Evaluation of the Impacts of the Stone Lake Boat Races Held May 31-June 2, 2013 LaPorte, Indiana

Division of Fish and Wildlife,

Indiana Department of Natural Resources

December 19, 2013

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I. EXECUTIVE SUMMARY

Stone Lake is a natural 150-acre public freshwater lake in LaPorte, Indiana. It is connected to 564-acre Pine Lake by a channel between the northern part of Stone Lake and southern part of Pine Lake. Stone Lake exhibits excellent water clarity when compared to other Indiana lakes. Secchi disk transparencies since 1975 have ranged from a low of 11.5 feet to a high of 22.0 feet (Baetis Environmental Services Inc. 2007). Other water quality and nutrient parameters have historically demonstrated high water quality at the lake.

The Indiana Department of Natural Resources (IDNR), Division of Law Enforcement held a public meeting regarding a high speed boat race at Stone Lake and then a permit was issued. Local residents contested the issuance of the permit, due to the already established speed limit of 10 mph and the size of the lake itself. The case then went to Administrative Law Judge, Stephen L. Lucas. The permit was issued to allow racing over a three day period (May 31-June 2, 2013) subject to several conditions related to public safety and protection of water quality and aquatic habitat. Specifically, Judge Lucas directed IDNR, Division of Fish and Wildlife to "work to assess the shoreline, vegetation, water quality and any other concerns prior to the event, during, and after." This report is presented in fulfillment of that requirement.

Aquatic plant surveys for emergent and submergent vegetation were conducted pre-race and post-race to determine what, if any, impacts were caused due to high speed boating of Formula One Tunnel Boats. High species diversity of aquatic plants is present at this small lake and all but one species were found after the race compared to pre-race. A slight decrease in frequency of occurrence was observed for nearly 60% of the species encountered post-race. Floristic Quality Index was evaluated and indicated that Stone Lake is an excellent example of high quality natural remnant community. Of the native plants present in Stone Lake, three are listed on the state Endangered, Threatened, Rare, and Extirpated list. White-stemmed pondweed and Beck's water marigold are listed as state threatened and critically imperiled in the state. Fern pondweed is state listed as rare and imperiled in the state. White water crowfoot is found in this lake, but is becoming less common in the state (Swink and Wilhelm 1994).

Dissolved oxygen levels in Stone Lake are sufficient to support fish down to 6 or 7 meters during summer stratification. Stone Lake tends to host relatively high dissolved oxygen numbers which spike deeper in the water column. Oxygen levels did not appear to be adversely affected by the weekend of racing.

Water chemistry analysis was performed to determine if any impacts to water quality had occurred as a result of the racing. Samples for water chemistry were performed pre-race, during the race, post-race, and two long-term samples to determine any late summer impacts to Stone Lake. Several water quality parameters were elevated post-race but most were within the range of those observed since 1989 by the Clean Lakes Program. The exceptions to this were nitrate and soluble reactive phosphorus which were both far higher in August than what has ever been observed at Stone Lake.

Water clarity was measured during pre-race, racing, and post-racing activities. Stone Lake typically hosts high water clarity. Clarity was maintained during race weekend and increased on June 3, 2013 to 7.2 meters. Water clarity declined substantially during the samples in July and August. The July decline coincided with when green algae, blue-green algae, and diatom numbers were at their highest.

Waterfowl were observed around Stone Lake by the IDNR District Wildlife Biologist. Although there is some waterfowl habitat available, Stone Lake hosts few waterfowl. Human disturbance is likely the limiting factor to greater waterfowl populations at Stone Lake.

Stone Lake is an exceptional lake by Indiana standards and the public should be aware of the impacts that high speed boating can have on the ecosystem and water quality of this small lake. Every effort should be utilized to maintain the high quality habitat and ecosystem at Stone Lake. If future races are held the following are recommended to aid in protection of this quality lake:

- High speed boating should not occur on more than one weekend per year.
- Preventing high speed boating within 200 feet from shore must continue to be a requirement in future permits.
- The race course should not pass over the shallow bench that crosses the lake.
- Enforcement should be increased for boats operating with propellers engaged when boats are at more than idle throttle at the boat ramp, beach staging area, and other areas within 200 feet of shore.
- Eurasian watermilfoil control should be performed three weeks or more before the racing weekend so that this invasive species is controlled to the greatest extent possible to prevent fragmentation by the high speed boats and additional spread within the lake.

It does not appear as though the single weekend of high speed boating in 2013 had irreversible effects on the lake. An annual weekend of high speed boating may or may not accelerate the eutrophication process at Stone Lake. Frequent or unregulated high speed boating would likely prove more detrimental to the water quality and quality plant community of Stone Lake.

II. INTRODUCTION

Stone Lake is a natural 150-acre public freshwater lake in the city of LaPorte in LaPorte County, Indiana. It is connected to 564-acre Pine Lake by a channel between the northern part of Stone Lake and southern part of Pine Lake. The shoreline of the lake is mostly natural with a low amount of shoreline development. A public beach lies on the northeastern shore, and a city-owned park with a DNR-leased boat ramp and parking lot is provided on the south shore for easy access to both Stone Lake and Pine Lake via the channel. Four private residences are located on the west shore of Stone Lake. Its watershed measures 1.41 square miles and has no defined outlet. The lake is classified as an oligotrophic lake but that quality has been noted as degrading (IDEM 2012).

Stone Lake exhibits excellent water clarity when compared to other Indiana lakes. Secchi disk transparencies since 1975 have ranged from a low of 11.5 feet to a high of 22.0 feet (Baetis Environmental Services Inc. 2007). The combination of relatively clear water and large areas of shallow water allows an abundance of beneficial native vegetation to flourish in Stone Lake.

Stone Lake has the highest Floristic Quality Index (FQI) value for LaPorte County lakes. The FQI is an assessment for rating the quality of the plant community. Past surveys of submerged aquatic vegetation conducted at Stone Lake revealed several species that are present on the Endangered, Threatened, Rare, and Extirpated Plants of Indiana (IDNR 2013). The species also tended to have much higher mean coefficients of conservatism (C) than those found at the other lakes (Baetis Environmental Services Inc. 2007). Eurasian watermilfoil is found in this lake and a Lake and River Enhancement (LARE) grant was awarded in the spring of 2013 to control this invasive species to help preserve the historically high quality of this lake.

A permit was issued by the IDNR, Division of Law Enforcement on March 28, 2013 (Appendix A) to hold a high speed boat race at Stone Lake. Ten letters from local residents were submitted to the Natural Resources Commission (NRC) opposing the permit for the boat race. A prehearing conference was scheduled for April 25, 2013. A concern about water depth was expressed initially in that Stone Lake may not be of suitable depth to conduct a high speed boat race, with respect to safety and potential environmental harm. At initial prehearing conferences a minimum water depth was not made as a condition on the permit as Stone Lake was alleged to have a reasonable water depth to conduct a high speed boat race. Claimants also expressed concern about adverse impacts to waterfowl due to activities of high speed boating. Several citizens expressed concerns to NRC as to Stone Lake's adequacy to support a high speed boat race. Stone Lake contains fewer than 300 acres; therefore, it is defined as a "small lake" in the Watercraft Operations Act (IC 14-15-3-1). A person may not operate a motorboat upon a small lake at a speed greater than ten (10) miles per hour, (IC 14-15-3-10). NRC may adopt rules to exempt Stone Lake (IC 14-15-03-11) because it is larger than 70 acres. Although, IDNR considers the size of a lake in evaluating a permit for a motorboat race, the status as a small lake is not the basis for denial of a permit.

On May 21, 2013, Stephen L. Lucas, Administrative Law Judge with NRC, issued a Notice of Entry of Findings of Fact and Conclusions of Law with Nonfinal Order for Administrative Cause Number 13-068L regarding the Boat Race Permit. The permit was issued to allow racing over a three day period (May 31-June 2, 2013) subject to several conditions related to public safety and protection of water quality and aquatic habitat. Specifically, Judge Lucas directed IDNR, Division of Fish and Wildlife to "work to assess the shoreline, vegetation, water quality and any other concerns prior to the event. A reassessment of the same will occur during and after the event in an effort to determine any effects of the activities authorized under this permit."

The Nonfinal order continues: "The assessment shall include consideration of impacts to waterfowl and shorebirds. Upon a reasonable request by the IDNR, the (LaPorte County Convention & Visitors) Bureau shall assist with the assessment. By December 31, 2013, the Division of Fish and Wildlife shall prepare a written report of its assessment." This report is presented in fulfillment of that requirement.

III. BOAT RACE SPECIFICS

Formula 1 powerboat racing is also referred to as "tunnel boat" racing and includes several different styles of competitive racing boats that can accelerate from a standstill to about 100 miles per hour in four seconds. The boat's design is such that only a few inches of the boat hull

touch the water at high speed. The organizing body for the race called the Maple City Grand Prix at Stone Lake was the US Formula 1 PROP (Professional Racing Outboard Performance Teams) organization. The Formula 1 boats are typically 20-foot carbon fiber, tunnel hull catamaran style boats that race around a circuit at speeds topping 130 mph. All boats are powered by V6 outboard engines, each pumping out 425 horsepower at 10,000 rpm. They contain no brakes or gearboxes (F1H20 2013).

The race permit issued required a minimum 200 foot from shoreline safety zone that was not to be entered during the race and heats that included event boats (Figure 1). Race and event boats were allowed to operate at idle within the safety zone. This safety zone was implemented as a supplement to the requirements of the permit to provide added measures for public safety and for environmental protection to near-shore aquatic resources, including waterfowl, shorebirds, and possible shoreline erosion due to increased wave action. Two race courses for the different classes of boats hosted for the weekend were established on the lake.

Figure 1. Race courses for Maple City Grand Prix held at Stone Lake in the City of LaPorte, LaPorte County, May 31- June 2, 2013.

IV. METHODS

Aquatic Plant Survey

Aquatic vegetation monitoring took place before the race on May 29, 2013, and after the race on June 3, 2013. Both submerged aquatic vegetation (SAV) and emergent plant beds were assessed during the surveys.

A Tier 2 SAV (see Tier 2 survey sampling protocol at http://www.in.gov/dnr/fishwild/files/fw-LARE_Tier_II_Procedure_Manual_Dec_2010.pdf for complete methods) survey consists of a number of stratified littoral sampling points. A lake between 100-199 acres typically has a minimum of 50 rake tosses. These tosses matched previous year's sampling points to enable comparison to sites from previous years. Tier 2 sampling protocol was followed, however 24 additional targeted rake tosses were added based on past collection locations of state-listed threatened plants that include Beck's water marigold (*Bidens beckii*) and white-stemmed pondweed (*Potamogeton praelongus*). These plants were first identified in 2000. Additionally, a less common plant, white water crowfoot (*Ranunculus longirostris*), was first identified at this lake during a pre-race Tier 2 survey. This plant is not listed on the State Endangered, Threatened, Rare and Extirpated Plants of Indiana list, but is not a commonly encountered species (Swink and Wilhelm1994). The State Endangered, Threatened, Rare and Extirpated Plants of Indiana list can be found at this web link: http://www.in.gov/dnr/naturepreserve/files/np-etrplants042513.pdf). Figure 2 shows all Tier 2 sampling locations.

Little is known about the historical composition and extent of coverage of emergent plant beds in Indiana lakes (Alix and Scribailo 1998). Emergent plants in natural lakes have been removed physically, mechanically, and chemically as a result of construction of piers, seawalls, beaches, and lakebed dredging associated with residential development. Other factors related to boating, such as disturbance from wave energy, destruction by propellers, and encroachment within shallow sensitive areas, are believed to be contributing to the loss of emergent plants (Indiana Lakes Management Workgroup 1999). Due to the possibility of negative impacts to emergent plant beds on Stone Lake an emergent plant bed mapping was conducted before the race on May 29, 2013 and after the race on June 3, 2013. Emergent plants were sampled by marking the edges of emergent plant beds with a GPS. This was a slightly modified sampling procedure compared to LARE Emergent Plant Sampling Guidelines (IDNR 2012) due to the presence of small emergent beds. The complete Guidelines can be found at http://www.in.gov/dnr/fishwild/files/fw-Emergent_Vegetation_Survey_Protocol_Jan_2012.pdf.

Floristic Quality of Vegetation

Much of the land in the State has been cleared, plowed, drained, converted to agriculture, and been transformed to urban and industrial environments. This is a drastic change from its pre-settlement environment of unbroken forests, prairies, and wetlands. As a result of this transformation, there has been a reduction of the State's biodiversity, which has encouraged the examination of how to effectively conserve and possibly restore many of these valuable habitats and monitor changes within the remnant natural communities present.

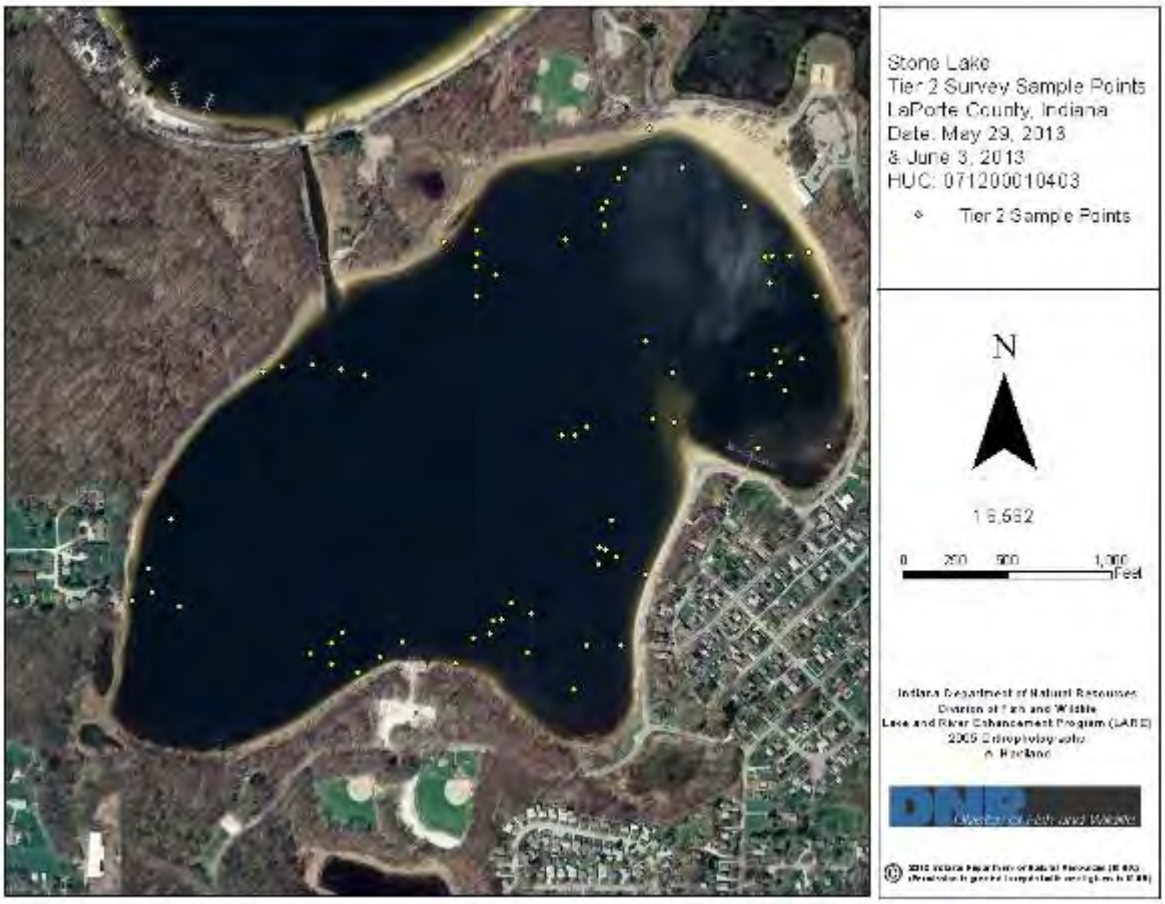

Figure 2. Tier 2 survey sampling locations for pre-race sampling on May 29th, 2013 and post-race sampling on June 3rd, 2013.

Floristic Assessment, which includes metrics such as the Floristic Quality Index (FQI) and Mean C values, have proven to be effective metrics in indentifying remnant habitats of floristic and ecological significance and in determining the qualitative and quantitative course of restoration and management efforts. The Floristic Assessment is the concept of species "conservatism," which is based upon the recognition that individual plant species display varying degrees of tolerance to disturbance and varying degrees of fidelity to specific natural habitats (Rothrock 2004). The assigned C values represent an estimated probability that a species is likely to occur in a landscape relatively unaltered from what is thought to be a pre-settlement condition (Rothrock 2004). The most conservative species require a narrow range of ecological conditions, are intolerant of disturbance, and are unlikely to be found outside intact remnant natural areas. The least conservative species can be found in a wide variety of settings and actually thrive upon disturbance (Rothrock 2004).

Coefficients range from 0 (highly tolerant of disturbance, little fidelity to any natural community) to 10 (highly intolerant of disturbance, restricted to pre-settlement remnants).

Conceptually this 10-point scale can be subdivided into several ranges as seen in Table 1 (Rothrock 2004).

Table 1. Range of coefficients to describe tolerance, quality, and disturbance in remnant communities.

Scale	Description
0-3	Species that provide little or no confidence that its inhabitance signifies remnant conditions.
4-6	Species that are typically associated with remnant plant community, but tolerate significant to moderate disturbance.
7-8	Species found in high-quality remnant plant communities, but appear to endure form time to time, some disturbance.
9-10	Species restricted to remnant landscapes that appear to have suffered very little post-settlement trauma.

Source: Rothrock 2004

Each species of submerged and emergent vegetation recorded at Stone Lake during the Tier 2 sampling and emergent plant sampling were evaluated on its C value and a management recommendation given to reflect their observed behavior in their environment. Equivalent Mean C values obtained from Stone Lake will establish the conservation potential. This can be accomplished through the Floristic Quality Index:

> "FQI adds a weighted measure of species richness by multiplying the Mean C by the square root of the total number of native species. As with Mean C, higher FQI numbers indicate higher floristic integrity and a lower level of disturbance impacts to the site."

FQI Method 2 was used to calculate the FQI of Stone Lake. Method 2 uses values by counting non-natives species and assigning them a value of 0. The method consists of this calculation taken from Rothrock 2004:

(a) Apply the appropriate Coefficient of Conservatism to each NATIVE species;
(b) Calculating the Mean C for the assessment area:

Mean C = $\Sigma(c1+c2+c3+\ldots cn)/N$ where c is the Coefficient of Conservatism for each native species identified on the site and N is the total number of NATIVE species inventoried in the assessment area.

(c) Compute the final FQI by multiplying the Mean C by the square root of the total number of NATIVE species

FQI = Mean C * $\sqrt{N}$

Hydroacoustic Survey

Hydroacoustics is defined as active sound in water (sonar) that is used to study submerged aquatic vegetation, bathymetry, and fish biomass (Domico 2007). Hydroacoustic technology proves useful in various environments, including marine and large lake ecosystems. Hydroacoustics is an effective method to study various habitat characteristics and parameters, such as bathymetry, bottom type, and aquatic vegetation distribution.

Hydroacoustic assessments in Indiana have traditionally employed mobile surveys from a slow moving boat to evaluate vegetation cover and bathymetry using Biosonics, Inc. echosounder and transducers. Most recently the technology has been utilized to analyze substrate composition of lake beds in northern Indiana. A pulse of energy (an echo) travels through the water at approximately 5 pings per second. When the acoustic pulse encounters vegetation, bottom, and a difference in bottom, the energy is reflected back to the transducer. Dual operation of 420 kHz and 200 kHz transducers allow for collection of multiple types of acoustical data such as substrate type, vegetation density and abundance, and bathymetry (Sabol 2002). The echo sounder surface unit then transmits the echo signal to a device, in this case a laptop computer, and displays the information to the operator. The echo signals are then stored in time interval transect files for later data analysis.

The hydroacoustic survey was completed on June 3, 2013 from a slow moving boat with transducers deployed parallel to the lake bottom. Two circuits were first made around the lake to ensure the littoral zone of the lake was adequately captured. Transects were then completed across the lake perpendicular to the longest length of shoreline, parallel to each other, and spaced approximately 20-30 meters apart depending on size, complexity of previous bathymetry, or the lack of any type of previous survey. Consistent even spacing is essential to ensure the best quality data because BioSonics algorithms, which calculate the average between data points, are most accurate with evenly spaced data points.

Erosion Bank Pins

Bank pins have been used elsewhere to measure and quantify bank erosion directly in the field (Asplund 2000). Bank pin monitoring is an established method of assessing bank erosion with a semi-permanent marker (a “pin”). This pin is installed and measurements of the amount of pin exposed are made over time. The erosion pin technique is based on the principle that a pin is inserted into a bank, leaving a known length exposed to provide a benchmark against which subsequent erosion can be measured. The pins were placed at bank level before the boat race on May 30, 2013. The erosion control pins were ¼” in diameter by 18.5 inches in length and a zip tie was affixed at the base of the pin where it met the substrate. If any erosion had occurred, soil would be washed away below the zip tie when the pins were re-measured on June 3, 2013. This would make it possible to determine the extent of erosion along the shoreline due to the increased wave action caused by high-speed boating.

Dissolved Oxygen and Temperature

Dissolved oxygen (DO) and temperature are two fundamental measurements of lake productivity. The amount of dissolved oxygen in the water is an important indicator of overall lake health. A lake's oxygen and temperature patterns influence not only the physical and chemical qualities of a lake, but also the sources and quantities of phosphorus, as well as the types of fish and animal populations. By measuring dissolved oxygen and temperature, scientists can gauge the overall condition of a waterbody. Aquatic organisms need dissolved oxygen for their survival, while water temperature also directly influences aquatic organisms' growth and survival. Dissolved oxygen and temperature were measured pre-race on May 29, 2013, during racing on June 1, 2013 and post-race on June 3, 2013. Additional measurements were also recorded on August 2, 2013 to measure any possible long-term changes. Measurements were recorded every meter to the bottom of the lake at the deepest point using an YSI Model 85 Temperature/Dissolved Oxygen Meter.

Water Chemistry Testing

Standards and guidelines are established to protect water for designated uses such as drinking, recreation, agricultural irrigation, or protection and maintenance of aquatic life. The US EPA and the States are responsible for establishing the standards for components in water that have been shown to pose a risk to human health. These standards protect aquatic life, including fish, and fish-eating wildlife such as birds. Samples were collected on May 28, 2013; June 1, 2013; June 3, 2013; July 1, 2013; and August 2, 2013 to determine any changes that occurred as a result of the race.

Water samples were collected according to Indiana University's Clean Lakes Program Sampling Protocol (Protocol can be found starting on page 17 in the Indiana Lake Water Quality Assessment Report for 2009-2011 by Jones *et al* 2012 at http://www.indiana.edu/~clp/documents/LWQA%202009-2011.pdf). Samples were collected in the field using a Kemmerer Sampler for laboratory analysis of several water chemistry parameters that included nitrate, ammonia, Total Kjeldhahl Nitrogen (TKN), total phosphorus, and Soluble Reactive Phosphorus (SRP). The water samples were collected in a 125-ml HDPE bottle which contained 0.125 mL of sulfuric acid (H_2SO_4) for preservation. Samples were then placed in an ice chest in the field until they were transported to the laboratory. Samples were collected from the epilmnion and hypolimnion, generally 1 meter below the surface and from 1 meter above the bottom of the lake. Samples were delivered to Indiana University and analyzed by their technicians.

Waterfowl

Waterfowl are a diverse group of birds that include geese, swans, and ducks. They are highly mobile species with diverse habitat needs and can have a home range that is continental in scale. Waterfowl habitat needs not only can change seasonally, but can change daily as well. Providing a diverse variety of high-quality waterfowl habitats is critical to ensuring waterfowl populations continue to thrive. Because waterfowl depend on wetlands throughout the year, the loss of natural habitat, including wetlands in the Midwest, due to human disturbance, pose a real threat

(Korschegen and Dahlgren 1992). Breeding waterfowl can nest in a wide range of habitats that include un-vegetated beaches to moderately tall grass in upland environments.

To evaluate available habitat, nesting activities of waterfowl, and overall waterfowl use of Stone Lake, IDNR District Wildlife Biologist Linda Byer, investigated the lake by boat the shoreline by foot. Observations were made on May 29 and 31, 2013.

V. RESULTS

Aquatic Plant Survey

Nineteen submersed aquatic plant species were found in the pre-race sampling (Table 2) compared to 18 species post-race (Table 3). The only species not observed post-race was eelgrass (*Vallisneria americana*) however it was very low in frequency of occurrence initially. The increase or decrease in a species could be due equipment accuracy, as the GPS can fluctuate in accuracy due to weather conditions. A rake toss can vary based on the individual throwing the rake, and the fact that the only specimen of a species could have been collected pre-race and thus would not be found at the site post-race.

Most species did not dominate a single plant bed as most species ranked only a "1" on a rake score, but rather the lake exhibited extensive plant diversity among the plant beds. The mean number of native species per site was identical in both samples at 2.12. The highest number of species per site was ten on May 29, 2013. The maximum number of species observed at a single site post-race decreased to seven. The number of sites with plants also decreased post-race from 61 to 60. Eurasian watermilfoil (*Myriophyllum spicatum*), coontail (*Ceratophyllum demersum*), flat-stem pondweed (*Potamogeton zosteriformis*), large-leaf pondweed (*Potamogeton ampilfolius*) and elodea (*Elodea canadensis*) were the five most dominant species in both surveys.

The majority of species observed had a decrease in the frequency of occurrence between pre-race and post-race sampling, although some species did increase. Of the 16 native species found in both surveys, nine species declined in frequency of occurrence post-race. Six species increased in frequency of occurrence post-race while *Nitella* sp. remained unchanged.

Of the native plants present in Stone Lake, three are listed on the state Endangered, Threatened, Rare, and Extirpated list. White-stemmed pondweed and Beck's water marigold are listed as state threatened and critically imperiled in the state. Fern pondweed (*Potamongeton robbinsii*) is state listed as rare and imperiled in the state. White water crowfoot is found in this lake, but is becoming less common in the state (Swink and Wilhelm 1994).

Beck's water marigold (*Bidens beckii*) was present at 10 locations during the pre-race Tier 2 survey, at variable depths, with the deepest location being at 14.5 feet with an average depth occurrence of 8.9 feet. *Bidens beckii* was present at only five locations post-race, with a maximum depth of 15 feet and with an average depth of occurrence at 10 feet.

Two aquatic invasive species were observed during the survey which included Eurasian watermilfoil and curly-leaf pondweed (*Potamogeton crispus*). Eurasian watermilfoil was found at about 42% of the sites while curly-leaf was at less than 15% of the locations sampled in the survey following the race. Approximately 36 acres of Eurasian watermilfoil was chemically treated on May 2, 2013.

Table 2. Tier 2 survey results from Stone Lake, pre-race sampling on May 29, 2013.

Occurrence and Abundance of Submersed Aquatic Plants in Stone Lake.

County:	LaPorte	Secchi (m):	6	Mean species/site:	2.74
Date:	5/29/2013	Sites with plants:	61	SE Mean species/site:	0.24
Littoral Depth (ft):	25.0	Sites with native plants:	59	Mean native species/site:	2.12
Littoral Sites:	74	Number of species:	19	SE Mean natives/site:	0.21
Total Sites:	74	Number of native species:	17	Species diversity:	0.89
		Maximum species/site:	10	Native species diversity:	0.88

All Depths	Frequency of	Rake score frequency per species				Plant
Species	**Occurrence**	**0**	**1**	**3**	**5**	**Dominance**
Eurasian watermilfoil	48.6	51.4	39.2	9.5	0.0	13.5
Coontail	47.3	52.7	45.9	1.4	0.0	10.0
Flat-stem pondweed	33.8	66.2	33.8	0.0	0.0	6.8
Large-leaf pondweed	29.7	70.3	23.0	6.8	0.0	8.6
Elodea	25.7	74.3	25.7	0.0	0.0	5.1
Curly-leaf pondweed	13.5	86.5	13.5	0.0	0.0	2.7
Water marigold	13.5	86.5	13.5	0.0	0.0	2.7
Variable pondweed	12.2	87.8	12.2	0.0	0.0	2.4
Leafy pondweed	9.5	90.5	9.5	0.0	0.0	1.9
Northern watermilfoil	8.1	91.9	8.1	0.0	0.0	1.6
Sago pondweed	6.8	93.2	6.8	0.0	0.0	1.4
Eelgrass	5.4	94.6	5.4	0.0	0.0	1.1
Southern naiad	5.4	94.6	5.4	0.0	0.0	1.1
Water stargrass	4.1	95.9	4.1	0.0	0.0	0.8
Fern pondweed	2.7	97.3	2.7	0.0	0.0	0.5
White-stemmed pondweed	2.7	97.3	2.7	0.0	0.0	0.5
White water crowfoot	2.7	97.3	2.7	0.0	0.0	0.5
Chara	1.4	98.6	1.4	0.0	0.0	0.3
Nitella	1.4	98.6	1.4	0.0	0.0	0.3

Table 3. Tier 2 survey results from Stone Lake, post-race sampling on June 3, 2013.

Occurrence and Abundance of Submersed Aquatic Plants in Stone Lake.

County:	LaPorte	Secchi (m):	7.2	Mean species/site:	2.69
Date:	6/3/2013	Sites with plants:	60	SE Mean species/site:	0.22
Littoral Depth (ft):	25.0	Sites with native plants:	58	Mean native species/site:	2.12
Littoral Sites:	74	Number of species:	18	SE Mean natives/site:	0.18
Total Sites:	74	Number of native species:	16	Species diversity:	0.91
		Maximum species/site:	7	Native species diversity:	0.89

All Depths	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		**0**	**1**	**3**	**5**	
Coontail	41.9	58.1	39.2	2.7	0.0	9.5
Eurasian watermilfoil	41.9	58.1	40.5	1.4	0.0	8.9
Flat-stem pondweed	32.4	67.6	32.4	0.0	0.0	6.5
Large-leaf pondweed	24.3	75.7	23.0	1.4	0.0	5.4
Elodea	20.3	79.7	20.3	0.0	0.0	4.1
Fern pondweed	17.6	82.4	17.6	0.0	0.0	3.5
Curly-leaf pondweed	14.9	85.1	14.9	0.0	0.0	3.0
Leafy pondweed	14.9	85.1	14.9	0.0	0.0	3.0
Northern watermilfoil	12.2	87.8	12.2	0.0	0.0	2.4
Variable pondweed	9.5	90.5	9.5	0.0	0.0	1.9
Chara	8.1	91.9	8.1	0.0	0.0	1.6
White water crowfoot	8.1	91.9	8.1	0.0	0.0	1.6
Water marigold	6.8	93.2	6.8	0.0	0.0	1.4
Water stargrass	6.8	93.2	6.8	0.0	0.0	1.4
Southern naiad	4.1	95.9	4.1	0.0	0.0	0.8
Sago pondweed	2.7	97.3	2.7	0.0	0.0	0.5
Nitella	1.4	98.6	1.4	0.0	0.0	0.3
White-stemmed pondweed	1.4	98.6	1.4	0.0	0.0	0.3

Emergent Plant Sampling

Many emergent plants were observed however three species dominated the emergent community that included spatterdock (*Nuphar advena*), white water lily (*Nymphaea odorata s. tuberosa*), and a bulrush species (*Scirpus spp*). The majority of the emergent plants were found along the southern shoreline, with a few patches along the other parts of the shore (Figure 3). Woody brush surrounds most of the immediate shoreline, while the emergent vegetation that is present, lays just lakeward of that. Emergent plant beds remained unchanged between sampling dates.

Figure 3. Locations of emergent plant beds on Stone Lake.

Floristic Quality of Vegetation

Each plant found in Stone Lake has a predetermined Coefficient of Conservatism, or C value (Table 4). Those values were obtained from Plants of the Chicago Region (Swink and Wilhelm 1994). The assigned C values represent an estimated probability that a species is likely to occur in a landscape relatively unaltered from what is thought to be a pre-settlement condition. The most conservative species require a narrow range of ecological conditions, are intolerant of disturbance, and are unlikely to be found outside intact remnant natural areas. The least conservative species can be found in a wide variety of settings and actually thrive upon disturbance (Rothrock 2004). Utilizing this method, a Floristic Quality Index (FQI) and Native Mean C are derived for a given area. The FQI is an indication of native vegetative quality for an area: generally 1-19 indicates low vegetative quality; 20-35 indicates high vegetative quality and above 35 indicates "Natural Area" quality (Rothrock 2004). Stone Lake has an FQI of 29.06, indicating that the lake exhibits high vegetative quality.

Table 4. C values of plants in Stone Lake as described in Plants of the Chicago Region.

Scientific Name	**Common Name**	**C Value**
Potamongeton robbinsii	Fern pondweed[3]	10
Potamogeton praelongus	White-stemmed pondweed[2]	10
Myriophyllum sibiricum	Northern watermilfoil	10
Bidens beckii	Beck's water marigold[2]	10
Potamogeton ampilfolius	Large-leaf pondweed	10
Potamogeton gramineus	Variable pondweed	9
Ranunculus longirostris	White water crowfoot[4]	8
Heteranthera dubia	Water stargrass	8
Najas guadalupensis	Southern naiad	8
Potamogeton zosteriformis	Flat-stem pondweed	8
Vallisneria americana	Eel grass	7
Potamogeton foliosus	Leafy pondweed	7
Nuphar advena	Spatterdock	7
Nymphae ordorata s. tuberosa	White water lily	7
Potamogeton pectinatus	Sago pondweed	5
Elodea canadensis	Elodea	5
Ceratophyllum demersum	Coontail	5
Myriophyllum spicatum	Eurasian watermilfoil[1]	0
Potamogeton crispus	Curly-leaf pondweed[1]	0

[1] indicates invasive species
[2] indicates State threatened species
[3] indicates State rare species
[4] indicates less common species

Hydroacoustic Survey

The hydroacoustic survey was used to determine the bathymetry of the lake in 5 foot intervals (Figure 4). This survey was able to determine a maximum depth of 39 feet in the northern basin

of the lake. The survey also identified a shallow bench between 5 and 10 feet deep extending across the lake from the northeast to the southwest shore.

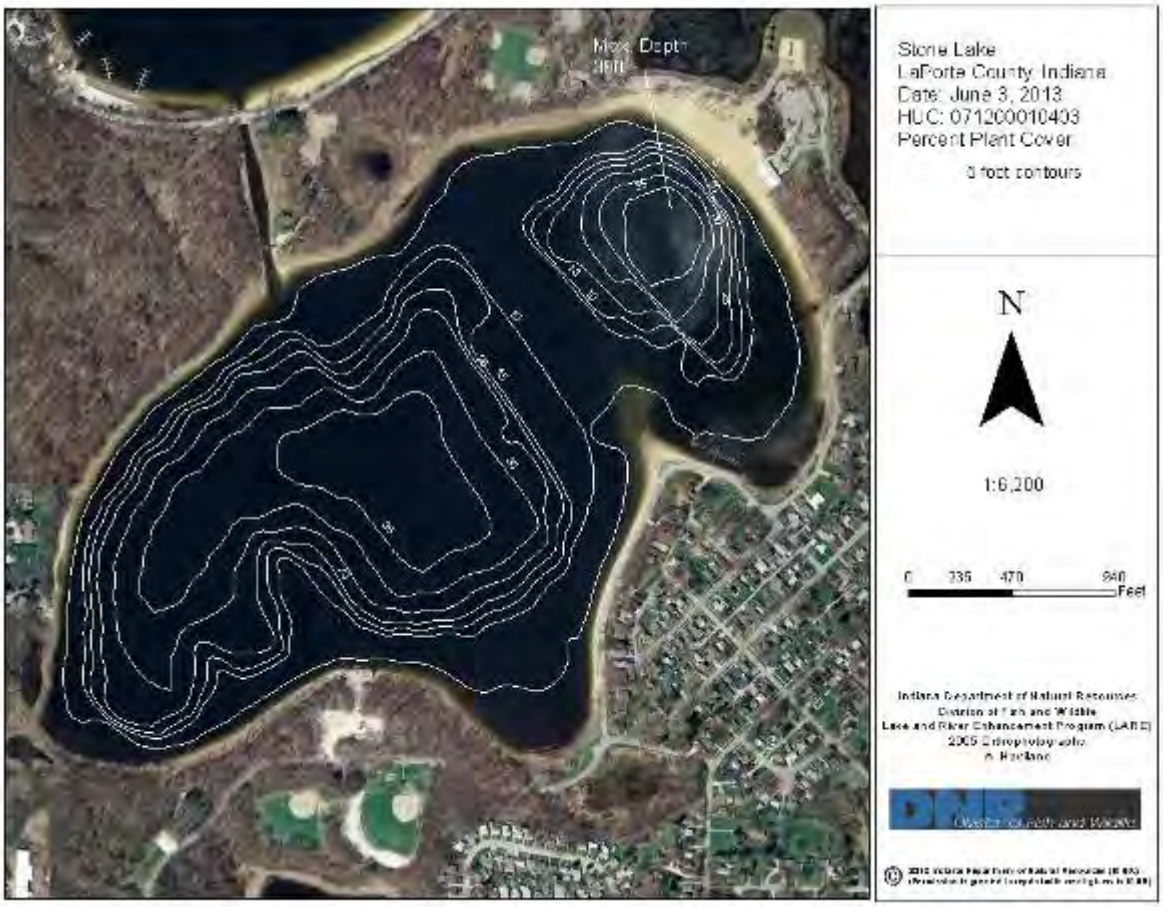

Figure 4. Bathymetric map of Stone Lake.

The hydroacoustic survey also yielded percent cover of submersed plants found in Stone Lake (Figure 5). A large area, approximately 12 acres, of the plant community that contains the highest density of submerged aquatic vegetation is found in the shallow bench area of the lake. This area was within both race courses.

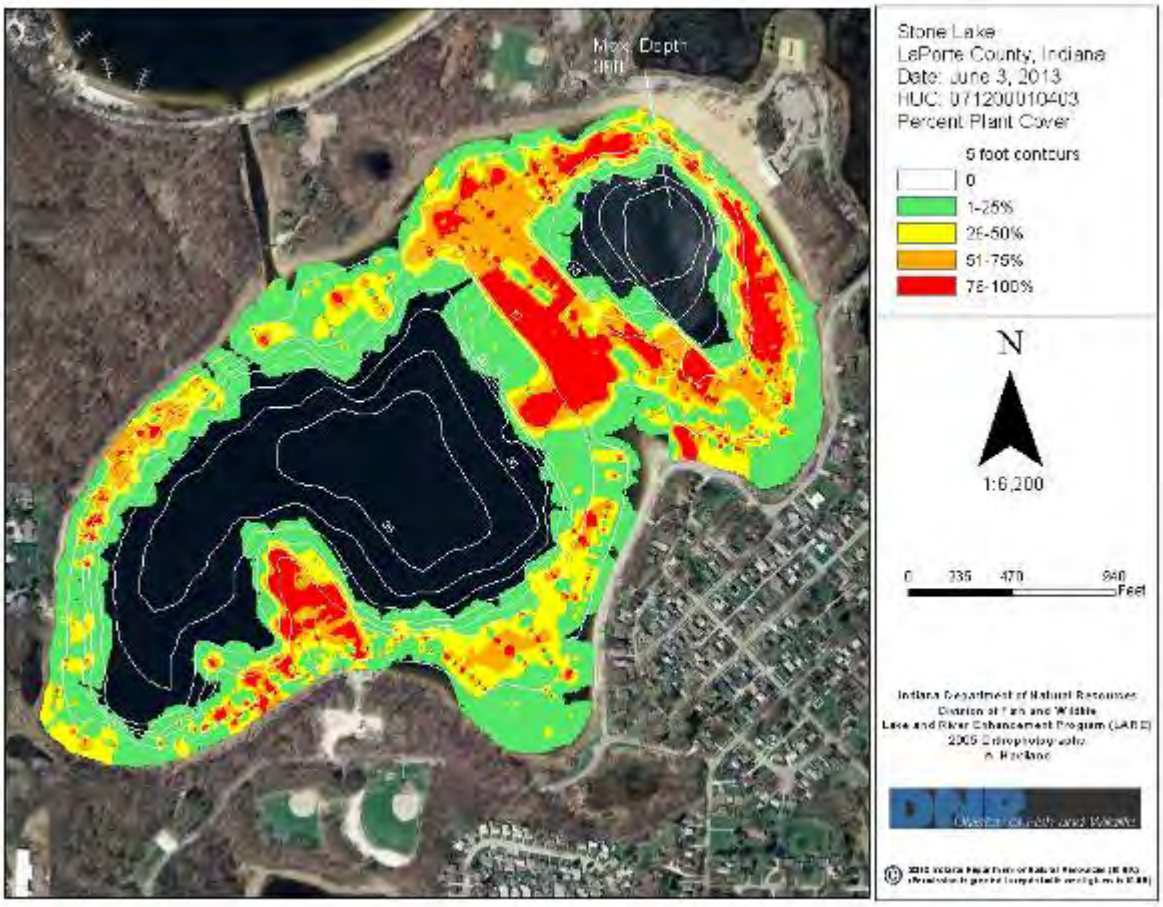

Figure 5. Plant cover at Stone Lake, June 3, 2013.

Erosion Bank Pins

Bank pins were observed for erosion post-race on June 3, 2013. While data from the bank pins yielded inconclusive evidence of erosion, there was a significant change in the amount of fragmented vegetation observed around the bank pins themselves and within the vicinity of the pins. Table 5 describes the change in fragmented vegetation (Appendix B for Photos).

Table 5. Observation of bank pins following the race on June 3, 2013.

Pin	**Notes/Site Details**
1	More vegetation has accumulated near/around the pin.
2	More vegetation has accumulated near/around the pin.
3	More vegetation has accumulated near/around the pin. Vegetation is noticeably stacked against the side of the pin facing the open water.
4	Little/No difference
5	More vegetation has accumulated near/around the pin.
6	Little/No difference

Dissolved Oxygen and Temperature

Higher dissolved oxygen (DO) concentrations are correlated with high primary productivity and little pollution. Oxygen saturation is temperature dependent, and cold water generally has higher dissolved oxygen concentrations than warm water. As the surface water temperature rises throughout the spring and summer, the denser cold water becomes trapped below the warm water and the lake becomes stratified. At deeper depths, oxygen is consumed by decomposition of organic material faster than it can be produced. Fish usually need a minimum DO of 4 mg/L to survive (United States Department of the Interior 2010). The DO levels in Stone Lake are sufficient to support fish down to 8 or 9 meters during summer stratification. Stone Lake tends to host relatively high dissolved oxygen numbers which spike deeper in the water column (Figures 6-9). This is referred to as a positive heterograde that is usually caused by extensive photosynthetic activity by algae in the metalimnion (Hebert & Ontario 2008).

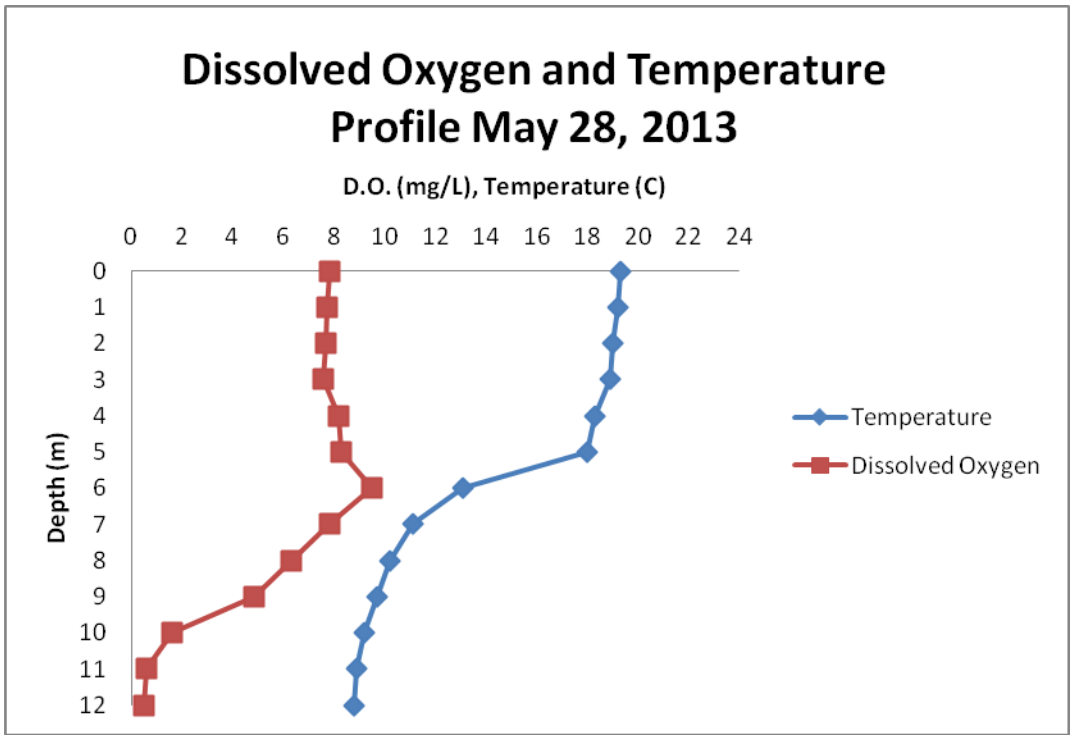

Figure 6. Dissolved Oxygen and Temperature Profile for Stone Lake May 28, 2013.

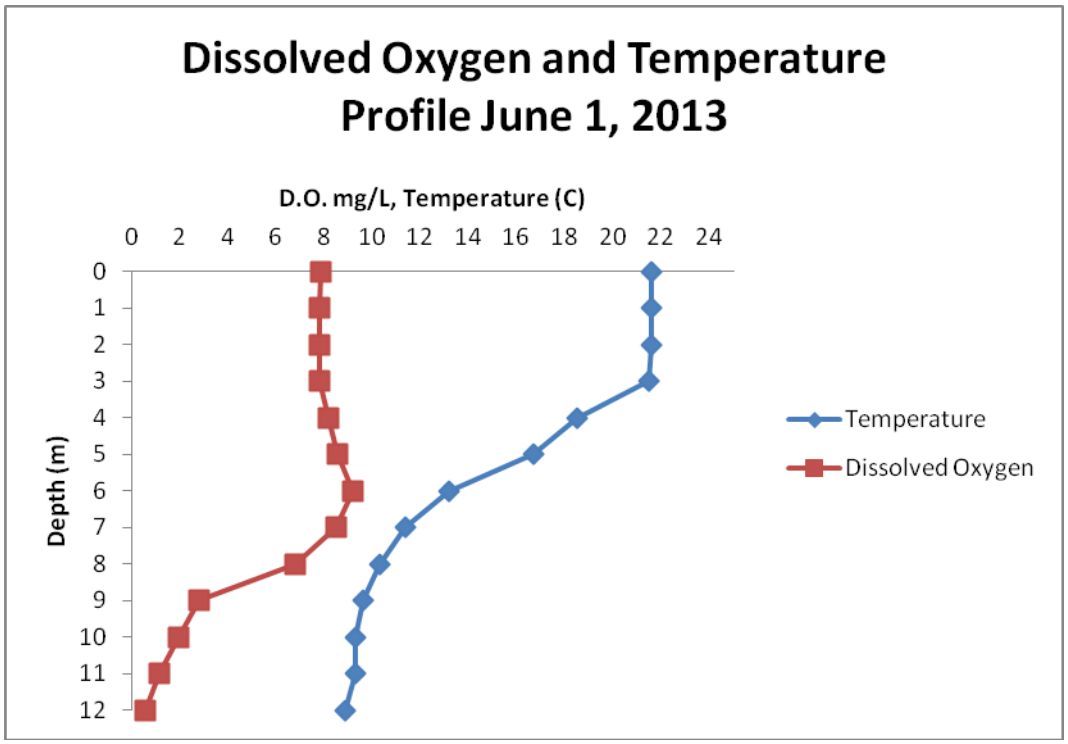

Figure 7. Dissolved Oxygen and Temperature Profile for Stone Lake, June 1, 2013.

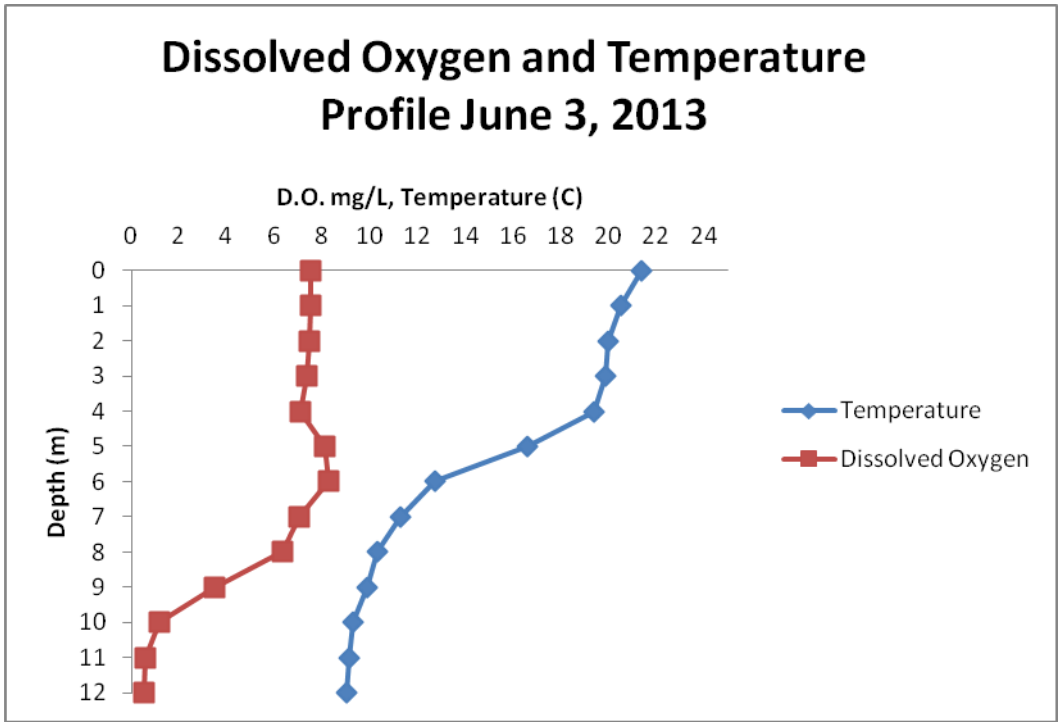

Figure 8. Dissolved Oxygen and Temperature Profile for Stone Lake, June 3, 2013.

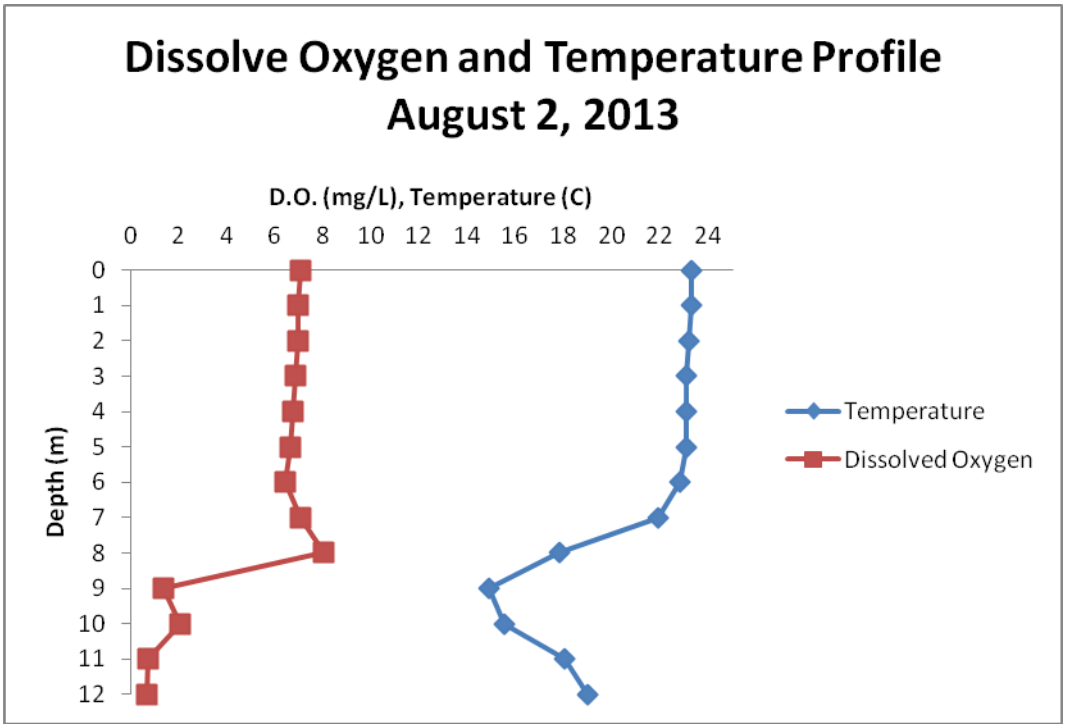

Figure 9. Dissolved Oxygen and Temperature Profile for Stone Lake, August 2, 2013.

Water Chemistry

Nitrate (NO^3) is a naturally occurring form of nitrogen found in soil that is essential to all life. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements. Most crop plants require large quantities to sustain high yields. Due to its high mobility, nitrate can leach into groundwater (Self 1998). High levels of nitrate can cause illness in humans. The Indiana Department of Environmental Management (IDEM) set a maximum standard of 10mg/L in waters designated as drinking water sources. While there was no change in NO^3 in May, June, and July samples, August did have higher readings at 0.5 mg/L in the epilimnion and 2.8 mg/L in the hypolimnion (Table 6).

Ammonia (NH_4) levels in excess of the recommended limits may harm aquatic life. The ammonia molecule is a nutrient required for life, but excess ammonia may accumulate in an organism and cause alteration of metabolism or increases in body pH (National Research Council 1987). At extreme ammonia levels, fish may experience convulsions, coma, and death. As ammonia levels breech 2.0 mg/L, fish can begin to die. The Clean Lakes Program has sampled 456 lakes between the months of July and August from 1998-2004, the median NH_4 level over these lakes and this period of time is 0.818 mg/L, with a maximum observation of 22.5 mg/L (Indiana Clean Lakes Program 2013). The ammonia levels in Stone Lake were all well below the state median. However, ammonia was significantly higher in the hypolimnion in the June and July samples at 0.286 and 0.165 mg/L, respectively. Typically high ammonia levels are a result of sanitary pollution or livestock waste.

Table 6. Nitrate, Ammonia, TKN, Total Phosphorus, and SRP water chemistry data pre-race, during, and a post race sample. An additional two long term monitoring samples were also taken.

Parameter	**5/28/2013**	**6/1/2013**	**6/3/2013**	**7/1/2013**	**8/2/2013**
NO^3 Epi	0.013	0.013	0.013	0.013	0.5
NO^3 Hyp	0.013	0.013	0.013	0.013	2.8
NH_4 Epi	0.018	0.019	0.005	0.018	0.013
NH_4 Hyp	0.054	0.078	0.286	0.165	0.013
TKN Epi	0.353	0.418	0.563	0.391	0.018
TKN Hyp	0.384	0.445	0.713	0.23	0.172
Total Phosphorus Epi	0.007	0.02	0.01	0.027	0.002
Total Phosphorus Hyp	0.01	0.025	0.014	0.0415	0.001
SRP Epi	0	0	0	0.0035	0.759
SRP Hyp	0.002	0.005	0.005	0.002	0.849

Total Kjeldhal Nitrogen (TKN) is the sum of organic nitrogen and ammonia in a water body and is measured in milligrams per liter (mg/L). High measurements of TKN typically result after sewage and manure discharges to water bodies. TKN is a portion of the total nitrogen measurement. The US EPA has a maximum limit established at 0.591 mg/L. The median level of TKN in Indiana is 1.66 mg/L (Indiana Clean Lakes Program 2013). Stone Lake samples did not exceed the USEPA maximum limit or the state median in the epilimnion. The sample taken in the hypolimnion exceeded the USEPA limit at 0.713 mg/L on June 3, 2013.

Phosphorus is one of the key elements necessary for growth of plants and animals. Phosphorus often exhibits a scarce presence in well-oxygenated lakes and low levels of phosphorus limit the production of freshwater systems (Ricklefs 1993). Unlike nitrogen, phosphorus is retained in the soil by a complex system of biological uptake, absorption, and mineralization. Phosphates are not toxic to people or animals unless present in very high levels. As phosphorus enters a lake, it can result in an increase in the growth of plankton and aquatic plants, which provide food for larger organisms, including zooplankton, fish, humans, and other mammals. Too much phosphorus entering the system over time can accelerate the aging process of the lake known as eutrophication (Ricklefs 1993). The impact of phosphorus on water quality is very complex, and IDEM has yet to establish a maximum standard concentration for Indiana lakes, but has draft Total Maximum Daily Load (TMDL) of 0.3 mg/L. Stone Lake water samples did not exceed the proposed TMDL of 0.3 mg/L on any sample. Measurements ranged from 0.001-0.0415 mg/L with the highest reading occurring on July 1, 2013 in the hypolimnion.

Soluble Reactive Phosphorus (SRP) is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae and cycled very rapidly. This phosphorus consists largely of the inorganic orthophosphate (PO_4) form. Orthophosphate is the phosphorus form that is directly taken up by algae, and the concentration of SRP constitutes an index of the amount of phosphorus immediately available for algal growth. USEPA water quality criteria limits SRP to 0.25 mg/L.

Median SRP levels as determined by the Clean Lakes Program for lakes in the State of Indiana is 0.12 mg/L (Indiana Clean Lakes Program 2013). SRP levels were extremely low for all samples except August. On August 2, 2013 levels of SRP in Stone Lake greatly exceeded the state median and USEPA limits in both the epilimnion and hypolimnion at 0.759 mg/L and 0.849 mg/L, respectively.

The most commonly encountered groups of freshwater plankton are green algae, blue-green algae (cyanobacteria), and diatoms. Green algae contain bright, grass-green pigments, and are more abundant than all the other groups (Sandgren1988). The cells of green algae may occur singly, as spherical colonies, or as filaments (Sandgren 1988). Most green algae are a good food source for zooplankton. Green algae cell counts were extremely low in all samples except for July 1, 2013 when the count rose considerably to 27 cells/ml (Table 7). This rise also corresponds with an increase of other photosynthetic plankton populations.

Cyanobacteria are known for their extensive and highly visible blooms and have a blue-green appearance. They are commonly referred to as blue-green algae. Some cyanobacteria produce toxins which can be toxic and dangerous to humans as well as other animals (Butler and Carlisle 2009). Blue-green algae blooms are common in Indiana from May to October (IDEM 2013). Factors that promote blue-green algae growth can include sunlight, water quality, weather, nutrient sources such as nitrogen and phosphorus, and suspended bottom sediments. For protection of human health from cyanobacteria, the World Health Organization uses a guideline level of greater than 100,000 cells/ml to issue a high risk health alert in recreational waters. Blue-green algae counts were extremely low throughout the sampling season with the highest reading being only 313 cells/mL in July.

Diatoms are a major component of the plankton community and appear as yellow-green or yellow-brown algae that occur singly or more rarely in colonies. Diatoms are photosynthetic, gaining energy from the sun using chlorophylls a and c. World-wide, diatoms provide a major food resource for zooplankton and also produce atmospheric oxygen. Diatom species are very particular about the water chemistry in which they live. Species have distinct ranges of pH and salinity where they will grow. Diatoms also have ranges and tolerances for other environmental variables, including nutrient concentration, suspended sediment, flow regime, elevation, and different types of human disturbance (Smohl and Stoermer 2010). Diatoms were elevated in the July 1 sample at 1314/L.

One group of toxins produced and released by cyanobacteria are called microcystins. Microcystins are the most common of the cyanobacterial toxins found in water, as well as being the ones most often responsible for contributing to adverse health issues for animals and humans who come into contact with toxic blooms. Microcystins are extremely stable in water because of their chemical structure which means they can survive in both warm and cold water and can tolerate radical changes in water chemistry, including pH. The World Health Organization uses microcystin toxin levels of 20 µg/Las the criteria for a high risk health alert in recreational waters. Indiana uses 6 µg/L of microcystin toxin as a warning level (IDEM 2013). Microcystin levels ranged from a low of 0.008 µg/L on August 2 to a high of 0.287 µg/L on July 1.

Chlorophyll *a* is the photosynthetic pigment that causes the green color in algae and plants. The concentration of chlorophyll *a* present in the water is directly related to the amount of algae living in the water. Excessive concentrations of algae give lakes an undesirable "pea soup" appearance (Carlson 1977). The water quality characteristics of a lake largely determine which types of algae will be present. Lakes with high nutrient enrichment will tend to support larger numbers of algae than lakes with low nutrient enrichment. Other factors such as water temperature, depth, pH, and alkalinity also influence the species and numbers of algae found in a lake. For an oligotrophic lake, Carlson's Trophic State Index indicates that Stone Lake would typically exhibit Chlorophyll *a* in a range between 0 and 2 (Figure 10). Except for the July 1 sample with a reading of 5.58mg/m3 which ranks in the mesotrophic classification, all other samples were well below 1 mg/m3 which indicates an oligotrophic lake.

Secchi disk transparency is the depth to which the black and white Secchi disk can be seen in the lake water. Water clarity, as determined by a Secchi disk, is affected by two primary factors those being algae and suspended particulate matter. Particulates (soil or dead leaves) may be introduced into the water by either runoff or sediments already on the bottom of the lake. Erosion from construction sites, agricultural lands, and riverbanks all lead to increased runoff of particulates. Bottom sediments may be re-suspended by fish such as carp, by motorboats operating in shallow water, or wave action created by strong winds and all can result in reduced Secchi disk readings. The state average for Secchi disk transparency is 2.1 meters (6.9 feet) (Indiana Clean Lakes Program 2001), Stone Lake's Secchi disk readings ranged from 3 to 7.2 meters in 2013. The poorest water clarity reading occurred on July 1, 2013. This was also the date that had the highest green algae, blue-green algae, and diatom counts which all impact the clarity of water. Chlorophyll *a* was also at highest level observed by far on this date.

Table 7. Results showing concentrations of green algae, blue-green algae, diatoms, Microcystin, Chlorophyll *a*, and Secchi disk readings from pre-race, during, and post-race sampling. An additional two long-term samples were also collected.

Date	Green algae (Cells/ml)	Blue-green algae (cells/mL)	Diatoms #/L	Microcystin (µg/L)	Chlorophyll *a* (mg/m3)	Secchi disk (m)
05/28/2013	4	7	626	0.15	0.38	6
06/1/2013	4	36	792	0.15	0.4	6
06/3/2013	6	1	417	0.15	0.72	7.2
07/1/2013	27	313	1,314	0.287	5.58	3
08/2/2013	3	11	84	0.008	0.002	3.35

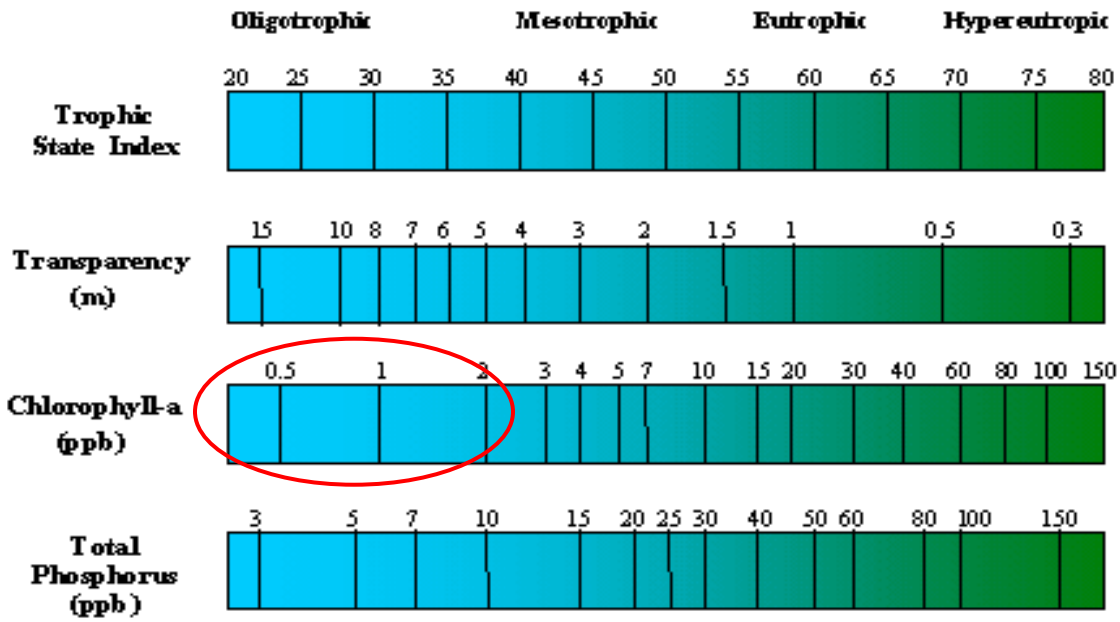

Figure 10. Carlson's Trophic State Index. Stone Lake's chlorophyll *a* concentrations should typically range between 0-2.
Source: United States Environmental Protection Agency 2007

Waterfowl Results
On May 29, 2013 District Wildlife Biologist, Linda Byer observed Stone Lake on foot and from a boat (See Appendix C for the full report). No waterfowl were observed on the main lake. Geese were observed along the shoreline feeding on grass, and a few wood ducks were observed in near shore emergent vegetation. Nesting activity was not observed anywhere along the entire perimeter of the lake.

May 31, 2013 observations were made in the morning prior to and a short time during race activity. A few geese were observed along the southeastern part of the lake moving from shoreline to the water. Later a couple of drake mallard ducks joined the geese, however, a dog and his owner came past and disturbed the mallard ducks, who then flew away. The family of geese moved east past the boat ramp and then exited the lake into a mowed yard. The boats entered the water around 11:20 A.M. CST, but this activity did not appear to disturb the geese. The geese remained undisturbed until observations concluded around 11:40 A.M.CST.

VI. DISCUSSION

Aquatic Plant Survey

The majority of sites that contained the rare and threatened plants Beck's water marigold, white-stemmed pondweed and fern pondweed were 6 feet or less, with a few sites being in deeper water. The majority of these sites were directly in the path of the race course. The greatest impact boats have on aquatic vegetation is in shallow waters less than 10 feet deep (Asplund 2000). Nine of 16 native species observed had a decrease in the frequency of occurrence between

pre-race and post race sampling. Six species increased. It is important to recognize that submerged aquatic plants perform many ecosystem functions including habitat for fish, wildlife, and invertebrates and stabilization of lake-bottom sediments and shorelines. Boats may impact aquatic vegetation either directly through contact with the propeller and boat hull, or indirectly through increased turbidity and wave damage.

Fragmentation of invasive species such as Eurasian watermilfoil and curly-leaf pondweed which are both present in Stone Lake can contribute to their rapid spread. Since Stone Lake has exceptional water clarity Eurasian watermilfoil will have ideal conditions to grow within many parts of the littoral zone and push out the diverse native vegetation present. This can lead to eutrophication of the lake and disappearance of the threatened and rare species of vegetation found at Stone Lake.

Stone Lake is rather unique for Indiana as plants can be found deeper than 20 feet. There is however, a very distinct "bench" which is between 5 and 10 feet deep that separates two deeper basins of the lake. This "bench" holds a significant amount of submerged vegetation with Beck's water marigold being located in the area of that bench. Both race courses passed over this shallow reach twice in each lap.

Emergent plants in Stone Lake are present mainly around the southern shore of the lake. Emergent plant beds play an important role in stabilizing sediment, providing habitat for fish, improving water clarity, and helps prevent shoreline erosion due to wave action. The 200 foot safety zone required in the race permit prevented the boats from coming into direct contact with the emergent plant beds.

Floristic Quality Index

The FQI has been developed and used for several regions throughout the United States to provide an objective assessment of the vegetation quality or biological integrity of wetland plant communities. Stone Lake's FQI score of 29.06 indicates that it exhibits high vegetative quality and a natural remnant community that is intolerant to disturbance. Losses of rare, natural remnant communities can have a serious impact on native biodiversity. Maintaining this high natural remnant community should be of highest priority as many of these types of communities have been loss due to development, urbanization, and increased nutrient inputs.

Erosion Bank Pins

While no conclusive results were drawn from bank pin observations, an increase in fragmented vegetation around the pins was observed. High speed boating in shallow water can result in fragmented vegetation that can be washed on shore due to the increase in wave action and can increase the spread of invasive species.

Water Chemistry

Stone Lake is an oligotrophic lake, which is characterized by a low accumulation of dissolved nutrients, supports sparse growth of algae and other organisms, and exhibits high oxygen

content. All water quality parameters tested indicated that there was not a dramatic change in water quality from normal readings although some parameters were elevated following the race.

Dissolved oxygen and temperature parameters indicated that the lake may have a productive layer deeper in the water column due to the exceptional water quality that Stone Lake exhibits. That layer persisted during and after the racing weekend. Water clarity remained steady during the race weekend and increased on June 3, 2013 to 7.2 meters (Figure 11). Clarity declined considerably on the July 1, 2013 sample. This decrease is more likely attributed to weather events around that time rather than impacts from the boat race. On June 26, 2013 nearly four inches of rain fell in LaPorte over a 24-hour period which almost certainly caused excessive runoff into the lake. Clarity increased slightly in the August sample but was below the average observed in samples from 1989 to 2010.

An increased suspension of nutrients in the water column can increase the risk of making the lake more productive in terms of algae growth. This can cause damage that may be irreversible in the near term. Motor boating activity particularly in shallow lakes with soft bottom substrates can increase phosphorus concentration in the water column by disturbing lake sediments (Yousef et al. 1980).

Some water quality parameters on Stone Lake have shown improvement since initial monitoring began in 1989. However, the largest spike in nitrate (NO_3) occurred in August 2013 following the boat races (Figure 12). Traditionally the lake has had nearly undetectable nitrate levels. Stone Lake has historically had ammonia levels that range from 0.013 to 0.336 mg/L during June, July, and August samples. During the sampling period from May 28, 2013 to August 2, 2013, Stone Lake exhibited some of the lowest observations of ammonia levels recorded to date. While levels were low, a steady increase ammonia was observed during and immediately after the race weekend. Late summer samples showed ammonia levels declining and exhibiting historical lows (Figure 13). Stone Lake has historically observed levels of Total Kjeldhal Nitrogen below the state median of 1.66 mg/L, but these samples exceeded the USEPA limit of 0.591 mg/L in the epilimnion and hypolimnion. Sampling in 2013 yielded historical lows of TKN in Stone Lake until the sample on June 3, 2013 which exceed the USEPA limit at 0.713 mg/L (Figure 14). Following the June 3, 2013 sample TKN levels declined to record lows.

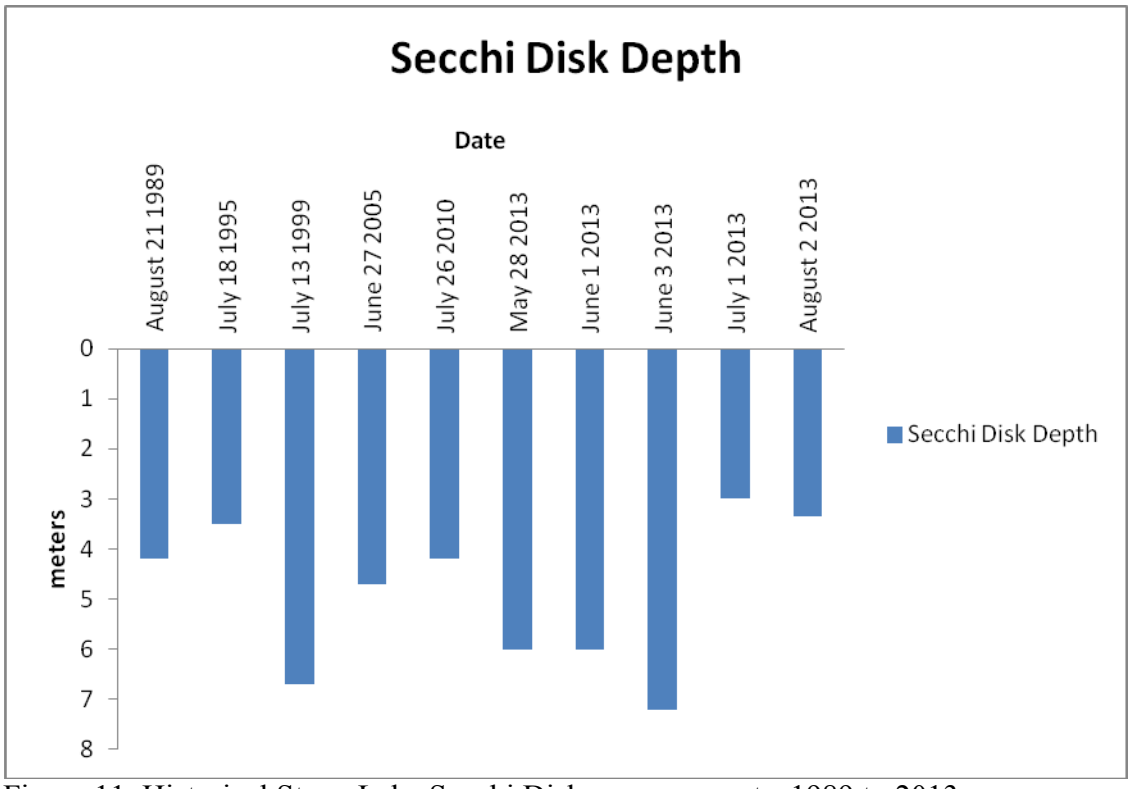

Figure 11. Historical Stone Lake Secchi Disk measurements, 1989 to 2013.

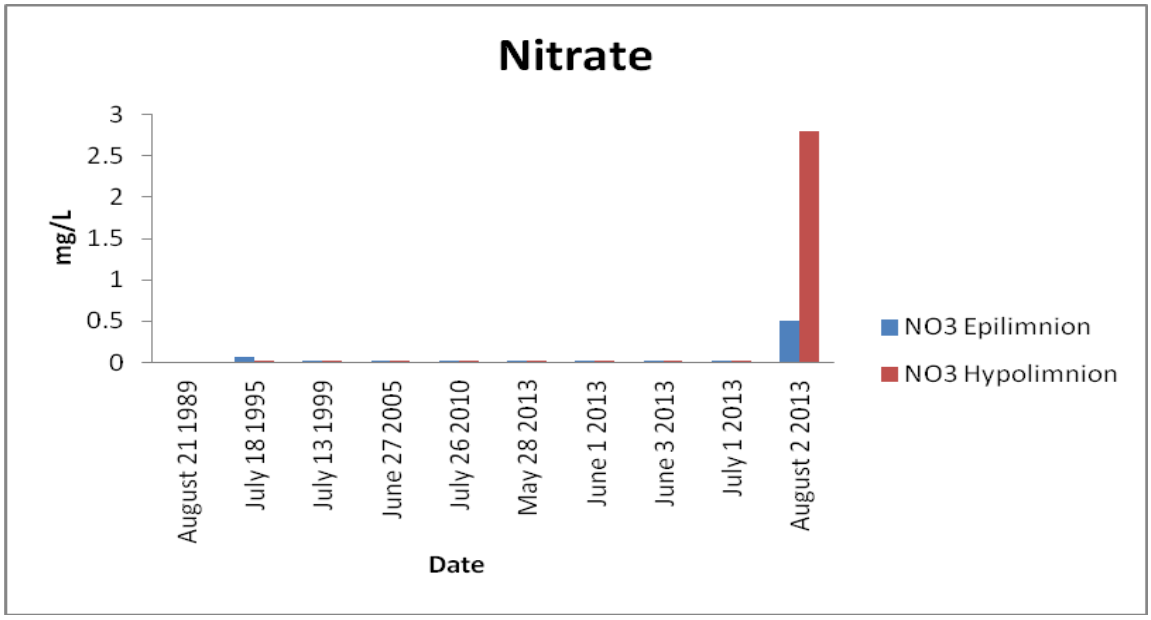

Figure 12. Historical nitrate values at Stone Lake, 1989 to 2013.

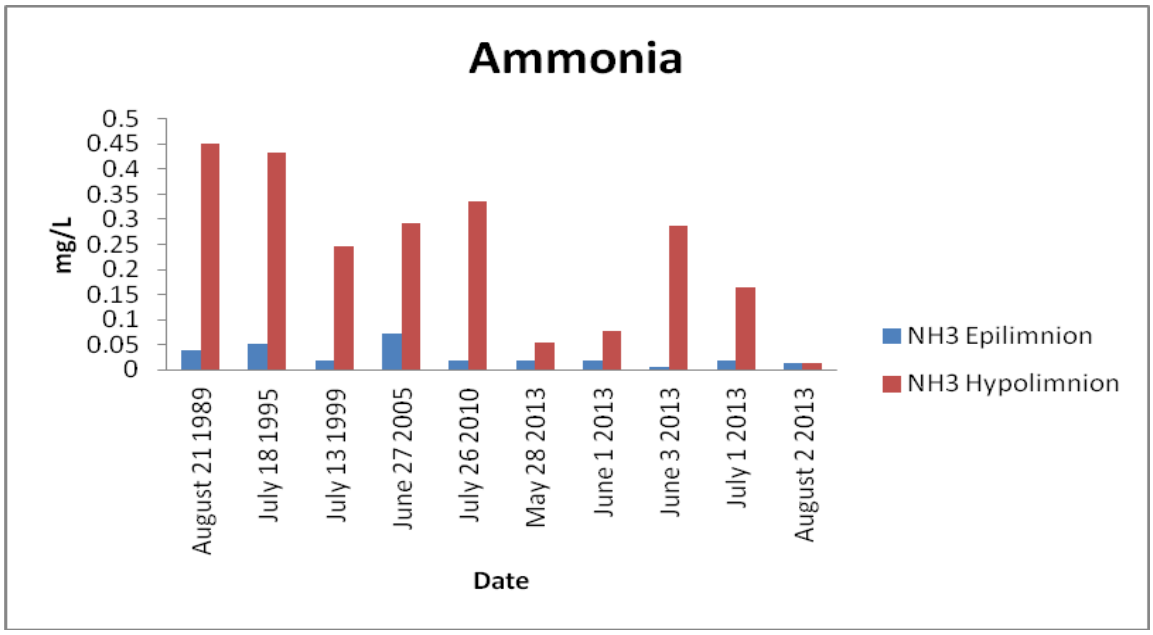

Figure 13. Historical ammonia levels at Stone Lake, 1989 to 2013.

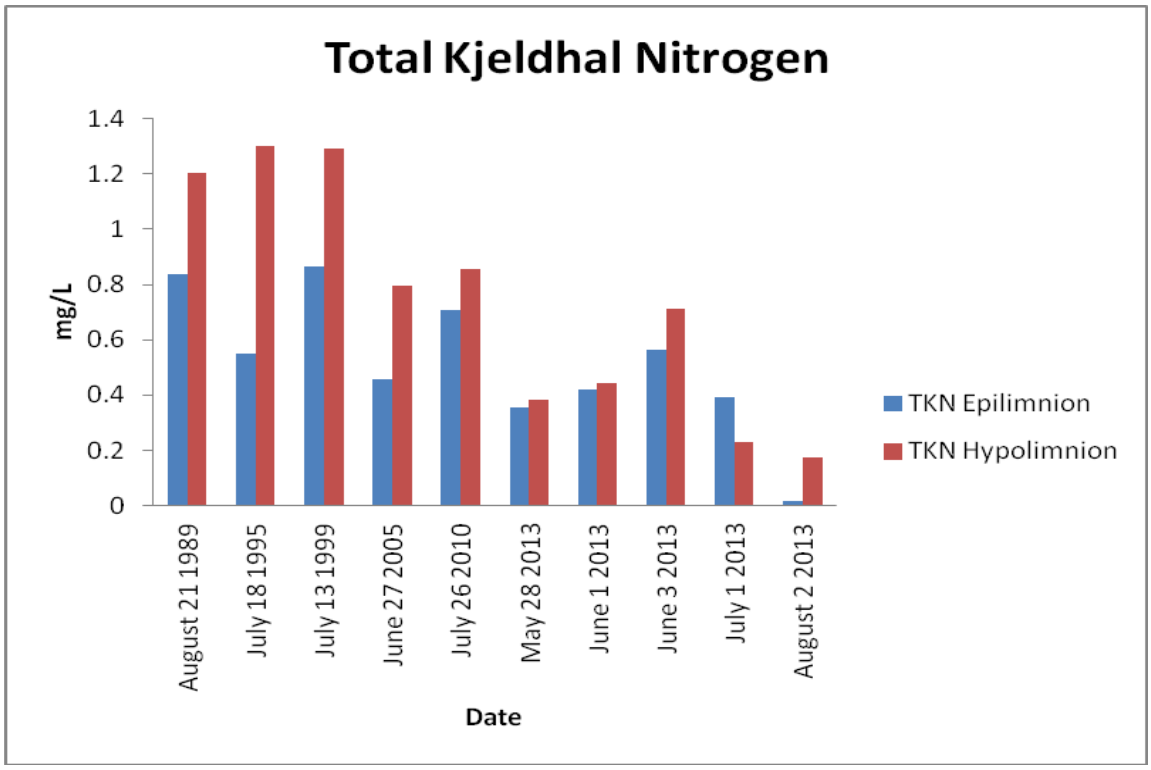

Figure 14. Historical Total Kjeldhal Nitrogen levels at Stone Lake, 1989 to 2013.

Introducing a small amount of additional phosphorus into a waterway can have adverse effects such as algae blooms, accelerated plant growth, and low dissolved oxygen from the decomposition of additional vegetation. Historically, Stone Lake has total phosphorus levels that

are below the proposed TMDL of 0.3 mg/L (Figure 15). On May 28, 2013, Stone Lake observed a record low for total phosphorus. During racing on June 1, 2013 the level of total phosphorus increased to 0.027 mg/L, the highest level observed since June 2005. On June 3, 2013 total phosphorus levels were lower following the weekend of the race. On August 2, 2013 the lowest total phosphorus levels to date were observed. Soluble reactive phosphorus at Stone Lake has historically fallen below the USEPA limit and the state median. Samples from 1989 to 2010 recorded 0.01 mg/L of SRP, which fall within the range of natural occurring levels of SRP, 0.005 to 0.05 mg/L (Dunne and Leopold 1978). Stone Lake historical highs of SRP were observed in August of 2013, 0.759 and 0.849 mg/L (Figure 16), which exceeded the USEPA limit (0.25 mg/L) and the state median (0.12 mg/L). Although, levels of 0.08 to 0.10 mg/L SRP may trigger periodic blooms, long term eutrophication will usually be prevented if total phosphorus and SRP levels are below 0.5 mg/L and 0.05 mg/L respectively (Dunne and Leopold 1978).

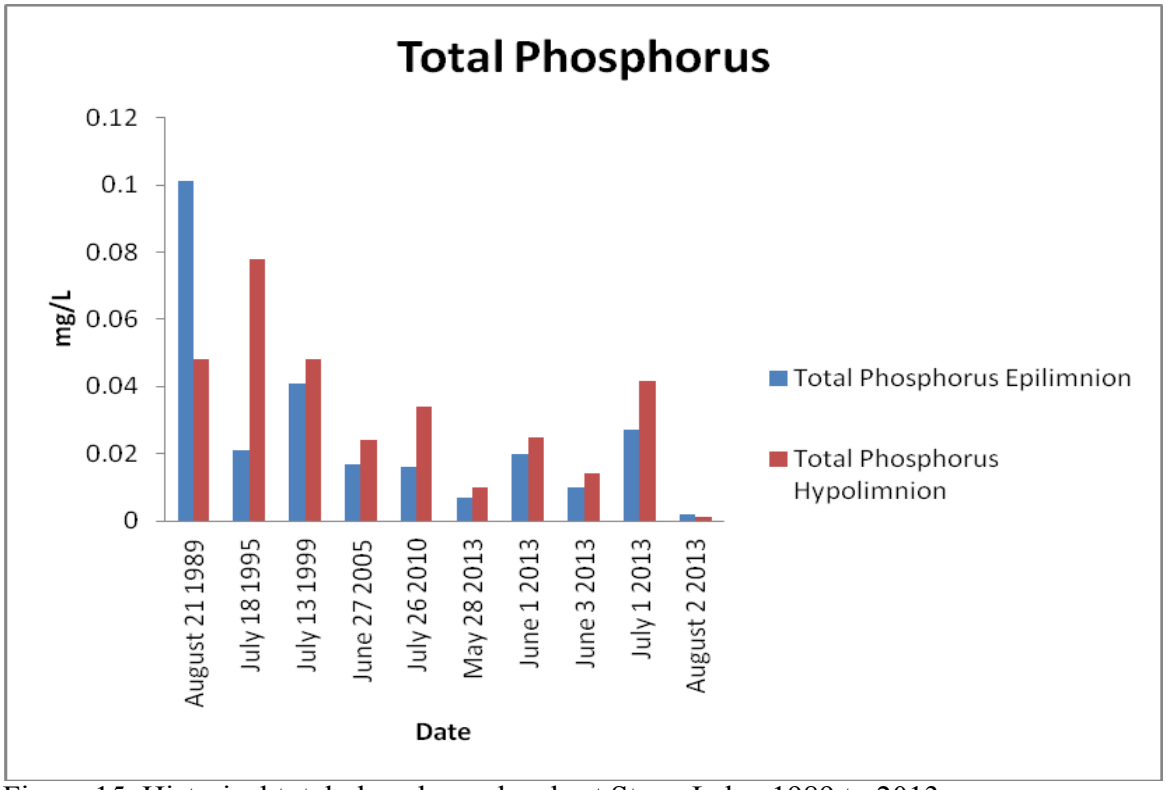

Figure 15. Historical total phosphorus levels at Stone Lake, 1989 to 2013.

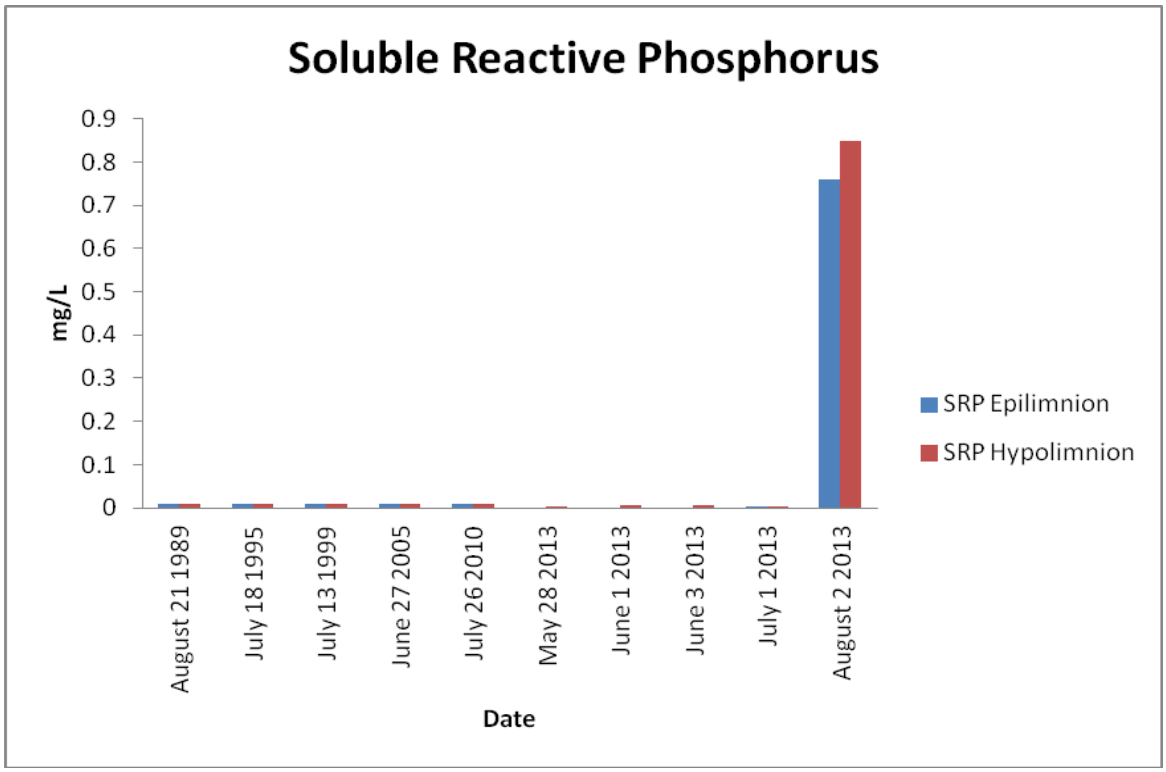

Figure 16. Historical level of Soluble Reactive Phosphorus at Stone Lake, 1989 to 2013.

Waterfowl

Disturbance to waterfowl by watercraft often accompanies increasing human populations and shoreline development. Negative impacts to waterfowl caused by motorized surface use of lakes have been documented both during spring and fall migration (Kahl 1991, Havera *et al.* 1992) While Stone Lake exhibits a wide range of characteristics that would be suitable habitat for waterfowl, such as clear water, abundant submerged vegetation, and low nutrient levels (Minnesota Department of Natural Resources 2010), it did not exhibit high waterfowl usage during the observation period. Stone Lake's shoreline is mostly owned by the La Porte Parks Department, which maintains a beach, some picnic areas, and a boat launch. While a considerable portion of the shoreline is relatively undisturbed, most of the natural shoreline is composed of woody shrubs which are less preferred by waterfowl than emergent wetland vegetation. A road along the eastern shore of the lake runs very close to shoreline itself. The multiple activities that occur around the lake and lack of desirable habitat likely deter many waterfowl from nesting around Stone Lake.

Boat Race Observations

Race boat and crew assisting activities were observed both before the boats were allowed to operate on the lake and during a portion of the racing activities. Some activities were observed that are not condoned to protect habitat, water quality, or man-made structures.

During the race weekend, several boats were at power but stationary in the staging area at the beach. One boat motor was "revved" repeatedly in the staging area causing displacement of

sediment and creating a large spray of water in the area. An All-Terrain Vehicle (ATV) was observed to be stuck in the water at the beach as it attempted to push a race boat to deeper water. The tires on the ATV were spun to try to remove it from the water, but that action caused the ATV to further sink into the water. A truck had to be used to pull the ATV out. These actions suspended sediment in the water, which can pose a threat to biological organisms and water quality.

Two Formula 1 tunnel boats were observed on May 30, 2013 (prior to permitted boat race activities) at the public boat launch engaging their propellers at considerable throttle while still on their boat trailers (See Appendix D for photos). This type of action is similar to "power loading", and can cause damage to launch ramps that may not be visible from the surface of the water. "Power loading" involves using the motor to load and unload the boat onto and off of the trailer. The propeller wash creates a significant force that can erode the lakebed and create a large hole at the end of the ramp. Eroded material is often deposited beyond the ramp to create a mound, which can result in a barrier for launching and loading. Boats and equipment can incur damage, if the boat or lower unit runs aground on the mound, or if the trailer becomes stuck in the hole. In a worse-case scenario, the end of the ramp could collapse, resulting in an unusable launch ramp (Minnesota DNR 2013). Slightly more than idle speed should be all that is necessary to load and/or unload a boat. Boaters should refrain from “power loading” and instead, use the trailer winch to load and unload their boat.

It is unknown how long-term high speed boating can impact a body of water, especially lakes. Most studies (Minnesota Department of Natural Resources 2010; Asplund and Cook 1997; Asplund 2000) that noted decreased plant growth in high boat traffic areas were in rivers where boat traffic is more confined and waves may be more of a factor. Also unknown is the effect on submerged vegetation species composition and the subsequent effect on other components of the aquatic ecosystem, such as water quality. It is unclear if the amount of plant material lost due to high speed boating has larger-scale or longer term impacts (Johnstone, *et al.* 1985).

One of the most common impacts associated with motorized watercraft is a decrease in water clarity. As motor boats travel through shallow water, the energy from the boat propeller may be sufficient to re-suspend sediment from the lake bottom, decreasing the lake’s water clarity. Several researchers have documented either an increase in turbidity or a decrease in Secchi disc transparency during and following motor boat activity (Wagner 1990; Asplund 1997; Yousef et al., 1980). Crisman (1986) reports a decrease in Secchi disc transparency following holiday weekend use of Lake Maxinkuckee in Culver, Indiana. Asplund (1996) also observed poorer water clarity in his study of lakes following weekend boating and that this decrease in water clarity is more pronounced in lakes with generally better water clarity.

VII. RECOMMENDATIONS

Stone Lake historically and currently has exceptionally high water quality and aquatic plant diversity. Maintaining this high quality at Stone Lake should remain a priority to the LaPorte Parks Department and local residents. The lake’s shoreline exhibits a natural woody barrier that helps decrease wave action impacts along the shoreline in most areas. Emergent plant beds also aid in protecting the shoreline by dissipating waves. While erosion was not evident, during observations of bank pins around the shoreline a substantial amount of fragmented vegetation

was present. Physical effects of propeller, waves, and turbulence appear to be an issue to submersed aquatic vegetation at Stone Lake. It is recommended that precautions be taken to protect all species of submerged vegetation but extra concern should be given due to the presence of Beck's water marigold, white-stemmed pondweed, fern pondweed, and white water crowfoot. Due to the locations of these plants in shallow water, if future races are held, the race course should make every effort to avoid any boating in these areas to reduce the effects to vegetation.

It is important, especially at a high quality lake such as Stone Lake, to protect the shallow water, near shore habitat areas. A 200 foot buffer should be maintained as a safety zone if future races are held. This must be strictly enforced by both race organizers and law enforcement staff monitoring the race so that the biological community of the lake can remain protected.

A shallow bench is found between the two deep basins in Stone Lake that contains an abundance of aquatic vegetation including rare species. A portion of the race course was held over this area, passing over it twice in each lap. This area is between 5 and 10 feet and subject to propeller disturbance. Due to the shallow nature of the area, it is recommended that high speed boating refrain from using this area as part of the course to reduce the amount of uprooted vegetation, suspension of bottom sediments, and disturbance of threatened and rare species. High speed boating should only be allowed in areas of Stone Lake that do not have shallow areas that are densely vegetated.

It must be required that the questionable boating activities observed by some race boats be eliminated if there are future races. Activities that unnecessarily increase suspended sediment or threaten aquatic plants or the structural integrity of the boat ramp must be strictly enforced. Boats must refrain from warming their engines on trailers at the boat launch above idle throttle when the propeller is engaged. Boats also must not run their engines at a high throttle and with propeller engaged while in the staging area at the beach or anywhere else within 200 feet of shore. Additional enforcement may be necessary to assure compliance if future races take place.

Eurasian watermilfoil is present and may be expanding at Stone Lake. If future races are to be held at this lake, treatment to control the milfoil should be performed at least three weeks before the race so that its biomass is reduced and less susceptible to propeller and wave induced fragmentation.

Stone Lake has historically been an exceptional lake by Indiana standards in terms of water quality and aquatic plant diversity. It does not appear as though a single weekend of high speed boating had irreversible effects on the lake. An annual weekend of high speed boating may or may not accelerate the eutrophication process at Stone Lake. Frequent or unregulated high speed boating would likely prove more detrimental to the water quality and quality plant community of Stone Lake.

# # #

This report was authored by Ashlee Haviland of the Division of Fish and Wildlife, Indiana Department of Natural Resources in fulfillment of the request of Administrative Law Judge, Steven L. Lucas with the Indiana Natural Resources Commission.

Other contributors include: Thomas Bacula, Gregory Biberdorf, Linda Byer, Rod Edgell, Eric Fischer, William James, Douglas Keller, Douglas Nusbaum, Jamie Pejza, Jeremy Price, and Jamie Smyth all of the Division of Fish and Wildlife, Indiana Department of Natural Resources.

Special thanks goes out to Melissa Clark, Sarah Powers and other staff of the Indiana Clean Lakes Program at Indiana University in providing direction for water quality sampling, the necessary supplies, and analysis of the collected water samples. A special thanks also to Nicole Messacar of LaPorte County Soil and Water Conservation District for her assistance in sampling.

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IX. APPENDIX A:

RACE PERMIT APPLICATION DETERMINATION

Major Michael L. Portteus
Law Enforcement Division
Support Services Commander
Boating Law Administrator
402 W. Washington Street, Rm. W-255D
Indianapolis, IN 46204
(317) 233-3847
(317) 232-8035 FAX

March 28, 2013

RE: Notification of initial determination of Stone Lake F1 race permit application

After careful consideration of all of the input received from the Informal Public Hearing, phone calls and emails received, DNR Staff, local business, event organizers and local government, a decision to grant the permit has been made, subject to several conditions and restrictions, listed below.

The IDNR Division of Fish and Wildlife will work to assess the shoreline, vegetation, water quality, and any other concerns prior to the event. A reassessment of the same will occur during and after the event in an effort to determine any effects of the activities authorized under this permit.

- The LaPorte County Convention and Visitors Bureau shall work with the LaPorte City Parks Department and race officials in defining safety procedures for the general public (spectators) and riparian property owners.
- IDNR District 10 Law Enforcement shall be given advance notice of planned meetings in order for an Indiana Conservation Officer to be present at those meetings.
- A minimum of **200' from shoreline safety zone** shall be established on the course that will not be entered during the race/heats to include event boats. Event organizers shall be responsible for establishing and clearly marking the safety zone. No watercraft shall be operated, moored, beached, or anchored within the safety zone with the exception of work/safety boats. Activity within the safety zone by these boats shall be limited to only what is necessary. All watercraft operating within the safety zone shall observe idle speed per **IC 14-15-3-17. IC 14-8-2-129 "Idle speed" definition;**
  Sec. 129. "Idle speed", for purposes of IC 14-15-3-17, means the slowest possible speed, not exceeding five (5) miles per hour, which maintains steerage so that the wake or wash created by the watercraft is minimal.
  Deviations from idle speed within the safety zone shall only occur in emergency situations where public safety, or the safety of those involved in the event exists.
- No public access for recreational watercraft activity shall be allowed on Stone Lake during the timeframe of this event, to include the 200' safety zone. This restriction into or upon Stone Lake includes ramps, waterways, and riparian owners. Event organizers shall be responsible for notification, closure, monitoring, and clearing of these areas prior to scheduled events.
- All work/safety boats shall obey the 10 mph speed zone already in effect on Stone Lake unless there would exist an emergency situation that necessitates otherwise.

- All staging of the event boats shall occur in the beach area to avoid shoreline and vegetation disturbance.

Notice of Right to Appeal and Administrative Review
This determination will become final within fifteen (15) days after receipt (eighteen (18) days if this determination is received by United State Mail) unless a person makes a timely request for administrative review under Indiana Code 4-21.5–3-5. In order to qualify for administrative review, a person must file a written request for administrative review within fifteen (15) days (eighteen (18) days if this determination is received by United State Mail) after receipt of this notice at the following address:

Natural Resources Commission
Division of Hearings
Indiana Government Center North
100 North Senate Avenue, Room N501
Indianapolis, Indiana 46204

Sincerely,

Major Michael L. Portteus

X: APPENDIX B:

BANK PIN PHOTOS

Bank Pin 1 Before Race. 05/30/2013

Bank Pin 1 After Race 06/03/2013

Bank Pin 2 Before Race 05/30/2013

Bank Pin 2 After Race 06/03/2013

Bank Pin 3 Before Race 05/30/2013

Bank Pin 3 After Race 06/03/2013

Bank Pin 4 Before Race 05/30/2013

Bank Pin 4 After Race 06/03/2013

Bank Pin 5 Before Race 05/30/2013

Bank Pin 5 After Race 06/03/2013

Bank Pin 6 Before Race 05/30/2013

Bank Pin 6 After Race 06/03/2013

XI. APPENDIX C:

WATERFOWL OBSERVATIONS

LINDA BYER

DISTRICT 2 WILDLIFE BIOLOGIST

IDNR DIVISION OF FISH AND WILDLIFE

NORTH JUDSON, INDIANA

ASSESSMENT OF STONE LAKE

Tuesday, May 28, 2013 at 3:53 pm CDT, I contacted Ashlee Haviland of LARE regarding when she would be on the lake. At 4:23 pm of the same day, she replied that she would be out there the next 3 days for water sampling.

Wednesday, May 29, 2013 at 9 am CDT, I asked if she would be using a boat and if so, could I ride along. At 9:14 am she responded that she was already there and that she would be for some time. So at approximately 9:30 am CDT I prepared to leave the office and drive up to LaPorte to Stone Lake.

Wednesday, May 29, 2013 at ~10:20 CDT I arrived at Stone Lake and as I turned onto Lake Shore Dr. from Craven Dr. I noted that there were 30 Canada geese along the shoreline, 7 adults and 23 goslings. I stopped and took a couple of pictures. While there, a muskrat came up out of the water and attempted to walk through the goslings and was attacked by an adult goose. I continued along the road and saw the boat with Ashlee and asked her to meet me back at the ramp if it did not interfere with her tasks at the moment. She agreed to meet me at the ramp, so I drove there.

Upon leaving the ramp, I took pictures looking back to the east along the shoreline and then as we moved west along the shore I took a picture looking back at the ramp. There were 3 leatherback turtles basking on a log just west of the ramp. We continued at idle speed along the shore to the west until we came to the SW corner. I took a couple of pictures of the area of spatterdock and pond lily in that corner and we flushed a pair of wood ducks out of it before we moved on towards the north.

I took pictures of the 4 private residences along the west shore as we proceeded to the NE to the park property. I took several pictures of the shoreline through here to show that the trees come all the way down the hillside and into the water. As we passed the channel to Pine Lake, I took another photo to show the size and accessibility of it. We then passed another area of somewhat shallow water that held emergent vegetation and a couple of fishermen before approaching the park lodge, shelter house and beach area. I took photos where the trees ended and the mowed shoreline began in the main part of the park. Once we got past the beach area a shore bird flushed from the shoreline. I tried several times to take a picture of it and to get close enough to ID it, but was unable to do either. The one picture I have, I believe, is too blurry to accurately identify the bird.

The park was already erecting snow fence along Lake Shore Drive to prevent spectators from trespassing onto the private property along the east side of the road. I took a picture of that also as we continued along the east side to the south. We went around the pier area and through the emergent vegetation that was there and out into the lake over the sandbar. I took several pictures of this area. We continued south along the east shore where stone lines the bank below the road to the water's edge. As we approached the SE corner where Craven Road meets Lake Shore Drive, I noticed that the geese that had been along the shoreline when I first got here were now across the road on the lawns of the houses there. At one point in time, one of the family groups

moved out into the roadway and a truck had to stop to prevent running into them. I took a couple of pictures of this. We continued to the ramp and I exited the boat, took a photo looking to the east and west from there then returned to my vehicle. I then took a picture of the lake from the parking area to show the drop and amount of woody vegetation there.

It was 11:20 am CDT and I then drove to the NE side of the lake to the park. There, I got out and starting from below the "lodge". I walked the shoreline to the channel that exits the lake south of the beach to the wetland on the NE side of the park road. This entire area is routinely mowed for public access as is the area below the road along Lake Shore Drive except where it is stoned. There were no waterfowl out on the main part of the lake. The geese were along the shoreline feeding on grass and the wood ducks flushed from somewhere inside the spatterdock. The only shorebird seen was along the east shoreline possibly trying to feed and it continued to flush as we moved along the shore to the south. I did not observe any signs of nesting activity anywhere along the entire perimeter of the lake.

Friday, May 31, 2013 – Race day

Wanting to make my observations before too much activity was occurring; I arrived at Stone Lake at 6:15 am CDT. As on Wednesday, along the shoreline north of the intersection of Craven Drive and Lake Shore Drive there was a pair of geese with 3 goslings. They were feeding in the grass along the shoreline. From that location I glassed the lake surface and saw nothing on the water. I took some pictures there and from the boat launch further west and then continued to drive the perimeter of the lake. I stopped, glassed the lake and took some pictures from the bridge over the channel to Pine Lake and from the beach area.

By 6:45 I was in the SE part of the Lake driving west along Lake Shore Dr. when a pair of adult geese flew onto the lake in that area and swam west toward the Craven Dr. Vegetation area. When I reached the intersection, the family of geese had moved from the shore into the lake and was feeding in the spatterdock there. This area is well inside the safety zone. They were joined by the adult pair of geese that flew in.

At this point in time I decided to stay and observe the waterfowl until the boats started to run. Around 7:40 a couple of drake mallards flew in and joined the geese in that area of spatterdock and ten minutes later all the birds were on or along the shore feeding just east of the intersection. Then ten minutes later a guy allowed his dog to go down to the water and the mallards flew away and the geese all went back into the water beyond the spatterdock. The amount of human and vehicle traffic has increased and is beginning to disturb the birds. There are also a couple of Jon boats on the water now setting up the course. By 8:55 the geese remain on or close to the shore but are moving away from the intersection to the east. A family goes down to the water's edge and push the geese into the water further away from the shoreline. They also keep moving east. By 9:30 I have lost sight of all the geese around the bend and decide to go look for them. The family is just around the bend on the shore feeding. There is a group of kids playing in the water further east along the shoreline and the pair of flying adults has left the lake.

A lady walking 2 small dogs walks past me going west towards the family of geese and spooks them back out into the water where they start to head out across the lake to the west. They continue past the boat ramp where there is some activity occurring and head toward the homes along the west shore and by 10:15 exit into one of the mowed yards there.

At 11:20 boats are entering the water and beginning to go around the smaller course. It appears that the course for both the larger and smaller boats does not go further west than a line between the channel to Pine Lake and 200 feet north of the boat ramp on only the eastern two thirds of the lake. The boat activity does not appear to bother the geese. However, one of the landowners is weed trimming and they leave that area and go to the southern most home yard. This is where they were feeding, apparently undisturbed, when I decided to leave at 11:40 am CDT.
I took several photos of the geese and the boats running during this period but have to download them.

Submitted by Linda K. Byer, District 2 Wildlife Biologist, IDNR Division of Fish and Wildlife, North Judson, Indiana

XI. APPENDIX D:

PHOTOS OF BOATS WARMING AND RACING THEIR ENGINES
May 30, 2013

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