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2004 Lake Lorraine Aquatic Plant Survey
Technical Report

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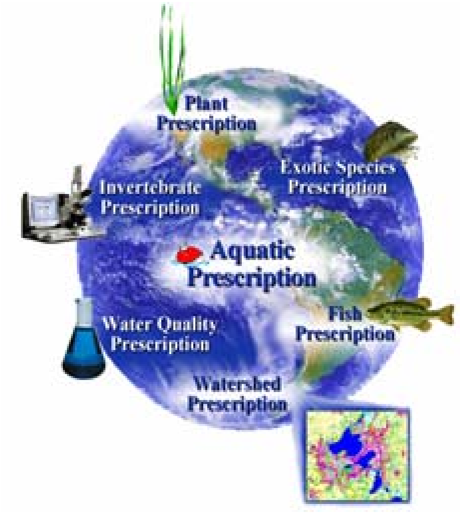

2004 Lake Lorraine Aquatic Plant Survey
Technical Report

June 2008

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In cooperation with the Wisconsin Department of Natural Resources and the Walworth County Land and Water Resources Department

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Lake Lorraine Restoration Association

Bill Yoss	Director
Richard Mikulecky	Vice President
Dorothy Camodeca	President
Tony Novak	Treasurer
Christy Chmielewski	Secretary

Wisconsin Department of Natural Resources

Heidi Bunk	Lake Coordinator
Mary Ellen Franson	Environmental Grant Specialist
Rick Dauffenbach	Fisheries Biologist
Doug Welch	Fisheries Biologist

Executive Summary

Lake Lorraine is a 133-acre seepage lake located in Walworth County, Wisconsin. The watershed for Lake Lorraine is largely agricultural with some development directly adjacent to the lake. Lake Lorraine experiences dense macrophyte growth throughout the summer largely caused by two invasive species, curly-leaf pondweed (*Potamogeton crispus,* CLP) and Eurasian water-milfoil (*Myriophyllum spicatum*, EWM). In 1996, Lake Lorraine was included in a milfoil weevil study conducted by the WDNR. The weevil stocking efforts were not successful in that weevil density never maintained at target levels and no noticeable milfoil reduction occurred. The efforts to maintain an effective weevil population have since ceased. CLP and EWM continue to dominate the macrophyte community and detract from the recreational and aesthetic value of the resource.

During the summer of 2004, Aquatic Engineering, Inc. (AEI) biologists assessed several key aspects of the Lake Lorraine ecosystem. Aquatic macrophytes, sediments, various water quality parameters, and riparian land use were analyzed. Sampling was performed twice during the aquatic plant growing season in 2004.

This report is a summary of the aquatic plant assessment activities that took place during 2004 which were funded, in part, by monies awarded through the WDNR Lake Management Grant program.

Deliverables listed in the grant and covered in this report include:

- Quantitative Aquatic Plant Community Assessment
- Qualitative Aquatic Plant Community Assessment
- Water quality assessment at plant sampling sites
- Sediment characterization at plant sampling sites
- Assessment of riparian land use

It was found that Lake Lorraine has a plant community that is dominated by few plants throughout the growing season. The data gathered were analyzed and compared to accepted values for similar lakes in Wisconsin and the region. Several key diversity indices show that Lake Lorraine is in the lower quartile for lakes in its region and in Wisconsin as a whole.

The average plant densities (on a 0 to 5 scale) per sample site for the spring and summer surveys were 3.27 and 2.72, respectively. The diversity of aquatic plants within Lake Lorraine is hampered by profuse CLP and EWM growth and by the generally mucky substrate; muck is conducive to CLP, EWM, and other low value native species such as coon's tail and common waterweed and hampers the growth of high-value natives such as wild celery, large-leaf pondweed, and naiads.

The early-season community is dominated by CLP, which dies off in the summer, during which excess nutrients are released from decomposing plant material that is used by algae and various aquatic plant species. EWM thrives on the release of nutrients from CLP .

EWM is also a non-native species of submersed aquatic vegetation. EWM is tolerant of low water quality and is not shade-sensitive. EWM will grow long stems that reach the surface of the lake and spread out. This creates dense beds of "topped-out" vegetation that is detrimental to the recreational and ecological value of the lake.

Plant community data were used to update the baseline information available for Lake Lorraine and provide information relevant to updating the current Lake Lorraine APM Plan.

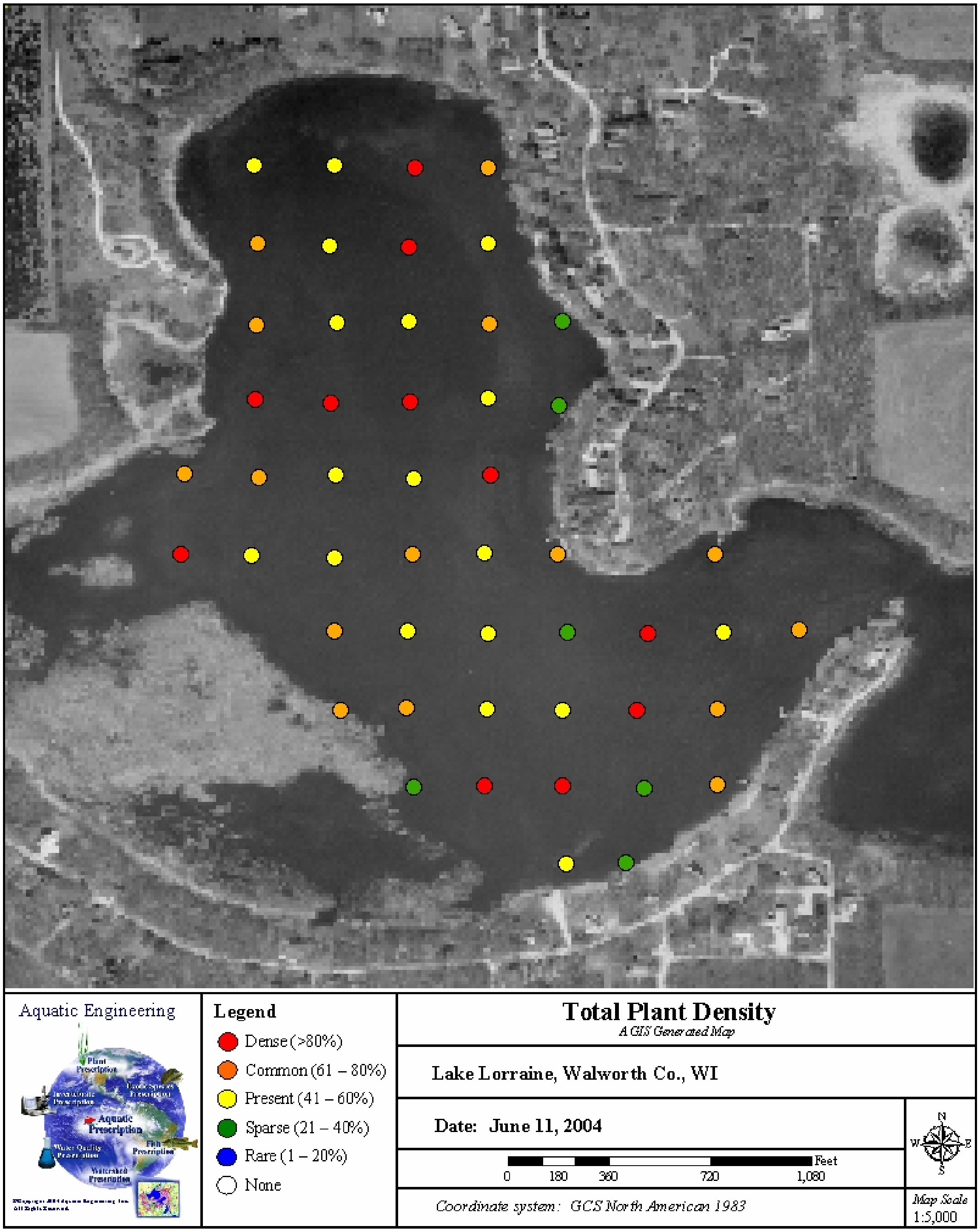

Figure E-1. Total vegetation within Lake Lorraine (Walworth County, Wisconsin) June, 2004.

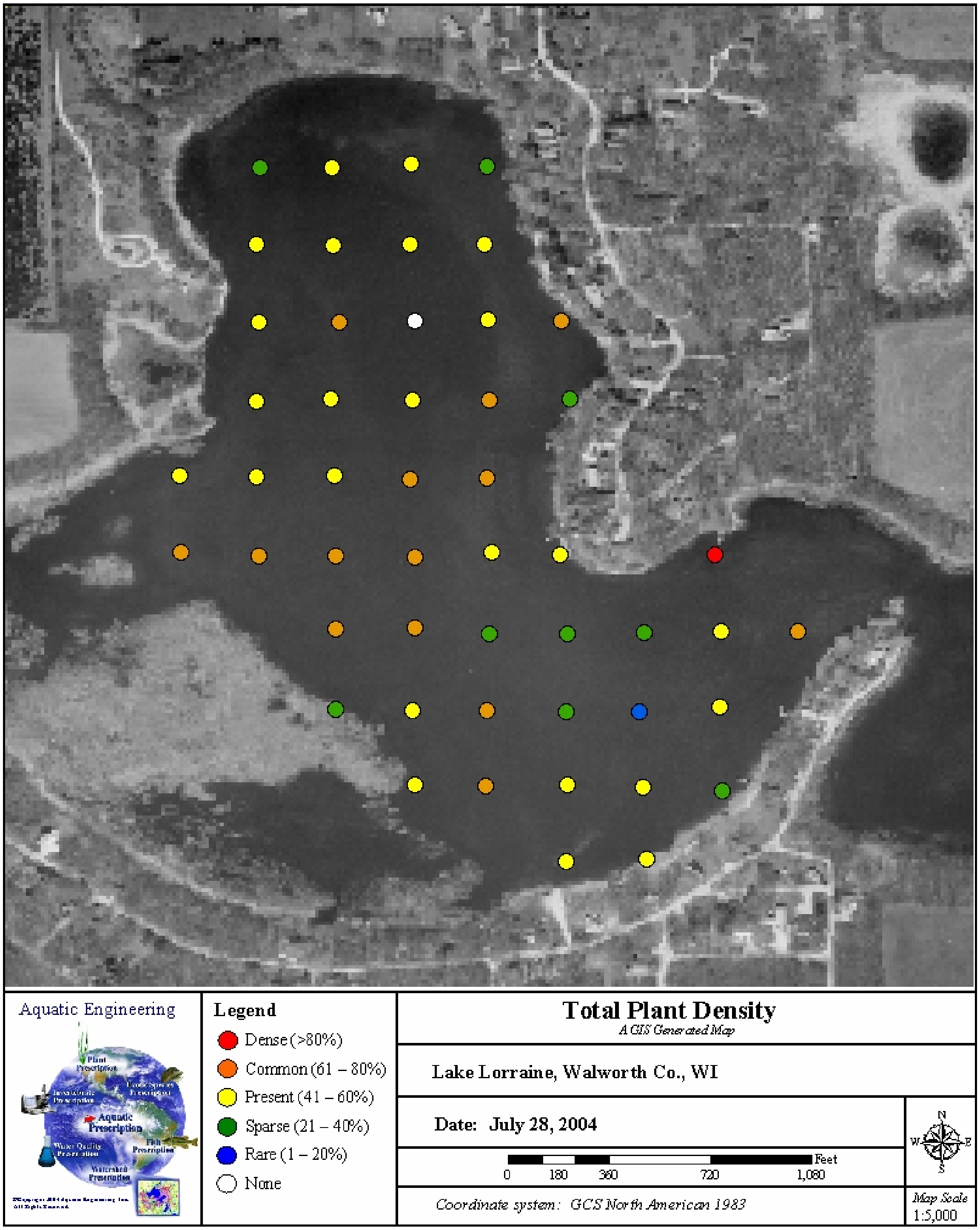

Figure E-2. Total vegetation within Lake Lorraine (Walworth County, Wisconsin) July, 2004.

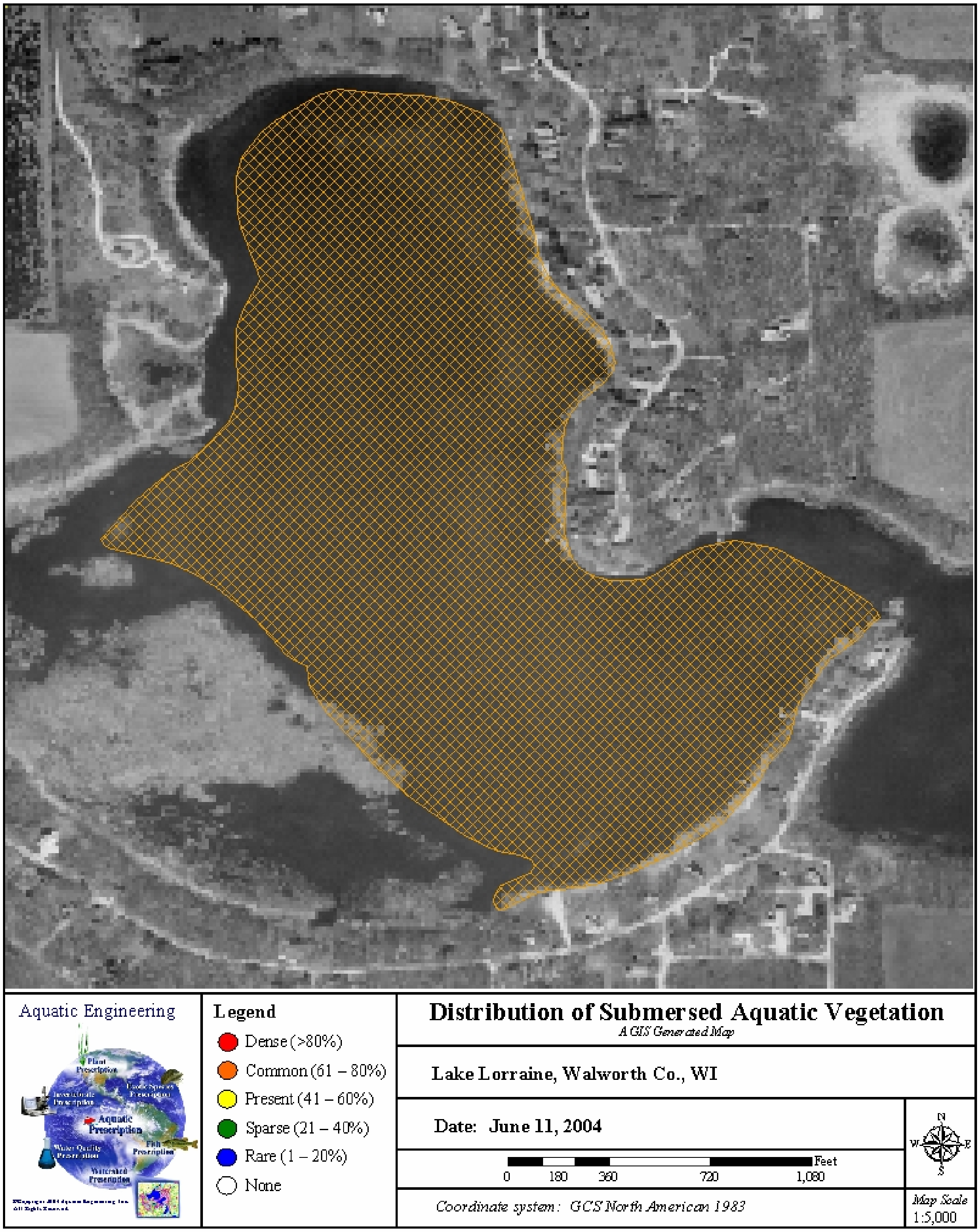

Figure E-3. Total area of submersed vegetation within Lake Lorraine (Walworth County, Wisconsin) June, 2004.

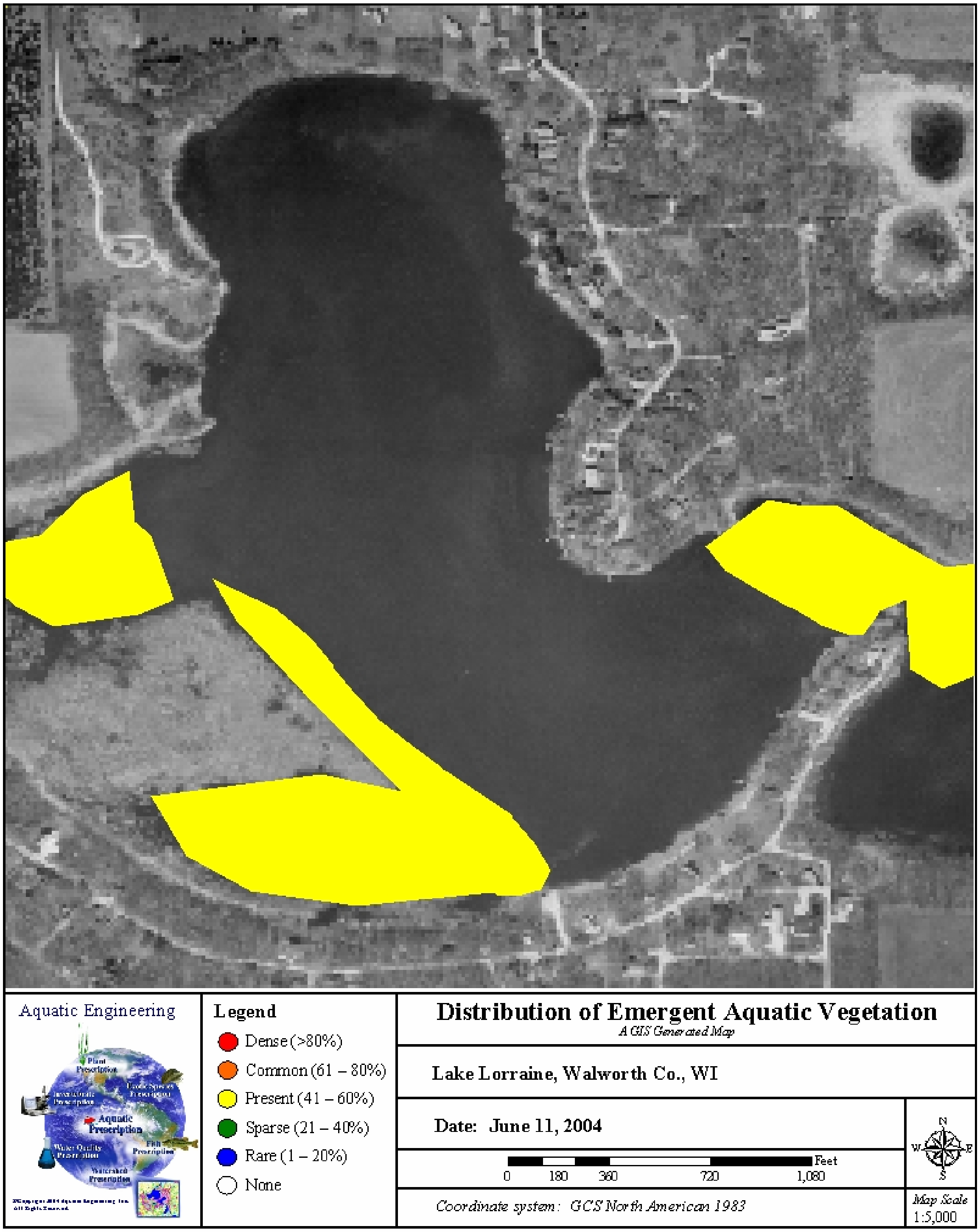

Figure E-4. Total area of emergent vegetation within Lake Lorraine (Walworth County, Wisconsin) June, 2004.

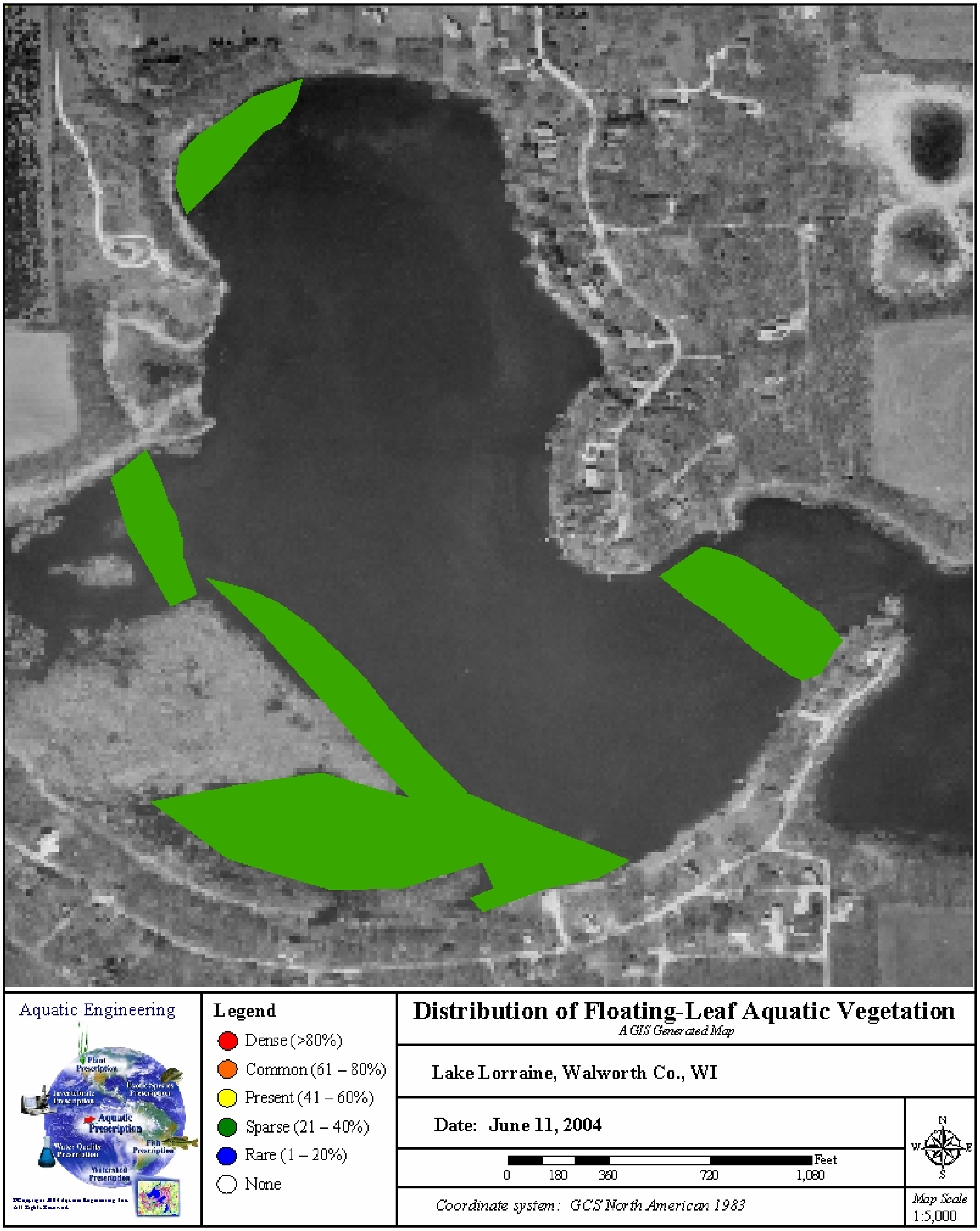

Figure E-5. Total area of floating leaf vegetation within Lake Lorraine (Walworth County, Wisconsin) June, 2004.

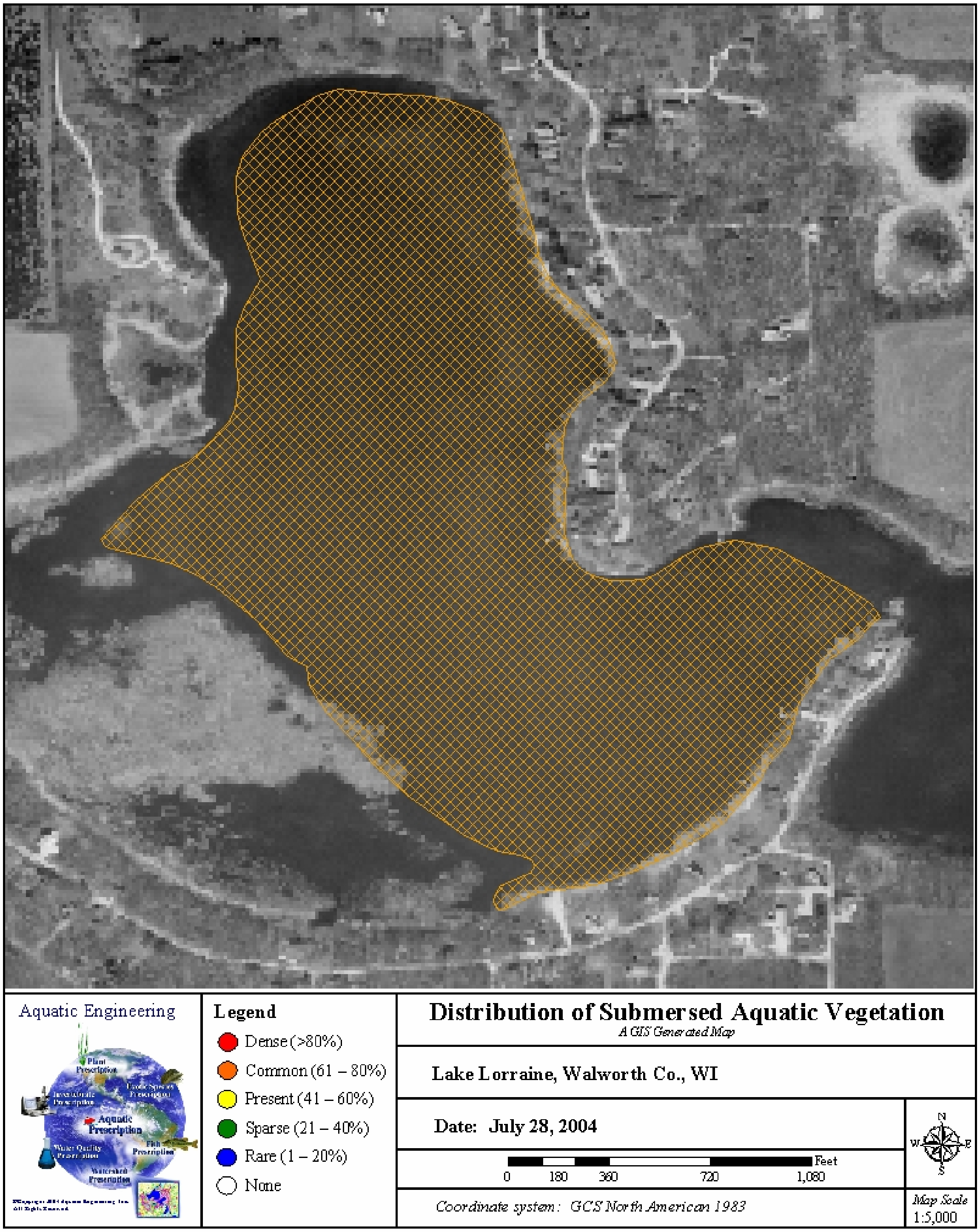

Figure E-6. Total area of submersed vegetation within Lake Lorraine (Walworth County, Wisconsin) July, 2004.

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1.0 Introduction

Lake Lorraine is a 133-acre seepage lake located near the town of Richmond in Walworth County, WI (WBIC 777500; T3N R15E S9), with a maximum depth of 8 feet and an unrecorded average depth (approximately 5 feet). Lake Lorraine was the subject of an experimental weevil management program for control of Eurasian water-milfoil (EWM) and has a history of chemical treatments for nuisance aquatic plants. Fish species present in Lake Lorraine include largemouth bass and panfish. Lake Lorraine's watershed is predominantly residential and agricultural which may be threatening its water quality and worsening the impacts of exotic plants.

In 2003, the Lake Lorraine Protection and Improvement Association contracted The Limnological Institute (TLI) to write a grant for WDNR funding to conduct a macrophyte survey. With this grant, TLI and Aquatic Engineering, Inc. (AEI) were contracted for technical guidance and ecological field services. This report is a summary of the aquatic plant assessment activities that took place during 2004 which were funded, in part, by monies awarded through the WDNR Lake Planning and Protection Grant program.

As part of the grant, TLI outlined the activities that were necessary to perform an adequate macrophyte survey. AEI also suggested water quality monitoring and macroinvertebrate sampling. Deliverables listed in the grant and covered in this report include:

- Quantitative Aquatic Plant Community Assessment
- Qualitative Aquatic Plant Community Assessment
- Water quality assessment at plant sampling sites
- Sediment characterization at plant sampling sites
- Delineated monotypic exotic macrophyte beds
- Assessment of riparian land use

2.0 Overview of Aquatic Plants

2.1 Aquatic Plant Distribution within Lakes

Aquatic plants grow in areas of lakes, ponds, and other impoundments called the littoral zone, which is the area between dry land and open water. The area of the littoral zone can vary greatly from lake to lake, but is generally considered the area where the water depth is less than 15 feet and rooted aquatic plants can be found. This definition is a general guideline, and the 15-foot depth can increase with clear, calm water or decrease with cloudy, disturbed water. Open water is considered any area deeper than 15 feet or where rooted aquatic vegetation does not grow.

The littoral zone is the area where most of the lake's "productivity" takes place. Abundant light and suitable sediment provide prime habitat for plants and algae, and photosynthesis from these provide the energy source for all other life forms in the lake.

Because of this, the littoral zone is the most biologically active area of a lake. Open water areas are also biologically productive in lakes where littoral habitat is available. Planktonic algae and zooplankton migrate to open water where photosynthetically-active radiation (PAR) penetrates the water.

2.2 Types of Aquatic Plants

There are four major categories of aquatic plants.

Algae can be found in all areas of a lake where sunlight penetrates. They have no true roots or leaves and can be single- or multi-celled. Planktonic algae are free-floating microscopic organisms that can be found anywhere light penetrates the water. Blooms of planktonic algae give a lake the "pea soup" look. Filamentous algae are generally found in the littoral zone because it first forms at or near the bottom of the lake. As these organisms reproduce, they form tangled mats that eventually trap gasses released during photosynthesis and float to the water surface, where they create an unpleasant odor while they decay.

Submersed macrophytes are true plants, having true stems and leaves that grow entirely underwater. These plants have a wide range of morphologies and are able to grow in all areas of the littoral zone. Although they grow entirely underwater, some produce flowers or seed heads that can stick out of the water completely. These plants can form dense beds or be scattered intermittently throughout the lake. They can grow close to the bottom or form long arrangements of stems that create surface mats.

Floating-leaved plants are often found rooted in the littoral zone where the lake surface is relatively protected from wave action caused by wind or boats. The leaves and flowers of these plants are found floating at the water surface. Water lilies are good examples of floating-leaved plants.

Emergent plants, such as cattails, have roots that are submersed, but their stems and leaves grow above the water surface. These plants are found in the shallow areas of the littoral zone and in wetlands and are the link between land and water. Emergent plants provide cover and food for wildlife and help protect shorelines from wave action.

2.3 Value of Aquatic Plants

Serve as a food source – Aquatic plants provide a source of food for insects, snails, and freshwater shrimp. Some fish also eat aquatic plants directly.

Provide shelter/habitat –Plants provide a place for fish to escape from sunlight and predators. They also provide an attachment point for certain insect larvae, and many fish species use vegetated areas of the lake for spawning.

Stabilize shoreline and sediment – Plant roots secure the sediments of a lake and keep them from being stirred by wave action. Plants also protect the shoreline from wave action created by wind and boats and from the erosion caused by those waves.

Improve water quality – Some plants absorb and break down harmful pollutants in the water. Plants also bind nutrients and make them unavailable to algae. The physical structure of plants filters surface runoff from shorelines keeping pollutants out of the water.

Improve aesthetics – Many plants produce beautiful flowers, leaves, and seeds that enhance the natural beauty of the lake. Shoreline vegetation also reduces noise pollution and offers privacy.

Increase economic value – Because aquatic plants fuel the aquatic ecosystem, they are responsible for the tourism value of the resource. Lakes with healthy plant communities generally have healthy fish and wildlife populations, which draw recreationalists interested in fishing, boating, camping, and hunting. Improved water quality and shoreline aesthetics also raises the value of lakeshore property. The WDNR deems aquatic plants an asset to a lake and regulates their protection under NR 107 and NR 109.

3.0 Review of Existing Data

3.1 Macrophytes

Historical data regarding the aquatic plant community of Lake Lorraine includes reports from management activities only. There has been no existing information collected as part of a formal aquatic plant survey. What is known is that Eurasian water-milfoil has been a problem for the residents of Lake Lorraine since at least 1995. The cattail bog located in the west section of the lake created problems in 1986 when a large section (3 to 5 acres) of the bog broke off and traveled freely from one end of the lake to the other. The bog destroyed two private piers and forced the residents to remove all piers and boats while the bog was at large.

From 1996 to 1998 a milfoil weevil project was conducted within Lake Lorraine. Test and control plots were established in beds of EWM. Weevil densities were determined and additional weevils were stocked to raise densities to desired levels. Pre- and post-stocking parameters were measured and compared from test to control plots. The result of the study was that for a multitude of reasons, milfoil weevils were not likely to noticeably control EWM within Lake Lorraine.

The cattail bog and EWM are the major concerns with respect to the plant community of Lake Lorraine. Coontail has also been historically managed with aquatic herbicides to aid property owners in maintaining access and navigable waterways to and from their piers. Curly-leaf pondweed has also become a problem, though no herbicide treatments specific for CLP have been attempted.

3.2 Water Quality

Self-help Secchi depth readings were found for the years 1995 to 1997. The average Secchi depth ranged from 2.8 feet to 3.8 feet, which corresponds to a TSI range of 59 to 64 (a TSI value greater than 50 indicates eutrophic conditions). There has been no other data found regarding the water chemistry of Lake Lorraine prior to this study.

3.3 Fishery and Wildlife

Lake Lorraine has historically been part of a WDNR fish stocking effort. Natural populations of northern pike, panfish and largemouth bass now exist. Fishing reports posted on Lake-Link show that the lake is mostly fished in the winter by ice fisherman. Although fishing experiences vary from fisherman to fisherman, the recurring theme is that the fish are plentiful if you know how to catch them.

The bog and wetland areas adjacent to Lake Lorraine support a diverse wildlife community. The bog has created nuisance conditions for lake residents in the past but remains a valuable part of the Lake Lorraine ecosystem.

Nuisance native and non-native plants appear each summer. CLP creates the greatest nuisance in the spring while coontail and EWM creates nuisance conditions in the summer. The nuisance conditions not only inhibit boat traffic and recreation but also choke out fish and other wildlife. When an entire lake becomes overgrown with aquatic plants, edge habitat becomes scarce. Many predators require edge habitat in order to feed. The plant community within Lake Lorraine is becoming more and more homogenous and will continue to decrease in diversity as will the fish and wildlife habitat it supports.

3.4 Phytoplankton and zooplankton

There is no data available regarding plankton in Lake Lorraine. Using plankton for biomonitoring is a relatively new practice and not many lakes have information regarding their plankton community.

3.5 Sensitive Area Designations

There are currently no WDNR-designated sensitive areas for Lake Lorraine.

4.0 Methods

4.1 Macrophyte Surveys

Biological assessments provide insight into the ecological integrity, or how far an ecosystem deviates from a natural, pristine state (Gerristen 1998). Aquatic plant surveys conducted in 2004 produced data that yielded a greater understanding of the composition and distribution of the existing aquatic plant community, determined the extent of the EWM and CLP infestation, and could be used to evaluate impacts of future management efforts.

Qualitative and quantitative aquatic plant surveys were conducted once in the spring and once in the summer of 2004. The quantitative surveys applied a point-intercept and rake method, while the qualitative surveys were visual and occurred in all areas of the lake. Global positioning system (GPS) integrated with geographical information system (GIS) technology was used to identify and record sample sites.

4.1.1 Qualitative Surveys

Prior to conducting the quantitative aquatic macrophyte survey, ecologists toured the lake collecting all unique species found. The whole plant was collected, including flowers and seeds if available. Herbarium samples were bagged and stored on ice until they were returned to the lab, pressed, dried, mounted, labeled, and laminated.

4.1.2 Quantitative Surveys

A variation on rake coverage techniques (Deppe and Lathrop 1992, Jessen and Lound 1962) was used to sample macrophytes. The following methodology was followed in the study:

- Fifty equally-spaced sample points were created prior to field activities. The points were stored electronically as GPS coordinates and used in the field to identify sample point locations.

- Each sample point was a circle around the boat eight feet in diameter, divided into quadrants. A two-headed, weighted rake was extended from a boat to the farthest extent of each quadrant and then dragged along the bottom while being retrieved to collect plants.
- GPS coordinates were collected at each sample point to accurately record each sample location.
- A plant density rating was given for each species on a scale from 0-5, depending on the percent of the rake head covered by that species.

Table 1. Percent Rake Coverage

Rake Coverage (% of rake head covered by a species)	Density Rating
81-100%	5
61-80%	4
41-60%	3
21-40%	2
1-20%	1
No Plants Recovered	0
Present but not Collected	P

4.2 Water Quality at Plant Survey Sites

Secchi depth readings were collected once per survey event and were taken at a mid-lake site. At each aquatic plant sampling point, dissolved oxygen, pH, and temperature were measured with a YSI SONDE probe. The probe was submersed to elbow depth in the majority of sites and to half the total depth in water too shallow for an elbow depth reading. The probe was left in the water until readings stabilized, and readings were transcribed to field data sheets.

4.3 Substrate at Plant Survey Sites

The sediment at each aquatic plant sampling site was classified based on major particle size (sand, gravel, organic, etc.). When the substrates sampled were a mix of two of the types listed, the most common type in the sample grab was recorded. When sediment appeared to be an even mix of two or more sediment types, the type with the largest particle size was recorded (e.g. an equal mix of sand and gravel was recorded as gravel). Depth was measured at each site using a surveyor's staff.

4.4 Riparian Land use Assessment at Plant Survey Sites

The riparian survey occurred at points where aquatic plant survey transects intersected with the shoreline. The immediate shoreline (50 feet wide and 30 feet back) was surveyed using the following characteristics as guidelines:

Table 2. Riparian Shoreline Classification

Natural	Wooded
	Native herbaceous
	Shrubs
	Emergent Aquatic Plants
	Wetland
Disturbed	Cultivated lawn
	Hard Structures *(decks, walkways, etc.)*
	Modified shoreline *(beach, rip-rap, etc.)*

Areas where buffer strips were present were noted but the size of the buffer was not measured. Recommendations will be made to the Lake Association based on the information collected in the riparian land use assessment.

4.5 Plankton Sampling

Phytoplankton and zooplankton samples were collected monthly from May to August at the water quality monitoring station. A vertical tow net with an 80 micron mesh size was used to sample the water column from one meter above the sediment to the water surface. Phytoplankton and zooplankton samples were mailed overnight to Phycotech. Organisms were identified to the lowest practical taxonomic level and biomass was calculated.

4.6 Water Quality Sampling

Laboratory Analysis

A sample site was established at the north end of mid-lake at the deepest location in the lake (approximately 8.5 feet deep). Water samples were collected by AEI ecologists and were delivered to the Wisconsin State Laboratory of Hygiene (WSLOH) located at UW – Madison. The samples were analyzed for reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll-*a*. These samples were collected with a composite surface sampling device from 0 to 4 feet deep and kept on ice until they arrived at the laboratory in Madison. Samples were collected in May, July, August, and October. Parameters measured during laboratory analysis are: total phosphorus, soluble reactive phosphorus, chlorophyll-*a*, pH, total Kjeldahl nitrogen, nitrate + nitrite, ammonia, alkalinity, total hardness, chloride, and total suspended solids.

On-Site Water Quality Measurements

Depth profiles were collected at the water quality monitoring sample site during the summer sampling periods (May, June, July, August and October). Data points were collected at one-meter intervals throughout the water column for dissolved oxygen, pH, conductivity, and temperature with a SONDE YSI probe.

4.7 Recreational Use Survey

A recreational use survey was composed by TLI and distributed via US postal service to 184 residents of Lake Lorraine on September 14, 2005. The deadline for returning the survey was set as October 31, 2005. The survey contained a variety of questions regarding the lake ecosystem and was intended to identify common perceptions, use conflicts, and accepted management practices (Appendix E).

5.0 Results

5.1 Overview of Macrophyte Surveys

Ten species of aquatic plants were found during the two macrophyte surveys combined. Nine species were found in the spring and seven in the summer (Table 3). Of the species found, two forms of duckweed and sago pondweed were unique to the spring survey, while flat-stemmed pondweed was unique to the summer survey. Seven of the species were submersed plants, two were free-floating, one was a floating leaf, and no emergent species were collected.

Table 3. Plant taxa identified during 2004 macrophyte surveys, Lake Lorraine, (Walworth County, WI).

Species Number	Scientific Name	Common Name	Relative Frequency of Occurrence	
			June	July
1	*Myriophyllum spicatum*	Eurasian water-milfoil	25%	45%
2	*Potamogeton crispus*	Curly-leaf pondweed	28%	1%
3	*Ceratophyllum demersum*	Coontail	20%	41%
4	*Stuckenia pectinata*	Sago pondweed	5%	0%
5	*Elodea canadensis*	Common waterweed	4%	6%
6	*Najas flexilis*	Slender naiad	15%	1%
7	*Nymphaea odorata*	White-water lily	2%	5%
8	*Lemna trisulca*	Star duckweed	1%	0%
9	*Lemna minor*	Common duckweed	1%	0%
10	*Potamogeton zosteriformis*	Flat-stemmed pondweed	0%	1%

The three most common species during the spring survey were Eurasian water-milfoil, curly-leaf pondweed, and coontail. Coontail and EWM were also the most common species found during the summer survey. Of these three species, two are non-native invasive species (EWM and CLP) and were found at nearly every sample site. CLP is a non-native cold water specialist that germinates in late fall, over-winters as an evergreen, reproduces both sexually and asexually, and senesces in the late spring and early summer. The reason for CLP's success is that it has a growth cycle that naturally reduces competition for resources such as nutrients and space.

Unlike CLP, EWM is a warm water specialist. It reproduces mainly by fragmentation (asexually), and little is known about its use of sexual reproduction other than it happens under certain conditions and hybridization is possible with other native milfoil species. EWM is tolerant of turbid conditions caused by runoff, algae, and recreation, and it prefers soft sediment types.

Coon's tail, commonly referred to as coontail, is a native plant capable of creating nuisance conditions. Coontail is a submersed plant that will grow anywhere light penetrates to the bottom of the lake. Coontail grows rapidly during early summer and is usually one of the most dominant early summer species present. Coontail prefers soft, organic substrates but can grow in just about any conditions. Coontail is resistant to poor water quality and can grow in low-light conditions when turbidity or algae blooms shade the water column. Because coontail has small, weak roots, mats of coontail can become dislodged from the substrate, float around the lake and settle in another location.

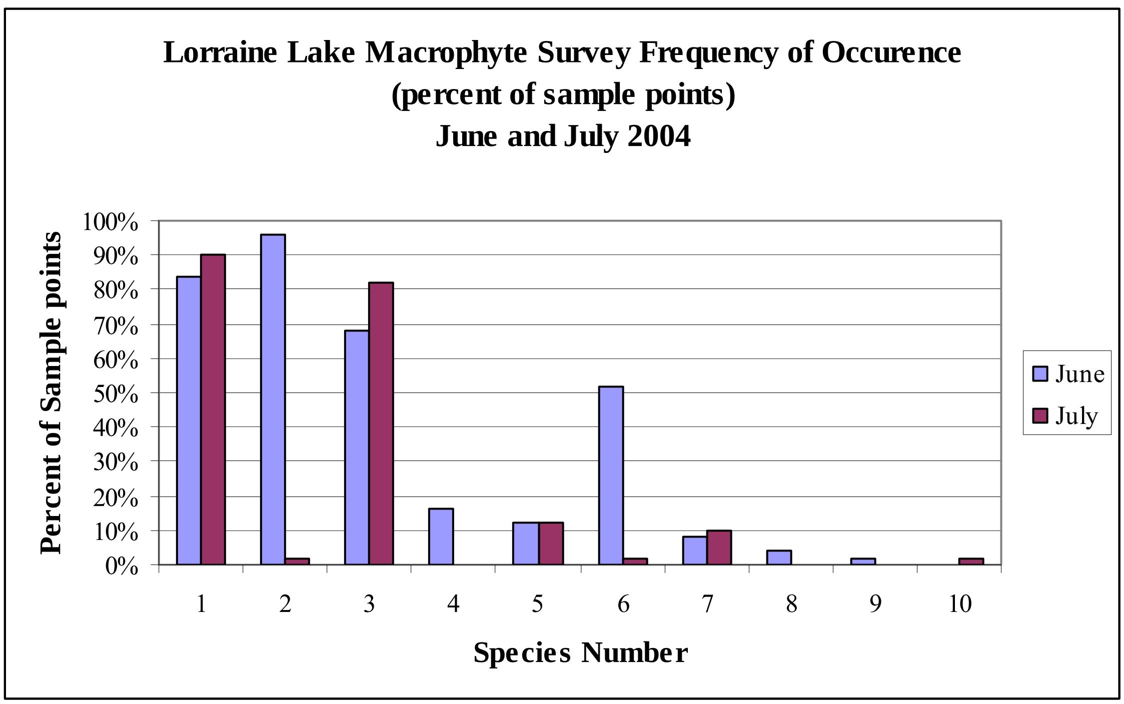

Figure 3. Lake Lorraine macrophyte frequency of occurrence as a percent of sample points during June and July surveys of Lake Lorraine (Walworth County, WI).

Algae – Filamentous and planktonic algae were not documented during either survey. For more information refer to the 2004 Lake Lorraine Water Quality Technical Report.

Submersed vegetation – Submersed macrophytes made up 96 percent of the plant coverage sampled in the spring and 95 percent of the plant coverage sampled during the summer survey.

Floating leaf vegetation – Floating leaf plants made up 2 and 5 percent of the coverage for the spring and summer surveys, respectively. Several areas of the lake where floating leaf plants occurred adjacent to the sample points were mapped during the qualitative survey.

Emergent plants – No emergent plants were sampled during either quantitative survey. Several areas of the lake were mapped during the qualitative survey where emergent vegetation occurred adjacent to sample points.

5.2 Quantitative Macrophyte Surveys

Each plant species found during the qualitative survey was sampled during the quantitative survey. A total of 10 species were found in 2004; nine unique plant species were found in the spring and seven in the summer. The three most abundant plants, by site occurrence, in the spring were curly-leaf pondweed (28% relative frequency), Eurasian water milfoil (25%) and coon's tail (20%). The two most common species in the summer survey were EWM (*45%)* and coon’s tail (41%). The average density per sample site for the spring survey was 3.27 (on a 0 to 5 scale) and was 2.72 for the summer survey. The maximum rooting depth located during either survey was 8’3” and was located at sample point number 6 (summer auto_ID). EWM and coon's tail were found rooted at this depth.

The Floristic Quality Index (I), calculated: $I = ((\sum C_i) \div N) \sqrt{N})$, was performed for the species found in Lake Lorraine in 2004. A total of 8 unique native species (N) had an average coefficient of conservatism of 4.75. The FQI for Lake Lorraine in 2004 was 13.4.

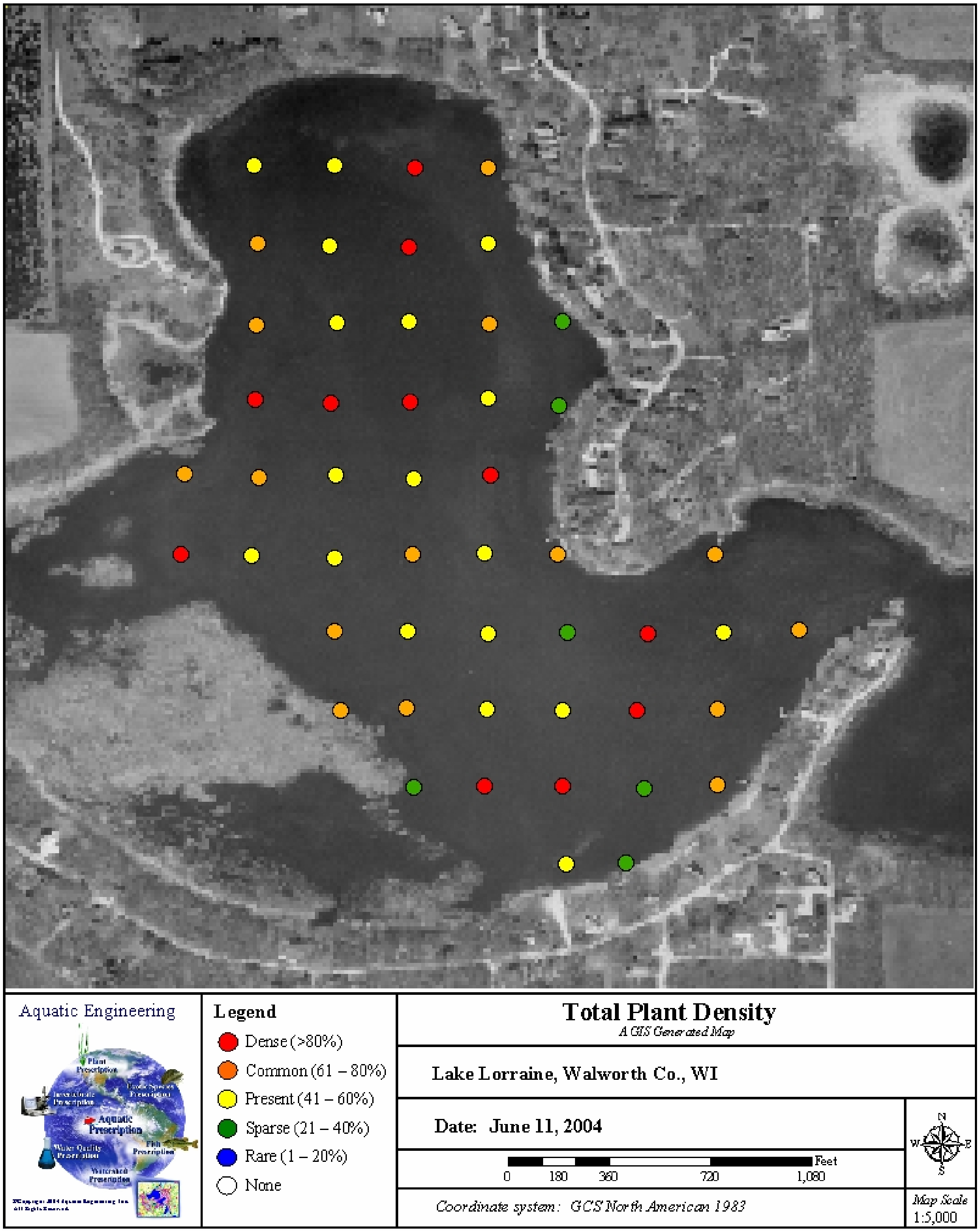

Figure 4. Macrophyte Species Distribution and Density Range for Lake Lorraine (Walworth County, WI) June, 2004.

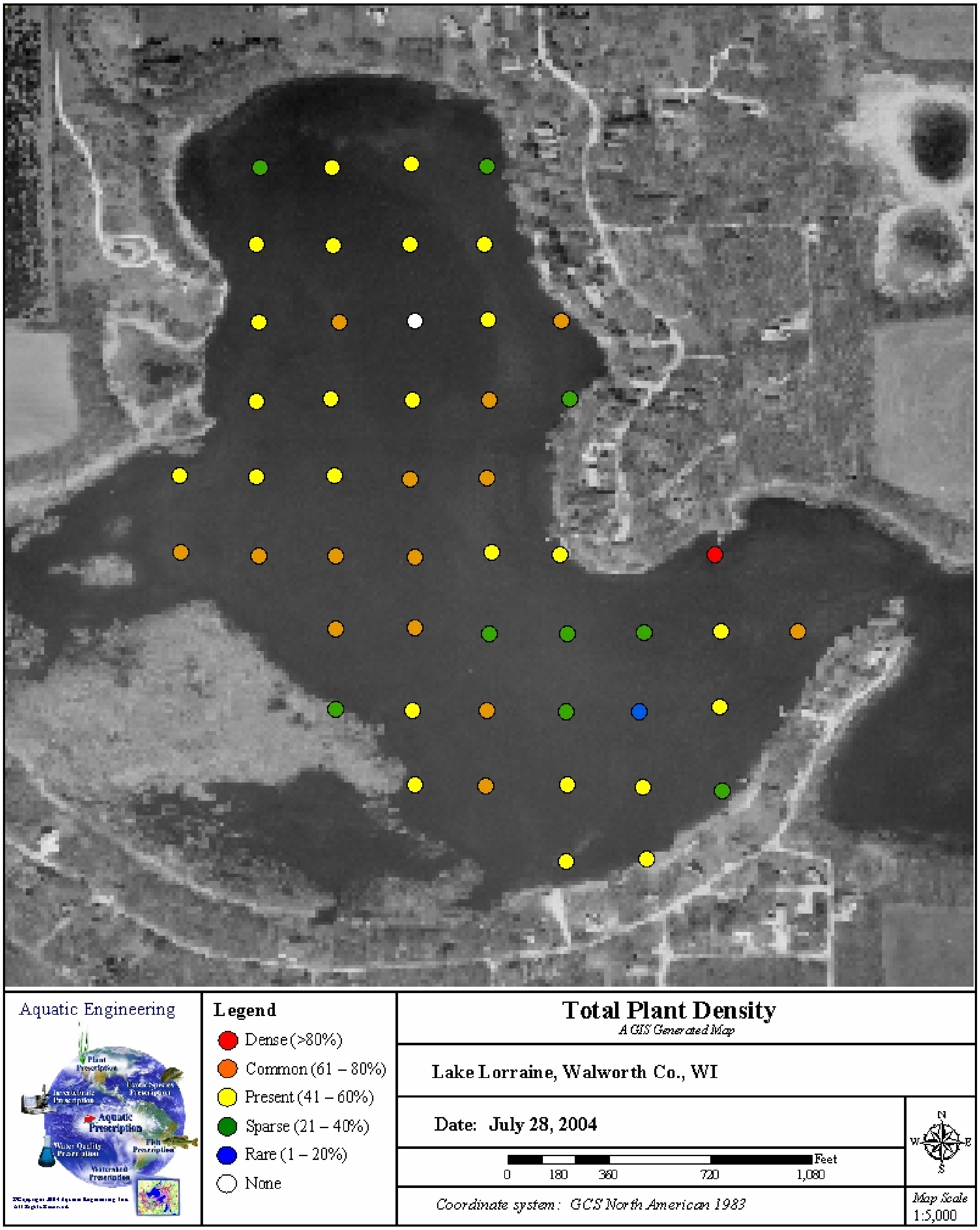

Figure 5. Macrophyte Species Distribution and Density Range for Lake Lorraine (Walworth County, WI) July, 2004.

Simpson's diversity index (D_S) can be calculated using the following formula:

$D_S = [1 - \sum (\text{species relative frequency}^i)^2] \times 100$

i = calculated by taking the number of sampling points an individual species is present in divided by the total number of sampling points equal to or less than the maximum rooting depth.

The D_S values for Lake Lorraine during the spring and summer surveys were 79.4 and 62.3, respectively. The value represents the percent chance that any two randomly selected individuals will belong to different species. This version of the Simpson's index is directly related to diversity, where 100 is the maximum value attainable, though it is rarely reached.

The Shannon index (H) measures the uncertainty the taxon of a randomly chosen individual can be predicted (Shannon and Weaver 1949). Diverse communities will have a high value for the Shannon index. This index is sensitive to the presence of rare species and widely used to analyze biological communities. The calculation for the Shannon index is:

$$H = \sum -p_i \log_2 p_i$$

where p_i is the relativized proportion of taxon i. The H value can be compared to the H_{max} value, which is a measure of the maximum diversity possible given the taxa pool of the community. It is calculated as:

$$H_{max} = \log_2 P$$

where P is the total number of taxa present. The ratio of H/H_{max} provides an estimate of how close a community approaches its theoretical maximum diversity. Ideally, a climax plant community will approach H_{max} but will rarely achieve it.

The Shannon index for Lake Lorraine in the spring of 2004 was 2.51, with an H_{max} of 3.17. The H/H_{max} ratio is 0.79. The Shannon index for the summer survey was 1.70, with an H_{max} of 3.17. The H/H_{max} ratio was 0.54. The H/H_{msx} values for both the spring and summer surveys show that Lake Lorraine has very little diversity in its macrophyte community.

The Aquatic Macrophyte Community Index (AMCI) is based on seven characteristics of aquatic plant communities called metrics. The scoring system for metrics is based on characteristics of reference or undisturbed plant communities. A lake can score from 0 – 70 where 70 reflects an ideal plant community (Nichols, Weber, and Shaw1995). The metrics used in the AMCI are: the maximum rooting depth, percent littoral zone vegetated, Simpson's index, total taxa, relative frequency of submersed taxa, relative frequency of exotic species, and the relative frequency of sensitive species. A score for each metric is assigned and the individual scores are summed for the overall score. The AMCI value for Lake Lorraine in the spring was 29 and in the summer was 26.

5.3 Invasive Species Assessment

Curly-leaf pondweed

The spring survey found CLP at 48 sites (96% of sites sampled). The average CLP coverage per occurrence was 1.35 (roughly 27% coverage) with 2 sites having nuisance conditions (generally considered any site with CLP coverage at or above 60%). The summer survey found CLP at one site (47 fewer sites than the spring survey). Only 2% of sites sampled had CLP as opposed to 96% during the previous survey. The average coverage of CLP per occurrence was 0.25 (approximately 5% coverage) with no sites having nuisance conditions.

Eurasian watermilfoil

The spring survey found EWM at 42 sites (84% of sites sampled). The average EWM coverage per occurrence was 2.33 (roughly 47% coverage) with 8 sites having nuisance conditions (generally considered any site with EWM coverage at or above 60%). The summer survey found EWM at 45 sites (approximately equal to the spring survey). The average coverage of EWM per occurrence was 2.36 (approximately 49% coverage) with 16 sites having nuisance conditions.

5.4 Water Quality at Plant Survey Sites

The water quality parameters measured at each plant survey site (pH, temperature, DO, and conductivity) did not reveal abnormalities among the sites. Nearly the entire lake contained dense weed growth, and no major variances occurred from site to site.

5.5 Substrate at Plant Survey Sites

The most common substrate type recorded during the plant surveys was muck (Table 4).

Table 4. Substrate composition of Lake Lorraine (Walworth County, WI).

Substrate	Percent Sites
Rock	0
Gravel	2
Sand	8
Muck	90
Organic	0

5.6 Riparian Land use Assessment at Plant Survey Sites

The riparian land use assessment revealed the immediate shoreline of Lake Lorraine is in a "balanced" condition, which reflects the mix of natural forest, wetlands and mild residential development around the lake.

Table 5. Riparian land use coverage for Lake Lorraine (Walworth County, WI) in 2004.

<table>
<tr><th></th><th># of Sites</th><th>% of Sites</th></tr>
<tr><td>Natural</td><td>5</td><td rowspan="4">56%</td></tr>
<tr><td>Wooded</td><td>2</td></tr>
<tr><td>Emergent[1]</td><td>2</td></tr>
<tr><td>Shrubs</td><td>1</td></tr>
<tr><td>Disturbed</td><td>4</td><td rowspan="3">44%</td></tr>
<tr><td>Lawn</td><td>4</td></tr>
<tr><td>Buffer Strip[2]</td><td>0</td></tr>
</table>

[1] Emergent plants occurred at 2 of the 3 wetland sites and were not separate occurrences.
[2] Buffer strips were documented at sites where cultivated lawns were present but did not directly border the shoreline.

5.7 Water Quality

Lake Lorraine is a phosphorus-driven lake that does not form a thermocline in the summer. The maximum depth does not allow a thermocline to form, regardless of weather conditions. It has water quality properties similar to other lakes in its region. None of the parameters measured in 2004 revealed any abnormalities.

Total phosphorus (TP) was reported five times in 2004. The average TP was 85µg/L with a maximum of 168µg/L and a minimum of 44µg/L. The TSI_{TP}[3] value is 68.2. Because phosphorus is cycled so rapidly through biota, soluble reactive phosphorus (SRP) concentrations as low as 5 µg/L are enough to maintain eutrophic or highly productive conditions in lake systems (Tippecanoe Environmental Lake and Watershed Foundation, 2005). The average SRP for Lake Lorraine in 2004 was 38µg/L.

Chlorophyll *a* (Chl-*a*) was reported five times in 2004. The average Chl-*a* for Lake Lorraine was 22.2 µg/L with a maximum of 25.6µg/L and a minimum of 16.4µg/L. The 2004 TSI_{chl} value is 61.0.

Secchi disk readings were collected four times in 2004. The average Secchi reading in 2004 was 5.0 feet. The maximum value observed was 6.0 and the minimum was 3.33 feet. The TSI_{SD} for Lake Lorraine in 2004 is 52.3.

Nitrogen, like phosphorus, is an essential macronutrient needed for algal production. Most lakes, however, are phosphorus limited, and attempts to reduce lake nitrogen levels may have little effect on algal biomass (Holdren 2001). The average TKN for Lake Lorraine in 2004 was 1,340µg/L and supports the fact that Lake Lorraine is phosphorus limited.

The average conductivity of Lake Lorraine in 2004 was 201UMHOS/cm which is typical of lakes in its region.

[3] See the 2004 Lake Lorraine Water Quality Report for information and calculations regarding TSI values.

5.8 Phytoplankton and Zooplankton

Fourteen unique zooplankton species belonging to four different classes were found during the zooplankton sampling. Organisms belonging to the Copepoda and Ostracoda groups contributed the greatest biomass throughout the season. The results for phytoplankton and zooplankton are discussed in the "2004 Lake Lorraine Water Quality Report".

5.9 Recreational Use Survey

Of the 184 surveys that were distributed, 29 were returned (16% participation). The results are included in Appendix E of this report and indicate that the residents of Lake Lorraine are residential home owners (83%), live on or within ¼ mile of the lake (89%), and cite peace and tranquility or recreational opportunity as the major reason for owning their property. Approximately 50 percent of the respondents are seasonal and 50 percent are year-round residents. Approximately 33 percent of respondents use the lake in the summer only while another 39 percent use the lake year-round. Many of the respondents cite owning row boats, canoes, kayaks, and motorboats less than 25 horsepower. Nearly all residents (93%) believe that there is sufficient public access to the lake.

Fishing was the recreational use listed as the primary activity of enjoyment more often than all other categories. Fishermen reported that they prefer sunfish (36%) and largemouth bass (37%), almost always practice catch and release of sport-fish (66%), and catch a "good" number of fish (50%) of "fair" size (48%).

When asked about water quality, respondents indicated that fertilizers are not needed or needed only sporadically (84%). Respondents also indicated that water clarity was worst in the summer and believe conditions in the winter are murky (62%) to "pea soup" (25%). Respondents believed that aquatic plant growth was "too much" (93%) and most agreed that certain areas are worse than others (90%).

The current perceived detractions from enjoyment of the lake are excessive weed growth (#1), shoreline development (#2), and noise and algae blooms (tied for #3). When asked about the level of importance of certain lake issues, respondents felt that water quality was the most important issue (39% of respondents listed as #1). Plant growth and wildlife habitat were the second and third most commonly listed #1 issues. Respondents report that water clarity, nuisance weed growth, algae, mucky sediments, and water level fluctuation have become worse over time. The perceived causes of the problems are lake level fluctuation, fertilizer and pesticide use, and inappropriate lake management.

When asked about whether they felt they had a voice in lake management issues, 38 percent of respondents claimed “yes”, 41 percent claimed “no” and 21 percent claimed “not sure”. The large majority of respondents also believe that the current weed program is ineffective (93%).

6.0 Discussion

6.1 Qualitative Aquatic Plant Surveys

During the qualitative plant surveys in 2004, ecologists found a good amount of emergent and floating leaf aquatic plants in Lake Lorraine. The lake contained mostly CLP in the spring and EWM in the summer, which shows that the lake is in an advanced state of disturbance. These non-native species typically cause nuisance conditions for recreationists, hamper native plant distribution, and decrease diversity within the plant community and invertebrate community. The timing of CLP decay also increases the chances of algal blooms in mid-summer.

The entire lake is considered littoral zone, and therefore there is an opportunity for plants to completely cover the lake bottom. In 2004, the entire lake bottom was covered with plants and only sporadic open areas were navigable.

Some floating leaf and emergent vegetation around the border of the lake is really the most positive aspect of the plant community. These plants have held their ground against the non-native invasive species and provide good cover and habitat for fish and wildlife. The southwest and southeast corners of the lake contain wetland conditions with floating leaf and emergent plants. Wetlands help filter out pollutants and decrease nutrient loads to lakes and rivers. Some of these areas within Lake Lorraine should be considered for sensitive area designations.

6.2 Quantitative Aquatic Plant Surveys

Lake Lorraine's aquatic plant community was analyzed for a number of diversity and quality indices that allow it to be compared objectively to other lakes statewide and in the Southern till plains region. The Shannon Diversity Index, maximum Shannon Diversity, Simpson's Index of Diversity, Floristic Quality Index, and Aquatic Macrophyte Community Index were calculated for Lake Lorraine.

The Shannon Diversity Index value for Lake Lorraine in the summer is 1.70 out of a possible 3.17. This indicates that the aquatic plant community in Lake Lorraine is far from an ideal community. The Simpson's Index value of 0.62 for the summer survey is below average compared to other Wisconsin lakes (Nichols, Weber, and Shaw 1995). This value reflects the uneven distribution of plant species.

The Floristic Quality Index value is 13.4, which is in the lower quartile range for both the Southeastern till plains (17.0) and the state (16.9). The most degraded lakes fall into the lower quartile range in both categories. The total number of native species found in Lake Lorraine (8) is in the lower quartile for the region (less than or equal to 10) and is at the lower quartile for the state (less than or equal to 8). The Aquatic Macrophyte Community Index value for Lake Lorraine peaked at 29, which is very low compared to the Wisconsin state-wide average (51) and the regional average (48) for lakes (Nichols, Weber, and Shaw 1995). In general, the data indicate that the aquatic plant community of Lake Lorraine is in a disturbed condition and is below average for both the state and region.

6.3 Water Quality at Plant Survey Sites

The water quality sampling performed at the aquatic plant sampling sites did not reveal any abnormalities. The water chemistry from point to point was relatively constant, and monotypic beds of CLP did not seem to affect any of the parameters measured. The parameters measured at the plant survey sites are not likely to change from site to site unless measured in a dense, monotypic CLP bed during die-off and decomposition. Since the plant surveys were performed before and after the seasonal die-off of CLP, no water quality abnormalities are expected.

6.4 Substrate at Plant Survey Sites

The most commonly occurring sediment in the littoral zone of Lake Lorraine is mud (muck). Some aquatic plants prefer one sediment type over others and are able to compete better than plants less suited to that particular substrate. In sandy areas, one will typically find more pondweeds and naiads, which were found in 2004 at low densities.

Areas that contained soft substrates were dominated by CLP in the spring and EWM and coon's tail in the summer. Soft sediment types, like muck, along shoreline areas are also ideal for floating-leaf and emergent vegetation, which appear in the wetland areas adjacent to the lake. The abundance of soft sediment in Lake Lorraine helps explain the low relative abundance of high value submersed aquatic vegetation that typically prefer sand.

6.5 Riparian Land use Assessment at Plant Survey Sites

Cultivated lawn was the most common type of shoreline coverage (44%). As a whole, the riparian land surrounding the lake is a good mix of natural vegetation and residentially landscaped lawn. This type of coverage would generally cause slight nutrient and sediment problems for lakes. Typical symptoms would include excessive plant growth and algal blooms. Algal blooms can occur in two varieties: filamentous algal blooms and planktonic algal blooms. While both types can create problems for lake patrons, filamentous algae can form dense floating mats that decay and cause noxious odors. This type of algae tends to cause nuisance conditions more easily than planktonic algae. Planktonic algae cause the "pea soup" effect in lakes where the water itself seems to turn green. None of the sites that had cultivated lawns contained a buffer strip separating the lawn from the water. Buffer strips are ideal for property owners that wish to have a cultivated lawn but want to prevent excessive nutrients and sediments from entering the lake. Though the theoretical width of effective buffer strips is debated, it is agreed that any buffer width is better than no buffer at all. The WDNR suggests that the state mandated 35-foot buffer may be insufficient to fully protect against erosion and nutrient loading even when most vegetation is intact (WDNR 1999).

6.6 Water Quality

The TSI values for Lake Lorraine in 2004 show that it is a eutrophic lake. Water clarity, chlorophyll *a*, and total phosphorus data support this trophic status. Lake Lorraine has qualities expected of this status. As part of a future monitoring strategy, the TSI values can be calculated and compared from year to year and will indicate whether the eutrophication process is increasing, decreasing, or remaining constant. Sudden changes could be due to changes in the watershed or weather conditions. Any major changes and long-term trends in TSI values should be investigated. Finding sources of nutrient loading is also necessary for future water quality management and protection.

6.7 Recreational Use Survey

The recreational use survey shows that the majority of people in the Association believe that excessive weeds are causing problems for recreationists and that the current management plan is not effectively addressing the problem. Association members believe that water quality and aquatic weed conditions need the most management and have the most room for improvement. Fish size and numbers are acceptable for the current public interest. Property owners seem willing to reduce harmful watershed inputs by decreasing fertilizer use and are willing to protect high value areas of the lake by expanding no-wake times and zones.

7.0 Recommendations

It is recommended that the Lake Lorraine Protection and Improvement Association take the following steps to managing its aquatic resource:

1) Conduct visual qualitative plant surveys once per year and calculate the FQI of the plant community. This is the minimal action recommended and is supported by draft WDNR APM guideline recommendations.

2) Perform a quantitative plant survey every five years to update the plant community inventory information gathered in 2004. This is also the minimum recommendation for this type of survey.

3) Participate in WDNR-sponsored Self-help Secchi depth monitoring and Clean Boats, Clean Waters programs. Resident participation is a good way to minimize cost while demonstrating a commitment to improving and protecting the resource.

4) Form a Lake District. An official Lake District has certain legal abilities that Associations do not have. Lake Districts can also require financial participation of their members and can apply directly for state funding.

5) Continue to manage nuisance aquatic plant growth through aquatic herbicides, harvesting, and water quality improvements. It is important to be consistent with selected management practices and to give them time to realize results.

6) Crate and implement an Aquatic Plant Management Plan. The plan will investigate the potential uses of lake wide relief available from dredging and whole lake SONAR treatments. A state approved plan will also expedite future permitting if required.

7) Create and implement a comprehensive Lake Management Plan (LMP). The plan should include collecting missing inventory data such as a hydrologic budget and nutrient modeling, and should include a review of management options. An LMP is more comprehensive than an APM Plan and includes plans to manage every aspect (watershed, water quality, aquatic plants, public support, etc.) of the natural resource.

8) Investigate the possibility of large scale dredging. Refer to the Managing Lakes and Reservoirs handbook (Holdren, 2001). Removing sediments will improve water quality by reducing nutrients, improve the fishery by exposing various sediment types useful for spawn habitat, and improve aquatic plant distribution by creating dynamic depth contours and diversifying sediment types.

8.0 References

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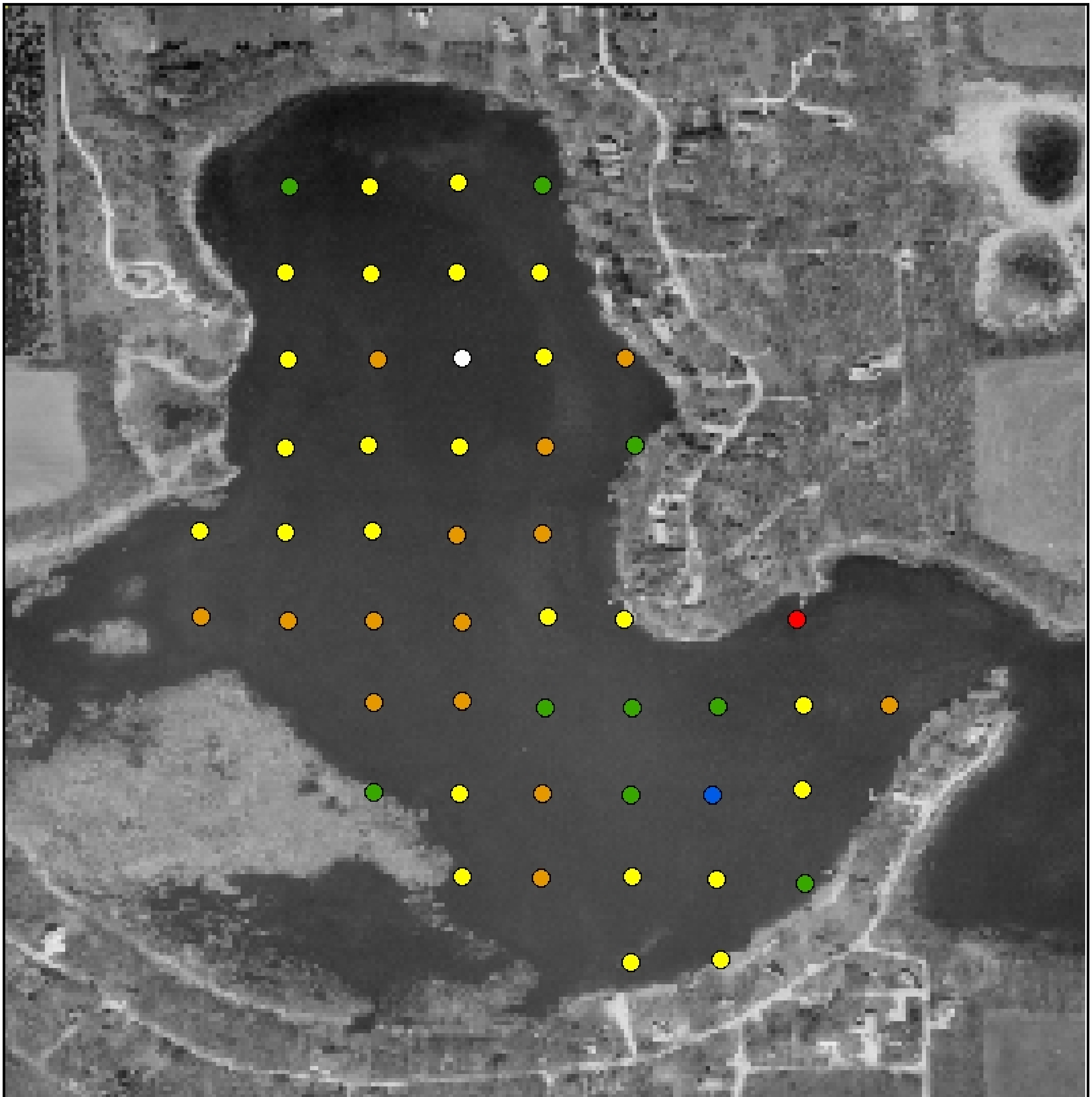
Appendix A:
July Plant Survey Maps



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Total Plant Density

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

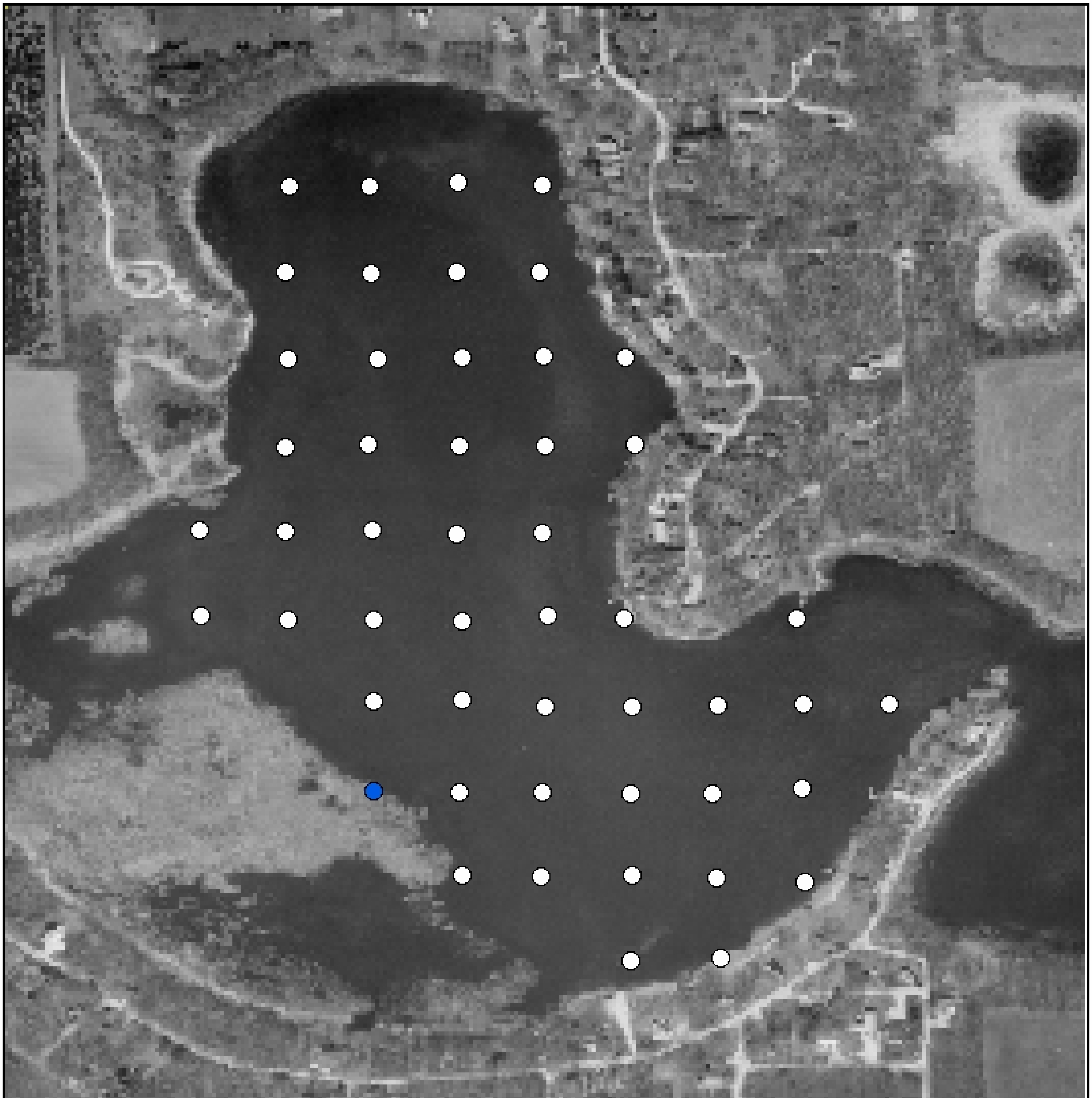
Date: July 28, 2004

Feet: 0 180 360 720 1,080

N E S W

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Curly-leaf pondweed *(Potamogeton crispus)*

A GIS Generated Map

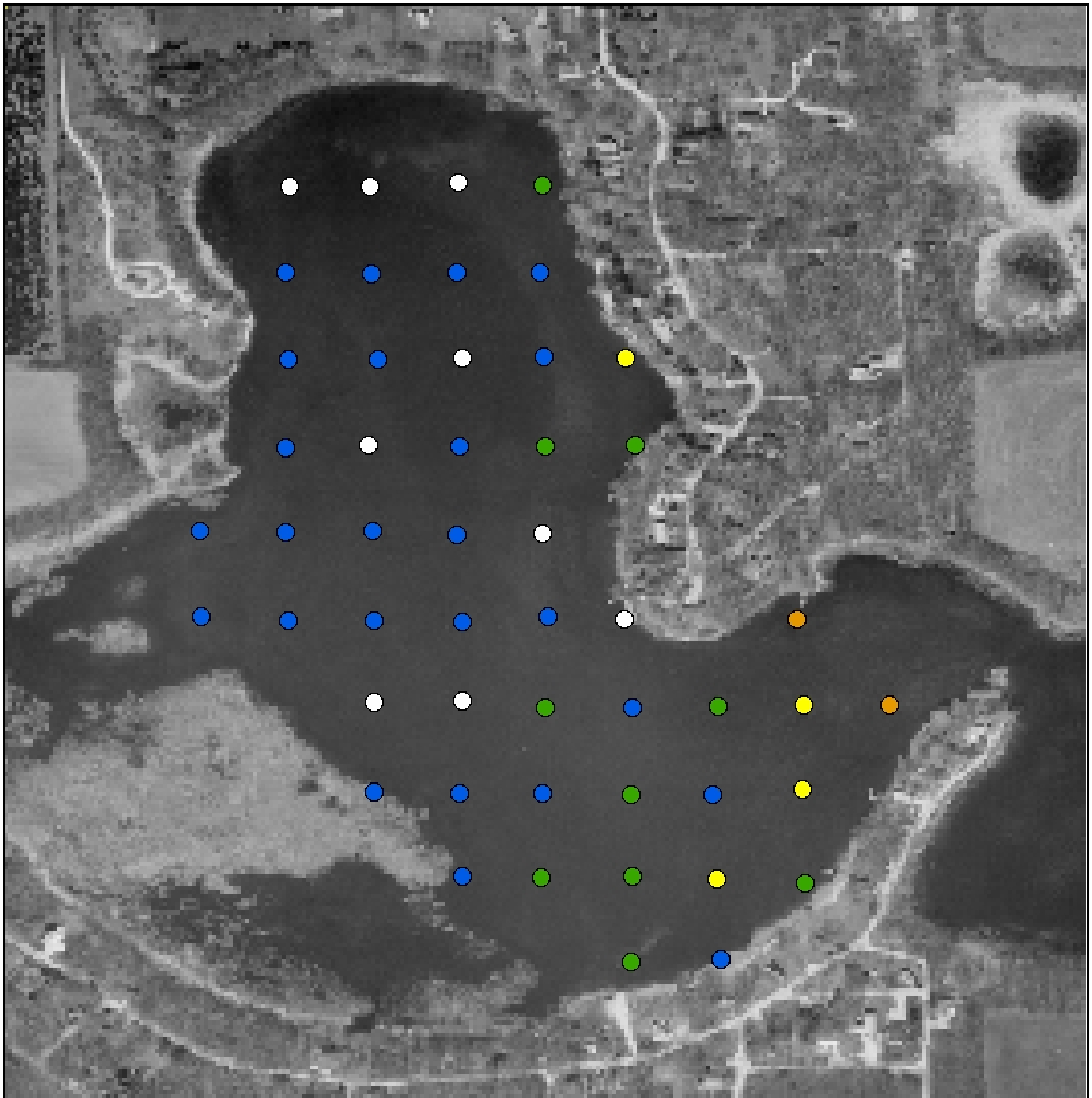
Lake Lorraine, Walworth Co., WI

Date: July 28, 2004

0 180 360 720 1,080 Feet

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Plant Prescription
Exotic Species Prescription
Invertebrate Prescription
Aquatic Prescription
Water Quality Prescription
Fish Prescription
Watershed Prescription

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Coon's tail *(Ceratophyllum demersum)*

A GIS Generated Map

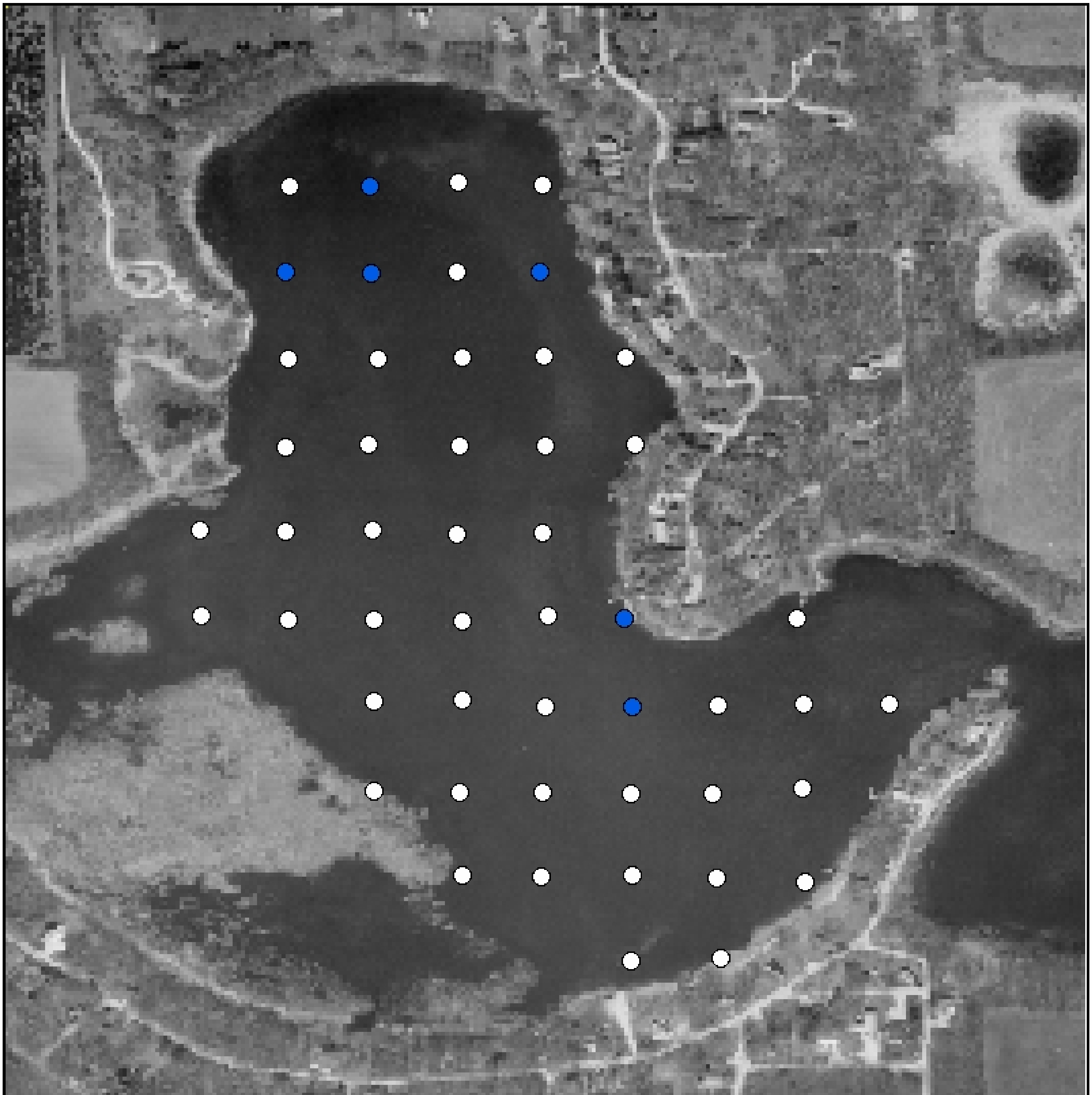
Lake Lorraine, Walworth Co., WI

Date: July 28, 2004

0 180 360 720 1,080 Feet

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Common waterweed *(Elodea canadensis)*

A GIS Generated Map

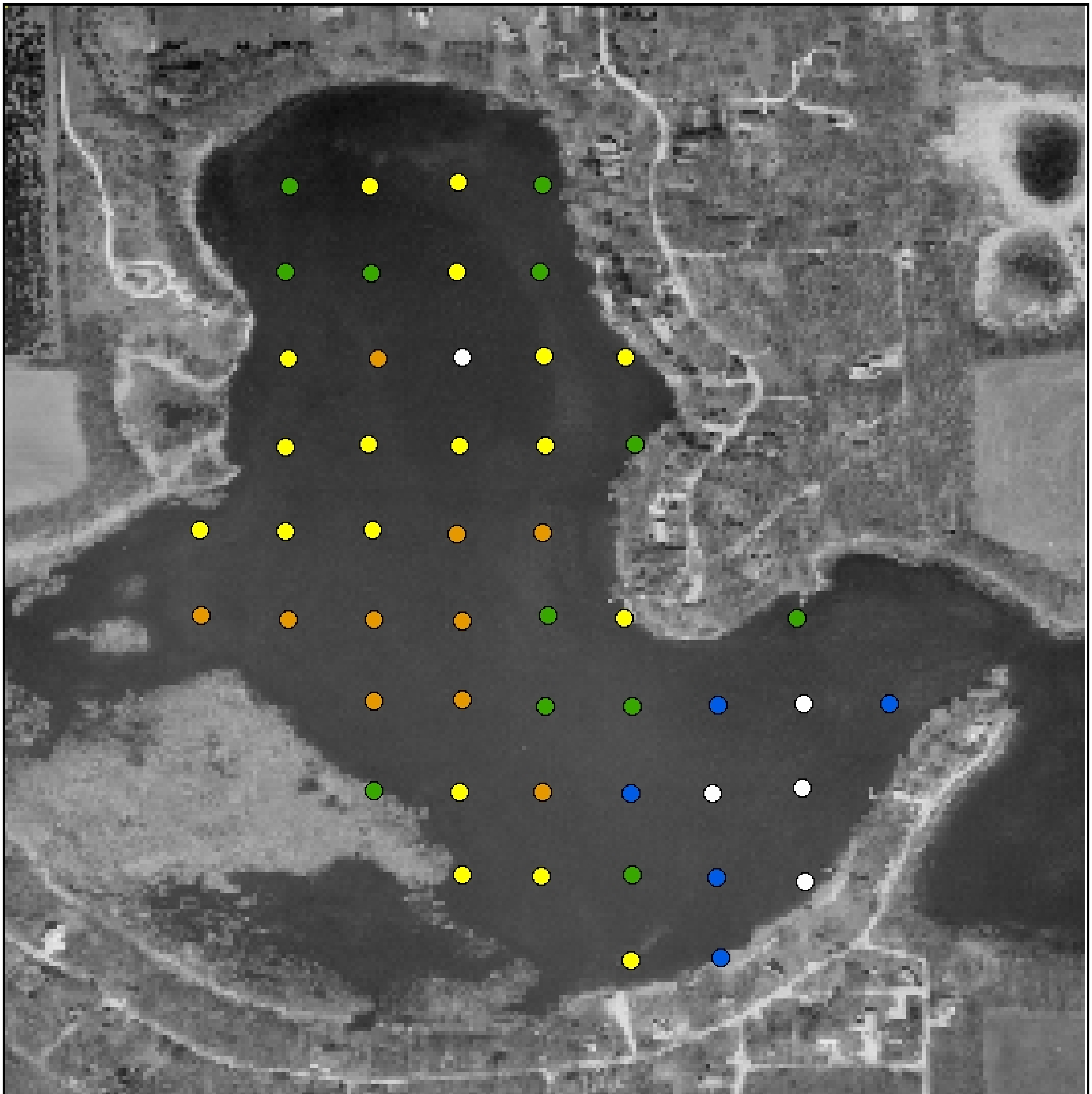
Lake Lorraine, Walworth Co., WI

Date: July 28, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Eurasian water milfoil *(Myriophyllum spicatum)*

A GIS Generated Map

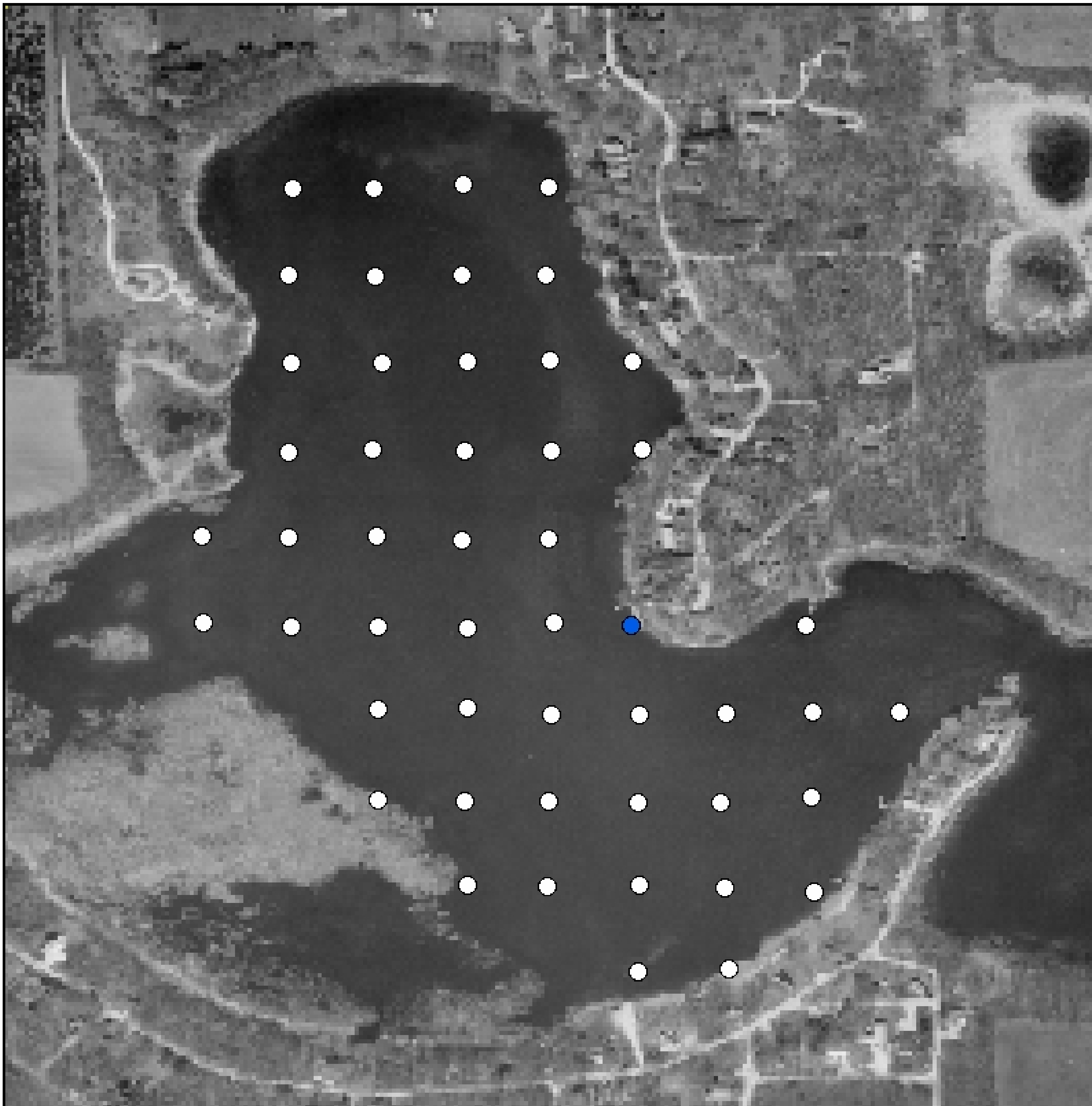
Lake Lorraine, Walworth Co., WI

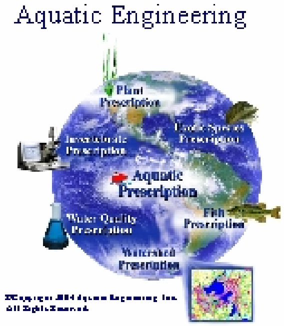
Date: July 28, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

Map Scale 1:5,000





Legend

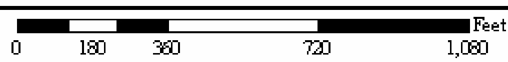
- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

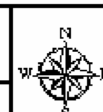
Flat-stemmed pondweed *(Potamogeton zosteriformis)*

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

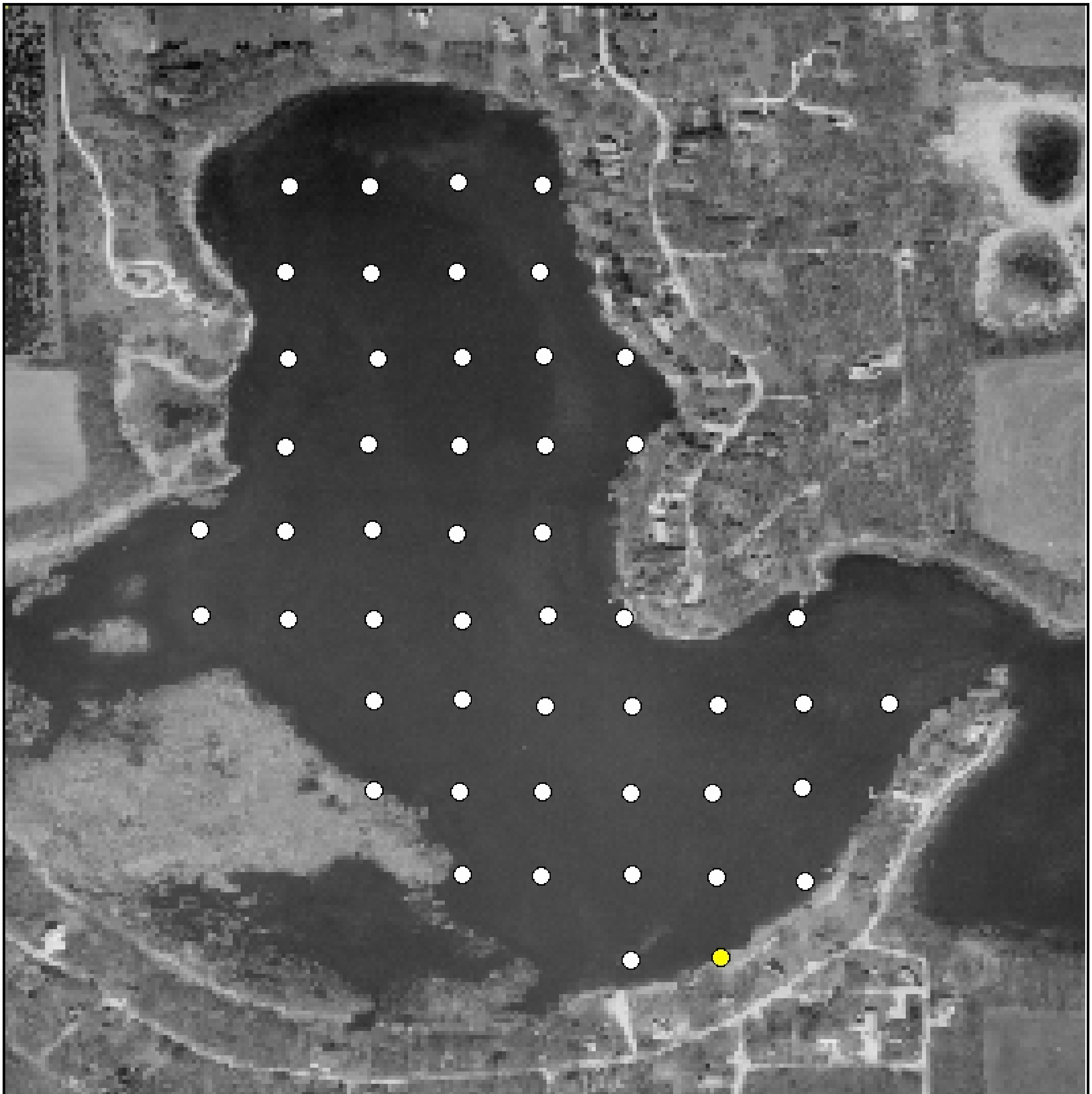
Date: July 28, 2004





Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Slender niad *(Najas flexilis)*

A GIS Generated Map

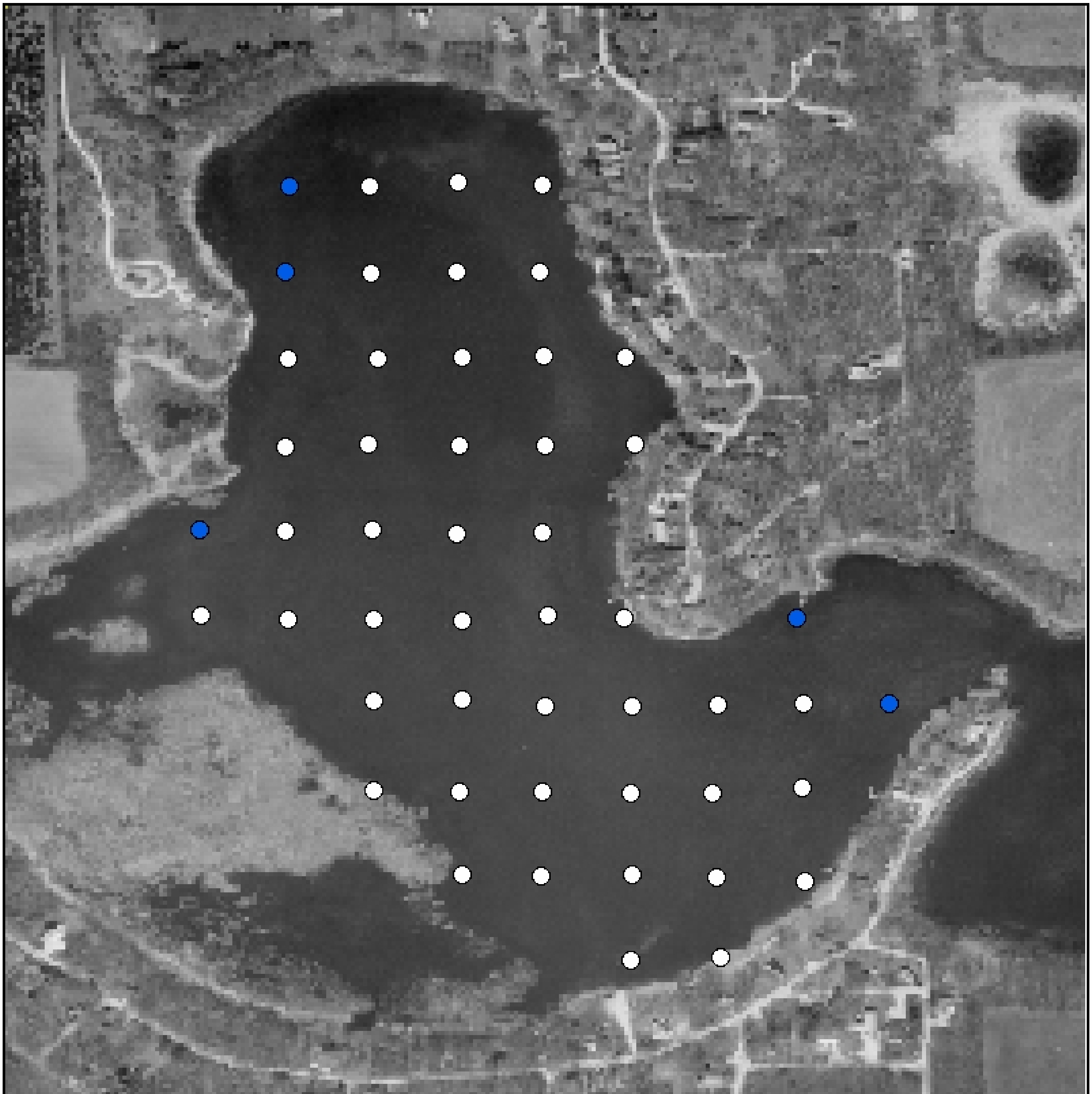
Lake Lorraine, Walworth Co., WI

Date: July 28, 2004

0 180 360 720 1,080 Feet

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

White-water lily *(Nymphaea odorata)*

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

Date: July 28, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

Map Scale 1:5,000

Appendix B:
July APS Raw Data

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Elodea	S. niad	White lily	Flat stem
1	7/28/2004	1	1	1	0	0	0	0	1	0
1	7/28/2004	2	1	1	0	0	0	0	1	0
1	7/28/2004	3	1	1	0	0	0	0	1	0
1	7/28/2004	4	2	2	0	0	0	0	1	0
2	7/28/2004	1	1	1	0	0	1	0	0	0
2	7/28/2004	2	2	2	0	0	0	0	0	0
2	7/28/2004	3	3	3	0	0	0	0	0	0
2	7/28/2004	4	3	3	0	0	0	0	0	0
3	7/28/2004	1	2	2	0	0	0	0	0	0
3	7/28/2004	2	2	2	0	0	0	0	0	0
3	7/28/2004	3	3	3	0	0	0	0	0	0
3	7/28/2004	4	3	3	0	0	0	0	0	0
4	7/28/2004	1	2	1	0	2	0	0	0	0
4	7/28/2004	2	2	1	0	2	0	0	0	0
4	7/28/2004	3	2	1	0	2	0	0	0	0
4	7/28/2004	4	2	2	0	1	0	0	0	0
5	7/28/2004	1	2	2	0	0	0	0	0	0
5	7/28/2004	2	1	1	0	1	0	0	0	0
5	7/28/2004	3	3	2	0	1	1	0	0	0
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6	7/28/2004	1	4	4	0	0	0	0	0	0
6	7/28/2004	2	1	1	0	0	0	0	0	0
6	7/28/2004	3	2	2	0	1	0	0	0	0
6	7/28/2004	4	3	3	0	1	0	0	0	0
7	7/28/2004	1	2	2	0	1	0	0	0	0
7	7/28/2004	2	4	3	0	1	1	0	0	0
7	7/28/2004	3	2	2	0	1	0	0	0	0
7	7/28/2004	4	1	1	0	1	0	0	0	0
8	7/28/2004	1	3	2	0	1	0	0	1	0
8	7/28/2004	2	2	2	0	0	0	0	1	0
8	7/28/2004	3	2	2	0	0	1	0	0	0
8	7/28/2004	4	2	1	0	1	0	0	1	0
9	7/28/2004	1	3	3	0	1	0	0	0	0
9	7/28/2004	2	3	3	0	0	0	0	0	0
9	7/28/2004	3	3	3	0	1	0	0	0	0
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10	7/28/2004	3	1	1	0	1	0	0	0	0
10	7/28/2004	4	4	4	0	1	0	0	0	0
11	7/28/2004	1	0	0	0	0	0	0	0	0
11	7/28/2004	2	0	0	0	0	0	0	0	0
11	7/28/2004	3	0	0	0	0	0	0	0	0
11	7/28/2004	4	0	0	0	0	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Elodea	S. niad	White lily	Flat stem
12	7/28/2004	1	3	3	0	1	0	0	0	0
12	7/28/2004	2	3	3	0	0	0	0	0	0
12	7/28/2004	3	3	3	0	1	0	0	0	0
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15	7/28/2004	4	4	2	0	3	0	0	0	0
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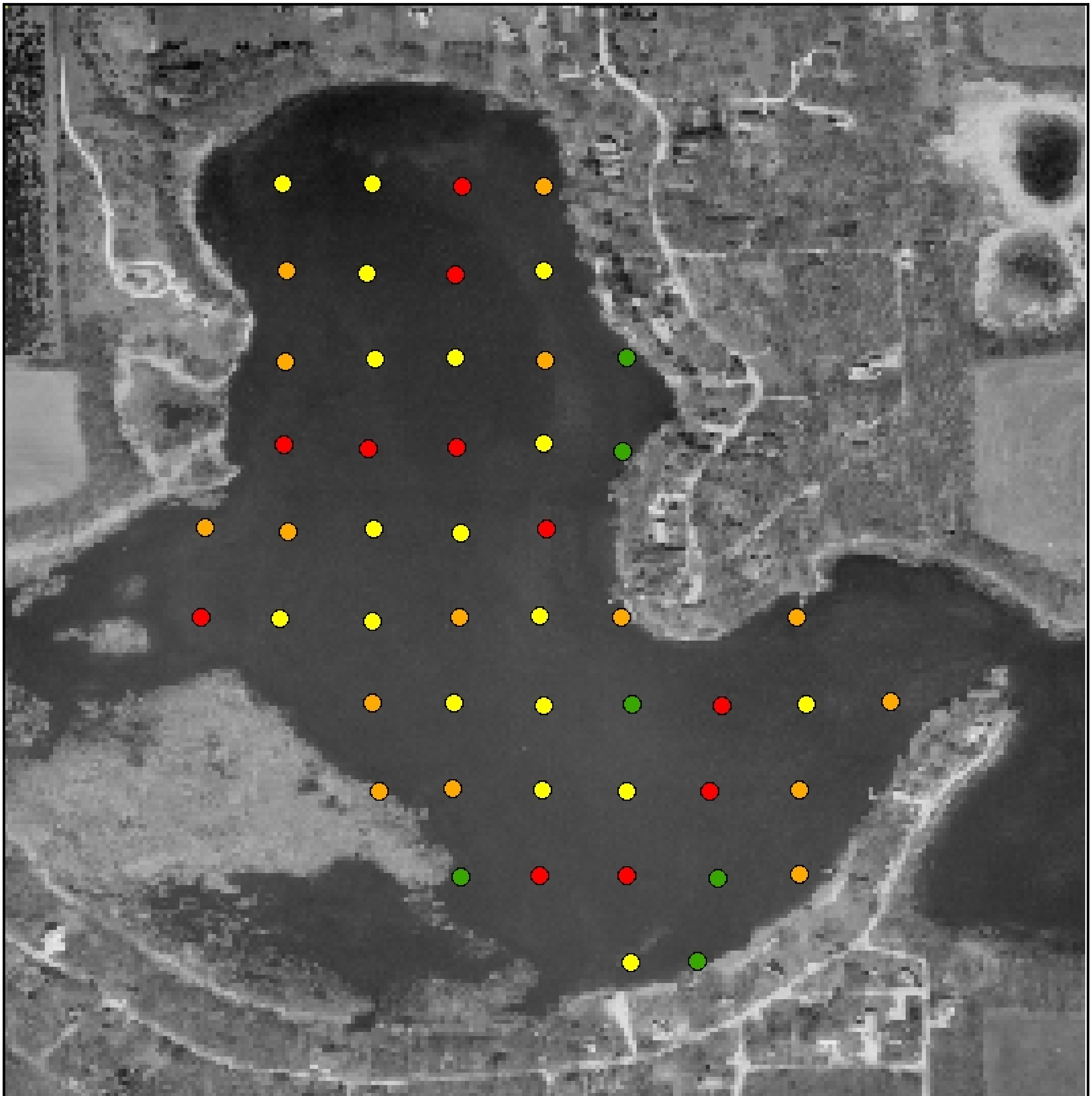
16	7/28/2004	2	3	3	0	1	0	0	0	0
16	7/28/2004	3	2	2	0	0	0	0	0	0
16	7/28/2004	4	2	2	0	0	0	0	0	0
17	7/28/2004	1	3	3	0	0	0	0	0	0
17	7/28/2004	2	3	3	0	0	0	0	0	0
17	7/28/2004	3	3	3	0	0	0	0	0	0
17	7/28/2004	4	3	3	0	0	0	0	0	0
18	7/28/2004	1	3	3	0	1	0	0	0	0
18	7/28/2004	2	3	3	0	0	0	0	0	0
18	7/28/2004	3	3	3	0	0	0	0	0	0
18	7/28/2004	4	2	2	0	0	0	0	0	0
19	7/28/2004	1	2	2	0	0	0	0	1	0
19	7/28/2004	2	3	3	0	0	0	0	1	0
19	7/28/2004	3	4	4	0	0	0	0	1	0
19	7/28/2004	4	2	2	0	1	0	0	1	0
20	7/28/2004	1	3	2	0	2	0	0	0	0
20	7/28/2004	2	2	2	0	0	0	0	0	0
20	7/28/2004	3	3	3	0	1	0	0	0	0
20	7/28/2004	4	4	4	0	1	0	0	0	0
21	7/28/2004	1	3	3	0	1	0	0	0	0
21	7/28/2004	2	3	3	0	0	0	0	0	0
21	7/28/2004	3	3	2	0	2	0	0	0	0
21	7/28/2004	4	3	3	0	0	0	0	0	0
22	7/28/2004	1	4	4	0	1	0	0	0	0
22	7/28/2004	2	4	4	0	1	0	0	0	0
22	7/28/2004	3	4	4	0	1	0	0	0	0
22	7/28/2004	4	3	3	0	0	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Elodea	S. niad	White lily	Flat stem
23	7/28/2004	1	3	3	0	0	0	0	0	0
23	7/28/2004	2	3	3	0	0	0	0	0	0
23	7/28/2004	3	4	4	0	0	0	0	0	0
23	7/28/2004	4	4	4	0	0	0	0	0	0
24	7/28/2004	1	3	3	0	0	0	0	0	1
24	7/28/2004	2	2	2	0	0	0	0	0	0
24	7/28/2004	3	2	2	0	0	0	0	0	0
24	7/28/2004	4	2	2	0	0	1	0	0	0
25	7/28/2004	1	3	3	0	0	0	0	0	0
25	7/28/2004	2	1	1	0	1	0	0	0	0
25	7/28/2004	3	1	1	0	1	0	0	0	0
25	7/28/2004	4	4	3	0	2	0	0	0	0
26	7/28/2004	1	5	4	0	2	0	0	0	0
26	7/28/2004	2	3	3	0	1	0	0	0	0
26	7/28/2004	3	4	4	0	1	0	0	0	0
26	7/28/2004	4	4	4	0	0	0	0	0	0
27	7/28/2004	1	4	4	0	0	0	0	0	0
27	7/28/2004	2	3	3	0	0	0	0	0	0
27	7/28/2004	3	4	4	0	1	0	0	0	0
27	7/28/2004	4	4	4	0	1	0	0	0	0
28	7/28/2004	1	4	4	0	1	0	0	0	0
28	7/28/2004	2	4	4	0	0	0	0	0	0
28	7/28/2004	3	3	3	0	0	0	0	0	0
28	7/28/2004	4	4	4	0	1	0	0	0	0
29	7/28/2004	1	4	4	0	1	0	0	0	0
29	7/28/2004	2	4	4	0	0	0	0	0	0
29	7/28/2004	3	3	3	0	1	0	0	0	0
29	7/28/2004	4	4	4	0	1	0	0	0	0
30	7/28/2004	1	3	3	0	0	0	0	0	0
30	7/28/2004	2	4	4	0	0	0	0	0	0
30	7/28/2004	3	3	3	0	0	0	0	0	0
30	7/28/2004	4	3	3	0	0	0	0	0	0
31	7/28/2004	1	3	3	0	0	0	0	0	0
31	7/28/2004	2	3	3	0	0	0	0	0	0
31	7/28/2004	3	4	4	0	0	0	0	0	0
31	7/28/2004	4	4	4	0	0	0	0	0	0
32	7/28/2004	1	2	2	0	1	0	0	0	0
32	7/28/2004	2	2	2	0	1	0	0	0	0
32	7/28/2004	3	2	1	0	2	0	0	0	0
32	7/28/2004	4	2	2	0	1	0	0	0	0
33	7/28/2004	1	2	2	0	0	0	0	0	0
33	7/28/2004	2	3	2	0	1	1	0	0	0
33	7/28/2004	3	1	1	0	1	0	0	0	0
33	7/28/2004	4	2	1	0	2	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Elodea	S. niad	White lily	Flat stem
34	7/28/2004	1	2	1	0	2	0	0	0	0
34	7/28/2004	2	2	0	0	2	0	0	0	0
34	7/28/2004	3	2	1	0	2	0	0	0	0
34	7/28/2004	4	2	1	0	2	0	0	0	0
35	7/28/2004	1	2	0	0	2	0	0	0	0
35	7/28/2004	2	3	0	0	3	0	0	0	0
35	7/28/2004	3	2	0	0	2	0	0	0	0
35	7/28/2004	4	2	0	0	2	0	0	0	0
36	7/28/2004	1	3	0	0	3	0	0	0	0
36	7/28/2004	2	3	0	0	3	0	0	1	0
36	7/28/2004	3	4	1	0	4	0	0	0	0
36	7/28/2004	4	4	1	0	3	0	0	1	0
37	7/28/2004	1	2	0	0	2	0	0	0	0
37	7/28/2004	2	2	0	0	2	0	0	0	0
37	7/28/2004	3	3	0	0	3	0	0	0	0
37	7/28/2004	4	3	0	0	3	0	0	0	0
38	7/28/2004	1	1	0	0	1	0	0	0	0
38	7/28/2004	2	1	0	0	1	0	0	0	0
38	7/28/2004	3	1	0	0	1	0	0	0	0
38	7/28/2004	4	1	0	0	1	0	0	0	0
39	7/28/2004	1	2	1	0	2	0	0	0	0
39	7/28/2004	2	2	0	0	2	0	0	0	0
39	7/28/2004	3	2	0	0	2	0	0	0	0
39	7/28/2004	4	2	0	0	2	0	0	0	0
40	7/28/2004	1	4	4	0	0	0	0	0	0
40	7/28/2004	2	3	3	0	0	0	0	0	0
40	7/28/2004	3	5	5	0	0	0	0	0	0
40	7/28/2004	4	4	4	0	1	0	0	0	0
41	7/28/2004	1	3	3	0	1	0	0	0	0
41	7/28/2004	2	3	3	0	0	0	0	0	0
41	7/28/2004	3	3	3	0	0	0	0	0	0
41	7/28/2004	4	3	3	0	0	0	0	0	0
42	7/28/2004	1	1	0	0	1	0	0	0	0
42	7/28/2004	2	2	2	0	1	0	0	0	0
42	7/28/2004	3	3	2	1	1	0	0	0	0
42	7/28/2004	4	1	1	0	1	0	0	0	0
43	7/28/2004	1	4	3	0	2	0	0	0	0
43	7/28/2004	2	2	2	0	0	0	0	0	0
43	7/28/2004	3	3	3	0	1	0	0	0	0
43	7/28/2004	4	3	3	0	1	0	0	0	0
44	7/28/2004	1	3	3	0	1	0	0	0	0
44	7/28/2004	2	4	3	0	2	0	0	0	0
44	7/28/2004	3	3	3	0	1	0	0	0	0
44	7/28/2004	4	3	3	0	1	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Elodea	S. niad	White lily	Flat stem
45	7/28/2004	1	3	3	0	1	0	0	0	0
45	7/28/2004	2	3	3	0	1	0	0	0	0
45	7/28/2004	3	3	1	0	3	0	0	0	0
45	7/28/2004	4	2	0	0	2	0	0	0	0
46	7/28/2004	1	3	0	0	3	0	0	0	0
46	7/28/2004	2	3	0	0	3	0	0	0	0
46	7/28/2004	3	3	1	0	3	0	0	0	0
46	7/28/2004	4	2	1	0	2	0	0	0	0
47	7/28/2004	1	1	0	0	1	0	0	0	0
47	7/28/2004	2	1	0	0	1	0	0	0	0
47	7/28/2004	3	3	0	0	3	0	0	0	0
47	7/28/2004	4	2	0	0	2	0	0	0	0
48	7/28/2004	1	3	1	0	1	0	2	0	0
48	7/28/2004	2	2	0	0	1	0	2	0	0
48	7/28/2004	3	3	1	0	0	0	3	0	0
48	7/28/2004	4	2	1	0	0	0	2	0	0
49	7/28/2004	1	3	1	0	3	0	0	0	0
49	7/28/2004	2	2	2	0	1	0	0	0	0
49	7/28/2004	3	4	4	0	1	0	0	0	0
49	7/28/2004	4	3	3	0	1	0	0	0	0
50	7/28/2004	1	5	2	0	4	0	0	0	0
50	7/28/2004	2	5	2	0	4	0	0	0	0
50	7/28/2004	3	5	0	0	5	0	0	1	0
50	7/28/2004	4	3	1	0	1	0	0	2	0

Appendix C:
June APS Maps



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Total Plant Density

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

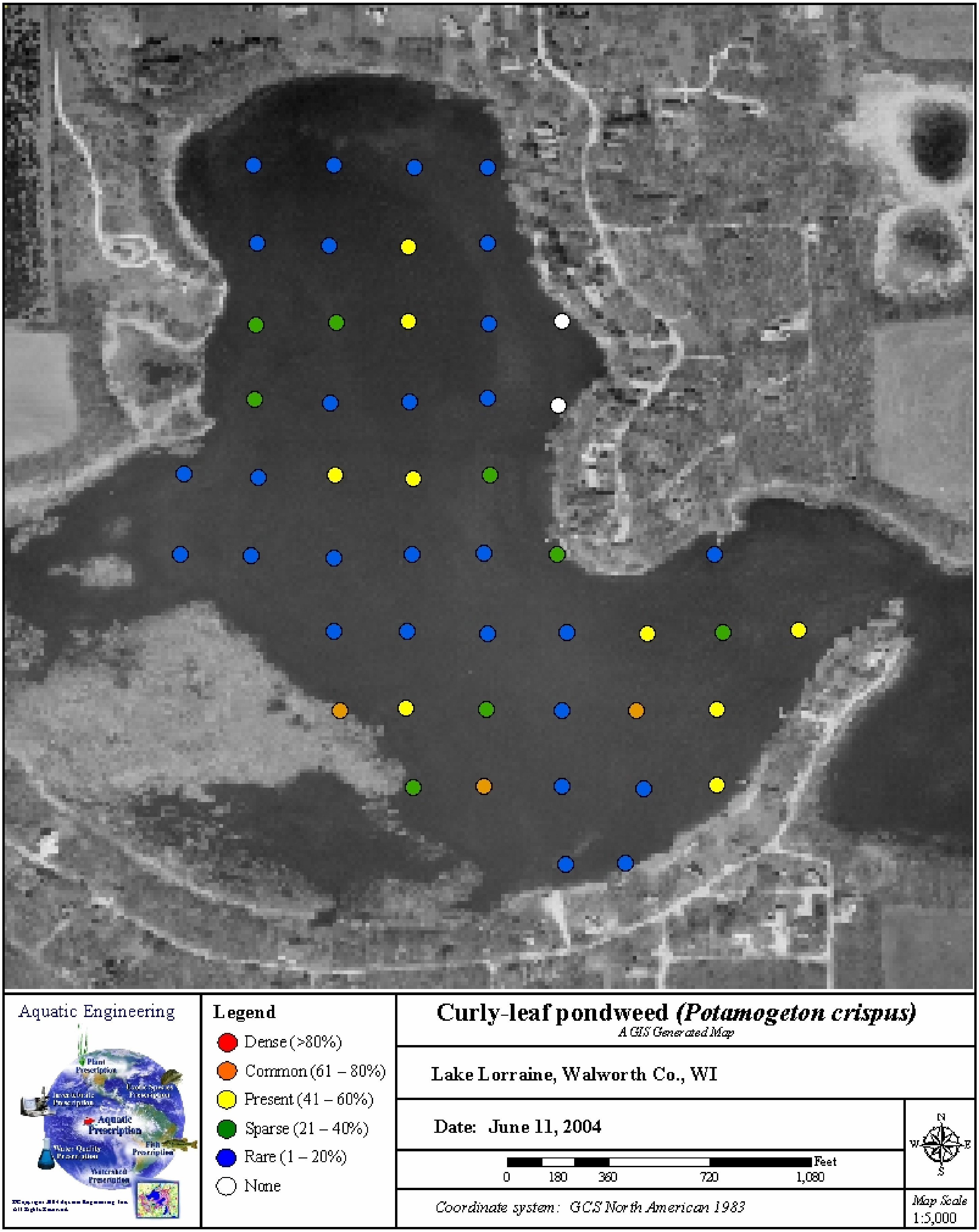
Date: June 11, 2004

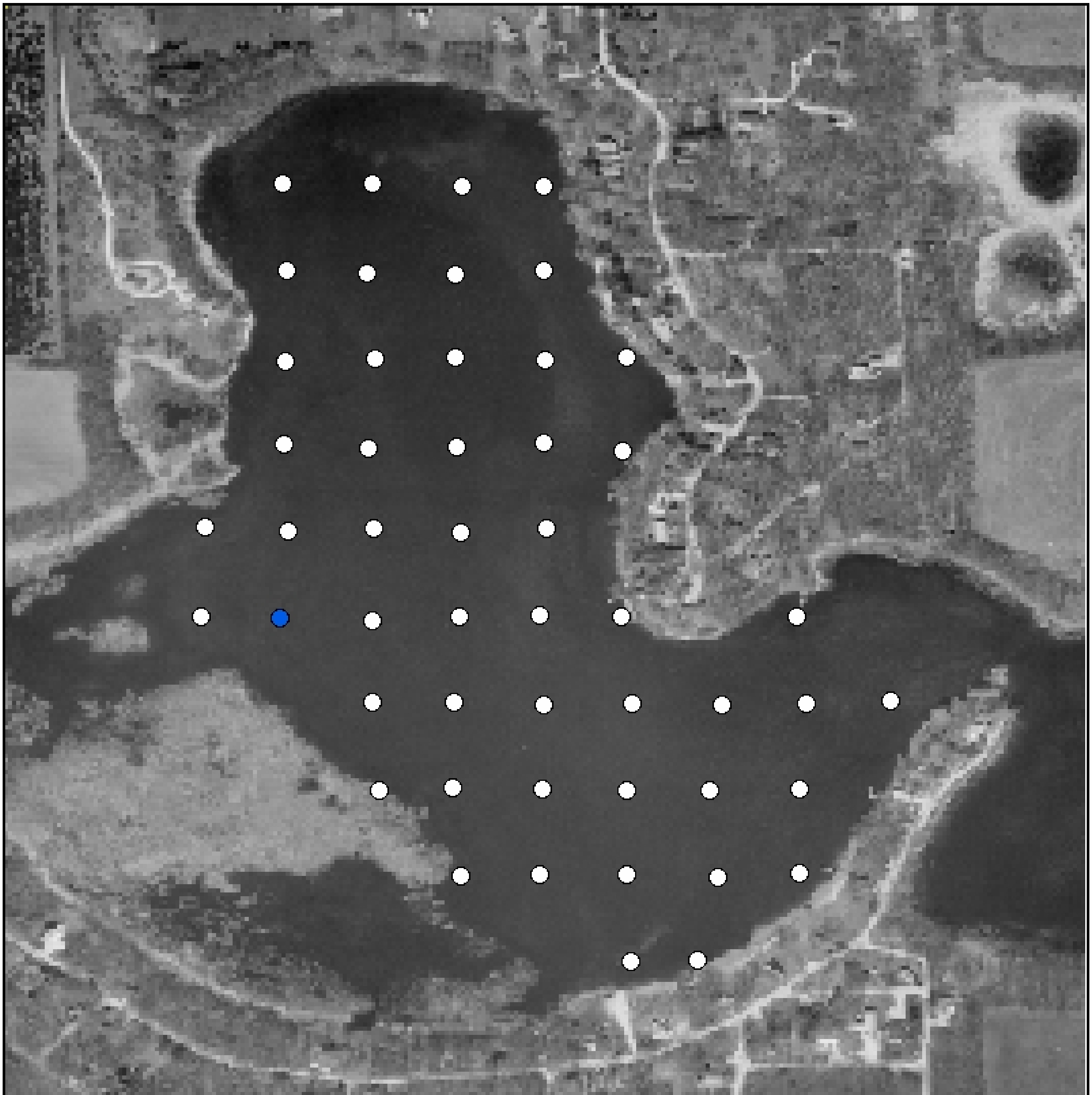
0 180 360 720 1,080 Feet

N W E S

Coordinate system: GCS North American 1983

Map Scale 1:5,000


Aquatic Engineering
Legend
Dense (>80%)
Common (61 – 80%)
Present (41 – 60%)
Sparse (21 – 40%)
Rare (1 – 20%)
None
Curly-leaf pondweed (Potamogeton crispus)
A GIS Generated Map
Lake Lorraine, Walworth Co., WI
Date: June 11, 2004
Feet
0
180
360
720
1,080
N
W
E
S
Coordinate system: GCS North American 1983
Map Scale
1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Common duckweed *(Lemna minor)*

A GIS Generated Map

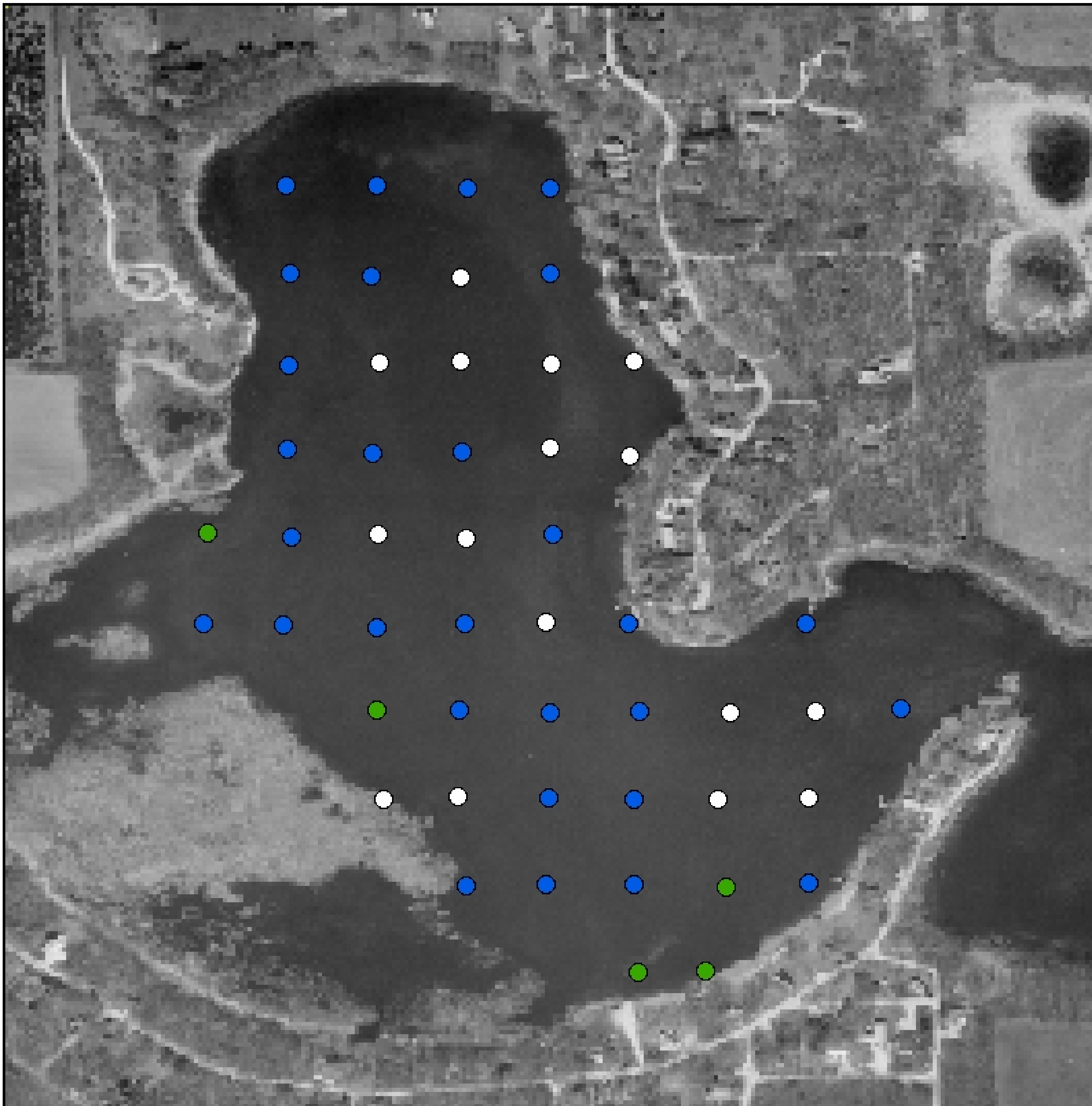
Lake Lorraine, Walworth Co., WI

Date: June 11, 2004

Feet
0 180 360 720 1,080

Coordinate system: GCS North American 1983

Map Scale
1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Coon's tail *(Ceratophyllum demersum)*

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

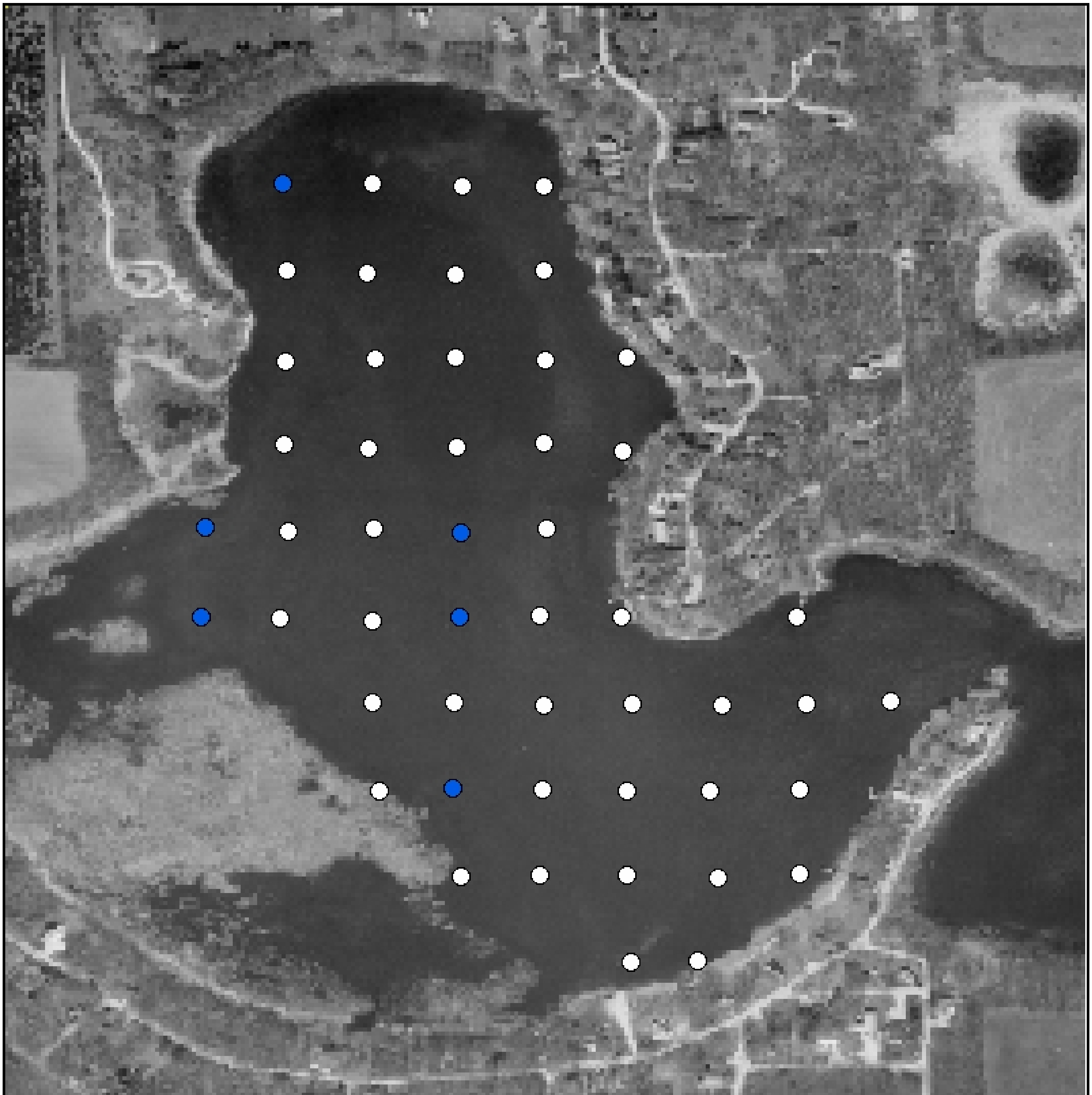
Date: June 11, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

N, W, E, S

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Common waterweed *(Elodea canadensis)*

A GIS Generated Map

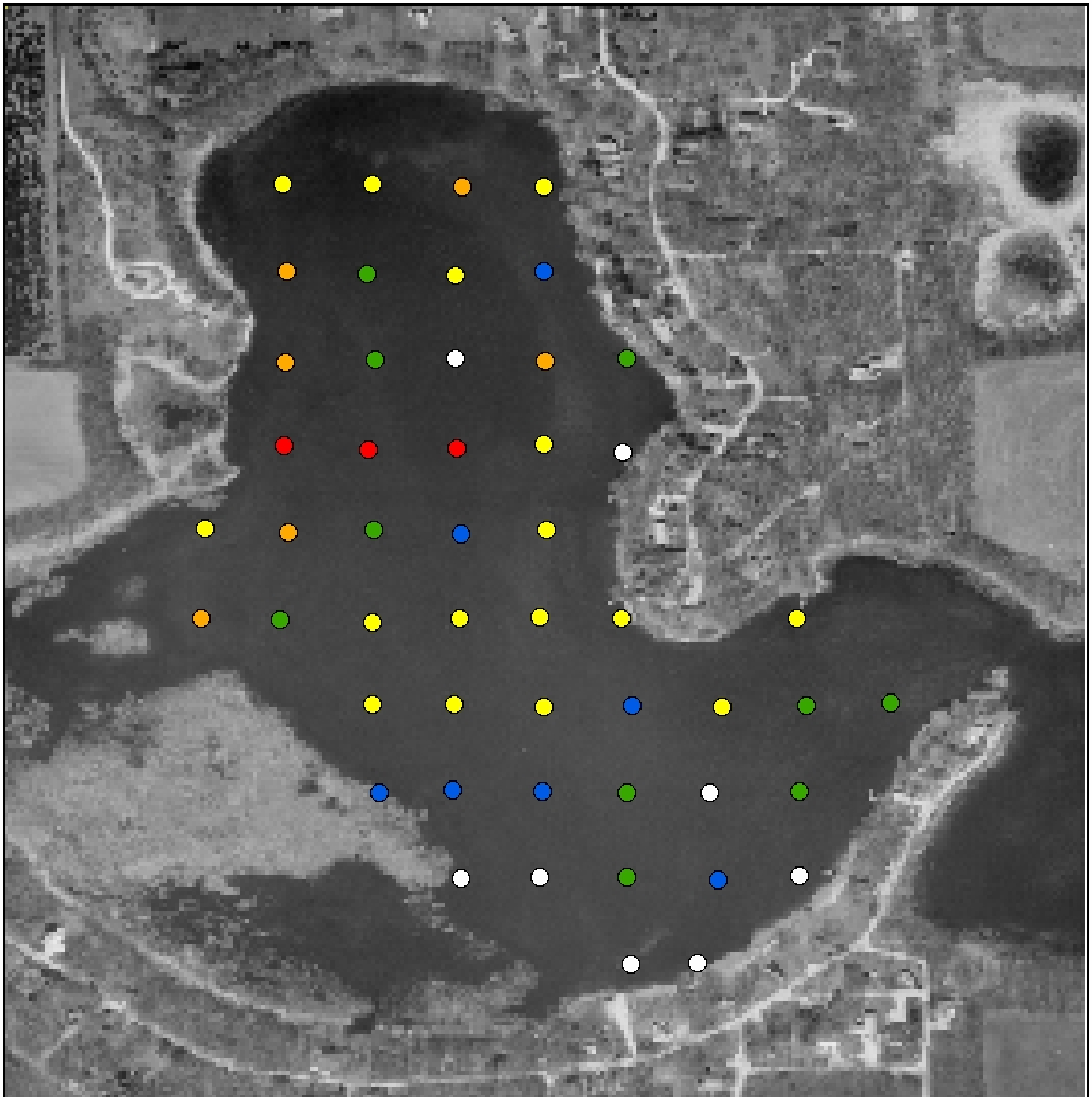
Lake Lorraine, Walworth Co., WI

Date: June 11, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Eurasian water milfoil *(Myriophyllum spicatum)*

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

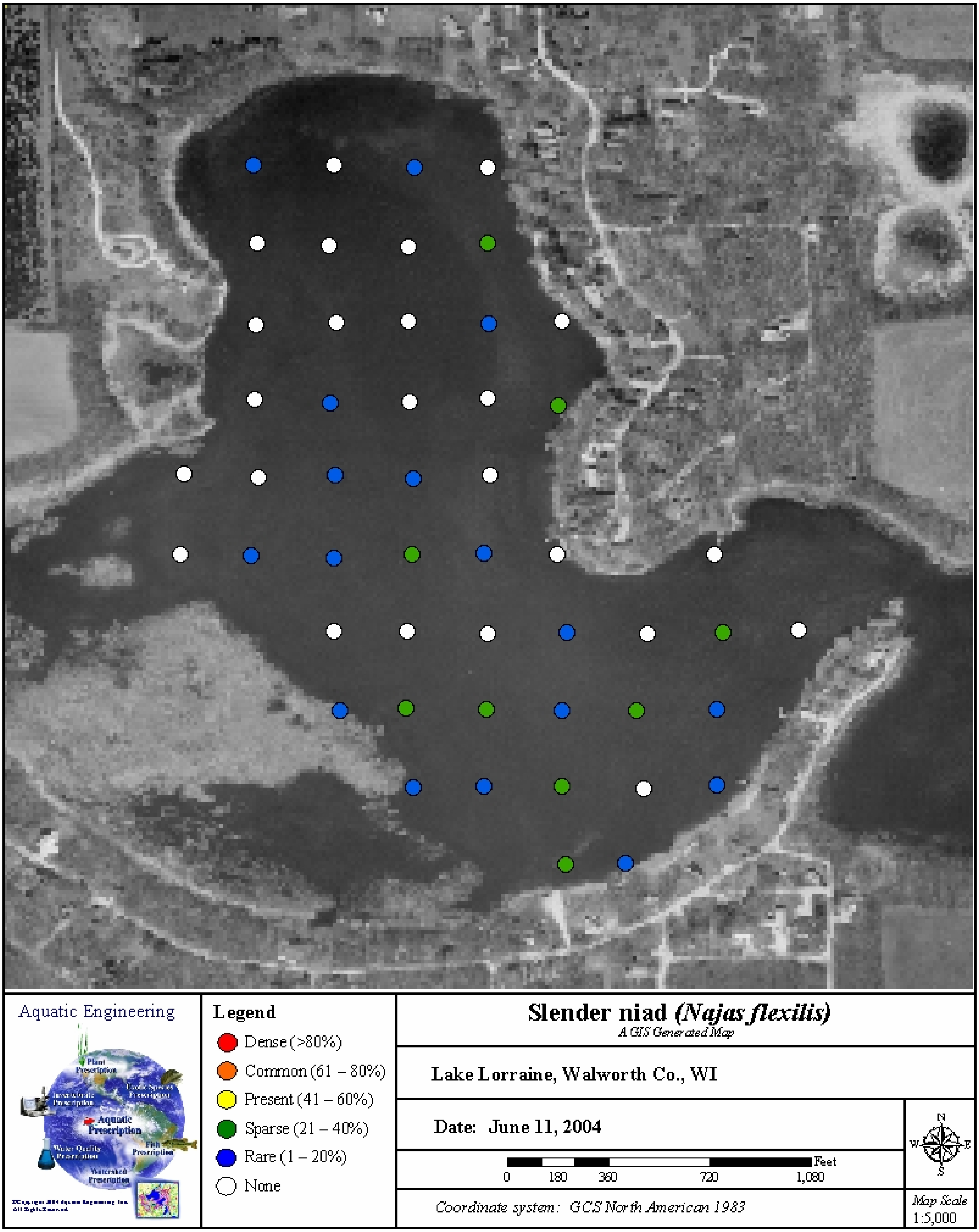
Date: June 11, 2004

Feet: 0, 180, 360, 720, 1,080

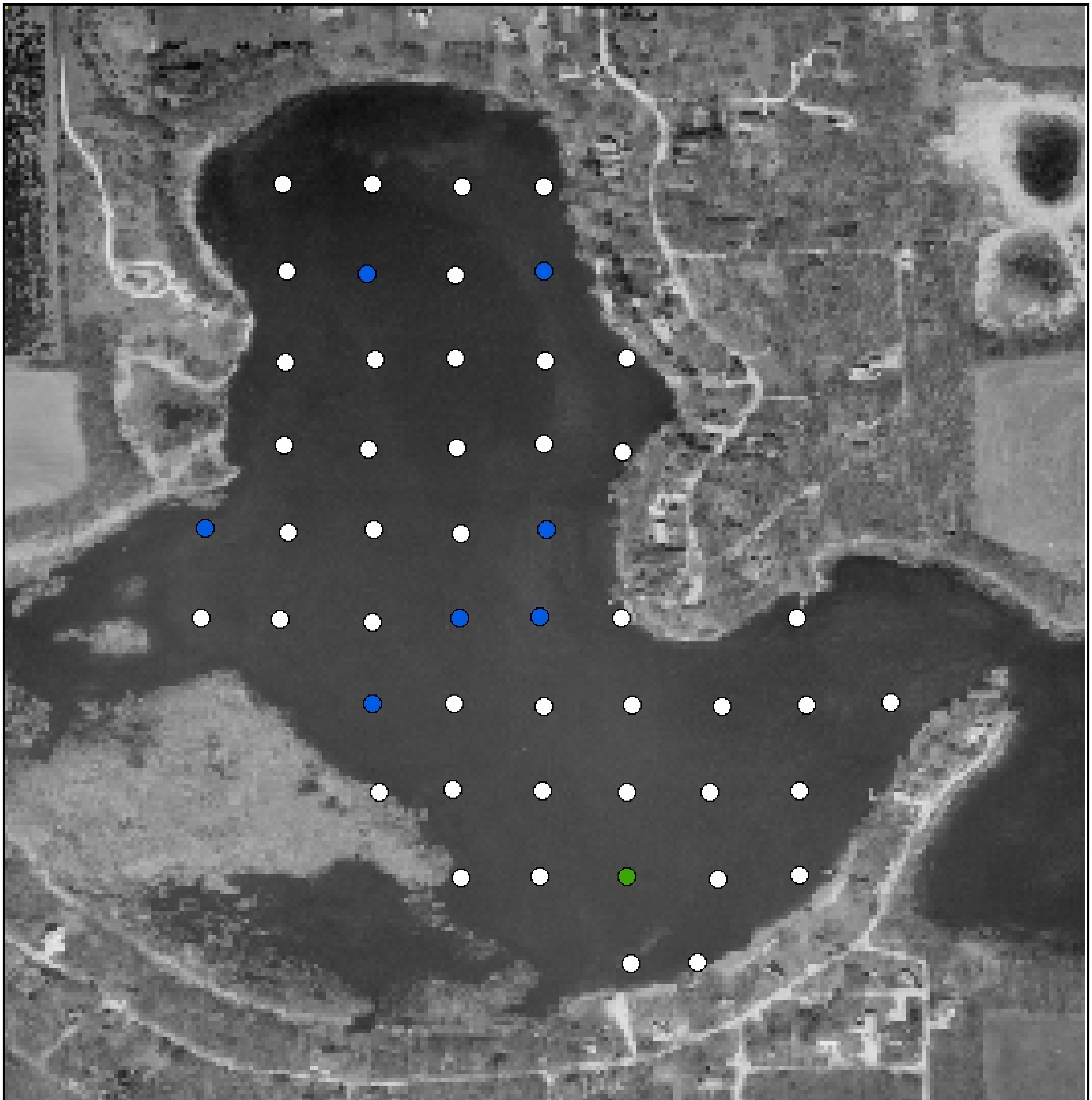
N, W, E, S

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering
Legend
Dense (>80%)
Common (61 – 80%)
Present (41 – 60%)
Sparse (21 – 40%)
Rare (1 – 20%)
None
Slender niad (Najas flexilis)
A GIS Generated Map
Lake Lorraine, Walworth Co., WI
Date: June 11, 2004
Feet
0 180 360 720 1,080
N
W E
S
Coordinate system: GCS North American 1983
Map Scale
1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Sago pondweed *(Stuckenia pectinata)*

A GIS Generated Map

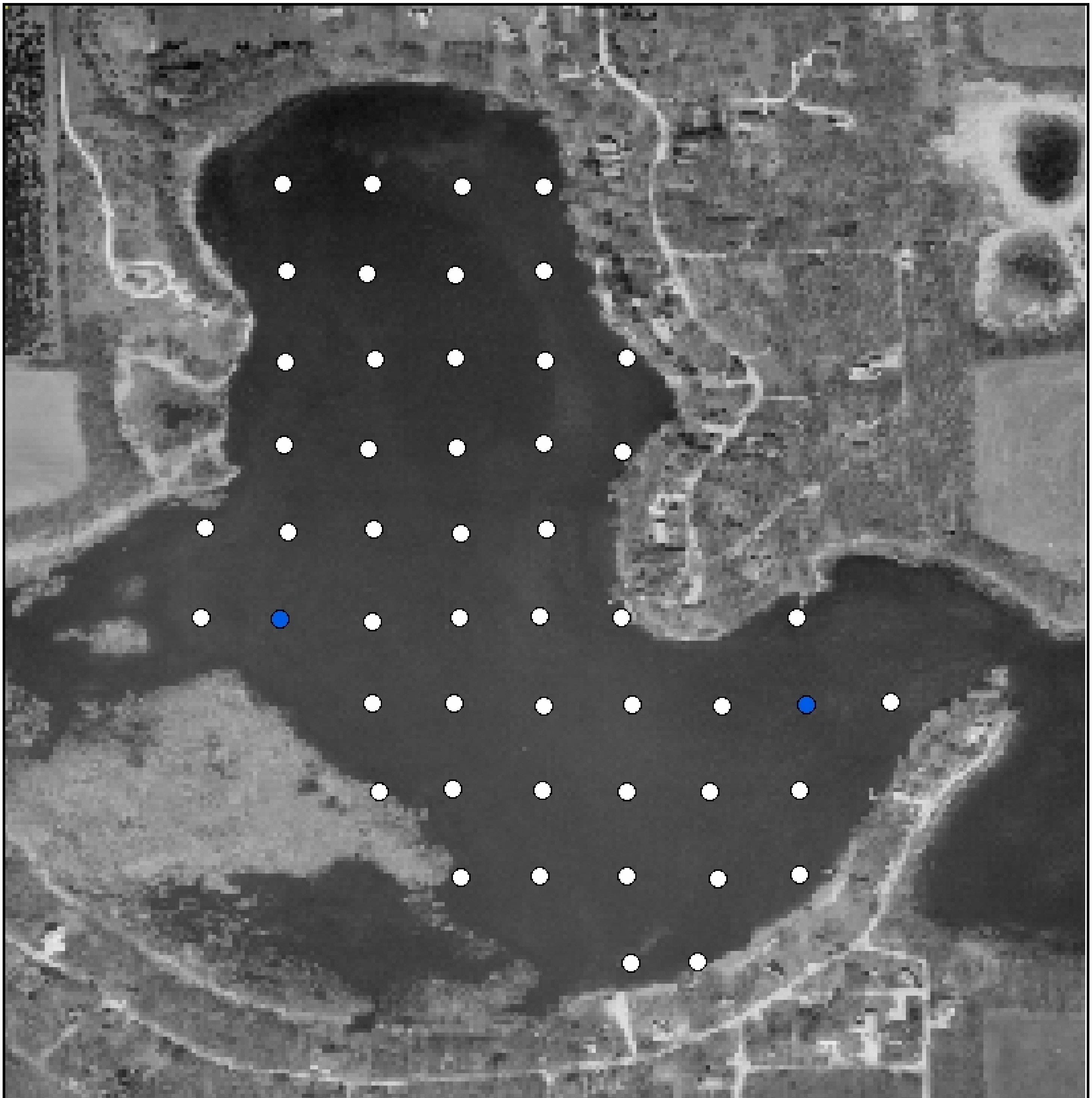
Lake Lorraine, Walworth Co., WI

Date: June 11, 2004

Feet: 0, 180, 360, 720, 1,080

Coordinate system: GCS North American 1983

Map Scale 1:5,000



Aquatic Engineering

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Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

Star duckweed *(Lemna trisulca)*

A GIS Generated Map

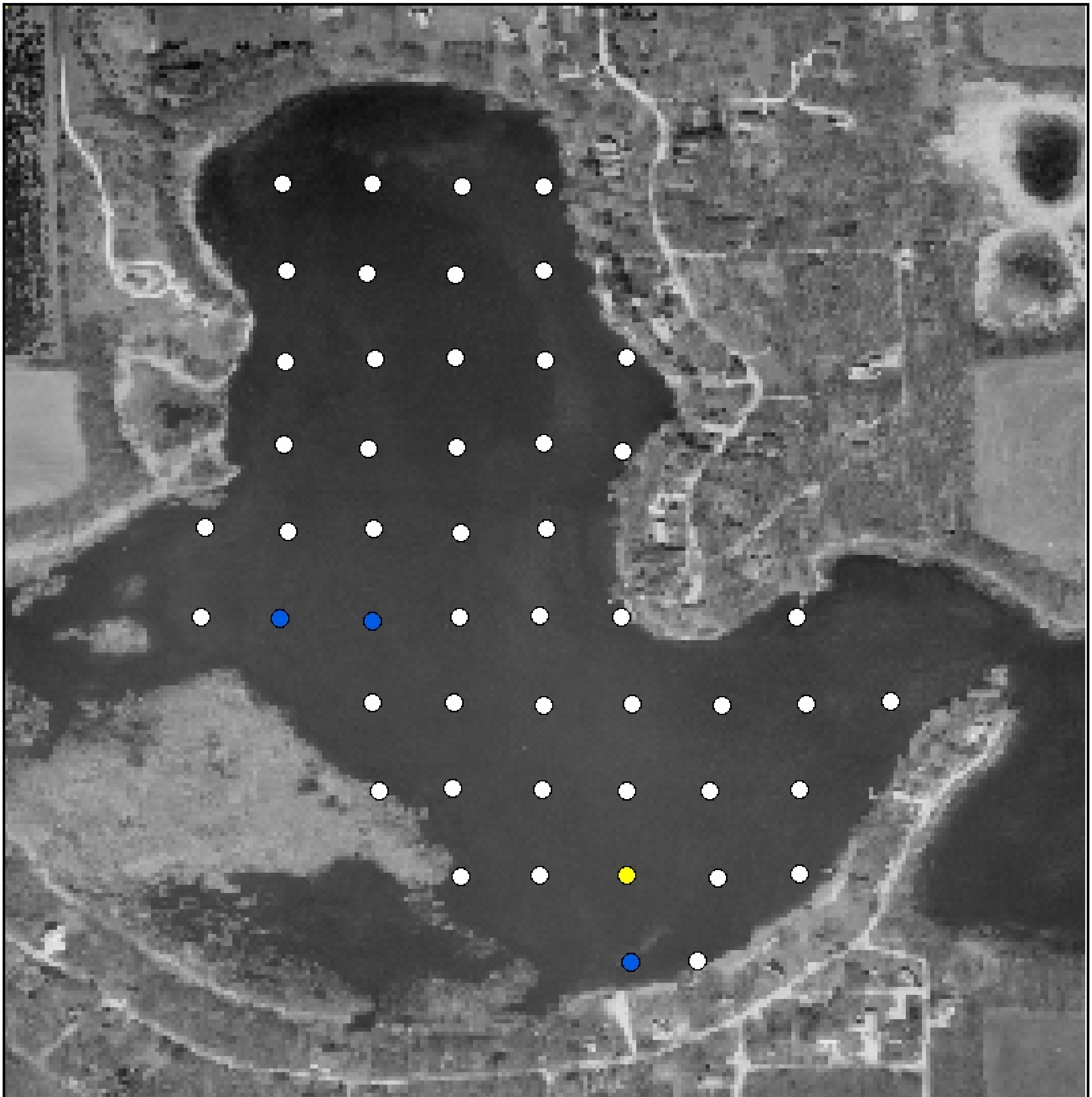
Lake Lorraine, Walworth Co., WI

Date: June 11, 2004

Feet
0 180 360 720 1,080

Coordinate system: GCS North American 1983

Map Scale
1:5,000



Aquatic Engineering

Legend

- Dense (>80%)
- Common (61 – 80%)
- Present (41 – 60%)
- Sparse (21 – 40%)
- Rare (1 – 20%)
- None

White-water lily *(Nymphaea odorata)*

A GIS Generated Map

Lake Lorraine, Walworth Co., WI

Date: June 11, 2004

Feet: 0 180 360 720 1,080

N W E S

Coordinate system: GCS North American 1983

Map Scale 1:5,000

Appendix D:
June APS Raw Data

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Sago	Elodea	S. niad	White lily	Star duckweed	Common duckweed
1	6/11/2004	1	4	3	1	1	0	0	0	0	0	0
1	6/11/2004	2	4	3	0	2	0	0	0	0	0	0
1	6/11/2004	3	3	2	1	2	0	0	0	0	0	0
1	6/11/2004	4	4	3	0	1	1	1	0	0	0	0
2	6/11/2004	1	4	4	0	1	0	0	0	0	0	0
2	6/11/2004	2	5	4	0	1	0	1	0	0	0	0
2	6/11/2004	3	5	4	1	1	0	0	0	0	0	0
2	6/11/2004	4	4	4	1	0	0	0	0	0	0	0
3	6/11/2004	1	2	1	1	0	0	0	0	1	0	1
3	6/11/2004	2	2	1	1	0	0	0	0	1	0	1
3	6/11/2004	3	4	2	0	1	0	0	1	1	1	1
3	6/11/2004	4	4	1	2	1	0	0	1	1	0	1
4	6/11/2004	1	2	2	0	0	0	0	0	1	0	0
4	6/11/2004	2	4	3	1	1	0	0	0	1	0	0
4	6/11/2004	3	3	2	1	1	0	0	0	0	0	0
4	6/11/2004	4	2	2	0	0	0	0	1	0	0	0
5	6/11/2004	1	5	4	0	1	0	0	1	0	0	0
5	6/11/2004	2	3	2	0	0	0	0	2	0	0	0
5	6/11/2004	3	4	2	1	0	1	0	2	0	0	0
5	6/11/2004	4	4	1	1	0	0	3	0	0	0	0
6	6/11/2004	1	4	4	0	0	0	0	1	0	0	0
6	6/11/2004	2	2	2	0	0	1	0	0	0	0	0
6	6/11/2004	3	2	2	0	0	0	0	1	0	0	0
6	6/11/2004	4	3	3	1	0	0	0	0	0	0	0
7	6/11/2004	1	3	1	2	1	0	0	0	0	0	0
7	6/11/2004	2	3	3	1	0	0	0	0	0	0	0
7	6/11/2004	3	3	2	1	1	0	0	0	0	0	0
7	6/11/2004	4	4	3	1	1	0	0	0	0	0	0
8	6/11/2004	1	4	3	1	1	0	0	0	0	0	0
8	6/11/2004	2	4	3	1	0	1	0	0	0	0	0
8	6/11/2004	3	5	4	1	1	0	0	0	0	0	0
8	6/11/2004	4	4	2	3	0	0	0	0	0	0	0
9	6/11/2004	1	4	1	4	0	0	0	0	0	0	0
9	6/11/2004	2	2	0	2	0	0	0	1	0	0	0
9	6/11/2004	3	3	1	2	0	0	1	0	0	0	0
9	6/11/2004	4	3	1	3	0	0	0	0	0	0	0
10	6/11/2004	1	4	1	4	0	0	0	0	0	0	0
10	6/11/2004	2	4	2	3	0	0	0	1	0	0	0
10	6/11/2004	3	2	1	1	0	0	0	1	0	0	0
10	6/11/2004	4	2	1	1	0	0	0	1	0	0	0
11	6/11/2004	1	4	4	0	0	0	0	0	0	0	0
11	6/11/2004	2	5	5	1	0	0	0	0	0	0	0
11	6/11/2004	3	3	3	1	0	0	0	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Sago	Elodea	S. niad	White lily	Star duckweed	Common duckweed
11	6/11/2004	4	4	3	1	1	0	0	0	0	0	0
12	6/11/2004	1	5	4	2	1	0	0	0	0	0	0
12	6/11/2004	2	4	4	1	0	0	0	0	0	0	0
12	6/11/2004	3	5	5	2	1	0	0	0	0	0	0
12	6/11/2004	4	5	4	2	0	0	0	0	0	0	0
13	6/11/2004	1	5	5	1	0	0	0	0	0	0	0
13	6/11/2004	2	5	5	1	1	0	0	0	0	0	0
13	6/11/2004	3	4	4	1	0	0	0	0	0	0	0
13	6/11/2004	4	5	4	1	0	0	0	1	0	0	0
14	6/11/2004	1	5	5	0	0	0	0	0	0	0	0
14	6/11/2004	2	5	5	0	0	0	0	0	0	0	0
14	6/11/2004	3	5	5	1	1	0	0	0	0	0	0
14	6/11/2004	4	5	5	0	0	0	0	0	0	0	0
15	6/11/2004	1	2	2	0	0	0	0	0	0	0	0
15	6/11/2004	2	3	3	1	0	0	0	0	0	0	0
15	6/11/2004	3	3	3	1	0	0	0	0	0	0	0
15	6/11/2004	4	3	3	1	0	0	0	0	0	0	0
16	6/11/2004	1	2	0	0	0	0	0	2	0	0	0
16	6/11/2004	2	4	0	0	0	0	0	4	0	0	0
16	6/11/2004	3	0	0	0	0	0	0	0	0	0	0
16	6/11/2004	4	0	0	0	0	0	0	0	0	0	0
17	6/11/2004	1	3	3	0	0	0	0	0	0	0	0
17	6/11/2004	2	2	2	0	0	0	0	0	0	0	0
17	6/11/2004	3	1	1	0	0	0	0	0	0	0	0
17	6/11/2004	4	1	1	0	0	0	0	0	0	0	0
18	6/11/2004	1	4	4	1	0	0	0	0	0	0	0
18	6/11/2004	2	4	3	1	0	0	0	1	0	0	0
18	6/11/2004	3	4	4	1	0	0	0	0	0	0	0
18	6/11/2004	4	4	3	1	0	0	0	1	0	0	0
19	6/11/2004	1	3	0	3	0	0	0	0	0	0	0
19	6/11/2004	2	3	0	3	0	0	0	0	0	0	0
19	6/11/2004	3	3	0	3	0	0	0	0	0	0	0
19	6/11/2004	4	3	0	3	0	0	0	0	0	0	0
20	6/11/2004	1	2	2	1	0	0	0	0	0	0	0
20	6/11/2004	2	3	3	1	0	0	0	0	0	0	0
20	6/11/2004	3	1	1	1	0	0	0	0	0	0	0
20	6/11/2004	4	5	2	4	0	0	0	0	0	0	0
21	6/11/2004	1	3	3	1	0	0	0	0	0	0	0
21	6/11/2004	2	3	3	1	0	0	0	0	0	0	0
21	6/11/2004	3	4	3	2	0	0	0	0	0	0	0
21	6/11/2004	4	5	4	1	1	0	0	0	0	0	0
22	6/11/2004	1	4	3	1	1	0	0	0	0	0	0
22	6/11/2004	2	4	4	1	0	0	0	0	0	0	0

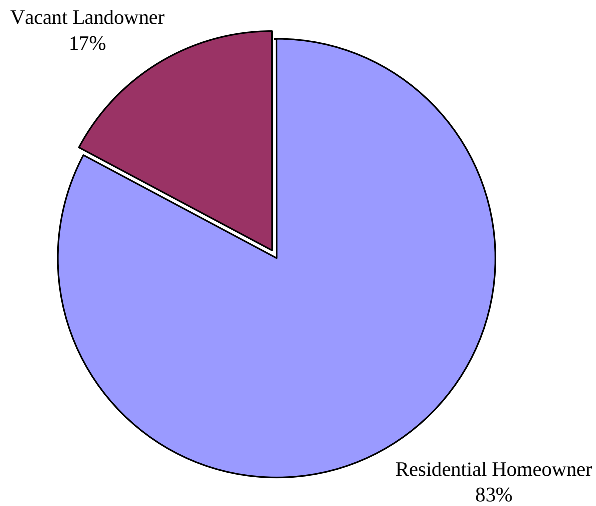
AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Sago	Elodea	S. niad	White lily	Star duckweed	Common duckweed
22	6/11/2004	3	3	3	1	0	0	0	0	0	0	0
22	6/11/2004	4	5	4	1	1	0	0	0	0	0	0
23	6/11/2004	1	1	1	1	0	0	0	0	0	0	0
23	6/11/2004	2	3	2	1	0	1	0	0	0	0	0
23	6/11/2004	3	4	3	1	1	0	0	0	0	0	0
23	6/11/2004	4	2	2	1	0	0	0	0	0	0	0
24	6/11/2004	1	4	1	4	0	0	0	0	0	0	0
24	6/11/2004	2	5	3	3	0	0	0	0	0	0	0
24	6/11/2004	3	4	3	2	0	0	0	0	0	0	0
24	6/11/2004	4	4	2	3	0	0	0	0	0	0	0
25	6/11/2004	1	3	1	1	1	1	0	1	0	0	0
25	6/11/2004	2	2	1	1	0	0	0	1	0	0	0
25	6/11/2004	3	2	1	1	1	0	0	1	0	0	0
25	6/11/2004	4	3	1	0	1	0	0	2	0	0	0
26	6/11/2004	1	2	1	0	2	0	0	0	0	0	0
26	6/11/2004	2	3	1	1	2	0	0	0	0	0	0
26	6/11/2004	3	3	3	1	0	0	0	0	0	0	0
26	6/11/2004	4	5	5	0	0	0	0	0	0	0	0
27	6/11/2004	1	5	5	1	0	0	0	0	0	0	0
27	6/11/2004	2	5	4	2	0	0	0	0	0	0	0
27	6/11/2004	3	3	3	0	1	0	0	0	0	0	0
27	6/11/2004	4	4	3	1	1	0	0	1	0	0	0
28	6/11/2004	1	3	3	1	0	0	0	0	0	0	0
28	6/11/2004	2	2	2	1	0	0	0	0	0	0	0
28	6/11/2004	3	3	3	0	0	0	0	0	0	0	0
28	6/11/2004	4	3	3	0	1	0	0	0	0	0	0
29	6/11/2004	1	5	5	1	1	0	1	1	0	0	0
29	6/11/2004	2	2	1	1	1	0	0	0	0	0	0
29	6/11/2004	3	1	1	0	0	0	0	0	0	0	0
29	6/11/2004	4	4	3	2	1	0	0	0	0	0	0
30	6/11/2004	1	3	2	1	1	0	0	0	0	0	0
30	6/11/2004	2	3	3	0	0	0	0	0	0	0	0
30	6/11/2004	3	3	3	0	1	0	0	0	0	0	0
30	6/11/2004	4	4	3	1	1	0	0	0	0	0	0
31	6/11/2004	1	4	2	3	1	0	0	0	0	0	0
31	6/11/2004	2	4	2	3	1	0	0	0	0	0	0
31	6/11/2004	3	3	1	2	1	0	0	0	0	0	0
31	6/11/2004	4	4	2	3	1	0	0	0	0	0	0
32	6/11/2004	1	3	2	2	0	0	0	1	0	0	0
32	6/11/2004	2	3	1	2	0	0	0	1	0	1	0
32	6/11/2004	3	3	1	2	0	0	0	2	0	0	0
32	6/11/2004	4	3	1	2	0	0	0	1	0	0	0
33	6/11/2004	1	5	3	3	0	0	0	0	0	0	0

AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Sago	Elodea	S. niad	White lily	Star duckweed	Common duckweed
33	6/11/2004	2	5	3	3	0	0	0	0	0	0	0
33	6/11/2004	3	3	3	1	0	0	0	0	0	0	0
33	6/11/2004	4	4	3	2	0	0	0	0	0	0	0
34	6/11/2004	1	1	1	0	0	0	0	1	0	0	0
34	6/11/2004	2	1	0	1	1	0	0	1	0	0	0
34	6/11/2004	3	2	2	0	1	0	0	0	0	0	0
34	6/11/2004	4	2	1	1	1	0	0	0	0	0	0
35	6/11/2004	1	2	2	0	1	0	0	0	0	0	0
35	6/11/2004	2	3	3	0	1	0	0	0	0	0	0
35	6/11/2004	3	4	4	1	0	0	0	0	0	0	0
35	6/11/2004	4	3	2	1	1	0	0	0	0	0	0
36	6/11/2004	1	3	3	0	1	0	0	0	0	0	0
36	6/11/2004	2	4	3	1	1	0	0	0	0	0	0
36	6/11/2004	3	2	2	0	1	0	0	0	0	0	0
36	6/11/2004	4	3	2	1	1	0	0	0	0	0	0
37	6/11/2004	1	3	2	1	1	1	0	0	0	0	0
37	6/11/2004	2	2	2	0	1	0	0	0	0	0	0
37	6/11/2004	3	5	4	1	2	0	0	0	0	0	0
37	6/11/2004	4	4	3	1	2	0	0	0	0	0	0
38	6/11/2004	1	4	1	4	0	0	0	0	0	0	0
38	6/11/2004	2	4	1	4	0	0	0	0	0	0	0
38	6/11/2004	3	4	1	4	0	0	0	0	0	0	0
38	6/11/2004	4	2	0	1	0	0	0	2	0	0	0
39	6/11/2004	1	3	0	3	0	0	0	1	0	0	0
39	6/11/2004	2	4	0	3	0	0	1	1	0	0	0
39	6/11/2004	3	3	1	1	0	0	0	2	0	0	0
39	6/11/2004	4	3	0	2	0	0	0	2	0	0	0
40	6/11/2004	1	1	0	1	1	0	0	0	0	0	0
40	6/11/2004	2	3	2	1	0	0	0	1	0	0	0
40	6/11/2004	3	3	0	2	1	0	0	2	0	0	0
40	6/11/2004	4	2	0	1	0	0	0	2	0	0	0
41	6/11/2004	1	3	2	1	1	0	0	0	0	0	0
41	6/11/2004	2	2	1	0	1	0	0	0	0	0	0
41	6/11/2004	3	2	2	0	1	0	0	0	0	0	0
41	6/11/2004	4	4	3	1	1	0	0	1	0	0	0
42	6/11/2004	1	5	0	4	0	0	0	2	0	0	0
42	6/11/2004	2	4	0	4	0	0	0	1	0	0	0
42	6/11/2004	3	5	0	4	0	0	0	2	0	0	0
42	6/11/2004	4	3	0	3	0	0	0	1	0	0	0
43	6/11/2004	1	4	2	3	0	0	0	0	0	0	0
43	6/11/2004	2	3	1	2	0	0	0	2	0	0	0
43	6/11/2004	3	4	1	3	0	0	0	1	0	0	0
43	6/11/2004	4	4	1	3	0	0	0	1	0	0	0

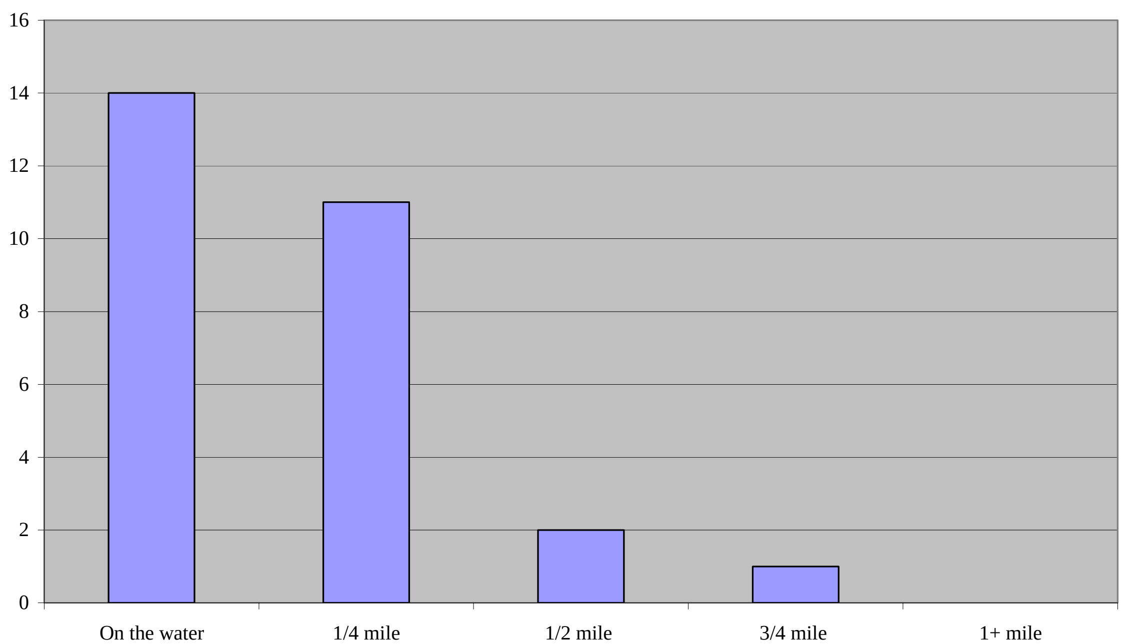
AEI_FID	Date	Rake toss	Density	EWM	CLP	Coontail	Sago	Elodea	S. niad	White lily	Star duckweed	Common duckweed
44	6/11/2004	1	4	0	3	1	0	0	2	0	0	0
44	6/11/2004	2	3	0	3	0	0	0	1	0	0	0
44	6/11/2004	3	4	0	3	1	0	0	1	0	0	0
44	6/11/2004	4	2	0	2	1	0	0	0	0	0	0
45	6/11/2004	1	2	0	0	2	0	0	0	0	0	0
45	6/11/2004	2	1	1	0	1	0	0	0	0	0	0
45	6/11/2004	3	1	0	1	1	0	0	0	0	0	0
45	6/11/2004	4	1	0	0	1	0	0	0	0	0	0
46	6/11/2004	1	5	2	0	1	1	0	2	3	0	0
46	6/11/2004	2	5	1	0	1	1	0	2	3	0	0
46	6/11/2004	3	3	2	0	0	0	0	2	1	0	0
46	6/11/2004	4	5	1	1	0	5	0	1	3	0	0
47	6/11/2004	1	3	0	3	0	0	0	0	0	0	0
47	6/11/2004	2	5	0	5	0	0	0	1	0	0	0
47	6/11/2004	3	5	0	4	1	0	0	1	0	0	0
47	6/11/2004	4	4	0	4	0	0	0	1	0	0	0
48	6/11/2004	1	2	0	2	1	0	0	0	0	0	0
48	6/11/2004	2	1	0	1	0	0	0	0	0	0	0
48	6/11/2004	3	2	0	2	0	0	0	1	0	0	0
48	6/11/2004	4	1	0	1	0	0	0	0	0	0	0
49	6/11/2004	1	1	0	0	1	0	0	1	0	0	0
49	6/11/2004	2	3	0	1	2	0	0	1	0	0	0
49	6/11/2004	3	1	0	0	1	0	0	1	0	0	0
49	6/11/2004	4	3	0	0	3	0	0	1	0	0	0
50	6/11/2004	1	2	0	1	1	0	0	1	1	0	0
50	6/11/2004	2	3	0	0	2	0	0	1	1	0	0
50	6/11/2004	3	4	0	2	2	0	0	1	1	0	0
50	6/11/2004	4	3	0	1	1	0	0	2	1	0	0

Appendix E:
Public Use Survey and Data Results

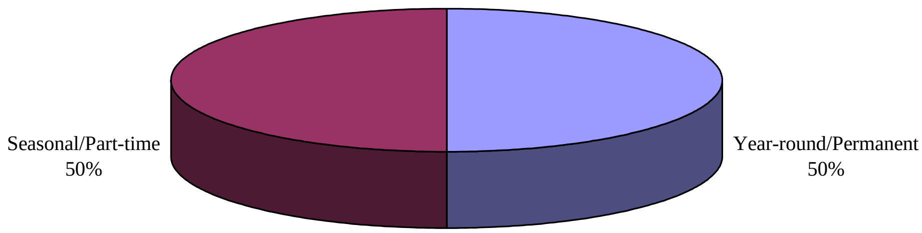
1. What type of property owner are you? (29 of 29 responded)



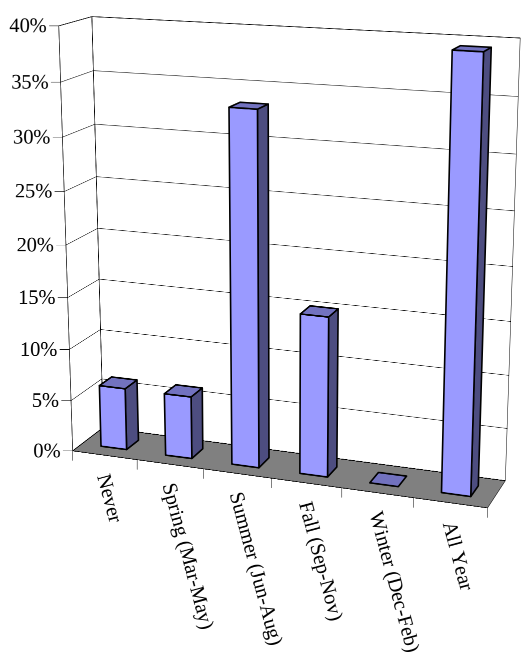
2. Approximately what distance from the lake is your property located? (28 of 29 responded)



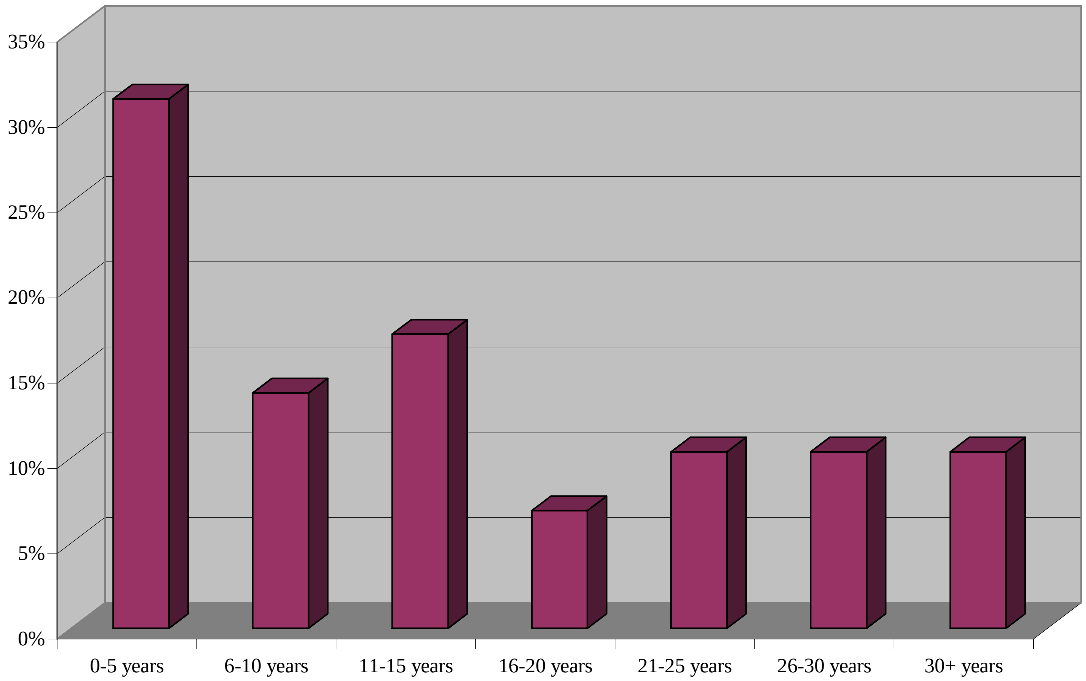
3. Which of the following best describes your residency status? (26 of 29 responded)



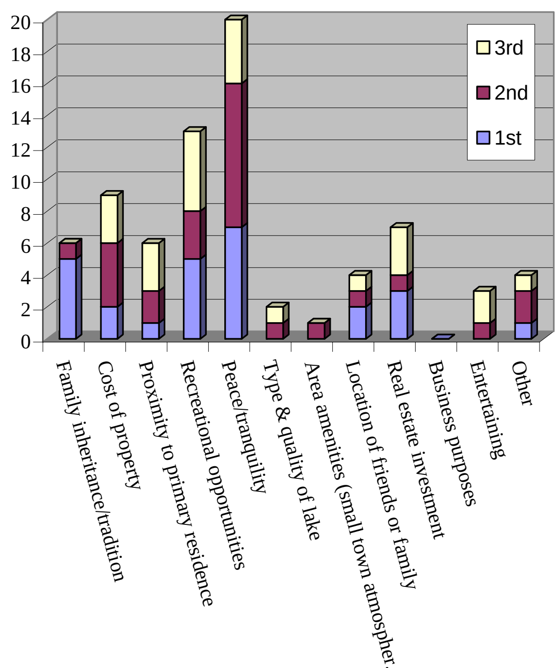
4. When do you most often spend time recreating on your lake? (29 of 29 responded)



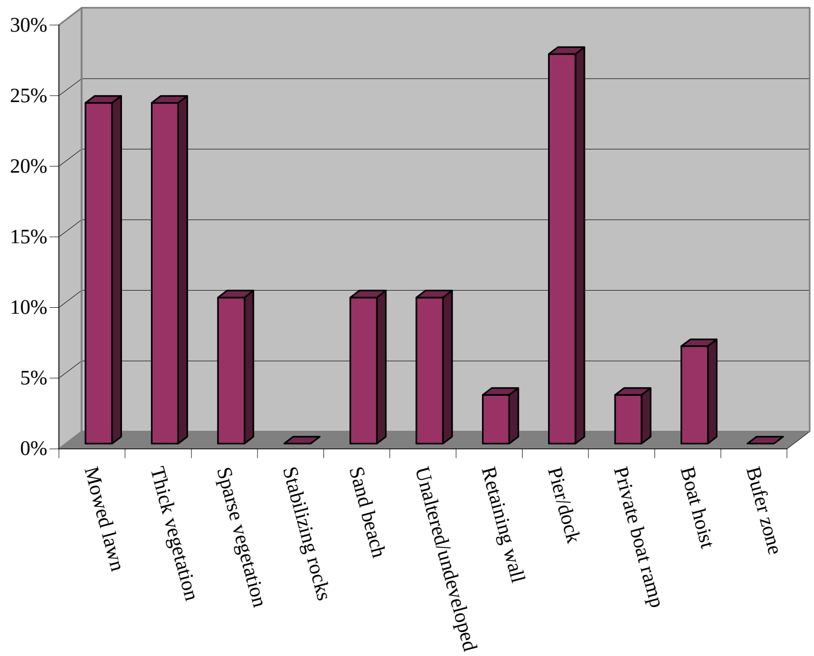
5. How many years have you owned property in your lake District? (29 of 29 responded)



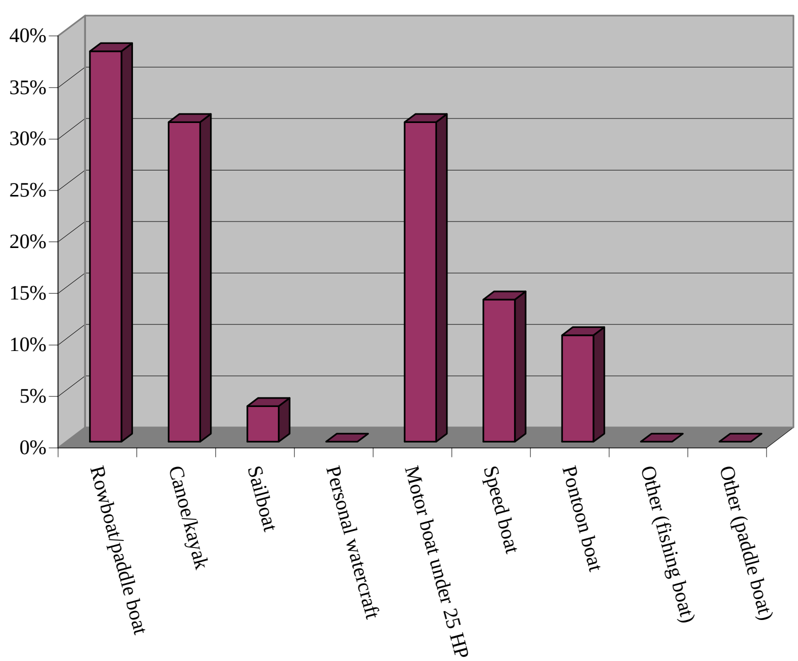
6. List the top three reasons why you chose to own property on or near your lake? (26 of 29 responded)



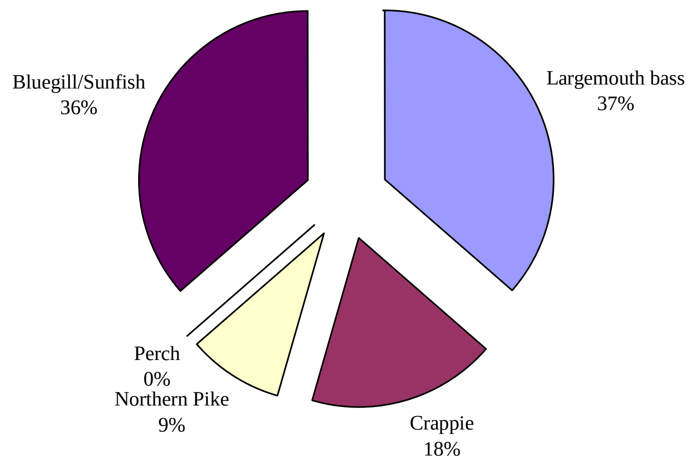
7. If you own lakefront property, which of the following describes your lake frontage within 25 feet of the water's edge? (Check all that apply.) (16 of 29 responded)



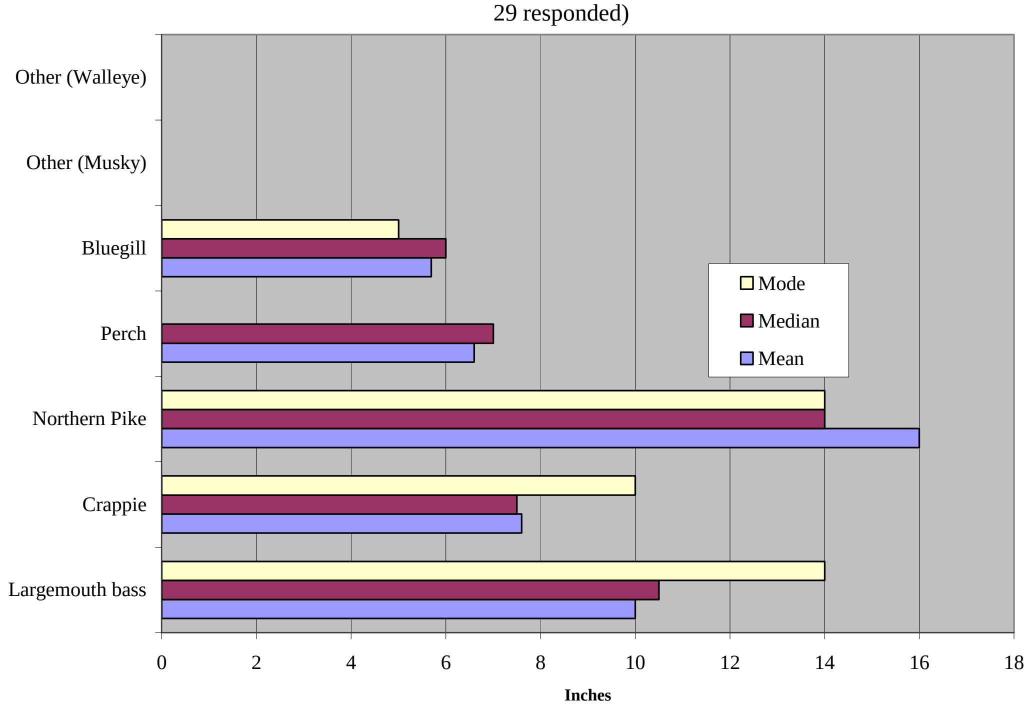
8. What types of watercraft do you routinely use on your lake? (Check all that apply.) (22 of 29 responded)



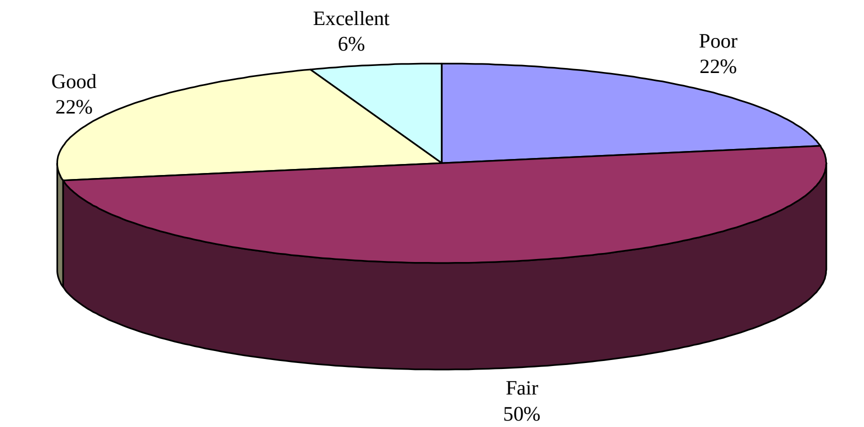
9A. Rank the following fish species that you prefer to catch on your lake?
(shows % of people that ranked each species #1) (11 of 29 responded)



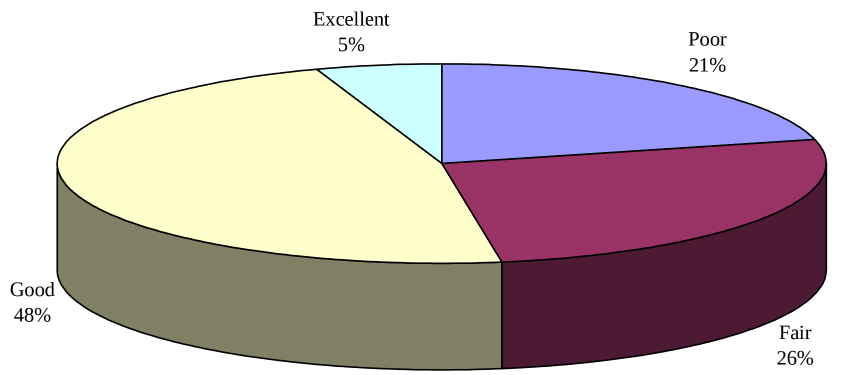
9B. What is the average size of each type of fish that can be caught on your lake? (13 of 29 responded)



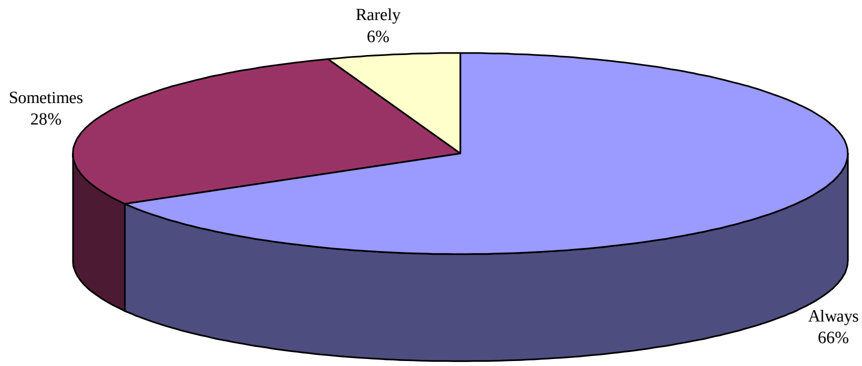
9C. How would you rate the quality of fishing on your lake in terns of fish SIZE? (18 of 29 responded)



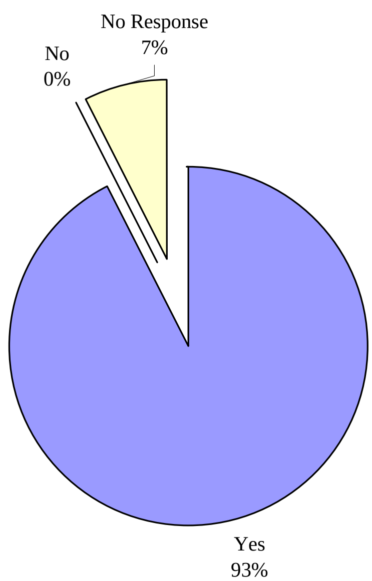
9D. How would you rate the quality of fishing on your lake in terns of fish NUMBERS? (19 of 29 responded)



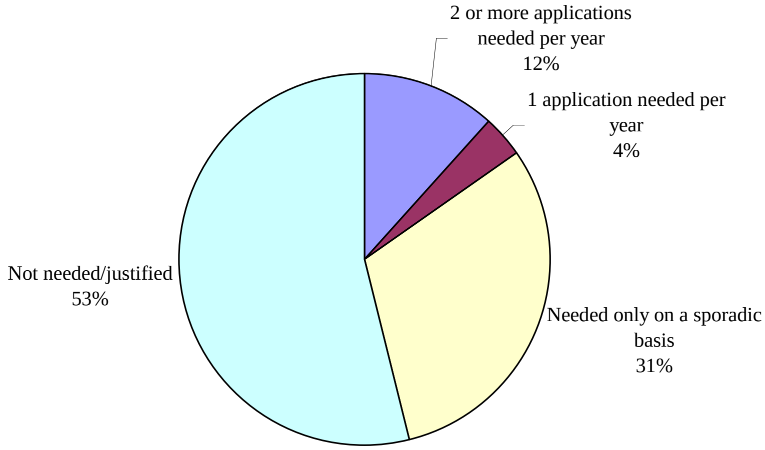
9E. Do you voluntarily practice "catch and relaese" when fishing for species other than panfish? (18 of 29 responded)



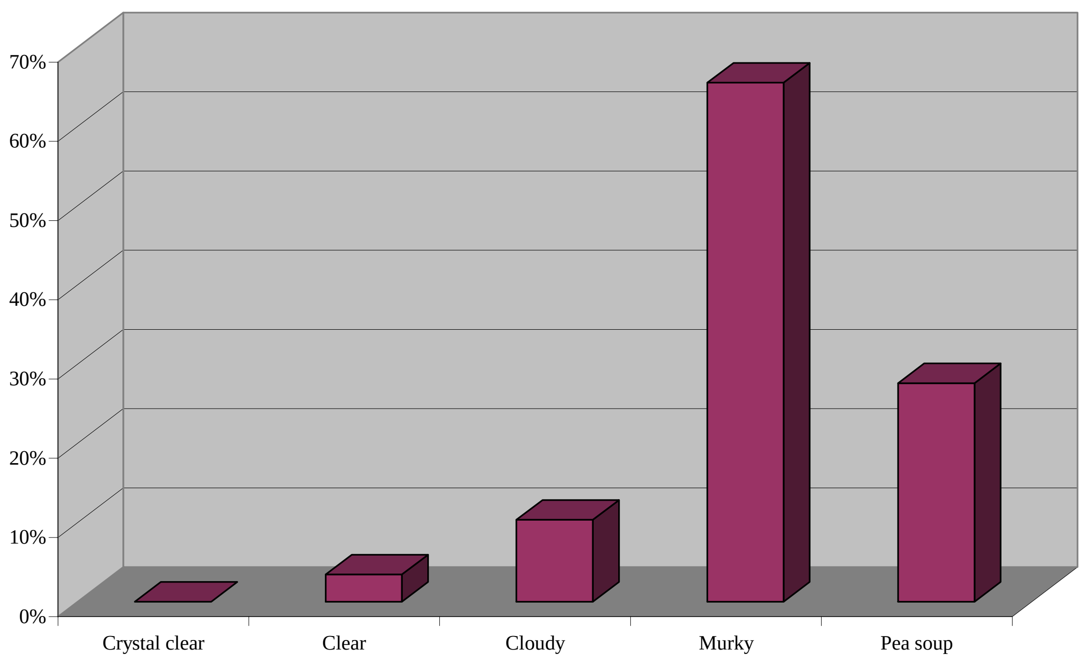
10. Do you feel your lake has more than adequate public access? (27 of 29 responded)



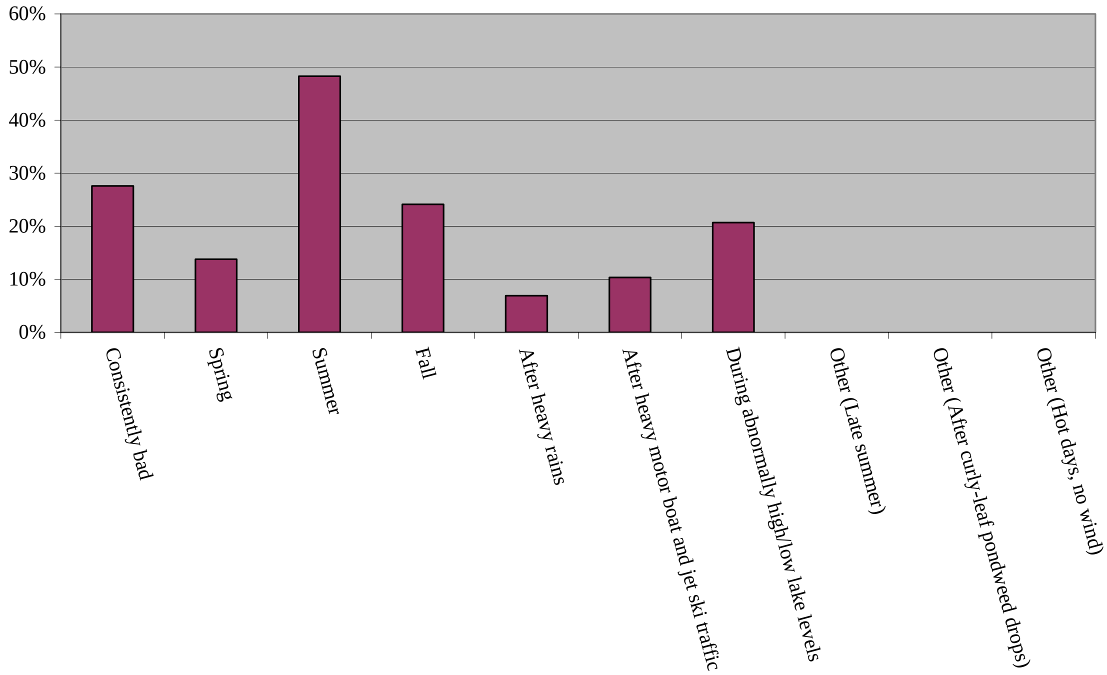
11. What is your opinion regarding the use of fertilizers and/or weed killer to maintain lawns around your lake (check all that apply) (25 of 29 responded)



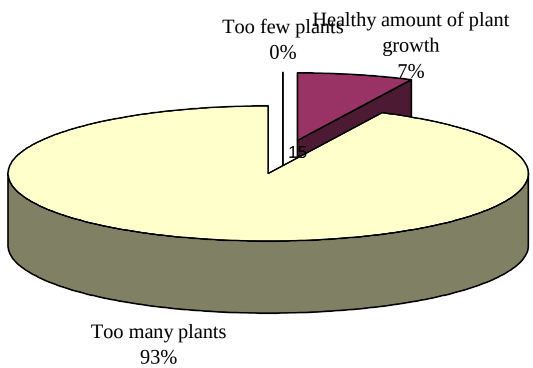
12. Overall, how would you descibe the water clarity in your lake during the winter months? (27 of 29 responded)



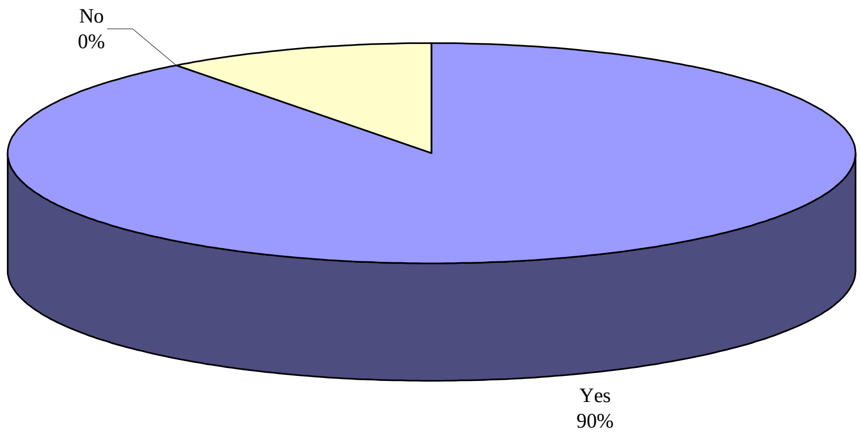
13. When is water clarity at its worst? (check all that apply) (24 of 29 responded)



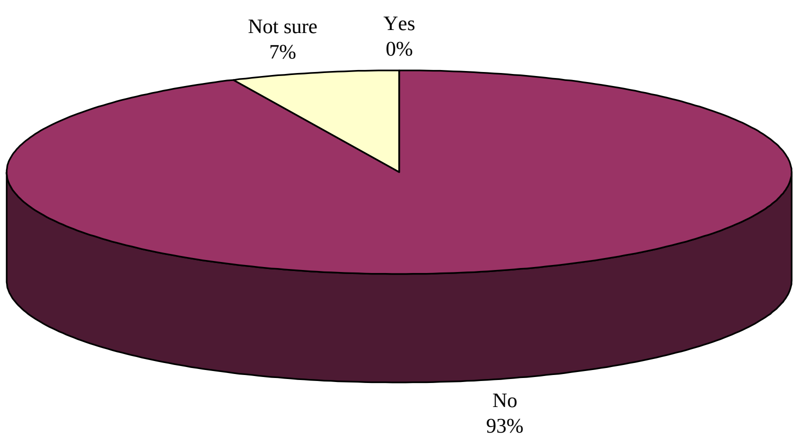
14. Overall, how would you describe your lake's aquatic plant growth? (28 of 29 responded)



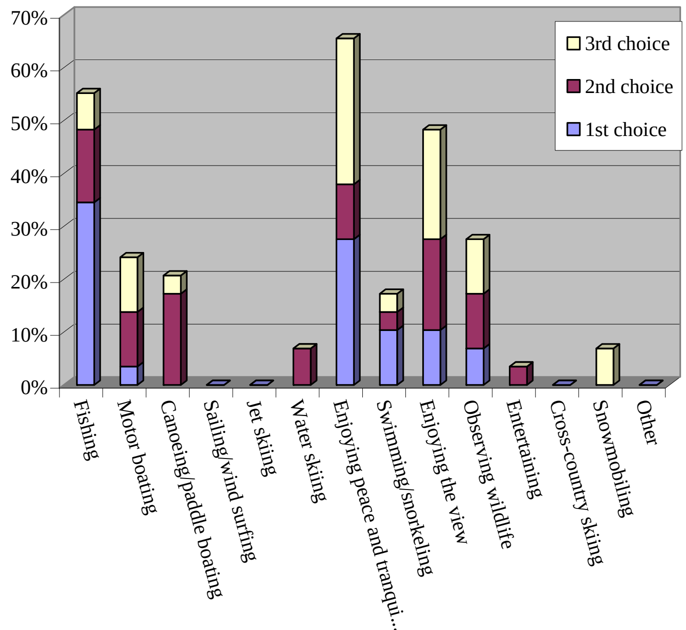
15. Are there areas on the lake where aquatic plant growth becomes especially problematic? (26 of 29 responded)



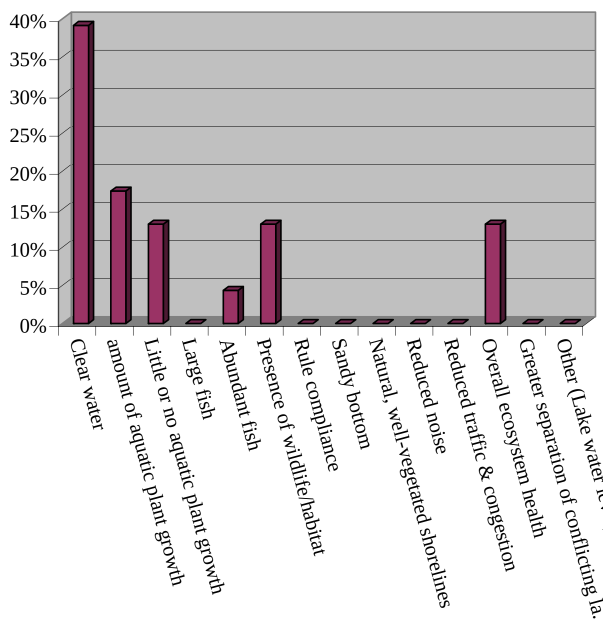
16. Do you feel the current weed management program is effectively controlling nuisance plant growth? (27 of 29 responded)



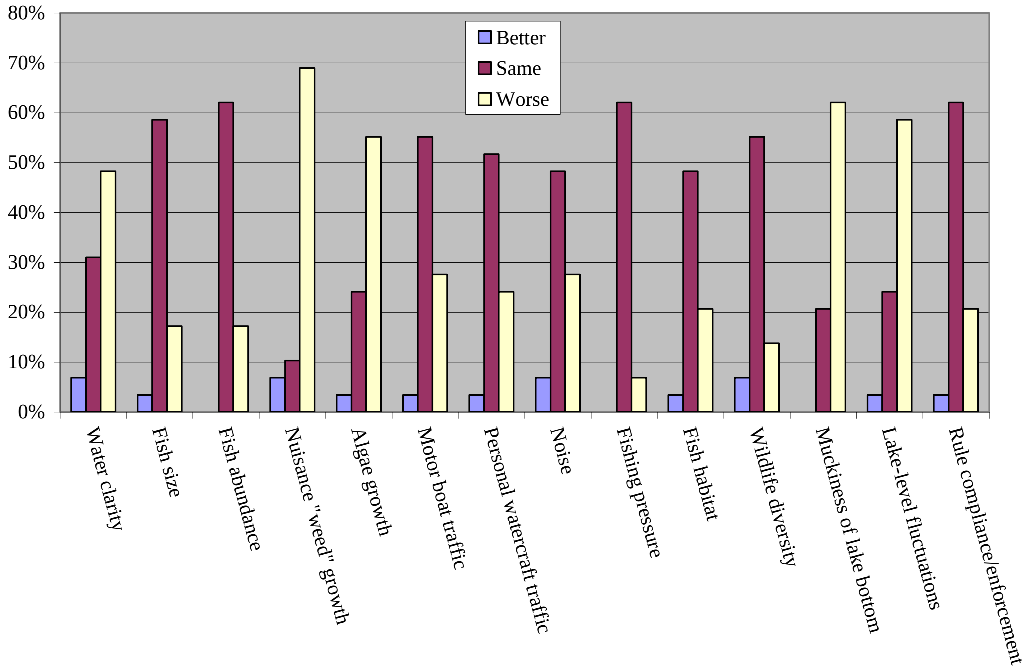
17. What activities do you and the members of your household most enjoy while recreating on your lake? (List the letters of your top three choices) (27 of 29 responded)



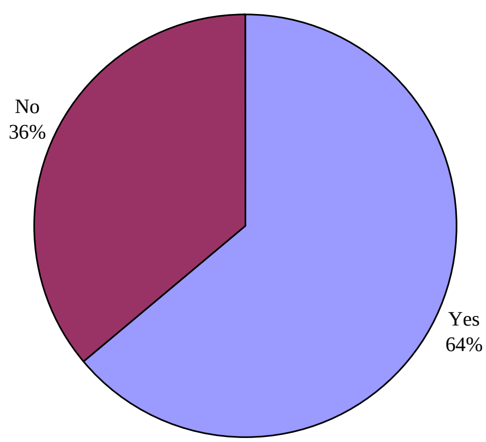
18. Rank the following according to their level of importance to you. (% ranked #1) (22 of 29 responded)



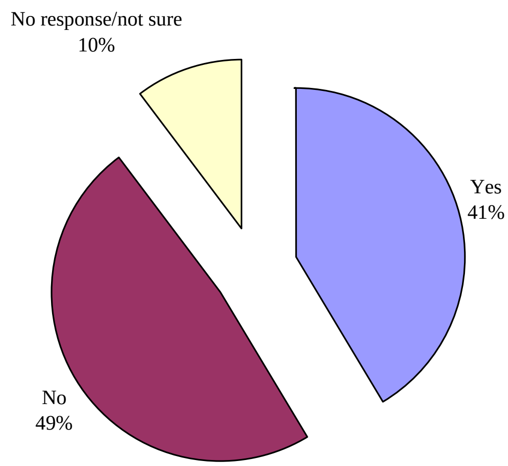
19. How have the following changed since you've lived on or near your lake? (25 of 29 responded)



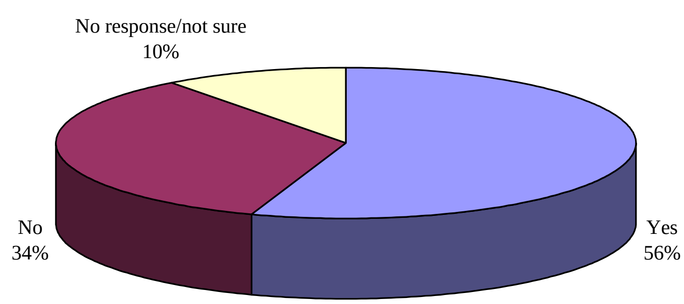
20. Do you feel that there is an adequate law enforcement presence on your lake? (25 of 29 responded)



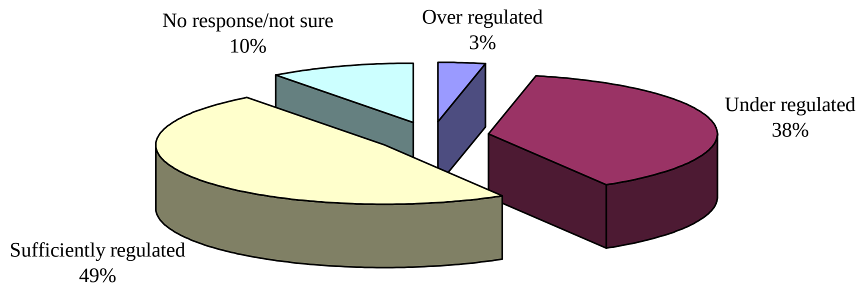
21. Are there any types of behavior, recreational activities or lake uses that you believe are seriously jeopardizing the health and safety of the lake? (26 of 29 responded)



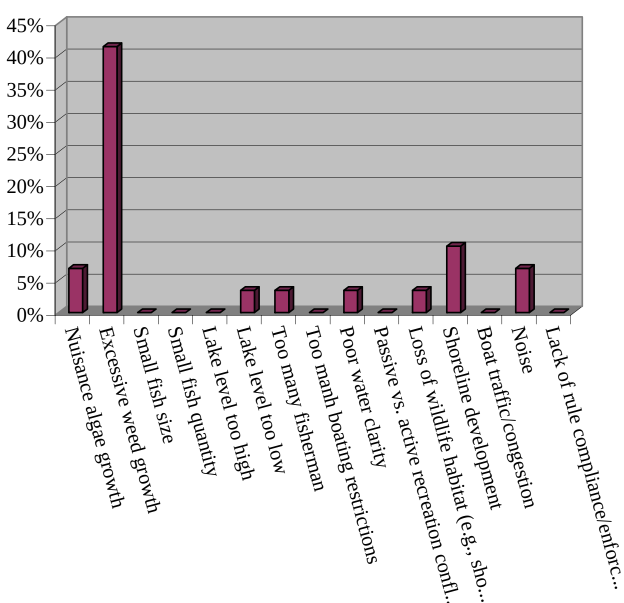
22. Would you be in favor of expanding "slow-no-wake" times and/or locations to promote safety and protect sensitive habitat areas on your lake? (26 of 29 responded)



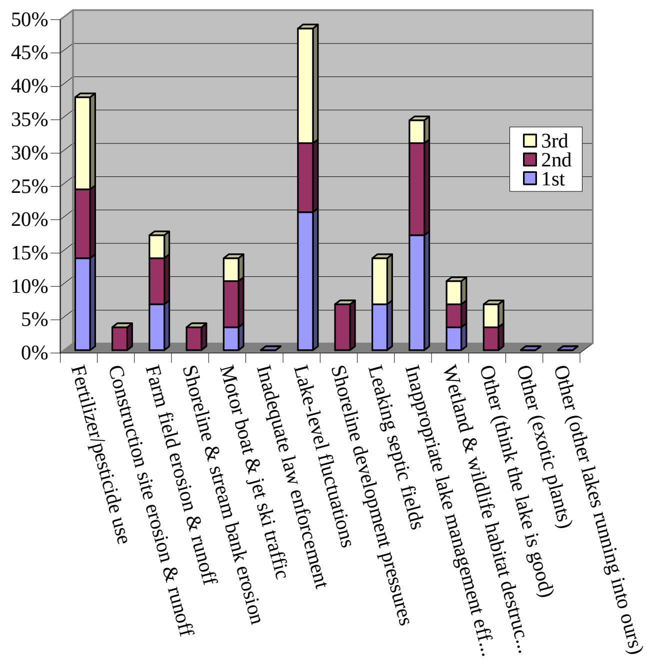
23.What is your opinion regarding lake-use regulations on your lake in general? (26 of 29 responded)



24. Rank the following according to the degree each condition negatively impacts your use or enjoyment of your lake? (Shows % of people who ranked each category #1) (21 of 29 responded)



25. What do you feel are the top three factors that contribute to problems an your lake? (list the letters of your top three choices) (21 of 29 responded)



26. Do you feel that you have a voice in decision-making matters regarding the management of your lake? (23 of 29 responded)