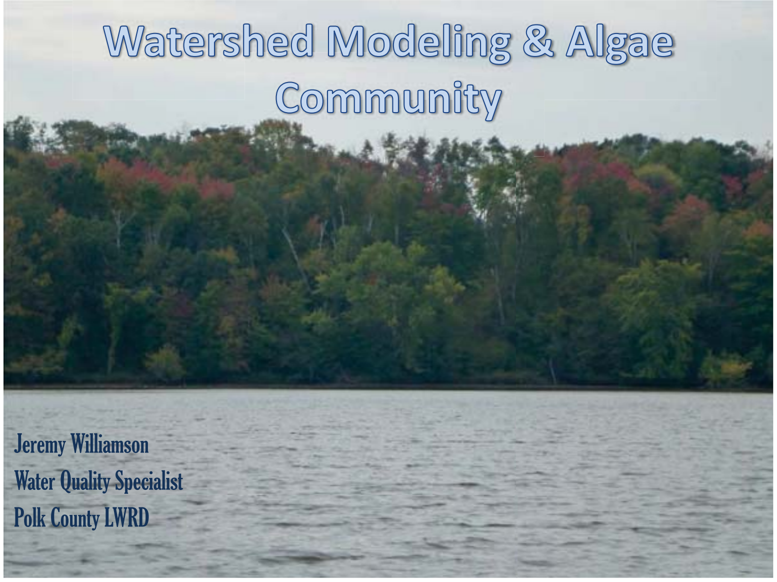
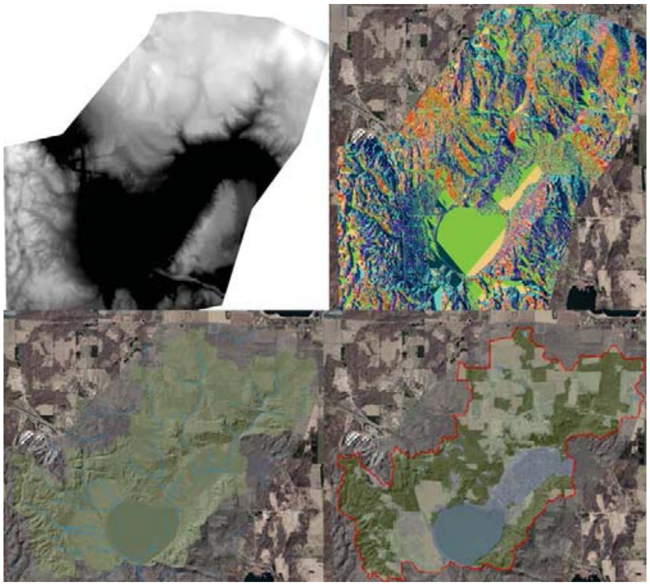
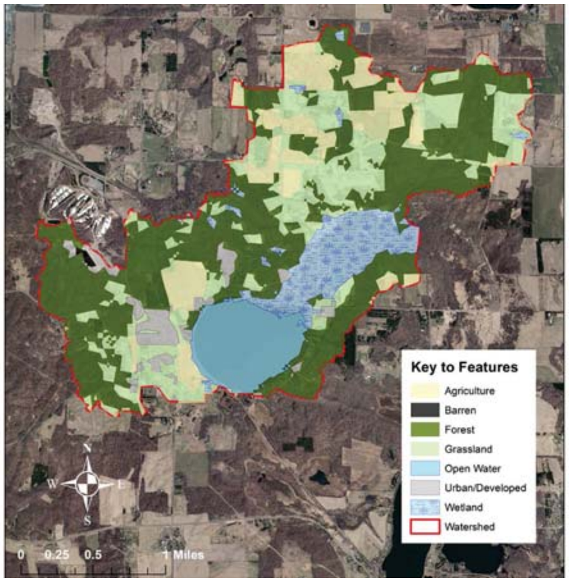


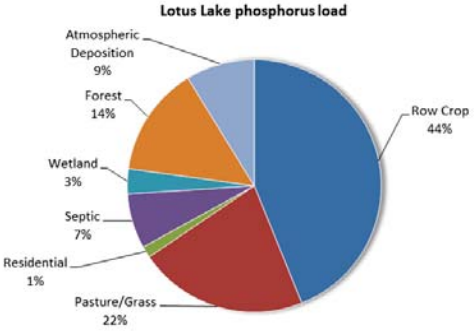
Watershed Modeling & Algae Community

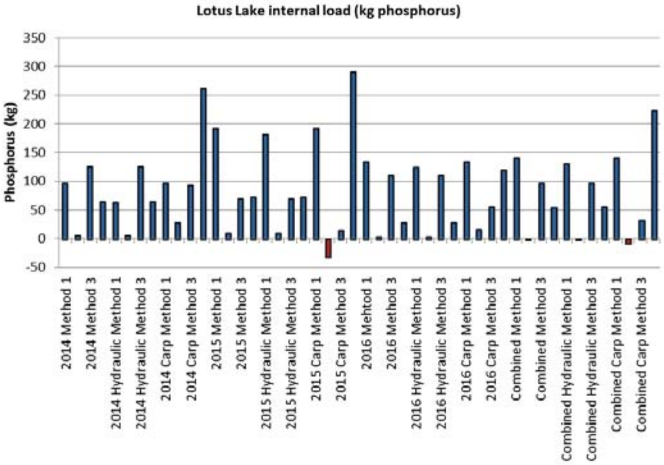
Jeremy Williamson
Water Quality Specialist
Polk County LWRD





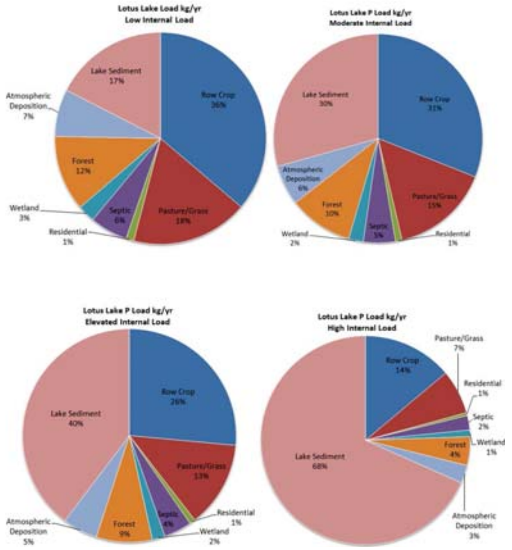
Lotus Lake Nonpoint P	
Source	Load kg/yr
Row Crop	150
Pasture/Grass	74
Residential	5
Septic	23.89
Wetland	11
Forest	48
Atmospheric Deposition	30





$$P = \frac{L_{Ext}}{q_s}(1 - R) + \frac{L_{Int}}{q_s}\text{; where } R = \frac{15}{18+q_s}$$

$$OI = z/\sqrt{km^2}$$

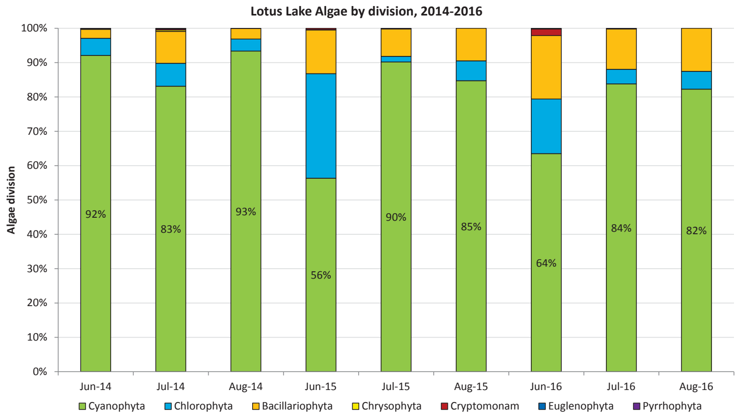


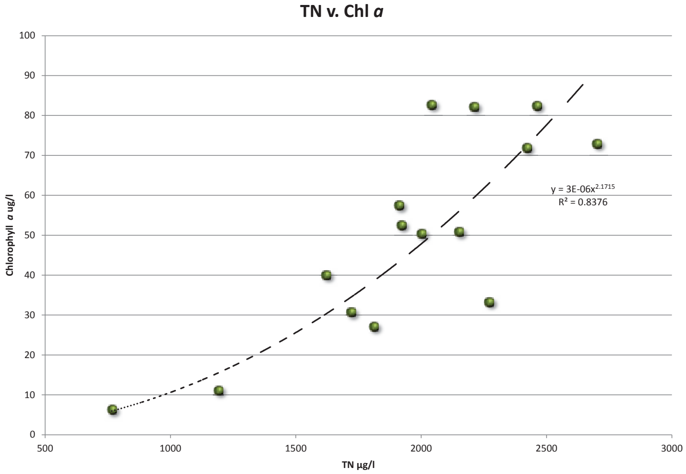
$$P = \frac{0.8L}{\left(z\left(0.0569\left({}^{L}/_{z}\right)^{0.422}\right)+p\right)}$$

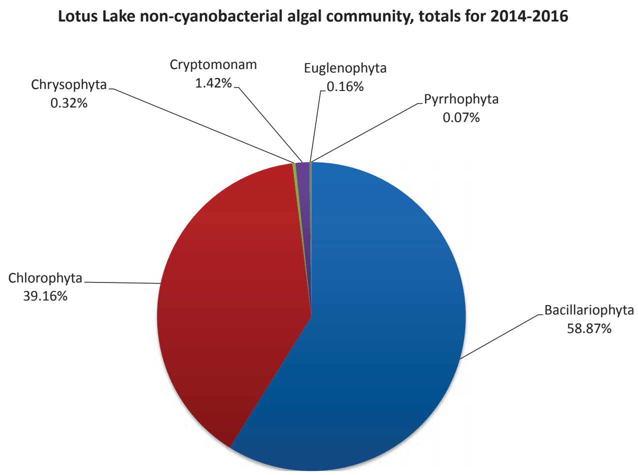
Scenario	Internal P flux mg/m² lake area	Predicted mixed-lake TP μg/l
1	0	110.5
2	47.6	122.69
3	141	145.97
4	223.11	165.33
5	733.46	272.12

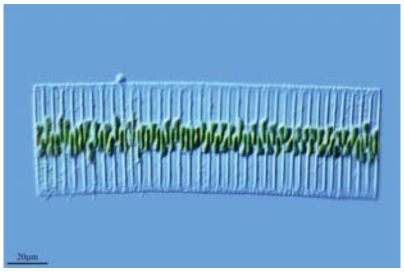
Algae

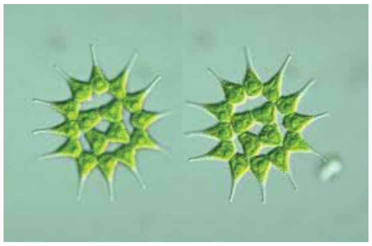
Algal Division	Common Name	Characteristics
Bacillariophyta	Diatoms	Sensitive to chloride, pH, color, and total phosphorus in water. As total phosphorus increases, diatoms decrease. Generally larger in size. Tend to be highly present in spring and late spring.
Chlorophyta	Green algae	Provide high nutritional value to consumers. Can be filamentous and intermingle with macrophytes.
Chrysophyta	Golden brown algae	A genus of single-celled algae in which the cells are ovoid. Contain chlorophyll a, c_1 and c_2, generally masked by abundant accessory pigment, fucoxanthin, imparting distinctive golden color to cells.
Cryptomonam	Cryptomonads	Bloom forming, are not known to produce any toxins, and feed small zooplankton. Cryptomonads frequently dominate the phytoplankton assemblages of the Great Lakes.
Cyanophyta	Blue green algae	Prevail in nutrient-rich standing waters. Blooms can be toxic to zooplankton, fish, livestock, and humans. Can be unicellular, colonial, planktonic, or filamentous. Can live on almost any substrate. More prevalent in late to mid-summer.
Euglenophyta	Euglenoids	Commonly found in freshwater that is rich in organic materials. Most are unicellular.
Pyrrhophyta	Dinoflagellate	Have starch food reserves and serve as food for grazers.

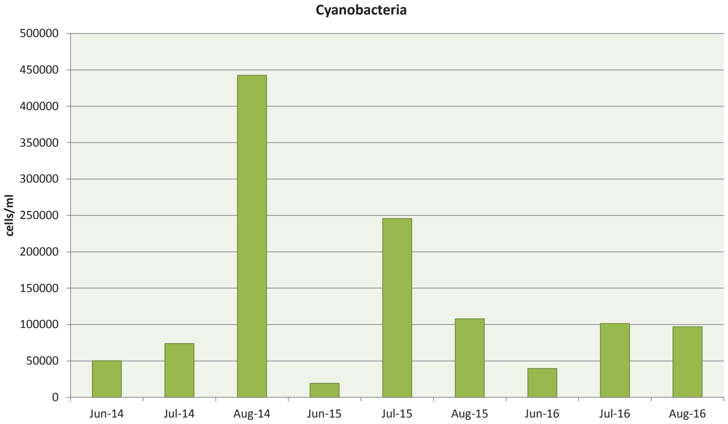


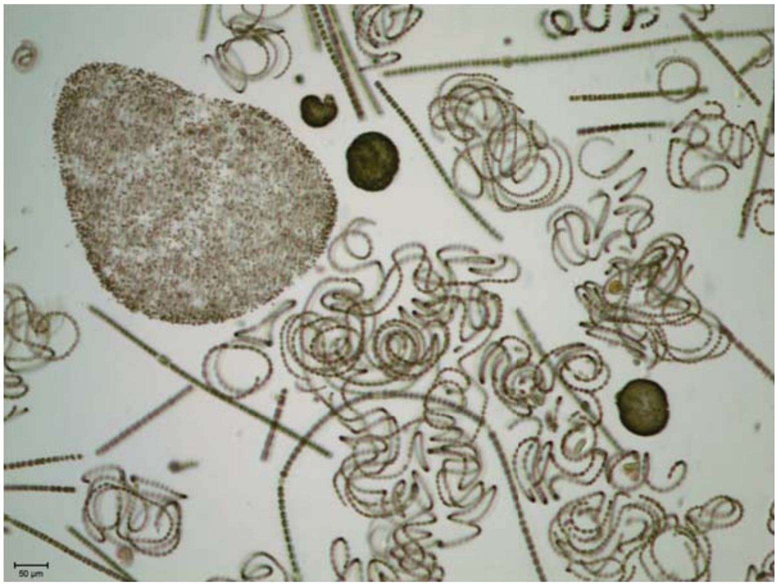




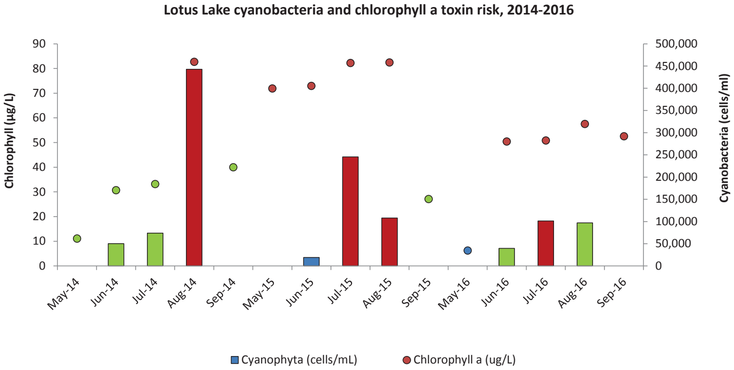




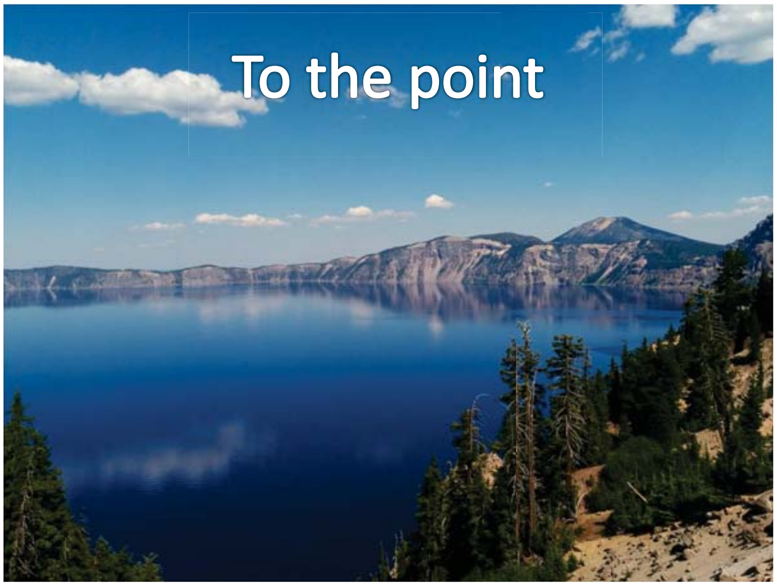


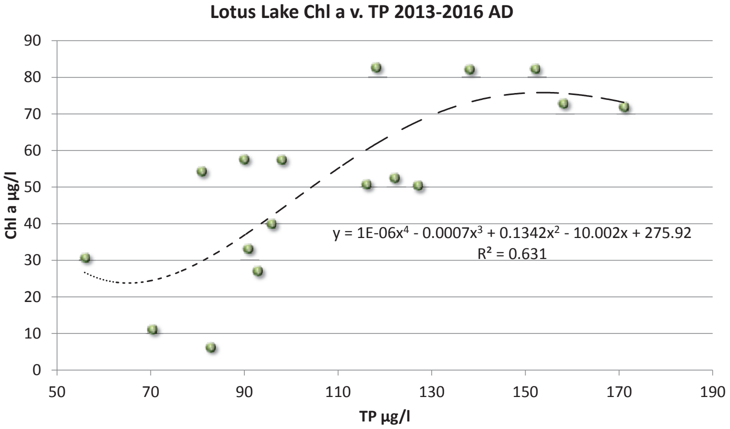


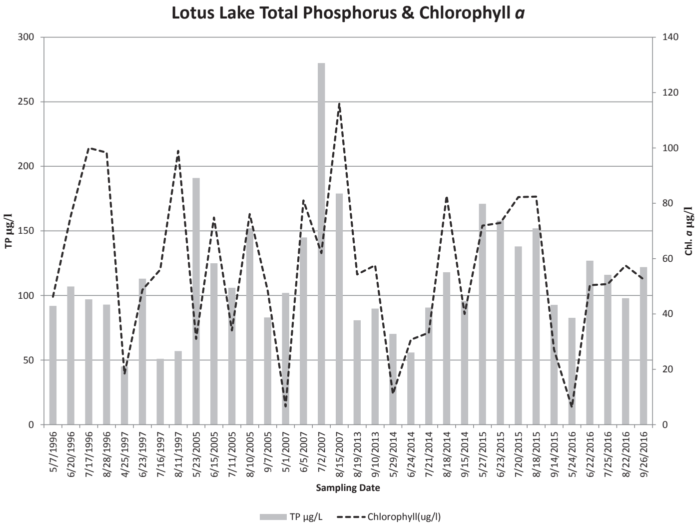
Blue green algae cell density (cells/mL)	Chlorophyll a (µg/L)	Risk
Less than 20,000	Less than 10	Low
20,000 to 100,000	10 to 50	Moderate
Greater than 100,000	Greater than 50	High

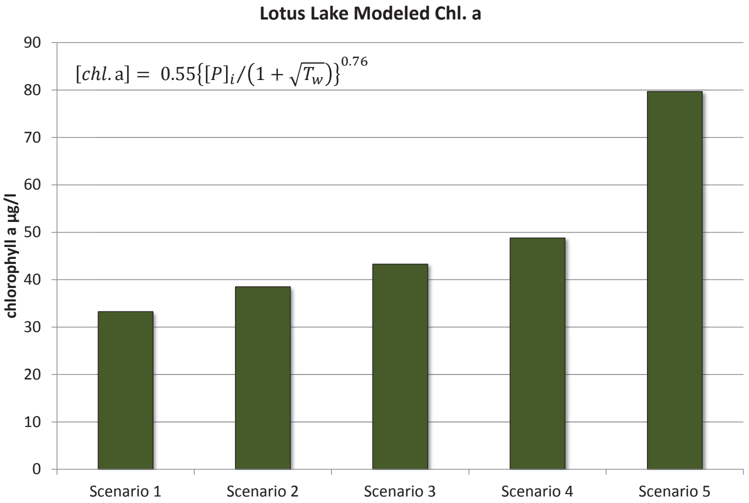


To the point

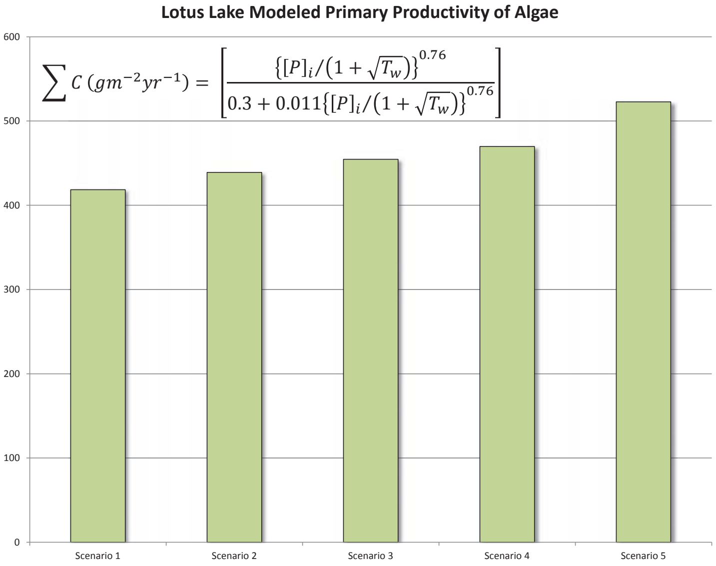




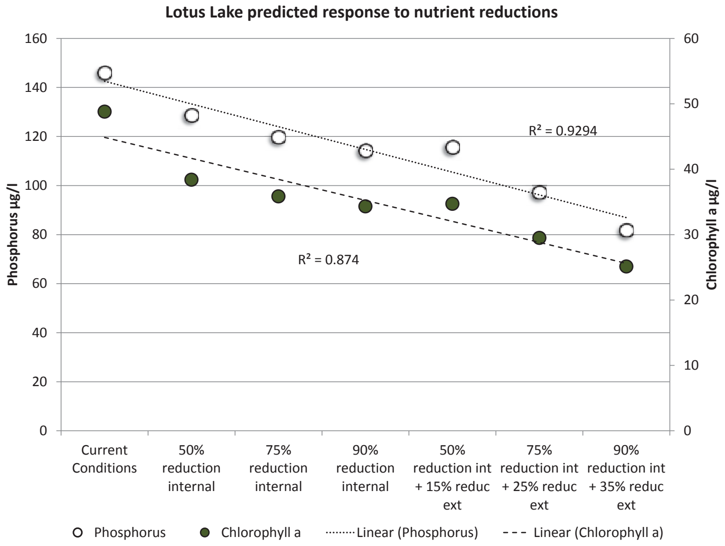


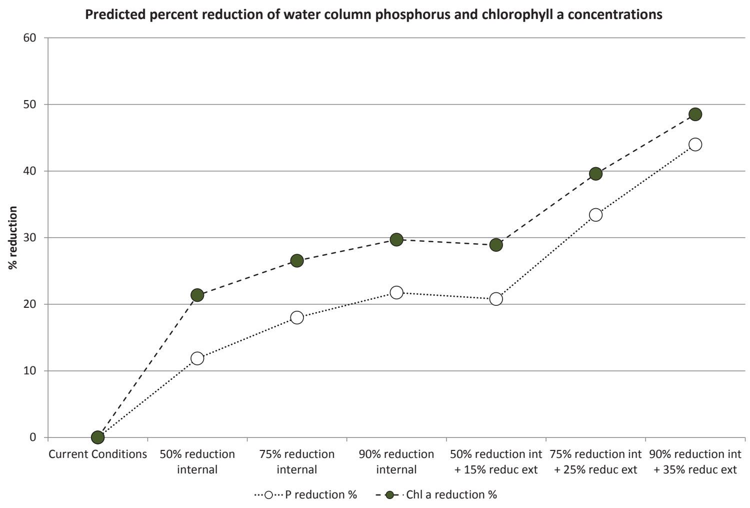


$$[chl.\mathrm{a}] = 0.55\{[P]_i/(1+\sqrt{T_w})\}^{0.76}$$



$$\sum C\,(gm^{-2}yr^{-1}) = \left[\frac{\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}{0.3+0.011\{[P]_i/(1+\sqrt{T_w})\}^{0.76}}\right]$$




Predicted percent reduction of water column phosphorus and chlorophyll a concentrations
60
50
40
30
20
10
0
% reduction
Current Conditions
50% reduction internal
75% reduction internal
90% reduction internal
50% reduction int + 15% reduc ext
75% reduction int + 25% reduc ext
90% reduction int + 35% reduc ext
P reduction %
Chl a reduction %


Questions?

Lotus Lake fisheries update

Aaron J. Cole
WDNR Senior Fisheries Biologist
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FISHERIES MANAGEMENT............we make fishing better

Fisheries Mgmt. timeline

- Surveys
  - 2000, 2012
- Aeration
  - 2004
  - Used compressed air and surface
- Carp management
  - Marked carp in 2013, 2014, and 2015
  - Carp contracts 2013, 2014, 2015, and 2016
- Considerable amount of focus for the lake

WISCONSIN DEPT. OF NATURAL RESOURCES

Carp population estimates

- Adult population estimates:
  - Electrofishing (Year 1 and Year 2)
  - Determine number of adult carp/acre

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

- Determine exploitation
  - Effectiveness of commercial removal

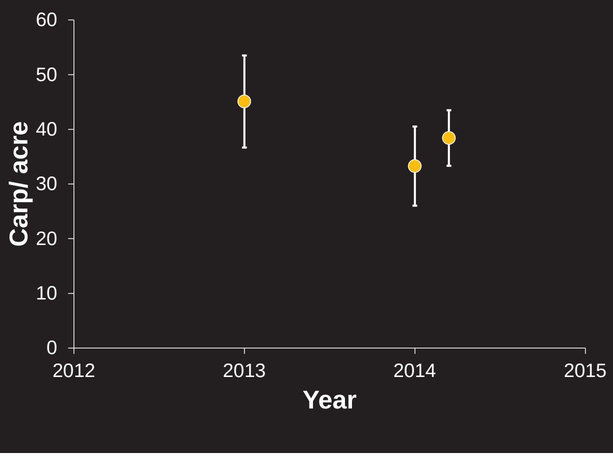
Carp marking

- 2013
  - 1,275
- 2014
  - 644
- 2015
  - 696

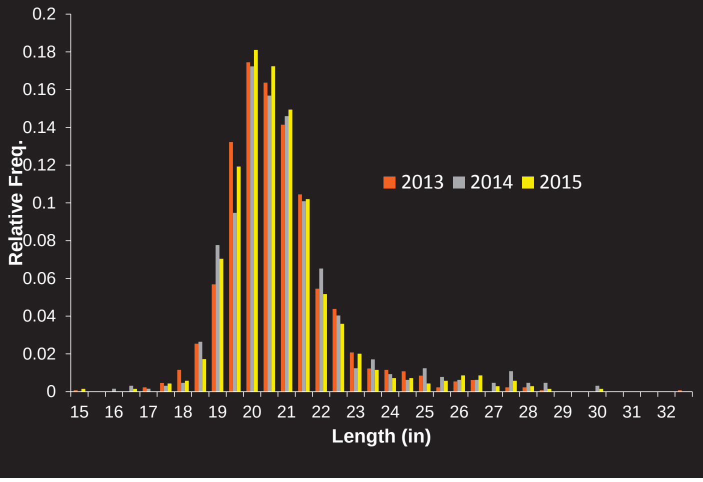
Carp Population estimates

- 2013-2014
  - PE: 10,688 (±1,996)
  - 45.1 carp/ac
  - Biomass: 197 lbs/acre
- 2014-2015
  - PE: 7,886 (±1,714)
  - 33.3 carp/ac
  - Biomass: 150 lbs./acre
- 2013,2014-2015
  - PE: 9,103 (±1,203)
  - 38.4 carp/ac
  - Biomass: 174 lbs./acre

Carp Population estimates



LFs by year



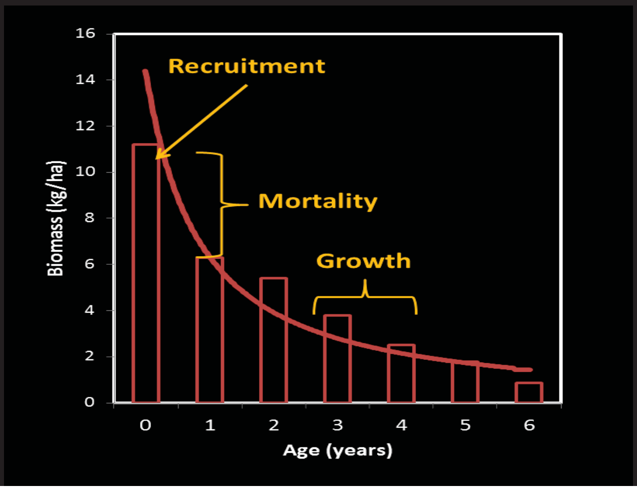
Removal efforts by year

- 2013
  - December- Seine net got stuck and no carp were removed
- 2014
  - No attempts
- 2015
  - No attempts
- 2016
  - April-an open water seining attempt
    - approximately 70 carp removed
  - June-large mesh gill net. 100-150 carp removed
    - Electrofishing also used
- <u>ONLY ~220 CARP REMOVED OVER FOUR YEARS</u>

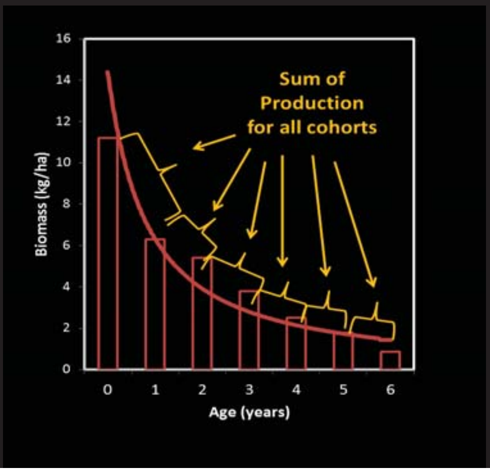
Fisheries 101

- Dynamic Rate Functions
  - Growth
  - Recruitment
  - Mortality

Production



Production (cont.)



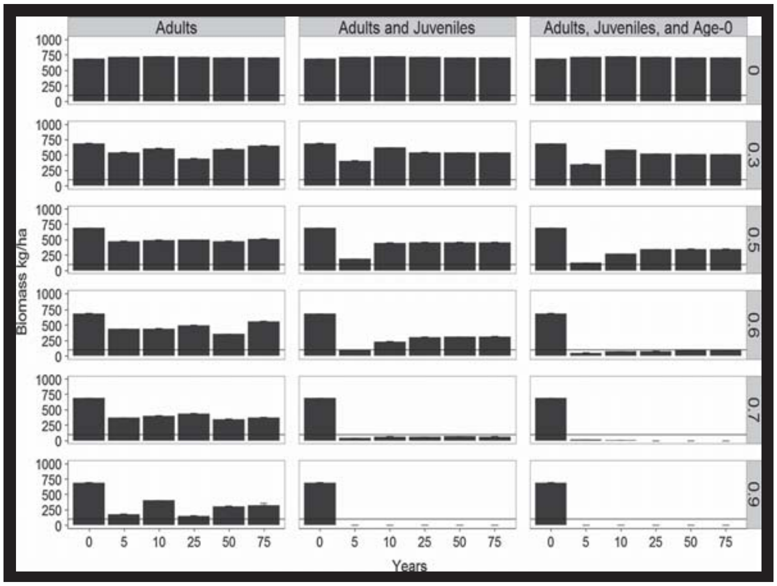
2013 Lotus Lake carp production

Carp Biomass:	197.5 lbs./ac
Annual Production:	33.9 lbs./ac
Production/Biomass:	0.17

- Must remove 8039.4 lbs. carp/year
  - to BEGIN to alter population structure
  - VERY CONSERVATIVE ESTIMATE!!!
  - Invasive species in a novel habitat

Other factors

- Compensatory growth
  - Less competition…grow faster
- Compensatory recruitment
  - Less competition…survival increases
- Downstream immigration
- Recent research suggests it takes a lot more exploitation…
  - Lechelt and Bajer 2016



Lechelt and Bajer 2016

- Recruitment dynamics strongly impact ability to control common carp using physical removal
- Population control is unlikely in systems with strong internal recruitment
  - 90% annual adult removal is insufficient
  - Additional life stages need to be targeted

Carp Management

- Contracts from 2013-2016
  - AVG: 0.7% exploitation (0.07)
  - NOT ENOUGH TO ACCOMPLISH ANYTHING
- Annual carp removals
- Concerns of killing bycatch and AIS

- NO unsubsidized carp contract has drastically reduced, crashed, or “flipped” a system in WI

Lotus Lake

- Ideal conditions for carp
- High carp recruitment
- Connected to shallow marsh and Horse Creek
- Habitat, habitat, habitat…
- Removal nearly impossible

Reality

- Maintain realistic expectations
- Boom and bust winterkill lake
- Appreciate the lake for what it is
  - Small, quiet, scenic, lightly developed
- Vegetation without carp
- Role of carp in nutrient budget?

Questions?

Aaron J. Cole
WDNR Senior Fisheries Biologist
Barron & Polk counties
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715-637-6864

FISHERIES MANAGEMENT............we make fishing better

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

- Project Goals
  - Determine if wild rice would survive and mature if protected (are sediments conducive)
  - Track carp movements to compliment DNR PE and determine level of mixing and if barriers would be necessary

---

Lotus Lake Wild Rice Feasibility and Carp Management

Why??

- Anecdotal information
  - Tribal Elders
  - Wild Rice Regs
  - Local Knowledge
- Lake is suited
  - Depths
  - Low Development
  - Flocculent Substrates
- Interest in restoration

Lotus Lake Wild Rice Feasibility and Carp Management

Project Partners

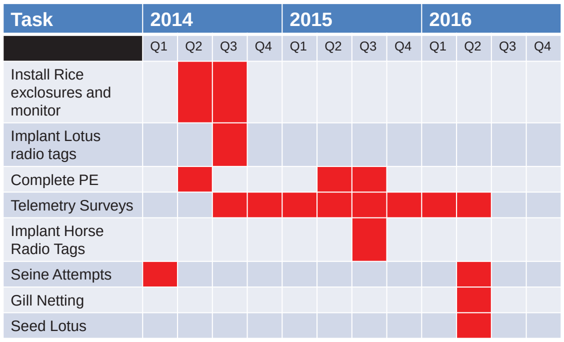
- St Croix Tribal Environmental Department
- Polk County Land and Water
- WI DNR
- Lotus Lake Association
- USDI-BIA
- Osceola Rod and Gun Club

Lotus Lake Wild Rice Feasibility and Carp Management

Project Area

Lotus Lake Wild Rice Feasibility and Carp Management

Project Timeline



Task	2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Install Rice exclosures and monitor		🟥	🟥									
Implant Lotus radio tags			🟥									
Complete PE		🟥				🟥	🟥					
Telemetry Surveys			🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥		
Implant Horse Radio Tags							🟥					
Seine Attempts	🟥									🟥		
Gill Netting										🟥		
Seed Lotus										🟥		

Lotus Lake Wild Rice Feasibility and Carp Management

Wild Rice Feasibility

– 2 sites

– 1 “open area” and 1 exclosure at each site

– Installed/seeded April 2014

– Monitored through summer

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

Results

– Protected seedings did well

– Dramatic drop in water levels

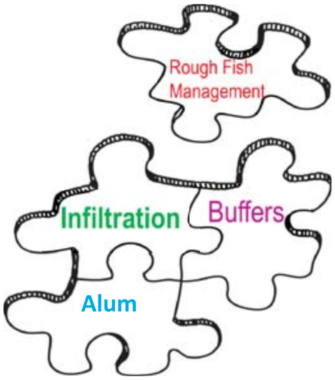
– Rice matured

	Site 1 Open	Site 1 Exc.	Site 2 Open	Site 2 Exc.
Stems/m²	0	46	0	88

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

WATER QUALITY
IMPROVEMENT
PUZZLE

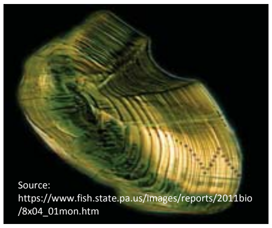


Lotus Lake Wild Rice Feasibility and Carp Management

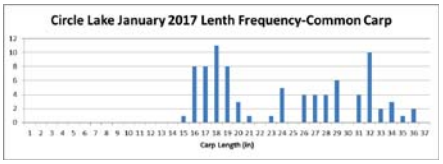
- Integrated Pest Management (IPM) Approach

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM- Data Collection
- – Assess the Population
  - Mark/Recap PE and/or CPUE
  - – Model
  - Length Frequency
  - Aging



Source:
https://www.fish.state.pa.us/images/reports/2011bio
/8x04_01mon.htm



Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Data Collection
- – Movement Surveys
  - Aggregations
  - Nurseries
  - Migration Routes

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Bio Control
  - – Use predator species
  - Egg
  - Larvae
  - Juveniles

Source:
http://fireflyforest.net/firefly/2006/02/17/bluegill/

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM- Barriers
  - – Can be temporary or permanent
  - – Consider native fish movement

Lotus Lake Wild Rice Feasibility and Carp Management

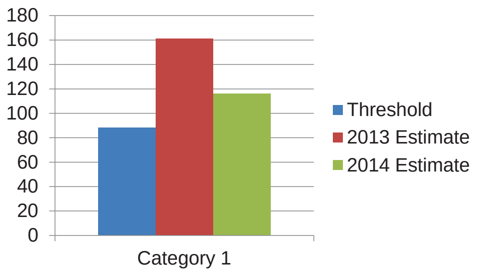
- Carp IPM- Biomass Removal

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Biomass Removal
  - ❖ Bajer & Sorensen (Hennepin-Hopper) developed biomass threshold of 100 kg/ha or 88 lbs/ac
  - ❖ Generally supported by obs on other projects

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Biomass Removal- 24-45% biomass removal necessary (6,636-17,301 pounds)



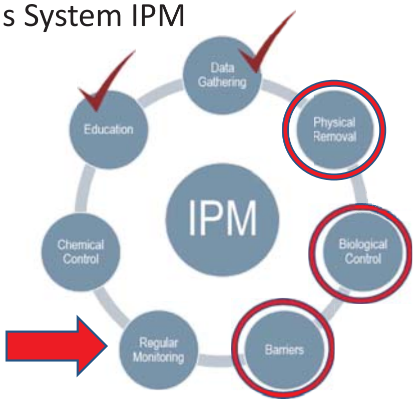
Horse= 416 lbs/acre

Lotus Lake Wild Rice Feasibility and Carp Management

- Carp IPM-Telemetry Surveys
  - Carp haven't aggregated well in Lotus
  - Movement out of Lotus
  - Horse Carp aggregate, move to inlet

Lotus Lake Wild Rice Feasibility and Carp Management

- Lotus System IPM



Lotus Lake Wild Rice Feasibility and Carp Management

Future Steps

- Carp/BLG YOY Surveys
  - No YOY seen yet in Lotus
  - Look in Wetlands
- Barriers
  - Multiple types could be used in many areas
  - Watch native migration (timing)
- Removal traditional/new tech
  - Seine
  - Box Net
  - Electro
  - Modified Trap

Lotus Lake Wild Rice Feasibility and Carp Management

Future Steps

- Support Predator Species
  - Bluegill
  - NOP
  - Aerator
- Wild Rice restoration
  - Habitat (fish/waterfowl)
  - Sequester P
  - Reduce effect of wind
- Monitor Carp Population
  - PE
  - Telemetry
  - PIT

Lotus Lake Wild Rice Feasibility and Carp Management

- Clam Lake- Burnett County, WI
- – Restore wild rice beds
  - 84 acres in 2009-~200 by 2016
  - Seeding taking
  - Removed over 640,000 pounds
  - 92% biomass removal

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

Lotus Lake Wild Rice Feasibility and Carp Management

- Silver Lake – Ramsey/Anoka County, MN
  - Improve water clarity and lower Chlorophyll-A/ Total Phosphorus concentrations
    - 1.25 m average secchi to 2.5 m (max depth 6.7 m)
    - Decreased TP and Chl-a
    - Increased vegetation (21% to 86%)

Lotus Lake Wild Rice Feasibility and Carp Management

- Spring Lake – Scott County, MN
- Ongoing Carp management
- Removal of over 70% of carp biomass (January 2017)
  - 84.5 kg/ha to **25.9 kg/ha**
  - Facilitate alum treatment

Lotus Lake Wild Rice Feasibility and Carp Management

- Staring Lake – Hennepin County, MN
- Ongoing carp management
- Removal of over 70% of carp biomass
  - 498 kg/ha to **95 kg/ha**
- Increased early season water clarity
- Increase in vegetative richness and abundance

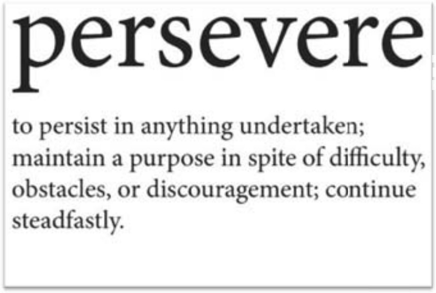
Lotus Lake Wild Rice Feasibility and Carp Management

Others Include

- ❖ Circle Lake-58% biomass reduction
- ❖ Phelan Chain of Lakes, West Metro, Riley-Purgatory

Lotus Lake Wild Rice Feasibility and Carp Management

Carp IPM can be successfully implemented as part of a holistic plan to improve the ecological integrity of Lotus Lake.



persevere

to persist in anything undertaken; maintain a purpose in spite of difficulty, obstacles, or discouragement; continue steadfastly.

Lotus Lake Management Plan Development
Committee Meeting 3

Wednesday, April 12th, 2017
6-8 PM
Polk County Government Center, AB Room

6:00 Introductions

6:05 Presentation (Katelin Anderson and Jeremy Williamson)
  Plant surveys
  Shoreline inventory

6:35 Brainstorm goals for lake management (all)

8:00 Adjourn

Next meeting Wednesday, May 10th
6-8 PM
Polk County Government Center, AB Room

Katelin Anderson
Polk County Land and Water Resources Dept.
(715) 485-8637
katelin.anderson@co.polk.wi.us

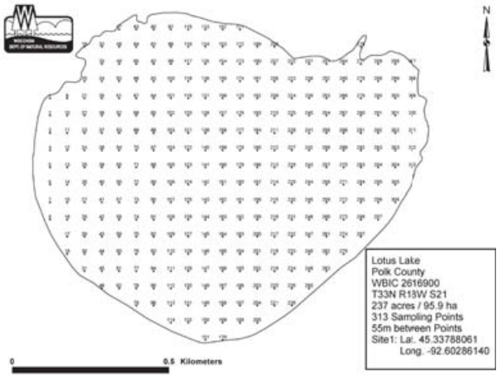
Jeremy Williamson
Polk County Land and Water Resources Dept.
(715) 485-8639
jeremyw@co.polk.wi.us

Lotus Lake Planning Meeting

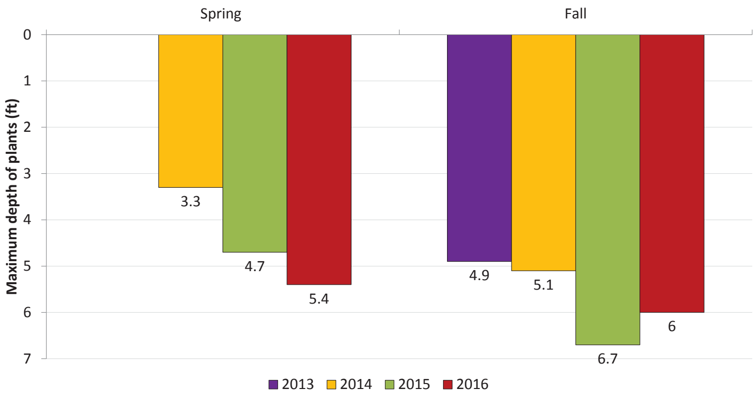
Meeting 3

Wednesday, April 12th, 2017

Plant Surveys



Lotus Lake
Polk County
WBIC 2616900
T33N R18W S21
237 acres / 95.9 ha
313 Sampling Points
55m between Points
Site1: Lat. 45.33788061
Long. -92.60286140

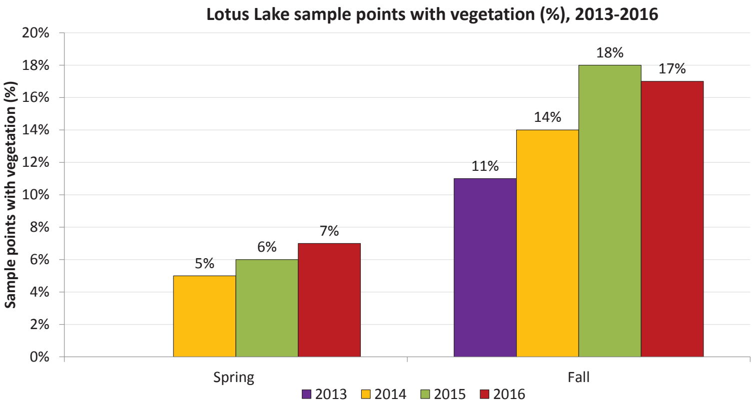


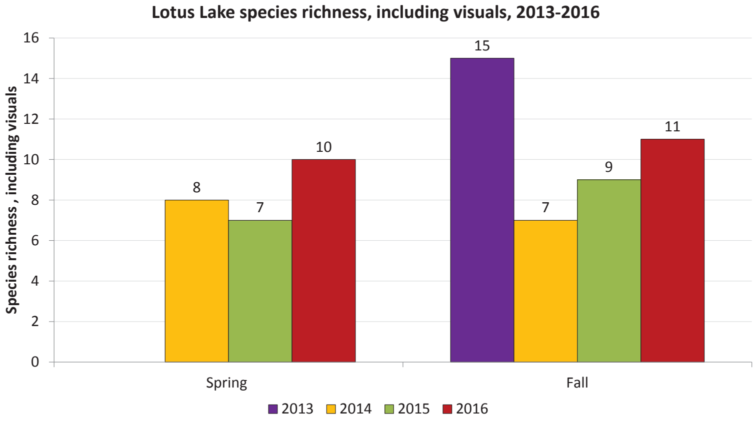
Lotus Lake maximum depth of plants (ft), 2013-2016

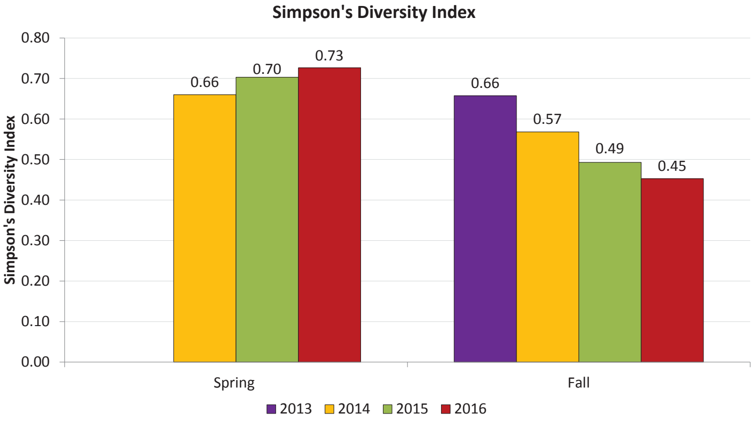
Frequency of occurrence within vegetated areas (%)	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	6.3	35.3	4.7	26.3	5.5	31.8	6.0
Elodea canadensis, Common waterweed					1.8		2.0
Lemna minor, Small duckweed	3.1				1.8		
Nelumbo lutea, American lotus	62.5		65.1	10.5	74.5	45.5	78.0
Nuphar variegata, Spatterdock	9.4	35.3	23.3	42.1	10.9	18.2	8.0
Nymphaea odorata, White water lily	21.9	47.1	11.6	42.1	10.9	9.1	14.0
Potamogeton natans, Floating-leaf pondweed					1.8	4.5	
Schoenoplectus tabernaemontani, Softstem bulrush	6.3						
Stuckenia pectinata, Sago pondweed	3.1		2.3	5.3		4.5	
Wolffia sp.	3.1						
Filamentous algae		5.9				18.2	

Frequency of occurrence at sites shallower than maximum depth of plants	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	1.4	18.8	1.3	4.3	1.6	4.3	1.9
Elodea canadensis, Common waterweed					0.5		0.6
Lemna minor, Small duckweed	0.7				0.5		
Nelumbo lutea, American lotus	13.5		17.9	1.7	21.9	6.2	24.8
Nuphar variegata, Spatterdock	2.0	18.8	6.4	6.9	3.2	2.5	2.5
Nymphaea odorata, White water lily	4.7	25.0	3.2	6.9	3.2	1.2	4.5
Potamogeton natans, Floating-leaf pondweed					0.5	0.6	
Schoenoplectus tabernaemontani, Softstem bulrush	1.4						
Stuckenia pectinata, Sago pondweed	0.7		0.6			0.6	
Wolffia sp.	0.7						
Filamentous algae		3.1		0.9		2.5	

Relative frequency (%)	Fall 2013	Spring 2014	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016
Ceratophyllum demersum, Coontail	5.4	30.0	4.3	21.7	5.1	28.0	5.6
Elodea canadensis, Common waterweed					1.7		1.9
Lemna minor, Small duckweed	2.7				1.7		
Nelumbo lutea, American lotus	54.1		60.9	8.7	69.5	40.0	72.2
Nuphar variegata, Spatterdock	8.1	30.0	21.7	34.8	10.2	16.0	7.4
Nymphaea odorata, White water lily	18.9	40.0	10.9	34.8	10.2	8.0	13.0
Potamogeton natans, Floating-leaf pondweed					1.7	4.0	
Schoenoplectus tabernaemontani, Softstem bulrush	5.4						
Stuckenia pectinata, Sago pondweed	2.7		2.2			4.0	
Wolffia sp.	2.7						







Floristic Quality Index

<u>North Central Hardwood Forest</u>

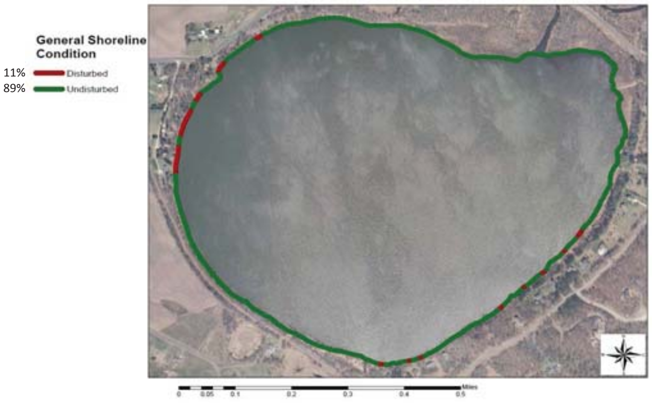
Mean species richness = 14
Mean average conservatism = 5.6
Mean Floristic Quality = 20.9

<u>Lotus Lake</u>

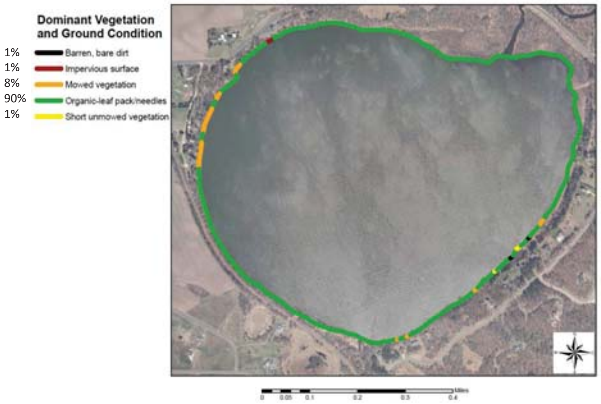
Mean species richness = 5
Mean average conservatism = 5
Mean Floristic Quality = 11

Shoreline Inventory

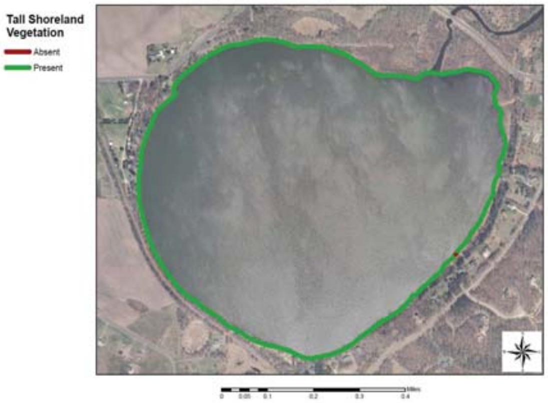
Lotus Lake General Shoreline Condition Within 35 feet



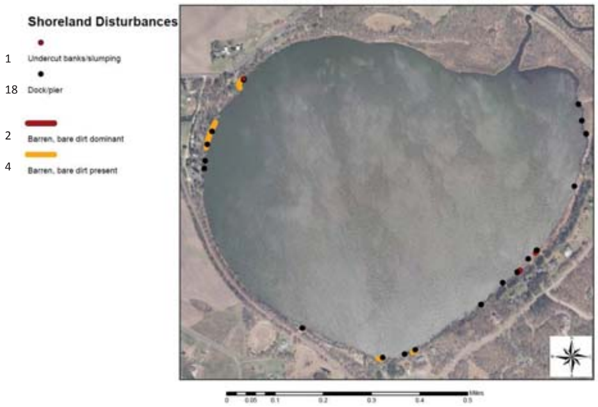
Lotus Lake Dominant Shoreland Vegetation and Ground Conditions



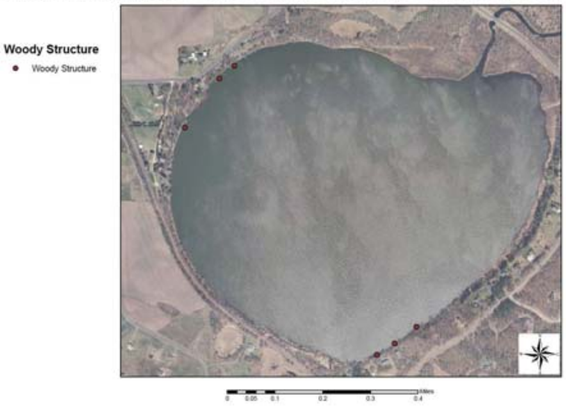
Lotus Lake Tall Shoreland Vegetation



Lotus Lake Shoreland Disturbances



Lotus Lake Woody Structure Below the Ordinary High Water Mark



Appendix L

Public Comments

From: Tony Havranek
To: Katelin Anderson; "Trish Carlson"; Aaron Cole; "Alex.Smith@wisconsin.gov"; Jeremy Bloomquist
Subject: Goal 1_AJHComments
Date: Friday, December 01, 2017 12:40:44 PM
Attachments: image5639cd.PNG
Goal 1_AJHComments.docx

Attached is the budget section.

I added a few items to address concerns previously raised and included additional items for data collection and implementation based on other project experience.

I think carp management and the other items outlined are feasible and will allow Lotus to achieve designated uses and meet federal and state mandated water quality standards.

Thanks for the opportunity to comment.

Tony Havranek
Sr. Environmental Scientist
P (651) 286-8473 | M (612) 246-9346
WSB & Associates, Inc. | 178 East 9th Street, Suite 200 | St. Paul, MN 55101

GOAL 1. IMPLEMENT MULTIPLE INTEGRATED STRATEGIES TO ACTIVELY MANAGE THE CARP POPULATION IN LOTUS LAKE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Reduce the carp population to less than 89 pounds/acre (100 kg/hectare)	Contingent on approval			LLAB, WDNR	
Remove carp through commercial fishing or contracted siening	2018-Future as needed	$10,000/year	400		BIA-CoF, USFWS-TWG, DU,
Remove carp through targeted harvesting: electrofishing/netting. Box netting has been used successfully in other smaller systems like Lotus	2018-future				
Electrofishing	2018-future	$10,300	40		BIA-CoF, USFWS-TWG, DU,
Box Netting	2018-Future	$10,533	288		
Organize a carp fishing tournament on Lotus Lake	2018				
Consider experimental options including: species specific pathogens/viruses, poisoned corn, pheromone lure traps, water level manipulations, etc.					
Eradicate carp with chemical pesticides such as rotenone	If feasible				
Carcass Disposal	2018-Future	$1,500	20		
Build a modified seine for use in Horse and Lotus to eliminate the potential spread of invasives. Modify mesh size, roller size, density, and weight.	2019	$17,000			
Monitor carp locations to increase the likelihood of successful management efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Radio tag/monitor carp to determine locations and formation of population aggregates *This would be for 10 high frequency radio tags in Lotus and monitoring once/week for 12 weeks/year*	2018-Future	$7,180			BIA-CoF, USFWS-TWG, DU,
Determine spawning locations for the Lotus Lake carp population	2018-2020	Included in above estimate			BIA-CoF, USFWS-TWG, DU,
Determine movement of carp between Horse Lake, Lotus Lake, and surrounding wetlands	2018-2020	$7,180			BIA-CoF, USFWS-TWG, DU,
Determine locations for the installation of carp barriers		$1,500			BIA-CoF, USFWS-TWG, DU,

WDNR = Wisconsin Department of Natural Resources, LWRD = Polk County Land and Water Resources Department, SCENRD = St. Croix Environmental and Natural Resources Department, LLA = Lotus Lake Association Board, LLAV = Lotus Lake Association Volunteers, CON = Consultant, HCFLWC = Horse Creek Farmer Led Watershed Council

LPL = WDNR Lake Planning and Protection Grant Program; AEPP = WDNR Aquatic Invasive Species Grant Program

Maintain reduced carp populations in Lotus Lake	Contingent on funding			LLAB	Contingent on removal
Install carp barriers to limit carp movement into and out of Lotus Lake *This cost is for fixed grate barrier at the culverts crossing the Stower*	2019 or 2020	$4,000			
PIT tag Carp and NOP to confirm movement observed anecdotally and through radio telemetry. This will dictate timing of barrier install and location.	2018-2019	$22,000			
Rotating Drum or vertical barrier at Lotus outlet and fixed grate at Horse inlet	2019 or 2020	$11,000			
Stock bluegill and gamefish to sustain a reduced carp population and/or replenish the Lotus Lake fishery in the case of rotenone					
Stock bluegill in wetlands that serve as nursery ground for spawning carp					
Maintain the aerator to prevent winterkill of bluegills and gamefish- Solar	Ongoing	$14,500	30		
Assess carp population following reduction efforts	Contingent on funding			LLAB, WDNR, SCENRD	Contingent on removal
Determine number of marked fish removed from Lotus Lake to estimate population reductions- Develop a mark recap PE	2018-Future	$7,665	16		
Determine yearly carp population estimates This could be done using the ElectroFishing CPUE	2018-Future	$5,465	16		
Use existing population data to inform the need for future removal efforts to keep carp populations below 89 pounds/acre (100 kg/hectare)	2018-Future	Included in above Estimates			
Complete late summer/early fall trap netting to confirm nursery sites- Lotus, horse, wetlands, 3 net nights per site, 3 sites	2018-2021		$19,400		
Effectively communicate project goals and results to the broader community					
Use multiple methods of communication: website, Facebook, press releases, lake fair, etc.	Ongoing	$100-500	20	LLAB	-
Attend local town, village, sportsman's club, lake organization, and other community group meetings and events to share project goals and results	Ongoing	-	20	LLAB	-
Evaluate a carp-proof exclosure to provide a pilot demonstration of what Lotus Lake could look like without carp	2018	$5,200			

GOAL 2. REDUCE INTERNAL AND EXTERNAL PHOSPHORUS LOADING TO LOTUS LAKE TO LEVELS WHERE WATER QUALITY IMPROVES, ALGAE GROWTH DECREASES, AND RECREATION IS POSSIBLE	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
INTERNAL PHOSPHORUS LOADING					
Implement multiple strategies to actively manage the carp population in Lotus Lake	**SEE GOAL 1**				

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Conduct a study of water aerators to determine the most effective system for Lotus Lake (efficiency, cost, placement)	Ongoing	-	20	LLAB	-
Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	Contingent on funding/ removal	$12,000		LLAB, SCENRD	
Research the costs and benefits of installing a dam at the outlet of Lotus Lake to maintain water levels	2019?	-	40	LLAB	-
EXTERNAL PHOSPHORUS LOADING					
Install best practices including: native plantings, diversion, rock infiltration, and rain gardens using the Healthy Lakes Grant program	2020	$250 per practice	100	LLAB, LWRD	Healthy Lakes
Identify a person or committee responsible for the grant application and implementation					-
Provide information to homeowners regarding each practice and how it relates to improved water quality and decreased algae growth	Ongoing				-
Identify homeowners interested in installing grant eligible best practices					
Include the county owned boat landing and park as a Healthy Lakes site					
Apply for and implement a Healthy Lakes Grant application					
Install WDNR signage at Healthy Lakes project sites					
Organize a tour of properties where successful practices have been installed					
Support the work of the Horse Creek Famer Led Council	Ongoing	As able	-	LLAB, LWRD, HCFLWC	-
Design new homeowner packets that highlight the impact of shoreline development on water quality	2018	$100	24	LLAB, LLAC	LPL
Participate in meetings on the proposed quarry and share concerns for Lotus Lake	Ongoing	-	3	LLAB	-
If plant growth becomes problematic for recreation and navigation, develop an aquatic plant management plan which is mindful of the benefits of submerged aquatic plants	If necessary			LLAB, LWRD, CON	LPL

GOAL 3. RESTORE THE LOTUS LAKE ECOSYSTEM TO SUPPORT WILDLIFE, FISHERIES, WILD RICE, AND SUBMERGED AQUATIC PLANTS	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**
Implement multiple strategies to actively manage the carp populations in Lotus Lake	**SEE GOAL 1**				

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Re-establish wild rice and additional submerged aquatic plants in Lotus Lake	**SEE GOAL 2**				
Install best management practices including: native plantings, rain gardens, and fish sticks using the Healthy Lakes Grant program	**SEE GOAL 2**				
For fish sticks: work with fisheries biologist to determine locations for fish sticks and other habitat improvements	2020	-	25	LLAB	-
Promote practices to restore the fishery of Lotus Lake					
Determine if natural reproduction of northern pike and other species of fish is occurring					
Stock northern pike and other species of fish if natural reproduction is not occurring					
Improve natural reproduction by enhancing habitat for spawning					
Reduce populations of purple loosestrife					
Map purple loosestrife locations on Lotus Lake	Ongoing	$200-400	8	LLAB, CON	AEPP
Hire a contractor to spray for purple loosestrife	Ongoing	$75/hour	2	CON	AEPP
Determine effectiveness of contracted removal efforts	Ongoing		2	LLAB, CON	AEPP
Follow up herbicide treatment with volunteer removal of flowers and/or spot herbicide treatment	If needed	$50	40	LLAB, LLAV	AEPP
Contact Polk County LWRD to implement a bio-control program	If interest	-	50	LLAB, LWRD	AEPP
Prevent the introduction of aquatic invasive species into Lotus Lake and contain newly introduced invasive species					
Develop an active base of educated volunteers to participate in WDNR statewide AIS efforts: Clean Boat, Clean Waters; Landing Blitz; Drain Campaign; Bait Dealer Initiative; Citizen Lake Monitoring Network for AIS	Ongoing	$100-500	100	LLAB, LLAV, LWRD	AEPP
Ensure that signage at the boat landing is in place and updated as necessary	Ongoing	-	1	LLAB	-
Conduct professional level AIS monitoring at public boat landing and likely areas of introduction	Yearly	$200-400	-	LWRD/CON	LPL/AEPP
Conduct professional level whole lake point intercept plant surveys	Yearly	$800-1,600	-	LWRD/CON	LPL/AEPP
Maintain a contingency fund for rapid response to newly introduced invasive species	2018	If funds available	-	LLAB	-
Develop an Aquatic Invasive Species Rapid Response Plan	2018	-	10	LLAB, LWRD	-

GOAL 4. SUSTAIN THE IMPLEMENTATION OF THE PLAN	**TIMELINE**	**$ ESTIMATE**	**VOLUNTEER HOURS**	**PARTNERS**	**FUNDING SOURCES**

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LPL = WDNR Lake Planning and Protection Grant Program; AEPP = WDNR Aquatic Invasive Species Grant Program

Ensure that the goals of the plan are met through board delegation					
Review and document progress made towards plan implementation	Ongoing	-	10	LLAB	-
Identify actions that weren't completed and identify why they were not completed	Ongoing	-	10	LLAB	-
Report progress towards goals related to: carp management, water quality, and aquatic invasive species	Ongoing	-	10	LLAB	-
Continue current data collection efforts and expand data collection efforts to evaluate progress					
Ensure that Citizen Lake Monitoring volunteer is in place each year to collect phosphorus, chlorophyll and secchi data	Yearly	-	10	LLAB, LLAV	CLMN program
Continue to collect beach sampling for coliform bacteria	Yearly		20	LLAB, LWRD	-
Conduct spring and summer aquatic plant point intercept surveys to determine plant community recovery and expansion of American Lotus	As needed	$800-1,600	-	LWRD	LPL
Repeat the 2014-2016 water quality study in five to ten years	2019-2024	$25,000		LLAB, LWRD, CON	LPL
Develop an aquatic plant management plan to address navigation and recreation if plant growth becomes problematic as a result of carp management	If needed			LLAB, LWRD, CON	LPL
Analyze the presence of lead in fish tissues	If needed			LWRD, CON	
Determine if the culverts for the trail impacted water levels	2018			LLAB	LPL
Evaluate the costs, benefits, and feasibility of forming a District		-	80	LLAB	-

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