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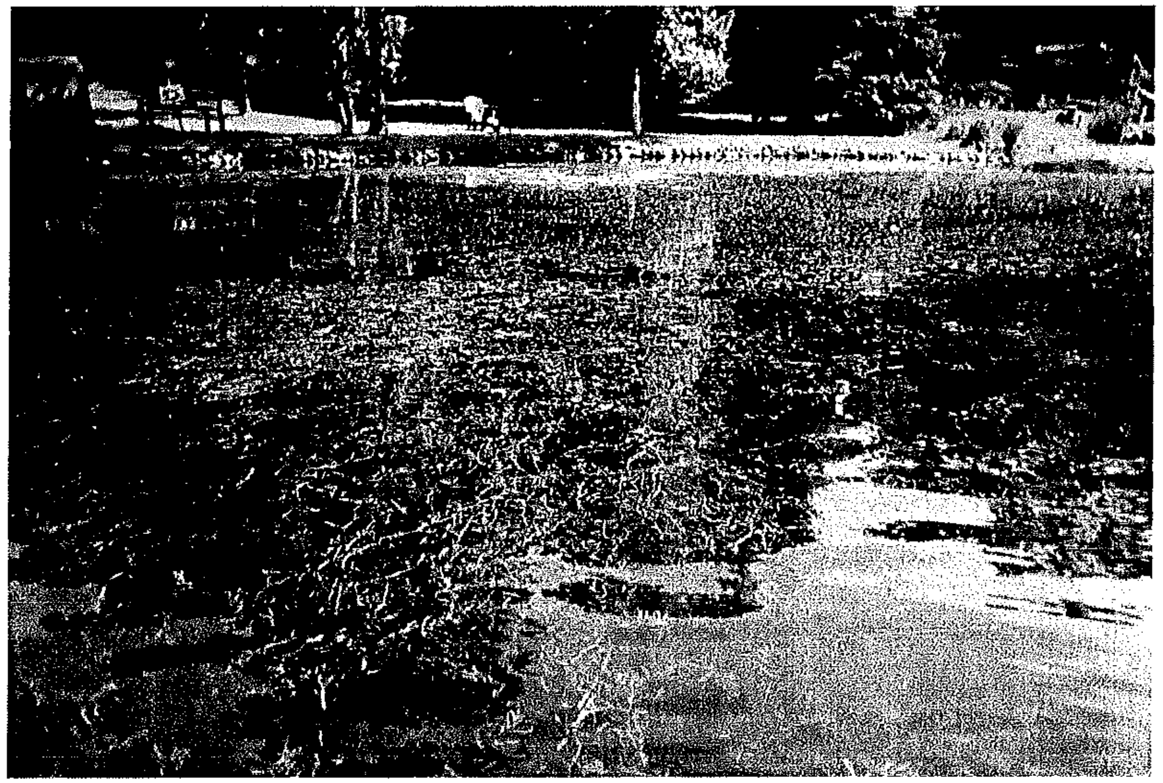
2004 Big Blake Lake Aquatic Plant Survey
Technical Report and Management Plan



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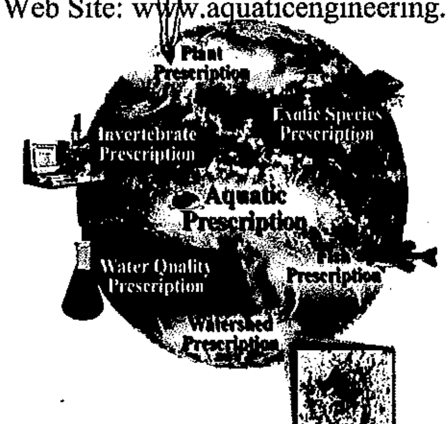

2004 Big Blake Lake Aquatic Plant Survey Technical Report and Management Plan

May 2006

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In cooperation with the Wisconsin Department of Natural Resources

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Blake Lake Management District Commissioners

Loey Weber	Chairperson
Delritta Grill	Past Chairperson
Jim Maxwell	Treasurer
Judy Everson	Secretary
Mr. Anderson	Georgetown Commissioner
Ford Elliott	Volunteer Lake Steward

Wisconsin Department of Natural Resources

Danny Ryan	Lake Coordinator
Jane Malishke	Environmental Grants Specialist
Heath Benike	Fish Biologist

Polk County Land and Water Resources

Jeremy Williamson	Water Quality Specialist
Amy Kelsey	Information and Education Coordinator

Blake Lake *(WBIC# 2627000)* is a 217-acre drainage lake with a 9-foot average depth and a 14-foot maximum depth according to the Wisconsin Department of Natural Resources (WDNR) that is located in Polk County, Wisconsin. The inflow to the lake comes directly from the adjacent watershed and from Little Blake Lake via the Straight River. The Blake Lake watershed is part of the Upper Apple River watershed in the Saint Croix River Basin. This basin was designated as a priority for non-point source pollution control by the Saint Croix Water Quality Management Plan *(WDNR 1994)* and was included in the Polk County Land and Water Resource Plan *(Bursik 2001)*.

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
- Delineated monotypic Curly-leaf pondweed beds
- Macroinvertebrate community assessment
- Update the current aquatic macrophyte component of the Lake Management Plan
- Assessment of riparian land use

The three most abundant plants, by site occurrence in the spring, were curly-leaf pondweed, coon's tail, and flat-stem pondweed. The three most common species in the summer survey were coon's tail, flat-stem pondweed, and naiad. The average density per sample site for the spring and summer were 2.05 and 1.8 *(on a 0-5 scale)*, respectively. The maximum rooting depth located during either survey was 15.5 feet and was located at transect number 12. Only curly-leaf pondweed was found rooted at this depth.

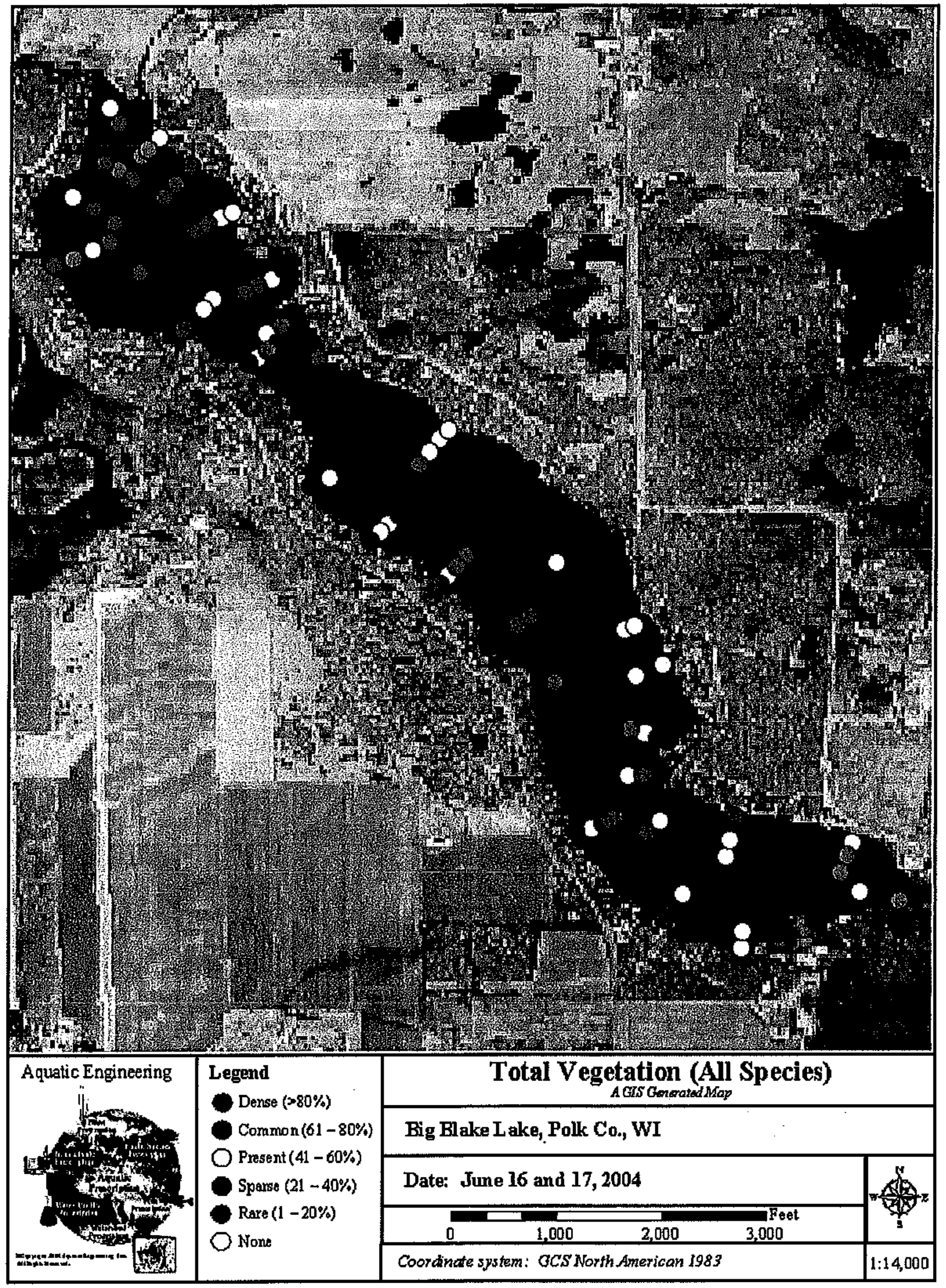

Figure 1. Total vegetation within Big Blake Lake (*Polk County, WI*) spring, 2004.

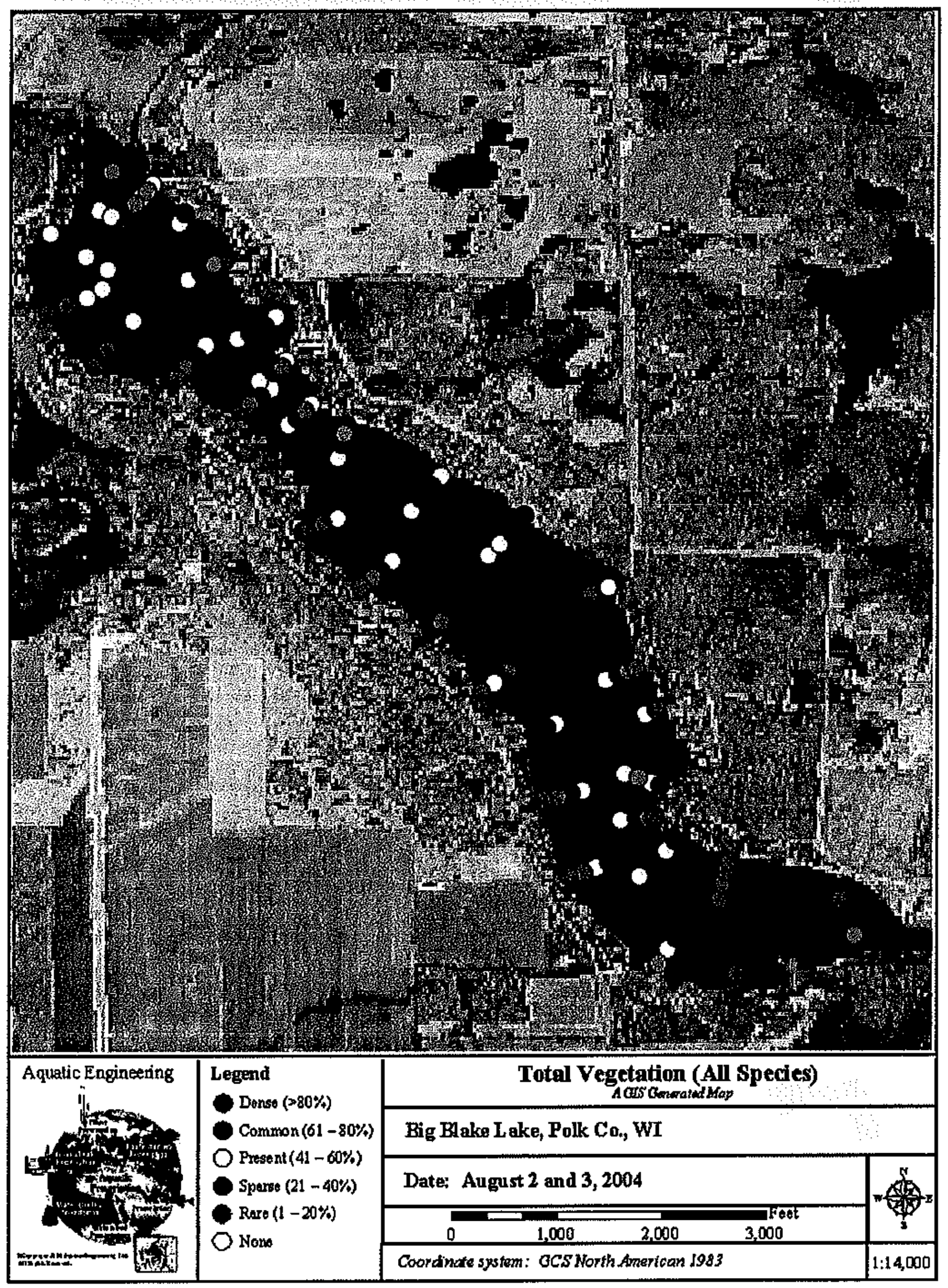

Figure 2. Total Vegetation within Big Blake Lake (*Polk County, WI*) summer 2004.

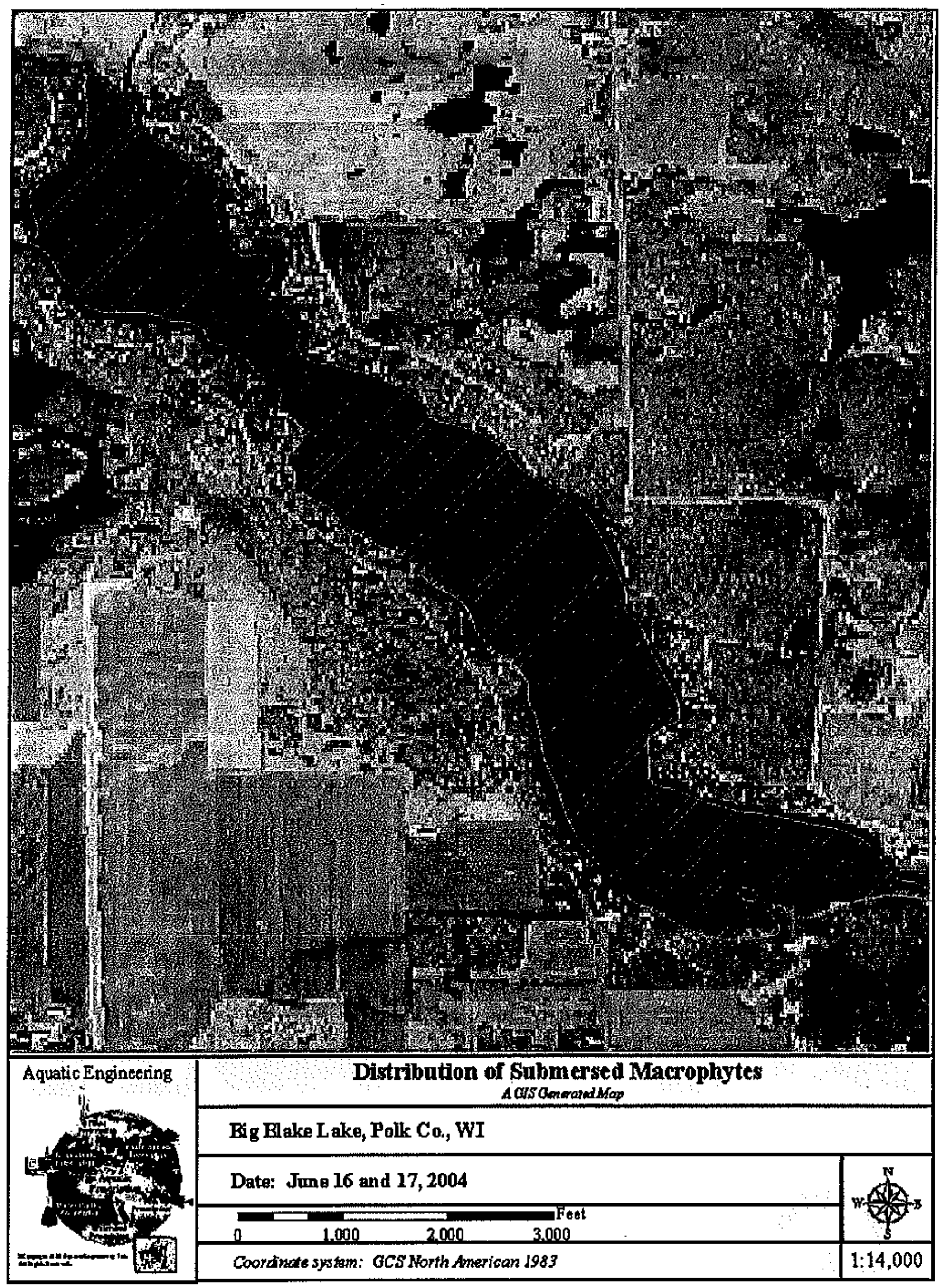

Figure 3. Total area of submersed vegetation within Big Blake Lake (*Polk County, WI*) spring, 2004.

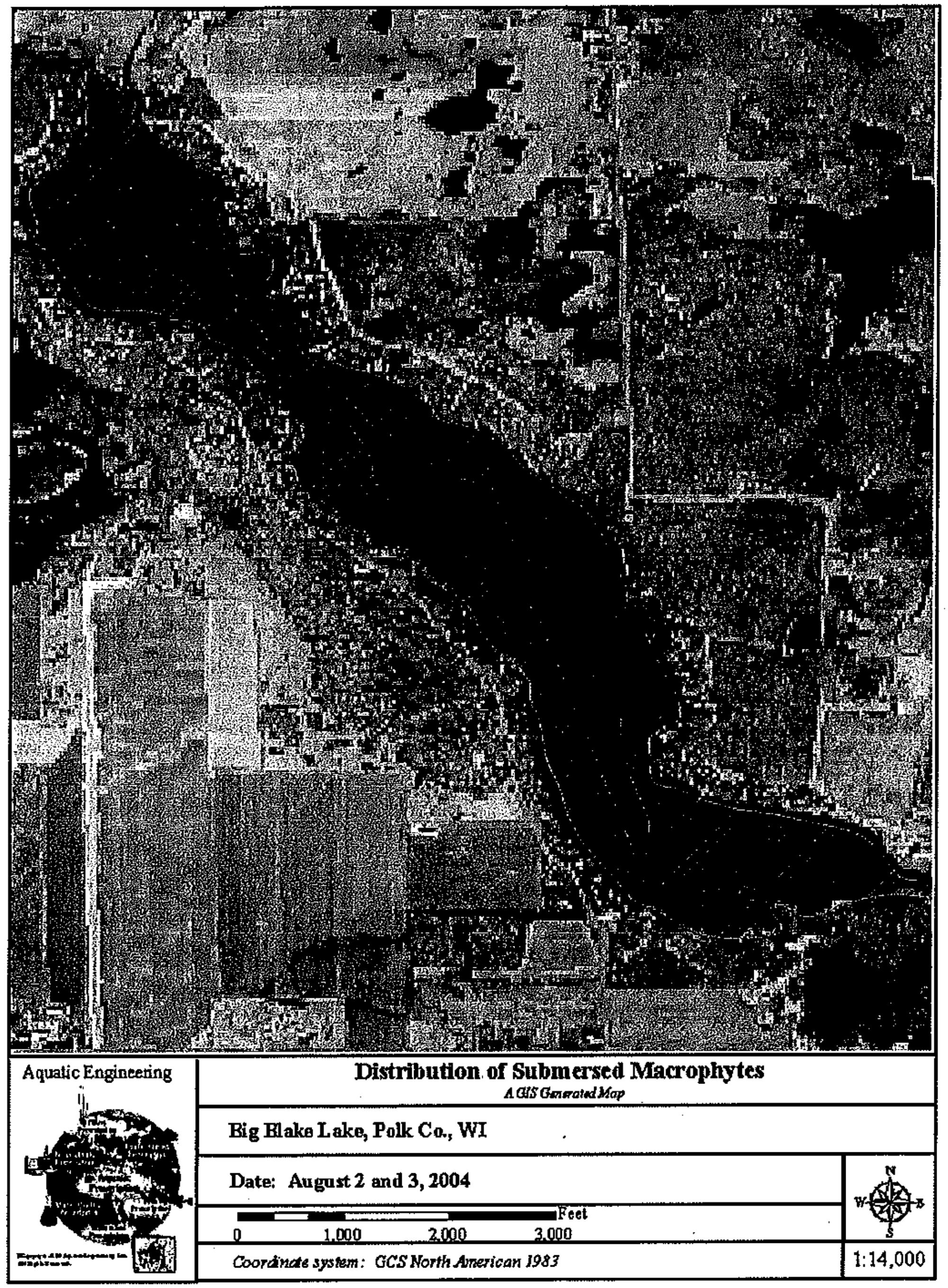

Figure 4. Total area of submersed vegetation within Big Blake Lake (*Polk County, WI*) summer, 2004.

2004 Big Blake Lake Aquatic Plant Survey Technical Report and Management Plan

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

Big Blake Lake is a 217-acre drainage lake located in Polk County, Wisconsin *(WBIC# 2627000, NE ¼ Sec. 22 T35N R6E)*. Four inflows are located in the sub-watersheds. The inlet to Big Blake Lake is the channel that flows directly from Little Blake Lake. The Big Blake Lake watershed encompasses Big Round Lake, Little Blake Lake and the adjoining Straight River and is part of the Upper Apple River watershed in the Saint Croix River Basin. This basin was designated as a priority for non-point source pollution control by the Saint Croix Water Quality Management Plan *(WI DNR 1994)* and included in the Polk County Land and Water Resource Plan *(Bursik 2001)*.

The Big Blake Lake Protection and Rehabilitation District *(BBLP&RD)* was formed in 1976 to address issues of dense algal blooms and extensive weed beds. The District received help from the WDNR, who conducted a management alternatives feasibility study in 1981. A macrophyte survey was conducted by Barr Engineering in 1997, and a macrophyte management plan was presented to the District by Barr Engineering in 1998.

In 2003, the District contracted The Limnological Institute *(TLI)* to write a grant for WDNR funding to conduct a macrophyte survey and update the Lake Management Plan. With this grant, TLI, Aquatic Engineering Inc. (AEI) and Polk County 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. Also included in the report is a review of existing information regarding aspects of a lake management plan that were not covered as part of the grant awarded in 2004.

As part of the grant, TLI outlined the activities that were necessary to perform an adequate macrophyte survey. Aquatic Engineering Inc. and Polk Co. 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 curly-leaf pondweed beds
- Macroinvertebrate community assessment
- Update of the current Aquatic Plant Management Plan
- Assessment of riparian land use

Purpose Statement[1]

The Big Blake Lake Protection and Rehabilitation District exists for the purpose of lake improvement, protection, and rehabilitation of Big Blake Lake.

Goal Statement[1]

The overall goal of Big Blake Lake P&R District's Aquatic Management Plan is to create a diverse aquatic plant community while maintaining a healthy fish population and preserving water quality in order to fully appreciate the entire spectrum of recreation, relaxation, and visual beauty this lake has to offer.

We intend to reach this goal by:

Providing a progressive and flexible weed-harvesting program whereby we create maximum recreational use of the lake with minimum disturbance to the plant and animal life that depend on these waters.

Protecting a flourishing native aquatic plant community in order to safeguard Big Blake Lake's biodiversity since native plants are essential in slowing the spread of invasive species via competition.

Promoting community involvement through heightened awareness and support of the preservation of our lake, and by creating a positive atmosphere of responsible action and an awareness of what individuals and communities can do to make a difference.

[1] Written by Big Blake Lake P&RD, October 2005.

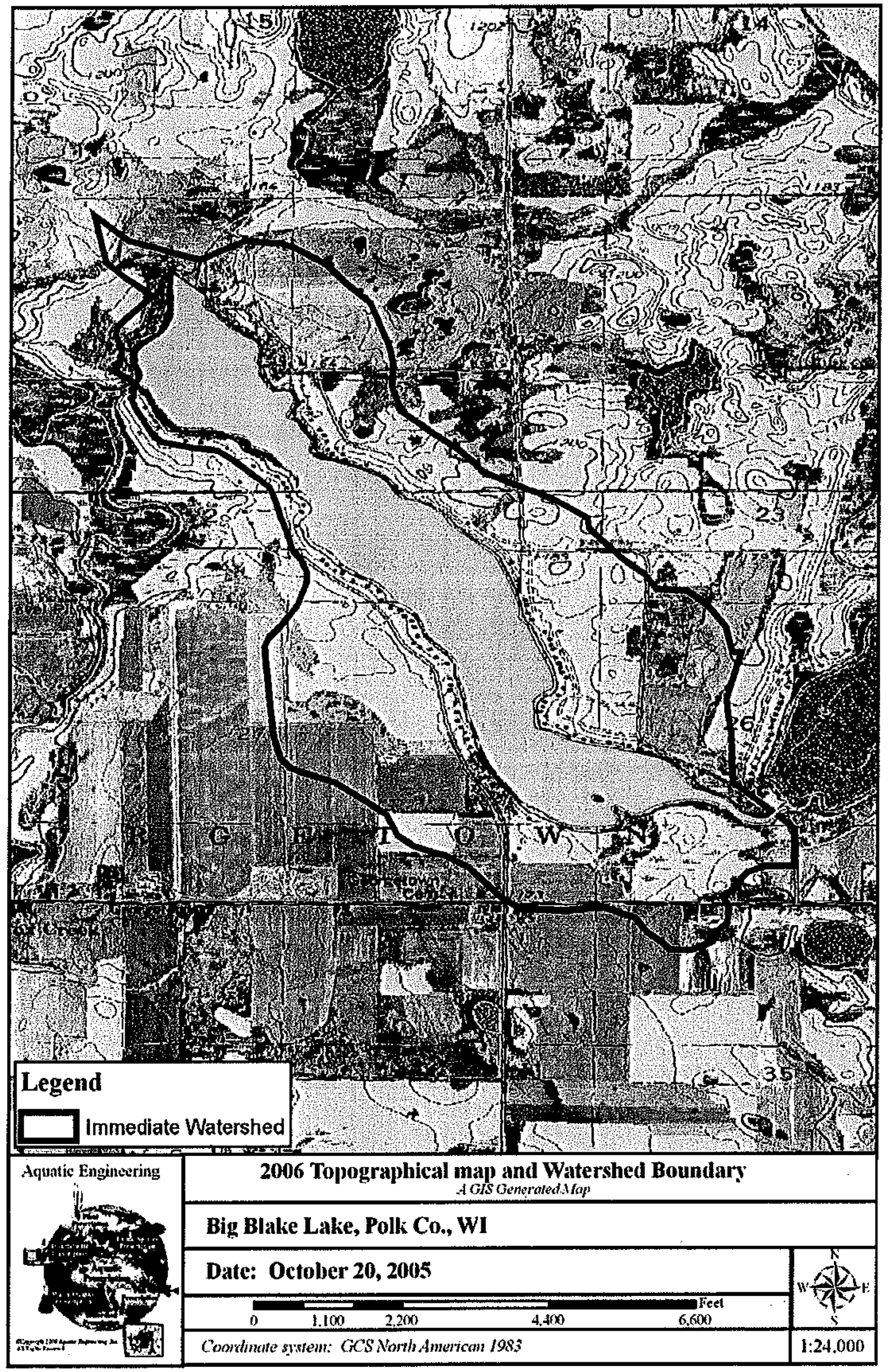

Figure 5. Immediate watershed of Big Blake Lake (*Polk County, WI*) used for WiLMS nutrient modeling.

2.0 Project Overview

During the summer of 2004, AEI biologists assessed several key aspects of the Big Blake Lake ecosystem. Aquatic macrophytes, sediments, various water quality parameters and macroinvertebrates were sampled. All parameters were sampled twice during the aquatic plant growing season in 2004. Water quality monitoring occurred on a weekly basis for June and July and monthly from August to October.

Biological assessments provide insight into the *ecological integrity*—how far an ecosystem deviates from its natural, pristine state *(Gerristen 1998)*. Aquatic plant surveys planned for late spring and late summer of 2004 revealed data yielding a greater understanding of the composition and distribution of the existing aquatic plant community, determined the extent of the CLP infestation and provided data to be used to evaluate impacts of future management efforts. These plant surveys specifically meet the recommendations of the Polk County Land and Water Resources Plan *(2001)*, which recommended the monitoring, prevention, and control of exotic plants and animals.

The data gathered were analyzed and compared to accepted values for similar lakes in the region. Plant community data were used to update the baseline information available for Big Blake Lake, create an aquatic plant management plan and provide information relevant to updating the lake management plan (LMP). It was found that Big Blake Lake has a plant community that changes from the spring to the summer. This change is in part due to CLP *(Potamogeton crispus)*, which dominates the community in the spring and dies off in the summer. During the summer die-off, excess nutrients are released from decomposing plant material and used by algae and native aquatic plant species. Key community indices show that diversity in Big Blake Lake is average for lakes in its region and in Wisconsin. However, when CLP is at its peak in early spring, the diversity of the plant community is well below average. Both Simpson's and Shannon indexes show great improvement in diversity from the June survey to the August survey.

2.1 Aquatic Plant Distribution within Lakes

Aquatic plants grow in the area of a lake, pond or impoundment called the *littoral zone.* The littoral zone is the area between dry land and open water. The littoral zone can vary greatly from lake to lake but is generally considered to be the area where the water depth is less than 15 feet. This depth is a general guideline and can increase with clear, calm water or decrease with cloudy, disturbed water. *Open water* is considered any area where water depth is greater than 15 feet, or where aquatic vegetation does not grow from the sediment.

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, which in turn provide the energy source for all other life forms in the lake through photosynthesis. Because of this, the littoral zone is the most biologically active area of a lake. Open water areas are also biologically productive; planktonic algae and zooplankton can be found everywhere in open water where photosynthetically active radiation penetrates the water.

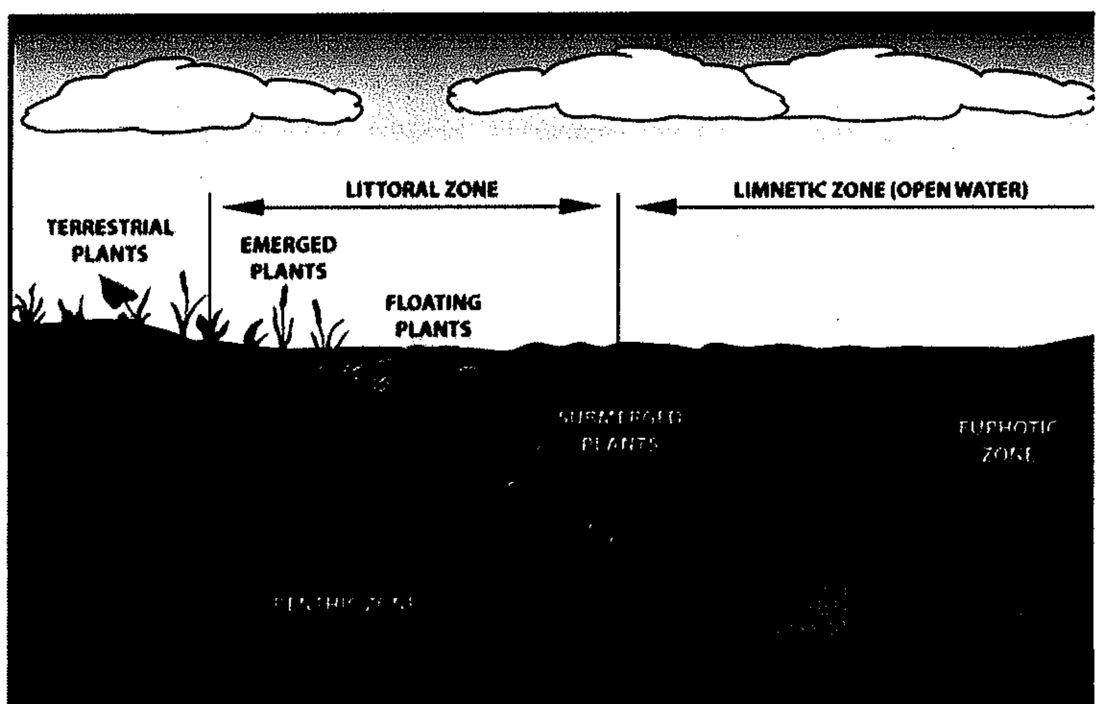

Figure 6. Littoral zone within a lake.

2.2 Types of Aquatic Plants

There are four major categories of aquatic plants:

Algae can be found in every area of a lake where sunlight penetrates. They have no true roots or leaves and can be single-celled or multi-cellular organisms. 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 only 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 surface, where they create unpleasant odors while they decay.

Submersed macrophytes are true plants and have true stems and leaves that grow entirely underwater. These plants have a wide range of morphologies and can grow in any area 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's surface. Water lilies are good examples of floating-leaf 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. Emergent plants provide cover and food for wildlife and help protect shorelines from wave action.

2.3 Value of Aquatic Plants

Food source – Aquatic plants provide a source of food for insects, snails, and freshwater shrimp. Some fish also feed directly on aquatic plants.

Shelter/Habitat – Besides providing a source of food, plants provide a place for fish to escape from sunlight and predators. They also provide an attachment point for certain insect larvae. 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 that results.

Improve water quality – Some plants absorb and break down harmful pollutants in the water. Plants also bind nutrients and make them unavailable to algae.

Improve aesthetics – Many plants produce beautiful flowers and seeds that enhance the natural beauty of the lake.

Economic value – Because aquatic plants fuel the aquatic ecosystem, they are responsible for maintaining the tourism value of this resource. Lakes with healthy plant communities generally have healthy fish and wildlife populations, which draw recreationists interested in boating, fishing, camping, and hunting. Improved water quality and shoreline aesthetics can also raise the value of lake shore property.

Invertebrates have been monitored for decades to assess ecosystem health. They respond to a myriad of environmental conditions including habitat complexity and water chemistry. The findings of the macroinvertebrate survey provided baseline data of community composition and can be used as indicators of water quality and habitat conservation.

2.4 Water Quality and Trophic Status

Trophic status is a term used to describe the amount of primary productivity that occurs within a body of water. *Primary productivity* is the production of biomass by the bottom layer of the aquatic food pyramid, algae. Water quality parameters such as phosphorous concentrations, Secchi depth, and chlorophyll *a* concentrations were used to classify nutrient levels in the water and determine trophic status. Analyzing water quality parameters may also help determine if monotypic stands of CLP have localized effects on water quality.

3.0 Review of Existing Data

3.1 Water Quality

A Barr Engineering report written in 1998 for the BBLP&RD summarizes the historical water quality conditions of Big Blake Lake. The report summarized data collected by the WDNR from November 1978 through October 1979. The report also summarized information collected by the University of Saint Thomas in 1983 and 1993. Secchi depth averages in the report range from 1.7 meters in 1991 to 1.15 meters in 1993. Although yearly variance in water clarity is not uncommon, the past trend in Big Blake Lake suggests that conditions are worsening. In general, past data show that Big Blake Lake is eutrophic and has been as early as 1978. It it likely that Big Blake Lake has been eutrophic for some time since prior to 1978, but sufficient data is lacking to make that determination.

Table 1. Historical water quality parameters for Big Blake Lake (Polk County, WI). Adapted from 1998 Barr Engineering Big Blake Lake Macrophyte Surveys and Management Plan.

Parameter	**Range**	**Mean**
Total Phosphorus (mg/L)	0.026-0.095	0.048
Total Kjeldahl Nitrogen (mg/L)	0.46-0.55	0.51
Conductivity (μohms/cm)	275-405	336
pH	7.14-8.98	8.10
Alkalinity (as $CaCO_3$) (mg/L)	96-130	108

Physical characteristics were also assessed during the 1997 Barr Engineering survey. The mean depth of the lake was calculated as 8.6 feet with a maximum depth of 14 feet. The watershed area was calculated at 15,369 acres compared to a lake surface area of 250.7 acres, which means the watershed to lake surface area ratio is 61:1. The hydraulic retention time was figured to be 0.10 years or approximately 37 days *(Barr 1998)*.

3.2 Aquatic Macrophytes

The report written by Barr Engineering in 1998 summarized macrophyte data gathered by WDNR in 1979. At that time, the reported coverage of aquatic vegetation was 10 percent, or approximately 25 acres, of the lake. More recently, aquatic macrophytes have been found throughout the littoral zone of Big Blake Lake. Surveys conducted by Barr Engineering in 1997 showed that approximately 120 acres of the lake contained aquatic vegetation *(Barr 1998)*. Of the 120 acres of aquatic vegetation found during these surveys, approximately 65 acres of CLP were found in June and 40 acres in July. The Barr study concluded that the macrophyte community was diverse *(Simpson's Index of Diversity values of 0.89 and 0.91 in the spring and summer, respectively)* but would require monitoring, harvesting and herbicide treatments to maintain a healthy community. Since the 1998 recommendations were provided, the BBLP&RD has not followed through with the Barr plan. Global positioning systems integrated with GIS technology were used in 2003 to conduct a vegetation survey which accurately documented 57.7 acres of topped-out CLP.

3.3 Fishery

The fish survey conducted in 1978 found that there were a few northern pike *(the target fish for the survey)*, walleye, and muskellunge in Big Blake Lake. The largemouth bass population was the largest of the sport fish. Bluegills were abundant, and bottom-dwelling fish such as suckers and bullheads were common. The survey of 1978 was conducted to evaluate the success of a 1976 northern pike stocking effort where 1,250 fish averaging 9 inches were stocked that summer. The results of the 1978 survey showed that the 1976 stocking was a failure due to low densities of pike and no year-class for 1977. Stocking efforts were discontinued until 1984, when northern pike were again stocked until 1989—302,000 northern pike fry were stocked annually in Big Blake Lake. Stocking continued again in 1991, '92, '94, and '97, when walleye were stocked. Over those four years, approximately 51,000 walleye fingerlings *(1.7 to 4.0 inches long)* were stocked into Big Blake Lake.

3.4 Macroinvertebrates

There is no prior data regarding the macroinvertebrate community within Big Blake Lake.

3.5 Phytoplankton and Zooplankton

There is no prior data regarding the plankton communities within Big Blake Lake.

3.6 Watershed

The watershed of Big Blake Lake is approximately 15,369 acres *(Barr 1998)*. The watershed includes the Straight River which flows from Big Round and Little Blake lakes prior to entering Blake Lake. A study completed by the WDNR from 1978 to 1979 showed that 87 percent of the inflow to Big Blake Lake came from surface runoff which entered primarily through the Straight River *(Barr 1998)*. The 2004 Big Blake Lake Water Quality Report *(AEI 2005)* contains a current watershed analysis and updates information within the 1998 report.

3.7 Sediments

A WDNR study conducted from 1978 through 1979 found that Blake Lake was nearly half filled with sediment and that the sediment in Blake Lake was 48 percent organic and 52 percent inorganic on a dry weight basis. The inorganic portion of the sediment primarily consisted of silt and clay *(Barr 1998)*.

3.8 Membership Surveys

Members of the BBLP&RD were surveyed during 1997 as part of a Barr Engineering study. The return rate of surveys was 31 percent *(77 of 225 surveys were returned)*. Barr summarized the results in the 1998 report to the District which are paraphrased below.

- 88 percent of respondents recognize aquatic plants have value
- Respondents indicated plants have value for fish shelter and food

- Respondents indicated the primary uses of the lake include fishing *(94 percent)*, viewing *(82 percent)*, swimming *(70 percent)*, power boating *(47 percent)*, and canoeing *(43 percent)*.
- Respondents indicated that swimming and fishing were impaired by aquatic plants
- 56 percent of respondents indicated they have attempted to remove plants from their shoreline
- 39 percent of respondents were opposed to using chemicals to remove vegetation
- 23 percent of respondents were opposed to harvesting vegetation
- 57 percent of respondents indicated the District should not own and operate a weed harvester

3.9 Sensitive Areas

In 2000 the WDNR designated three areas within Big Blake Lake as sensitive. The purpose of the designations is to raise awareness of the ecological significance of those areas and help protect the natural plant and animal communities that inhabit them. The areas are protected from disturbances under NR 107 and NR 109. The areas are depicted in section 9.3 of this report.

4.0 Methods

4.1 Macrophyte Surveys

Qualitative and quantitative aquatic plant surveys were conducted once in the spring and once in the summer of 2004. The quantitative surveys applied a transect-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 transects, record sample sites, and map monotypic stands of CLP.

4.1.1 Qualitative Surveys

Prior to conducting the quantitative aquatic macrophyte survey, ecologists toured the lake, collecting samples of all unique species found. Whole plants were collected, including flowers and seeds, if available. Herbarium samples were bagged and stored on ice until they were returned to the lab for processing.

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 methods were used for the study:

- Thirty-four transects were sampled along the shoreline. Samples were collected from shallow *(0-1.5 feet)*, intermediate *(1.5-5.0 feet)*, near-deep *(5-10 feet)* and deep *(10 feet-maximum rooting depth)* areas.
- Each sample area was a circle around the boat 8 feet in diameter divided into quadrants. A two-headed, weighted rake was extended from a boat to the farthest extent of each quadrant and dragged along the bottom to collect plants.
- GPS coordinates were collected at the center of each sample area 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 2. Coverage numbering methodology.

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

The Simpson's diversity index (D_s) was determined using the following equation:

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

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 Shannon index (*H*) measures the uncertaintly that the taxon of a randomly chosed individual can be predicted (Shannon and Weaver 1949). 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.

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 values were collected with a YSI SONDE probe prior to plant sampling. The probe was submersed to elbow depth in most sites and to half the total depth for 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.

The probe was calibrated each day it was used prior to recording sample values. The pH probe was calibrated using a two-point bracketing standard solution method with a low end of pH 7.0 and a high end of pH 10.0. The dissolved oxygen probe was calibrated with oxygen saturated deionized water to 100% saturation. The temperature probe did not require calibration.

4.3 Substrate at Plant Survey Sites

The sediment at each aquatic plant sampling site was characterized based on particle size *(sand, gravel, muck, etc.)*. In areas where the sediment was not sufficiently visible from the water surface, an Eckman dredge was used to collect a sediment sample. Depth was measured using a surveyor's staff for sites less than 16 feet deep and a boat-mounted Eagle® depth finder for sites greater than 16 feet.

4.4 Riparian Land use Assessment at Plant Survey Sites

The riparian survey occurred at each point where aquatic plant survey transects intersected the shoreline. The immediate shoreline *(50 feet wide and 30 feet back)* was surveyed using the following characteristics as categories.

Table 3. 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 zone was not recorded.

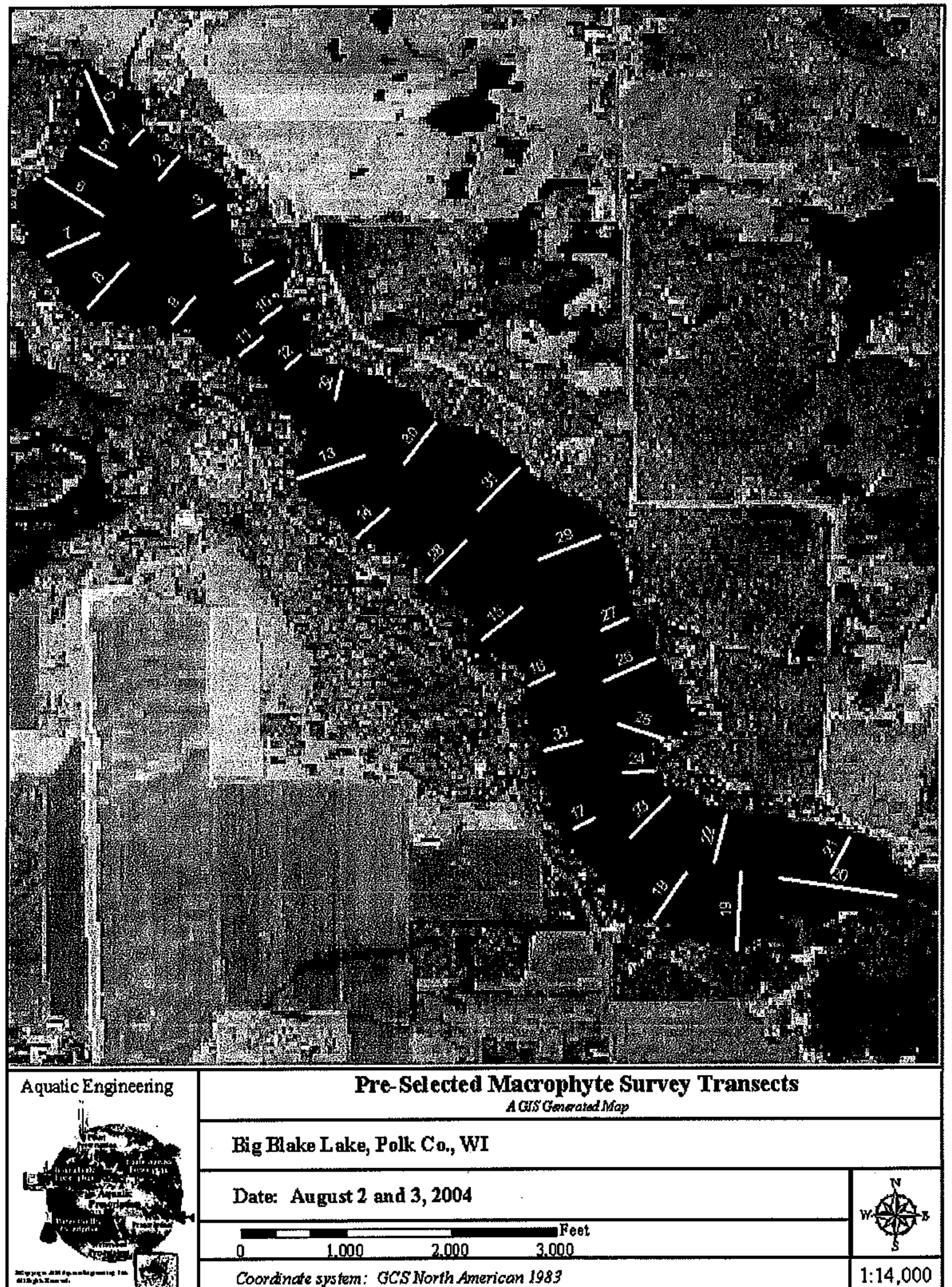

Figure 7. Location of transects for quantitative macrophyte survey of Big Blake Lake (*Polk County, WI*) in 2004. Transects are shown with their "FID" numbers (field ID) assigned by ArcMap.

4.5 Macroinvertebrate Sampling

Aquatic macroinvertebrates were collected twice in 2004. The first was June 28. Due to the late spring warm-up, CLP was just starting to die and decompose. This was the first target period. The second sampling was performed on August 27th and chosen because a native plant community would likely be present and later-season larval invertebrates would be mature enough to be easily identified.

There is evidence that dense, monotypic plant beds have a negative impact on the density and diversity of aquatic insects *(Sloey, Schenck, and Narf 1997)*, which in turn can negatively affect other organisms, especially fish. Therefore, three different conditions were sampled: monotypic CLP stands, moderate CLP invasion, and native-dominated stands. At each site, physical and chemical parameters were monitored *(i.e., substrate and percent DO)*. Metrics used to quantify were indicator groups at the population level *(e.g., ETO richness and abundance and* Diptera *populations)*. At the community level, richness was calculated along with the Shannon-Wiener diversity index. The Shannon-Wiener Index uses the equation:

$H = -\sum_{i=1}^{s}(p_i)(\log_2 p_i)$. Where H = Shannon-Wiener Diversity, $\sum$ = sum of species, s = the number of species, p_i = the proportion of individuals of the total sample belonging to species i calculated as ni/N for each *ith* species with ni being the number in species *I*, and N being the total number of individuals in the sample *(Barbour, et al, 1987)*.

Each site was sampled using a D-frame kick net at four 15-second intervals to eliminate backwash in the nets. After each interval, the nets were dragged 180° through any standing vegetation. This was done until all four sweeps were completed or 3785 ml *(1 gal)* of organic matter was collected. The organic matter samples were placed in gallon jars and brought back to the lab.

In the lab, each sample was placed in a 5 percent ethanol solution for 24 hours to relax the sample and avoid unnecessary damage that can make individuals difficult to identify.

Next, the samples were placed in a 95 percent ethanol solution for preservation, with glycerol as a wetting agent.

To identify all the individuals, each sample was sorted in mosquito larval trays under magnification and identified to the lowest possible taxonomic level with either a dissecting or compound microscope.

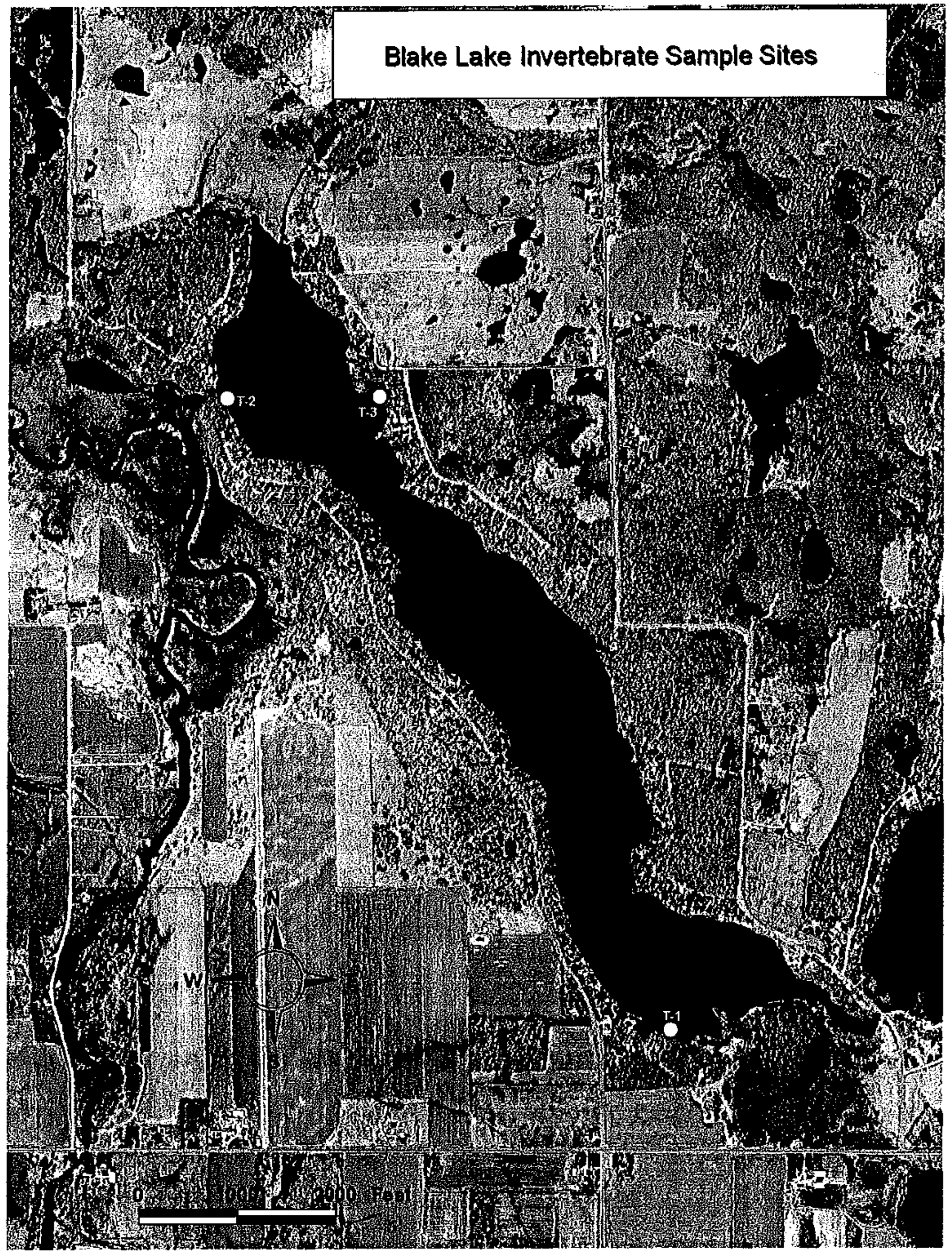

Figure 8. Location of macroinvertebrate sampling sites for Big Blake Lake (*Polk County, WI*) in 2004.

4.6 Water Quality Sampling

Laboratory Analysis

Three water quality sampling sites *(mid-basin, inlet, and outlet)* were established for Big Blake Lake in 2004. Water quality monitoring is a specific recommendation of the Polk County Land and Water Resource Plan *(p. 22)*. Water quality, phytoplankton, and zooplankton samples were all taken from a "mid-basin" site, while other water quality parameters were collected from the inlet and outlet sample sites *(Refer to the 2004 "Big Blake Lake Water Quality Report")*. Water samples were collected during the summer by representatives of Polk Co. and were sent to the Water and Environmental Analysis Laboratory *(WEAL)* located at UW–Stevens Point. The samples were analyzed for reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll *a*. These samples were collected using a six-foot integrated surface sampling device and kept on ice until they arrived at the laboratory. Other parameters measured during laboratory analysis were pH, nitrate and nitrite, ammonia, alkalinity, total hardness, chloride, and total suspended solids.

On-Site Water Quality Measurements

Depth profiles were collected at the mid-basin sampling site during the summer sampling period *(June through October)*. Data points were collected with a water quality probe at one-meter intervals throughout the water column, measuring for dissolved oxygen, conductivity, and temperature. Additional monitoring also occurred at the inlet and outlet sample sites.

The conductivity probe was calibrated at the beginning of the sampling season with a 1,000 μS/cm standard solution. The probe is designed to hold its last calibration and so daily calibrations were not reqired. The dissolved oxygen probe was calibrated using water saturated air prior to each sampling event. The dissolved oxygen probe is not designed to hold its calibration, therefore daily calibrations were required.

4.7 Phytoplankton and Zooplankton Samples

Phytoplankton and zooplankton samples were collected in August and September at the lake water quality monitoring station. A 66-micron zooplankton tow net was used to collect all plankton samples. The net was lowered to one meter above the sediment and slowly pulled to the lake surface. See the 2004 Big Blake Lake Water Quality report for specific activities related to plankton monitoring.

4.8 Public Input

During the development of this plan, public input has been solicited from three sources. Polk County officials, BBLP&RD members and employees of the WDNR were solicited during the grant development and approval phases of the project. All parties involved in the grant development and approval phase had input in the study design and specific deliverables listed in the grant. At that time, there was no survey of Big Blake Lake residents planned for any portion of this study. The BBLP&RD felt their previous survey was adequate and that another survey was not warranted. In the spring of 2005, the previous survey was analyzed by TLI, and it was determined that a public opinion survey to assess the current opinions of the lake residents was warranted. A membership survey was created by TLI and mailed to District members.

Further input came from District members during annual meetings where lake management options for Big Blake Lake was discussed. All parties present at those meetings had the opportunity to voice opinions and concerns. Meeting minutes were requested from the District and have been included with this report *(Appendix G)*.

District representatives identified private irrigation intakes, culverts and public and private access points. District members thought it necessary to mark all private irrigation intakes, drain tiles, drainage ditches and boat access points so that all their bases were covered. TLI assisted the District with collecting waypoints on a Garmin Rino 110 GPS unit. The District used the waypoint marking options to record the locations of the aforementioned features and returned the unit to TLI where the information was downloaded into Arc Map *(Figure 4)*.

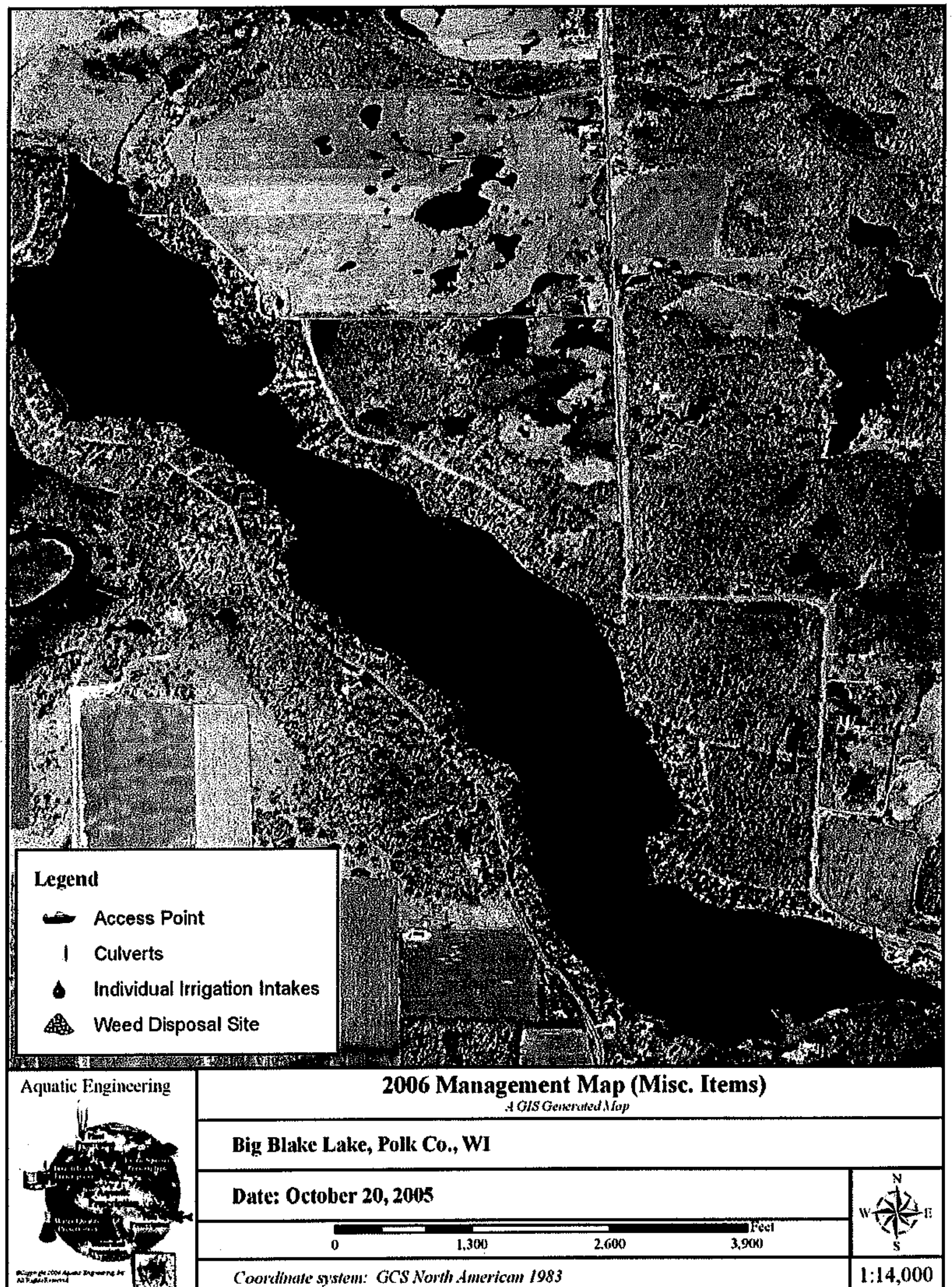

Figure 9. Location of various watershed features of Big Blake Lake (*Polk County, WI*).

5.1 Overview of Macrophyte Surveys

Seventeen different species were identified during the two macrophyte surveys; 14 different plant taxa were identified in the spring and 12 in the summer. Plants unique to the spring survey were Robbin's pondweed, common waterweed, and naiad. Plant taxa unique to the summer survey were white-stem pondweed, water buttercup, cattails, duckweed, and yellow-water lily.

Table 4. Plant taxa identified during 2004 aquatic plant surveys in Big Blake Lake (Polk County, WI).

Species Number	Scientific Name	Plant Common Name	Frequency of occurrence (relative percent) June	August
1	*Ceratophyllum demersum*	Coon's Tail	16.9	32.0
2	*Potamogeton zosteriformis*	Flat-stemmed pondweed	12.1	20.3
3	*Myriophyllum sibiricum*	Northern milfoil	5.8	10.8
4	*Nymphaea odorata*	White-water lily	<1	1.0
5	*Zosterella dubia*	Water stargrass	1.0	1.3
6	*Potamogeton richardsonii*	Clasping leaf pondweed	4.3	2.6
7	*Vallisneria americana*	Wild Celery	<1	7.8
8	*Potamogeton crispus*	Curly-leaf pondweed	56.9	8.8
9	*Potamogeton strictifolius*	Narrow leaf pondweed	1.0	1.6
10	*Potamogeton Robbinsii*	Robbin's pondweed	0	<1
11	*Elodea Canadensis*	Common waterweed	0	<1
12	*Najas* sp.	Naiad	0	13.1
13	*Potamogeton praelongus*	White stem pondweed	<1	0
14	*Ranunculus longirostris*	Water buttercup	<1	0
15	*Scirpus* sp.	Cattails	<1	0
16	*Nuphar advena*	Yellow-water lily	<1	0
17	*Lemna minor*	Common duckweed	<1	0

The most abundant species found in the spring survey was CLP. Curly-leaf pondweed is a cold water specialist that begins germinating in the winter when native species are dormant. It continues to grow throughout the winter, through spring and into summer. At the beginning of summer, CLP reproduces and senesces. The reason for CLP's success is that its growth cycle naturally reduces competition for resources such as nutrients and space by growing "out of season" from native plants.

The predominant plants in the summer were flat-stem pondweed,, naiad, and coon's tail. Flat-stem pondweed is a common plant in Wisconsin lakes. Its stem is compressed, or flattened, and the leaves that arise alternately from the flattened stem have a predominant mid-vein. Flat-stem pondweed can grow in shallow water as well as depths up to a few meters and is usually found in soft sediment.

Naiads are small plants that grow close to the sediment. The stems and leaves do not typically cause any nuisance conditions at any time of the year. Naiads can spread through fragmentation in the summer. However, slender naiad is a true annual which relies solely on its seeds to return in the spring. Naiads are somewhat intolerant of poor water quality and are generally found in lakes with good water clarity and sandy to rocky substrate.

Coon's tail, commonly called coontail, is a native plant capable of creating nuisance conditions. It is a submersed plant that will grow anywhere light penetrates to the bottom of the lake. Coon's tail grows rapidly during early summer and is usually one of the most dominant early summer species present. It prefers soft, organic substrates but can grow in just about any condition. Resistant to poor water quality, it can grow in low-light conditions when turbidity or algae blooms shade the water column. Coon's tail lacks true roots but can loosely anchor itself in sediment using thin, modified leaves. Because of this, mats of coon's tail easily become dislodged from the sediment, float around the lake and settle in other locations. Coon's tail overwinters as an evergreen, actively photosynthesizing and rarely producing seeds. Its major form of reproduction is through plant fragmentation.

There were no rare, threatened or endangered species in the plant inventory in 2004. Yellow-water lily is listed as a species of "special concern" in the state of Wisconsin. Yellow-water lily was only found during the spring survey and was located in the shallow area of transect 19, which is located along the southernmost shoreline just southwest of the Straight River inflow. Yellow-water lily was found in the qualitative survey and was marked as "present" in the quantitative survey but was never collected on the rake head.

Algae – Filamentous algae were documented during the spring survey. Algae do not contribute to overall plant density, nor are they assigned their own density. Rather, a 'P' was recorded for the presence of filamentous algae. Only one site contained filamentous algae during the spring survey. For more information regarding algae refer to the 2004 Big Blake Lake Water Quality Technical Report.

Submersed vegetation – Submersed macrophytes made up 100 % of the plant coverage sampled in the spring and 99 percent of the plant coverage sampled during the summer survey.

Floating- leaf vegetation – Floating-leaf plants made up 0 and 1 percent of the coverage for the spring and summer surveys, respectively. Some sites contained white and yellow pond lily, but they were not captured on the rake. A density of 'P' (for 'present') was recorded when this occurred.

Emergent plants – No emergent plants were noted during either quantitative survey. Areas of the lake where emergent vegetation occurred adjacent to transects were noted during the qualitative survey.

5.2 Quantitative Macrophyte Surveys

Each plant species found during the qualitative survey was also sampled during the quantitative survey, yielding a total of 14 unique plant species in the spring and 12 in the summer. The three most abundant plants, by site occurrence in the spring, were CLP, coon's tail, and flat-stem pondweed. The three most common species in the summer survey were coon's tail, flat-stem pondweed, and naiad. The average density per sample site was 2.05 in the spring and 1.80 in the summer. The maximum rooting depth located during either survey was 15.5 and was located at transect number 12. Only CLP was found rooted at this depth.

The Floristic Quality Assessment (I), calculated: $I = ((\sum C_i) \div N) \sqrt{N})$, was performed for all species found in Big Blake Lake in 2004. A total of 17 unique native species (N) had an average coefficient of conservatism of 5.875. The FQI for Big Blake Lake in 2004 was 24.22. The separate spring and summer FQI values were 21.9 and 19.2, respectively

Simpson's diversity index (D_S) values for Big Blake Lake during the spring and summer surveys were 62.82 and 81.2, respectively. This 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 rarely reached.

The Shannon index (*H*) measures the uncertainty that 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 Shannon index value for Big Blake Lake was 1.98 in spring, with an H_{max} of 3.19, and was 2.76 in the summer, with an H_{max} of 3.58. H/H_{max} ratios were 0.506 and 0.769, in spring and summer, respectively, which suggests a low amount of diversity in the spring and improved conditions in the summer.

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 values for Big Blake Lake in the spring and summer of 2004 were 36 and 42, respectively.

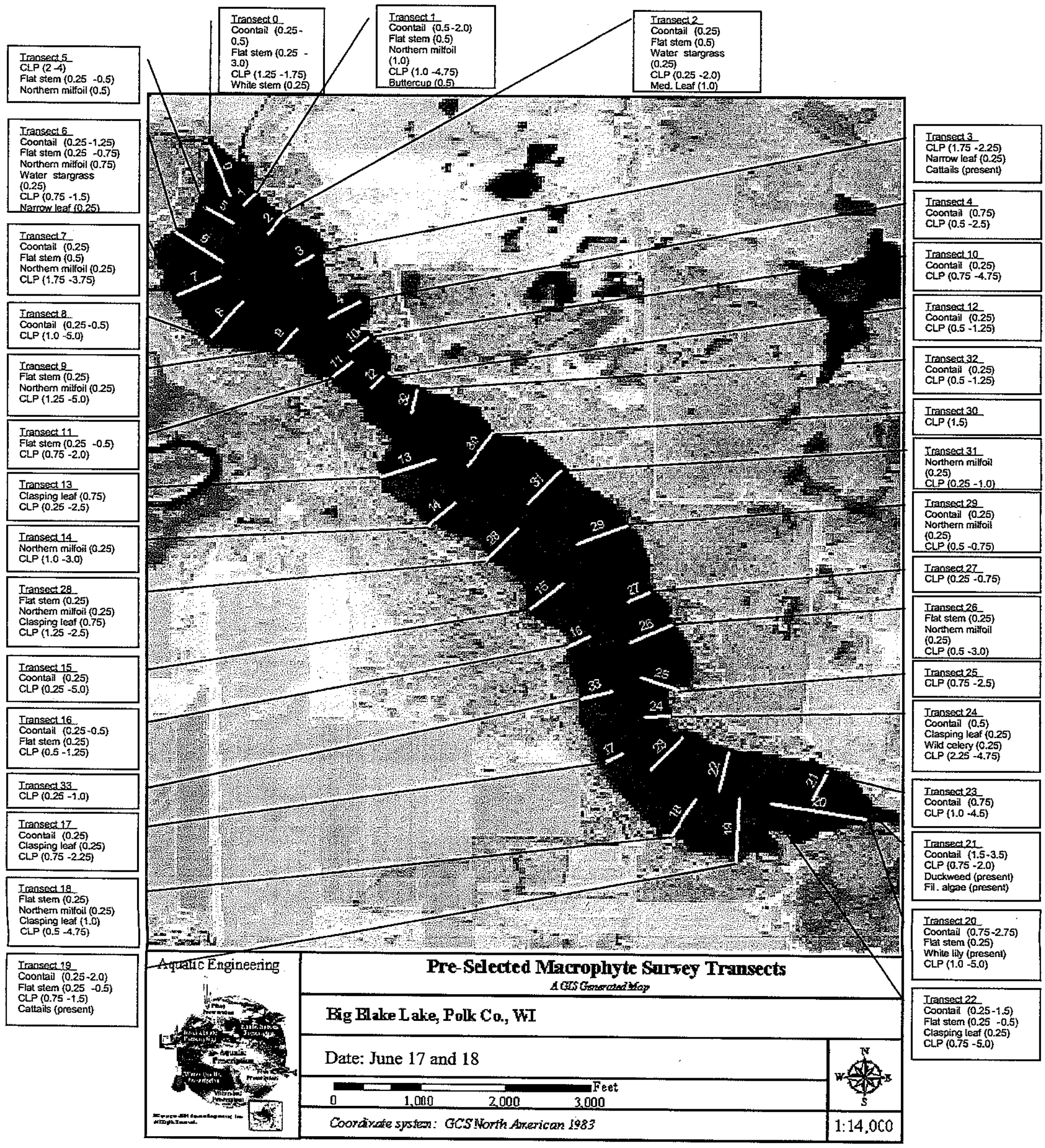

Figure 10. Macrophyte species distribution and density range for big Blake Lake (*Polk County, WI*) spring 2004.

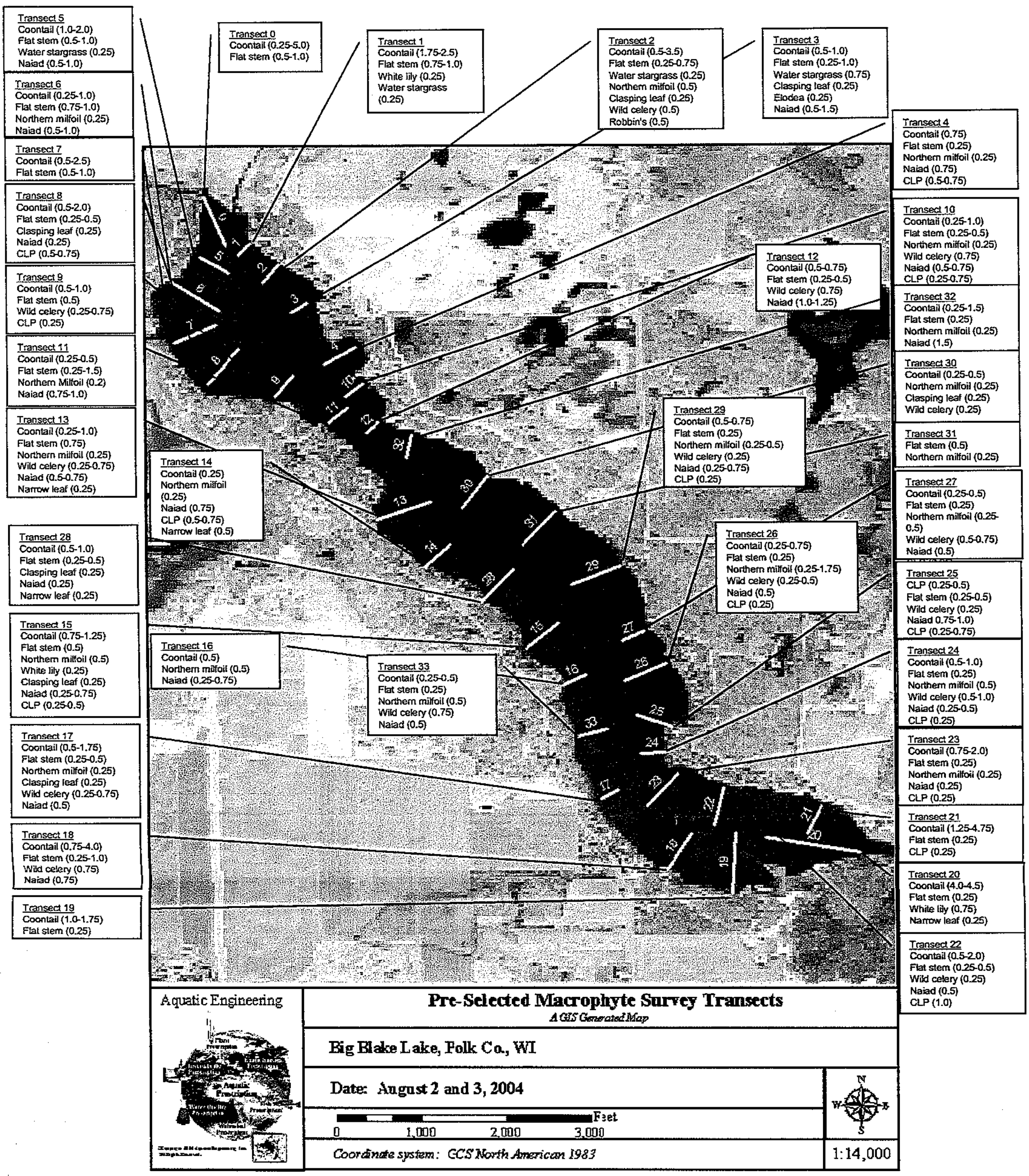

Figure 11. Macrophyte species distribution and density range for Big Blake Lake (*Polk County, WI*) summer 2004.

5.3 Invasive Species Assessment

The spring survey found CLP at 118 sites *(87% of sites sampled)*. The average CLP coverage per occurrence was 1.8 *(on a 0-5 scale; roughly 36% coverage)* with 18 sites having nuisance conditions *(generally considered any site with CLP coverage at or above 60%)*. The summer survey found CLP at 27 different sites; only 20% of sites sampled had CLP as opposed to 87% during the previous survey. The average coverage of CLP per occurrence was 0.44 *(on a 0-5 scale; approximately 9% coverage,)* with zero sites having nuisance conditions.

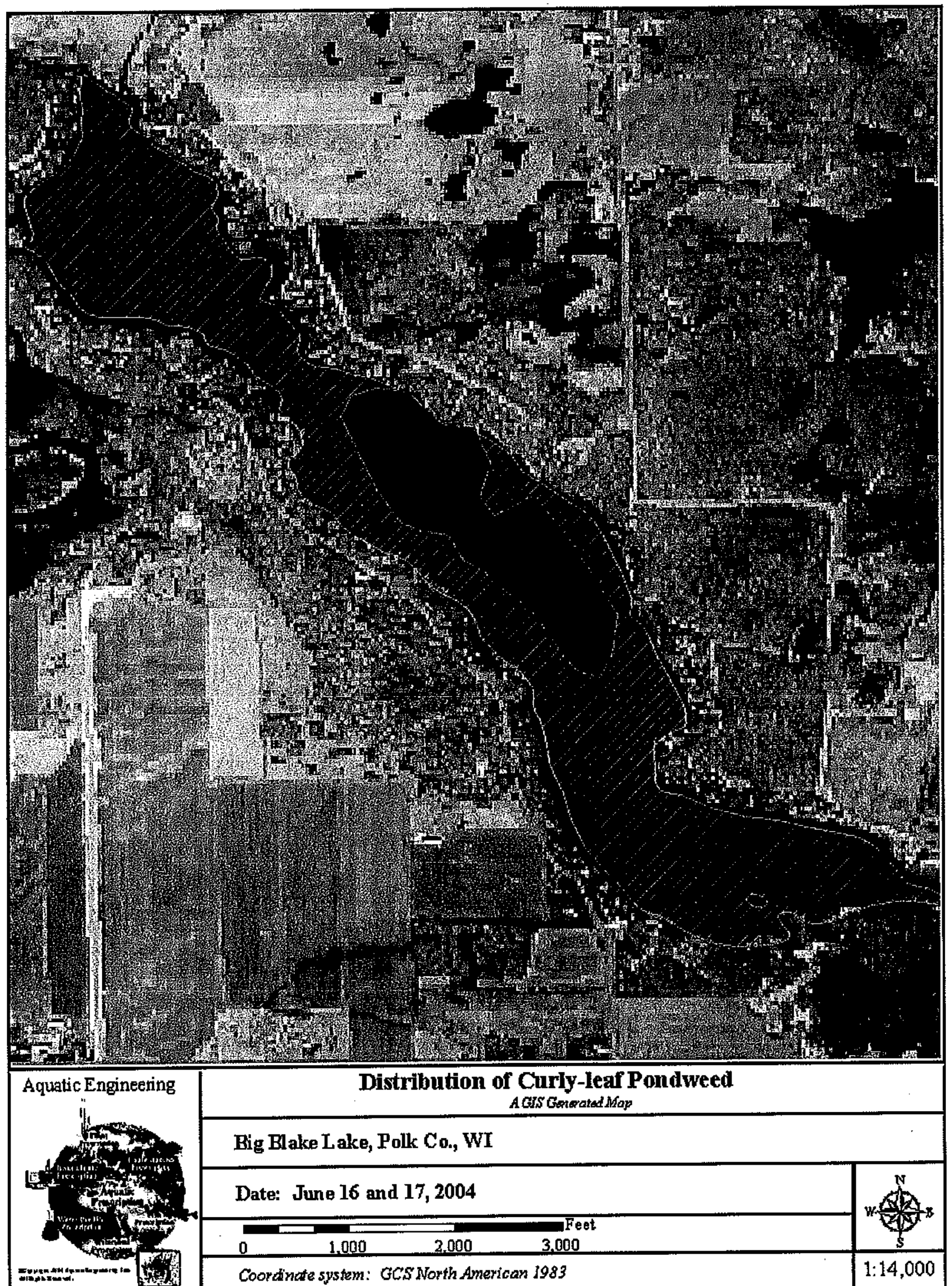

Figure 12. Curly-leaf pondweed distribution within Big Blake Lake (*Polk County, WI*).

5.4 Substrate at Plant Survey Sites

The substrates encountered in 2004 were rock *(32 sites)*, gravel *(14 sites)*, sand *(18 sites)*, and muck *(67 sites)*. 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)*.

5.5 Riparian Land use Assessment at Plant Survey Sites

From the riparian land use assessment, we see that the majority of the immediate shoreline of Big Blake Lake is in a "disturbed" condition, which reflects the residential development around the lake.

Table 5. Riparian land use coverage for Big Blake Lake (Polk County, WI) in 2004.

	# of Sites	% of Sites
Natural	7	21%
Wooded	5	
Wetland	2	
Disturbed	**26**	79%
Lawn	26	

5.6 Macroinvertebrate Community

When all individuals were identified, they were compared with a comparative statistics package *(Table 6 & Figure 9)* and analyzed. The overlap of the box-whisker plots shows that there is only a significant level of variation in one site *(Figure 6),* the reason being that no individuals were found in the August sample at T-1 4 feet. Only immature gastropods were more significant than any other species when sheer numbers where counted *(Figure 7),* and the total richness did not differ significantly. This can be seen in the species richness comparison and the species diversity comparison *(Figures 10 & 11)*. Although at first glace there appears to be more differences between sites, Analysis of variance *(ANOVA)* was applied to all sites, species and the total richness of each site *(Tables 7-10)*. ANOVA is a very common form of hypothesis testing and is a powerful and general technique applicable to data from virtually any experiment or field study. This was further separated using a Bonferroni t-test, which separates the means and shows which samples are different.

Table 6. Comparative statistics of Big Blake Lake Invertebrate Samples. SD = standard deviation, SE = standard error, and CI = confidence interval.

INVERTS - TOTAL by Site	n	Mean	SD	SE	95% CI of Mean
T-1 Near Shore	33	2.788	16.0151	2.7879	-2.891to 8.467
T-1 2'	33	2.212	12.3535	2.1505	-2.168to 6.592
T-1 4'	33	2.727	15.3099	2.6651	-2.701to 8.156
T-2 Near Shore	33	1.091	3.8517	0.6705	-0.275to 2.457
T-2 2'	33	1.091	2.1267	0.3702	0.337to 1.845
T-2 4'	33	0.970	3.1867	0.5547	-0.160to 2.100
T-3 Near Shore	33	2.212	7.6435	1.3306	-0.498to 4.922
T-3 2'	33	8.485	42.3299	7.3687	-6.525to 23.494
T-3 4'	33	6.424	33.8730	5.8965	-5.587to 18.435
T-1 Near Shore A	33	2.061	7.9527	1.3844	-0.759to 4.881
T-1 2' A	33	0.182	0.7687	0.1338	-0.091to 0.454
T-1 4' A	33	0.000	-	-	-to -
T-2 Near Shore A	33	1.152	2.1812	0.3797	0.378to 1.925
T-2 2' A	33	3.061	8.4185	1.4655	0.076to 6.046
T-2 4' A	33	2.879	6.7210	1.1700	0.496to 5.262
T-3 Near Shore A	33	7.182	29.5322	5.1409	-3.290to 17.653
T-3 2' A	33	3.212	11.5265	2.0065	-0.875to 7.299
T-3 4' A	33	5.879	24.5888	4.2804	-2.840to 14.598

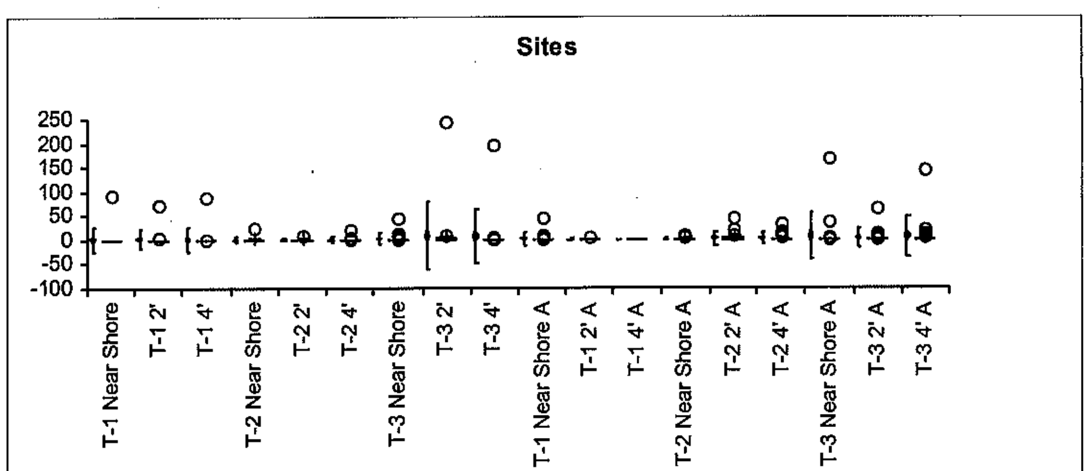

Figure 13. Comparative statistics of Big Blake Lake macroinvertebrate sample sites. "A" designates an August sample. Red dots are far outliers (3 IQR). Red crosses are close outliers.

Table 7. ANOVA of June sites.

n 60

INVERTEBRATES - JUNE by 6/28/2004	n	Mean	SD	SE
T-1 Near Shore	1	92.000	-	-
T-1 2'	2	36.500	48.790	34.5000
T-1 4'	3	30.000	50.229	29.0000
T-2 Near Shore	9	4.000	6.801	2.2669
T-2 2'	10	3.600	2.459	0.7775
T-2 4'	8	4.000	5.707	2.0178
T-3 Near Shore	8	9.125	13.964	4.9369
T-3 2'	11	25.455	72.517	21.8646
T-3 4'	8	26.500	68.097	24.0758

Source of variation	SSq	DF	MSq	F	p
6/28/2004	13411.898	8	1676.487	0.90	0.5198
Within cells	94490.502	51	1852.755		
Total	107902.400	59			

Table 8. ANOVA of August sites.

n 60 (cases excluded: 237 due to missing values)

INVERTEBRATES - AUG. by 8/27/2004	n	Mean	SD	SE
T-1 Near Shore	6	11.333	16.693	6.8150
T-1 2'	2	3.000	1.414	1.0000
T-1 4'	0	-	0.000	-
T-2 Near Shore	12	3.167	2.623	0.7571
T-2 2'	11	9.182	12.844	3.8726
T-2 4'	7	13.571	8.463	3.1986
T-3 Near Shore	5	47.400	67.781	30.3127
T-3 2'	8	13.250	21.339	7.5445
T-3 4'	9	21.556	45.147	15.0491

Source of variation	SSq	DF	MSq	F	p
8/27/2004	-	8	-	-	-
Within cells	41421.273	51	812.182		
Total	-	59			

Table 9. ANOVA of June and August sites combined.

n	594

INVERTS - TOTAL by Site	n	Mean	SD	SE
T-1 Near Shore	33	2.788	16.015	2.7879
T-1 2'	33	2.212	12.354	2.1505
T-1 4'	33	2.727	15.310	2.6651
T-2 Near Shore	33	1.091	3.852	0.6705
T-2 2'	33	1.091	2.127	0.3702
T-2 4'	33	0.970	3.187	0.5547
T-3 Near Shore	33	2.212	7.643	1.3306
T-3 2'	33	8.485	42.330	7.3687
T-3 4'	33	6.424	33.873	5.8965
T-1 Near Shore A	33	2.061	7.953	1.3844
T-1 2' A	33	0.182	0.769	0.1338
T-1 4' A	33	0.000	0.000	0.0000
T-2 Near Shore A	33	1.152	2.181	0.3797
T-2 2' A	33	3.061	8.419	1.4655
T-2 4' A	33	2.879	6.721	1.1700
T-3 Near Shore A	33	7.182	29.532	5.1409
T-3 2' A	33	3.212	11.526	2.0065
T-3 4' A	33	5.879	24.589	4.2804

Source of variation	SSq	DF	MSq	F	p
Site	3354.534	17	197.326	0.65	0.8520
Within cells	174876.182	576	303.604		
Total	178230.715	593			

Table 10. ANOVA of Species richness June vs. August

	n	18			
DIVERSITY by 6/30/2004	**n**	**Mean**	**SD**	**SE**	
T-1 Near Shore	2	0.563	0.796	0.5627	
T-1 2'	2	0.381	0.361	0.2555	
T-1 4'	2	0.061	0.086	0.0610	
T-2 Near Shore	2	1.820	0.545	0.3852	
T-2 2'	2	1.942	0.230	0.1629	
T-2 4'	2	1.647	0.202	0.1429	
T-3 Near Shore	2	1.136	0.367	0.2599	
T-3 2'	2	0.987	0.465	0.3287	
T-3 4'	2	0.743	0.450	0.3183	
Source of variation	**SSq**	**DF**	**MSq**	**F**	**p**
6/30/2004	7.020	8	0.877	4.60	0.0175
Within cells	1.716	9	0.191		
Total	8.736	17			

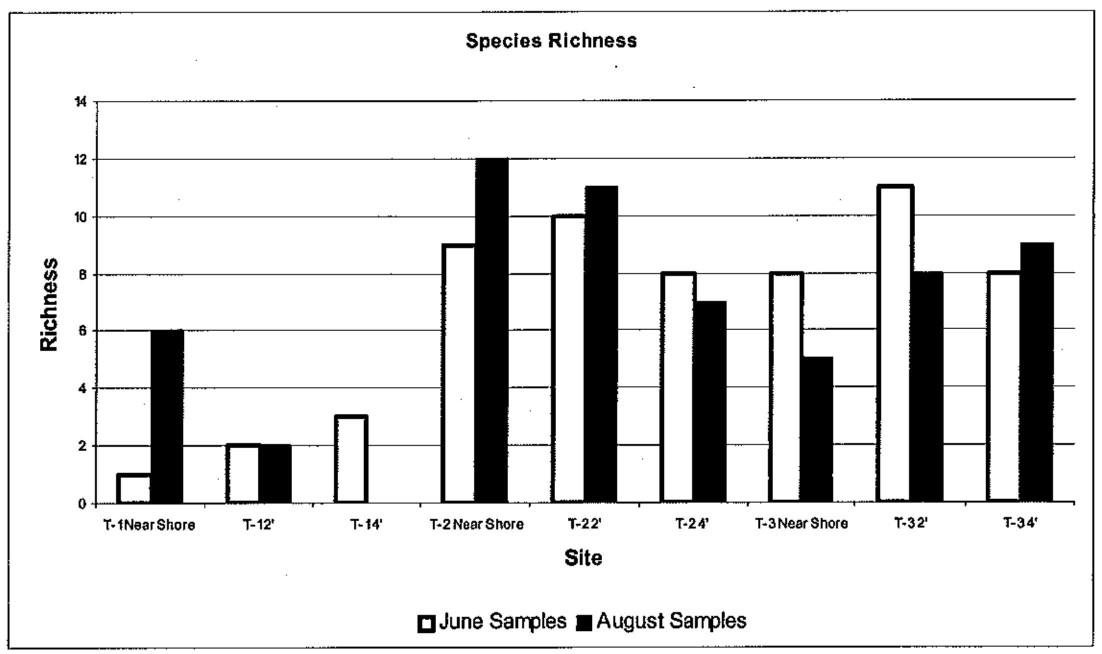

Figure 14. Species richness June vs. August samples.

The Shannon-Wiener Diversity Index was also calculated for the aquatic macroinvertebrates. The Shannon-Wiener Index is based on information theory and determines how difficult it would be to correctly predict the species of the next individual collected. This in turn tells us how diverse the invertebrate community is. A number close to one indicates that an individual could easily predict correctly the next organism collected, which means there is low diversity in the lake. A higher number indicates a more diverse lake.

The Shannon-Wiener diversity index was calculated for each site in June and August *(Figure 11)*. Big Blake Lake has a lot of human impact and has a watershed with diverse land uses, resulting in a low rating *(Tables 9 and 10)*. The actual diversity rating is probably higher than calculated because the sampling techniques used did not allow for a large number of burrowing invertebrates to be collected. Although it does appear that the June samples are a little more diverse, the difference is not significant enough to state this definitively.

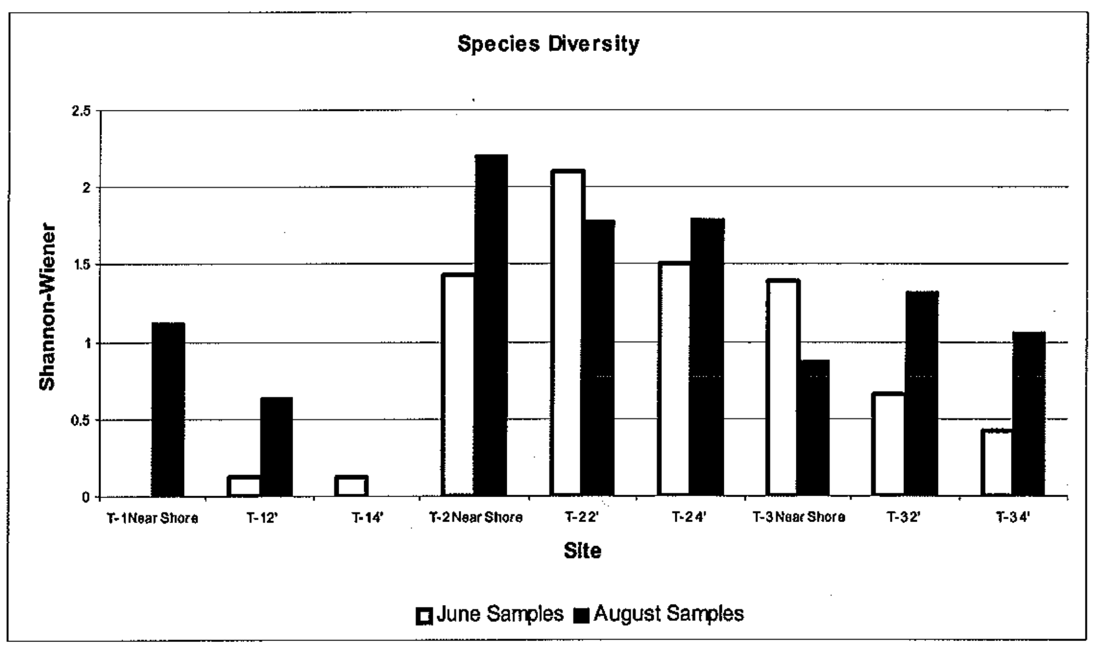

Figure 15. Species diversity, June vs. August samples

5.7 Water Quality

Total phosphorus was measured for Big Blake Lake five times in 2004. Average TP was 48.5 µg/L, with a maximum of 72 µg/L and a minimum of less than 12 µg/L. The TSI_{TP}[2] value for 2004 is 60.1. 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 Big Blake Lake in 2004 was 14.2 µg/L.

Chlorophyll *a* was also measured five times in 2004. Average chlorophyll *a* was 19.3 µg/L ranging from >1 µg/L to 38.9µg/L and a minimum of <1µg/L. The TSI_{chl} value for Big Blake Lake in 2004 was 59.6.

Secchi disk readings were collected at each sample point weekly in June and July and monthly from August to October. The average Secchi reading for the entire season was 5.9 feet, with a maximum of 11 feet and a minimum of three feet. The TSI_S for Big Blake Lake in 2004 was 51.5.

Nitrogen, like phosphorus, is an essential macronutrient needed for algal production. Most lakes, however, are phosphorus driven, and attempts to reduce lake nitrogen levels may have little effect on algal biomass *(Holdren 2001)*. The average TKN for Big Blake Lake in 2004 was 605 µg/L, which supports the fact that Big Blake Lake is phosphorus-driven.

In 2004, Big Blake Lake did not form a thermocline. During the June 8, 2005 sampling event, it appeared as if the lake was already forming a thermocline. However, as the summer progressed, it was clear that no thermal stratification occurred within the lake. It is not uncommon for drainage lakes, with even moderate flow, to remain well-mixed throughout the year.

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[2] See the 2004 Big Blake Lake Water Quality Report for information and calculations regarding TSI values.

The conductivity of Big Blake Lake in 2004 was 175 µs/cm, which is typical of lakes in this region. Conductivity is increased by additions of urban runoff, minerals leeching from soils and products of microbial decomposition. Conductivity was generally higher at the water-sediment interface due to the presence of these factors.

5.8 Phytoplankton and Zooplankton

Seventeen algal species belonging to five unique divisions were found during the July phytoplankton sampling. Organisms belonging to the Cyanophyta *(blue-green algae)* and Chlorophyta *(green algae)* groups were most abundant during this sampling period. Twenty species were identified in the September sample. Cyanophyta were the majority of the relative percent of species identified. A third sample was collected in October of 2004. Only three divisions of organisms were identified and six individual species were identified. *Dinobryon divergens (division Chrysophyta)* was the most common organism found and made up 77.7 percent of the sample. This organism is also the most common algae in Lakes Michigan and Ontario and can cause taste and odor problems when it reaches high concentrations in water. The results for phytoplankton are discussed in the 2004 "Big Blake Lake Water Quality Report" *(AEI, 2005)*.

5.9 Public Input

5.9.1 Recreational Use Survey

Public opinion pertaining to lake use preferences and perceived problems were evaluated using feedback from a 2005 survey of Lake District residents (*Appendix F*). The purpose of this survey was to determine people's general feelings regarding the lake, their impression of the overall management policies, and whether there were any suggestions regarding new policies or ideas for improving the lake.

In the spring of 2005, a survey was developed and distributed to all property owners within the Big Blake Lake District. The purpose of the effort was to engage public participation in the lake planning process by soliciting the opinions and concerns of Lake District residents regarding the lake and its management. Ultimately, 87 of 218 *(40* *percent)* were completed and returned for analysis. Results from the 2005 survey are presented in t he following paragraphs.

Demographics The majority of Lake District respondents are seasonal/part-time residents *(69 percent)* that own residential property *(82 percent)* in the immediate vicinity of Big Blake Lake *(89 percent)*. Property ownership timeframes were highly variable but fairly evenly distributed and ranged from less than a few years to over 30 years. The top reasons for owning property on or near the lake were peace/tranquility and recreational opportunities. Most people spend time on the lake during warmer months.

User Preferences Lakefront residents most frequently describe their immediate lake frontage as consisting of a mowed lawn that leads to a pier at the water's edge. Stabilizing rocks are commonly used for erosion control. The majority of respondents believe that the use of fertilizer or weed killer to maintain lawns around the lake is not needed or justified *(60 percent)*. The most common watercraft types on the lake are pontoon boats, rowboats/paddle boats, canoes/rowboats, and motorboats under 25 horsepower.

Survey respondents generally feel that clear water is the most important quality associated with Big Blake Lake, followed by amount of aquatic plant growth and ecosystem health. Recreational activities of choice in order are fishing, enjoying peace and tranquility, enjoying the view, and motor boating. Of those who fish, 60 percent indicate that they practice catch-and-release on a consistent basis when fishing for species other than panfish. In order of preference, anglers enjoy fishing for bluegill/sunfish and largemouth bass *(tied)*, crappie, and muskellunge. A vast majority of respondents *(96 percent)* indicate that Big Blake Lake offers adequate public access.

Opinions of Existing Conditions When asked how various conditions have changed over time, nuisance weed growth and algae growth are perceived to have worsened the most. The aquatic plant growth in Big Blake Lake is considered "excessive" by 87 percent of survey respondents. Another 86 percent believe that there are areas on the lake where aquatic plant growth becomes especially problematic. Most people *(89 percent)* do not feel the current weed control program is effectively controlling nuisance plant growth.

Respondents describe Big Blake Lake's water clarity as generally murky, and the lake is perceived to be at its worst in the summer months. The angling community most often ranked the quality of fishing as "fair" in terms of fish size and numbers.

Lake use conflicts do not currently appear to be a significant concern for Big Blake Lake. A slight majority of respondents *(52 percent)* do not feel there are any types of behavior, recreational activities, or lake uses that seriously jeopardize the health and safety of the lake. Of the 41 percent that disagreed with this assessment, many pointed to fertilizer runoff and inappropriate lake management efforts as the biggest issues of concern. Roughly two-thirds of respondents believe that the lake is sufficiently regulated and that there is an adequate law enforcement presence. A majority of respondents *(56 percent)* are in favor of expanding slow-no-wake times and/or locations to promote safety and protect sensitive habitat areas.

Perceived Problems and Management Opinions Survey respondents overwhelmingly consider nuisance weed and excessive algae growth as the two conditions that most negatively impact their use and enjoyment of Big Blake Lake. Most people voiced the opinion that current management efforts are ineffective at controlling excessive weed growth. Just over half of the respondents *(52 percent)* however, feel that they do have a voice in decision-making matters regarding the management of the lake.

5.9.2 Polk County

Employees of Polk County Land and Water Resources Department (*PCLWRD*) were included in the preparation and submission of grant application materials. The county was also contracted to provide technical services and aide in collecting data in the field. The PCLWRD will also be included in reviewing draft versions of the completed plan prior to the District adopting the final draft.

5.9.3 District Meetings

Regular District meetings were held prior to, during and after monitoring activities. Throughout the planning process of their aquatic macrophyte management plan, District members have debated several important issues regarding how to best manage their lake. Previous to the membership survey, the District was pursuing chemical herbicide applications to control CLP growth in large areas of the lake. After TLI obtained the results of the survey and the District had time to evaluate its options, the District decided that harvesting was the best option even though the membership survey conducted by Barr Engineering in 1997 showed that 57 percent of respondents did not believe the District should own or operate harvesting equipment. Representatives from TLI were present at several District meetings and obtained copies of the meeting minutes distributed by the District after these meetings. The documents are included as Appendix G of this report and help explain the process the District used to arrive at their current management decision. While the notes provide insight as to the thought process of the District members, the general tone of the meeting and of individual topics is not recorded.

6.1 Qualitative Aquatic Plant Surveys

During the qualitative plant surveys in 2004, ecologists found very little emergent and floating-leaf aquatic plants in Big Blake Lake. The littoral zone of the lake contained mostly CLP in the spring and had a balanced mix of naiad, coon's tail, flat-stem pondweed and northern milfoil in the summer. There were five sensitive species found during the survey *(white- stem pondweed, yellow lily, Robbin's pondweed, water buttercup, and narrow-leaf pondweed)* and one non-native invasive species *(CLP)*. Although Big Blake Lake is widely impacted by CLP, the presence of so many sensitive species indicates that the large degree of disturbance has had a minimal impact on the quality of aquatic macrophytes within the community. The quantity of those few high-value plants is currently low but management efforts could help restore large stands.

6.2 Quantitative Aquatic Plant Surveys

Big Blake Lake'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 northwestern region. The Shannon Diversity Index, maximum Shannon Diversity, Simpson's Index of Diversity, Floristic Quality Index, and Aquatic Macrophyte Community Index were calculated for Big Blake Lake.

The Shannon Diversity Index Species Evenness values of 0.506 and 0.769 further supports the theory that the lake has two distinct seasons for aquatic macrophytes, largely due to the seasonal die-off of CLP. The spring value of 0.509 indicates that if one were to randomly pick any two plants from the lake, one would have a 50% chance of picking different species. A value of 0.509 indicates the lake is dominated by a few species. After CLP died off, the chance of randomly picking plants of different species increased to about 77%. A slight difference in the Shannon Diversity Index Species Evenness would be noted in most aquatic systems due to typical seasonal succession. In Big Blake Lake however, the difference from spring to summer is likely due to CLP.

The Floristic Quality Index value is 24.2, which is above the mean value for both the North Central Hardwoods region *(20.9)* and the state *(22.2)*. This is a good indication for Big Blake Lake, because both the regional and state averages include lakes that are not impacted by exotic species. The most degraded lakes would fall into the lower quartile range in both categories. The total number of native species found in Big Blake Lake *(17)* is above the average for the region and the state *(13)*. The Aquatic Macrophyte Community Index value for Big Blake Lake was at its highest during the summer survey *(43)*, which is below average compared to the Wisconsin state-wide average *(51)* and the regional average *(52 ± 4)* for lakes *(Nichols, Weber, and Shaw1995)*.

The AMCI value early in the year is only 37, which is low compared to the average for the region and state. Although seasonal succession of a plant community is natural, AMCI values do not statistically vary between early and late season plant surveys *($P <$ 0.05)*. Any AMCI value variance greater than 4.7 from spring to summer is not likely due to seasonal or sampling variability *(Nichols, Webber, and Shaw, 1995)*. The 2004 AMCI value changed 6 points from spring to summer and suggests that natural seasonal variability is not solely responsible for the observed change in the plant community.

In general, the data indicate that the aquatic plant community of Big Blake Lake is just below average for the state and region. However, there are two important things to remember about the AMCI value for Blake Lake. First, the AMCI values have not been compared by lake type, and there is insufficient data to compare Blake Lake to other drainage lakes. Drainage lakes are typically at a higher state of "disturbance" than seepage lakes, but state and local AMCI averages are calculated using values from both types of lakes. Therefore, one would expect drainage lakes to have a slightly lower AMCI value on average. Secondly, seasonal and sampling variability should account for no more than 4.7 points difference between spring and summer surveys. Since the change noted in Big Blake Lake was 6 points, one can conclude with 95% certainty the variation in AMCI values was not due to seasonal succession or sampling variability alone *(Nichols, Webber, and Shaw, 1995)*. We suspect that CLP is dominating the spring survey, making the AMCI value artificially low.

6.3 Water Quality at Plant Survey Sites

The water quality sampling performed at the aquatic plant sampling sites did not reveal any abnormalities or localized affects of dense plant beds. The water chemistry from point to point was relatively constant, and monotypic beds of CLP did not 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 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 were expected.

This plant survey and water quality assessment was not specifically designed to investigate the effects CLP may have on water chemistry. Had timing of the second survey been a couple of weeks earlier, we may have seen effects of decaying CLP. A drop in dissolved oxygen would be expected in areas where microbial activity is high due to dying CLP. However, the retention time of the lake is 0.10 years, and there may be enough flow through the entire lake that localized effects would be diluted by currents.

6.4 Substrate at Plant Survey Sites

The most commonly occurring sediment in the littoral zone of Big Blake Lake is muck. For this study, *muck* is defined as a mix of silt and decaying organic mater. Big Blake Lake also has shorelines containing a mixture of cobble and sand; muck was rarely present in the shallowest *(0-1.5ft.)* zones. 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, you will typically find pondweeds, naiad, and wild celery. Areas that contained softer substrates were dominated by CLP in the spring and coon's tail in the summer, the two most common plants in their respective surveys. Soft sediment types along shoreline areas are also ideal for floating-leaf and emergent vegetation which commonly spread by running specialized roots called "runners" through the soft substrate. The low occurrence of soft sediment in the shallow areas of Big Blake Lake may explain the low relative abundance of emergent and floating-leaf plants.

6.5 Riparian Land use Assessment at Plant Survey Sites

Cultivated lawn was the most common type of shoreline coverage *(79 percent)*. This type of coverage would generally cause nutrient and sediment problems for lakes. Typical symptoms would include excessive plant growth and algal blooms. Algal blooms can occur in two varieties: filamentous and planktonic. 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 26 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 also 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 Recreational Use Survey

Actively involving the public is important in facilitating the identification and prioritization of desired lake uses and problems. In addition, public involvement helps educate users about the lake ecosystem, their role in contributing to certain problems, and the actions they can take to eliminate or reduce the severity of these problems. Greater understanding and awareness of problems will generally lead to increased cooperation in their action and thus a greater likelihood of program success.

The District should now recognize that lakes cannot be all things to all people at all times, and that lake uses often conflict and must be separated. Therefore, desired lake uses and values must be prioritized based on considerations such as level of lake resident support, and the feasibility of attainment given the natural limitations of the aquatic environment. Prioritizing is commonly used to resolve mutually exclusive recreational desires and management goals. It also reduces the likelihood that any random special interest group would be able to unduly influence the decision-making process by making claims of "need" or "resident support".

The average member of the Lake District fits this description: A part-time or seasonal resident who believes water quality is the most important aspect of the lake, the lake water is generally murky, aquatic plant growth is excessive and that the current aquatic plant management plan is not sufficient. One of the most interesting, and ultimately disturbing, statistic arising from the survey is that only 52 percent of respondents feel they have a voice in how the lake is managed. This could be because seasonal residents do not feel connected to the lake group over the winter months or because lack of participation in regular meetings leaves those not in attendance "in the dark" regarding decisions made. The District has an opportunity to improve the perception of the average District member throughout its public education campaign component of its future management plan.

6.7 Macroinvertebrate Community

Although the statistical analysis did not show a significant difference at most sites, the samples still differed some. Both June and August samples tended to be less rich and less diverse than would be expected on a less-impacted lake. This could be for a variety of reasons. The most likely scenario is that there is such dominance by aquatic macrophytes in the lake that there is only a certain number of niches to be filled; the lake is very homogeneous.

A majority of the species found were in the collector and gatherer functional feeding groups. Typically these groups have a higher tolerance of pollution and low oxygen levels. A community made up entirely of these organisms would indicate impaired water quality.

The low diversity and richness of the lake can be explained by the high abundance of collectors and gatherers as well. This is an indication that a majority of the allochthonous material in the lake is fine organic matter and probably not efficiently processed. If Big

Blake Lake were less impacted and had a less disturbed watershed, the invertebrate study would have probably have had a different result. A higher input of leaves and other coarse organic material, instead of fine sediment, would shift the functional feeding ecology of the macroinvertebrate community, and a higher number of shredders and scrapers would have been found. The nutrients in the coarse material would also be much more efficiently processed and less available for algae in the water column.

The macroinvertebrate community is very important for the food web and for nutrient cycling within the lake. Because Big Blake Lake had a low diversity rating, improvements in the lake and surrounding watershed would be seen by a change in the macroinvertebrate community. As such, the biotic community of the lake should be monitored as management decisions are made and carried out, along with the basic chemical and physical parameters typically used in limnology studies.

6.8 Water Quality

Water quality is one of the most important factors in the public's perception of water quality and recreational use impairment. Clear water with relatively low algal biomass and unrestrictive aquatic plant growth is the condition most desired by recreationalists. Specific public opinions were covered in section 6.6 of this report.

Big Blake Lake is a phosphorus-driven lake that does not thermally stratify in the summer. It has water quality properties similar to other lakes in its region. The lake is receiving eutrophic water from Little Blake Lake through the Straight River, based on an average TP measurement of 29.33µg/L from the Big Blake Lake inlet water quality site, and discharging water with nearly three times the amount of phosphorus and nitrogen into Fox Creek.

The TSI values for Big Blake Lake in 2004 show that Big Blake Lake is a eutrophic lake. Water clarity, chlorophyll *a*, and total phosphorus values from 2004 support the eutrophic 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 major changes in the watershed and should be investigated.

In order to improve the water clarity of Big Blake Lake, nutrient inputs must be minimized. The lake will continue to be eutrophic unless nutrient inputs from the watershed are reduced. The lake's water quality is directly impacted by the Straight River, Little Blake Lake and Big Round Lake. The District should coordinate with WDNR and county officials to organize and implement BMPs aimed at protecting water quality throughout the Straight River watershed. The 1981 WDNR hydrologic budget showed that surface runoff, primarily from the Straight River, comprised 87 percent of the source of water for Big Blake Lake. The same report also claimed 90 percent of the phosphorus load to Big Blake Lake was from the same surface runoff *(Barr 1998)*. This means that non-point pollution control BMPs are most applicable to improving the water quality in the lake.

6.9 Fishery

Based on public opinion, the panfish community of Big Blake Lake is doing well. Predator fish such as northern pike, walleye, and muskellunge are on the decline within the lake. Additional stocking may be needed as Big Blake Lake becomes more and more eutrophic. Warm-water fish such as like largemouth bass and bluegill will be the dominant species, while northern pike, walleye and muskellunge populations will decline. This process will not happen quickly but will be the result of declining habitat quality over several decades. Water quality and aquatic plant management efforts will help protect and improve the fishery.

The WDNR is equipted to perform whole-lake fish surveys, which should be performed if current fish conditions are going to be manipulated by stocking efforts. Stocking fish is an artificial way to improve the recreational opportunities within a lake. Stocking can also be used during "top-down" management when prey fish become too abundant. A top-down management approach should only be implemented if conditions are favorable for long-term predator fish survival.

7.0 Review of Management Options

7.1 Managing Aquatic Macrophytes

The following subsections provide an overview of management strategies that are commonly used to manage eutrophic effects on lakes. The purpose of this section is to provide a general introduction to popular management strategies for future reference and consideration. Methods described are derived from the *Managing Lakes and Reservoirs* manual prepared by the North American Lake Management Society. Practices that are relevant to Big Blake Lake are described in more detail in the following sections.

Mechanical weed harvesting can be used to remove the upper portion of rooted vegetation. Weed harvesters are low-draft barges that cut and remove vegetation growing at or near the water surface. A harvester can generally operate at a rate of 0.2 to 0.6 acres per hour, depending on the equipment. Once cut, the plants are moved via conveyer to a holding area on the barge itself until they can be unloaded, via a second conveyer, at the shore. Plants are usually transported away from the lake to a compost site or a landfill. The physical removal of plant material means that the nutrients trapped in the plants are also removed from the lake ecosystem.

Harvesting is most effective to remove plants in three to six feet of water growing in dense beds. Harvesting can be used to open navigational channels, remove weedy obstructions from highly used recreational areas, or to produce relief for fish in weed-choked areas of a lake. Harvesting is non-specific and will remove all plants within the harvested area. Sometimes fish become trapped in harvested plants and end up being removed from the lake as well. Harvesting equipment is usually expensive, and operational costs vary depending on the harvesting effort required. Effects of harvesting are immediate, and there is no use restriction during operations. WDNR permits are required for mechanical harvesting. Contact the local APM coordinator for more information regarding permitting requirements.

Manual weed harvesting is a scaled-down method of mechanical harvesting. In manual weed harvesting, weeds can be uprooted completely or simply cut close to the sediment using a variety of equipment from drag lines and garden rakes to specially designed weed cutters. This method is the most species-specific mechanical method of plant removal since an individual can physically see which plants are going to be removed and which will be missed. This method, however, is also the most labor-intensive means of controlling plants, and its feasibility is directly affected by the available labor force. This method is most applicable to individual property owners who wish to maintain clear areas for swimming, fishing, and for boat access to their dock. And since many times plants are not removed from the root, repeated efforts are needed to maintain the benefits. WDNR permits may be required for manual harvesting. Contact the local APM coordinator for more information regarding permitting requirements.

Sediment screens range from fiberglass or plastic mesh screens to simply sand or gravel, and are placed on the existing sediment and plants to block light and suppress growth. While the synthetic barriers make better screens, they are the most difficult to install and maintain. The screens must be installed early in the year and securely anchored to the sediment to prevent them from being disturbed. The screens must be removed and cleaned periodically to prevent sediment from building up on top of them.

Sand and gravel are more natural means of suppressing aquatic vegetation and are less expensive, but they also require maintenance on an annual basis and are less effective. WDNR permits are required for sediment screening. Contact the local APM coordinator for more information regarding permitting requirements.

Water level manipulation, commonly referred to as "draw-down", is a useful way to control nuisance vegetation that occurs in the shallow regions of a lake. This method is typically applied in the fall and over winter. Cold, dry conditions are best for a draw-down event, because frozen sediments will kill most of the seed bank and compress soft sediments. Both of these conditions prevent plant growth in the following spring when the water level is brought back up to normal conditions. This method severely impacts recreational uses while the water level is lowered and has the potential to trap fish and other wildlife in shallow areas that may not become completely dry but do freeze from top to bottom over the winter.

Drawing the water level down in the summer has the opposite effect on plant growth. Lowering the water level generally increases the wetland area, and the littoral zone of a lake becomes larger. This provides more habitat for plants to become established. This is a low-labor option but can become expensive if power is generated at the dam. The power company may be entitled to compensation for loss of power generated during the draw-down.

Raising the water level in the summer can also suppress aquatic vegetation by limiting the amount of light penetrating to the bottom thereby making the littoral zone smaller.

Wisconsin DNR permits are required for water-level manipulations. Contact the local APM coordinator for more information regarding permitting requirements.

Dredging sediments and plants is usually only performed when an increase in depth is a required part of the management outcome. If the depth is increased sufficiently, light penetration is limited in the dredged area and plant growth is suppressed. Dredging an entire lake bed is very rarely performed. Dredging small areas for boat access and other recreational uses is a cheaper and more applicable compromise. Wisconsin DNR permits are required for dredging. Contact the local APM coordinator for more information regarding permitting requirements.

Chemical control of aquatic plants and algae is often used in areas where vegetation has created nuisance conditions. Herbicides and algaecides are used to control a wide variety of plant and algae species. Some herbicides and application methods are very specific for which plants they will control. Others control a wide variety of vegetation. In some cases, the precision and concentration of herbicide applied will also determine which species are controlled.

Chemical applications are designed to control vegetation which is already present and rarely address the underlying nutrient problem associated with nuisance plants and algae. WDNR permits are required for aquatic herbicide applications. Contact the local APM coordinator for more information regarding permitting requirements.

Biomanipulation refers to altering a food web in order to obtain a desired end result. In the case of controlling algae, a "top-down" approach is taken. Promoting top-level predator fish like muskellunge, walleye, largemouth bass, and northern pike naturally reduces the panfish population. Panfish typically graze on zooplankton *(algae eaters)*. When zooplankton reach higher numbers, more algae is consumed and the water clarity is increased. This is generally used only to improve water clarity, however improved water clarity has a significant impact on plant distribution within the lake. WDNR permits are required for biomanipulation. Contact the local APM coordinator for more information regarding permitting requirements.

Biological Control Agents is a term used to describe organisms capable of controlling other organisms within their ecosystem by various methods. For example, loosestrife weevils have been used to control the exotic plant purple loosestrife. The weevils are tiny insects that use the plants for food, shelter and reproduction. The weevil larvae consume plant material and make growth and reproduction difficult, if not impossible, for the plant. A similar situation is suggested to occur for Eurasian water-milfoil, an aquatic exotic plant. There are no known biological control agents that would improve conditions on Big Blake Lake with respect to CLP and nuisance natives.

8.0 Aquatic Plant Management Plan Overview

A complete aquatic macrophyte management plan follows a series of events. A plan should organize labor and resources for a clearly defined mission and outline a way to measure success. The WDNR is currently in the process of creating a guide for aquatic plant management in Wisconsin. The guide outlines a seven-step process to managing aquatic plants. The steps to completing an aquatic plant management plan are:

- Setting Goals. . .Why are We Doing This?
- Inventory. . .Gather Information
- Analysis. . .Synthesis of Information
- Alternatives. . .Providing Choices
- Recommendations. . .Completing a Plan for a Formal Decision
- Implementation. . .Taking Action
- Monitor and Modify. . . How are We Doing?

8.1 Setting Goals

In order to set goals for the District's aquatic plant management plan, the District must identify the problems facing lake users and what endpoint is desired through management efforts. Setting goals involve the following three steps: (1) develop a goal statement; (2) create a plan of work; (3) create a communication and education strategy.

The main aquatic macrophyte problem facing Big Blake Lake is CLP. In addition to the presence of CLP, certain areas of Big Blake Lake experience nuisance levels of native plants that impede many aspects of lake recreation. In 2004, a survey conducted by AEI showed CLP was present at 87% of the sites *(118 sites)* sampled and averaged approximately 36% of the rake coverage at the sites CLP was found. Curly-leaf pondweed accounted for more than 60% of the rake coverage at 18 of those sites, which are prime examples of CLP beds that create nuisance conditions and need to be managed to meet District goals.

Goal Statement [3]

The overall goal of the District's Aquatic Management Plan is to create a diverse aquatic plant community while maintaining a healthy fish population and preserving water quality. By achieving theses goals, one could fully appreciate the entire spectrum of recreation, relaxation, and visual beauty this lake has to offer.

We intend to reach this goal by:

- Providing a progressive and flexible weed-harvesting program whereby we create maximum recreational use of the lake with minimum disturbance to the plant and animal life that depend on these waters.
- Protecting a flourishing native aquatic plant community in order to safeguard Big Blake Lake's biodiversity since native plants are essential in slowing the spread of invasive species via competition.
- Promoting community involvement through heightened awareness and support of the preservation of our lake, and by creating a positive atmosphere of responsible action and an awareness of what individuals and communities can do to make a difference.

The District has already taken the initiative for creating a plan of work in consulting with Barr Engineering in 1998 and TLI in 2004-05. The District has held several committee meetings in 2005 in addition to the normally scheduled biannual meetings. The Lake District plans to educate the district residents on meeting notices via its bi-annual newsletter and physical postings at nearby locations to the lake. The communication and education strategy is currently being developed and should include members from Little Blake Lake and Big Round Lake organizations, any organization involved in managing the Straight River, and state and local government agencies. The plan should focus on informing the public of issues regarding the plant community and water quality within Big Blake Lake and soliciting public input on how best to correct the problems. Section 9.5 of this report has more specific recommendations regarding watershed management.

[3] Written by the Big Blake Lake P&R District, October 2005.

8.2 Inventory

In this step of the plan, information regarding several aspects of the lake and surrounding area need to be collected and analyzed. Examples of information that should be gathered include:

- ✓ Existing plans and studies
- ✓ Data regarding plants, fish, wildlife, and water quality within the lake
- ✓ Maps and historical documentation that describes past conditions of the lake
- ✓ Aerial photographs of the lake
- ✓ State and local regulations and ordinances
- ✓ Technical information or research on the topics of concern to the District
- ✓ Examples of other lake APM plans

Additional information may have to be reviewed depending on the goals of the District. The WDNR, UW-Extension and regional resources such as county zoning, town clerk, and planning offices are great places to gather most of this information. Past consulting firms may also be able to provide some information specific to their findings.

As part of this study, TLI has gathered all the information listed above regarding the aquatic plant community of Big Blake Lake and included it in section 3.0 *(Review of Existing Data)* of this report.

8.3 Analysis

The analysis step is the most critical step in the management process. It is in this step that the information gathered in the previous step is thoroughly analyzed and compared to the initial issues voiced. The information provides an objective view of the perceived problems. Individuals dedicated to completing this step need to approach the analysis with open and objective minds so that decisions are based on fact and not emotion or public pressure. To arrive at an objective endpoint, these three variables are considered: (1) What is the nature of people's concerns? (2) Where do conflicts occur? and (3) Has the problem changed over time?

Considering the nature of people's concerns involves dissecting public input to decide if opinions genuinely have the health of the resource in mind. People must understand that not all plants are nuisances and that a certain amount of vegetation is necessary to sustain fish and wildlife and also helps improve water quality and general aesthetics. Based on conversations during regular District meetings, the District has genuine concern that aquatic plants are creating nuisance conditions throughout the lake and water quality is in an undesirable state. The District is educated about the value of aquatic plants and is open-minded regarding management methods and is proactive in seeking help to reach their goals.

Identifying areas where conflicts regarding lake use and proposed management may occur will help create a more detailed management plan. Areas that will have restricted use based on management activities need to be identified and management activities timed according to expected lake use. For example, one would not propose to perform a large scale herbicide treatment prior to the 4th of July when use restrictions may prevent activities such as swimming or fishing over the holiday weekend. The District has discussed areas where management should occur and appropriate timing of management activities. There does not seem to be any use conflicts with the proposed management plan.

Based on the 1998 report written by Barr Engineering and the 2004 study conducted by AEI the aquatic plant community has changed over time. More specifically, the abundance and distribution of CLP has increased in the last six years. In addition, water quality has not improved since implementing BMPs recommended by Barr Engineering in 1998.

The three analysis actions are complete and the District can create an analysis report from the findings of the public use survey, quantitative plant data, water quality data and public input. The report should characterize the lake's condition, its natural features, recreational uses, community values, and problems based on objective information. Between the 1998 Barr Engineering report and this report, many of the issues that will be addressed in the District's report have been touched on. Opportunities to resolve any conflicts will be evident once this report is written. The report should also include a list of conclusions and findings according to the need for management intervention.

8.4 Alternatives

Mechanical harvesting and chemical control are the two most applicable techniques from section 7.0 for managing the aquatic vegetation situation encountered in Big Blake Lake. Individuals may consider manual removal of CLP from anywhere in the lake. Manual removal, however, is labor intensive and will not result in the scale of control needed to noticeably improve conditions within Big Blake Lake.

A list of alternatives adopted from *Managing Lakes and Reservoirs* is provided on the following page. Benefits and drawbacks are provided so that an informed decision can be made.

Based on the goals of the District and the objective information gathered by Barr Engineering in 1997 and AEI in 2004, Level III is the appropriate level of management for Big Blake Lake. Level III management is defined by the WDNR as "Moderate to severe plant concerns exist. Extensive management is proposed that may substantially impact or change the current state of the lake ecosystem. Established infestations of invasive or exotic species are present." All Level I, II and III management requirements have been met in order to perform Level III management. A checklist of necessary items is included at the end of section 8.7 of this report. Any items not currently satisfied need to be completed prior to seeking WDNR approval.

	Benefits	Drawbacks	Applicable	Recommended	Costs[4]	Longevity
Mechanical Harvesting	Removes plants and nutrients	Small areas controlled	Yes	Yes	$200,000 equipment and $200-1,500 per acre	1-3 Weeks
	Immediate relief	Can not reach shallow areas				
	No use restrictions	Not species selective				
	No potentially harmful chemicals	Promotes growth of opportunistic plants				
Manual Harvesting	Species specific	Labor intensive	Yes	Conditionally	$100-500 per acre	1-3 Weeks
	Shallow areas affected	Very small areas controlled				
	No chemicals	Slow				
	Removes plants and nutrients	Correct plant ID required				
Sediment Screens	Little negative impact to whole lake	Harms benthic invertebrates	Yes	No	$20,000-50,000 per acre	Months to Years
	No chemicals	Difficult to install				
	Site specific control	Permit required				
	Reversible	Expensive				
Water Level Manipulation	Controls plants in shallows	Restricts recreational use during	No	No	$<100-2,000 per acre	1-2 Years
	2 years of control	Perfect weather conditions required				
	Sediment compaction	Disrupts wildlife				
	Inexpensive (maybe)	Expensive (maybe)				
Dredging	Improves navigation	Very expensive	Yes	No	$20,000-80,000 per acre	Depends on sedimentation rate
	Removes plants and nutrients	Releases toxic contaminants				
		Destroys habitat				
		Increases turbidity				
Chemical Control	Quick relief	Repeat treatments required	Yes	Conditionally	$200-2,000 per acre	Weeks to Years
	Species specific	Does not remove nutrients				
	2 months of relief	Can promote aggressive species				
	Cost effective	Can increase algal blooms				
Biomanipulation	Long lasting	Hard to start	Yes	No	$50-300 per acre	Years
	Self sustaining	Alters habitat				
	No chemicals	May have negative impacts on habitat				
	Improves water quality	Can be irreversible				
	Improves fishery					

[4] Cost range per acre treated without consideration of longevity of effects *(Holdren et.al. 2001)*

8.5 Recommendations

In this step of the plan, a preferred management tool is selected. This requires reviewing the goals and objectives set in step one, reviewing existing conditions from step two, reviewing the level of management decided in step three, and reviewing management alternatives from step four. The next step in the recommendations is to evaluate the action plan, organize resources such as volunteer time and District budget, and identify and meet legal obligations prior to implementing the plan. Such legal obligations may be obtaining state permits for managing plants or informing the public of herbicide applications. Many of the requirements are listed in Wisconsin state statutes NR 107 and NR 109.

Primary Management Tool Selected[5]

The District contracted TLI to research three primary problems occurring in Big Blake Lake: nuisance aquatic plant growth *(CLP in particular)*, algae blooms, and impaired water clarity. The District also formed a committee to work with TLI, PCLWRD and the WDNR to address the problems based on the findings of this research. As a result of these studies and numerous conversations with the WDNR, the committee researched four possible solutions to the problems.

1. Chemically treating the weeds
2. Mechanically harvesting the weeds
3. A combination of chemical treatment and harvesting
4. Doing nothing at all

The committee, which was comprised of nine men and women in the District, met at least once a month from May to October, 2005, to work on this aquatic management plan. In between these meetings, members of the committee met with or had phone conversations with several representatives of the WDNR, Polk County Land and Water, Clam Lake Flowage, White Ash Lake, and concerned members within the District. As a result of these meetings, hours of research, and through listening to the various representatives, the committee decided that by harvesting the lake correctly we will be able to reduce the CLP levels and improve the water quality.

[5] Written by Big Blake Lake P&RD, October 2005.

The committee presented its findings to the District at the Annual Meeting of 2005. A Special Meeting was scheduled and held on October 8, 2005, wherein the District voted to address this issue by purchasing its own weed harvesting equipment. The decision to mechanically harvest the weeds was primarily based on four things:

1. The need to make more of the lake recreationally useful to the public with the least amount of ecological upset to the lake.
2. The knowledge and research indicating that by reducing CLP we will allow native plants to reproduce and grow.
3. Chemically treating the lake was economically unfeasible.
4. Representatives from the WDNR, Polk County Land and Waters, and representatives from local lakes who mechanically harvest their waters led us to believe we could vastly improve our CLP problem in Big Blake Lake by using a harvester.

8.6 Implementation

Implementation can be broken down into three steps. The first step is to adopt the plan. The plan will be available for review to all vested parties prior to releasing the final draft. The final plan should then be adopted by the District. The District should present the adopted plan to local units of government for additional support. In the case of creating ordinances as part of the plan, government bodies will be essential in creating and enforcing laws.

The second step is to prioritize and schedule actions. Actions can be immediate, short-range, and long-range. The following three subsections outline an implementation plan suitable for Big Blake Lake.

Immediate actions Educational campaigns designed to inform property owners about the value of aquatic plants and what they can do to help improve the water quality will begin immediately. The public education campaign plans are outlined in section 9.2 of this report and recommended actions to improve water quality are listed in section 9.5.

Short-range actions A short-range action is to harvest CLP throughout the lake in the spring and native plants in designated navigational channels in the summer. The District wishes to harvest beginning in 2006. To meet this deadline, the District must complete a permit application for the WDNR *(Appendix H)* in order to satisfy requirements of NR107 and NR109. The District also wishes to apply for a grant which would cost share the purchase of harvesting equipment up to 50 percent. The District must complete the Wisconsin Waterways Commission Financial Assistance Application *(form 8700-121)* as well *(Appendix I)*.

Long-range actions A long-range plan should include improving water quality *(measured by annual average TP, Chla, and Secchi depth)* by implementing certain BMPs throughout the Straight River watershed. Since 63 percent of the total phosphorus load enters Big Blake Lake from the Straight River, the District has an interest in improving land use throughout the watershed. The BBLP&RD should participate in a committee including members from various lake districts, associations, government agencies, and special interest groups within the watershed. The committee will be responsible for all aspects of a plan dealing with watershed improvements, ordinance creation and enforcement. A more detailed explanation is provided in section 9.5 of this report.

Another goal of the District is to protect and promote the growth of native aquatic vegetation within designated sensitive areas. The District can accomplish this through public education campaigns and voluntary "no-wake" or "no disturbance" zones throughout sensitive areas.

The final step of implementation is to assign roles and responsibilities for the various agencies involved in the management activities. The responsibilities need to be clearly defined and recognized by the individuals and organizations responsible for carrying them out. Formal resolutions and contracts are usually adequate in covering these responsibilities. The following is a partial checklist of roles and responsibilities for Big Blake Lake and proposed harvesting during 2006:

- ☐ Who will operate the harvester?
- ☐ Who will operate the transportation vehicle?
- ☐ Where will plants be offloaded and disposed?
- ☐ Who tracks the harvesting effort, specifically who monitors and maps the areas harvested?
- ☐ How are operational costs such as fuel, maintenance and personnel budget paid for?
- ☐ Who is responsible for acquiring harvesting permits?
- ☐ Who is responsible for submitting the harvester grant application?
- ☐ Who is responsible for pre and post-harvesting plant monitoring?
- ☐ Who is responsible for implementing a public education campaign?
- ☐ Who will organize volunteer help for implementing self-help monitoring and clean boats, clean waters programs?
- ☐ Who is responsible for enforcing ordinances?

This list touches on some of the responsibilities related to the two major recommendations for Big Blake Lake *(public education and harvesting)*. The District will have to create its own comprehensive list in its effort to organize. The list will change periodically as membership, participation, and management activities change. However, the purpose or goal of the list will remain the same–to organize responsibilities and aid implementation.

Implementation Statement[6]

The purpose of Big Blake Lake's Aquatic Plant Management Program is to address the problem of nuisance and invasive weeds such as CLP that endanger the ecosystem, negatively impact the biodiversity, and impede the natural and recreational enjoyment of our lake.

The District empowered a committee to research this problem and based on studies provided by Polk County, AEI, TLI, and the WDNR, the committee looked to the following options:

(1) Mechanically harvest the weeds.

(2) Chemically treat the weeds.

(3) Combine chemical treatments and mechanical harvesting.

(4) Do nothing at all.

[6] Written by the Big Blake Lake Protection and Rehabilitation District, October 2005.

After researching all four options, the committee presented their findings to the District at the annual meeting and more in depth at a special meeting in October, 2005. The District voted, and we intend to address this issue by mechanically harvesting, collecting, and transporting weeds out of our lake at specific times of the year and in specific areas determined by the WDNR to best protect our sensitive areas while allowing maximum aquatic plant control.

We have researched the option of chemically treating the weeds, but the District determined this option is economically unfeasible at this time. We also realize that not actively addressing this issue on Big Blake Lake has allowed a previously small population of CLP to explode, which has led to a significantly less diverse plant community. Therefore, mechanically harvesting the weeds is our best option to make more of the lake recreationally useful to the public while still maintaining our commitment to the ecological health of our plant and animal community within our financial means.

Communication between the WDNR, the District, and the harvester operators is integral to the success of this aquatic plant management program on Big Blake Lake. Being mindful that this is a work in progress, our intent is to be flexible in the program's infancy to allow for the learning curve inherent in a lake association taking on a project of this magnitude within a District where approximately only twenty percent of its residents live here and receive mail year round. That is to say, contacts and addresses where public opinions are received may take on several different forms before we determine the best way for all members of the District to have their concerns heard and addressed to their full satisfaction.

During the initial phase of the implementation of our aquatic plant management plan, Mr. Ford Elliot has agreed to handle all the public's concerns and processing the feedback to address the issues at hand. Mr. Elliot chaired the committee empowered to research this problem and has the most well-rounded picture of the problem, the options, and the final implementation of the weed harvesting program.

Statement of Intent for Funding of Harvester[7]

The District intends to obtain a grant from the Wisconsin Waterways Commission for financial assistance to purchase the weed harvesting equipment. The District currently has ample funds to purchase and maintain the harvester with the support offered through the Wisconsin Waterways Commission matching grant program for fifty percent matching funds on the equipment purchase *(application form 8700-121)*.

The District has obtained quotes from four separate harvester equipment manufacturers. We have selected to purchase our harvester from Spooner Machine based on financial considerations and their geographical proximity, which will allow for maximum customer support with minimal travel and shipping costs for parts and service.

8.7 Monitor and Modify

Monitoring the plant community with methods outlined by the WDNR ensures that objective values are obtained and that management activities are evaluated without bias. Future decisions concerning the plant community will be based on objective data gathered annually throughout implementation of the plan. Effective monitoring will be the result of clearly defined performance objectives.

The new WDNR APM guidelines outline the necessary monitoring and background information needed to perform large-scale aquatic plant management activities in Wisconsin lakes. The method for tracking progress occurs prior to and after management activities. The WDNR recommends calculating the Floristic Quality Index value annually. Calculating the FQI is explained in the WDNR's "Aquatic Plant Management in Wisconsin" guide.

Specific monitoring methods are also outlined in the guide. Specific monitoring is required for harvesting, while other recommendations exist for the monitoring of current exotic species and prevention of others. The current expectations regarding harvesting and monitoring for known exotics and preventing others is outlined in sections 9.2 and

[7] Written by Big Blake Lake Protection and Rehabilitation District, October 2005.

9.3 of this report. The District should insist that all management and monitoring activities follow the recommendations within the guide.

9.0 Big Blake Lake APM Plan

9.1 Specific Elements of the Big Blake Lake APM Plan

This section lists the specific recommendations of the WDNR for level III management. The recommendations have either been satisfied based on information gathered during the 1997 Barr Engineering study and 2004 Aquatic Engineering, Inc. study *(checked items)* or still need to be fulfilled *(x'ed boxes)*.

Goals

- ✓ Purpose Statement *(Section 1.0)*
- ✓ Goal Statement *(Section 8.1)*

Management History

- ✓ Summary of past management activities *(Section 1.0)*

Plant Community

- ✓ Comprehensive species list and review growth cycles of dominant species *(Section 5.1)*
- ✓ Total surface area covered by aquatic vegetation *(Appendix A and C)*
- ✓ Highlight rare, threatened or endangered species and species of concern *(Section 5.1)*
- ✓ Highlight invasive and non-native species, map, and compare to native community *(Section 5.3 and Appendix A and C)*
- ✓ Describe beneficial use of plants as well as nuisance or use conflicts associated with plant community *(Sections 2.1, 2.2 and 2.3)*
- ✓ Describe vegetative characteristics of near shore or shoreland areas *(Section 5.5)*
- ✓ Collect quantitative data of the lake's aquatic plant community *(Section 5.2 and Appendix B and D)*
- ✓ Determine the percent frequency of each species present *(Section 5.1)*
- ✓ Determine the lake's FQI *(Section 5.2)*
- ✓ Collect 3 samples of each species for herbarium specimens *(Section 4.1.1)*
- ✓ Label sites where rare, threatened, endangered, special concern, invasive, and non-native plants were found *(Appendix A and C)*
- ✓ Map areas to show dominant species type and aquatic invasive species *(AIS) (Appendix A and C)*
- ✓ Maintain plant information in database or GIS including species name, location, and date sampled *(Appendix A and C)*
- ✓ Create map depicting proposed management areas and affect of management *(Section 9.3)*
- ✓ Map coordinates to be recorded on GIS map *(Section 9.3)*

Lake Map

- ✓ Obtain map with accurate scale *(Section 1.0 and Appendix A and C)*
- ✓ Determine township, range and section of lake *(Section 1.0)*
- ✓ Tabulate lake surface area, maximum and mean depths *(Section 1.0)*
- ✓ Find Water Body Identification Code (WBIC) assigned by WDNR *(Section 1.0)*
- ✓ Obtain aerial photos of lake *(Appendix A and C)*
- ✓ Obtain bathymetric map of lake *(2005 Water Quality Report, Section 2.0)*
- ✓ Identify sediment characteristics *(Section 5.4)*
- ✓ Use GPS to record locations of specific sites of interest such as plant sampling locations *(Appendix A through D)*

Fishery & Wildlife

- ✓ Prepare a narrative describing the fish and wildlife community and their relationship to the plant community *(Section 2.0)*
- ✓ Identify any areas designated as "Sensitive Areas" by the WDNR *(Section 9.3)*
- ✓ Identify areas where rare, threatened, or endangered species or species of special concern exist *(Appendix A and C)*
- ✓ Conduct specific surveys as required *(N/A)*

Water Quality

- ✓ Obtain one year of current water quality, including a minimum of 5 Secchi disk readings from June 1 to August 31 *(Section 5.7)*
- ✓ Prepare summary of historical data *(Section 3.0)*
- ✓ Measure the temperature and dissolved oxygen at 1 meter intervals at the deepest point of the lake during the summer *(Section 5.7 and 2004 Water Quality Report)*
- ✓ Measure nutrient levels for TP, TKN, nitrate, ammonium and nitrite throughout the summer and obtain nutrient budget if available *(Section 5.7 and 2004 Water Quality Report)*
- ✓ Measure chlorophyll-*a* concentrations, turbidity, alkalinity and pH throughout the summer *(Section 5.7 and 2004 Water Quality Report)*

Water Use

- ✓ Note primary human use patterns in the lake and on shore *(Section 5.9)*
- ✓ Note areas where use is restricted for any reason *(Section 5.9)*
- ✓ Collect public survey to gather opinions and perceptions on plant and water conditions *(Section 5.9)*
- ✓ Note water intakes for public water supply or irrigation *(Section 4.9)*
- ✓ Include the above information on GIS map *(Section 4.0)*

Watershed Description

- ✓ Provide topographical map showing watershed boundaries, inflows and outflows *(Section 1.0)*
- ✓ Determine watershed area *(Section 3.6)*

- ✓ Quantify land use areas within watershed *(2005 Water Quality Report, Section 3.5)*
- ✓ Calculate nutrient loading by area *(2005 Water Quality Report, Section 4.3)*
- ✓ Locate all inputs into lake including streams, drainage ditches, drain tile, etc. *(Section 4.9)*
- ✓ Include the above information on GIS map *(Section 4.9)*
- ✓ Model the lake and watershed to develop annual nutrient budget *(2005 Water Quality Report, Section 4.3)*

Analysis

- ✓ Identify lake management objectives needed to maintain and restore beneficial uses of the lake *(Section 8.5)*
- ✓ Create maps and overlays of the information from the inventory and interpret the results *(Appendix A and C)*
- ✓ Identify target levels or intensity of manipulations *(Section 8.4)*
- ✓ Map areas proposed for management *(Section 9.3)*
- ✓ Mapping coordinates should be recorded on a GIS map *(Section 9.3)*

Alternatives

- ✓ Plans should include measures to protect the valuable elements of the aquatic plant community as well as measures to control nonnative and invasive plants, plants that interfere with beneficial lake uses, and plants that enhance habitat for fish and aquatic life *(Section 8.4)*
- ✓ Discuss most common plant control techniques, benefits, drawbacks with vested parties *(Section 8.4)*
- ✓ Provide sufficient information regarding the feasibility, costs, and duration of control expected of each alternative *(Section 8.4)*
- ✓ Discuss the potential adverse impacts of each alternative *(Section 8.4)*

Recommendations

- ✓ Develop an invasive species prevention program including education and monitoring *(Sections 9.2 and 9.4)*
- ✓ Implement "Clean Boats, Clean Waters" program *(Section 9.4)*
- ✓ Involve the public in keeping the lake healthy by finding ways to decrease harmful watershed inputs *(Section 9.2)*
- ✓ List proposed control actions beyond those strictly necessary for aquatic plant management that will be implemented to achieve desired level of control *(Sections 9.5 and 9.6)*
- ✓ Identify specific areas for control on a map and list the level of proposed management *(Section 9.3)*
- ✓ Identify plant offloading and disposal locations for harvested plants *(Section 4.9)*
- ✓ Identify were and how you plan on obtaining equipment necessary for harvesting *(Section 8.6)*

Implementation

- ✓ A description of education or prevention strategies needed to maintain and protect the plant community *(Sections 8.6 and 9.2)*
- ✓ A description of how all the management recommendations will be implemented, the methods and schedules applicable to the operation, including, timing, capital, operational cost estimates, and maintenance schedules if applicable. A description of the roles and responsibilities of the persons and/or organizations involved in the management process *(Section 9.3)*
- ✓ A description of how the public will be involved *(Section 9.2)*
- ✓ A budget and identification of funding sources, including plans for grant application *(Section 8.6)*
- ✓ A description of the process by which the plan will be adopted, revised, and coordinated, with WDNR approval *(Section 8.6)*

Monitoring and Evaluation *(Lakes with Known Invasive Populations and Following Management Actions)*

- ✓ Monitor for invasive aquatic plants in early spring and twice in the summer *(Section 9.4)*
- ✓ Perform quantitative plant survey at least once every five years. Track diversity indices such as FQI for early warning signs of decreasing diversity or water quality *(Section 9.3)*
- ✓ Contract for a professional survey every 3 to 5 years for the presence of exotic species and for updating the native plant list *(Section 9.4)*
- ✓ For lakes with known exotics, sample more often, use the rake method, and sample areas of know infestation, major inlets, and boat launches *(Section 9.4)*
- ✓ Following management activities collect basic water chemistry and physical parameters such as TP, TKN, temperature, pH, dissolved and dissolved oxygen at a mid lake site and within each management zone *(Sections 9.3 and 9.5)*

9.2 Public Education Campaign

The public education campaign for Big Blake Lake will begin immediately following plan adoption. The District should form a Public Education Committee *(PEC)* which will be responsible for all aspects of the public education campaign. Informing residents of the adverse affects of invasive species and benefits of native plants will be the primary focus of the public education campaign. Information on these topics can be gathered from the WDNR, Polk County LWRD and local UW-Extension office. Information is typically available in pamphlet, poster, and handbook form or may be downloaded from the internet in PDF format. Information specific for Big Blake Lake may be typed and distributed, posted in a public place or presented as part of regular District meetings. Pursuant to the deliverables, electronic copies, in PDF form, for each report will be provided at no cost and a CD copy will be mailed to Lake Coordinator with the finalized plans. The purpose of the committee is to raise awareness, solicit involvement, and promote action.

The current public education program will be an integral part of the new campaign. The current public education campaign has four facets[8]:

1. The District holds two regular meetings per year. The first meeting is a seasonal meeting on the 3rd Saturday in May. The second meeting is the Annual Meeting and is held on the 3rd Saturday in August.
2. Approximately 220 copies of the BBLP&RD Newsletter are sent out by mail semi-annually. The newsletter generally contains the minutes of the past District meeting and any pertinent issues facing the District.
3. The District has existing signs in place addressing the issue of the risk of exotic species at both public accesses on the lake. These signs identify harmful exotic species and advise the boater on how to prevent the spread of non-native plants and animals.
4. A final copy of the District Plan will be available at the Balsam County Public Library if possible. The District has arranged to have the final draft of the Blake Lake Aquatic Plant Management Plan available on-line through TLI's website.

9.3 Annual Harvesting of Navigational Channels

The first step to managing macrophytes from year to year is to conduct a pre-management survey of the entire lake, map potential harvesting areas, and perform a detailed quantitative aquatic plant survey in harvesting areas as recommended by the WDNR. In addition to pre-harvesting surveys, the District must have a quantitative plant survey performed at least once every five years and track diversity indices such as FQI for early warning signs of decreasing diversity or water quality.

The harvesting map may be the same from year to year but could change due to annual variation in plant growth. The map should show each proposed harvesting zone with a

[8] Written by the Big Blake Lake Protection and Rehabilitation District, October 2005.

detailed description of the area. The map should be all that is needed by the equipment operator in order to accurately perform mechanical harvesting. The proposed management to begin in 2006 includes harvesting CLP throughout the lake in the spring and navigational channels throughout the littoral zone in the summer *(Figure 12)*. This step is simply a way to manage the current problems which include nuisance aquatic plant growth, elevated nutrient levels and a wide distribution of CLP. Harvesting is a short to intermediate-term solution to provide temporary relief of nuisance conditions.

The second step is to implement activities. Implementing the plan begins by getting organized, creating a map of the proposed management area, preparing equipment and personnel, and coordinating administrative activities. Equipment should be maintained throughout the season but will need an annual full-service check prior to the first harvest of the year. Also, the District will need to coordinate with the person(s) responsible for performing the harvesting operations so that the budget is not exceeded and use conflicts are avoided.

Harvested plant material will need a predetermined destination. Many townships have a designated compost area where plant material can be disposed of. If a compost area is not available, one can be created or arrangements can be made with local residents who are willing to take the nutrient rich waste. Plant material should not be allowed to sit in a dump truck at the upload site for extended periods of time because the decaying plants will only add nutrients back to the lake during rain events. It is also important that the removed plant material be transported outside the immediate catchment of the lake so that runoff does not transport the nutrients back to the lake.

Budget for Harvesting - Worksheet[9]

Spring CLP Harvesting approx 80 acres	
165 Hours – Harvester Operator	@ $10 per hr
165 Hours – Conveyor Operator	@ $ 9 per hr
Operator Hourly Expense	$19 per hr
Plus FICA Expenses	x 1.4
Total Operator Expense	$26.60 per hr

[9] Prepared by the Big Blake Lake Protection and Rehabilitation District, October 2005.

Summer Harvesting approx 40 acres

84 Hours – Harvester Operator	@ $10 per hr	
84 Hours – Conveyor Operator	@ $ 9 per hr	
Operator Hourly Expense	$19 per hr	
Plus FICA Expenses	x 1.4	
Total Operator Expense	$26.60 per hr	

165 Hours + 84 Hours = 249 Hours of Harvesting Operation per year

$ 6650.00	total operator wages
1065.00	operator maintenance
1000.00	parts and supplies
2125.00	insurance
480.00	storage
+700.00	fuel
$12,020.00	annual operating budget

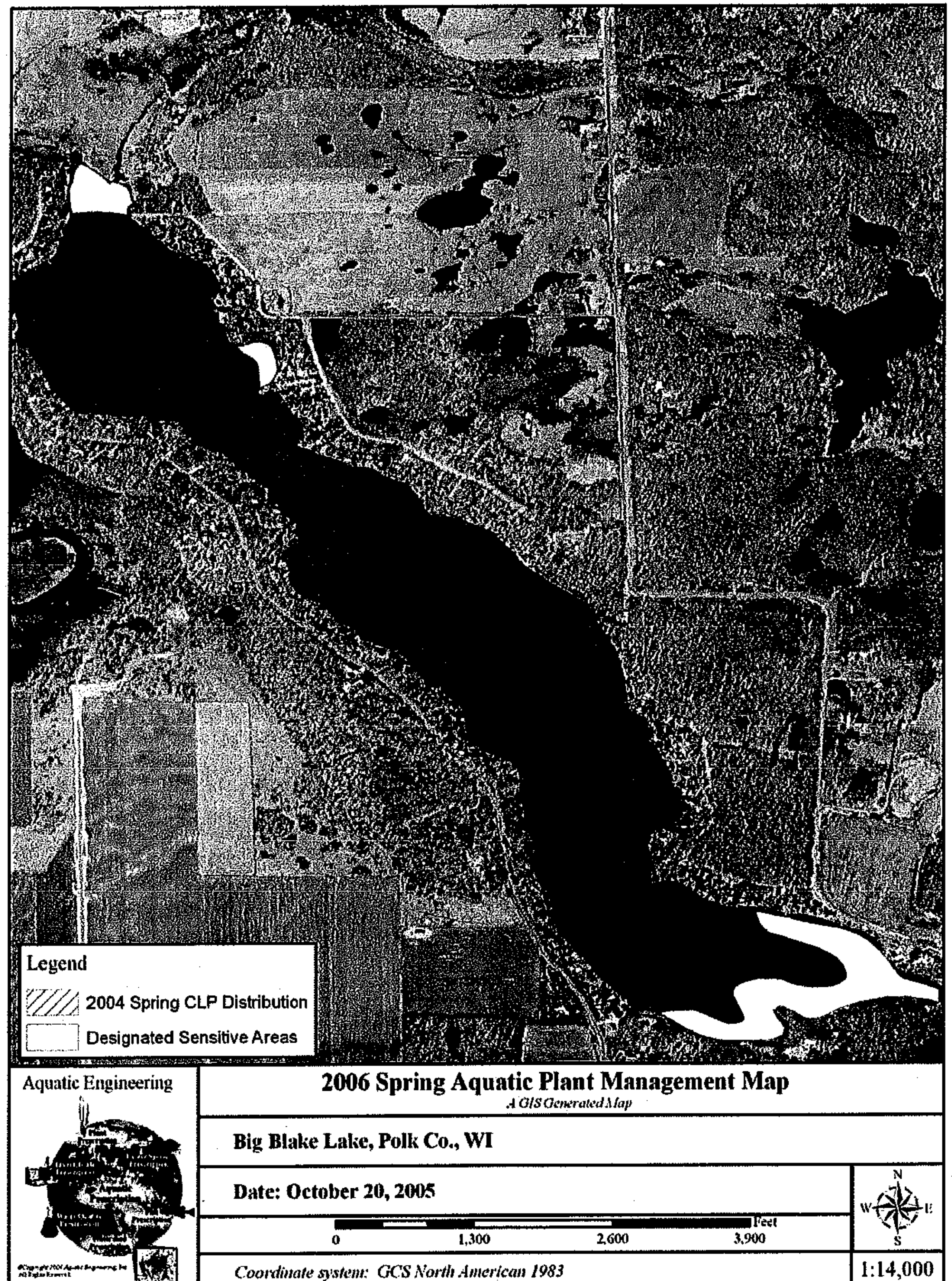

Figure 16. Aquatic plant management map for Big Blake Lake (*Polk County, WI*) beginning spring of 2006. All areas of the lake were CLP is growing may be harvested in the spring.