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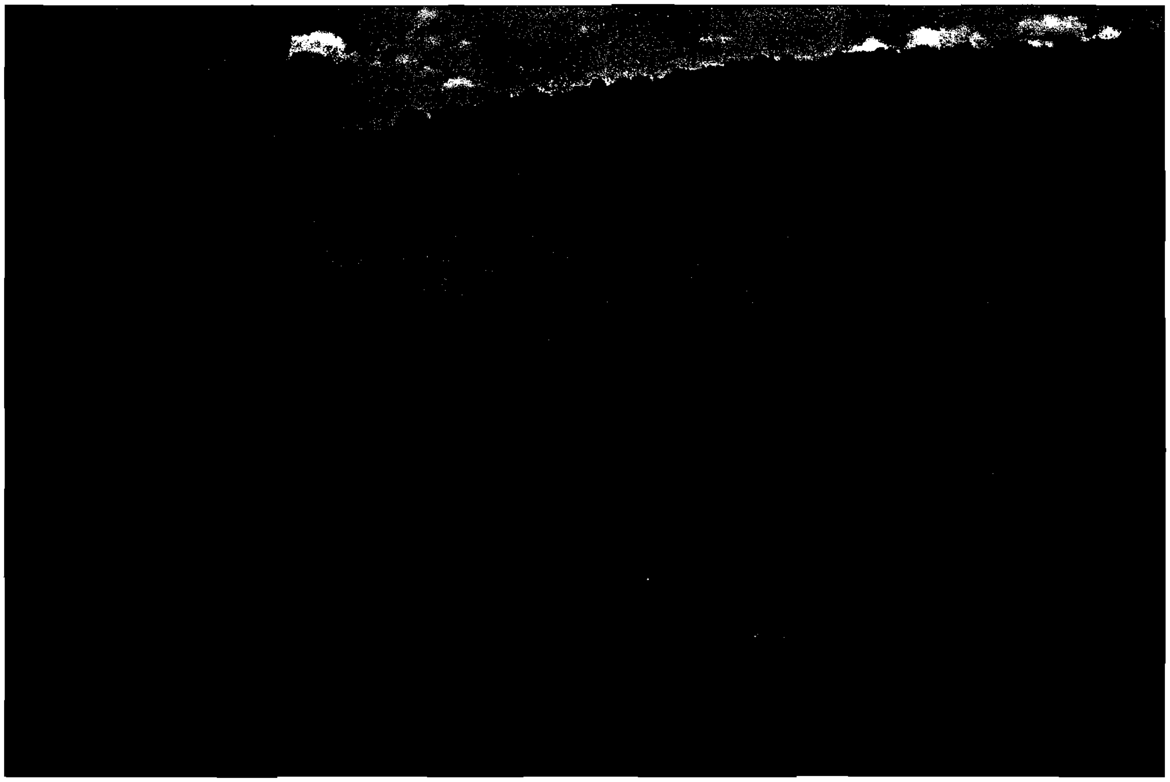
2004 Big Blake Lake Water Quality Monitoring Technical Report



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2004 Big Blake Lake Water Quality Monitoring Technical Report

May 2006

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Blake Lake Management District Commissioners

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Executive Summary

Big Blake Lake is a 217-acre drainage lake located in Polk County, Wisconsin. The watershed of Big Blake Lake is predominantly agricultural and is likely the reason the lake experiences advanced eutrophic conditions. Nutrient-high runoff from the watershed is causing elevated phosphorus concentrations that in turn promote extensive macrophyte growth within the lake. Curly-leaf pondweed (CLP) is an invasive plant causing the greatest degree of problems for Big Blake Lake recreationists. Recent studies have shown that CLP can release large amounts of phosphorus in the summer when CLP decays and can contribute a significant portion of the internal loading of phosphorus to a lake system in the summer.

The water quality of Big Blake Lake was sampled from June to October of 2004. A single sample station was selected at the deepest point in Big Blake Lake, and one station was created at both the inflow and outflow of the lake. The parameters analyzed were soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll *a*. These parameters were analyzed by the Water and Environmental Analysis Laboratory *(WEAL)* located in Stevens Point, Wisconsin. Temperature, dissolved oxygen, conductivity, and specific conductance were measured and recorded on site June through October.

The water quality results and Secchi readings show that Big Blake Lake is a eutrophic lake with a composite[1] TSI value of 57.3. Big Blake Lake did not thermally stratify in the summer of 2004. The condition of the lake water quality is similar to that of other eutrophic drainage lakes. The relatively high concentrations of phosphorus and chlorophyll *a* should produce an algal-dominated system. This problem should be compounded by the release of phosphorus from decaying CLP in early summer.

[1] A composite TSI value was calculated by averaging the TSI_{TP}, $TSI_{Chl\ a}$ and TSI_{S} values from both basins.

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1.0 Introduction

1.1 Scope

Big Blake Lake is a 217-acre drainage lake located in Polk County, Wisconsin (WBIC 2627000). Four inflows are located in the subwatersheds of which the Straight River is the major source of surface water. The Straight River flows from Big Round Lake to Little Blake Lake, which drains directly into Big Blake Lake. The watershed of Big Blake Lake 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 included in the Polk County Land and Water Resource Plan (Bursik 2001).

In 2003, the Blake Lake Management District contracted The Limnological Institute (TLI) to write a grant for WDNR funding to conduct baseline water quality monitoring in 2004. The grant was approved in early 2004 for work to begin that spring. This report covers the water quality parameters sampled on site, water quality analyzed at the Water and Environmental Analysis Laboratory (WEAL) located in UW – Stevens Point, phytoplankton analyzed at the Wisconsin State Laboratory of Hygiene (WSLOH), and zooplankton analyzed at PhycoTech.

1.2 CLP as a Water Quality Issue

Curly-leaf pondweed (CLP) is an exotic aquatic plant that impacts water quality. It was unintentionally introduced to Wisconsin during common carp stocking activities in the 1800's and is present in many Wisconsin lakes. All aquatic plants contribute nutrients to lakes as they decay, but native plants die off in the late summer or early fall, when their nutrients are consumed by bacteria instead of fueling algal growth. CLP releases nutrients into the water column in mid-summer, promoting algal blooms (Crowell 2003). As much as 5.5 pounds of phosphorus per acre can be released from monotypic CLP beds (McComas 2000). This release of phosphorus can contribute to over half of the internal load of phosphorus in a lake for the summer. The 1988 Barr Engineering report also cited that CLP is detrimental to lakes because it may cause oxygen depletion and exacerbate internal loading of phosphorus as it decays in the summer. The Big Blake Lake Protection and Rehabilitation District is currently creating a plan to manage its aquatic macrophyte community, water quality, and watershed.

2.0 Review of Existing Information

There is relatively little known about the historical water quality of Big Blake Lake. In 1997, the District contracted Barr Engineering to perform a macrophyte survey and to write a management plan, which included a review of existing information for water quality monitoring activities. Past management activities have been performed by the WDNR, Saint Thomas University, and volunteers (Table 1)(Barr 1998). The District does not currently participate in the "Self-help Monitoring" program promoted by the WDNR.

Table 1. Summary of past water quality monitoring for Big Blake Lake (Polk County, WI).

Agency/Group	Duration	Activities
Wisconsin DNR	1978 to 1979	Water Quality Monitoring Nutrient Budget Hydrologic Budget
Saint Thomas University	1983 and 1993	Water Quality Monitoring Secchi Transparency
Volunteers	1991-1992	Secchi Transparency

The findings of the 1998 Macrophyte Survey and Management Plan were that Big Blake Lake is a eutrophic system and has been since as early as 1978. A phosphorus budget performed by Barr Engineering in 1998 used data collected by the WDNR in 1978-79 and found that 90 percent of the phosphorus load to Big Blake Lake came from the Straight River, and ultimately the majority came from Big Round Lake, which is also eutrophic and has high levels of internal phosphorus loading in the summer *(Barr 1998)*. Data collected in 1983 and 1993 by Saint Thomas University also showed that Big Blake Lake was eutrophic.

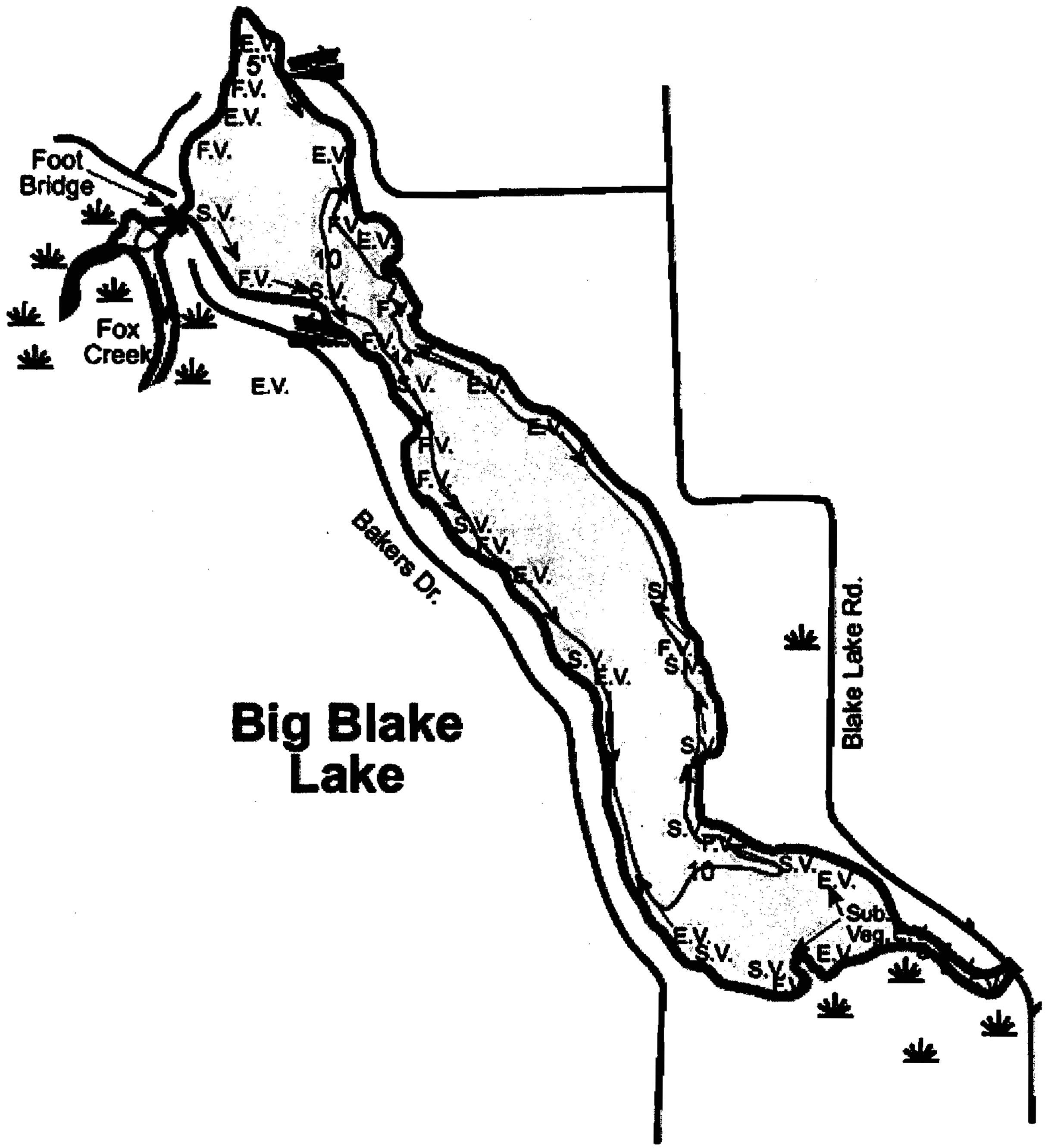

Figure 1. Bathymetric map of Big Blake Lake (Polk County, WI).

3.0 Methods

3.1 Sample Collection

A sample site was established at mid-lake, near the inflow from Little Blake Lake, and at the outflow of Big Blake Lake (Figure 2); the mid-lake site was at the deepest location in the lake (approximately 8.5 feet deep). Water samples were collected by representatives of Polk County Land and Water Resource Department (LWRD) and were sent to WEAL at UW –Stevens Point for analysis. The samples were analyzed for reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll a. These samples were collected monthly from June to October, with a composite surface sampling device designed to sample a column of water from 0 to 6 feet deep. The samples were kept on ice until they arrived at the laboratory in Stevens Point.

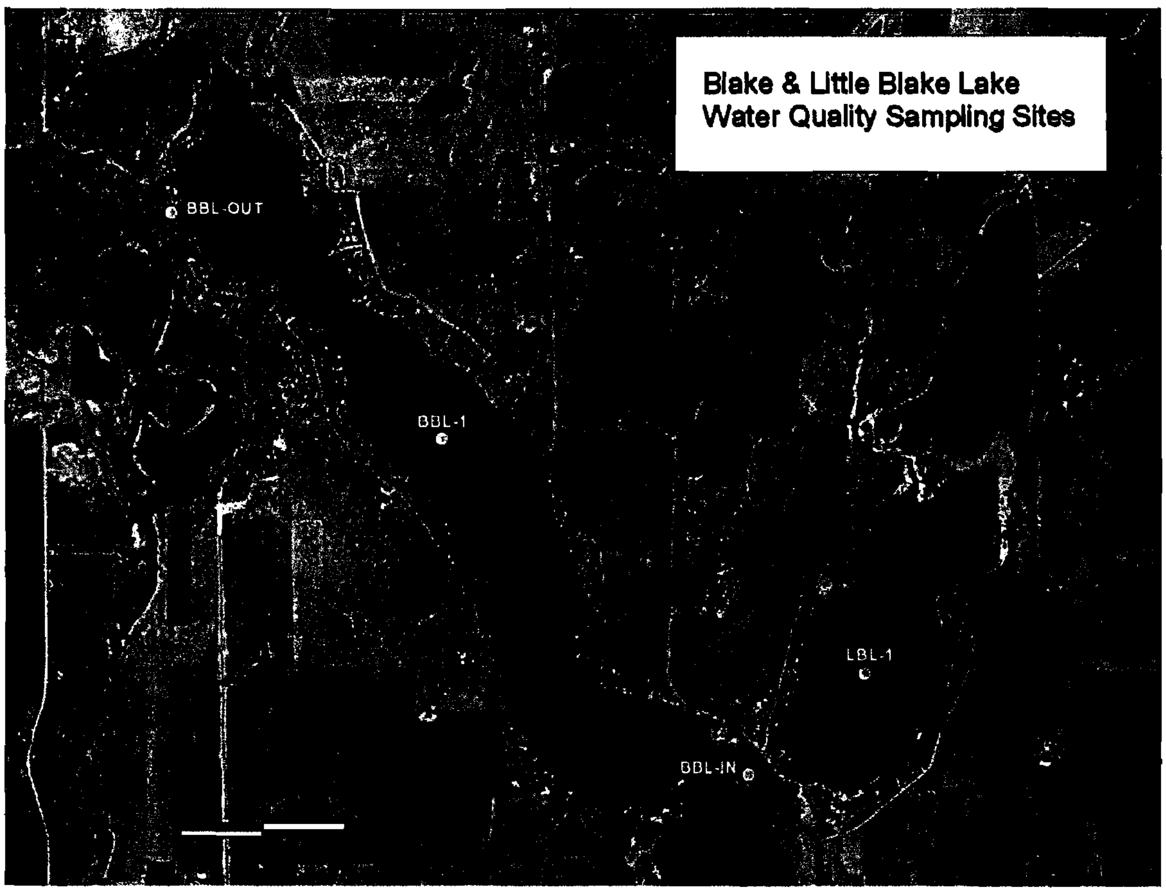

Figure 2. Big Blake Lake 2004 water quality sampling stations (Polk County, WI).

3.2 On-Site Measurements

Depth profiles were collected at the mid-lake water quality monitoring site during the summer sampling periods *(June through October).* Data points were collected at one-meter intervals throughout the water column for dissolved oxygen, pH, salinity, conductivity, specific conductance and temperature with a SONDE YSI probe.

3.3 Phytoplankton and Zooplankton Samples

Phytoplankton and zooplankton samples were collected in August and September at the mid-lake water quality monitoring site. A 66-micron zooplankton tow net was used to collect zooplankton samples. The net was lowered to one meter above the sediment and slowly pulled to the lake surface. The samples were put on ice and mailed overnight to PhycoTech for identification. All taxa were identified to the lowest practical taxonomic level.

Phytoplankton samples were collected July through September in 2004. The samples were collected with a 6-foot integrated surface sampling device, put on ice, and mailed overnight to the WSLOH in Madison, WI. All taxa were identified to the lowest practical taxonomic level.

3.4 Trophic Status Calculations

Trophic status was calculated for Big Blake Lake water samples using the following equations *(the units of measurement required for each parameter are included as a subscript in the equation):*

$TSI_{SD} = 60 - 14.41 * \ln (SD_m)$

$TSI_{chl} = 9.81 * \ln (chl_{\mu g}) + 30.6$

$TSI_{TP} = 14.42 * \ln (TP_{\mu g}) + 4.15$

The following scale is used to evaluate trophic status *(Lillie and Mason 1983):*

TSI < 30	oligotrophic
40 < TSI < 50	mesotrophic
TSI > 50	eutrophic

3.5 Phosphorus Budget and Watershed Analysis

Assumptions made to complete WiLMS modeling were:

1) Straight River deposits point source pollution into Big Blake Lake

- Flow = $25.4 ft^3 * sec^{-1}$ ➔ $2.27 x 10^7 m^3 * year^{-1}$ *(Barr 1988)*
- Average 2004 [phosphorus] = $31 \mu g * L^{-1}$ ➔ $31 mg * (m^3)^{-1}$ *(Based on 2004 inlet average total phosphorus concentration)*
- Total yearly phosphorus load equals annual flow multiplied by the 2004 average phosphorus concentration ➔ $703.7 kg * year^{-1}$

This is generally considered a more accurate calculation than collecting precipitation, land-use types and soil coefficients for the entire watershed. Potential flaws of this assumption are that total phosphorus (TP) was only measured on five separate occasions from June through October. The average TP is then calculated from only five readings and must be extrapolated over the remaining seven months of the year. Secondly, the annual flow from the Straight River is referenced in the 1998 report, but that rate was referenced from a 1981 WDNR report. The total water volume that flowed into Big Blake Lake via the Straight River in 2004 was not recorded.

2) The immediate watershed was considered the watershed area that drained directly into Big Blake Lake without first passing through the Straight River. The resulting watershed was 798.37 acres, and land use information was gathered from the WDNR land use database accessed through the WDNR Webview and imported into ArcMap version 9.1. The land coverage data for the immediate watershed of Big Blake Lake was broken down into seven functional categories in order to enter the information into the WiLMS modeling software. The total amount of watershed area in acres was summed for each functional category *(Table 2)*.

Table 2. Land use within the immediate Big Blake Lake watershed.

Category	Area (acres)
Forest	385.8
Lake surface	230
Grassland	144.6
Agriculture (row crop)	68.2
Agriculture (mixed)	12.7
Wetland	51.6
Barren	2.4

3) Septic system load was calculated based on the following assumptions[2]:

- There are 135 homes on the lake and approximately 70 percent *(101 homes)* are on septic.
- The average number of residents per home is 2.2.
- Approximately 20 percent of homes are occupied year round *(365 days)*
- Approximately 30 percent of homes are occupied seasonally in the summer only *(100 days)*
- Approximately 50 percent of homes are occupied year-round on weekends only *(75 days)*

The capita years value is calculated as follows:

[(101 homes x 0.20) x (365days/365days per year) x 2.2 persons per house]
[(101 homes x 0.30) x (100days/365days per year) x 2.2 persons per house]
+ [(101 homes x 0.50) x (75days/365days per year) x 2.2 persons per house]

85.53 Capita years

4) Soil retention for septic system leachate was estimated at 80 percent *(Barr 1998)*

5) There was no thermal stratification observed in 2004 and therefore no hypolimnion and no internal loading from the sediments. The 2004 data does show that oxygen depletion occurred near the sediments in late June through early July and again in September. The total surface area of the lake sediments experiencing oxygen depletion is not known, but the cause of the depletion is likely a high biological oxygen demand caused by microbial respiration during decomposition of decaying organic matter.

[2] Provided by the Big Blake Lake P&RD, October 2005.

Because water samples were not collected from the anoxic zone of the water column, we can not predict if internal loading is occurring.

4.0 Results

4.1 Water Quality

Big Blake Lake is a eutrophic system which does not thermally stratify in the summer, has a retention time of approximately 37 days, with pH, salinity, and dissolved oxygen profiles typical of drainage lakes of northern Wisconsin. The phosphorus, chlorophyll *a*, and Secchi disk readings all support the eutrophic status. The watershed analysis shows that a majority of the phosphorus load originates from the Straight River inflow, which drains directly from Little Blake Lake.

4.1.1 Phosphorous

Total phosphorus was reported for each sampling event *(Figure 3).* The average TP for the mid-lake site of Big Blake Lake in 2004 was 48.5 µg/L, with a maximum of 72 µg/L and a minimum of less than 12 µg/L. The TSI_{TP} value for Big Blake Lake in 2004 was 60.1.

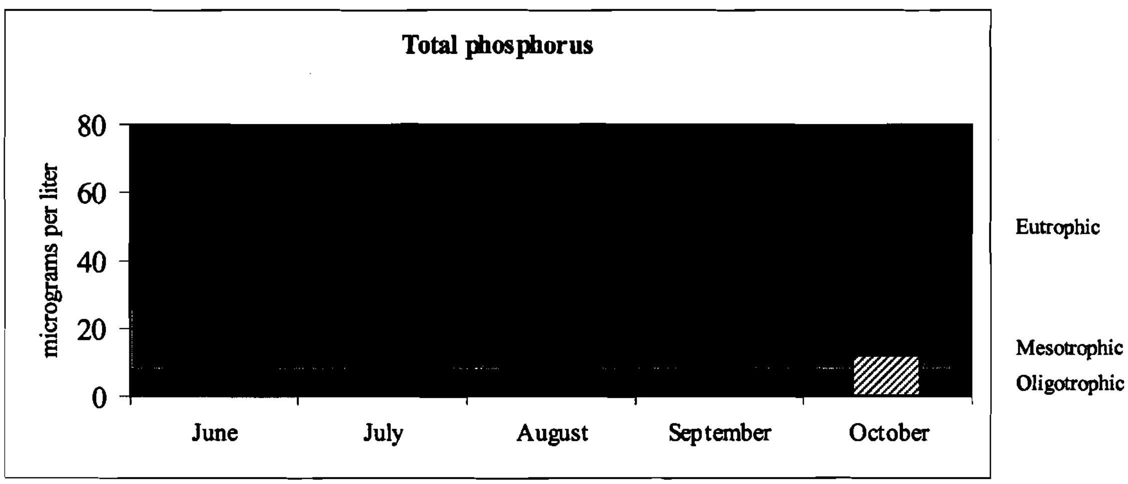

Figure 3. Total phosphorus measurements for Big Blake Lake (Polk County, WI) 2004. October analysis concentration >12 µg/L.

The Straight River inlet to Big Blake Lake had an average summer TP concentration of 31µg/L. The Fox Creek outlet of Big Blake Lake had an average summer TP concentration of 66 µg/L. The TSITP of the inlet and outlet is 53.7 and 64.6, respectively.

4.1.2 Chlorophyll *a*

Chlorophyll *a* was also reported for each sampling event *(Figure 4)*. The average chlorophyll *a* for the mid-lake site of Big Blake Lake in 2004 was 19.3 μg/L, ranging from less than 1.0 μg/L to 31.6 μg/L. The TSI_{chl} value for Big Blake Lake in 2004 is 59.6. Chlorophyll *a* concentrations were inversely proportionate to the Secchi depth readings in 2004.

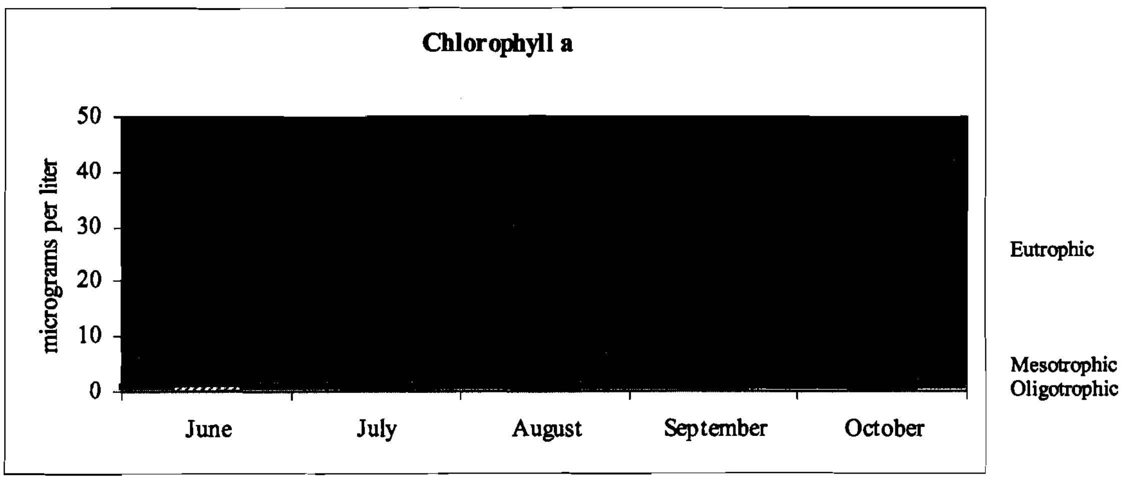

Figure 4. Chlorophyll *a* measurements for Big Blake Lake (Polk County, WI) 2004. June analysis concentration >1.0 μg/L.

4.1.3 Secchi Transparency

Secchi disk readings were collected ten times in 2004. The average Secchi reading in 2004 was 6.0 feet and ranged from 3.0 to 11.0 feet. The TSI_{SD} for Big Blake Lake in 2004 was 51.3. Secchi depths were inversely proportionate to the concentration of chlorophyll *a* in 2004 *(Figure 5)*.

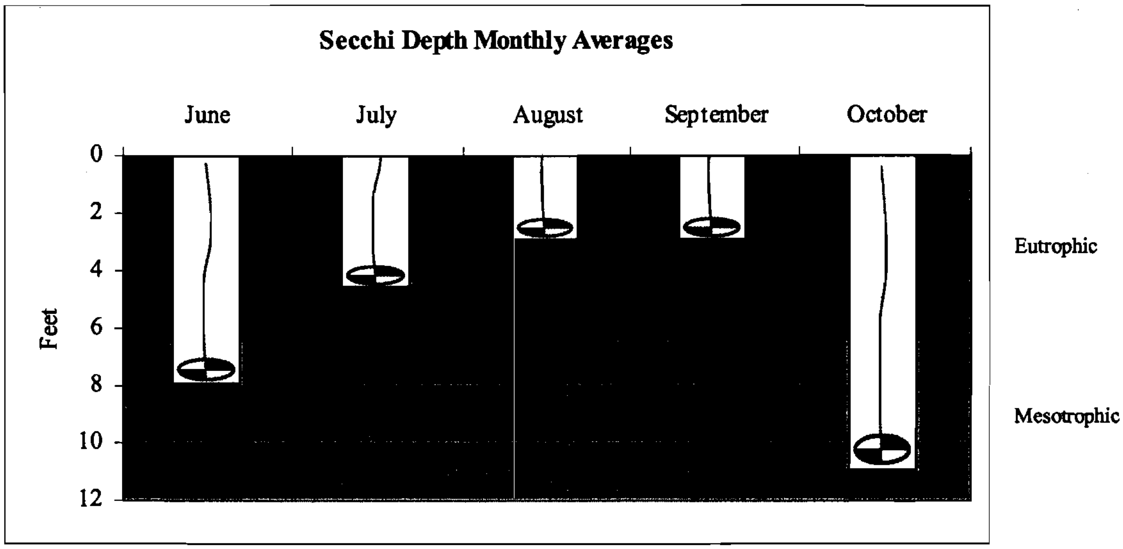

Figure 5. Monthly average Secchi depths from the mid-lake sample location of Big Blake Lake (Polk County, WI) 2004.

4.1.4 Other Parameters

Other parameters measured were total Kjeldahl nitrogen, soluble reactive phosphorus, temperature, conductivity, specific conductance, and salinity. The aforementioned chemical and physical parameters affect water quality in many different ways and are discussed separately in the following subsections.

Total Kjeldahl Nitrogen (TKN)

The Kjeldahl technique is a laboratory test for measuring the amount of organic nitrogen contained in water. The organic nitrogen concentration is actually the total Kjeldahl nitrogen concentration minus the ammonia concentration. Organic nitrogen may be either dissolved or suspended particulate matter in water. High levels of organic nitrogen in water may indicate excessive production or organic pollution from the watershed. Animal and human waste, decaying organic matter, and live organic material like tiny algae cells can cause organic nitrogen enrichment of lake water *(Tippecanoe*

Environmental Lake and Watershed Foundation 2005). 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 the mid-lake site of Big Blake Lake in 2004 was 605 µg/L. The N:P *(TKN:TP)* ratio was approximately 12.5 to 1 *(by mass)* and supports the fact that Big Blake Lake is phosphorus-driven *(generally any ratio over 7:1 N:P by weight is phosphorus limited).* The average TKN for the inlet and outlet was 569 µg/L and 1,301 µg/L, respectively.

Soluble Reactive Phosphorus (SRP)

Soluble reactive phosphorus (SRP) is a dissolved form of phosphorus. Dissolved phosphorus is the form of phosphorus which plants and algae use to create biomass. Since plant and algae growth is typically limited by phosphorus, added phosphorus, especially in the dissolved bio-available form, can fuel plant growth and cause algae blooms. Sources of SRP can include failing septic systems, animal waste, fertilizers, decaying plants and animals, and resuspension from the lake bottom. Because phosphorus is cycled so rapidly through biota, 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 the mid-lake site of Big Blake Lake in 2004 was 14.2 µg/L.

Temperature

Temperature plays a major role in water quality, especially in lakes that become thermally stratified. Thermal stratification occurs when water in the top layer of a lake becomes heated by the sun and insufficient mixing action allows the warm water layer at the surface *(epilimnion)* to "float" on top of a cooler, more dense layer of water near the bottom *(hypolimnion).* As the summer progresses, the difference in density between the two layers increases and, when the difference becomes too great for wind energy to mix, the lake becomes stratified *(Holdren et al. 2001).* The region between the epilimnion and hypolimnion is called the metalimnion. The particular depth within the metalimnion where the rate of change in temperature is greatest is called the thermocline *(Holdren et al. 2001).* In 2004, Big Blake Lake did not thermally stratify; many drainage lakes do not thermally stratify because the constant current prevents a thermocline from forming. The difference between the surface temperature and bottom temperature on August 17^{th} was less than one degree Celsius.

Conductivity and Specific Conductance

Conductivity in lake water comes from a variety of sources. Agricultural and industrial runoff contributes large amounts of dissolved salts, which raise the conductivity. Sewage from septic tanks and treatment facilities also add to the conductive properties in water. Another source of conductive properties can come from decomposing organic matter near the sediment. As planktonic algae die throughout the summer, a "rain" of dead algal cells is constantly falling on the sediments of the lake. Bacteria in and near the sediment aide in decomposition of the algal cells by breaking high energy bonds stored in the algal cell wall. When this occurs, CO_2 is released into the water where it rapidly dissolves into carbonic acid, bicarbonate, and carbonate ions. These ions contribute to the conductive properties of the lake water. The average conductivity of Big Blake Lake at mid-depth in 2004 was approximately 181 µS/cm which is typical of freshwater lakes.

Dissolved Oxygen

Dissolved oxygen plays an important role in both the biology and chemical properties of the lake. Anoxic conditions make certain compounds more soluble in water. The chemical and biological properties are most affected during summer stratification when the hypolimnion does not mix with the oxygen-rich epilimnion. As reported above, Big Blake Lake did not thermally stratify in 2004. The water column was fairly well mixed throughout the season, which is also typical of drainage lakes *(Figure 6)*. The percent saturation of oxygen decreased as the probe neared the sediment. This oxygen depletion is likely due to a high biological oxygen demand caused by algae, plankton, and bacteria and is common for all types of lakes. Decomposition of organic waste near the sediment consumes oxygen faster than it can be replaced through photosynthesis and natural mixing of the water in the lake.

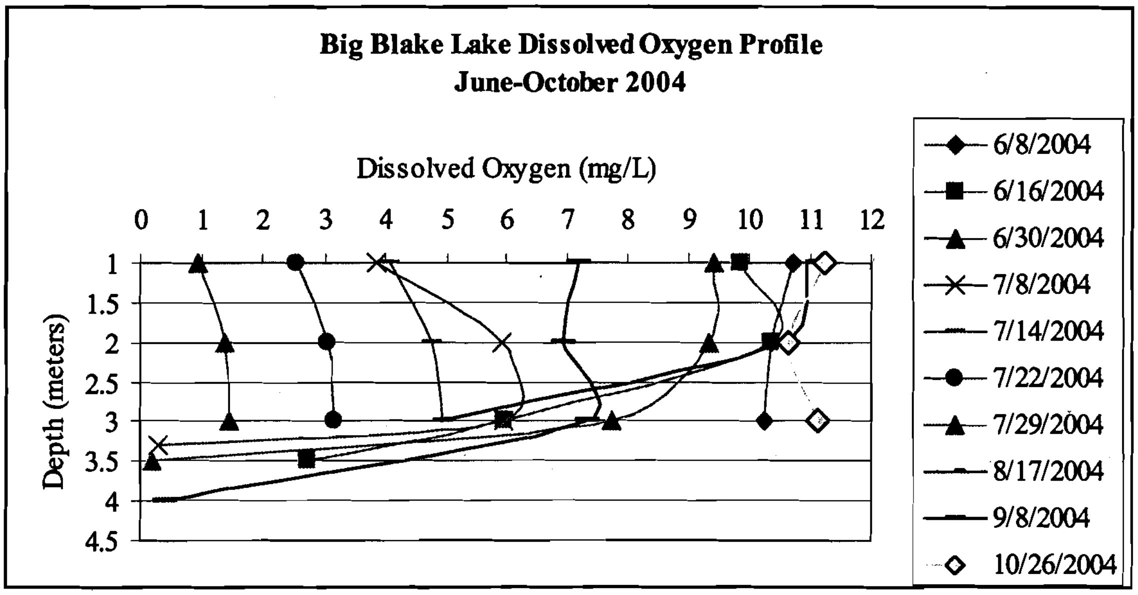

Figure 6. Big Blake Lake mid-lake dissolved oxygen profiles for 2004.

4.2 Phytoplankton and Zooplankton

Phytoplankton

Composite surface samples were collected for phytoplankton analysis from the water quality site three times in 2004. The results show that Cyanophyta *(blue-green algae)* was the most common species present *(by concentration)* in July and September *(Appendix B)*. The most common species present in October, *Dinobryon divergens,* belongs to the Chrysophyta division.

Zooplankton

The most common organisms during the August 17th survey in 2004 were the Rotifera *(Figure 7.)*. The most common organism was *Chnochilus unicornis,* which made up 58.8% of the relative abundance. By early September the Rotifera were still the most common organisms *(Figure 8)*, but the dominant organism was *Keratella cochlearis.*

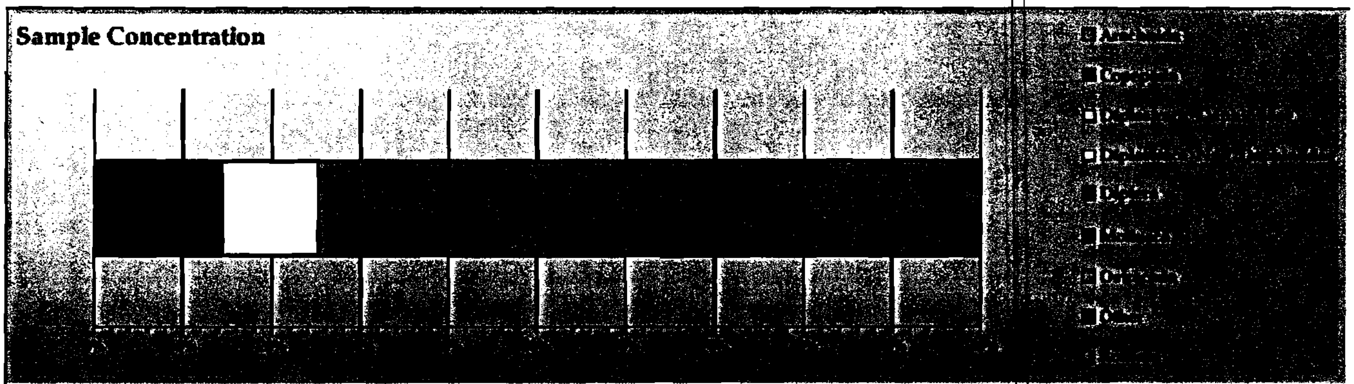

Figure 7. Zooplankton community composition of Big Blake Lake, August 17, 2004.

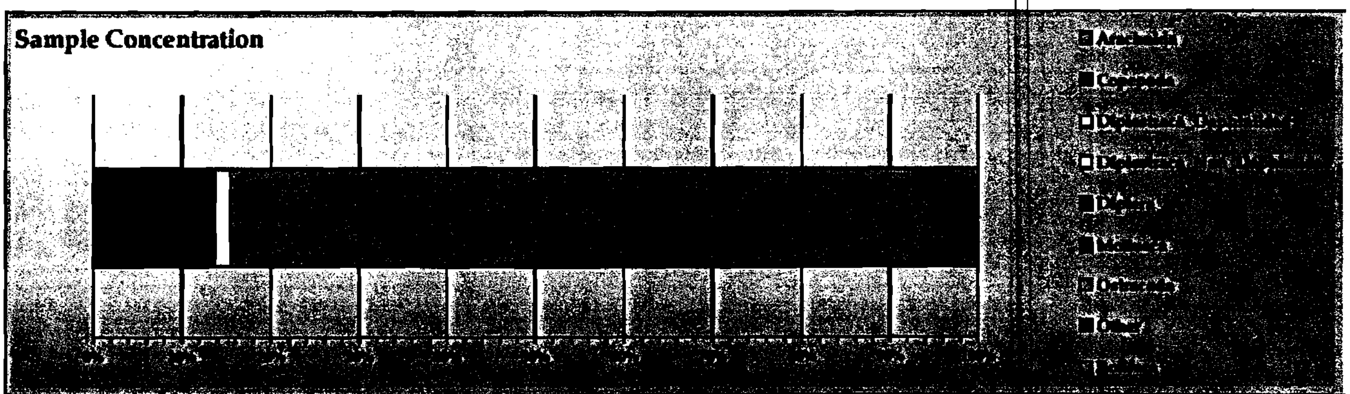

Figure 8. Zooplankton community composition of Big Blake Lake, September 8, 2004.

4.3 Watershed Analysis and Phosphorus Budget

Based on WiLMS modeling and the data gathered in 2004, the most likely total annual phosphorus load to Big Blake Lake is 808 kg. This only considers external loads to the lake and is a sum of the point source load of 712 kg per year and the non-point source load of 96 kg per year. No internal loading could be calculated using the WiLMS model for three reasons: (1) WiLMS is not designed to calculate internal loading of non-stratified lakes, (2) no samples were collected from the anoxic region within the lake, and (3) WiLMS does not work well with lakes having short hydrologic retention times. The single major source of phosphorus *(703.7 kg per year)* in 2004 came from the Straight River *(approximately 87 percent of the total load).*

5.0 Discussion

5.1 Trophic Status Index

TSI values for 2004 show that Big Blake Lake is an eutrophic lake. Water clarity data shows that the average Secchi depth suggests a moderate eutrophic status, while chlorophyll *a* and total phosphorus support a higher eutrophic status. Big Blake Lake has qualities expected of its eutrophic status, which occurs seasonally. Phosphorus and chlorophyll *a* levels peak each summer and decline in the fall. This cycle is caused by environmental conditions that favor algae growth in the heat of the summer when sunlight is high and rain washes nutrients into the lake. An additional source of phosphorus comes from decaying *CLP* in early summer. McComan (2000) showed that one acre of monotypic CLP is capable of releasing 5.5 pounds of phosphorus when it decomposes. Some nutrient budgets consider the amount of CLP within a lake as a source of phosphorus in the summer. It may be possible to control algal growth in the summer by limiting CLP biomass accumulation in the spring.

As part of a future monitoring strategy, the TSI values should be calculated and compared from year to year to indicate whether the eutrophication process is increasing, decreasing, or remaining constant. Sudden changes could be due to environmental changes or major changes in the watershed. If TSI values steadily increase over several years, the water quality of the lake will continue to decrease. Watershed best management practices will be needed to halt or reverse the eutrophication process.

5.2 Water Quality

Big Blake Lake is a phosphorus-driven lake that remains well mixed throughout the year. It has water quality similar to other lakes in its region. Parameters measured for conductivity, temperature, pH, SRP, dissolved oxygen, TNK, and TP fell within normal ranges for Wisconsin lakes. The depletion of dissolved oxygen near the sediment of the lake is likely due to biological oxygen demand caused by microbes during decomposition of organic matter.

The inflow from Little Blake Lake is adding to the nutrient problem in Big Blake Lake; water entering Big Blake from Little Blake is high enough in phosphorus to cause eutrophic effects within Big Blake Lake. The average TP concentration for the outlet is abnormally high due to the concentration reported for September *(168µg/L)*. Without this reading, the outflow average would be near the mid-lake average of 48.5 µg/L. As with TP, the September TKN sample caused the average TKN to appear abnormally high. A concentration of 3,100 µg/L was reported for the outlet when the TKN at the mid-lake site was only 870 µg/L. It is possible for the TP and TKN to be higher at the outlet than in the rest of the lake, but the values should be closer than they are, especially considering the short hydrologic retention time of Big Blake Lake. One possible explanation is that there could have been mishandling of the samples at some point between the lake and the laboratory that is unaccounted for.

5.3 Phytoplankton and Zooplankton

Phytoplankton and zooplankton are quite often the largest contributors to the bottom level of the food chain in aquatic systems. Macroinvertebrates, fish and some waterfowl feed on these organisms. Their relationships with their environment and responses to conditions, including predation, have been widely studied with a generalization that as eutrophication increases, species richness declines. Currently, criteria are being established that will allow ecologists to make predictions of water quality based on the assemblages of plankton in the water.

Phytoplankton

Cyanophyta *(blue-green algae)* dominated the concentration of the phytoplankton samples in the summer. Blue-green algae are common in aquatic ecosystems throughout Wisconsin. The phytoplankton community contained 17 unique species in July and 20 in September *(Appendix B)*. In October, the number of species identified dropped to just six.

There is not sufficient background information for phytoplanktonic populations in Wisconsin lakes to make a judgment on water quality based on the 2004 data. Continued sampling and analysis of these organisms will provide background information for the lake and may be used in the future to construct assessment criteria for water quality biomonitoring. It is important to continue monitoring the phytoplankton community if future biocriteria will be used for gauging water quality changes.

Zooplankton

There is not enough data available regarding zooplankton in Wisconsin lakes to make any judgments on water quality based on the assemblage present in Big Blake Lake in 2004. Some bio-assessment criteria are available through the USEPA. These criteria require that the members of the population be broken down into their respective functional groups for analysis of the whole community. As with phytoplankton sampling, continuing this effort is important to establishing criteria for biomonitoring.

5.4 Watershed Analysis and Nutrient Budget

The watershed analysis agrees with previously reported results. The major source of phosphorus is the Straight River inflow to the lake. This study did not include ground water interactions, which were previously reported to account for approximately 72 kg of phosphorus per year. Assuming this value is correct, the total predicted phosphorus load in 2004 was 880 kg, which would mean the calculated load from the Straight River inlet was approximately 80 percent. A previous phosphorus budget reported that approximately 63 percent of the phosphorus load entered the lake through the inlet. It is likely that the value calculated in this report is artificially high because internal sources of phosphorus such as ground water and CLP decomposition were not accounted for in the total phosphorus amount.

The fact that the lake is well mixed and has a hydrologic retention time of approximately 37 days would lead one to assume that the water column should contain a relatively consistent concentration of dissolved oxygen from the water surface to the sediment interface. This is not the case, however, and a more detailed sampling protocol will have to be developed to determine the effects of the anoxic sediment on the potential for internal loading of phosphorus.

Watershed management practices that are going to help Big Blake Lake will need to be incorporated throughout the Straight River watershed. If CLP is contributing a large internal load of phosphorus to Big Round Lake, Little Blake Lake and Big Blake Lake, the total effects will be a sum of the releases from each lake, and the longevity of those releases will be greater for Big Blake Lake.

6.0 Recommendations

The water quality of Big Blake Lake is impacted by two major components - the Straight River Inflow and curly-leaf pondweed. Although no specific study has been performed on Big Blake Lake, previous scientific research has proven decaying CLP contributes to nutrient loading in the summer. It is fair to assume that decaying curly-leaf pondweed will react similarly from lake to lake.

We are recommending the following practices for improving the water quality of Big Blake Lake:

- Public education and implementation of buffer strips and shoreline restoration
- Create a committee including members from Little Blake Lake, Big Round Lake and any organizations or special interest groups interested in improving the Straight River watershed whose goal is to reduce nutrient loading throughout the Straight River watershed
- Work with the County and local townships as they create their land use and zoning regulations to help minimize effects of current and future development
- 2-meter surface integrated laboratory analysis for TP, Chl *a*, TKN and SRP one year out of every three. Sampling should occur monthly from May to October during that year. Sample the anoxic region of the water column if internal loading of phosphorus is under investigation.
- Annual participation in WDNR's self-help monitoring program
- Manage internal loading in the summer by reducing CLP biomass throughout the spring
- Adoption and implementation of the current 2005 Aquatic Plant Management Plan goals and recommendations

7.0 References

Bursik, B. 2001. Polk County Land and Water Resources Plan. Polk County Land Conservation Committee.

Crowell W. 2003. Curlyleaf pondweed: new management ideas for an old problem. Minnesota Department of Natural Resources Exotic Species Program.

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Mange. Soc. And Terrene Inst. In coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI.

Lillie, R. A. and J. W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Technical Bulletin 138, Madison, WI.

McComas, S. 2000. Curlyleaf pondweed: another exotic aquatic plant in Minnesota. Minnesota Lake Association.

Tippecanoe Environmental Lake and Watershed Foundation. website accessed on February 2, 2005 http://www.telwf.org/watertesting/watertesting.htm

Wisconsin Department of Natural Resources (WDNR). 1994. St. Croix River Basin Water Quality Management Plan.

DATA REPORT FORM

REPORT IDENTIFICATION:	POLK COUNTY LCD	Sampled By:	WILLIAMSON & HOLMS
Sample Location:	BLAKE LAKE	Preserved:	H2SO4
Sample Date:	6/8/04	Sample Type:	SW
Sample Time:	1-3 PM	Field Filtered:	YES
Date Received in Lab:	6/10/04	Unusual circumstances that may affect results:	RECD ON ICE PH <2
Purchase Order #:			
ETF Receipt #:	#S05831	RESEARCH ACCOUNT CHARGED?	

Water & Environment
DNR Cert. No.: 7500
College of Natural Res
UW-Stevens Point
Stevens Point, WI 544
(715) 346-3209

ALL DATA mg/l UNLESS NOTED		Reactive Phosphorus	Total Phosphorus	Total Kjeldahl Nitrogen	Chlorophyll-a
Date Analyzed		11-Jun	17-Jun	17-Jun	29-Jun
Lab #	Site				
189-04-1	BBL-1 Big Blake Lake	0.014	0.030	0.520	<1
2	BBL-IN Big Blake Lake Inlet	0.008	0.021	0.535	
3	BBL-Out Big Blake Lake Outlet	0.004	0.015	0.722	

DATA REPORT FORM

REPORT IDENTIFICATION:	BONE & BLAKE LAKES	Sampled By:	WILLIAMSON
Sample Location:		Preserved:	H2SO4
Sample Date:	7/8/04	Sample Type:	SW
Sample Time:	9:20-12 NOON	Field Filtered:	YES
Date Received in Lab:	7/9/04	Unusual circumstances that may affect results:	RECD ON ICE PH <2
Purchase Order #:			
ETF Receipt #:	#515798	RESEARCH ACCOUNT CHARGED?	

Water & Environmental Anal
DNR Cert. No.: 750040280
College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481
(715) 346-3209

ALL DATA mg/l UNLESS NOTED		Chlorophyll-a	Total Phosphorus	Reactive Phosphorus	Total Kjeldahl Nitrogen
Date Analyzed		15-Jul	26-Jul	23-Jul	28-Jul
Lab #	Site				
260-04-1	BON 1	5.4	0.035	0.027	0.430
2	BON 2	7.5	0.018	<.003	0.374
3	LBL 1	20.3	0.029	0.009	0.379
4	BLB 1	4.0	0.029	0.013	0.486

DATA REPORT FORM

REPORT IDENTIFICATION: POLK COUNTY LWCD
Sample Location: BLAKE LAKE
Sample Date: [redacted]
Sample Time: AM
Date Received in Lab: 8/18/04
Purchase Order #:
ETF Receipt #: #572052

Sampled By: ALD, KH
Preserved: H2SO4
Sample Type: SW
Field Filtered: NO
Unusual circumstances that may affect results: RECD ON ICE PH <2
RESEARCH ACCOUNT CHARGED?

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College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481
(715) 346-3209

DATA mg/l UNLESS NOTED

Lab #	Site	Total Phosphorus	Reactive Phosphorus	Total Kjeldahl Nitrogen	Chlorophyll-a
Date Analyzed		24-Sep	27-Aug	24-Sep	26-Aug
314-04-1	Little Blake	0.100	0.020	1.38	12.7
2	Big Blake Inlet	0.036	0.011	0.64	
3	Big Blake Mid	0.063	0.012	0.86	38.9
4	Big Blake Outlet	0.061	0.012	1.05	

(Little Blake outlet)

DATA REPORT FORM

REPORT IDENTIFICATION: POLK COUNTY LWRD
Sample Location:
Sample Date: 9/8/04
Sample Time:
Date Received in Lab: 9/9/04
Purchase Order #:
ETF Receipt #: #572566

Sampled By:
Preserved:
Sample Type:
Field Filtered:
Unusual circumstances that may affect results:
RESEARCH ACCOUNT CHARGED?

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College of Natural Resources
UW-Stevens Point
Stevens Point, WI 54481
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ALL DATA mg/l UNLESS NOTED

Lab #	Site	Total Phosphorus	Reactive Phosphorus	Total Kjeldahl Nitrogen	Chlorophyll-a
Date Analyzed		24-Sep	14-Aug	24-Sep	14-Sep
348-04-1	Big Blake Inlet	0.046	0.017	0.76	
2	Big Blake Mid	0.072	0.024	0.87	31.8
3	Big Blake Outlet	0.168	0.022	3.10	
4	Little Blake	0.062	0.012	0.69	13.9
5	Bone North	0.035	0.013	0.51	17.6
6	Bone South	0.029	0.013	0.49	7.6

DATA REPORT FORM

REPORT IDENTIFICATION: BLAKE LAKES
Sample Location:
Sample Date: 10/26 & 27/04
Sample Time:
Date Received in Lab: 10/28/04
Purchase Order #:
ETF Receipt #: #572661

Sampled By: JW & ALD
Preserved: H_2SO_4
Sample Type: SW
Field Filtered: NO
Unusual circumstances that may affect results: RECD ON ICE
RESEARCH ACCOUNT CHARGED?

Water & Environmental Analyses L
DNR Cert. No.: 750040280
College of Natural Resources
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Stevens Point, WI 54481
(715) 346-3209

ALL DATA mg/l UNLESS NOTED

Lab #	Site	Reactive Phosphorus	Total Phosphorus	Total Kjeldahl Nitrogen	Chlorophyll-a
Date Analyzed		4-Nov	12-Nov	12-Nov	3-Nov
414-04-1	Big Blake - Mid	0.008	<.012	0.29	2.7
2	Big Blake - Outlet	<.003	0.021	0.33	
3	Big Blake - Inlet	0.009	0.021	0.44	
4	Little Blake	0.009	0.038	0.64	11.9
5	Bone North	0.020	0.022	0.31	7.7
6	Bone South	0.016	0.034	0.39	3.2

UNIVERSITY OF WISCONSIN MADISON

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STATE
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University of Wisconsin

fication Report

Site: Big Blake Lake
Station/Location: Midlake
Depth: 3 feet integrated
Laboratory Number: 2004-184

Collection Date: July 8, 2004
Identification Date: August 10, 2004
Identified By: Dawn Karner

Taxa	Division	# Counted	Concentration (Units/mL)[a,b]	Relative % Concentration
Fragilaria crotonensis	Bacillariophyta	4	7	2.6%
Eudorina sp.	Chlorophyta	1	2	0.6%
Oocystis sp.	Chlorophyta	15	25	9.6%
Pediastrum sp.	Chlorophyta	1	2	0.6%
Quadrigula sp.	Chlorophyta	6	10	3.8%
Scenedesmus sp.	Chlorophyta	1	2	0.6%
Schroederia sp.	Chlorophyta	21	35	13.5%
Tetraedron sp.	Chlorophyta	4	7	2.6%
Dinobryon sp.	Chrysophyta	12	20	7.7%
Ochromonas sp.	Chrysophyta	16	27	10.3%
Cryptomonas erosa	Cryptophyta	8	13	5.1%
Anabaena sp.	Cyanophyta	5	8	3.2%
Aphanocapsa sp.	Cyanophyta	2	3	1.3%
Aphanothece clathrata	Cyanophyta	35	58	22.4%
Chroococcus sp.	Cyanophyta	18	30	11.5%
Coelosphaerium sp.	Cyanophyta	6	10	3.8%
Lyngbya sp.	Cyanophyta	1	2	0.6%
	TOTAL		258	100%

Notes/Comments: Analyzed via the Utermohl settling chamber method.

Signature and Date: Dawn Karner 8/10/2004

a Natural Unit Count = unicell, colony or filament equals 1 Unit
b Method Reference = American Public Health Association et al. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed, Method 10200 F2a1.

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University of Wisconsin

Algae Identification Report

Site: Big Blake Lake
Station/Location: Midlake
Depth: 6 feet composite
Laboratory Number: 2004-367
Collection Date: September 8, 2004
Identification Date: September 17, 2004
Identified By: Dawn Karner

Taxa	Division	# Counted	Concentration (Units/mL)[a,b]	Relative % Concentration
Aulacoseira granulata	Bacillariophyta	3	6	0.9%
Oocystis sp.	Chlorophyta	1	2	0.3%
Oocystis sp.	Chlorophyta	1	2	0.3%
Pediastrum sp.	Chlorophyta	1	2	0.3%
Scenedesmus sp.	Chlorophyta	8	15	2.5%
Dinobryon sertularia	Chrysophyta	2	4	0.6%
Cryptomonas sp.	Cryptophyta	30	57	9.4%
Anabaena circinalis	Cyanophyta	66	126	20.7%
Anabaena crassa	Cyanophyta	14	27	4.4%
Anabaena sp.	Cyanophyta	14	27	4.4%
Aphanizomenon issatschenkoi	Cyanophyta	74	141	23.2%
Aphanocapsa sp.	Cyanophyta	6	11	1.9%
Aphanothece sp.	Cyanophyta	2	4	0.6%
Chroococcus sp.	Cyanophyta	7	13	2.2%
Chroococcus sp.	Cyanophyta	1	2	0.3%
Coelosphaerium sp.	Cyanophyta	5	10	1.6%
Dactylococcopsis sp.	Cyanophyta	2	4	0.6%
Planktothrix sp. (Oscillatoria)	Cyanophyta	51	98	16.0%
Ceratium hirundinella	Pyrrhophyta	30	57	9.4%
Peridinium sp.	Pyrrhophyta	1	2	0.3%
	TOTAL		610	100%

Notes/Comments: Sample was preserved with Lugol's in the field. Analyzed via the Utermohl settling chamber method.

Signature and Date: Dawn A. Kr 9/17/04

a Natural Unit Count = unicell, colony or filament equals 1 Unit
b Method Reference = American Public Health Association et al. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed, Method 10200 F2c1

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University of Wisconsin

Rec 12/20/04

Algae Identification Report

Site:	Big Blake Lake	Collection Date:	October 26, 2004
Station/Location:	Mid-lake	Identification Date:	December 15, 2004
Depth:	6 feet	Identified By:	Dawn Karner
Laboratory Number:	2004-451		

Taxa	Division	# Counted	Concentration (Units/mL)[a,b]	Relative % Concentration
Asterionella sp.	Bacillariophyta	2	4	0.4%
Cocconeis sp.	Bacillariophyta	3	7	0.6%
Synedra sp.	Bacillariophyta	2	4	0.4%
Dinobryon divergens	Chrysophyta	383	850	77.7%
Dinobryon divergens (empty lorica)	Chrysophyta	94	209	19.1%
Cryptomonas sp.	Cryptophyta	9	20	1.8%
		TOTAL	1094	100%

Notes/Comments:

Signature and Date: Dawn A. Karner 12/15/04

a Natural Unit Count = unicell, colony or filament equals 1 Unit
b Method Reference = American Public Health Association et al. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed, Method 10200 F2a1

http://www.slh.wisc.edu

Tracking Code:	040013-184	**Sample ID**	BBL	**Replicate #**	1
Customer ID:	184	**Sample Date:**	8/17/2004	**Level**	.
Job Number:	2	**Station:**	.	**Depth**	8
System Name:	Big Blake Lake	**Site:**	Mid-Lake	**Preservative**	Ethanol

Report Notes .

Taxa ID	Genus	Species	Subspecies	Variety	Morph	Structure	Concentration Animal/L	Relative Concentration
Phylum: Arthropoda								
Order:	**Calanoida**							
131852	*.	spp	.	.	.	nauplius	3.13	7.49
1088944	*.	spp	.	.	CI-CIV	Whole Animal	1.57	3.74
128120	Diaptomus	spp	.	.	.	Whole Animal	1.34	3.21
						TOTAL Calanoida	6.04	14.44
Phylum: Arthropoda								
Order:	**Diplostraca**							
194229	Chydorus	sphaericus	.	.	.	Whole Animal	0.89	2.14
194683	Diaphanosoma	leuchtenbergi	.	.	Female	Whole Animal	3.58	8.56
						TOTAL Diplostraca	4.47	10.70
Phylum: Rotifera								
Order:	**Flosculariaceae**							
125872	Conochilus	unicornis	.	.	.	Whole Animal	24.61	58.82
						TOTAL Flosculariaceae	24.61	58.82
Order:	**Ploima**							
131840	Ascomorpha	spp	.	.	.	Whole Animal	0.22	0.53
125281	Keratella	cochlearis	.	.	.	Whole Animal	2.01	4.81
126153	Polyarthra	vulgaris	.	.	.	Whole Animal	1.79	4.28
131850	Trichocerca	spp	.	.	.	Whole Animal	2.68	6.42
						TOTAL Ploima	6.71	16.04

Total Sample Concentration
41.84

Tracking Code:	040023-184	**Sample ID**	.	**Replicate #**	1
Customer ID:	184	**Sample Date:**	9/8/2004	**Level**	.
Job Number:	2	**Station:**	.	**Depth**	8
System Name:	Big Blake Lake	**Site:**	Mid-Lake	**Preservative**	Ethanol

Report Notes .

Taxa ID	*Genus*	*Species*	*Subspecies*	*Variety*	*Morph*	*Structure*	*Concentration Animal/L*	*Relative Concentration*
Phylum: Arthropoda								
Order:	**Calanoida**							
134832	*.	spp	.	.	.	nauplius	0.65	9.20
1000344	*.	spp	.	.	CI-CIV	Whole Animal	0.13	1.84
						TOTAL Calanoida	0.78	11.04
Order:	**Cyclopoida**							
1000248	*.	spp	.	.	CI-CV	Whole Animal	0.17	2.45
						TOTAL Cyclopoida	0.17	2.45
Phylum: Arthropoda								
Order:	**Diplostraca**							
104229	Chydorus	sphaericus	.	.	.	Whole Animal	0.04	0.61
104403	Diaphanosoma	leuchtenbergi	.	.	Female	Whole Animal	0.09	1.23
						TOTAL Diplostraca	0.13	1.84
Phylum: Rotifera								
Order:	**^.**							
127862	*.	spp	.	.	.	Whole Animal	0.09	1.23
						TOTAL ^.	0.09	1.23
Order:	**Flosculariaceae**							
125972	Conochilus	unicornis	.	.	.	Whole Animal	0.09	1.23
						TOTAL Flosculariaceae	0.09	1.23
Order:	**Ploima**							
131840	Ascomorpha	spp	.	.	.	Whole Animal	0.04	0.61
131841	Asplanchna	spp	.	.	.	Whole Animal	0.04	0.61
125281	Keratella	cochlearis	.	.	.	Whole Animal	5.52	78.53
126153	Polyarthra	vulgaris	.	.	.	Whole Animal	0.17	2.45
						TOTAL Ploima	5.78	82.21