Big Butternut Lake
Polk County, Wisconsin

Water Quality and Biological Monitoring Study, Phase 1, LPL-1297-09
Aquatic Plant and Stormwater Management Study, Phase 2, LPL-1298-09

Polk County Land and Water Resources Department
100 Polk County Plaza, Suite 120
Balsam Lake, Wisconsin 54810

Jeremy Williamson, jeremyw@co.polk.wi.us, 715.485.8639
Katelin Holm, katelin.holm@co.polk.wi.us, 715.485.8637
Eric Wojchik, ericw@co.polk.wi.us, 715.485.8644
Scott Geddes, P.E., scott.geddes@co.polk.wi.us, 715.485.8638

Table of Contents

List of Figures

List of Tables

List of Appendices

Background

In the past, Big Butternut Lake has received three lake planning grants from WDNR. The first two were implemented in 1995 by Barr Engineering to study the water quality and macrophytes of Big Butternut Lake. At this time the in-lake phosphorus concentration indicated that Big Butternut Lake was eutrophic to hypereutrophic with a growing season average of 55 µg/l. Additionally, a transect survey found curly-leaf pondweed at nuisance densities. Management recommendations included: determining watershed phosphorus, developing lake-wide goals for curly-leaf pondweed management, lakeshore owner education, and continued monitoring.

A third lake planning grant, also implemented by Barr Engineering, was received in 1999. The recommendations from this study included: implementing in-lake best management practices, installing a detention pond on the north stream, and installing grit chambers in the Village storm sewers to reduce total phosphorus. Due to high financial cost, grit chambers were not installed in the Village. In 2000, Cedar Corp performed a feasibility study to evaluate site conditions and design a two-cell wet detention pond. The receipt of a Target Runoff Management grant allowed for the installation of the wet detention ponds. The feasibility study recommended continued water quality monitoring to verify project pollutant reductions. However, monitoring has not been completed on the wet detention ponds since their installation in 2002.

The main issues facing Big Butternut Lake are water clarity, aquatic plant growth, and blue green algae blooms. Curly leaf pondweed (CLP) is also very prolific on Big Butternut Lake. Currently, the Village of Luck does not have a no-phosphorus ordinance in place and is considering implementing stormwater practices to improve water quality. These factors prompted the Big Butternut Lake Protection and Rehabilitation District, the Village of Luck, and the Polk County Land and Water Resources Department to apply for a two phase lake planning grant in 2009 to reassess and lake and attempt to devise new management strategies to address the main issues facing Big Butternut Lake.

The studies on Big Butternut Lake were performed by the Polk County Land and Water Resources Department with assistance from the Big Butternut Lake Protection and Rehabilitation District and the Village of Luck with financial assistance from two Department of Natural Resources Lake Planning Grants (LPL-1297-09 and LPL-1298-09). The majority of data was collected in 2009.

Big Butternut Lake Introduction

Big Butternut Lake (WBIC 2641000) is located entirely in the Village of Luck in Polk County, Wisconsin. Big Butternut Lake is at the headwaters of the Trade River Watershed which drains to the St. Croix River Basin. Butternut Creek flows from Big Butternut Lake to Little Butternut Lake and eventually into the Trade River. There are two inflows to Big Butternut Lake. One enters on the East side of the lake and the other enters on the North side of the lake. Road culverts flow under State Hwy 48 towards the lake, and Village storm sewers also enter Big Butternut Lake (Figure 1).

Lake area: 378 acres
Watershed area: 1970.3 acres
Watershed to lake area ratio: 5.2 to 1

- Typically water quality decreases with an increasing ratio of watershed area to lake area. This is obvious when one considers that as the ratio of watershed to lake area increases there are additional sources (and volumes) of runoff to the lake. Big Butternut Lake has a relatively small watershed to lake area ratio.

DNR classification of lake type: drainage
Mean depth: 13 feet
Maximum depth: 19 feet
Shoreline: 3.4 miles

Growing season mean total phosphorus concentration: 71 µg/l
Growing season mean soluble reactive phosphorus concentration: 45.8 µg/l

Growing season mean nitrate/nitrite concentration: 98 µg/l
Growing season mean ammonium concentration: 224 µg/l

Growing season mean TN:TP ratio in Big Butternut Lake: 16.8:1

Surface area coverage of aquatic plants: June = 26% and September = 17%
Number of plants species found in survey (species richness): June = 17 and September = 15

**Growing season mean concentrations exclude values for turnover samples.*

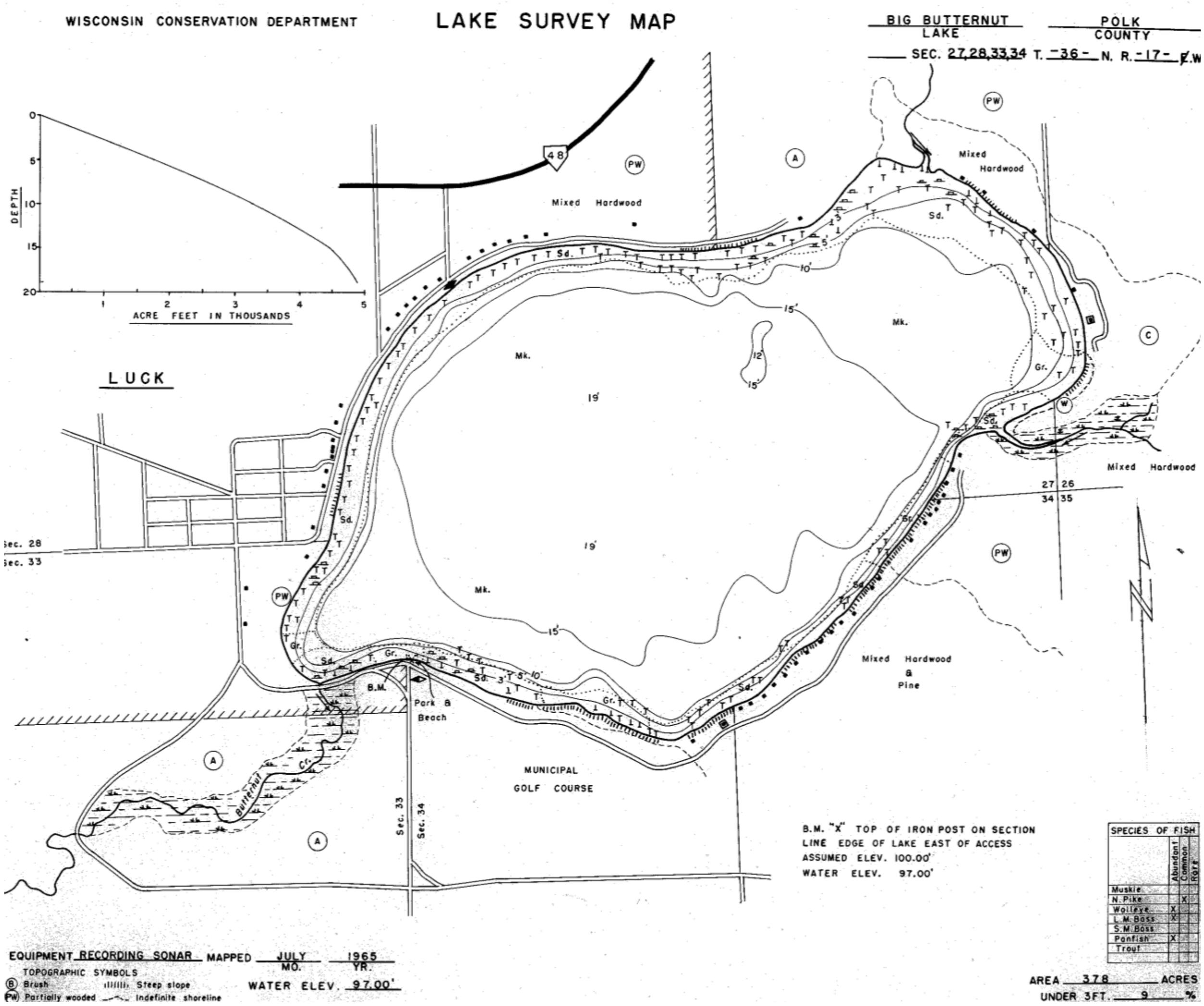


Figure 1. Map of Big Butternut Lake

Physical and Chemical Data

Physical and chemical data were collected in-lake at the deep hole of Big Butternut Lake beginning on April 21th and ending on October 19th, 2009.

Integrated samples were collected from the water column once a month and analyzed at the Water and Environmental Analysis Lab (WEAL) at UW-Stevens Point for two types of phosphorus (total phosphorus and soluble reactive phosphorus), three types of nitrogen (nitrate/nitrite, ammonium, and total Kjeldahl nitrogen), chlorophyll a, sulfate, and total suspended solids. Additionally, spring and fall turnover samples were collected in April and October. Big Butternut Lake in-lake chemical data for 2009 can be found in Appendix A and historical in-lake water quality data can be found in Appendix B.

Lake profile monitoring data, which included dissolved oxygen, temperature, conductivity, pH, and Secchi depth was conducted bi-monthly. Dissolved oxygen, temperature, and conductivity readings were recorded at every meter within the water column using a YSI 85 multi-parameter probe. pH readings were recorded at every meter within the water column using a YSI 60 pH meter. Secchi depth was recorded using a Secchi disk, which is an eight inch round disk with alternating black and white quadrants. To record Secchi depth the Secchi disk was lowered into the lake on the shady side of a boat until it just disappeared from sight. This depth was measured and recorded as the Secchi depth. Big Butternut Lake in-lake physical data for 2009 can be found in Appendix C and Big Butternut Lake in-lake historical physical data can be found in Appendix D.

Phosphorus

Phosphorus is an element present in lakes which is necessary for plant and algae growth. It occurs naturally in soil, rocks, and the atmosphere and can make its way into lakes through soil erosion from construction site runoff and other human induced disturbances. Additional sources of phosphorus input into a lake can include fertilizer runoff from urban and agricultural settings and manure. While phosphorus is necessary for plant and animal growth, excessive amounts lead to an overabundance of growth which can decrease water clarity and cause nutrient pollution in lakes. Phosphorus is present in lakes in several forms. This study measured two forms of phosphorus: total phosphorus and soluble reactive phosphorus.

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

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

A "healthy" limit of phosphorus is set at 20 µg/l total phosphorus and 10 µg/l soluble reactive phosphorus to prevent nuisance algal blooms.

Data collected in Big Butternut Lake at each sampling date indicated elevated levels of both total phosphorus and soluble reactive phosphorus as compared to the "healthy" limit (Figure 2 and Figure 3) where the "healthy limit" is indicated by a red threshold line. The growing season averages for each parameter (TP = 71 µg/l and SRP = 45.8 µg/l) were also elevated as compared to the healthy limit.

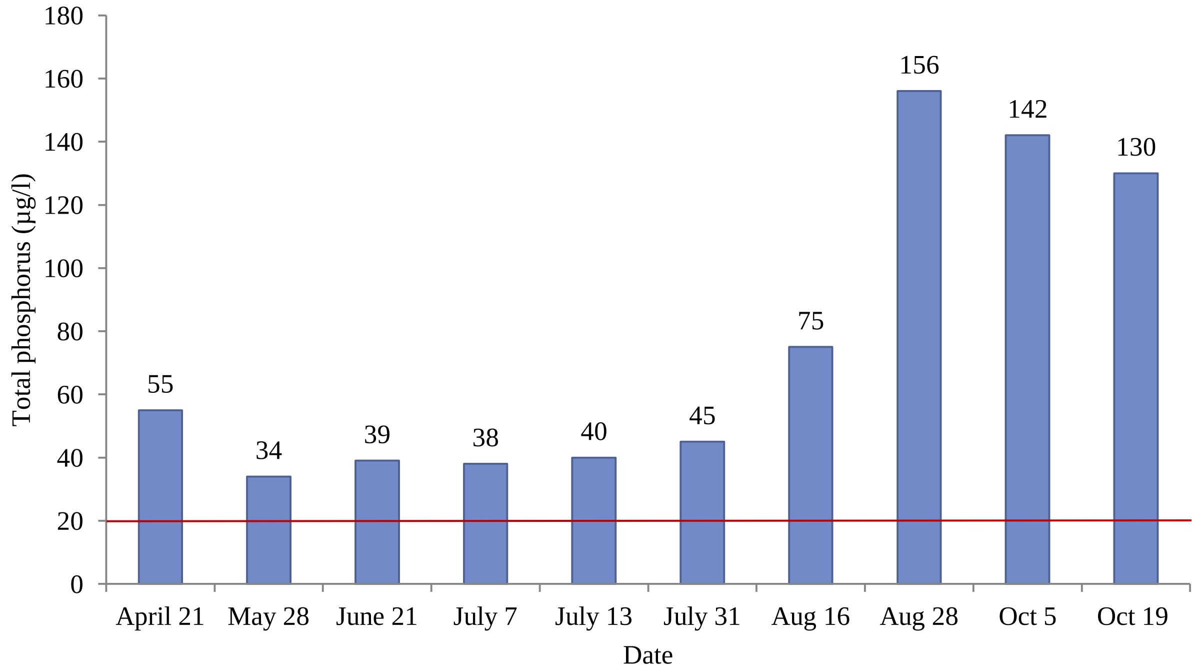


Figure 2. Big Butternut Lake total phosphorus (µg/l), 2009. Red threshold line represents a healthy limit of total phosphorus, 20 µg/l. Data presented includes Citizen Lake Monitoring Data from SWIMS.

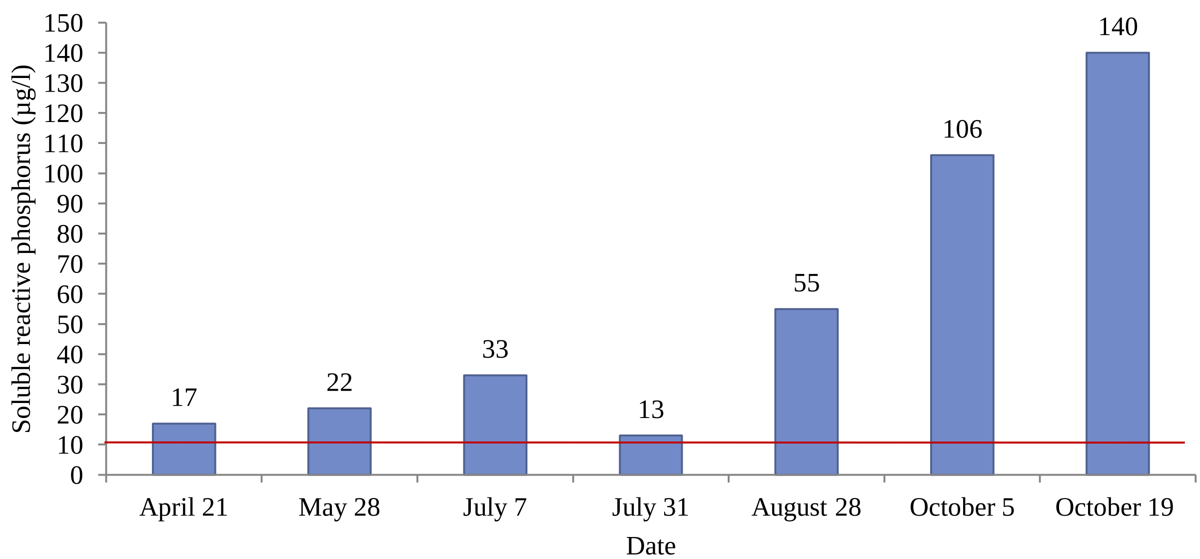


Figure 3. Big Butternut Lake soluble reactive phosphorus (µg/l), 2009. Red threshold line represents a healthy limit of soluble reactive phosphorus, 10 µg/l.

Total phosphorus reached a peak on August 28th and soluble reactive phosphorus reached a peak on October 19th. Summer spikes in phosphorus are typical and can arise from the release of nutrients when aquatic plants and algae senesce, or grow old and die. These data show a snapshot of Big Butternut Lake over a year long period. However, a single year of data does not allow for long term conclusions to be made.

Fortunately, data regarding total phosphorus has been collected on Big Butternut Lake since 1995. This allows for the generalization of historical data and trends with regards to total phosphorus (Figure 4).

Continued data collection related to phosphorus will be necessary to determine whether or not lake health is improving.

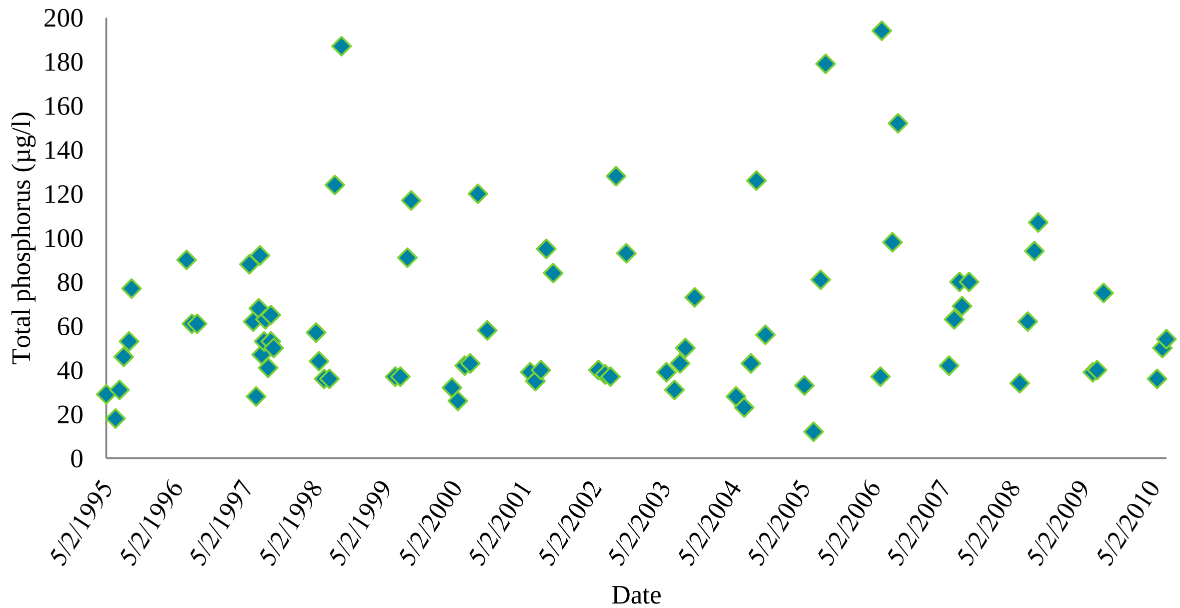


Figure 4. Big Butternut Lake total phosphorus (µg/l), 1995-2010.

Nitrogen

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

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

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

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

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

In Big Butternut Lake the inorganic forms of nitrogen that are available for plant and algal uptake (NO_3+NO_2+NH_4) were below the threshold level of 300 µg/l in all the sample dates with the exception of October 5th and October 19th (Figure 5). The growing season mean nitrate/nitrite concentration was 98 µg/l and the growing season mean ammonium concentration was 224 µg/l.

The spike in inorganic nitrogen in October is possibly due to the release of nitrogen from plants/algae when they senesce, or grow old and die. The concentration of organic nitrogen found in plants and algae reached a peak on August 28th, possibly representing an algae bloom, and then returned to pre-August levels which could support this conclusion (Figure 6).

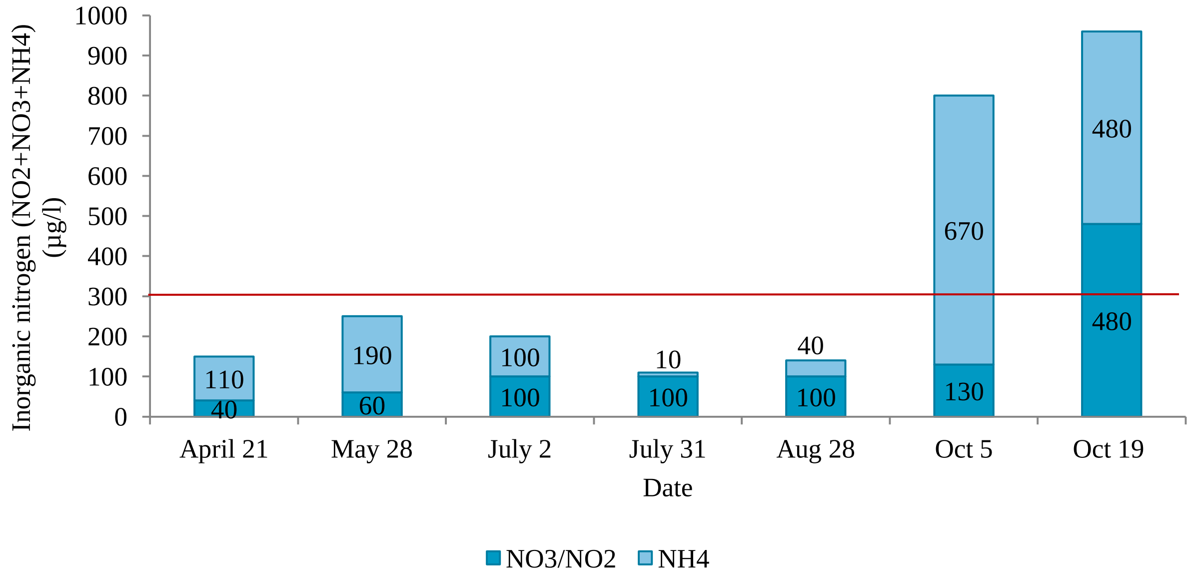


Figure 5. Big Butternut Lake inorganic nitrogen (µg/l), 2009. Red threshold line represents a healthy limit of inorganic nitrogen, 300 µg/l.

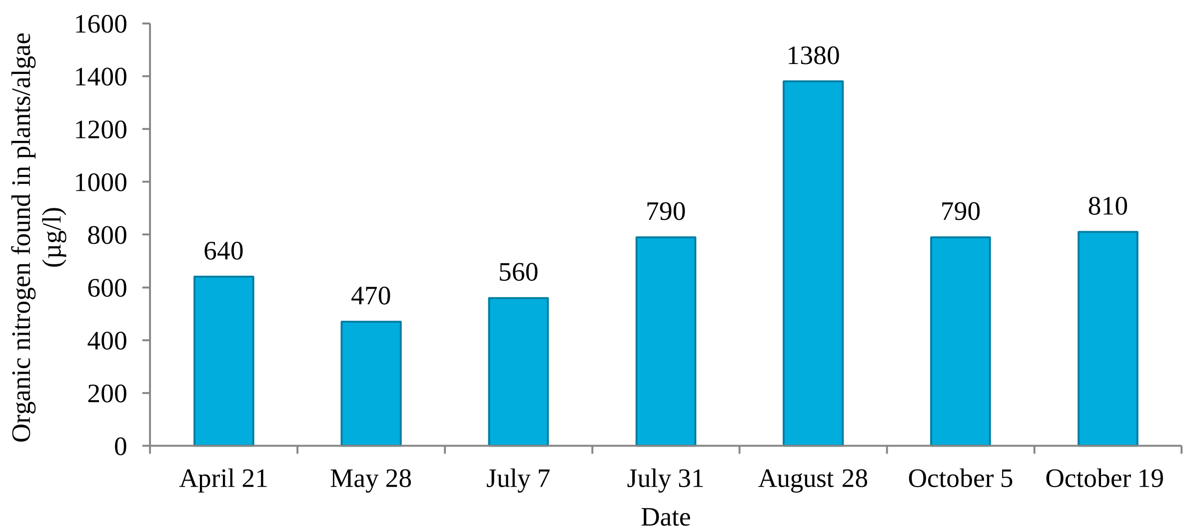


Figure 6. Big Butternut Lake organic nitrogen found in plants/algae (µg/l), 2009.

Total Nitrogen to Total Phosphorus Ratio

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

In Big Butternut Lake the total nitrogen to total phosphorus ratio varied throughout the 2009 growing season. Although half of the sample points indicate that the lake is phosphorus limited, the remainder of the sample points indicate that the lake is transitional or nitrogen limited (Figure 7). The growing season mean total nitrogen to total phosphorus ratio is 15, which indicates a transitional state. Continued monitoring would provide more thorough analysis. For present, both nitrogen and phosphorus inputs into the lake should be minimized.

The study conducted by Barr Engineering in 1995 found phosphorus to be the limiting nutrient over the entire growing season in Big Butternut Lake.

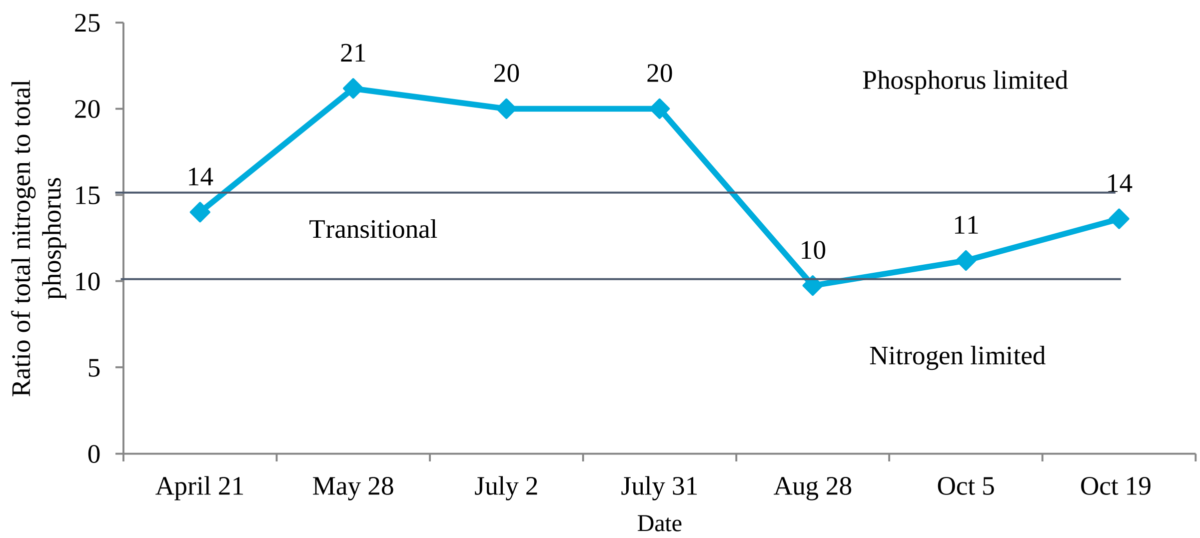


Figure 7. Big Butternut Lake ratio of total nitrogen to total phosphorus, 2009. Values below 10 represent lakes which are nitrogen limited and values above 15 represent lakes which are phosphorus limited. Values between 10 and 15 indicate a transitional state.

Sulfate

Sulfate is a naturally occurring ion that is often associated with heavy mineral deposits and tends to accumulate in lake ecosystems unless removed. The amount of sulfate in lakes is primarily related to the types of minerals within the watershed and to acid rain. In Wisconsin, the highest levels of sulfate in lakes (over 40,000 µg/l) are found in the southeast portion of the state. In Polk County, lake sulfate levels are generally less than 10,000 µg/l.

Sulfate concentrations increased over the year from 4,360µg/l at spring turnover, 10,240 µg/l in early July, and 11,400 µg/l at fall turnover.

Chlorophyll a

Chlorophyll a is a pigment in plants and algae that is necessary for photosynthesis and is an indicator of water quality in a lake. While chlorophyll a gives a general indication of the amount of algae growth in the water column, it is not directly correlated with algae biomass. Chlorophyll a seems to have the greatest impact on water clarity when levels exceed 30 µg/l. Lakes which appear clear generally have chlorophyll a levels less than 15 µg/l.

The mean growing season chlorophyll a concentration in Big Butternut Lake was 27.5 µg/l. The concentration ranged from 4 µg/l in May and spiked to a high of 91.2 µg/l by August (Figure 8). Historically (1995 onward), chlorophyll a concentrations in Big Butternut Lake have shown a slight increase (Figure 9).

Studies completed by Barr Engineering in 1995 and 1997 noted similar trends of increasing chlorophyll a over the growing season. Their studies noted that in both 1995 and 1997 chlorophyll a levels remained low through June and increased to bloom levels in August.

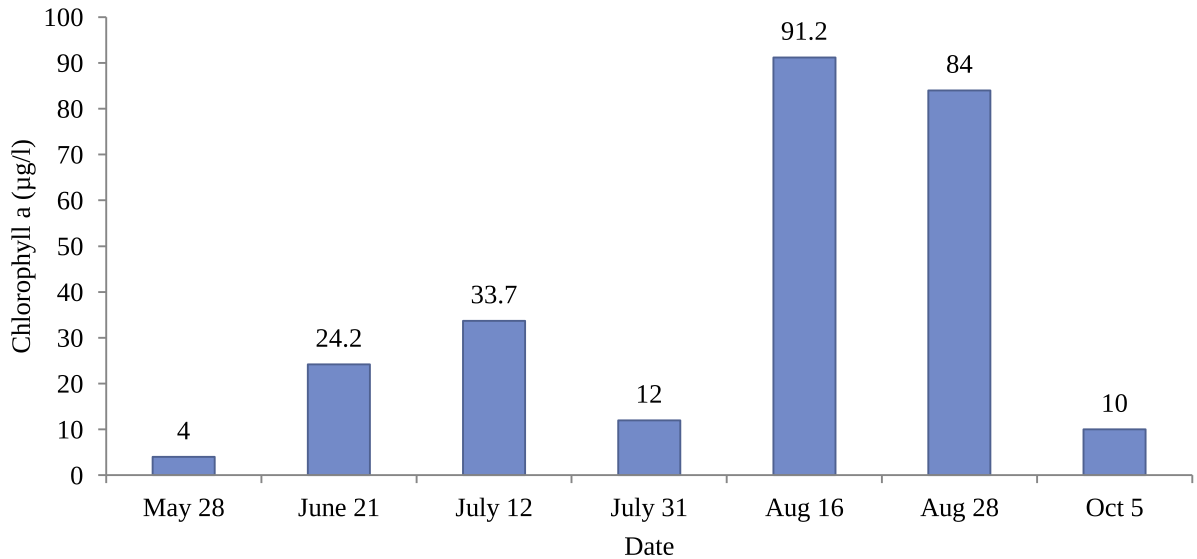


Figure 8. Big Butternut Lake chlorophyll a (µg/l), 2009. Data presented includes Citizen Lake Monitoring Data from SWIMS.

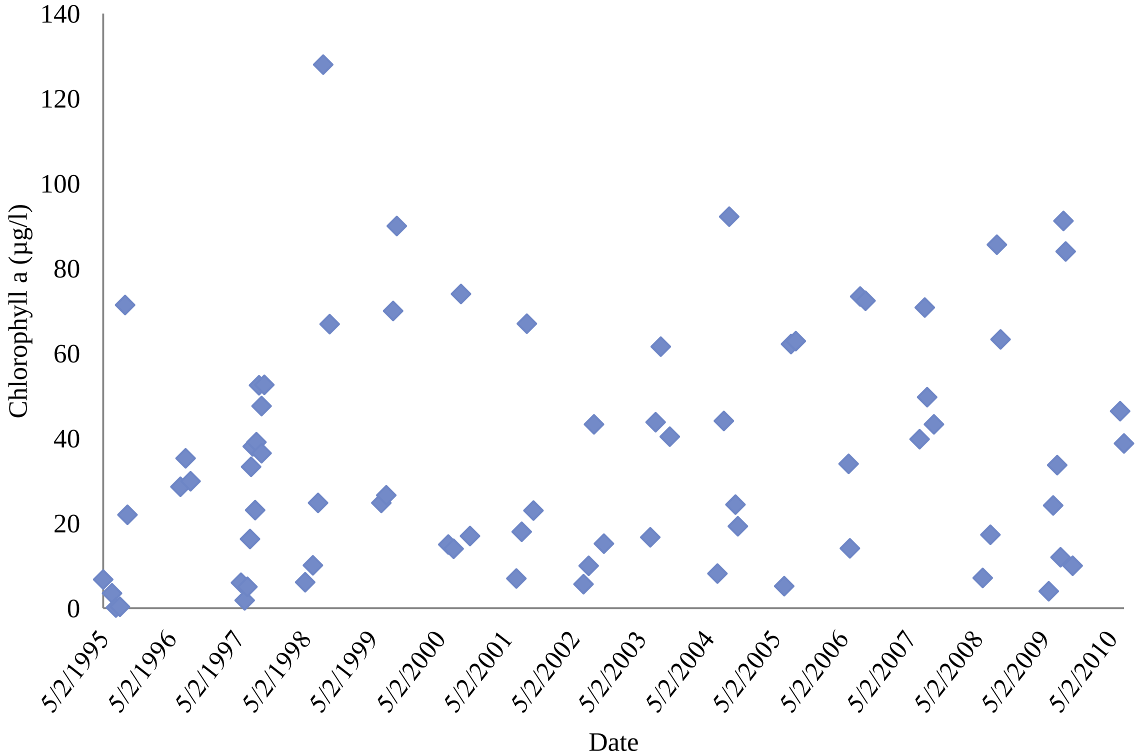


Figure 9. Big Butternut Lake chlorophyll a (µg/l), 1995-2010.

Total Suspended Solids

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

The total suspended solids measured in Big Butternut Lake ranged from 8,000 µg/l to less than 2,000 µg/l, with the maximum value occurring on July 31st, 2009. As these values are not incredibly high, sediment is not likely the primary cause of turbid water. Instead algae are likely driving the season variation in total suspended solids (Figure 10).

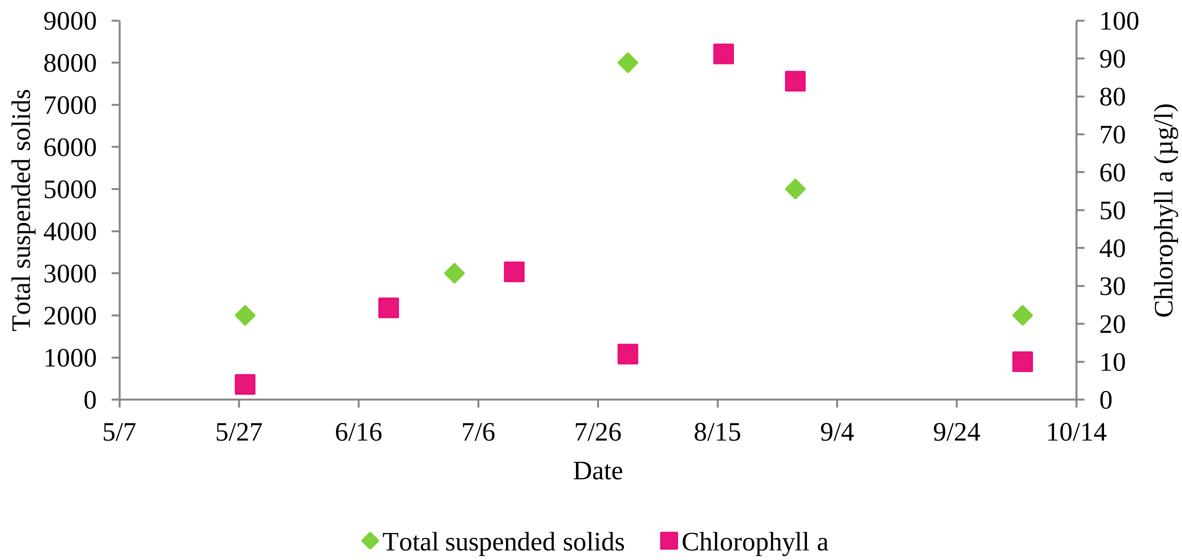


Figure 10. Big Butternut total suspended solids versus chlorophyll a, 2009.

Dissolved Oxygen

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

Big Butternut Lake has a mixed water column that does not stratify (separate into distinct layers). Instead wind and wave action are able to mix the water in Big Butternut Lake such that oxygen is distributed throughout the water column. This same process also allows nutrients from the sediments to become re-suspended in the water column and contribute as a source of nutrient inputs.

At the surface of Big Butternut Lake dissolved oxygen ranged from 9.38 to 4.60 mg/l over the growing season. At the bottom of the lake dissolved oxygen ranged from 0.10 to 0.39 mg/l. The amount of dissolved oxygen is rather consistent throughout the water column which is typical of shallow lakes that do not stratify. However, there is stratification in dissolved oxygen between three and four meters in June and July which could be due to heavy phytoplankton growth. Dissolved oxygen levels are typically lower near the bottom of a lake due to oxygen consumption by decomposing organic matter which sinks to the bottom of a lake (Figure 11).

A study by Barr Engineering in 1995 suggested that as the hypolimnion became anoxic a change in sediment chemistry resulted.

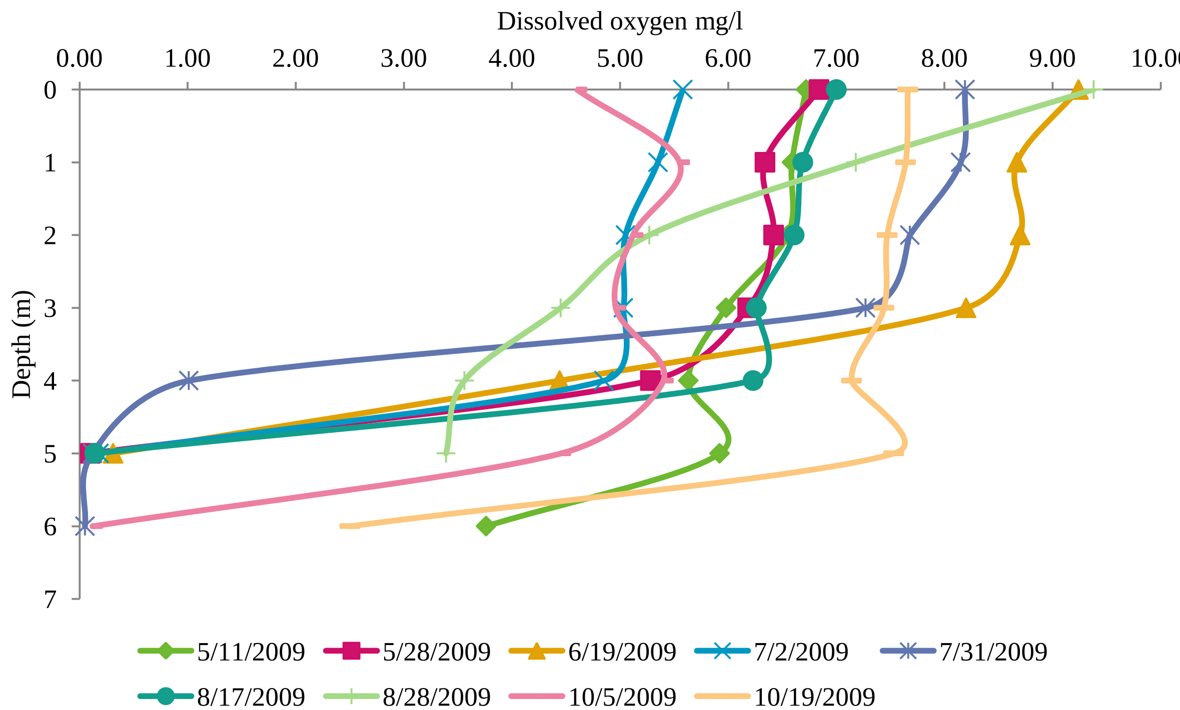


Figure 11. Big Butternut Lake dissolved oxygen (mg/l) profile, 2009.

Temperature

Big Butternut Lake is said to be isothermal, meaning that the lake water is the same temperature from top to bottom (Figure 12). On any given date that sampling occurred, the difference between water temperature at the surface and bottom of the lake differed by only 1-3 degrees Celsius. Under these conditions, wind can mix the entire lake because water from all parts of the lake has the same density. The warmest temperature on the surface of Big Butternut Lake was 23.5°C on August 17th, 2009 and the coldest temperature on the surface of the Lake was 7.8°C on October 19th, 2009.

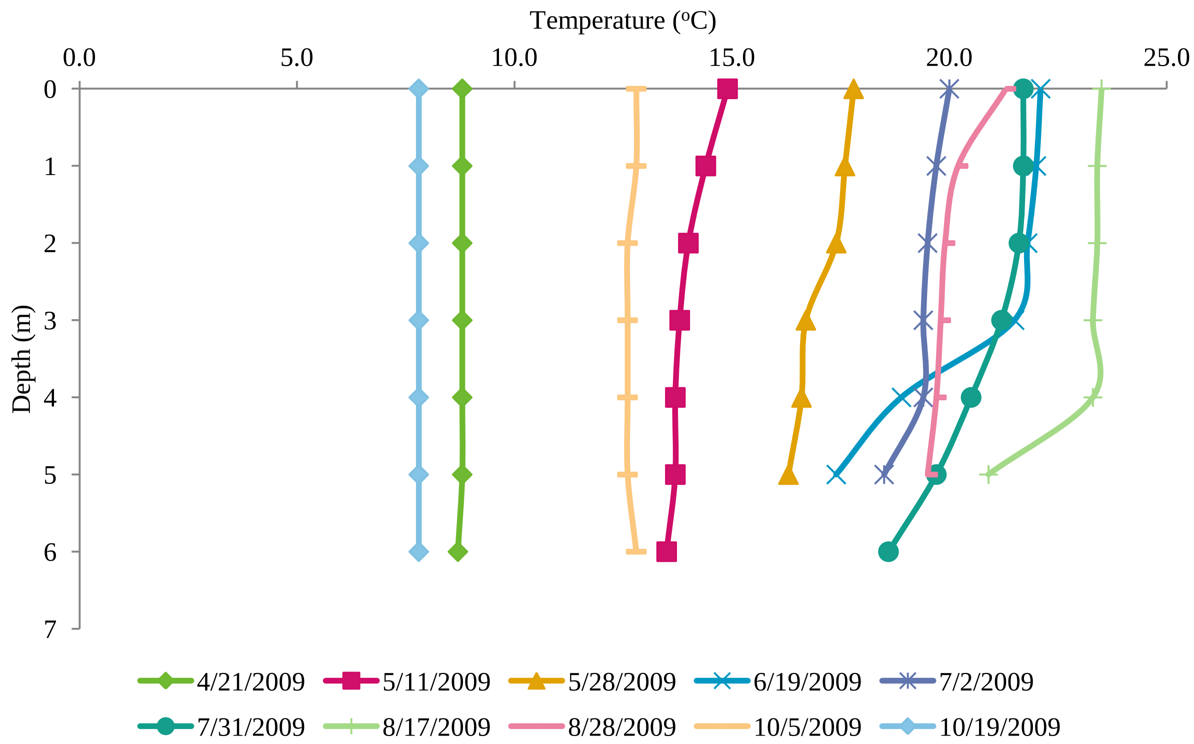


Figure 12. Big Butternut Lake temperature (°C) profile, 2009.

Specific Conductance

Specific conductance is a measure of the ability of water to conduct an electrical current and serves as an indicator of the concentration of dissolved solids in the water. Since conductivity is temperature related, reported values are normalized at 25^0C and termed specific conductance. Specific conductance increases as the concentration of dissolved minerals in a lake increase.

At any given date, specific conductance remained fairly constant within the water column with the exception of late June through July where specific conductance increased drastically near the sediment interface of the water column (Figure 13). Due to anoxic conditions there was likely a reducing condition at the sediment-water interface, causing the release of cations and nutrients.

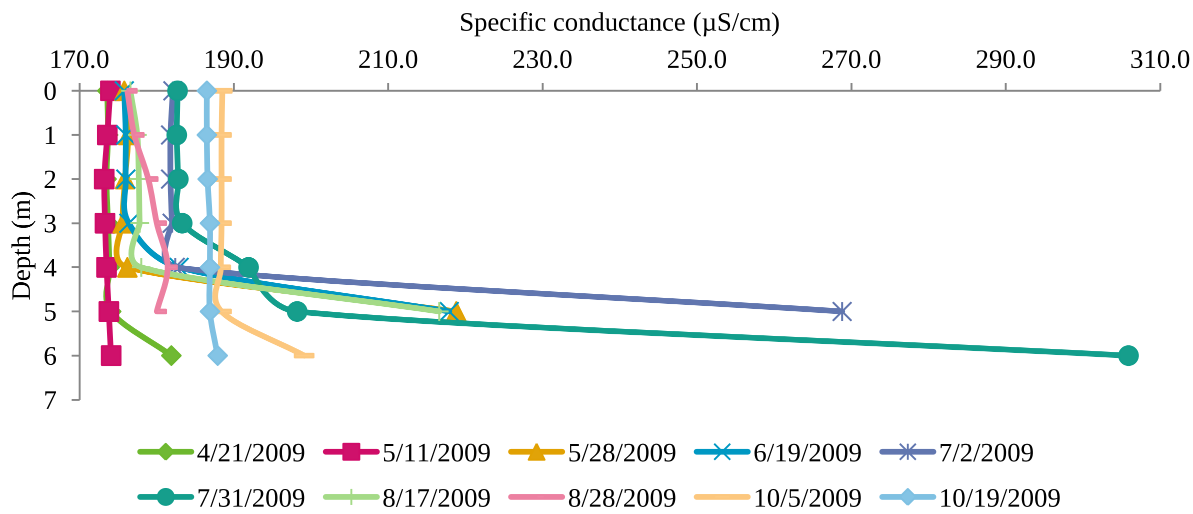


Figure 13. Big Butternut Lake specific conductance (µS/cm) profile, 2009.

pH

pH is a measure of the acidity of the water. A pH value of 7 is considered neutral. Values less than 7 indicate acidic conditions; whereas, values greater than 7 indicate alkaline conditions. Algae can cause the pH in a lake to increase as they deplete the bicarbonate in the lake.

A study conducted by Barr Engineering in 1995 found the pH in Big Butternut Lake to be within the normal range.

Figure 14 shows the pH profile for Big Butternut Lake. In July and August the surface pH was two to three orders of magnitude greater than in May and June. On August 28th the pH instrument failed after taking a surface reading of 10, which is a very high reading. There was a significant algae bloom on August 28th which could account for the increase in pH (Figure 15).

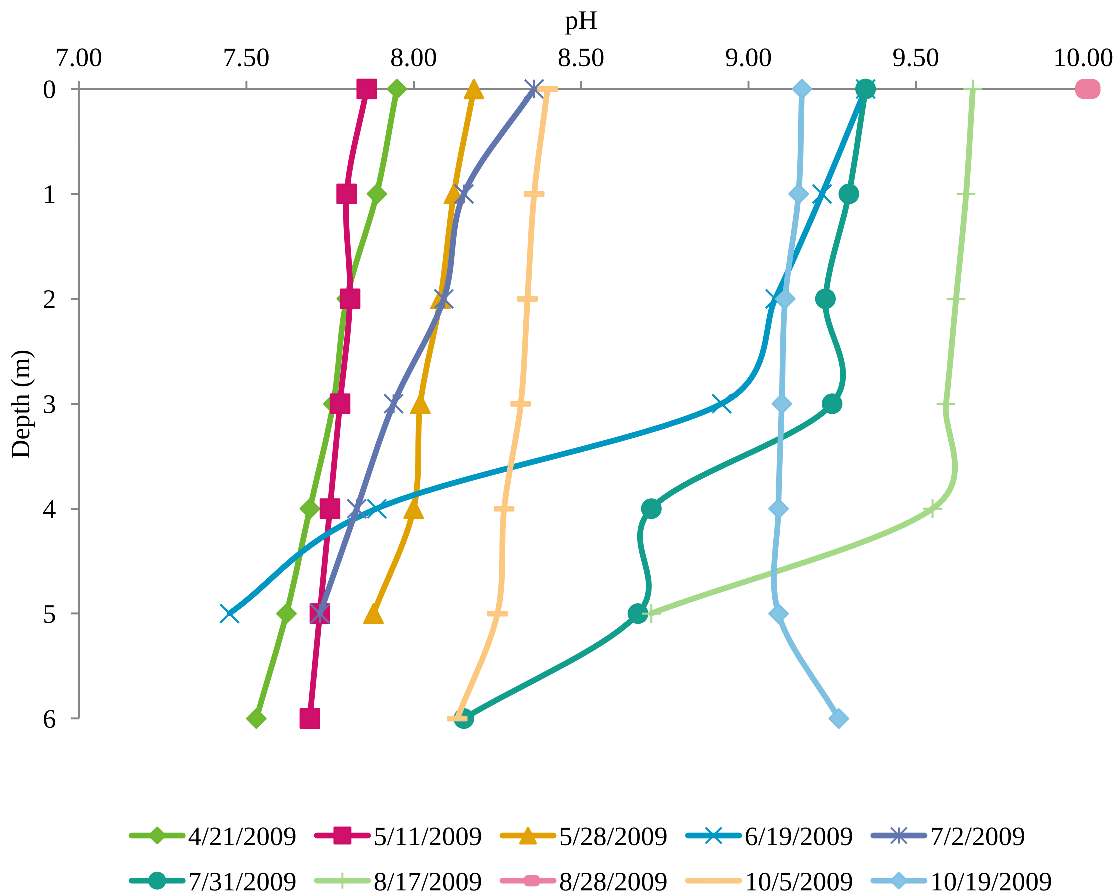


Figure 14. Big Butternut Lake pH profile, 2009.

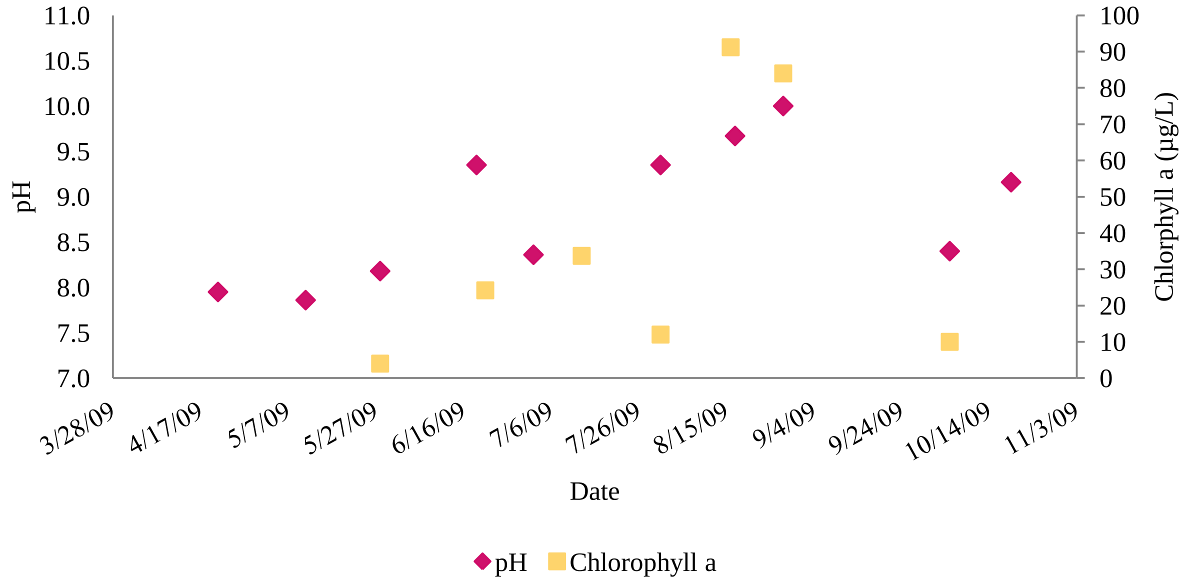


Figure 15. Big Butternut Lake pH versus chlorophyll a, 2009.

Secchi Depth

Secchi depth is a measure of the amount of light that can penetrate the water column and serves as a measure of water clarity. Secchi depth is affected by dissolved and suspended materials in the water column, as well as phytoplankton (algae).

The average summer Secchi depth (July 15-September 15) in Big Butternut Lake was 2.57 feet. As expected, the Secchi depth was lowest in August when peak chlorophyll a levels were noted (Figure 16).

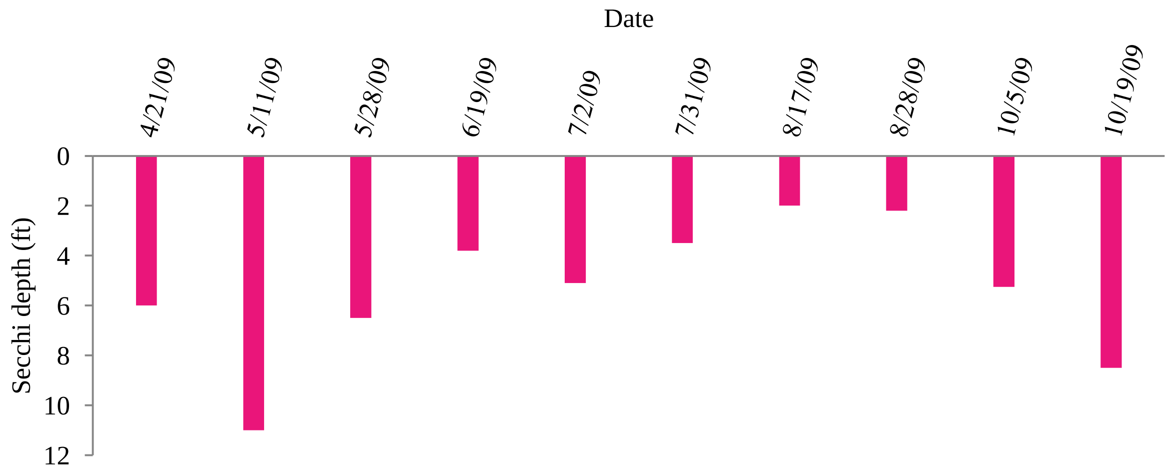


Figure 16. Big Butternut Lake Secchi disk profile, 2009.

Although the seasonal variation in Secchi depth is great; historically Secchi depth readings have remained fairly constant (Figure 17).

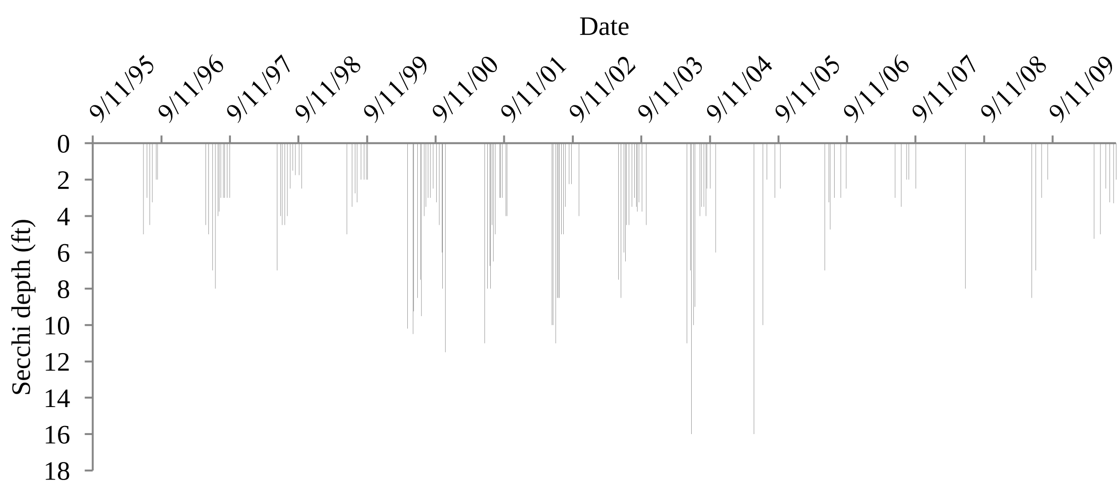


Figure 17. Big Butternut Lake historical Secchi depth, 1995-2010.

Trophic State Index (TSI)

Lakes are divided into three categories based on their trophic states: oligotrophic, eutrophic, and mesotrophic. These categories reflect a lake's nutrient and clarity level and serve as an indicator of water quality. Each category is designed to serve as an overall interpretation of a lake's primary productivity (Figure 18).

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

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

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

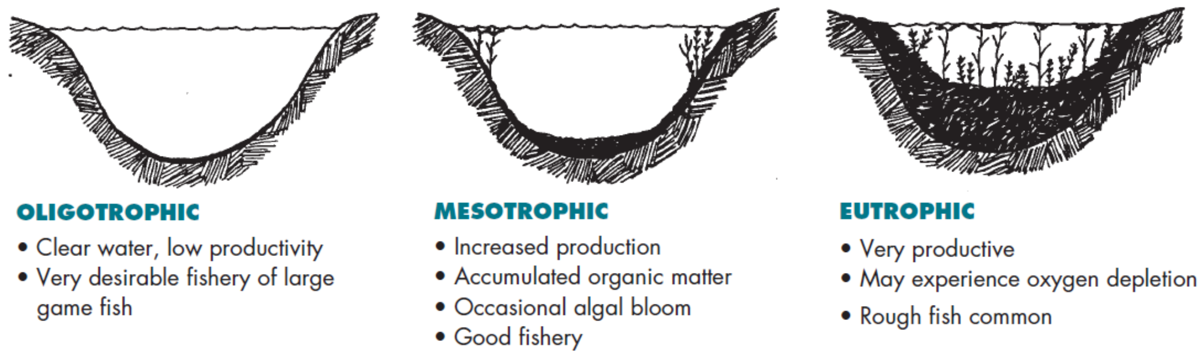


Figure 18. Lake aging process. *Photo from Understanding Lake Data (G3582).*

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

Three equations for summer TSI (July 15-Septebmer 15) were examined for Big Butternut Lake using data collected by Polk County Land and Water Resources Department:

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

Big Butternut Lake	Value for Equation	**TSI**
Total Phosphorus	101	**71**
Chlorophyll a	48	**69**
Secchi Depth	.78	**64**

Table 1. Values used to determine the Trophic State Index for Big Butternut Lake

The Trophic State Index for total phosphorus is higher than the TSI for chlorophyll a which is higher than the TSI for Secchi depth (Table 1). This indicates that the lake is algae dominated (rather than macrophyte), but that algal biomass is limited by zooplankton grazing or possibly other factors.

By finding an average of the three values for the Trophic State Index equations an overall TSI rating of 68 was found for Big Butternut Lake, which indicates that Big Butternut Lake is eutrophic (Table 2).

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

Big Butternut Lake TSI Ratings

Table 2. Trophic State Index values and descriptions, including Big Butternut Lake's rating.

Monitoring the Trophic State Index of a lake gives stakeholders a method by which to gauge productivity over time. Fortunately, Trophic State Indexes have been monitored for Big Butternut Lake since 1995. From these data it can be concluded that Big Butternut Lake has been categorized as mildly eutrophic to eutrophic since 1995 (Table 3)

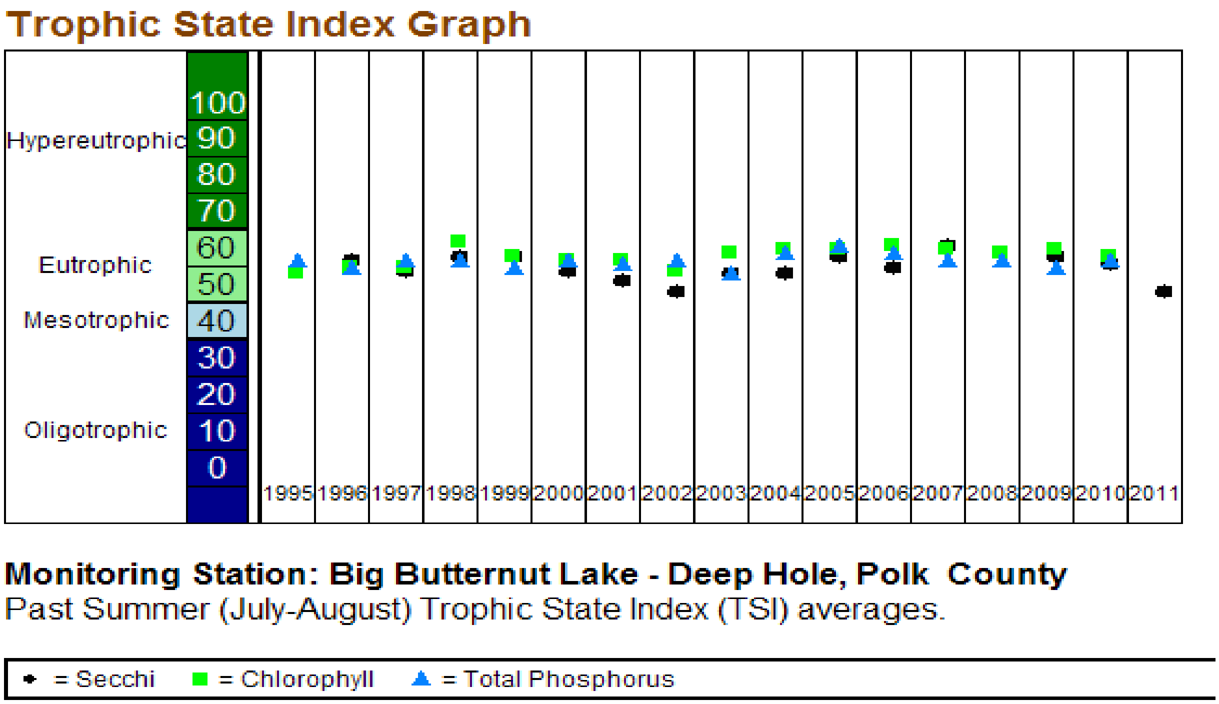


Table 3. Big Butternut Lake historical Trophic State Index, 1995-2011, from DNR website.

Phytoplankton

Algae, also called phytoplankton, are microscopic plants that convert sunlight and nutrients into biomass, which may or may not be consumable. They are the primary producer in an aquatic ecosystem and respond quickly to changes in water chemistry. The size of different types of algae is an important determination of what types of zooplankton can graze upon them. Because of their short life cycle, changes in water quality are often reflected by changes in the algal community within a few days or weeks. Determination of the numbers and types of algae present in a water body is useful in environmental monitoring programs, impairment assessments, and the identification of management strategies.

Algal morphologies can be unicellular, planktonic, colonial, pseudo filamentous, filamentous, or take other forms. Algae are classified by a combination of their characteristics including photosynthetic pigments (like chlorophyll a), starch-like reserve products, cell covering, and other aspects of cellular organization.

The types of algae in a lake will change over the course of a year. Typically there is less biological activity in winter and spring because of ice cover and cold temperatures. As the lake warms up and gains access to more sunlight, algae communities begin to grow. Their short life span quickly cycles the nutrients in a lake and affects nutrient dynamics. Algae can live on bottom sediments and substrate, in the water column, and on plants and leaves. The genus and species present in a lake are influenced by environmental factors like climate, phosphorus, nitrogen, silica and other nutrient content, carbon dioxide, grazing, substrate, and other factors in the lake. When high levels of nutrients are available, blue green algae often become predominant.

Chlorophyll a is a pigment in plants and algae this is necessary for photosynthesis. While chlorophyll a gives a general indication of the amount of algae growth in the water column, it is not directly correlated with algae biomass. Certain flora also contain accessory pigments for photosynthesis making universal statements about algal communities and quality based on chlorophyll a samples difficult to make. For this reason, composite samples from a 2 meter water column were collected monthly and sent to the State Lab of Hygiene for identification and enumeration of algae species present in Big Butternut Lake. Algae from the samples were identified to genus and a relative concentration and natural unit count was made to describe the assemblage throughout the growing season. This method of sampling also allows the identification of any species of concern which might be present. Big Butternut lake phytoplankton data can be found in Appendix E.

There are 12 classes of algae found in typical lakes of Wisconsin. Six classes were found in Big Butternut Lake (Table 4):

Algal Class	**Common Name**	**Characteristics**
Chlorophyta	Green Algae	Have a true starch and provide high nutritional value to consumers. Can be filamentous and intermingle with macrophytes.
Bacillariophyta	Diatoms	Have a siliceous frustule that makes up the external covering. Sensitive to chloride, pH, color, and total phosphorus (TP) in water. As TP increases, see a decrease in diatoms. Generally larger in size. Tend to be highly present in spring and late spring. Can be benthic or planktonic.
Cryptophyta	Cryptomonads	Have a true starch. Planktonic. Bloom forming, are not known to produce any toxins and are used to feed small zooplankton. Cryptomonads frequently dominate the phytoplankton assemblages of the Great Lakes.
Cyanophyta	Blue Green Algae	Prevail in nutrient-rich standing waters. Blooms can be toxic to zooplankton, fish, livestock, and humans. Can be unicellular, colonial, planktonic, or filamentous. Can live on almost any substrate. More prevalent in late to mid-summer.
Pyrrhophyta	Dinoflagellates	Have starch food reserves and serve as food for grazers
Chrysophyta	Golden Brown Algae	Organisms which bear two unequal flagella. A genus of single-celled algae in which the cells are ovoid. Contain chlorophyll a, c_1 and c_2, generally masked by abundant accessory pigment, fucoxanthin, imparting distinctive golden color to cells.

Table 4. Description of algal classes found in Big Butternut Lake.

The species composition of algal communities change seasonally in response to light, temperature, nutrients, grazing of zooplankton, and rain events. Figure 19 and Figure 20 show the changes in species composition in Big Butternut Lake over the 2009 growing season. Total algae populations peaked on August 28th and decreased to their lowest levels on October 5th. Cyanophyta, or blue green algae, were found at very low levels in May with their populations increasing through July and August. The increase in cyanophyta accounted for the total algae population peak that occurred on August 28th.

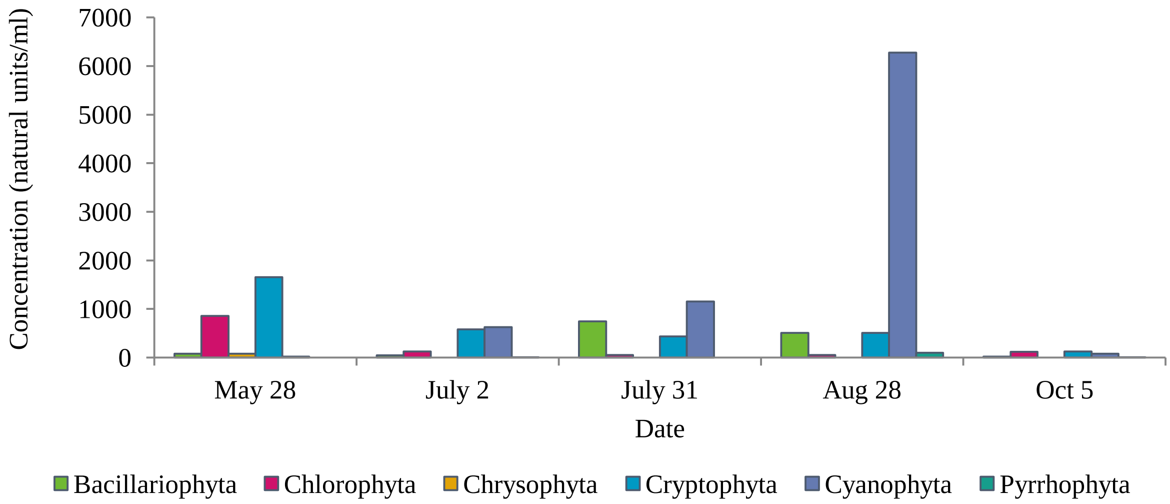


Figure 19. Natural units/ml of each algae division, Big Butternut Lake, 2009.

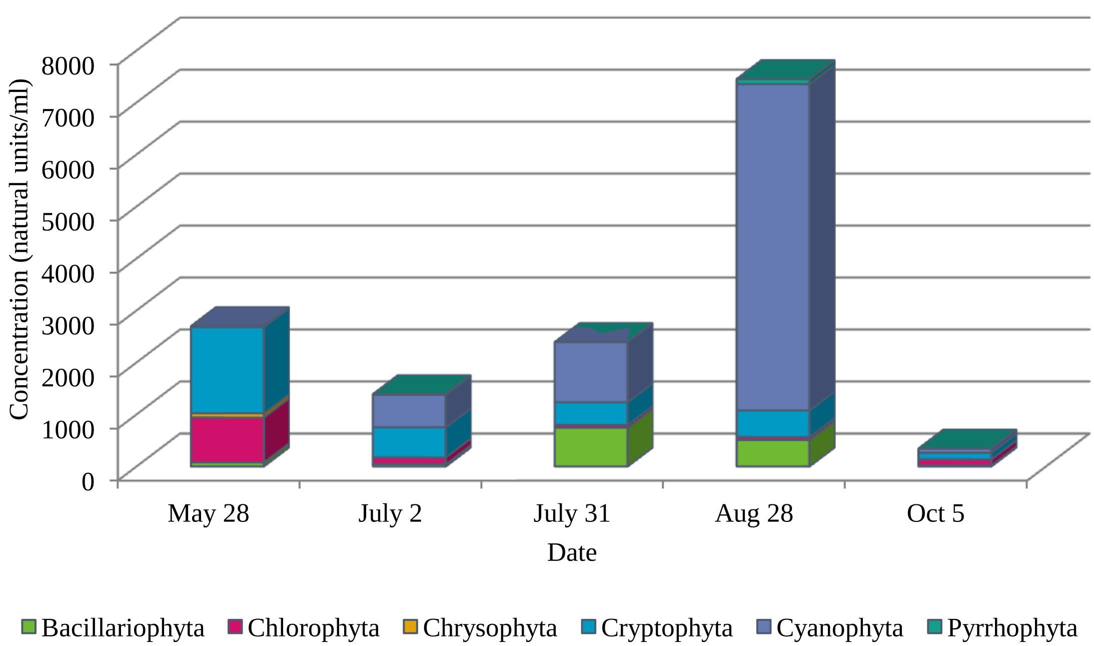


Figure 20. Natural units/ml of each algae division as a stacked column, Big Butternut, 2009.

Phosphorus was abundant in the lake water column while inorganic nitrogen was tied up in algae during the growing season. Some types of algae are able to capitalize on this type of system. Cyanobacteria (blue-green algae) can acquire nitrogen from the atmosphere as a gas (N_2) instead of through the water column with a structure called heterocysts. These types of algae have a competitive advantage in Big Butternut Lake where the water column is continuously mixed. In fact, blue green algae were the dominant algae type from July until fall turnover.

The pattern of ups and downs in algae species composition is typical in all lake systems, however well mixed eutrophic lakes tend to be dominated by cyanobacteria which could reach a threshold of balance and, in conjunction with the animal community, helps maintain the turbid phytoplankton dominated state through positive feedback mechanisms. Big Butternut Lake has a fragile aquatic plant community and is at the turbid water state at this point in time. However, because there are still macrophytes in the littoral zone, controlling phosphorous to limit phytoplankton growth could tip the lake back to a clear water regime.

While blue-green algae, also called cyanophyta or cyanobacteria, have been around for billions of years and typically do bloom each summer, blue-green algae blooms may be more frequent because of the increased nutrients reaching our waters or being released from the sediments themselves. One of the primary concerns with cyanobacteria beyond aesthetics stems from the production of cyanotoxins.

Cyanotoxins are naturally produced chemical compounds that are sometimes found inside the cells of certain blue green algae species. These chemicals can affect the skin and mucous membranes with an allergy-like reaction, cause damage to the liver or internal organs, or affect the central nervous system, depending on the type of toxin that an algae species produces. It is not know which environmental conditions cause the production of cyanotoxins, but scientists have found that when blue green algae is present in concentrations over 100,000 cells/ml toxin production is more likely to occur. The difference between the algae units of cells/ml and units/ml depends on how the algae live, either as a free cell or colonial. The blue green algae species that are capable of producing toxins were counted as individual units per milliliter of sample (in addition to the natural units that they occur in) to determine their ultimate concentration.

On Big Butternut Lake, there were no samples where blue green algae concentrations were above 100,000 units/ml. The highest concentration occurred in August with a value of 6,277 units/ml (Figure 21). While concentrations over 100,000 units/ml are capable of producing toxins, it is not know why or when this will occur. If blue-green blooms continue to persist it may be necessary to begin an algae monitoring regime and start testing for toxins.

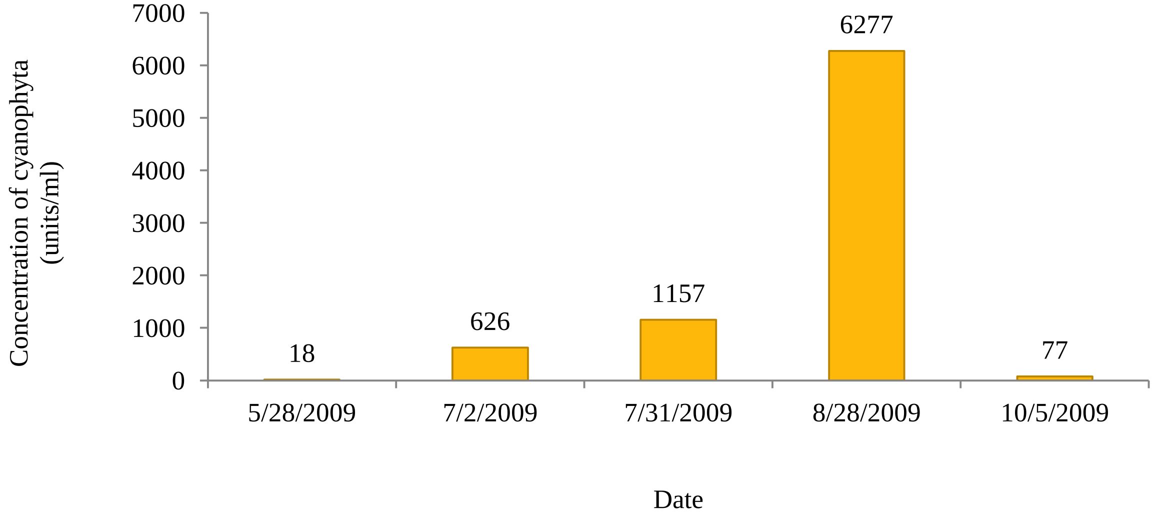


Figure 21. Total concentration of cyanophyta in Big Butternut Lake, 2009.

Zooplankton

Zooplankton are small aquatic animals which range in size from 0.03 to 3 mm long. The three primary components of the zooplankton community are rotifers, copepods, and cladocerans.

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

Copepods are size selective omnivores which feed on algae and other plankton. They are eaten by larger plankton and are preyed heavily upon by planktivores like pan fish and minnows and the fry of larger fish.

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

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

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

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

Zooplankton also respond to changes to lakeshore and the littoral zone communities. Changes in the aquatic plant community and shoreland habitat impact plankton populations both directly and indirectly. This occurs especially in shallow lakes where zooplankton are more likely to have the ability to migrate horizontally to avoid predation from fish and other invertebrates.

Zooplankton were sampled from Big Butternut Lake during the 2009 ice free season. Samples were collected mid-lake on a monthly basis beginning in late May and ending in early October and counted and identified at the St. Croix Watershed Research Station of the Science Museum of Minnesota. This analysis shows the abundance of the major zooplankton groups: cladocera, copepoda, and rotifer in Big Butternut Lake. In Big Butternut, the zooplankton community is dominated by rotifers; which are very tolerant of fish predation. However, the presence of copepods and cladocerans indicate the potential for a more robust zooplankton community that could mitigate algae blooms. Big Butternut Lake zooplankton data can be found in Appendix F.

The abundance of cladocerans and copepods remained fairly stable with a late-July increase, while rotifers increased dramatically in late-July (Figure 22). The rotifer and copepod biomass closely tracks the rotifer and copepod abundance (Figure 23). However, cladoceran biomass shows the opposite trend as cladocerans abundance. Whereas cladocerans abundance remains fairly stable with a mid-July increase, cladoceran biomass crashes from a very high level in early spring and climbs again in the fall.

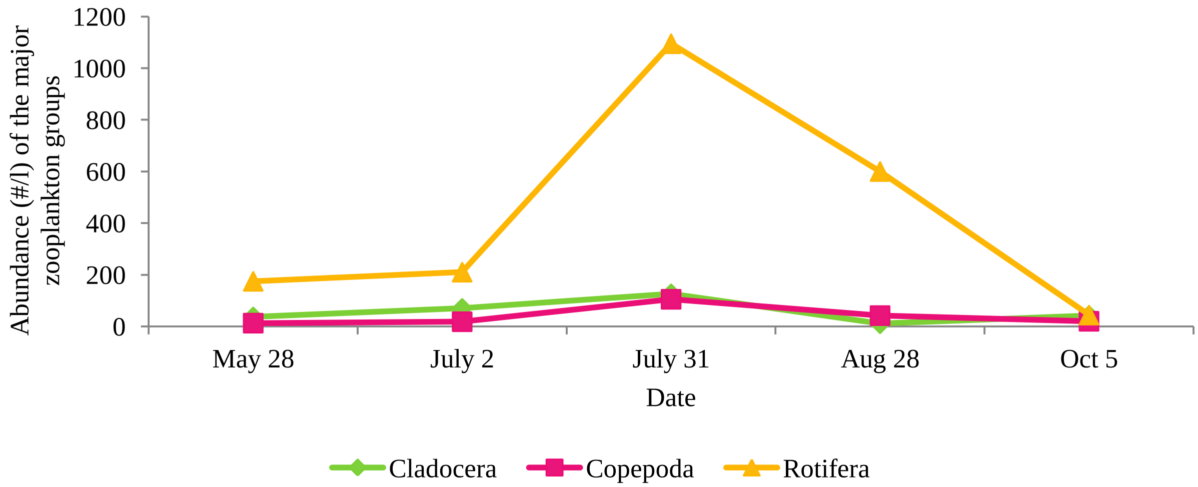


Figure 22. Abundance (#/l) of the major zooplankton groups, Big Butternut Lake, 2009.

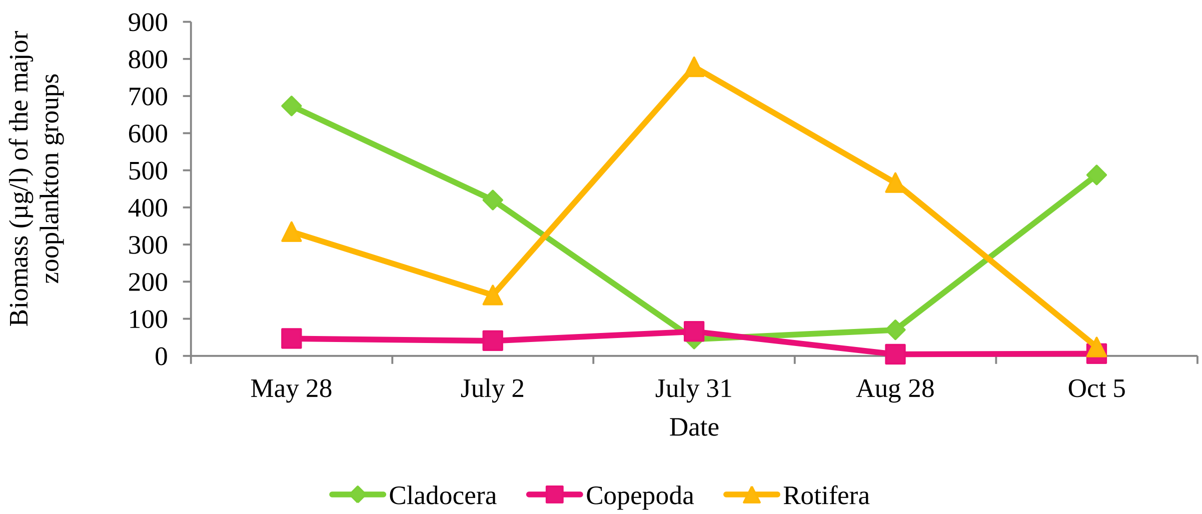


Figure 23. Biomass (µg/l) of the major zooplankton groups, Big Butternut Lake, 2009.

Lake Level and Precipitation Monitoring

Lake level and precipitation data was collected on a daily basis by volunteers during the summer and fall of 2009. Big Butternut Lake received 14.6125 inches of rainfall from April 27 to October 9. After precipitation events, the lake level responded by increasing (Figure 24). Big Butternut Lake level and precipitation data can be found in Appendix G.

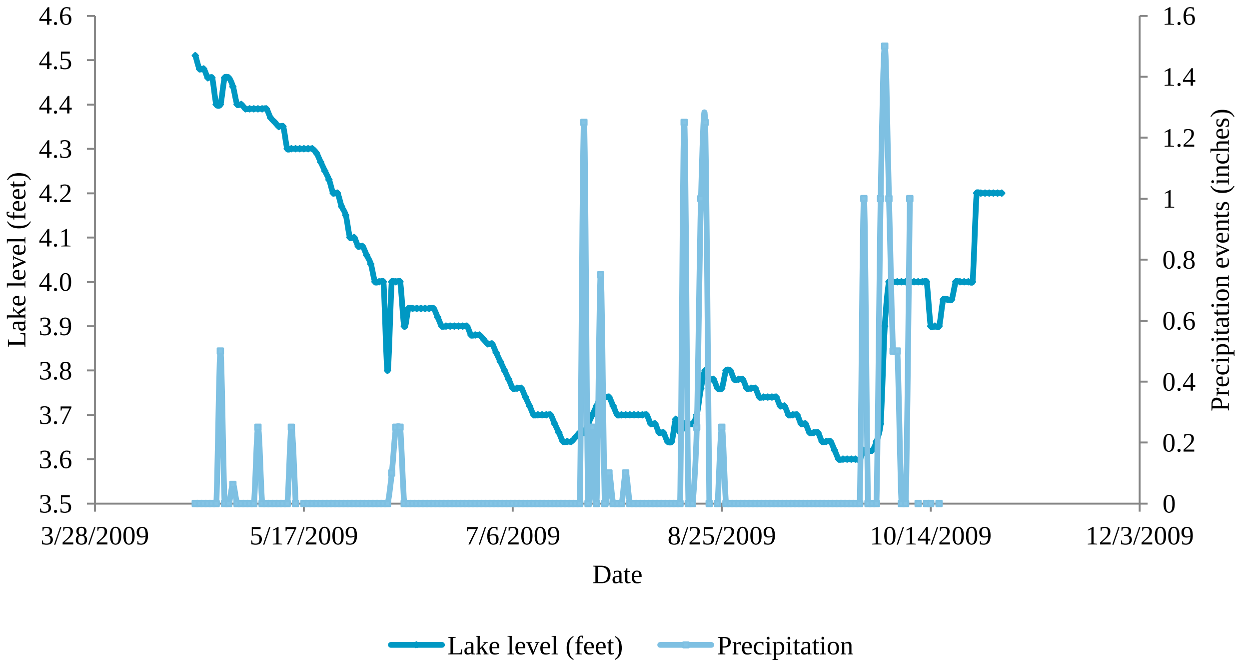


Figure 24. Big Butternut Lake level and precipitation monitoring profile, 2009.

Sociological Survey

In winter 2009 a sociological landowner survey was distributed by the Village of Luck to five hundred and twenty-one property owners on or near Big Butternut Lake. The Big Butternut Lake Watershed survey can be found in Appendix H. The survey was designed to obtain demographic data of the lake's residents, the lake's current usage and condition, and its intended use to direct future management decisions. Ninety-one surveys were returned for a response rate of 17%. The results of the Big Butternut Lake Watershed survey can be found in Appendix I.

Demographic Data

Forty percent of respondents have owned property on or near Big Butternut Lake for over twenty years and 21% have owned property between eleven and twenty years. This is in comparison to 14% who have owned their property between six and ten years and 24% who have owned their property between two and five years. At the time of this survey, no respondents (0%) have owned their property for less than two years. This data is interesting because it shows that nearly two-thirds of respondents (61%) have owned property on or near the lake for over ten years and that no acquisition of property has occurred in the last two years.

About half of the respondents (52%) own shoreline property; whereas the remainder (48%) do not.

Over half of respondents (51%) are 60 years of age or older. Within this age group, 23% are between 60-69 years and 28% are over 70 years of age. About one-third of respondents (31%) are between ages 50-59, and 14% are between the ages of 40 and 49. The remainder of respondents (3%) were between the ages of 20 and 29.

Over two-thirds of respondents (64%) occupy their property year-round, or 9-12 months out of the average year. Five percent of respondents occupy their property six to nine months per year, 16% occupy their property three to six months per year, 10% occupy their property one to three months per year, and 4% occupy their property less than one month per year.

Almost three-fourths (71%) of respondents indicated that 1-2 people occupy their property on a regular basis. Nineteen percent of respondents cited that 3-4 people occupy the property on a regular basis and 9% responded that 5-6 people occupy the property on a regular basis.

Reasons for Owning Property

Survey respondents were asked to rank their top three most important reasons for owning property on or near Big Butternut Lake. To analyze this data each reason that ranked first received 3 points, each reason that was ranked 2nd received 2 points, and each reason that ranked third received 1 point. Total points were then added to determine the ranking of the most important reasons for owning property on or near Big Butternut Lake. Scenic beauty/being near nature ranked as the 1st reason for owning property, followed by lake lifestyle in 2nd, and fishing in 3rd (Table 5).

Reasons for owning property	**Points**	**Rank**
Scenic beauty/being near nature	127	1st
Lake lifestyle	83	2nd
Fishing	66	3rd
Other	56	4th
Financial investment	46	5th
Sense of community	42	6th
Rural life style	39	7th
Motorized water sports *(PWC, boating, water skiing)*	23	8th
Non-motorized water sports *(swimming, birding, canoeing)*	16	9th
Motorized winter activities *(ATV, snowmobile)*	6	10th
Farming	5	11th
Hunting	3	12th
Non-motorized winter activities *(skiing, snowshoeing)*	1	13th

Table 5. Most important reasons for owning property on or near Big Butternut Lake.

Lake Usage

In all, survey respondents keep 136 watercraft on their property for use on Big Butternut Lake. Of these, 69 are motorboats/pontoons, 39 are canoes/kayaks, 18 are paddleboats/rowboats, 7 are jet skis, 2 are sail boats, and 1 is a catamaran. Of the 69 motorboats/pontoons owned by survey respondents, 19 are 1-20 HP, 18 are 21-50 HP, and 32 are 50+ HP.

Lake Values and Concerns

Respondents value wildlife, beauty, sunsets, serenity, and sunrises the most (28%), as well as the recreational activities provided by the lake such as fishing, boating, and swimming (20%). In addition, respondents value the relatively small size of the lake and related usage pressure (22%) and the location of the lake (16%).

Survey respondents were asked to rank the top three impacts that concern them about Big Butternut Lake. To analyze this data each impact that ranked first received 3 points, each impact that ranked 2nd received 2 points, and each impact that ranked third received 1 point. Total points were then added to determine the ranking of the impacts of most concern for Big Butternut Lake. Water quality ranked as the 1st concern for Big Butternut Lake, followed by pollution in 2nd, and aquatic plants in 3rd (Table 6).

Concerns	Points	Rank
Water quality	148	1st
Pollution *(chemical inputs, septic systems, ag, erosion, storm water runoff)*	137	2nd
Aquatic plants *("weeds")*	82	3rd
Quality of life *(noise, property value, taxes)*	47	4th
Development *(population density, loss of wildlife habitat)*	44	5th
Fisheries	20	6th
Level of environmental awareness and education	16	7th
Other *(please describe)*	9	8th
Safety *(boat traffic, no wake zones)*	8	9th

Table 6. What impacts concern you most about Big Butternut Lake?

Water Quality Perceptions

Over half of respondents (55%) describe the current water quality of Big Butternut Lake as being below average. A quarter of respondents (25%) described the water quality as average and 16% had no opinion or were unsure. Only 5% of respondents described the water quality as above average.

Interestingly, only slightly more than half of respondents (52%) felt that they have an impact on lake and water quality, whereas the remainder of respondents (48%) felt that they had no impact. This is highly interesting when considering that 48% of respondents do not own shoreline property on Big Butternut Lake.

Respondents were also asked to describe the current amount of shoreline vegetation and aquatic vegetation on Big Butternut Lake. Forty-three percent felt that the current amount of shoreline vegetation was just right in comparison to about a quarter of respondents (24%) who felt there was not enough shoreline vegetation. Thirty-one percent were unsure or had no opinion regarding shoreline vegetation.

In comparison, the majority of respondents (62%) felt that there was too much aquatic vegetation in Big Butternut Lake. In comparison only 14% described the amount of aquatic vegetation as being just right. Nearly a quarter of respondents (23%) were unsure or had no opinion regarding the amount of aquatic vegetation.

The fact that around a quarter of respondents were unsure or had no opinion regarding the amount of shoreline and aquatic vegetation suggest an educational need related to this topic.

Lake Quality Support

Survey respondents were asked to identify specific management practices that they use to protect Big Butternut Lake. The most cited response was refraining from using fertilizer (34%). Related to fertilizer usage, it was a positive result to find that 88% of respondents were aware that a ban on using fertilizer containing phosphorus exists.

Other management practices include: cleaning boat of debris (8%), refraining from cutting grass along the shoreline (7%), shoreline erosion protection (5%), maintaining shoreline in its natural state (5%), being careful about run-off (4%), refraining from polluting (4%), and clearing weeds (4%). Other activities which are being implemented by less than 3% of respondents include: planting natural grasslands and flowers, picking up garbage, protecting bulrushes, implementing buffer zones, using no-wake near shorelines, restoring shorelines, landscaping, retaining runoff, catching and releasing, not fueling up boat while in the water, cleaning up dead leaves, cutting and raking the shoreline, using a 4 stroke motor, and implementing a holding tank for septic.

With the exception of refraining from using fertilizer, most management practice options are only being implemented by a small percentage of respondents. Since more than half of respondents (55%) describe the current water quality as below average, education and information regarding management practices to increase water quality are likely to be viewed positively. Since few management practices are currently being implemented on a wide scale, a change in attitude and behavior could have a great impact on water quality.

Willingness to Provide Financial Support

Slightly more than half of respondents (53%) would be willing to provide financial support to maintain and improve the quality of Big Butternut Lake. Forty-one percent of respondents were not willing to provide support and 6% were unsure.

Of those respondents willing to contribute financially on a yearly basis (48 respondents), close to half (44%) were willing to contribute $51-100/year. Over a quarter of respondents (27%) would contribute $11-50/year. On either end of the spectrum 15% of respondents would be willing to contribute $1-10/year and 15% would be willing to contribute $101-500/year. A calculation of financial support from the 48 respondents answering the survey question yielded between $1928-$6320 available to maintain or improve the quality of Big Butternut Lake and its associated land resources on a yearly basis.

Point Intercept Macrophyte Survey

Two aquatic macrophyte surveys were carried out on Big Butternut Lake. The first was on June 3rd and the second was on September 1st, 2009. Three hundred and forty-seven sampling points were established in and around the lake using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total lake acres (Figure 25). Points were generated in ArcView (a GIS program) and downloaded to a GPS unit. These points were then sampled in field.

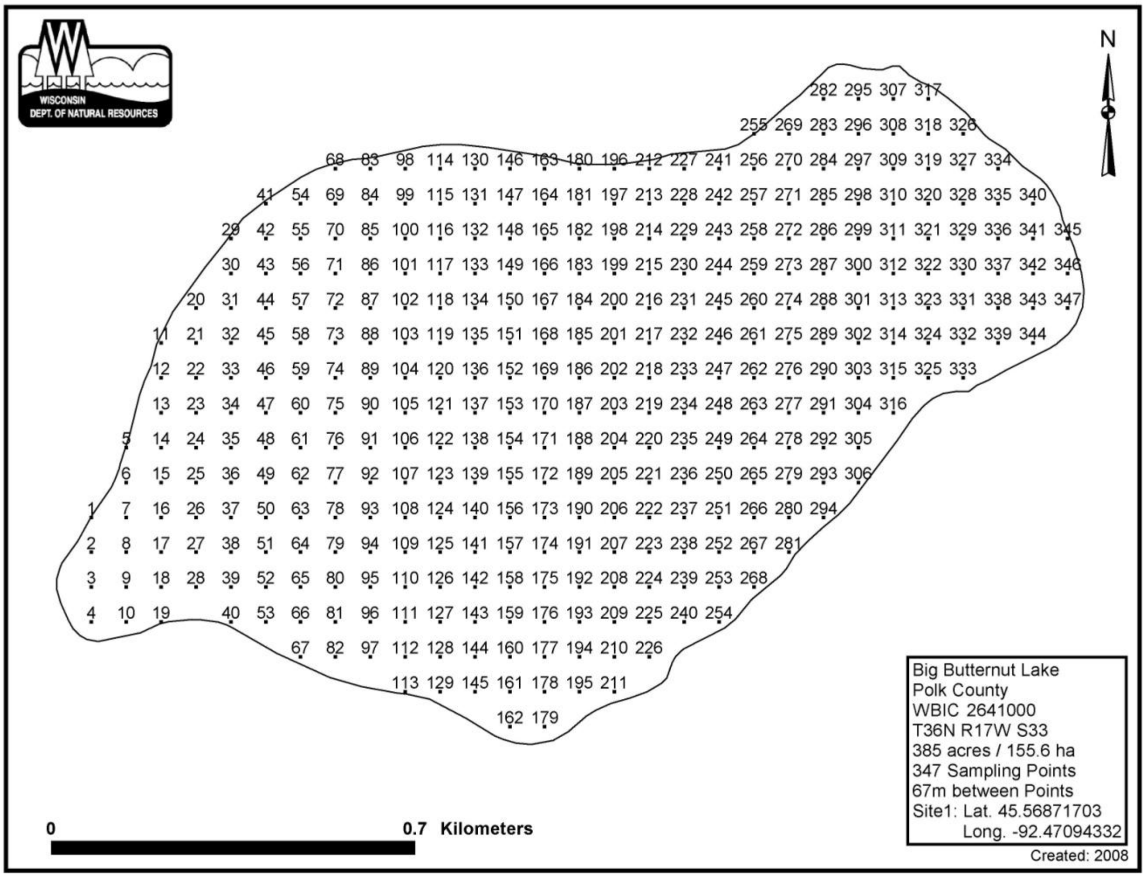


Figure 25. Big Butternut Lake sampling points for point intercept macrophyte survey, 2009.

During the point intercept survey, each sampling point was located using a handheld mapping GPS unit. The depth at each sampling point was recorded using a handheld depth finder. At each sampling point a rake, either on a pole or throw line depending on depth, was used to sample the plant community of an approximately 1 meter section of the benthos. All plants on the rake, as well as any that were dislodged by the rake, were identified to species (except *Nitella*, which did not have oocytes present) and assigned a rake fullness value of 1 to 3 to estimate abundance (Table 7). Visual sightings of plants within six feet of the sample point were also recorded. The lake bottom type, or substrate, was also assigned at each sampling point where the bottom was visible or it could be reliably determined using the rake. Data was collected at each sampling point, with the exception of those that were too shallow or terrestrial.

Shallow communities were characterized visually. Although one hundred and thirty eight sampling points were established in Big Butternut Lake it was only possible to sample ninety-eight sampling points due to decreased water levels. Big Butternut Lake point intercept aquatic macrophyte results can be found in Appendix J.

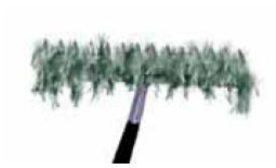
Rating	Coverage	Description
1		A few plants on rake head
2		Rake head is about ½ full Can easily see top of rake head
3		Overflowing Cannot see top of rake head

Table 7. Rake fullness ratings as an estimation of abundance.

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

- Frequency of occurrence for all sample points in lake
- Relative frequency
- Sample points with vegetation
- Species richness
- Simpson's diversity index
- Maximum plant depth
- Floristic Quality Index

The following are explanations of the various analysis values with data from Big Butternut Lake.

Frequency of Occurrence

Two values are computed for frequency of occurrence. The first value is a percentage of all sample points that a specific species was found at and is used to compare the frequency of occurrence across an entire lake. The second value is a percentage of all littoral sample points that a specific species was found at and is used to compare the frequency of occurrence only where plants are probable (relative frequency). The first value shows how often the plant would be encountered *everywhere in the lake*; whereas, the second value shows how often the plant would be encountered *only within the depths plants potentially grow*. In both instances, the greater the value, the more frequently the plant would be encountered in the lake.

Frequency of occurrence example:
Plant A sampled at 35 of 150 total points = 35/150 = 0.23 = 23%
Plant A's frequency of occurrence = 23% considering whole lake sample.
This frequency can tell us how common the plant was sampled in the entire lake.

Frequency of occurrence values for Big Butternut in June and September are shown in Table 8.

Relative Frequency

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

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

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

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

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

Relative frequency values for Big Butternut in June and September are shown in Table 8.

Species	**Common Name**	**Frequency of Occurrence (%) June**	**Relative Frequency (%) June**	**Frequency of Occurrence (%) Sept**	**Relative Frequency (%) Sept**
Ceratophyllum demersum	Coontail	2.25	1	8.47	3.6
Eleocharis acicularis	Needle spikerush	1.12	0.5	NA	NA
Elodea canadensis	Common waterweed	1.12	0.5	6.78	2.9
Heteranthera dubia	Water star-grass	19.1	8.7	27.12	11.4
Lemna trisulca	Forked Duckweed	21.35	9.7	22.3	9.3
Myriophyllum sibiricum	Northern water-milfoil	7.87	3.6	23.73	10
Najas flexilis	Bushy pondweed	1.12	0.5	13.56	5.7
Nitella sp	Nitella	4.49	2.1	NA	NA
Nuphar variegata	Spatterdock	visual	visual	1.69	0.7
Potamogeton praelongus	White-stem pondweed	1.12	0.5	3.39	1.4
Potamogeton pusillus	Small pondweed	13.48	6.2	1.69	0.7
Potamogeton richardsonii	Clasping-leaf pondweed	12.36	5.6	28.81	12.1
Potamogeton zosteriformis	Flat-stem pondweed	10.11	4.6	30.51	12.9
Ranunculus aquatilis	Stiff water crowfoot	1.12	0.5	10.17	4.3
Sagittaria latifolia	Common arrowhead	3.37	1.5	5.08	2.1
Vallisneria americana	Wild celery	2.25	1	23.73	10
Potamogeton crispus	Curly-leaf pondweed	71.91	32.8	18.64	7.9

Table 8. Big Butternut Lake aquatic macrophyte frequency of occurrence and relative frequency, 2009.

Sample Points with Vegetation

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

In Big Butternut Lake 26% of the sample points had vegetation in June and 17% of the sample sites had vegetation in September.

Species Richness

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

Big Butternut is not a highly diverse lake with only 16 species being sampled in June (17, if including visuals) and 15 species being sampled in September (Table 9). These values include the presence of curly leaf pondweed, an aquatic invasive species.

Species	**Common Name**	**June**	**September**
Ceratophyllum demersum	Coontail	x	x
Eleocharis acicularis	Needle spikerush	x	
Elodea canadensis	Common waterweed	x	x
Heteranthera dubia	Water star-grass	x	x
Lemna trisulca	Forked duckweed	x	x
Myriophyllum sibiricum	Northern water-milfoil	x	x
Najas flexilis	Bushy pondweed	x	x
Nitella sp	Nitella	x	
Nuphar variegata	Spatterdock	x (visual)	x
Potamogeton praelongus	White-stem pondweed	x	x
Potamogeton pusillus	Small pondweed	x	x
Potamogeton richardsonii	Clasping-leaf pondweed	x	x
Potamogeton zosteriformis	Flat-stem pondweed	x	x
Ranunculus aquatilis	Stiff water crowfoot	x	x
Sagittaria latifolia	Common arrowhead	x	x
Vallisneria americana	Wild celery	x	x
Potamogeton crispus	Curly-leaf pondweed	x	x

Table 9. Aquatic macrophyte species list for June and September.

Simpson's Diversity Index

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

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

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

Simpson's Diversity example:

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

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

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

The Simpson's Diversity Index on Big Butternut Lake was calculated to be 0.82 in June and 0.91 in September. Although the species richness was not extremely high in Big Butternut Lake, the diversity of plants in Big Butternut Lake was quite high. A diverse plant community increases the likelihood that by reducing phosphorus and the amount of phytoplankton in the lake, the native plant community will be able to flourish and help to create a clear water regime for the lake.

Maximum Depth of Plants

The maximum depth of plants indicates the depth at which plants are able to grow. Generally clearer lakes have a greater maximum depth of plants. In contrast, in lakes with lower water clarity, light penetration is limited thereby reducing the maximum depth at which plants are found. The maximum rooting depth of plants on Big Butternut Lake was 11 feet (3.33 meters) in June and dropped to 10 feet (3.03 meters) by September. Again, a robust plant community increases the likelihood that water clarity can be increased in Big Butternut through the uptake of phosphorus.

Floristic Quality Index

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

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

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

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

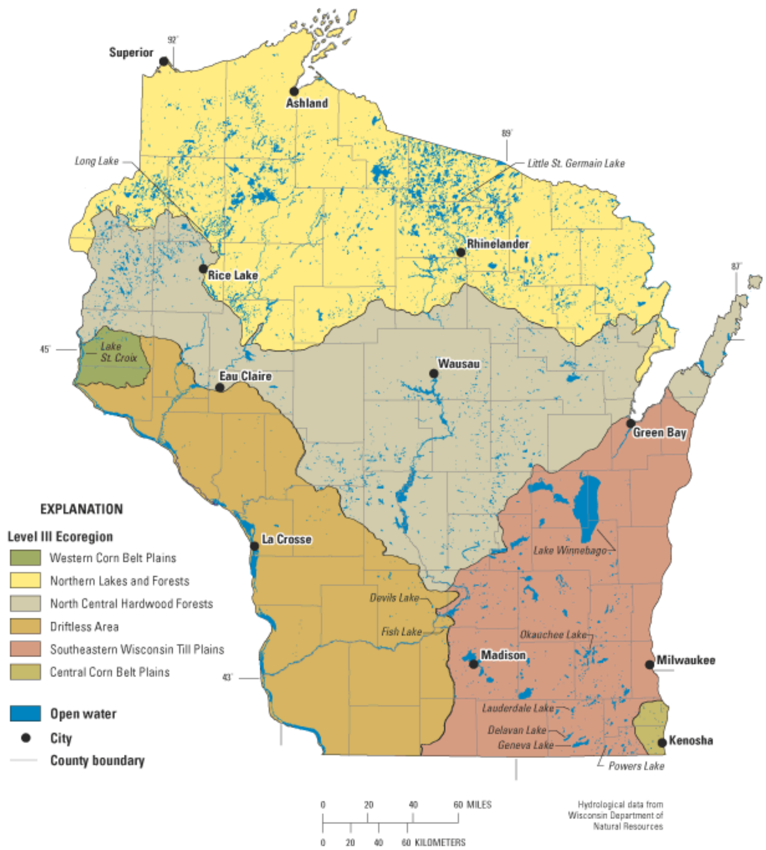


Figure 26. Wisconsin Eco-regions map. *(USGS, 2003).*

Summary of North Central Hardwood Forest values for Floristic Quality Index (Figure 26):

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

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

Summary of Big Butternut Lake values for FQI:

Mean species richness = 16
Mean average conservatism = 6.19
Mean Floristic Quality = 24.75

Big Butternut Lake Floristic Quality Index data can be found in Appendix K.

Based on the data collected, the aquatic macrophyte community of Big Butternut Lake is sensitive and is likely a barometer of the lakes health (particularly *Nitella*). Additionally, the isoetid part of the plant community (small near shore plants such as *Eleocharis acicularis*) is extremely sensitive to sedimentation. The aquatic plant community in Big Butternut Lake should constantly be monitored. This data, combined with traditional water chemistry parameters, will help assess the lakes health and possible recovery along with the success of implementing the aquatic plant management plan.

Exotic Species Inventory

Curly leaf pondweed, Eurasian water milfoil, and purple loosestrife are specifically designated as aquatic invasive species. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c))." Detailed information regarding each of the above mentioned aquatic invasive species is provided below.

Curly Leaf Pondweed

The Polk County Land & Water Resources Department conducted an early season survey to assess the location of invasive species, namely curly leaf pondweed *(Potamogeton crispus)*. Since curly leaf pondweed (CLP) is most robust in early summer, the survey was conducted in June. A complete point intercept grid was surveyed for curly leaf pondweed and beds were mapped (Figure 27). The curly leaf pondweed beds were at or near surface, had a consistent density of 2 or 3 (with a scale from least to greatest density of 0 to 3), had an estimated aerial coverage of greater than 50%, and were navigable around the perimeter of the bed.

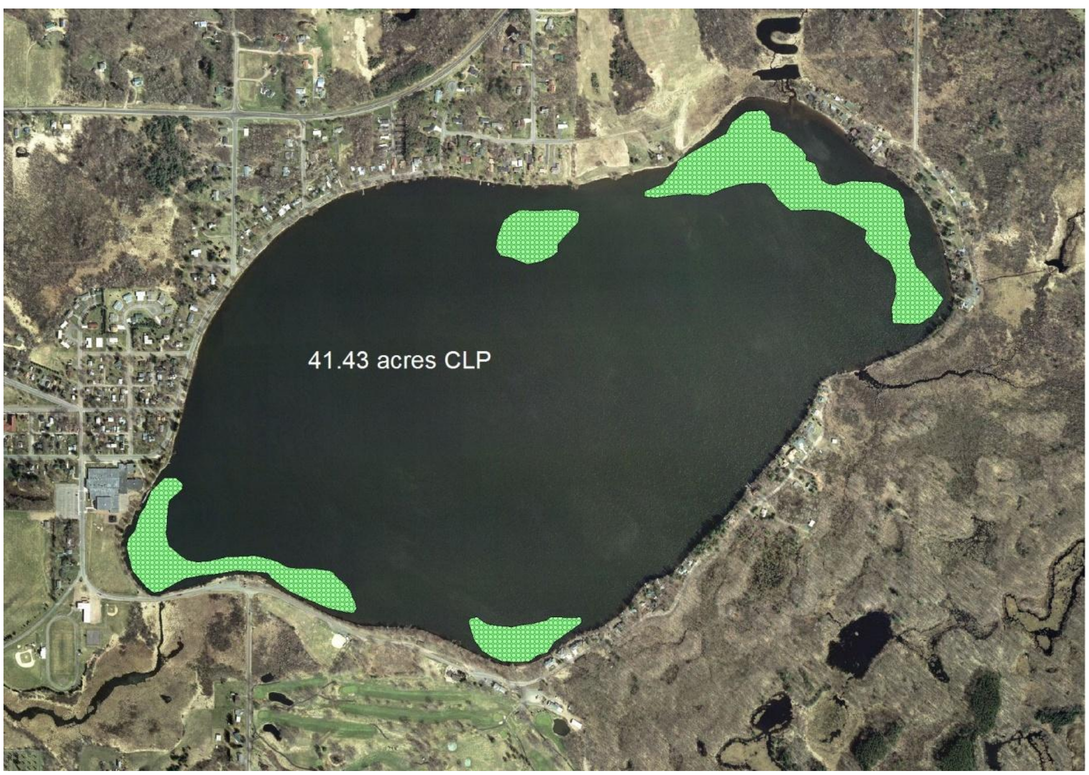


Figure 27. Curly-leaf pondweed beds, June 2009.

The curly leaf pondweed coverage of Big Butternut Lake is quite extensive. The total area of bed coverage (as defined previously) is 41.43 acres. There were several plots that could be viewed as nuisance plots because they adversely affect recreational uses such as swimming and boater navigation. Curly leaf pondweed was also found in the September survey at full lake sample points. This was likely secondary growth and fell within the boundaries of the mapped beds.

The following information regarding curly-leaf pondweed was taken from the Wisconsin DNR website.

Curly-Leaf Pondweed (Potamogeton crispus) (Figure 28)

Figure 28. Curly leaf pondweed

DESCRIPTION: *Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early July*

DISTRIBUTION AND HABITAT: *Curly-leaf pondweed is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all states but Maine*

LIFE HISTORY AND EFFECTS OF INVASION: *Curly-leaf pondweed spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring.*

It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and outcompete native plants in the spring. In mid-summer, when most aquatic plants are growing, curly-leaf pondweed plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. Curly-leaf pondweed forms surface mats that interfere with aquatic recreation.

CONTROL METHODS: *Turions and plant fragments can be carried on boats, trailers, motors and fishing gear from one water body to another, thus proper prevention techniques are essential to curb the spread of this aquatic invasive. An effective prevention and remediation program also addresses the overall health of a waterbody: Maintaining a healthy ecosystem with diverse native aquatic plants and animals as well as minimizing nutrient and pollutant inputs will deter invasions. Once introduced, curly-leaf pondweed spreads rapidly. Long-term management requires the reduction or elimination of turions to interrupt the lifecycle.*

DNR permits are required for chemical treatments, mechanical treatments, some manual treatments, biological control, bottom screening, and buoy/barrier placement.

Manual/Mechanical Control: To have the maximum benefit, manual/mechanical control efforts should be undertaken in the spring or early summer. Mechanical control includes raking, hand-cutting or harvesting vegetation. Raking and hand cutting remove plants at the sediment surface, and there is some evidence that early season cutting of pondweed can prevent turion production. Harvesting generally removes the top 5 feet of the plant. Curly-leaf pondweed can spread from plant fragments, so it is important to clean all vegetation off boats and equipment before leaving water access.

Chemical Control: *There are a small number of aquatic herbicides that can be used to control curly-leaf pondweed. In Minnesota, good to excellent control was obtained using formulations of diquat (Reward) and endothall (Aquathall K). These chemicals can be used in small areas and will usually knock down curly-leaf pondweed within 2 weeks. The best time for treatment is in spring or early summer when natives are still dormant and temperatures are low enough for endothall be effective. In early experiments with fluridone (Sonar), production of turions was completely inhibited following early season treatments. Fluridone usually has to be applied to an entire lake and requires 30 days to knock down curly-leaf pondweed.*

Habitat manipulation: *Habitat manipulation such as drawdowns and dredging can also be used to manage curly-leaf pondweed. Fall drawdown can kill the plants by exposing them to freezing temperatures and desiccation. Dredging can be used as a control by increasing the water depth. In deep water, the plants do not receive enough light to survive. This method can be detrimental to desired plants, as all macrophytes would be prevented from growing for many years. This high level of disturbance may also create favorable conditions for the invasion of other invasive species.*

Eurasian Water Milfoil

The Polk County Land and Water Resources Department did not locate Eurasian water milfoil on Big Butternut Lake. However, there are several lakes in Polk and Burnett Counties as well as nearby Washburn and Barron Counties with Eurasian water milfoil (Table 10). Big Butternut Lake should continue to be monitored for the presence of Eurasian water milfoil. Control efforts are more likely to be successful if novel populations are identified and managed during the pioneer infestation stage.

Waterbody	County	Year Identified
Horseshoe Lake	Polk	2006
Pike Lake	Polk	2010
Long Trade Lake	Polk	1995
Round Lake	Burnett	2003
Big (Little) Trade Lake	Burnett	2009
Ham Lake	Burnett	2003
Minong Flowage	Washburn	2002
Nancy Lake	Washburn	1991
Totogatic River	Washburn	2003
Shallow Lake	Washburn/Burnett/Barron	2003
Beaver Dam	Barron	1991

Table 10. Eurasian water milfoil status in surrounding area.

The following information on Eurasian water milfoil is taken from the Wisconsin DNR website.

Eurasian Water Milfoil (Myriophyllum spicatum)

Description: *Eurasian water milfoil is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like most of the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves. The stems of Eurasian water milfoil tend to be limp, and may show a pinkish-red color. The 4-petaled, pink flowers of Eurasian water milfoil are located on a spike that rises a few inches out of the water. The leaves are typically divided into 12 or more pairs of threadlike leaflets. The most common native water milfoils tend to have whitish or brownish stems, and leaves that divide into fewer than 10 pairs of leaflets. Coontail is often mistaken for the milfoils, but its leaves are not feathery, but rather branch once or twice with several small teeth along the leaves. Bladderworts can also be mistaken for Eurasian water milfoil, but they are easily distinguished by the presence of many small bladders on the leaves, which serve to trap and digest small aquatic insects.*

Distribution and habitat: *Eurasian water milfoil first arrived in Wisconsin in the 1960's. During the 1980's, it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. As of 1993, Eurasian water milfoil was common in 39 Wisconsin counties (54%) and at least 75 of its lakes, including shallow bays in Lakes Michigan and Superior and Mississippi River pools.*

Eurasian water milfoil grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes.

Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Life history and effects of invasion: *Unlike many other plants, Eurasian water milfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist.*

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, Eurasian water milfoil is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian water milfoil provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes.

Controlling Eurasian water milfoil : *Preventing a milfoil invasion involves various efforts. Public awareness of the necessity to remove weed fragments at boat landings, a commitment to protect native plant beds from speed boaters and indiscriminate plant control that disturbs these beds, and a watershed management program to keep nutrients from reaching lakes and stimulating milfoil colonies--all are necessary to prevent the spread of milfoil.*

Monitoring and prevention are the most important steps for keeping Eurasian water milfoil under control. A sound precautionary measure is to check all equipment used in infested waters and remove all aquatic vegetation upon leaving the lake or river. All equipment, including boats, motors, trailers, and fishing/diving equipment, should be free of aquatic plants.

Lake managers and lakeshore owners should check for new colonies and control them before they spread. The plants can be hand pulled or raked. It is imperative that all fragments be removed from the water and the shore. Plant fragments can be used in upland areas as a garden mulch.

Mechanical Control: *Mechanical cutters and harvesters are the most common method for controlling Eurasian water milfoil in Wisconsin. While harvesting may clear out beaches and boat landing by breaking up the milfoil canopy, the method is not selective, removing beneficial aquatic vegetation as well. These machines also create shoot fragments, which contributes to milfoil dispersal. Harvesting should be used only after colonies have become widespread, and harvesters should be used offshore where they have room to turn around. Hand cutters work best inshore, where they complement hand pulling and bottom screening. Bottom screening can be used for severe infestations, but will kill native* *vegetation as well. A diver-operated suction dredge can be used to vacuum up weeds, but the technique can destroy nearby native plants and temporarily raise water turbidity.*

Hand pulling is the preferred control method for colonies of under 0.75 acres or fewer than 100 plants. The process is both thorough and selective (not to mention time-consuming); special care must be taken to collect all roots and plant fragments during removal. Sites remote from boat traffic can be covered with bottom screens that are anchored firmly against the lake bed to kill grown shoots and prevent new sproutings, but screens must be removed each fall to clean off sediment that encourages rooting. Buoys can mark identified colonies and warn boaters to stay away.

Whenever possible, milfoil control sites should become customized management zones. For example, colony removal by harvesting can be followed by planting native plants to stabilize sediments against wave action, build nurseries for fry, attract waterfowl, and compete against new milfoil invasions.

DNR permits are required for chemical treatments, bottom screening, and buoy/barrier placement.

Chemical Control: *Herbicide treatment is not recommended because it is typically disruptive to aquatic ecosystems and not selective in the vegetation it affects, thus threatening native plants.*

Biological Control: *Eurhychiopsis lecontei, an herbivorous weevil native to North America, has been found to feed on Eurasian water milfoil. Adult weevils feed on the stems and leaves, and females lay their eggs on the apical meristem (top-growing tip); larvae bore into stems and cause extensive damage to plant tissue before pupating and emerging from the stem. Three generations of weevils hatch each summer, with females laying up to two eggs per day. It is believed that these insects are causing substantial decline in some milfoil populations. Because this weevil prefers Eurasian water milfoil, other native aquatic plant species, including northern watermilfoil, are not at risk from the weevil's introduction. Twelve Wisconsin lakes are currently part of a two-year DNR project studying the weevil's effectiveness in curbing Eurasian water milfoil populations. The fungi Mycoleptidiscus terrestris is also under extensive research.*

Purple Loosestrife

In 2000 the Polk County Land and Water Resources Department documented purple loosestrife in the Village of Luck in the marshes along Hwy 35. *Galerucella* beetles, a biological control for purple loosestrife, were raised and released at the sites in both 2001 and 2010. Although purple loosestrife was documented along the shoreline of Big Butternut Lake during the 2000 DNR Sensitive Areas Report, the species was not present during the aquatic macrophyte surveys in 2009. The absence of purple loosestrife is likely the result of continued management efforts by the Big Butternut Lake Protection and Rehabilitation District. However, since extensive seed banks of the seed can exist, monitoring and management should be continued by the District. In 2011, the marshes along Hwy 35 exhibited a prolific population of beetles which could be collected and reared for additional beetle release projects.

The following information on purple loosestrife is taken from the Wisconsin DNR website.

Figure 29. Purple loosestrife

Purple Loosestrife (Lythrum salicaria) (Figure 29)

Description: *Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.*

This species may be confused with the native wing-angled loosestrife (Lythrum alatum) found in moist prairies or wet meadows. The latter has a winged, square stem and solitary paired flowers in the leaf axils. It is generally a smaller plant than the Eurasian loosestrife.

By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Distribution and habitat: *Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, about 24 states have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.*

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Life history and effects of invasion: *Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.*

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways.

Prevention: *This is the easiest control method and the best way to stop the spread of purple loosestrife. Monitor your wetlands annually and remove any new young plants. Find pioneering plants or isolated small colonies, especially in areas otherwise free of loosestrife. Check areas near moving water, wetland/upland edges, storm sewer outlets or gardens that may have contained purple loosestrife. Eliminate local purple loosestrife seed sources, such as gardens (it is illegal to cultivate purple loosestrife). Plants are most easily located when flowering. One mature purple loosestrife plant produces over 2 million seeds a season, so learn to recognize pre-flowering plants or search for them when they* *just start to bloom. Destroy plants before they mature, flower and drop seeds, which can start before flowering ends. It is believed that once flowering has begun, viable seed could be produced. When removing plants, take care not to leave stems or cuttings that can resprout or disperse viable seed.*

Dispose of plants/seeds in a capped landfill, or dry and burn them. Composting will not kill the seeds. Keep clothing and equipment seed-free to prevent its spread. Rinse all equipment used in infested areas before moving into uninfested areas, including boats, trailers, clothing, and footwear. Take responsibility to remove new plants wherever you see them.(Get landowner permission first.)Again, it is illegal to cultivate purple loosestrife in Wisconsin. Follow-up is critical for all loosestrife control methods.

Mechanical Control: *This method includes cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seed may have already fallen. Since lower pods can drop seed while upper flowers are still blooming, check for seed. If none, simply bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding it upright, then bend it over into a bag to catch any dropping seeds. Watch for holes in your bags so you don't spread seed where you drag the bags. Dispose of plant parts as above.*

Pulling and digging can be effective, but can also be disruptive by creating disturbed bare spots, which are good sites for purple loosestrife seeds to germinate, or leaving behind root fragments that grow into new plants. Use these methods primarily with small plants in loose soils, since they do not usually leave behind large gaps, nor root tips. Large plants with multiple stems and brittle roots often do. Dispose of plants as above. Drowning young purple loosestrife is effective if plants are completely submerged for a year (often after being cut to decrease height.)

Mowing has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full 12 months. Burning has also proven largely ineffective. Mowing and flooding are not encouraged because they can contribute to further dispersal of the species by disseminating seeds and stems. The U.S. Fish and Wildlife Service (FWS) has found water level manipulation to be effective: reduce water level until loosestrife has sprouted, then increase the level to drown the stems.

Follow-up treatments are recommended for at least three years after removal.

Chemical control: *This is usually the best way to eliminate purple loosestrife quickly, especially with mature plants. Chemicals used, have a short soil life. Timing is important: Treat in late July or August, but before flowering to prevent seed set. Always back away from sprayed areas as you go, to prevent getting herbicide on your clothes. Generally, the formula designed for use on wet or standing sites should be used. The best method is to cut stems and paint the stump tops with herbicide. Cut low on the stem (about knee level) with one hand and apply the herbicide with a second hand, while carefully stuffing the plant top into a plastic bag with the third and fourth hands (a two person crew works well for this). The herbicide can be applied with a small drip bottle or spray bottle, which can be adjusted to release only a small amount. Try to cover the entire cut portion of the stem, but not let the herbicide drip onto other plants since it is non-selective and can kill any plant it touches.*

Glyphosate herbicides: *Roundup and Glyfos are typically used, but if there is any open water in the area use Rodeo, a glyphosate formulated and listed for use over water. Currently, glyphosate is the most commonly used chemical for killing loosestrife. Glyphosate must be applied in late July or August to be most effective. It should be applied to loosestrife foliage in a 1% active ingredient (a.i.) solution--only 25% of the foliage of each plant need be covered. Glyphosate mixed to 3-10% a.i. can also be used on* *freshly-cut stems; this is especially effective on larger plants in areas of low loosestrife densities. Stem applied herbicides should be mixed to 20 to 40% active ingredient. Since you must treat at least some stems of each plant and they often grow together in a clump, all stems in the clump should be treated to be sure all plants are treated.*

Another method is using ***very carefully*** *targeted foliar applications of herbicide (NOT broadcast spraying). This may reduce costs for sites with very high densities of purple loosestrife, since the work should be easier and there will be few other plant species to hit accidentally. Use a glyphosate formulated for use over water. A weak solution of around 1% active ingredient can be used and it is generally necessary to wet only 25% of the foliage to kill the plant.*

Triclopyr (Garlon 3A) is another herbicide that can be used as a foliar spray. It is formulated for use around water and does not harm grasses or sedges. Unfortunately, it has not received final approval from the EPA for wetlands. Wet most of the foliage if using this chemical. (Broadcast spraying with a very weak solution of 0.5% active ingredient has been used as a broadcast spray and may reduce purple loosestrife, but be less harmful for other plant species. Bog plants and alders are seriously harmed. This is not yet recommended, since quantitative data on its effectiveness and safety are lacking.) Triclopyr formulated for water dilution may be the most effective herbicide for loosestrife. Triclopyr is broadleaf-specific--it does not harm sedges or monocots. Foliar application must cover nearly all of the foliage.

You must obtain a permit from WDNR before applying any herbicide over water. The process has been streamlined for control of purple loosestrife and there is no cost. The appropriate person to contact is your regional Aquatic Plant Management Coordinator. S/he will want to know about your site, may make control suggestions and will issue the permit.

Chemicals - Tools and Costs: *Chemicals and tools to apply them are often available from local farm cooperative stores and garden shops. Your APM Coordinator may be able to help you locate a supplier near-by. If you cannot get the herbicides locally, UAP, a business in DeForest, Wisconsin, will ship them. Contact them by calling 800/362-8049. Roundup is for drier sites and costs about $90/gallon. Buying in volume will save you money: 2.5 gallons of Roundup costs about $110! It usually requires no additives for stump application, but may perform better with a surfactant and ammonium sulfate in certain situations. Rodeo is for very wet sites and costs around $120/gallon. It comes mixed with a nonionic surfactant. Monsanto (800/332-3111) manufactures both of these glyphosates. Generic versions of Rodeo and Roundup (such as Glyfos made by Cheminova (800/548-6113)) are available; talk to your local supplier or the manufacturer for details, especially reliability. Concentrations discussed above are approximate since requirements are variable on different populations of plants in different situations. Test yours to be sure you use an appropriate amount of active ingredient. Call manufacturers or your APM Coordinator if you have additional questions.*

Figure 30. Rearing *Galerucella* beetles.

Biological Control: *Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective in controlling purple loosestrife; biocontrol is now considered the most viable option for more complete control for heavy infestations. The DNR, in cooperation with the U.S. Fish and Wildlife Service, is introducing several natural insect enemies of purple loosestrife from Europe. A species of weevil (Hylobius transversovittatus) has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue. In addition, two species of leaf-eating beetles (Galerucella calmariensis and G. pusilla) are being* *raised and released in the state, and another weevil that feeds on flowers (Nanophyes marmoratus) is being used to stress the plant in multiple ways. Research has shown that most of these insects are almost exclusively dependent upon Lythrum salicaria and do not threaten native plants, although one species showed some cross-over to native loosestrife. These insects will not eradicate loosestrife, but may significantly reduce the population so cohabitation with native species becomes a possibility. In a test area, 90% of the treated area saw a 90% reduction in loosestrife. Three additional species are also known to feed on purple loosestrife. All of these species remain experimental at the time of printing, but the DNR is seeking cooperators who will release and monitor the insects.*

Figure 31. *Galerucella* beetle.

Biological control must be started in all purple loosestrife infestations where there is no other effective control, no matter what size. Often this is on larger or higher density sites. Some sites may seem unlikely to benefit if they are ill suited to insect success (such as with summer flooding), but trying biological control is cheap and it's probably worth trying. Some small infestations should receive beetles to serve as local insectaries--growing insects for propagation stock--as long as purple loosestrife seed from these sites will not infest other nearby wetlands. Bio-control uses plant predator insects to control purple loosestrife. It is inexpensive and natural and can become self-sustaining and self-disseminating (even to hard-to-reach places) with minimal disturbance to wetlands. However, set-up time is longer and its outcome less certain. An insect population must grow commensurately large to affect the local purple loosestrife infestation, a process that usually takes at least several years, may require several infusions of propagated insects and may not work on some sites, especially if flooding can occur in midsummer. Many bio-control insect releases in Wisconsin have been quite successful, showing good control in only 2-3 years on smaller sites. Larger sites will take longer with the duration determined by many, hard-to-quantify factors. Contact Brock Woods (608/221-6349) at the DNR for further details.

Choosing among traditional and biological control methods: *Use traditional chemical and mechanical methods for quick initial control on all sites for which you have adequate resources and can be successful. These measures are labor intensive, and expensive on large sites, so small or low-density sites (usually 50-100 plants) are most often controlled this way. These methods should always be tried when quick action is necessary to prevent purple loosestrife seed from dispersing to other new areas. Up to 95% control can be achieved with careful, additional annual vigilance. Even if all purple loosestrife is accessible, some plants will be missed and a soil seed bank ensures germination of new purple loosestrife plants for up to a decade. Thus, you must annually treat any missed or new plants. You also need to eliminate any purple loosestrife in surrounding wetlands to stop seed dissemination to your site or hand control may not be worth the effort. All of these methods can be very disruptive to wetlands and, in addition to cost and chemical use, often suggest a serious consideration of alternative biological control.*

Integration of traditional controls and biocontrol may turn out to be the best plan for many sites, since some immediate purple loosestrife control can be maintained while biocontrol insects become common enough to exert meaningful control. As long as insects have foliage to eat and are not exposed to pesticides, various methods are compatible. One strategy is to cut inflorescences off to prevent seed production, but leave lower foliage to feed the developing beetle population. This eliminates the current year's seed production while encouraging beetles. Another is to start beetles in the center of a large purple loosestrife infestation, but use traditional controls to minimize the spread of plants at the periphery. More research is needed to see if other combinations of methods may prove even more effective, especially at shortening the overall control process while keeping costs and chemical use to a minimum.

For more information, contact your regional WDNR Aquatic Plant Management Coordinator or the Purple Loosestrife Bio-Control Program at Brock.Woods@wisconsin.gov or brock.woods@ces.uwex.edu or WDNR Research Center, 1350 Femrite Drive, Monona, WI 53716 (608/221-6349.)

Aquatic Plant Management Plan

Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for Big Butternut Lake. It also presents a detailed strategy of actions that will be used to reach aquatic plant management plan goals. Educational strategies that outline audience, messages, and methods are included under each goal. A timeline for implementation of the Aquatic Plant Management Plan can be found in Table 11.

Goals: are broad statements of direction.
Objectives: are measurable steps towards the goal.
Actions: are steps to accomplish objectives.

Overall Purpose

Preserve the Big Butternut Lake ecosystem for future generations.

Aquatic Plant Management Plan Goals

Goal 1. Manage curly leaf pondweed.

Goal 2. Manage other established invasive species and eradicate newly introduced invasive species.

Goal 3. Preserve the native plant community in Big Butternut Lake.

Goal 4. Maintain navigation for fishing and boating, access for lake residents, and comfortable swimming at the Village beach.

Goal 5. Minimize the runoff of pollutants entering Big Butternut Lake.

Goal 1. Manage curly leaf pondweed (CLP).

Objective: Identify the extent of CLP in Big Butternut Lake.

Objective: Develop a CLP management strategy to alleviate spring navigation concerns and improve early season swimming and boat access which follows recommendations from the WDNR Sensitive Areas report.

Objective: Test effectiveness of current CLP management on Big Butternut Lake.

Action: Train volunteers and seek expert volunteers to identify and survey for CLP.

Action: Coordinate contracted early season bed mapping survey for CLP.

Action: Conduct June surveys for CLP.

Action: Train shoreland property owners to recognize CLP and encourage manual removal.

Action: Follow WDNR recommended treatment methods for the management of CLP.

Action: Implement an education strategy to prevent CLP.

Audience

Lake monitors, lake residents, transient boaters

Messages

CLP is present in Big Butternut Lake
Trained volunteers can help identify CLP
Call lake monitors (and other trained volunteers) for help with CLP identification
Collect and bag suspected plant material before calling lake monitors
Call the Big Butternut Protection and Rehabilitation District for assistance

Methods

Hold a lake monitoring training
Use newsletters, brochures, posters, boat landing signs, annual meetings

Goal 2. Manage other established aquatic invasive species (AIS) and eradicate newly introduced aquatic invasive species.

Objective: Monitor and control purple loosestrife already present.

Objective: Prevent AIS introductions such as Japanese knotweed, Eurasian water milfoil, and zebra mussels.

Objective: If AIS introductions occur, ensure that they are discovered early.

Objective: Ensure that residents, renters, and visitors understand the impacts of AIS and the actions they can take to prevent their introduction.

Action: Work with volunteers, or some other designated authority, to raise and release *Galerucella* beetles into larger infestations of purple loosestrife.

Action: Continue the Clean Boats, Clean Waters program at boat landings using volunteer and/or paid monitors.

Action: Conduct surveys for other invasive species as information and methods become available.

Action: Consider and potentially implement new methods for AIS prevention, such as remote camera monitoring of boat landings, as they become available.

Action: Implement Polk County's "Amended Illegal to Transport Ordinance."

Action: Carry out a comprehensive AIS prevention education program.

- **Audience**
  - Lake residents, renters, visitors, Town of Luck
- **Messages**
  - Report status of existing and potential AIS
  - The State of Wisconsin and Polk County have "Illegal to Transport" ordinances
- **Methods**
  - Raise *Galerucella* beetles and communicate actively with the Polk County LWRD
  - Use newsletters, brochures, posters, boat landing signs, and annual meetings

Goal 3. Preserve and enhance the native plant community in Big Butternut Lake.

Objective: Prevent disturbance of native plants from watercraft.

Objective: Limit disturbance of native plants from homeowner removal.

Objective: Provide education regarding the functions and values of native plants.

Action: Implement recommendations from the WDNR Sensitive Areas report and Northern Region Aquatic Plant Management Strategy.

Action: Consider establishing no-wake zones to prevent the disturbance of native plants and to prevent the spread of curly leaf pondweed.

Action: Implement an education strategy aimed at preserving established native plants and establishing new populations of native plants.

Audience

Lake residents, renters, visitors, Town of Luck

Messages

Shallow bays are important for wildlife diversity.
Healthy populations of native plants help to prevent the introduction and spread of invasive species.
Diverse native plants provide diverse habitat for wildlife.
Invasive plants reduce plant and animal diversity.
Abundant plants keep lake water clean, especially in shallow areas of the lake.
Native plant removal is discouraged because disturbance provides areas for invasive species to grow.
If you believe that you have an AIS, please call a member of the Big Butternut Protection and Rehabilitation District to confirm identification.
Request/suggest that boaters and personal watercraft operators travel at no wake in certain areas to prevent plant removal and the introduction of invasive species to other portions of the lake.
Manage waterfront properties with minimal plant removal.
If you need to remove plants in front of your property, rake to a maximum opening of no more than thirty feet.

Methods

Use newsletters, brochures, posters, boat landing signs, and annual meetings

Goal 4. Maintain navigation for fishing and boating in problem areas, access for lake residents, and comfortable swimming at the Village beach.

Objective: Maintain summer navigational channels for fishing and boating following recommendations from the WDNR Sensitive Areas report.

Objective: Address aquatic plant nuisances to swimming at the Village of Luck public beach.

Objective: Conduct all herbicide treatments legally and according to permit conditions. In Wisconsin permits are required for all aquatic application of herbicides.

Action: Identify ongoing navigation areas of concern caused by native plant growth.

Action: Seek permits to address confirmed navigation impairment using appropriate method. Herbicide applications are generally used to manage impaired navigation areas and target species present in a problem area. Floating aquatic species such as water lilies may be addressed in subsequent years with preventative treatment measures.

Action: Allow harvesting to collect nuisance, uprooted, drifting plants. This is the only used where harvesting is considered to be the preferred method of removal. Requiring harvesting as the control method in a request for proposals likely may limit the herbicide applicators who qualify to respond to the bid.

Action: Select an aquatic plant control method for the public beach that will allow for herbicide use, harvesting, hand control, or a combination of these methods. The Village would apply for necessary permits and pay for any treatment.

Goal 5. Minimize the runoff of pollutants entering Big Butternut Lake.

Objective: Lake residents restore and preserve shoreline buffers of native vegetation.

Objective: Implement recommendations from the Big Butternut Lake Management Plan.

Objective: Develop a nutrient budget and watershed management plan for Big Butternut Lake.

Objective: Develop a stormwater management plan for Big Butternut Lake.

Action: Work with the Polk County LWRD to utilize cost sharing of Best Management Practices.

Action: Apply for WDNR Lake Planning Grant(s) to develop a nutrient budget and watershed management plan for Big Butternut Lake.

Action: Implement Polk County's "No Phosphorus Ordinance."

Action: Install rain garden and buffer strip demonstration sites.

Action: Implement a shoreline property owners' education program.

Audience

Waterfront property owners

Messages

Shoreline buffers protect water quality and provide fish and wildlife habitat.
Describe ways to restore shoreline buffers such as natural recovery, cease mowing, and plant native vegetation.
Describe the County shoreline buffer requirements and how to report violations of these requirements.
Highlight good examples of shoreline buffers on private waterfront property.

Methods

Use newsletters, brochures, posters, boat landing signs, and annual meetings

Action Items	Timeline	Responsible Parties
Goal 1. Manage curly leaf pondweed		
Train volunteers and seek expert volunteers to identify and survey for CLP.	Spring	LWRD, DNR, Association, Consultant
Coordinate contracted early season bed mapping survey for CLP.	Late May	Consultant, Association
Conduct June surveys for CLP.	June	Consultant, Association
Train shoreland property owners to recognize CLP and encourage manual removal.	Spring	LWRD, DNR, Association, Consultant
Follow WDNR recommended treatment methods for the management of CLP.	May	Association, Consultant
Implement an education strategy to prevent CLP.	Ongoing	Association, LWRD, DNR
Goal 2. Manage other established aquatic invasive species (AIS) and eradicate newly introduced aquatic invasive species		
Work with volunteers, or some other designated authority, to raise and release *Galerucella* beetles into larger infestations of purple loosestrife.	Spring, Summer	LWRD, DNR, Association
Continue the Clean Boats, Clean Waters program at boat landings using volunteer and/or paid monitors.	Ongoing	LWRD, Association
Conduct surveys for other invasive species as information and methods become available.	Ongoing	Association
Consider and potentially implement new methods for AIS prevention, such as remote camera monitoring of boat landings, as they become available.	Ongoing	Association
Implement Polk County's "Amended Illegal to Transport Ordinance."	One time	Association, Village of Luck
Carry out a comprehensive AIS prevention education program.	Ongoing	LWRD, Association
Goal 3. Preserve and enhance the native plant community in Big Butternut Lake.		
Implement recommendations from the WDNR Sensitive Areas report and Northern Region Aquatic Plant Management Strategy.	Summer	Association
Consider establishing no-wake zones to prevent the disturbance of native plants and to prevent the spread of curly leaf pondweed.	Spring	Association
Implement an education strategy aimed at preserving established native plants and establishing new populations of native plants.	Ongoing	LWRD, Association
Goal 4. Maintain navigation for fishing and boating, access for lake residents, and comfortable swimming at the Village beach.		
Identify ongoing navigation areas of concern caused by native plant growth.	Ongoing	Association
Seek permits to address confirmed navigation impairment using appropriate method.	February	Contractor

Allow harvesting to collect nuisance, uprooted, drifting plants.	Ongoing	Association
Select an aquatic plant control method for the public beach that will allow for herbicide use, harvesting, hand control, or a combination of these methods.	Ongoing	Village of Luck
Goal 5. Minimize the runoff of pollutants entering Big Butternut Lake		
Work with the Polk County LWRD to utilize cost sharing of Best Management Practices.	Ongoing	LWRD, Association
Apply for WDNR Lake Planning Grant(s) to develop a nutrient budget and watershed management plan for Big Butternut Lake.	February, August	LWRD, Association, DNR
Implement Polk County's "No Phosphorus Ordinance."	One time	Association, Village of Luck
Install rain garden and buffer strip demonstration sites.	One time	LWRD, Association, Village of Luck
Implement a shoreline property owners' education program.	Ongoing	Association, LWRD, DNR

Table 11. Timeline for implementing Aquatic Plant Management Plan action items.

Sensitive Areas Report

On August 17th, 2000 a WDNR Lake Sensitive Area Survey identified eight sites in Big Butternut Lake that merit special protection of aquatic habitat (Figure 32). Management guidelines recommended in the associated report should be followed for all sites when plant removal is considered. The full report can be found in Appendix L.

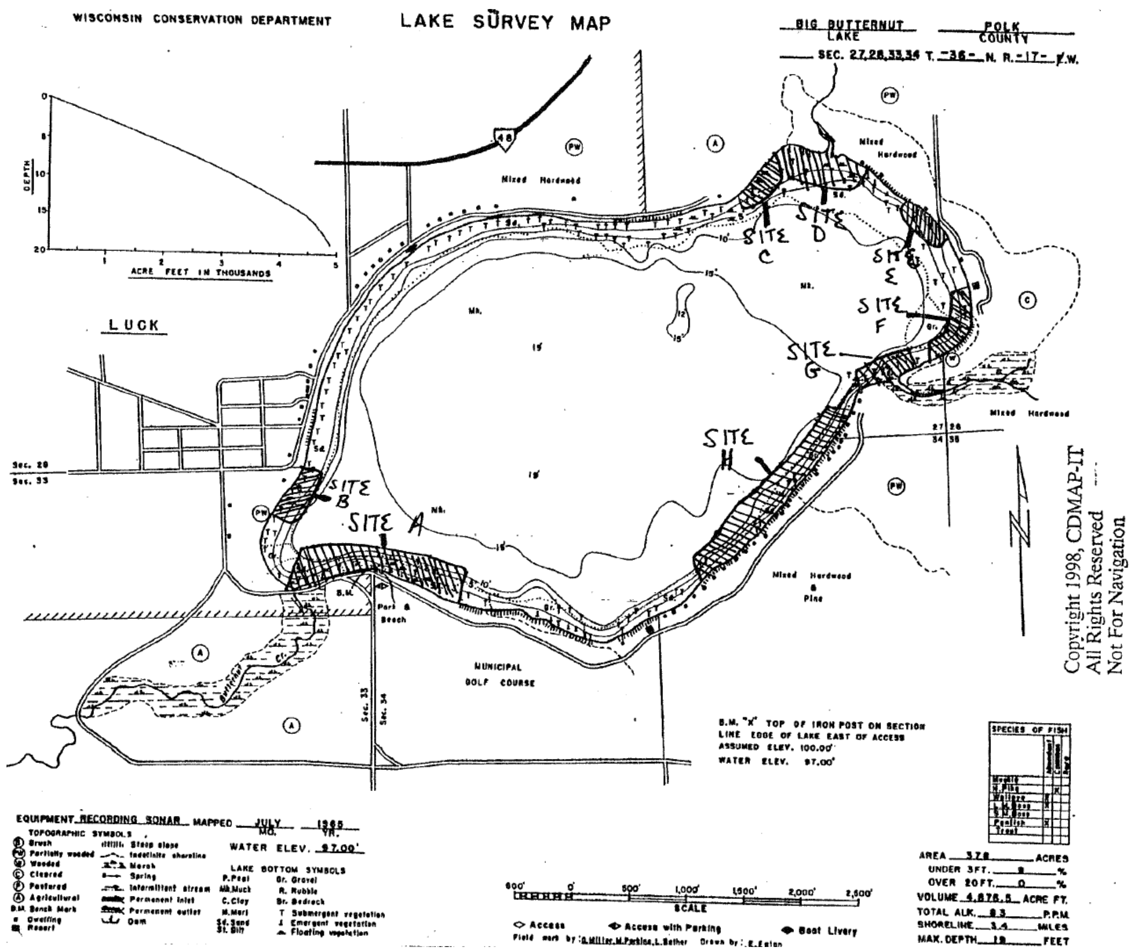


Figure 32. WDNR lake sensitive area survey results, Big Butternut Lake, 2000.

Land Use in Big Butternut Lake Subwatersheds

The Wisconsin Lake Modeling Suite (WiLMS) was used to model current conditions for Big Butternut Lake, verify monitoring, and estimate land use nutrient loading for each of the six subwatersheds. Phosphorous is the key parameter in the modeling scenarios used in WiLMS because it is the limiting nutrient for algal growth in most lakes. The output data from WiLMS can be found in Appendix M.

This data can be used to determine which best management practices will have the greatest impact for improving water quality for Big Butternut Lake.

Land uses in the Big Butternut Lake subwatersheds include: forest, wetlands, other water, row crop, high density residential (1/8 acre per person), medium density residential (1/4 acre per person), and rural residential (more than 1 acre per person).

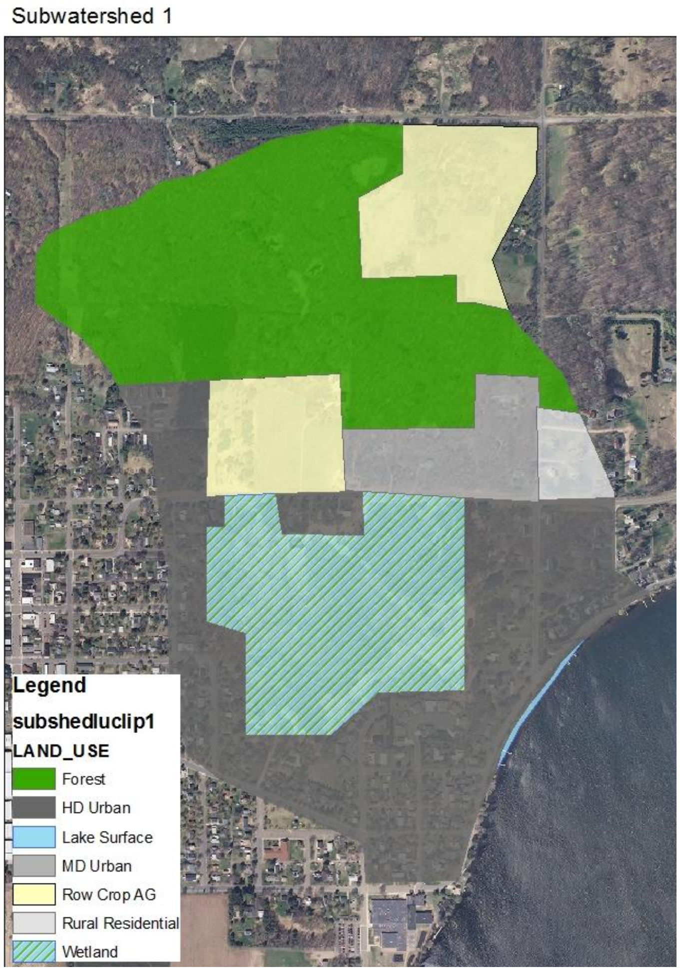


Figure 33. Land use in Big Butternut Lake subwatershed 1. Green = forest, dark gray = high density residential, medium gray = medium density residential, light yellow = row crop, light gray = rural residential, and hash blue = wetland.

Subwatershed 1 is approximately 312 acres in size. Most of subwatershed 1 is forest (30.8%) and high density residential (30.3). The remainder of subwatershed 1 is wetland (17.8%), row crop (13.5%), medium density residential (5.7%), and rural residential (1.9%) (Figure 33 and Table 12).

The greatest percentage of phosphorus loading in subwatershed 1 comes from high density residential (68.3%) and row crop (20.3%). To a lesser extent medium density residential (4.3%), forest (4.2%), wetland (2.7%), and rural residential (0.3%) contribute to the phosphorus load to Big Butternut Lake (Table 12).

Land Use	Acres	% Acreage	% Phosphorus Loading
Row Crop	42.162	13.5%	20.3%
Wetland	55.518	17.8%	2.7%
High Density Res.	94.771	30.3%	68.3%
Med. Density Res.	17.917	5.7%	4.3%
Rural Res.	5.801	1.9%	0.3%
Forest	96.23	30.8%	4.2%

Table 12. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 1.

Subwatershed 2

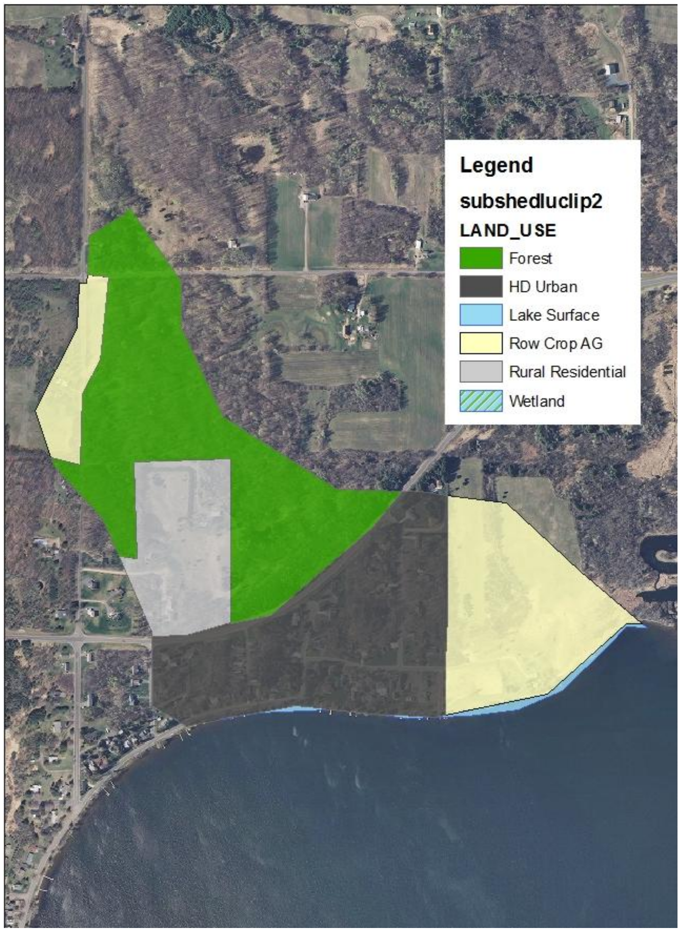


Figure 34. Land use in Big Butternut Lake subwatershed 2. Green = forest, dark gray = high density residential, light yellow = row crop, light gray = rural residential, and hash blue = wetland.

Subwatershed 2 is the second smallest subwatershed and is approximately 164 acres in size. Most of subwatershed 2 is forest (33.5%), high density residential (29.6), and row crop (23.9%). The remainder of subwatershed 2 is rural residential (11.9%) and wetland (1.1%) (Figure 34 and Table 13).

The greatest percentage of phosphorus loading in from subwatershed 1 comes from high density residential (60.9%) and row crop (32.8%). To a lesser extent forest (4.1%), rural residential (1.6%), and wetland (0.2%) contribute to the phosphorus load to Big Butternut Lake (Table 13).

Land Use	Acres	% Acreage	% Phosphorus Loading
Row Crop	39.125	23.9%	32.8%
Wetland	1.797	1.1%	0.2%
High Density Res.	48.48	29.6%	60.9%
Rural Res.	19.461	11.9%	1.6%
Forest	54.741	33.5%	4.1%

Table 13. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 2.

Subwatershed 3

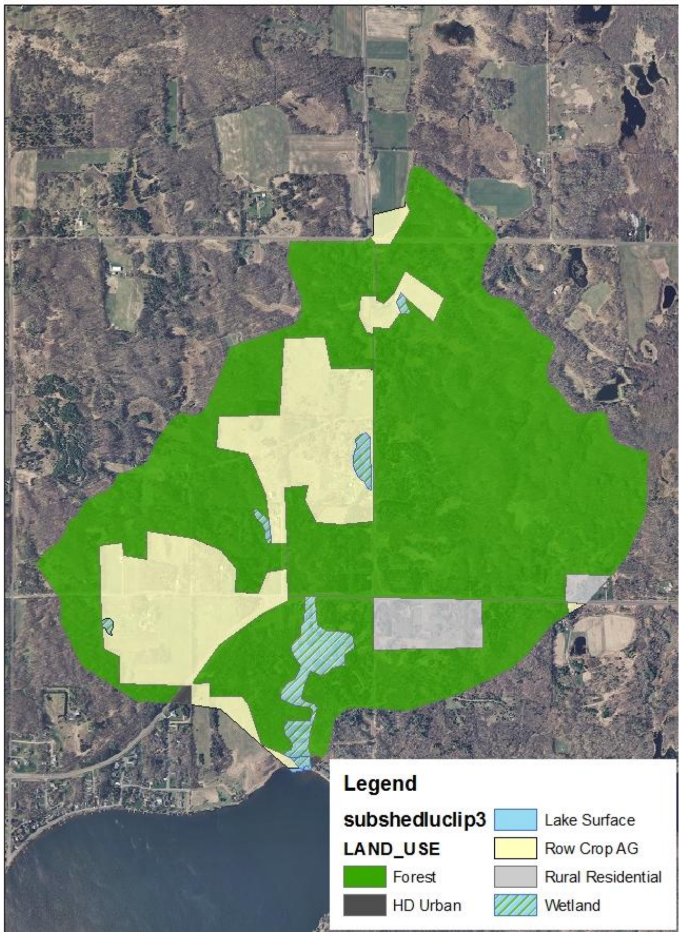


Figure 35. Land use in Big Butternut Lake subwatershed 3. Green = forest, dark gray = high density residential, light yellow = row crop, light gray = rural residential, and hash blue = wetland.

Subwatershed 3 is the second largest subwatershed of Big Butternut Lake and is approximately 1098 acres in size. Most of subwatershed 3 is forest (66.0%), row crop (18.9%), and wetland (12.0%). The remainder of subwatershed 3 is rural residential (2.9%) and high density residential (0.2%) (Figure 35 and Table 14).

The greatest percentage of phosphorus loading from subwatershed 3 comes from row crop (71.1%) and forest (22.3%). To a lesser extent wetlands (4.5%), rural residential (1.1%), and high density residential (0.9%) contribute to the phosphorus load to Big Butternut Lake (Table 14).

Land Use	Acres	% Acreage	% Phosphorus Loading
Row Crop	207.7	18.9%	71.1%
Wetland	132.13	12.0%	4.5%
High Density Res.	1.751	0.2%	0.9%
Rural Res.	31.721	2.9%	1.1%
Forest	724.76	66.0%	22.3%

Table 14. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 3.

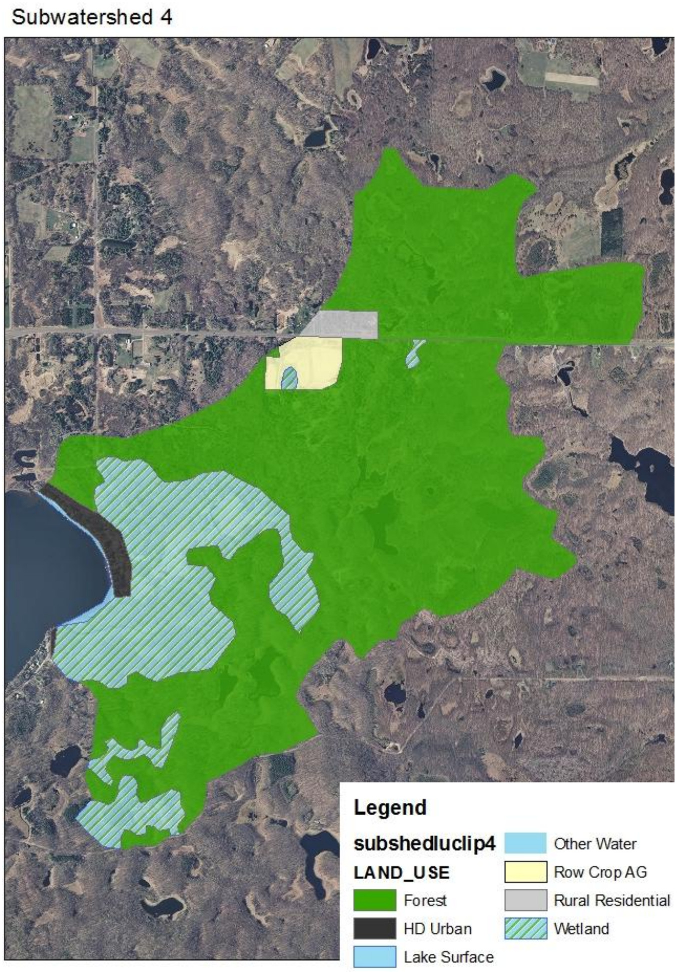


Figure 36. Land use in Big Butternut Lake subwatershed 4. Green = forest, dark gray = high density residential, light blue = other water, light yellow = row crop, light gray = rural residential, and hash blue = wetland.

Subwatershed 4 is the largest subwatershed of Big Butternut Lake and is approximately 1227 acres in size. Most of subwatershed 4 is forest (66.4%), and wetland (28.6%). The remainder of subwatershed 4 is other water (1.7%), high density residential (1.3%), row crop (1.2%), and rural residential (0.9%) (Figure 36 and Table 15).

The greatest percentage of phosphorus loading from subwatershed 4 comes from forest (49.2%) and wetland (23.6%). To a lesser extent high density residential (16.1%), row crop (9.6%), and rural residential (0.7%) contribute to the phosphorus load to Big Butternut Lake (Table 15).

Land Use	Acres	% Acreage	% Phosphorus Loading
Row Crop	14.277	1.2%	9.6%
Wetland	351.145	28.6%	23.6%
High Density Res.	15.938	1.3%	16.1%
Rural Res.	10.83	0.9%	0.7%
Forest	814.568	66.4%	49.2%
Other water	20.684	1.7%	0%

Table 15. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 4.

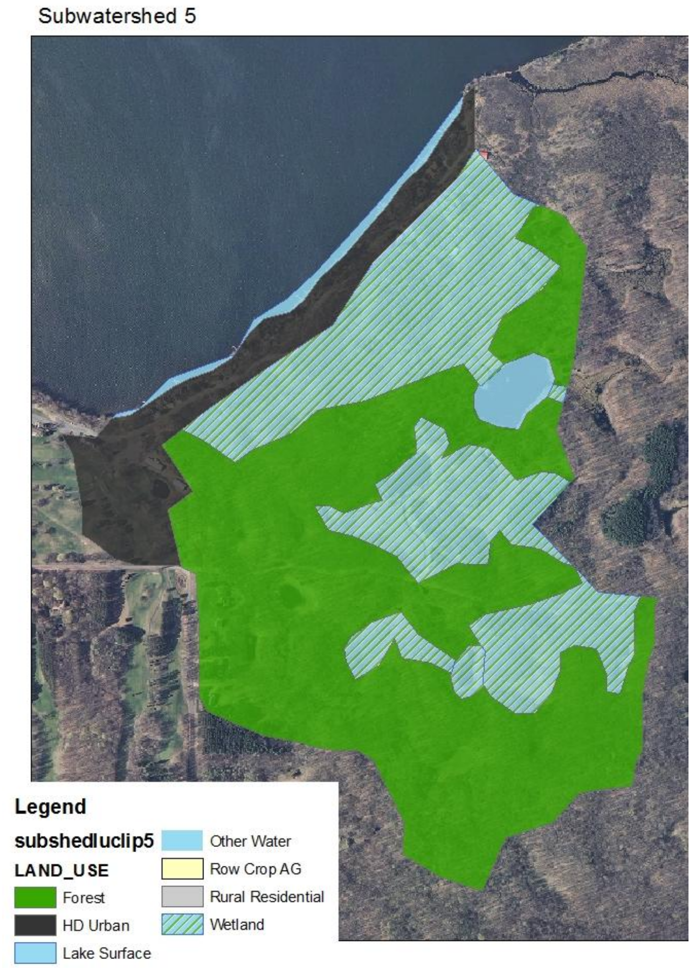


Figure 37. Land use in Big Butternut Lake subwatershed 5. Green = forest, dark gray = high density residential, light blue = other water, and hash blue = wetland.

Subwatershed 5 is approximately 243 acres in size. Most of subwatershed 5 is forest (53.6%), and wetland (33.0%). The remainder of subwatershed 5 is high density residential (11.7%) and other water (1.7%) (Figure 37 and Table 16).

The greatest percentage of phosphorus loading from subwatershed 5 comes from high density residential (67.2%). To a lesser extent forest (18.5%) and wetland (12.6%) contribute to the phosphorus load to Big Butternut Lake (Table 16).

Land Use	Acres	% Acreage	% Phosphorus Loading
Wetland	80.327	33.0%	12.6%
High Density Res.	28.447	11.7%	67.2%
Forest	130.386	53.6%	18.5%
Other water	4.013	1.7%	0%

Table 16. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 5.

Subwatershed 6

Figure 38. Land use in Big Butternut Lake subwatershed 6. Dark gray = high density residential.

Subwatershed 6 is the smallest subwatershed of Big Butternut Lake and is approximately 18 acres in size. The entire (100%) subwatershed is high density residential and contributes 97% of the phosphorus load to Big Butternut Lake (Figure 38 and Table 17).

Land Use	Acres	% Acreage	% Phosphorus Loading
High Density Res.	18.137	100%	97%

Table 17. Land use, acreage, % acreage, and % phosphorus loading for Big Butternut Lake subwatershed 6.

Land Use in the Big Butternut Lake Watershed

The area of land that drains towards a lake is called the watershed. The watershed area of Big Butternut Lake, including the lake itself is approximately 3,421.7 acres. The lake itself is 378 acres, and is represented in Figure 39 as 11% of the total land use in the Big Butternut Lake Watershed. The majority of the Big Butternut Watershed is forest (53%) followed by wetlands (18%). The remainder of land use is row crops (9%), high density residential (1/8 acre per person, 6%), medium density residential (1/4 acre per person, 1%), and rural residential (more than 1 acre per person, 2%). The majority of the shoreline of Big Butternut is high density residential land (Figure 40).

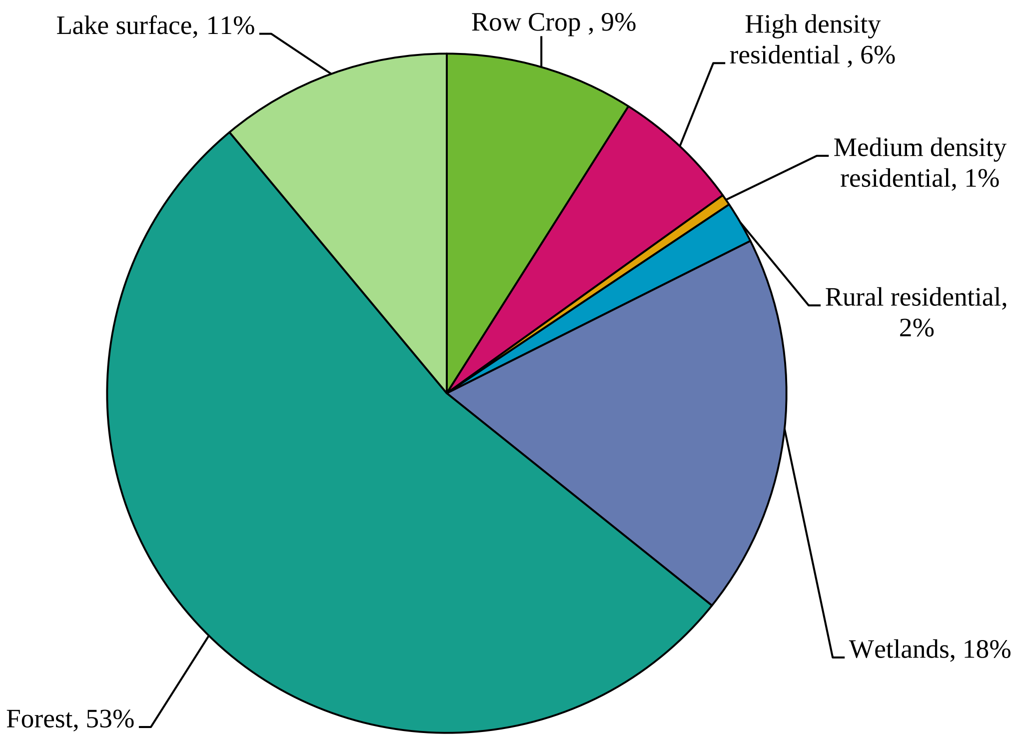


Figure 39. Land use in Big Butternut Watershed

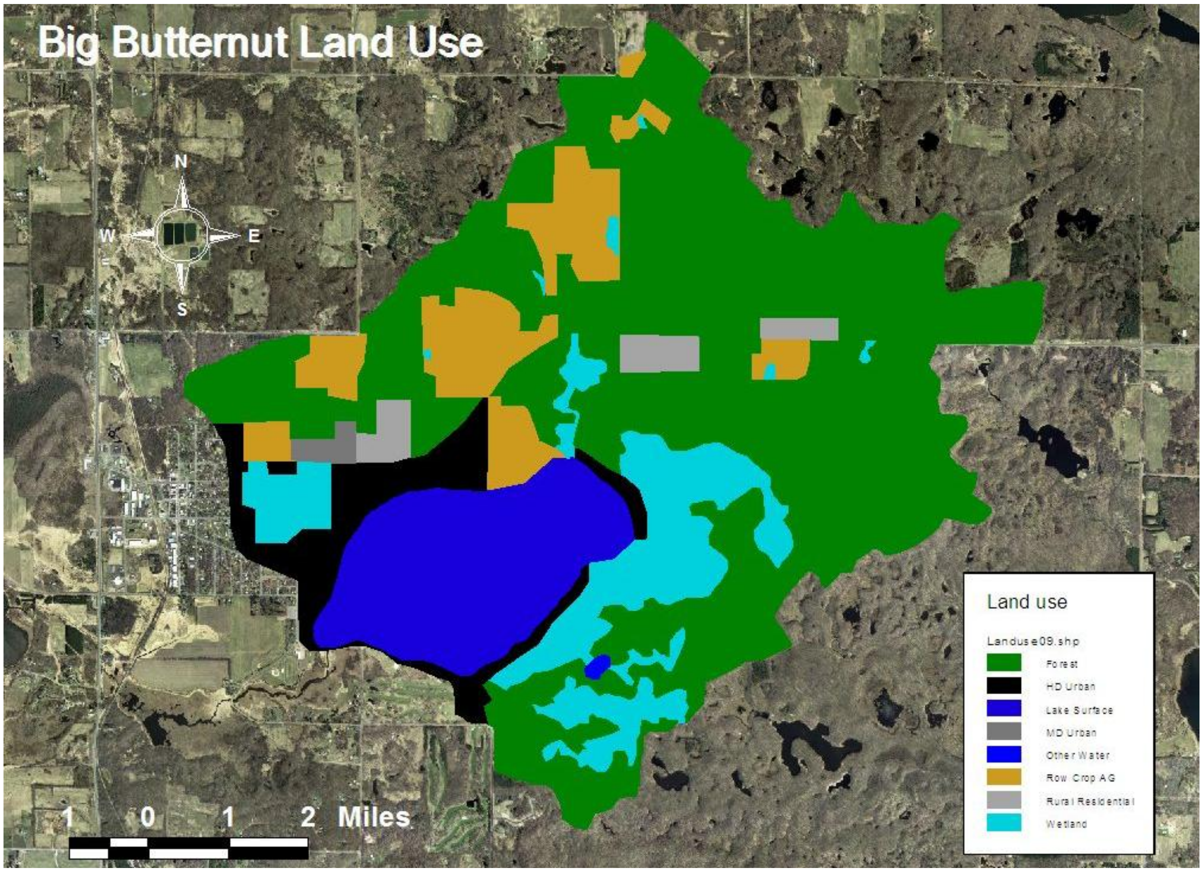


Figure 40. Land use in Big Butternut Lake Watershed. Green = forest; black = high density residential; dark blue = Big Butternut Lake surface and other water; dark gray = medium density residential; yellow = row crop agriculture; light gray = rural residential.

The amount of runoff which reaches a lake depends largely on the associated land use. This is important because runoff from precipitation events carry nutrients, organic material, and contaminants to Big Butternut Lake. Natural communities, such as forests and wetlands, allow for more infiltration of precipitation when compared with developed residential sites containing lawn, rooftops, sidewalks, and driveways. Median surface runoff estimates from wooded catchments are an order of magnitude less than those from lawn catchments.

The wetlands surrounding Big Butternut Lake are sensitive areas that should be preserved for their ability to protect water quality. Wetlands provide extensive ecosystem services by filtering nutrients and slowing the flow of water and the impacts of erosion.

WiLMS was used to model percent loading from each land use (i.e. nutrient budget). High density residential (32%) and row cropping (31%) contribute the greatest percentage of phosphorus loading to Big Butternut Lake followed by forest (17%), the lake surface (12%), wetlands (6%), medium density residential (1%), and rural residential (1%) (Figure 41). The large value for phosphorus loading from the forest land likely results due to the fact that forest makes up over half (53%) of the watershed area (Figure 39).

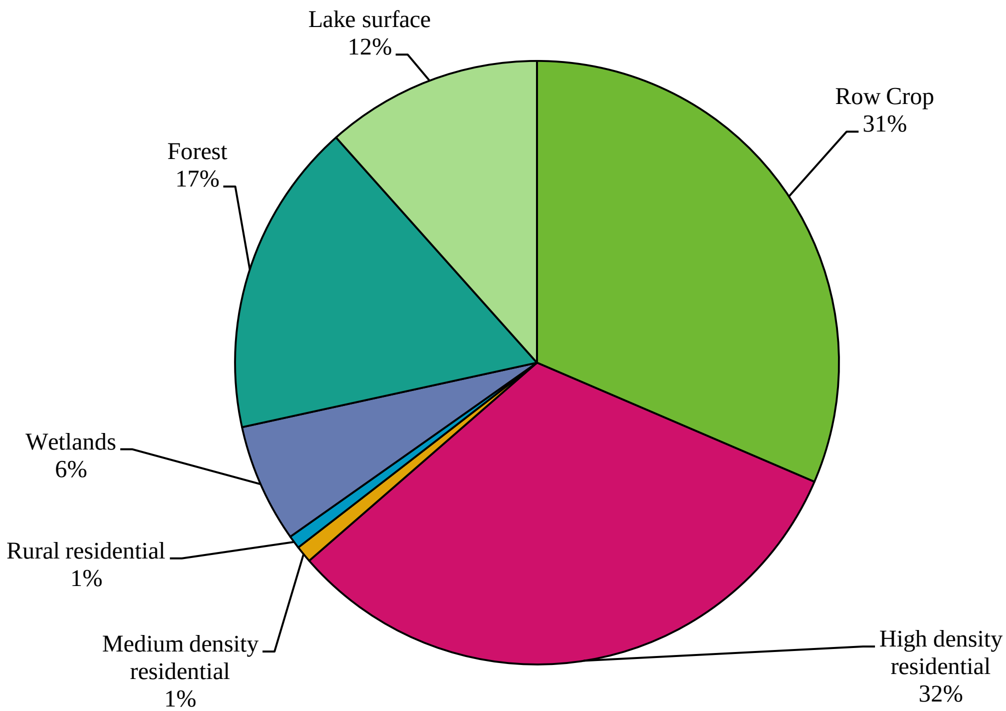


Figure 41. Percent loading of phosphorus from associated land uses.

Since none of the land in row crop is currently being utilized for field crops, this land use was converted to grass/pasture and the model was re-run. In this scenario, the high density residential (41%) contributes the greatest percentage of phosphorus loading to Big Butternut Lake followed by forest (22%), the lake surface (15%), pasture/grass (12%), wetlands (8%), medium density residential (1%), and rural residential (1%). (Figure 42).

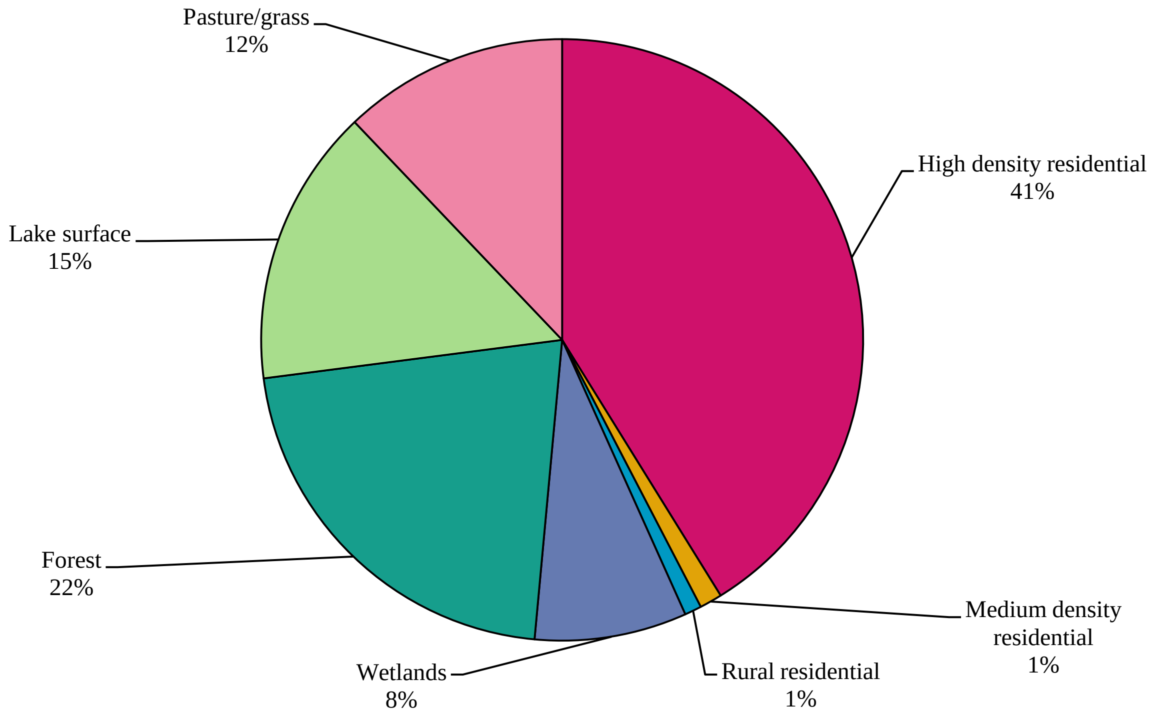


Figure 42. Percent loading of phosphorus from associated land uses with row crop converted to pasture/grass.

High density residential makes up only 6% of the land use in the Big Butternut Lake Watershed, yet contributes 41% of the phosphorous loading to Big Butternut Lake. Therefore, best management practices which focus on reducing the phosphorus loading from high density residential areas (such as shoreline restorations, rain gardens, and demonstration sites) will likely be most effective in improving water quality in Big Butternut Lake.

Although forest also contributes a large percentage of phosphorus loading to Big Butternut Lake (22%) this is likely due to the face that forest makes up 53% of the land use in the Big Butternut Lake Watershed. Since the forests remain in a natural state, best management practices which focus on this land use are unnecessary.

Areas Providing Water Quality Benefits to Big Butternut Lake

In early May 2009, LWRD ground truthed the wetlands in the Big Butternut Lake Watershed. Together the wetlands and forests make up the majority of the land use in the Big Butternut Lake Watershed (forest 53% and wetlands 18%; including the lake surface as 11%). Although these areas make up 71% of the land use in the Big Butternut Lake Watershed they contribute only 30% of the total phosphorus loading from the watershed, which is likely background phosphorus.

This is especially interesting given that high density residential makes up only 6% of the land use in the Big Butternut Lake watershed, yet contributes 41% of the phosphorous loading to Big Butternut Lake. To effectively manage phosphorus loading to Big Butternut Lake it is necessary to manage the high density residential area as a natural area by implementing shoreline restorations and rain gardens.

Natural areas such as forests and wetlands allow for more infiltration of precipitation when compared with developed residential sites containing lawn, rooftops, sidewalks, and driveways. This arises because dense vegetation slows the velocity of rain drops before they reach the soil interface thereby reducing erosion and allowing for greater infiltration. Additionally, wetlands provide extensive ecosystem services by allowing for the sedimentation of particles and filtering of nutrients.

The wetlands and forests in the Big Butternut Lake Watershed should be considered sensitive areas and preserved for the benefits they provide to Big Butternut Lake (Figure 43).

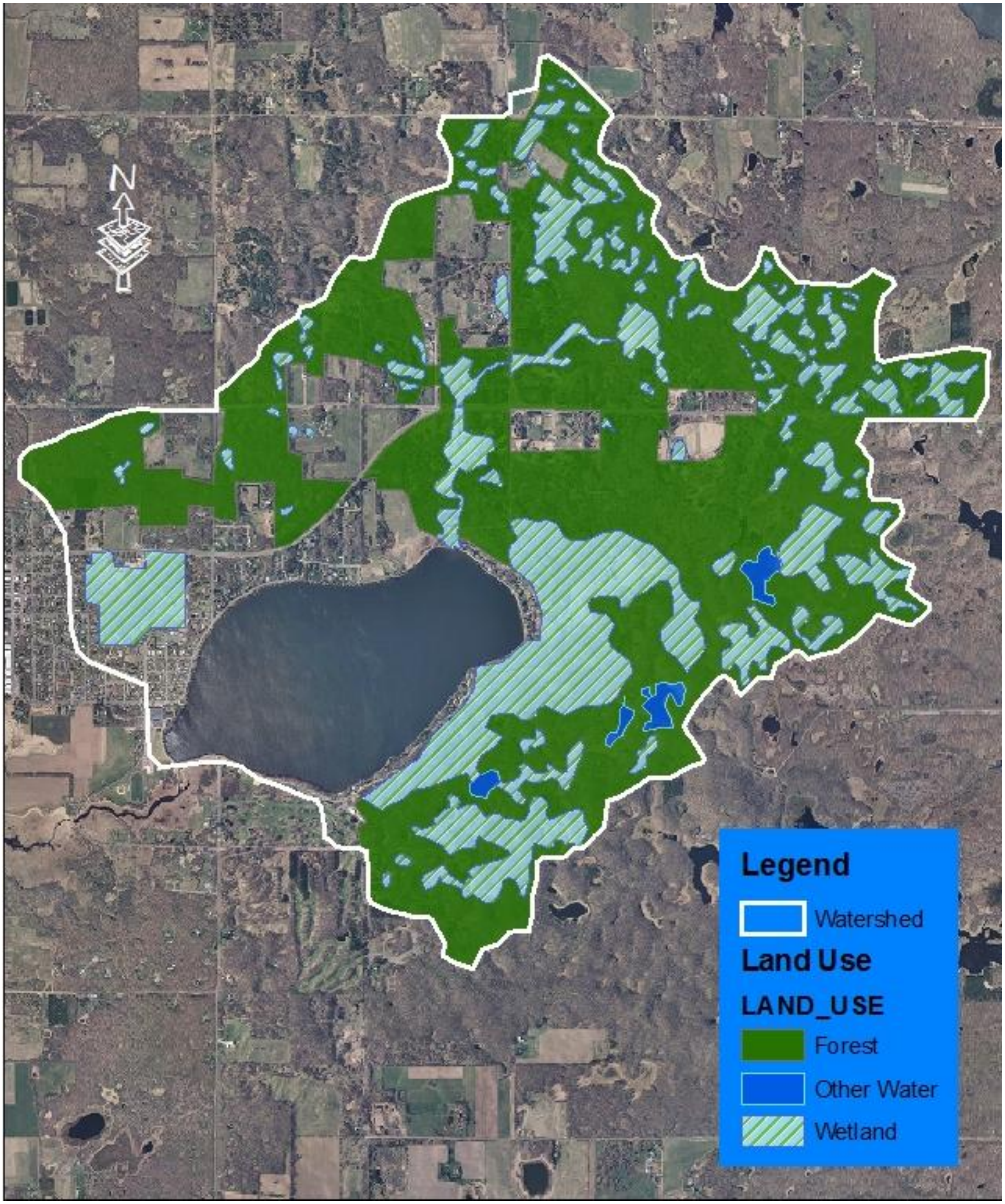


Figure 43. Areas in the Big Butternut Lake Watershed that provide benefits for the water quality of Big Butternut Lake. (Green = forest and hash blue = wetland).

Watershed Modeling

The Wisconsin Lake Modeling Suite (WiLMS) was used to model current conditions for Big Butternut Lake, verify monitoring, and estimate in-lake nutrient loading. Phosphorous is the key parameter in the modeling scenarios used in WiLMS because it is the limiting nutrient for algal growth in most lakes. The output data from WiLMS can be found in Appendix M.

Based on average evaporation, precipitation, and runoff coefficients for Polk County soils, the non-point source load was calculated to be 776.4 pounds of phosphorous annually. Since most of the agricultural land in the watershed is not actively row cropped, the row crop land use was converted to grassland and the watershed was modeled in a different scenario. In this scenario the total non-point source load was estimated to be 584.5 pounds of phosphorus.

Another scenario was run using the outlet of the constructed stormwater pond on the north end of the lake as a point source of phosphorus using water quality data collected in the field (Figure 44). In this scenario the non-point source load was estimated to be 514.0 pounds of phosphorus with the load from the inlet from the stormwater pond estimated to be 333.6 pounds annually.

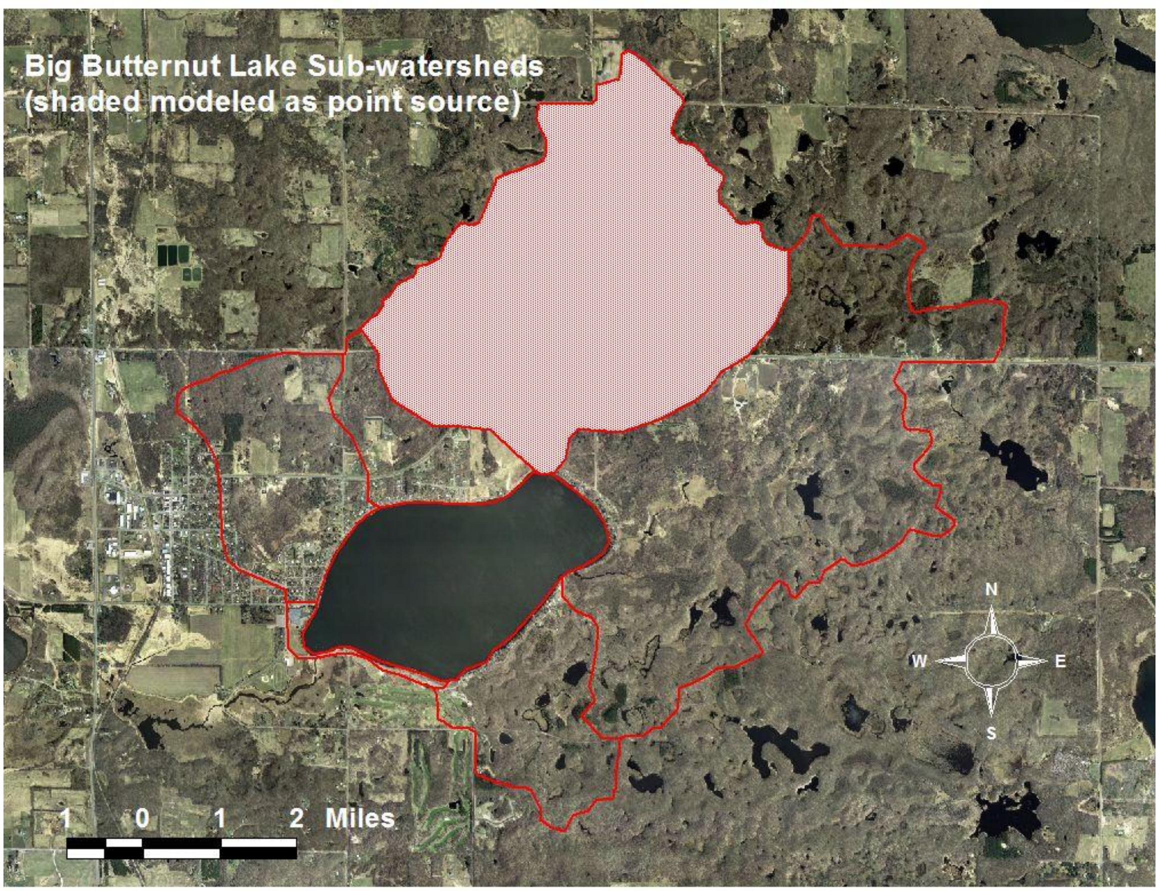


Figure 44. Big Butternut Lake subwatersheds. The shaded subwatershed was modeled as a point source based on data collected in the field.

In all three scenarios the land-use that contributed the most non-point phosphorus in the model was the Village. The model estimates that the Village itself contributes 275-279.4 pounds of phosphorus annually.

The internal load of the lake was estimated using in-situ data. This model quantifies the increase of phosphorous concentrations in the fall. Using this method it was predicted that 321 to 399 pounds of phosphorous are released from the sediment. That is 26.8% to 29.6% of the annual phosphorous budget. Continuous nutrient data should be taken in order to continue a trend and update the lakes nutrient budget as needed (especially as land-use changes and practices are implemented).

This data was used to select the 1977 Rechow Anoxic lake model: $P = \dfrac{L}{0.17z + 1.13\, z/T_w}$

> Where P = the predicted mixed lake total phosphorous concentration in mg/m^3;
> L = the areal total phosphorus load in mg/m^2 of lake;
> z = the lake mean depth; and
> T_w = the lakes hydraulic retention time in years.

This model was the best fit for Big Butternut Lake as it predicted the total phosphorous to be 99 mg/m^3; very close to the observed 91 mg/m^3.

This indicates that the effectiveness of traditional watershed and urban stormwater practices may work very well to reduce phosphorus and algae in Big Butternut Lake. As such, the Protection and Rehabilitation district and the Village of Luck should pursue policies and grant dollars to reduce the stormwater runoff from the village.

Traditional lake models do not predict water column phosphorous in shallow lakes well. However, WiLMS does have an expanded trophic response module that allows the prediction of nuisance algal bloom frequency. Based on the data collected, it is predicted that Big Butternut Lake will have nuisance blue-green algae blooms between 98.6-98.9% of the growing season. This is typical of the phytoplankton dominated state in lake ecosystems. However, because of the opportunities to reduce the phosphorus load from the Village there should be visible results when practices and policies are put in place.

Big Butternut Lake Tributaries

Big Butternut Lake has two unnamed inlets. One is located on the north side of the lake and crosses 140th Street and the other is located on the east side of the lake. The inlet located on the north side of the lake was dry late in the summer and the inlet on the east side of the lake never had flow. Although there was water in the east inlet, the lack of flow likely resulted from drought conditions and dense wetland vegetation within the channel. Due to a lack of flow, the east inlet was not monitored. However, two sites (site 5 and site 4) on the north inlet were monitored. Site 5 was located before the sediment ponds on the north side of the lake and site 4 was located after the sediment ponds (Figure 45).

Figure 45. Big Butternut Lake north inlet sample sites.

Flow data was collected biweekly on both sites on the north inlet with a Marsh McBirney Flo-Mate™ velocity flowmeter. Grab samples were collected once monthly at both sites on the north inlet and analyzed at the Water and Environmental Analysis Laboratory for total phosphorus and soluble reactive phosphorus. When sites were dry or without flow, samples were not collected.

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

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

In May and early July the total phosphorus concentration was lower downstream of the sediment ponds on the north inlet as compared to upstream of the sediment ponds. However, for the remainder of the season the total phosphorus concentration was actually higher downstream of the sediment ponds as compared to upstream of the ponds (Figure 46). Additionally, on August 28 total phosphorus concentrations at the outlet reached a maximum. This coincides with the sampling date where peak chlorophyll a and algae levels were noted.

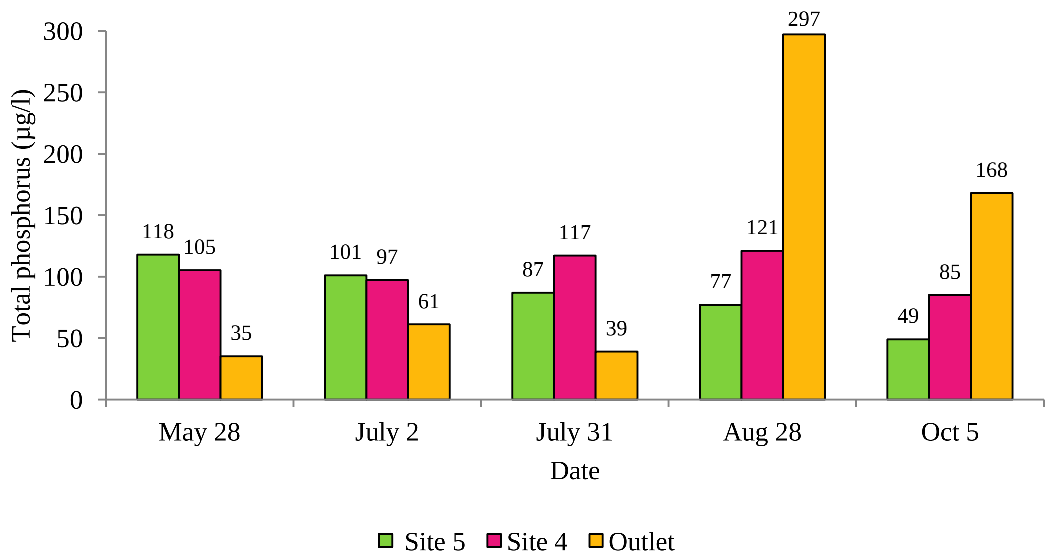


Figure 46. Big Butternut Lake Tributary total phosphorus (µg/l), 2009.

The average instantaneous load of phosphorus was higher at site 4 (located downstream of the sediment ponds) as compared to site 5 (located upstream of the sediment ponds) (Table 18).

Site	Total phosphorus (µg/l)	Discharge (l/s)	Instantaneous load (mg/s)	Instantaneous load (lb/yr)
5	86.4	46	3.9744	276.5034
4	105	41	4.305	299.5036
Outlet	120	99	11.88	826.5048

Table 18. Average total phosphorus, discharge, and instantaneous load of phosphorus for Big Butternut Lake Tributaries.

Wet Detention Ponds

Data collected by Barr Engineering in 1997 and 1998 and by Craig Roesler (WDNR) in 2000 showed a trend of increasing total phosphorus concentrations over the course of the growing season in the un-named tributary where the wet detention ponds on Big Butternut Lake are currently installed (Figure 47 & Figure 48).

Table 3 Total Phosphorus Concentrations in Stormwater

Date	Total Phosphorus Concentration (mg/L)									
Watershed:	*BL-09*	*BL-06*		*BL-05*			*BL-01*	*BL-02*	*BL-04*	*BL-03*
Site:	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
05/29/97	0.128	0.130	0.100	0.117	0.085	0.098	0.131	0.056	**	**
06/24/97	0.275	0.152	0.168	0.192	0.301	0.19	0.963	0.282	0.738	0.301
07/08/97	0.135	0.132	0.168	0.115	0.118	0.099	0.113	**	0.080	0.440
08/19/97	0.125	**	0.128	0.108	0.208	0.144	0.138	0.192	0.130	0.143
09/16/97	0.265	**	0.220	0.159	0.249	0.272	0.742	0.267	0.173	0.111
10/11/97	0.273	**	0.116	0.151	0.365	0.181	0.500	0.371	0.161	0.631
03/27/98	0.137	**	0.112	0.135	0.28	0.197	0.224	0.074	0.267	0.163

** indicates no sample taken due to low flow rates

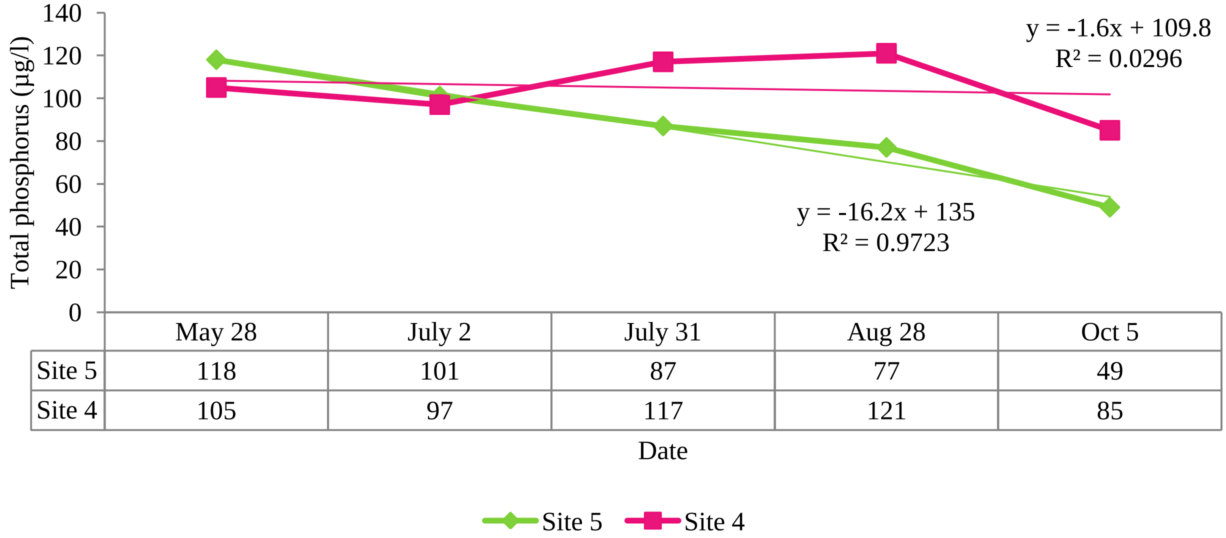
Figure 47. Graph from Big Butternut Lake Wisconsin Lake Planning Grant LPL-452 Final Report, prepared by Barr Engineering in 1999 for total phosphorus concentrations (Note units of mg/l). Sites BL-05: 4 and 5 correspond to Sites 4 and 5 in the 2009 LWRD study.

Surface Water Quality: Unnamed Creek

Date	Surface Water Site Location	Flow cfs	Total Phosphorus µg/L	Dissolved Phosphorus µg/L	Suspended Solids mg/L
4/17/00	F-6	--	49	16	17
	E-5	--	34	12	<5
	D-4	--	39	15	<5
	C-3	--	37	10	5
	B-2	--	36	12	<5
	A-1	3.2	36	12	<5
5/11/00	A-1	--	61	12	--
5/31/00	A-1	0.5	119	--	--
6/1/00	A-1	1	157	57	--

Figure 48. Graph from Big Butternut Lake Wisconsin Lake Planning Grant LPL-699 Final Report, prepared by Cedar Corporation in 2002 showing Craig Roesler's total phosphorus data (µg/l). Data for Site A-1 corresponds with data collected from the unnamed tributary that flows through the area where the wet detention ponds are currently installed.

Data collected by LWRD in 2009 showed that total phosphorus concentrations (mg/l) decreased at site 5 over the growing season; whereas concentrations at site 4 exhibited a cycle of increases and decreases over the growing season. However trendlines for both sites 4 and 5 show a slight decrease in total phosphorus concentrations over the growing season. The data also show that with the exception of the first two sample dates, total phosphorus concentrations are actually lower prior to the wet detention ponds, suggesting the need for maintenance and further sampling (Figure 49).



	May 28	July 2	July 31	Aug 28	Oct 5
Site 5	118	101	87	77	49
Site 4	105	97	117	121	85

Figure 49. Big Butternut Lake total phosphorus (µg/l) for sites 4 and 5 on the north inlet, 2009.

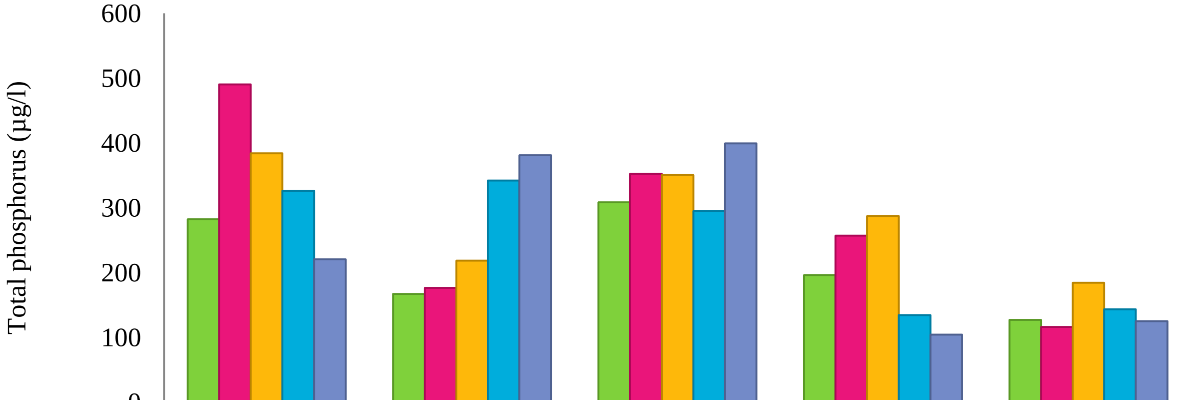
Stormwater Phosphorus Concentration

In 2009, stormwater samples were taken throughout the summer by volunteers from the Big Butternut Lake Protection and Rehabilitation District and workers from the Village crew. Samples were collected after rainfall events at six locations where stormwater enters Big Butternut Lake (Figure 50). Samples were analyzed at the Water and Environmental Analysis Lab (WEAL) at UW-Stevens Point for two types of phosphorus (total phosphorus and soluble reactive phosphorus) and three types of nitrogen (nitrate/nitrite, ammonium, and total Kjeldahl nitrogen).

Figure 50. Big Butternut Lake stormwater sample sites.

BBLPRD2 flowed from a wetland and only exhibited flow one time during the 2009 growing season. As a result, this sample point was discarded although the data is shown below in Table 19.

The stormwater total phosphorus concentration profile is show in Figure 51. Concentrations of phosphorus in the stormwater samples were relatively consistent between sites with the average concentration varying only 68.6 µg/l between all sites.



	July 15	July 21	July 22	July 27	August 19
BBLPRD1	282	167	308	196	127
BBLPRD3	490	176	352	257	116
BBLPRD4	384	218	350	287	184
BBLPRD5	326	342	295	134	143
BBLPRD6	220	381	399	104	125

Figure 51. Big Butternut Lake stormwater total phosphorus concentration (µg/l), 2009.

Historically, stormwater samples were taken in 1997 and 1998 by Barr Engineering and in 2000 by Cedar Corps. The sites used by Barr Engineering correspond with sites 2, 3, and 4 from the LWRD study and the sites used by Cedar Corps correspond with sites 3 and 4 from the LWRD study (Figure 19).

Although an average of all historical data shows stormwater from site 3 to have the greatest phosphorus concentration (µg/l), more data is necessary to make conclusive remarks regarding stormwater runoff to Big Butternut Lake.

Date	Total phosphorus (µg/l) Site 2 (BL-03 (10))	Total phosphorus (µg/l) Site 3 (BL-04 (9))	Total phosphorus (µg/l) Site 4 (BL-02 (8))
May 29 1997	-	-	56
June 24 1997	301	738	282
July 8 1997	440	80	-
Aug 19 1997	143	130	192
Sept 16 1997	111	173	267
Oct 11 1997	631	161	371
March 27 1998	163	267	74
June 21 2000	-	88	63
July 26 2000	-	101	80
July 15 2009	-	490	384
July 21 2009	-	176	218
July 22 2009	-	352	350
July 27 2009	250	257	287
Aug 19 2009	-	116	184
Average	145.6	223.5	200.6

Table 19. Historical stormwater data for total phosphorus (µg/l), 1997-2009.

P8 Urban Catchment Model for Stormwater

The P8 Urban Catchment Model was used to determine loads of phosphorus entering Big Butternut Lake from each watershed outlet. This model was developed for the Wisconsin DNR, Minnesota Pollution Control Agency, and the United State Environmental Protection Agency. The model uses a 30 year precipitation and temperature average to calculate a mass balance of phosphorus using curve numbers from the USDA Technical Release 55 Urban Hydrology for Small Watersheds (TR-55).

The inlet BBLPRD 2 was not included in the modeling analysis because it had only one day of flow and the watershed area is very large compared to the others. Additionally, this watershed is primarily wetland and is really not of management concern.

Similar to the average inflow total phosphorus concentration, which was relatively consistent between sites, the model predicted relatively consistent phosphorus loading across sites (Figure 52). The differences arose from the variation in watershed size.

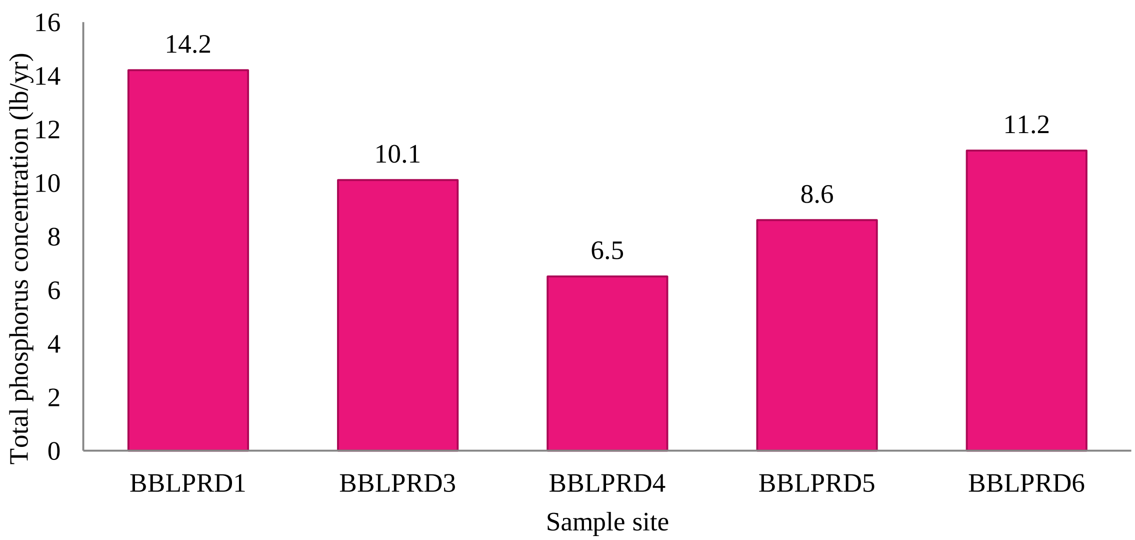


Figure 52. Big Butternut Lake P8 Urban Catchment Model total phosphorus concentration (lb/yr) for stormwater sample sites.

The model showed that the portion of the Village that contributes directly to those outlets the stormwater contributes just over 142 pounds of phosphorus to Big Butternut Lake annually. This is probably accurate as the default concentration values used by the model are very close to what was actually collected. Likely the Village contributes more phosphorus than this because other stormwater sewers are indirectly connected to the lake. Likely creating a stormwater ordinance and conducting engineering feasibility studies and installing urban Best Management practices would have a very positive impact on the lakes nutrient budget (see the Watershed Modeling Section of this report.

Nutrient Budget Summary

Non-point source load: 584.5 pounds

** Row crop converted to grass scenario*

- Pasture/grass: 12%
- HD residential: 40.8%
- MD residential: 1.2%
- Rural residential: 0.9%
- Wetlands: 8.1%
- Forest: 21.3%
- Lake surface: 14.8%

Internal load: 321-399 pounds of phosphorus

Village contribution: 275-279.4 pounds of phosphorus

Tributaries

- Site 5 (downstream the sediment pond): 277 pounds/year
- Site 4 (upstream the sediment pond): 300 pounds/year
- Outlet: 827 pounds/year

Stormwater: 48.8 pounds/year

- BBLPRD1: 14.2 pounds/year
- BBLPRD3: 10.1 pounds/year
- BBLPRD4: 6.5 pounds/year
- BBLPRD5: 6.8 pounds/year
- BBLPRD6: 11.2 pounds/year

Currently, the TSI(P) for Big Butternut Lake is 62, which indicates that the lake is eutrophic. A realistic goal would be to reduce the water column phosphorus between 15 and 30%. The 1977 Rechow Anoxic lake model predicted the total phosphorus to be between 57-218 mg/m^3. This model was used to determine the impacts of installing various best management practices to reduce phosphorus concentrations.

Controlling all stormwater would achieve a 16% reduction in growing season average in-lake phosphorus

Removing internal load would achieve a 51% reduction in growing season average in-lake phosphorus

Reducing 60% of stormwater and reducing internal load by 60% would achieve a 44% reduction in growing season average in-lake phosphorus

Reducing 30% of stormwater and reducing internal load by 30% would achieve a 22% reduction in growing season average in-lake phosphorus

**Controlling stormwater can be achieved through shoreline restoration, installing rain gardens, and professional engineered projects (i.e. sediment ponds). Internal load can be reduced through the introduction of native aquatic macrophytes.*

Education Programs

A number of educational programs were planned to accompany both the lake study and stormwater and aquatic plant study. The educational programs offered included:

- A pontoon classroom was held during Lucky Days on July 18th, 2009 and was attended by 13 people
- A hands on demonstration of aquatic macrophytes was held at the Luck Library on July 17th and 18th and was attended by 14 people
- Grant updates and presentation of results were provided at
    - Village Board Meetings
    - Lake District Meetings
- Aquatic Plant Management committee meetings were attended throughout the summer
    - Meeting minutes and example presentations can be found in Appendix O

Discussion

Likely the causes for the low water clarity and algae blooms experienced on Big Butternut Lake are a cause of cultural eutrophication, that is, human influences which have had a profound effect on the lakes ecosystem. Historically, agriculture has been a major cause of eutrophication; however, currently there is very little row crop in the watershed and there are no animal units. This strongly suggests that the Lake District and the Village must work collaboratively to develop a stormwater plan, including an ordinance to reduce the amount of nutrients entering the lake. The watershed and stormwater modeling supports this as and showed the most significant loading coming from the higher density residential areas.

The total phosphorus levels in Big Butternut Lake do indeed show the lake as eutrophic with an average value of 91µg/L. There would have to be significant reductions in external loading in order to bring the levels down to a level of 25-29 µg/l and in order for the lake to be considered mesotrophic. This will need to be achieved by the implementation of a series of urban runoff control practices and a re-evaluation and maintenance of the existing wet detention pond. Additionally, homeowners can begin reducing nutrients on their own properties by installing rain gardens and shoreline habitat restorations.

Reducing phosphorus should help limit algae blooms within the lake. In 2009 Big Butternut Lake experienced a significant bloom in August with blue-green algae totals of almost 65,000 natural units per milliliter of lake water. Health officials become concerned when levels reach 100,000 natural units per milliliter. This bloom disrupted the whole lake ecosystem by raising the pH to 9.67 (algae are capable of reducing bicarbonate in the water leaving cations that can raise the alkalinity of a system), and greatly reduced the dissolved oxygen below 1 meter depth (likely due to light limitation). Prolonged blooms of cyanobacteria (blue-green algae) can cause a regime shift in lake ecosystems and cause considerable health problems if not monitored and reduced.

The significance of the August cyanobacteria bloom can also be seen in the zooplankton community. Although zooplankton populations can change very rapidly the significant reduction in cladocera species is likely due to the proliferation of cyanobacteria. Cladocera are grazers of algae and can greatly reduce biomass; however, certain species of cyanobacteria can form colonies that are unable to be eaten by cladocera and can produce toxins.

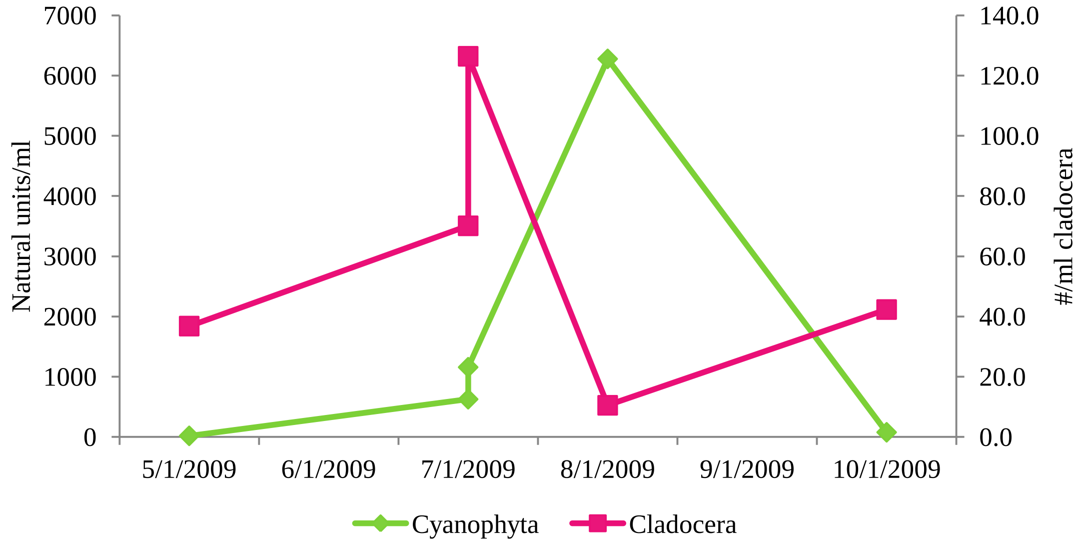


Figure 53. Cladocera (#/ml) versus cyanobacteria (natural units/ml).

The aquatic macrophyte community on Big Butternut Lake is encouraging and indicates that the lake will be able to respond positively to reduction in stormwater and nutrients. Although the rooting depth of macrophytes is reduced (10-11 feet maximum rooting depth) compared to some Polk County Lakes, the community composition has some relatively sensitive species, such as *Nitella sp.* and *Potamogeton praelongis*.

Aquatic macrophytes provide an array of benefits to lake ecosystems. They provide habitat for fish, zooplankton, and other invertebrates and can alter the biogeochemistry of the system. For example, charophytes such as *Nitella sp.* are very efficient at utilizing bicarbonate as a source of carbon in hard water systems (such as Big Butternut) often leaving calcium to form precipitates with phosphorus such as hydroxyapitite and calcite which can inhibit the internal release of phosphorus. Additionally, these compounds are often redox insensitive, meaning they are less likely to be released from the sediment. Aquatic angiosperms (i.e. *Potamogeton sp.*) are capable of introducing oxygen into the sediment, which is very crucial to inhibiting internal loading of phosphorus. Oxidizing the sediment allows iron to form many complexes with organic compounds which often absorbs phosphorus as well.

Algae blooms limit light penetration causing lake sediments to become reduced and release phosphorus back into the water column, making it available for algae (essentially creating a positive feedback loop). Anoxic sediments reduce both iron and sulfur and as they are diffused from the sediment they often form ferrous sulfides (FeS) and precipitate back to the sediment. If enough FeS precipitates, and enough Fe (iron) is removed, iron poor water results so at overturn more P is available for algal uptake. This in turn increases phosphate release, because it reduces the potential iron trap. Reducing the nutrient inputs could potentially expand the native aquatic plant community in the lake by limiting algae blooms and increasing light penetration in the lake. If water quality goals are met, the Lake District should control CLP more aggressively to further enhance water quality.

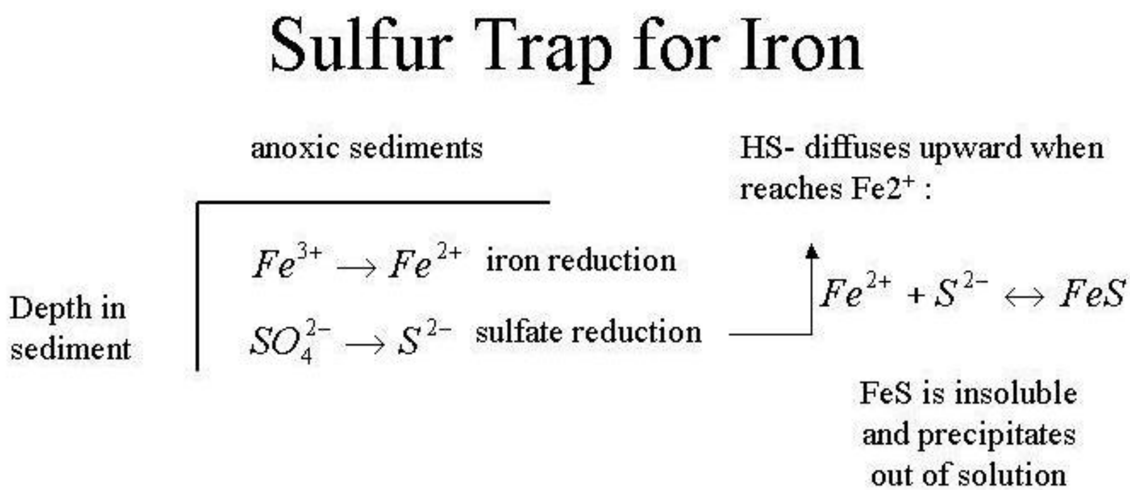


Figure 54. Sulfur trap for iron.

There was only one severe cyanobacteria bloom during 2009 and the aquatic plant community is relatively diverse, indicating that Big Butternut Lake is capable of recovery from cultural eutrophication. This recovery will involve engineering feasibility studies for urban stormwater practices along with individual homeowner practices. Reducing the nutrients entering the lake will help reduce frequency of algae blooms and provide benefits for the entire lake ecosystem.

Because modern data is limited in most lakes, paleolimnological techniques can be used to decipher historical trends over the last 200-300 years. This can be useful in determining realistic water quality goals and can also provide very insightful historic ecological information. Sediment cores could be used to decipher when cyanobacteria blooms started to occur, historical phosphorus content of the lake, historical dissolved oxygen, etc. and should be explored by the District.

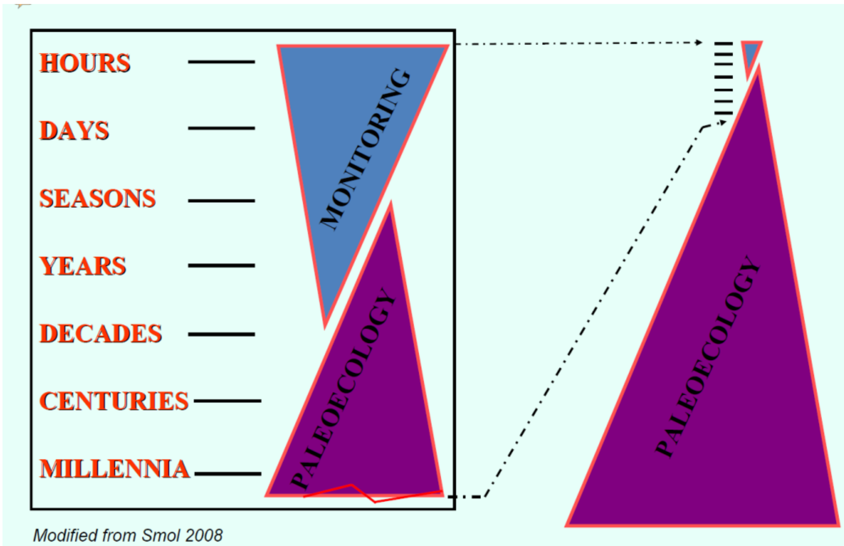


Figure 55. Comparison of monitoring and paleoecology.

Implementation Plan

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

Lake Management Plans are living documents that are under constant review and adjustment depending on the condition of a lake, available funding, level of volunteer commitment, and the needs of lake stakeholders.

The implementation plan presented below was created through collaborative efforts and takes into account input gathered from Village Board Meetings, Lake District Meetings, and a 2009 sociological survey regarding the needs of Big Butternut Lake stakeholders. The Implementation Plan was also presented at the District annual meeting on April 28th 2012. At this meeting the Plan was voted on and approved. The goals presented below are realistic based upon the findings of this project and the needs of Big Butternut Lake and the stakeholders that represent the lake.

Management Goal 1. Improve current water quality conditions in Big Butternut Lake.

Objective: Continue to monitor water quality through WDNR Citizens Lake Monitoring Network.

Action: Maintain current volunteers and recruit additional volunteers if necessary.

Action: If necessary contact Kris Larsen, WDNR (715-635-4072, kris.larsen@wisconsin.gov) to arrange for training and equipment.

Action: Volunteers collect data and report results to WDNR through the SWIMS database and present data at Lake District Annual Meetings.

Objective: Reconstruct past water quality conditions as a means to set future water quality goals and objectives.

Action: Pull lake sediment cores for analysis.

Action: Research possible funding sources to assist with costs of sediment cores.

Objective: Promote shoreline restoration and rain gardens through information and education.

Action: Recruit property owners or identify public property for shoreline restoration and rain garden demonstration sites.

Action: Research cost sharing opportunities for installation of shoreline restorations and rain gardens.

Management Goal 2. Reduce algae biomass in Big Butternut Lake.

Objective: Gain and understanding of algae population dynamics, zooplankton population dynamics, and nutrient availability in Big Butternut Lake.

> **Action**: Recruit volunteers to collect algae samples, zooplankton samples, and in-lake water samples to analyze for nitrogen and phosphorus.
>
> **Action**: If necessary, retain a consultant to coordinate a monitoring strategy.
>
> **Action**: If necessary, obtain a WDNR grant to fund monitoring activities.

Objective: Increase algae grazing by zooplankton.

> **Action**: Increase coarse woody habitat.
>
> **Action**: Provide education regarding the important role of coarse woody habitat for algae grazing and fishery improvement.

Management Goal 3. Reduce nutrient pollution to Big Butternut Lake.

Objective: Develop a stormwater management strategy.

> **Action**: Adopt an appropriate stormwater ordinance (see City of Amery).
>
> **Action**: Implement an engineering feasibility study to determine best management practices for stormwater management.
>
> **Action**: Research Lake Protection Grant and Stormwater Grant funding opportunities.

Objective: Promote the adoption of infiltration practices through information and education.

> **Action**: Recruit property owners or identify public property for demonstration sites for infiltration practices.
>
> **Action**: Research cost sharing opportunities for installation of demonstration sites.

Objective: Reassess the wet detention ponds on the North Inlet.

> **Action**: Conduct additional monitoring efforts to assess the effectiveness of the sediment ponds.
>
> **Action**: If the ponds are found to be ineffective, begin developing strategies to make improvements.
>
> **Action**: If necessary, hire a consultant to conduct the monitoring and make additional recommendations.
>
> **Action**: If necessary, research potential funding sources for pond repair.

Management Goal 4. Maintain scenic beauty and enjoyment of Big Butternut Lake through education.

Objective: Create an Education and Communication Committee to communicate information and education.

> **Action**: Recruit volunteer committee members.
>
> **Action**: Identify topics of focus for education and information based on priority and feasibility.
>
> *Example educational topics: water safety, shoreline restoration, water quality, noise pollution, septic system maintenance, minimizing pollution, etc.*

Objective: Provide users of Big Butternut Lake with important and timely information to assist with minimizing their impact on the lake.

> **Action**: Develop a P&R District website where information can be communicated.
>
> **Action**: Utilize multiple media types to communicate information such as newsletters, newspaper articles, signage at public boat landings and the public beach, demonstration sites, events, posters, etc.

Action Items	Timeline	Responsible Parties
Management Goal 1. Improve current water quality conditions in Big Butternut Lake.		
Maintain current volunteers and recruit additional volunteers if necessary.	Ongoing	District
If necessary contact Kris Larsen, WDNR (715-635-4072, kris.larsen@wisconsin.gov) to arrange for training and equipment.	Ongoing	District, WDNR
Volunteers collect data and report results to WDNR through the SWIMS database and present data at Lake District Annual Meetings.	Ongoing	District, WDNR
Pull lake sediment cores for analysis.	When funds available	District, LWRD, SCWRS
Research possible funding sources to assist with costs of sediment cores.	Ongoing	District, LWRD
Recruit property owners or identify public property for shoreline restoration and rain garden demonstration sites.	When funds available	District
Research cost sharing opportunities for installation of shoreline restorations and rain gardens.	Ongoing	District, LWRD
Management Goal 2. Reduce algae biomass in Big Butternut Lake.		
Recruit volunteers to collect algae samples, zooplankton samples, and in-lake water samples to analyze for nitrogen and phosphorus.	When funds available	District
If necessary, retain a consultant to coordinate a monitoring strategy.	Spring	LWRD, consultant
If necessary, obtain a WDNR grant to fund monitoring activities.	Ongoing	District, LWRD
Implement Polk County's "Amended Illegal to Transport Ordinance."	As soon as possible	District, Village
Increase coarse woody habitat.	Ongoing	District
Provide education regarding the important role of coarse woody habitat for algae grazing and fishery improvement.	Ongoing	District
Management Goal 3. Reduce nutrient pollution to Big Butternut Lake.		
Adopt an appropriate stormwater ordinance (see City of Amery).	As soon as possible	District
Implement an engineering feasibility study to determine best management practices for stormwater management.	When funds available	District, Consultant
Research Lake Protection Grant and Stormwater Grant funding opportunities.	Ongoing	District

Recruit property owners or identify public property for demonstration sites for infiltration practices.	Ongoing	District
Research cost sharing opportunities for installation of demonstration sites.	Ongoing	District, LWRD
Conduct additional monitoring efforts to assess the effectiveness of the sediment ponds.	When funds available	District, consultant
If the ponds are found to be ineffective, begin developing strategies to make improvements.	Ongoing	District
If necessary, hire a consultant to conduct the monitoring and make additional recommendations.	When funds available	District
If necessary, research potential funding sources for pond repair.	Ongoing	District
Management Goal 4. Maintain scenic beauty and enjoyment of Big Butternut Lake through education.		
Recruit volunteer committee members.	Ongoing	District
Identify topics of focus for education and information based on priority and feasibility.	Ongoing	Education committee, District
Develop a P&R District website where information can be communicated.	Ongoing	Education committee, District
Utilize multiple media types to communicate information such as newsletters, newspaper articles, signage at public boat landings and the public beach, demonstration sites, events, posters, etc.	Ongoing	Education committee, District

Table 20. Timeline for Implementation Plan Action items.

References

Aitchison, J. 1983. Principal Component Analysis of Compositional Data. Biometrika 70:57-65.

Aitchison, J. 1984. Reducing the Dimensionality of Compositional Data Sets. J. Math. Geol. 16:617-35.

Allen, T. F. H. 1977. Multiple Stable Configurations in Ordination of Phytoplankton Community Change Rates. Ecology 58:1076-84.

Borman, Susan, Robert Korth and Jo Tempte. Through the Looking Glass. University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

Carlson, R.E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology and Oceanography. 22:361-369.

Crow, Garrett E. and C. Barre Hellquist. Aquatic and Wetland Plants of Northeastern North America. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

EPA, Quality Criteria for Water, Goldbook, 1986. EPA 440/5-86-001 http://www.epa.gov/waterscience/criteria/goldbook.pdf.

Karr, J.R. and I.J. Schlosser. 1978. Water Resources and the Land-water Interface. Science 201: 229-34.

Karr, J. and C. Yoder. 2004. Biological Assessment and Criteria Improve Total Maximum Daily Load Decision Making. Journal of Environmental Engineering 130(6):594-604.

Lillie, R.A. and J.W. Mason. Limnological Characteristics of Wisconsin Lakes. Department of Natural Resources Technical Bulletin No. 138. 1983.

Moss, B. 1990. Engineering and Biological Approaches to the Restoration from Eutrophication of Shallow Lakes in which Aquatic Plant Communities are Important Components. Hydrobiologia 200/201:367-377.

Nichols, Stanley A. Distribution and Habitat Descriptions of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison Wisconsin. 1999. 266 p.

Nichols, Stanley A. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management 15 (2):133-141. 1999.

Novotny, V., A. Bartosova, N. O'Reilly, and T. Ehlinger. 2005. Unlocking the Relationship of Biotic Integrity of Impaired Waters to Anthropogenic Stress. Water Research 39:184-198.

O'Brien, W.J., F. DeNoyelles. 1972. Photosynthetically Elevated pH as a Factor in Zooplankton Mortality in Nutrient Enriched Ponds. Ecology 53.

Quiros, R. 2000. The nitrogen to phosphorus ratio for lakes: a cause or a consequence of aquatic biology? Proceedings Seminario Internacional Represa do Lobo-Broa, 30 Anos de Pesquisa em.

Limnologia, Gerenciamiento e Participacao da Comunidade e Bases Cientificas para o Gerenciamiento da Eutrofizacao. December 4-8, 2000. Sao Carlos, Sao Paulo, Brasil.

Sather, L.M. and C.W. Threinen. 1961. Wisconsin Conservation Department, Surface Water Resources of Polk County.

Scheffer, M. 1989. Alternative Stable States in Eutrophic, Shallow Freshwater Systems: A Minimal Model. Hydrobiol. Bull. 23:73-83.

Scheffer, M. 1997. The Ecology of Shallow Lakes. Chapman and Hall, London, U.K.

Shaw, B., C. Mechanich, and L. Klessig. 2000. Understanding Lake Data. UW-Extension publication SR-02/2002-1M-525.

University of Wisconsin-Extension. Aquatic Plant Management in Wisconsin. April 2006. Draft. 46 p.

United States Environmental Protection Agency. 1998. Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document. EPA 841-B-98-007.

Wehr, J.D. and R.G. Sheath. Freshwater Algae of North America: Ecology and Classification. Academic Press. 2003.

Wetzel, R. Limnology. 3rd Edition, CBS College Publishing. 2001.

Big Butternut Lake Management Plan

In-lake Chemical Data

Appendix A

Polk County Land and Water Resources Department
12/31/2011

	Site	Total Phosphorus	Soluble Reactive Phosphorus	Nitrate/nitrite	Ammonium	Total Kjeldahl Nitrogen	Total Suspended Solids	Chloride	Chlorophyll-a	Conductivity	Sulfate	pH	Alkalinity	Hardness	Calcium Hardness	Sodium	Potassium	Turbidity	Color
4/21/09	Mid Lake	0.055	0.017	0.04	0.11	0.75		6.9		172.2	4.36	7.71	72	79	49	4.2	1.3	3.2	15
5/28/09	6	0.057	0.046	0.12	0.29	1.19	3.00	12.3		129.3									
	5	0.118	0.085	0.17	0.39	1.12	5.00	16.5		246									
	4	0.105	0.114	0.06	0.4	1.23	13.00	2.9		238									
	Mid Lake	0.034	0.022	0.06	0.19	0.66	<2	8	4	152.7									
	Outlet	0.035	0.014	0.04	0.08	0.71	2.00	7.7		170.7									
7/2/09	4	0.097	0.048	0.1	0.06	0.86	11.00	9.4											
	5	0.101	0.101	0.22	0.31	0.69	4	10.8											
	Outlet	0.061	0.047	0.12	0.1	1.09	9	8.7											
	Mid Lake	0.038	0.033	0.1	0.1	0.66	3				10.24								
7/31/09	4	0.117	0.098	<.1	0.11	0.78	5.00	9.2											
	5	0.087	0.081	<.1	0.09	0.66	3	8.6											
	Outlet	0.039	0.041	<.1	0.07	0.75	2	9.2											
	Mid Lake	0.045	0.013	<.1	0.01	0.8	8	7.5	12										
8/28/09	4	0.121	0.086	0.07	0.13	1.04	3	10.5											
	5	0.077	0.063	0.14	0.19	0.5	<2	9.9											
	Outlet	0.297	0.056	0.12	0.12	2.74	9	8.3											
	Mid Lake	0.156	0.055	0.1	0.04	1.42	5	7.3	84										
10/5/09	4	0.085	0.024	0.45	0.14	1.06	4	11.3											
	5	0.049	0.036	0.48	0.43	0.68	<2	9.7											
	Outlet	0.168	0.107	0.18	0.66	1.57	<2	7.7											
	Mid Lake	0.142	0.106	0.13	0.67	1.46	2	7.1	10										
10/19/09	Mid Lake	0.13	0.14	0.48	0.48	1.29		12.2		163	11.4	7.75	88	80	49	4.8	1.9	3.9	22

Big Butternut Lake Management Plan

Historical In-lake Water Quality Data

Appendix B

Polk County Land and Water Resources Department
12/31/2011

Lake Water Quality Report - 1950 to 2010

Lake Name	County Name	Waterbody ID (WBIC)	Region Code	County Code
Big Butternut Lake	Polk	2641000	NO	49

Group Seq No	Start Date	Secchi (Feet)	Chlorophyll(ug/l)	Total Phosphorus (mg/L)	TP (ug/L)
1	5/2/1995		6.76	0.029	29
1	6/19/1995		3.52	0.018	18
1	7/10/1995		0.16	0.031	31
1	8/1/1995		0.34	0.046	46
1	8/29/1995		71.4	0.053	53
1	9/11/1995	6.6	22	0.077	77
8190296	6/5/1996	5		0	0
8190296	6/25/1996	3	28.6	0.09	90
8190296	7/9/1996	4.5		0	0
8190296	7/23/1996	3.25	35.3	0.061	61
8190296	8/12/1996	2		0	0
8190296	8/19/1996	2	29.9	0.061	61
8189284	5/4/1997	4.5		0	0
1	5/20/1997		6	0.088	88
8190296	5/20/1997	5		0	0
1	6/9/1997		1.85	0.062	62
8190296	6/9/1997	7		0	0
8190296	6/24/1997	8	5.05	0.028	28
1	7/8/1997		16.3	0.068	68
8190296	7/8/1997	4		0	0
8190296	7/14/1997	3.75	33.3	0.092	92
1	7/23/1997		38.1	0.047	47
8190296	7/23/1997	3		0	0
8190296	8/5/1997	3	23.1	0.053	53
1	8/12/1997		39.1	0.063	63
8190296	8/12/1997	3		0	0
1	8/26/1997		52.5	0.041	41
8190296	8/26/1997	3		0	0
1	9/9/1997		36.5	0.053	53
8190296	9/9/1997	3	47.6	0.065	65
1	9/24/1997		52.6	0.05	50
1	5/4/1998		6.12	0.057	57
8190296	5/19/1998	7		0.044	44
8190296	6/6/1998	4		0	0
8190296	6/15/1998	4.5	10.1	0.036	36
8190296	6/29/1998	4.5		0	0
8190296	7/13/1998	4	24.8	0.036	36
8190296	7/27/1998	2.5		0	0
8190296	8/10/1998	1.5	128	0.124	124
8190296	8/24/1998	1.75		0	0
8190296	9/14/1998	1.75	66.9	0.187	187
8190296	9/27/1998	2.5		0	0
8190296	5/26/1999	5		0	0
8190296	6/22/1999	3.5	24.8	0.037	37
8190296	7/9/1999	2.75		0	0
8190296	7/19/1999	3.25	26.6	0.037	37
8190296	8/9/1999	2		0	0
8190296	8/25/1999	2	70	0.091	91

8190296	9/6/1999	2		0	0
8190296	9/14/1999	2	90	0.117	117
7000017	4/14/2000	10.2		0.032	32
7000017	5/12/2000	10.5		0	0
8190296	5/15/2000	9.25		0.026	26
8190296	6/5/2000	8.5		0	0
8190296	6/20/2000	7.5	15	0.042	42
8190296	6/25/2000	9.5		0	0
8190296	7/11/2000	4		0	0
8190296	7/19/2000	3.5	14	0.043	43
8190296	7/31/2000	3		0	0
8190296	8/13/2000	3		0	0
8190296	8/28/2000	2.5	74	0.12	120
8190296	9/13/2000	3.25		0	0
8190296	9/29/2000	4.5		0	0
8190296	10/15/2000	6		0	0
8190296	10/16/2000	8	17	0.058	58
8190296	10/31/2000	11.5		0	0
8190296	5/29/2001	11		0.039	39
8190296	6/14/2001	8		0	0
8190296	6/25/2001	6.75	7	0.035	35
8190296	6/28/2001	8		0	0
8190296	7/7/2001	4.5		0	0
8190296	7/14/2001	6.5		0	0
8190296	7/24/2001	5	18	0.04	40
8190296	8/17/2001	3		0	0
8190296	8/21/2001	3	67	0.095	95
8190296	8/31/2001	3		0	0
8190296	9/18/2001	4		0	0
8190296	9/26/2001	4	23	0.084	84
8190296	5/21/2002	10		0.04	40
8190296	5/29/2002	10		0	0
8190296	6/12/2002	11		0	0
8190296	6/20/2002	8.5		0	0
8190296	6/25/2002	8.5	5.66	0.038	38
8190296	7/1/2002	8.5		0	0
8190296	7/12/2002	5		0	0
8190296	7/23/2002	5	9.99	0.037	37
8190296	8/2/2002	3.5		0	0
8190296	8/12/2002			0	0
8190296	8/21/2002	2.25	43.3	0.128	128
8190296	9/2/2002	2.25		0	0
8190296	10/14/2002	4	15.2	0.093	93
8190296	5/12/2003	7.5		0.039	39
8190296	5/25/2003	8.5		0	0
8190296	6/9/2003	6		0	0
8190296	6/18/2003	6.5		0	0
8190296	6/23/2003	4.5	16.7	0.031	31
8190296	7/7/2003	4.5		0	0
8190296	7/22/2003	3.5	43.8	0.043	43
8190296	8/5/2003	3		0	0
8190296	8/15/2003	3.5		0	0
8190296	8/19/2003	3.75	61.6	0.05	50
8190296	8/28/2003	3.25		0	0
8190296	9/15/2003	3.75		0	0
8190296	10/7/2003	4.5	40.4	0.073	73

8190296	5/10/2004	11		0.028	28
8190296	5/29/2004	7		0	0
8190296	6/3/2004	16		0	0
8190296	6/14/2004	10		0	0
8190296	6/22/2004	9	8.16	0.023	23
7000033	7/9/2004		28.3	0	0
8190296	7/19/2004	4		0	0
7000033	7/27/2004		39.3	0	0
8190296	7/27/2004	3.5	44.1	0.043	43
8190296	8/9/2004	3.5		0	0
8190296	8/21/2004	4		0	0
8190296	8/25/2004	2.5	92.2	0.126	126
8190296	9/12/2004	2.5		0	0
7000033	9/28/2004		24.4	0	0
8190296	10/11/2004	6	19.3	0.056	56
8191350	5/3/2005	16		0.033	33
8191350	6/20/2005	10	5.2	0.012	12
8191350	7/10/2005	2		0	0
8190296	7/27/2005		62.2	0.081	81
8191350	8/22/2005	3	62.9	0.179	179
8191350	9/20/2005	2.5		0	0
8191350	5/15/2006	7		0	0
8191350	6/5/2006	3.25	34	0.037	37
8191350	6/12/2006	4.75	14.1	0.194	194
8191350	7/5/2006	3		0	0
8191350	8/7/2006	3	73.4	0.098	98
8191350	9/5/2006	2.5	72.4	0.152	152
8191350	5/24/2007	3		0	0
8191350	5/30/2007			0.042	42
8191350	6/26/2007	3.5	39.8	0.063	63
8191350	7/24/2007	2	70.8	0.08	80
8191350	8/6/2007	2	49.7	0.069	69
8191350	9/12/2007	2.5	43.3	0.08	80
8191350	6/3/2008	8	7.13	0.034	34
8191350	7/15/2008		17.3	0.062	62
8191350	8/19/2008		85.6	0.094	94
8191350	9/8/2008		63.3	0.107	107
29302935	5/21/2009	8.5		0	0
29302935	6/13/2009	7		0	0
29302935	6/21/2009		24.2	0.039	39
29302935	7/13/2009	3	33.7	0.04	40
29302935	8/15/2009	2		0	0
29302935	8/16/2009		91.2	0.075	75
29302935	4/18/2010	5.25		0	0
29302935	5/23/2010	5		0.036	36
1	6/20/2010		46.4	0.05	50
29302935	6/20/2010	2.5		0	0
29302935	7/11/2010	3.25	38.8	0.054	54
29302935	7/31/2010	3.3		0	0
29302935	8/14/2010	2		0	0

Big Butternut Lake Management Plan

In-lake Physical Data

Appendix C

Land and Water Resources Department
12/31/2011

	Depth	Dissolved oxygen	Conductivity	Specific Conductance	Temperature	Salinity	pH	Secchi
4/21/09	0	0.13	119.9	173.6	8.8	0.1	7.95	6
	1	BM	120.0	173.7	8.8	0.1	7.89	6
	2	BM	119.8	173.5	8.8	0.1	7.80	6
	3	BM	119.8	173.7	8.8	0.1	7.76	6
	4	2.34	120.0	173.9	8.8	0.1	7.69	6
	5	BM	120.0	174.1	8.8	0.1	7.62	6
	6	BM	122.8	181.9	8.7	0.1	7.53	6
BM=Bad Membrane								
5/11/09	0	6.72	140.3	174.0	14.9	0.1	7.86	11
	1	6.59	138.2	173.6	14.4	0.1	7.80	11
	2	6.55	136.7	173.2	14.0	0.1	7.81	11
	3	5.98	136.3	173.3	13.8	0.1	7.78	11
	4	5.63	136.1	173.5	13.7	0.1	7.75	11
	5	5.92	136.3	173.8	13.7	0.1	7.72	11
	6	3.76	136.0	174.1	13.5	0.1	7.69	11
5/28/09	0	6.84	152.0	175.8	17.8	0.1	8.18	6.5
	1	6.34	151.0	176.3	17.6	0.1	8.12	6.5
	2	6.42	150.1	175.9	17.4	0.1	8.08	6.5
	3	6.18	147.9	175.6	16.7	0.1	8.02	6.5
	4	5.28	147.8	176.2	16.6	0.1	8.00	6.5
	5	0.10	180.9	218.8	16.3	0.1	7.88	6.5
6/19/09	0	9.24	166.2	175.8	22.1	0.1	9.35	3.8
	1	8.67	166.0	176.0	22.0	0.1	9.22	3.8
	2	8.70	165.4	176.0	21.8	0.1	9.08	3.8
	3	8.20	164.6	176.4	21.5	0.1	8.92	3.8
	4	4.44	161.4	182.9	18.9	0.1	7.89	3.8
	5	0.31	182.1	217.9	17.4	0.1	7.45	3.8
7/2/09	0	5.58	164.4	182.1	20.0	0.1	8.36	5.1
	1	5.35	163.4	181.8	19.7	0.1	8.15	5.1
	2	5.05	162.8	181.8	19.5	0.1	8.09	5.1
	3	5.03	162.7	182.0	19.4	0.1	7.94	5.1
	4	4.85	162.7	182.4	19.4	0.1	7.83	5.1
	5	0.18	234.9	268.8	18.5	0.1	7.72	5.1
7/31/09	0	8.19	171.2	182.7	21.7	0.1	9.35	3.5
	1	8.15	171.0	182.6	21.7	0.1	9.30	3.5
	2	7.68	170.8	182.8	21.6	0.1	9.23	3.5
	3	7.27	169.7	183.3	21.2	0.1	9.25	3.5
	4	1.01	175.4	191.9	20.5	0.1	8.71	3.5
	5	0.12	178.2	198.2	19.7	0.1	8.67	3.5
	6	0.05	266.9	305.9	18.6	0.1	8.15	3.5
8/17/09	0	7.00	171.5	176.6	23.5	0.1	9.67	2
	1	6.69	172.2	177.5	23.4	0.1	9.65	2
	2	6.61	172.2	177.7	23.4	0.1	9.62	2
	3	6.26	172.2	177.8	23.3	0.1	9.59	2
	4	6.23	172.1	178.0	23.3	0.1	9.55	2
	5	0.14	199.6	216.6	20.9	0.1	8.71	2
8/28/09	0	9.38	163.8	176.2	21.3	0.1	10.00	2.2
	1	7.18	160.6	177.1	20.2	0.1	BF	2.2
	2	5.27	161.5	178.9	19.9	0.1	BF	2.2
	3	4.45	162.2	180.0	19.8	0.1	BF	2.2
	4	3.56	162.9	181.4	19.7	0.1	BF	2.2
	5	3.39	161.1	180.0	19.5	0.1	BF	2.2
BF = Battery failed								

10/5/09	0	4.60	144.6	188.5	12.8	0.1	8.40	5.25
	1	5.55	144.5	188.4	12.8	0.1	8.36	5.25
	2	5.12	143.9	188.4	12.6	0.1	8.34	5.25
	3	4.96	143.7	188.4	12.6	0.1	8.32	5.25
	4	5.40	143.7	188.3	12.6	0.1	8.27	5.25
	5	4.45	143.8	188.4	12.6	0.1	8.25	5.25
	6	0.12	152.9	199.1	12.8	0.1	8.13	5.25
10/19/09	0	7.66	125.3	186.5	7.8	0.1	9.16	8.5
	1	7.64	125.3	186.5	7.8	0.1	9.15	8.5
	2	7.47	125.3	186.6	7.8	0.1	9.11	8.5
	3	7.44	125.5	186.9	7.8	0.1	9.10	8.5
	4	7.14	125.4	186.9	7.8	0.1	9.09	8.5
	5	7.53	125.4	186.9	7.8	0.1	9.09	8.5
	6	2.50	126.0	187.9	7.8	0.1	9.27	8.5

Big Butternut Lake Management Plan

Historical In-lake Physical Data

Appendix D

Polk County Land and Water Resources Department
12/31/2011

Lake Water Quality Report - 1950 to 2010

Lake Name	County Name	Waterbody ID(WBIC)	Region Code	County Code
Big Butternut Lake	Polk	2641000	NO	49

Start Date	Depth (ft)	Temperature (oF)	Dissolved Oxygen (mg/L)
6/25/1996	1	67	
6/25/1996	3	67	
6/25/1996	6	66	
6/25/1996	9	65	
6/25/1996	12	65	
6/25/1996	15	62	
6/25/1996	17	60	
7/23/1996	1	72	
7/23/1996	3	72	
7/23/1996	6	71	
7/23/1996	9	71	
7/23/1996	12	71	
7/23/1996	15	71	
7/23/1996	17	71	
8/19/1996	1	73	
8/19/1996	3	73	
8/19/1996	6	72	
8/19/1996	9	72	
8/19/1996	12	72	
8/19/1996	15	71	
8/19/1996	17	69	
9/9/1996	1	72	
9/9/1996	3	71	
9/9/1996	6	71	
9/9/1996	9	71	
9/9/1996	12	71	
9/9/1996	15	70	
9/9/1996	17	70	
5/4/1997	0	53	11
5/4/1997	3	52	11
5/4/1997	6	52	11
5/4/1997	10	52	11
5/4/1997	13	52	11
5/4/1997	16	51	10
5/4/1997	18	50	9
5/20/1997	0	56	10
5/20/1997	6	56	10
5/20/1997	10	55	10
5/20/1997	13	56	10
5/20/1997	16	54	10
5/20/1997	18	54	10
5/20/1997	20	54	10
6/24/1997	0	74	
6/24/1997	18	65	
7/14/1997	0	72	
7/14/1997	6	72	
7/14/1997	9	72	
7/14/1997	12	68	
7/14/1997	15	66	
8/5/1997	0	74	
8/5/1997	6	74	
8/5/1997	9	74	
8/5/1997	12	73	
8/5/1997	15	69	

8/5/1997	18	67	
9/9/1997	0	70	7
9/9/1997	3	70	7
9/9/1997	6	69	7
9/9/1997	9	69	7
9/9/1997	12	68	7
9/9/1997	15	68	6
9/9/1997	18	68	2
5/19/1998	3	67	
5/19/1998	6	67	
5/19/1998	9	67	
5/19/1998	12	67	
5/19/1998	15	65	
5/19/1998	18	65	
6/15/1998	3	68	
6/15/1998	6	67	
6/15/1998	9	66	
6/15/1998	12	63	
6/15/1998	15	63	
6/15/1998	18	62	
7/13/1998	3	76	
7/13/1998	6	76	
7/13/1998	9	76	
7/13/1998	12	72	
7/13/1998	15	71	
7/13/1998	18	68	
8/10/1998	3	75	
8/10/1998	6	74	
8/10/1998	9	73	
8/10/1998	12	72	
8/10/1998	15	72	
8/10/1998	18	71	
9/14/1998	3	71	
9/14/1998	6	71	
9/14/1998	9	71	
9/14/1998	12	70	
9/14/1998	15	69	
9/14/1998	18	68	
5/26/1999	3	60	
5/26/1999	6	59	
5/26/1999	9	58	
5/26/1999	12	58	
5/26/1999	15	58	
5/26/1999	18	58	
6/22/1999	3	69	
6/22/1999	6	68	
6/22/1999	9	68	
6/22/1999	12	68	
6/22/1999	15	68	
6/22/1999	18	65	
7/9/1999	3	73	
7/9/1999	6	73	
7/9/1999	9	72	
7/9/1999	12	72	
7/9/1999	15	72	
7/9/1999	18	67	
7/19/1999	3	76	
7/19/1999	6	75	
7/19/1999	9	75	
7/19/1999	12	74	
7/19/1999	15	69	
7/19/1999	18	68	

8/9/1999	3	73
8/9/1999	6	73
8/9/1999	9	73
8/9/1999	12	73
8/9/1999	15	73
8/9/1999	18	73
8/25/1999	3	71
8/25/1999	6	70
8/25/1999	9	69
8/25/1999	12	69
8/25/1999	15	69
8/25/1999	18	69
9/6/1999	3	70
9/6/1999	6	70
9/6/1999	9	70
9/6/1999	12	70
9/6/1999	15	69
9/6/1999	18	68
9/14/1999	3	61
9/14/1999	6	61
9/14/1999	9	61
9/14/1999	12	61
9/14/1999	15	61
9/14/1999	18	60
5/15/2000	3	57
5/15/2000	6	57
5/15/2000	9	57
5/15/2000	12	56
5/15/2000	15	55
5/15/2000	18	55
6/5/2000	3	59
6/5/2000	6	59
6/5/2000	9	58
6/5/2000	12	57
6/5/2000	15	57
6/5/2000	18	56
6/20/2000	3	67
6/20/2000	6	66
6/20/2000	9	66
6/20/2000	12	65
6/20/2000	15	65
6/20/2000	18	64
6/25/2000	3	68
6/25/2000	6	67
6/25/2000	9	66
6/25/2000	12	64
6/25/2000	15	64
6/25/2000	18	64
7/11/2000	3	75
7/11/2000	6	75
7/11/2000	9	73
7/11/2000	12	72
7/11/2000	15	71
7/11/2000	18	70
7/19/2000	3	72
7/19/2000	6	71
7/19/2000	9	71
7/19/2000	12	71
7/19/2000	15	70
7/19/2000	18	69
7/31/2000	3	74
7/31/2000	6	73

7/31/2000	9	72
7/31/2000	12	71
7/31/2000	15	70
7/31/2000	18	70
8/13/2000	3	74
8/13/2000	6	74
8/13/2000	9	74
8/13/2000	12	73
8/13/2000	15	72
8/13/2000	18	71
8/28/2000	3	70
8/28/2000	6	70
8/28/2000	9	70
8/28/2000	12	70
8/28/2000	15	70
8/28/2000	18	70
9/29/2000	3	58
9/29/2000	6	56
9/29/2000	9	56
9/29/2000	12	56
9/29/2000	15	56
9/29/2000	18	56
10/15/2000	3	52
10/15/2000	6	52
10/15/2000	9	52
10/15/2000	12	52
10/15/2000	15	52
10/15/2000	18	52
10/16/2000	3	52
10/16/2000	6	52
10/16/2000	9	52
10/16/2000	12	51
10/16/2000	15	51
10/16/2000	18	51
10/31/2000	3	52
10/31/2000	6	52
10/31/2000	9	52
10/31/2000	12	50
10/31/2000	15	50
10/31/2000	18	50
5/29/2001	3	61
5/29/2001	6	60
5/29/2001	9	60
5/29/2001	12	59
5/29/2001	15	59
5/29/2001	18	59
5/29/2001	20	57
6/14/2001	3	70
6/14/2001	6	69
6/14/2001	9	69
6/14/2001	12	69
6/14/2001	15	69
6/14/2001	18	68
6/14/2001	20	67
6/25/2001	3	72
6/25/2001	6	72
6/25/2001	9	72
6/25/2001	12	72
6/25/2001	15	71
6/25/2001	18	70
6/25/2001	20	66
6/28/2001	3	77

6/28/2001	6	76
6/28/2001	9	73
6/28/2001	12	72
6/28/2001	15	70
6/28/2001	18	68
6/28/2001	20	67
7/7/2001	3	73
7/7/2001	6	72
7/7/2001	9	71
7/7/2001	12	70
7/7/2001	15	70
7/7/2001	18	70
7/7/2001	20	69
7/14/2001	3	77
7/14/2001	6	76
7/14/2001	9	73
7/14/2001	12	72
7/14/2001	15	70
7/14/2001	18	69
7/14/2001	20	68
7/24/2001	3	79
7/24/2001	6	78
7/24/2001	9	77
7/24/2001	12	75
7/24/2001	15	71
7/24/2001	18	69
7/24/2001	20	69
8/17/2001	3	72
8/17/2001	6	72
8/17/2001	9	71
8/17/2001	12	71
8/17/2001	15	71
8/17/2001	18	71
8/17/2001	20	70
8/21/2001	3	72
8/21/2001	6	72
8/21/2001	9	71
8/21/2001	12	70
8/21/2001	15	70
8/21/2001	18	69
8/21/2001	20	69
8/31/2001	3	71
8/31/2001	6	70
8/31/2001	9	70
8/31/2001	12	70
8/31/2001	15	70
8/31/2001	18	70
8/31/2001	20	70
9/18/2001	3	66
9/18/2001	6	66
9/18/2001	9	66
9/18/2001	12	65
9/18/2001	15	64
9/18/2001	18	64
9/18/2001	20	64
9/26/2001	3	58
9/26/2001	6	58
9/26/2001	9	58
9/26/2001	12	58
9/26/2001	15	58
9/26/2001	18	58
5/21/2002	3	54

5/21/2002	6	54
5/21/2002	9	54
5/21/2002	12	54
5/21/2002	15	53
5/21/2002	18	52
5/21/2002	20	52
6/12/2002	3	69
6/12/2002	6	67
6/12/2002	9	67
6/12/2002	12	66
6/12/2002	15	62
6/12/2002	20	62
6/12/2002	62	62
6/20/2002	3	68
6/20/2002	6	68
6/20/2002	9	68
6/20/2002	12	68
6/20/2002	15	67
6/20/2002	18	67
6/20/2002	20	67
6/25/2002	3	72
6/25/2002	6	71
6/25/2002	9	71
6/25/2002	12	71
6/25/2002	15	70
6/25/2002	18	68
6/25/2002	20	68
7/1/2002	3	79
7/1/2002	6	79
7/1/2002	9	79
7/1/2002	12	76
7/1/2002	15	73
7/1/2002	18	69
7/1/2002	20	68
7/12/2002	3	78
7/12/2002	6	75
7/12/2002	9	74
7/12/2002	12	73
7/12/2002	15	73
7/12/2002	18	72
7/12/2002	20	71
7/23/2002	3	77
7/23/2002	6	76
7/23/2002	9	75
7/23/2002	12	75
7/23/2002	15	74
7/23/2002	18	72
7/23/2002	19	71
8/2/2002	3	76
8/2/2002	6	76
8/2/2002	9	76
8/2/2002	12	75
8/2/2002	15	74
8/2/2002	18	73
8/2/2002	20	72
8/12/2002	3	74
8/12/2002	6	73
8/12/2002	9	73
8/12/2002	12	73
8/12/2002	15	73
8/12/2002	18	73
8/12/2002	20	73

8/21/2002	3	70
8/21/2002	6	70
8/21/2002	9	70
8/21/2002	12	69
8/21/2002	15	69
8/21/2002	18	69
8/21/2002	20	68
9/2/2002	3	70
9/2/2002	6	70
9/2/2002	9	70
9/2/2002	12	70
9/2/2002	15	70
9/2/2002	18	70
9/2/2002	20	70
10/14/2002	3	59
10/14/2002	6	59
10/14/2002	9	59
10/14/2002	12	59
10/14/2002	15	59
10/14/2002	18	59
10/14/2002	20	59
5/12/2003	0	53
5/12/2003	3	53
5/12/2003	6	52
5/12/2003	9	52
5/12/2003	12	52
5/12/2003	15	52
5/12/2003	18	52
5/12/2003	20	51
6/23/2003	0	72
6/23/2003	3	72
6/23/2003	6	71
6/23/2003	9	71
6/23/2003	12	69
6/23/2003	15	62
6/23/2003	18	61
6/23/2003	20	61
7/22/2003	0	72
7/22/2003	3	72
7/22/2003	6	72
7/22/2003	9	72
7/22/2003	12	72
7/22/2003	15	68
7/22/2003	18	65
7/22/2003	20	64
8/19/2003	0	77
8/19/2003	3	77
8/19/2003	6	77
8/19/2003	9	77
8/19/2003	12	76
8/19/2003	15	74
8/19/2003	18	68
8/19/2003	20	66
10/7/2003	0	53
10/7/2003	3	53
10/7/2003	6	52
10/7/2003	9	51
10/7/2003	12	51
10/7/2003	15	50
10/7/2003	18	50
10/7/2003	20	50
5/10/2004	0	54

5/10/2004	3	53
5/10/2004	6	53
5/10/2004	9	53
5/10/2004	12	52
5/10/2004	15	52
5/10/2004	18	52
5/10/2004	20	51
6/22/2004	0	67
6/22/2004	3	66
6/22/2004	6	66
6/22/2004	9	62
6/22/2004	12	67
6/22/2004	15	67
6/22/2004	18	66
6/22/2004	20	66
7/27/2004	0	74
7/27/2004	3	74
7/27/2004	6	74
7/27/2004	9	73
7/27/2004	12	72
7/27/2004	15	68
7/27/2004	18	67
7/27/2004	19	65
8/25/2004	0	67
8/25/2004	3	67
8/25/2004	6	66
8/25/2004	9	66
8/25/2004	12	65
8/25/2004	15	65
8/25/2004	18	64
8/25/2004	19	64
10/11/2004	0	59
10/11/2004	3	59
10/11/2004	6	59
10/11/2004	9	59
10/11/2004	12	59
10/11/2004	15	59
10/11/2004	18	59
5/3/2005	1	45
5/3/2005	3	45
5/3/2005	6	45
5/3/2005	9	45
5/3/2005	12	44
5/3/2005	15	44
5/3/2005	18	43
6/20/2005	1	76
6/20/2005	3	76
6/20/2005	6	75
6/20/2005	9	74
6/20/2005	12	73
6/20/2005	15	67
6/20/2005	18	63
7/10/2005	1	74
7/10/2005	3	75
7/10/2005	6	75
7/10/2005	9	74
7/10/2005	12	74
7/10/2005	15	74
7/10/2005	18	69
9/20/2005	1	67
9/20/2005	3	67
9/20/2005	6	67

9/20/2005	9	66
9/20/2005	12	66
9/20/2005	15	66
9/20/2005	18	66
5/15/2006	0	50
5/15/2006	3	50
5/15/2006	6	50
5/15/2006	9	49
5/15/2006	12	49
5/15/2006	15	49
5/15/2006	18	48
6/12/2006	0	64
6/12/2006	3	64
6/12/2006	6	62
6/12/2006	9	62
6/12/2006	12	62
6/12/2006	15	61
6/12/2006	18	60
7/5/2006	0	69
7/5/2006	3	69
7/5/2006	6	69
7/5/2006	9	69
7/5/2006	12	68
7/5/2006	15	65
7/5/2006	18	64
8/7/2006	0	71
8/7/2006	3	71
8/7/2006	6	71
8/7/2006	9	71
8/7/2006	12	71
8/7/2006	15	70
8/7/2006	18	68
9/5/2006	0	65
9/5/2006	3	65
9/5/2006	6	65
9/5/2006	9	65
9/5/2006	12	64
9/5/2006	15	64
9/5/2006	18	64
6/26/2007	3	74
6/26/2007	6	73
6/26/2007	9	73
6/26/2007	12	70
6/26/2007	15	68
6/26/2007	18	68
7/24/2007	3	74
7/24/2007	6	72
7/24/2007	9	70
7/24/2007	12	70
7/24/2007	15	69
7/24/2007	19	69
8/6/2007	3	72
8/6/2007	6	72
8/6/2007	9	72
8/6/2007	12	71
8/6/2007	15	71
8/6/2007	18	68
9/12/2007	3	64
9/12/2007	6	64
9/12/2007	9	62
9/12/2007	12	62
9/12/2007	15	61

9/12/2007	18	61
6/3/2008	3	58
6/3/2008	6	58
6/3/2008	9	58
6/3/2008	12	57
6/3/2008	15	57
6/3/2008	18	57
6/13/2009	3	65.1
6/13/2009	6	65.1
6/13/2009	9	63.3
6/13/2009	12	60.9
6/13/2009	15	60.6
6/13/2009	18	60
7/13/2009	3	71.4
7/13/2009	6	71.4
7/13/2009	9	71
7/13/2009	12	69.6
7/13/2009	15	66.2
7/13/2009	18	63.6
8/15/2009	3	75.5
8/15/2009	6	75.2
8/15/2009	9	75
8/15/2009	12	69.2
8/15/2009	15	68
8/15/2009	18	67.2
4/18/2010	3	52.8
4/18/2010	6	52.5
4/18/2010	9	52.3
4/18/2010	12	52.1
4/18/2010	15	51.9
4/18/2010	18	51.4
5/23/2010	3	63.6
5/23/2010	6	63.3
5/23/2010	9	62.7
5/23/2010	12	55.4
5/23/2010	15	53.2
5/23/2010	18	52.5
6/20/2010	3	67.2
6/20/2010	6	66.9
6/20/2010	9	66.9
6/20/2010	12	66.7
6/20/2010	15	62
6/20/2010	18	59.1
7/11/2010	3	76.6
7/11/2010	6	76.4
7/11/2010	9	76.2
7/11/2010	12	70.1
7/11/2010	15	65.4
7/11/2010	18	60.4
7/31/2010	3	77
7/31/2010	6	75.9
7/31/2010	9	75.5
7/31/2010	12	74.1
7/31/2010	15	70.8
7/31/2010	18	65.6
8/14/2010	3	76.4
8/14/2010	6	76.2
8/14/2010	9	76.1
8/14/2010	12	75.9
8/14/2010	15	72.3
8/14/2010	18	70.3

Big Butternut Lake Management Plan

Phytoplankton Data

Appendix E

Polk County Land and Water Resources Department
12/31/2011

Site: Big Butternut Lake

Location: Mid-Lake

Depth: 6ft Composites

Collection Date	Taxa	Division	Number Counted	Concentration (Units/mL^a,b)	Relative % Concentration
5/28/2009	*Aulacoseira sp.*	Bacillariophyta	5	45	1.7
	Pennales Diatoms	Bacillariophyta	4	36	1.3
	Oocystis sp.	Chlorophyta	1	9	0.3
	Scenedesmus sp.	Chlorophyta	1	9	0.3
	Schroederia sp.	Chlorophyta	92	825	30.6
	Dinobryon sp.	Chlorophyta	2	18	0.7
	Cryptomonas sp.	Chrysophyta	9	81	3.0
	Komma caudata	Cryptophyta	184	1649	61.1
	Anabaena sp.	Cryptophyta	1	9	0.3
	Planktolyngbya sp.	Cyanophyta	2	18	0.7
	Total			2699	100.0
7/2/2009	*Aulacoseira sp.*	Bacillariophyta	4	18	1.3
	Centrales Diatoms	Bacillariophyta	3	14	1.0
	Pennales Diatoms	Bacillariophyta	3	14	1.0
	Gloeocystis sp.	Chlorophyta	1	5	0.4
	Oocystis sp.	Chlorophyta	2	9	0.6
	Quadrigula sp.	Chlorophyta	2	9	0.6
	Scenedesmus sp.	Chlorophyta	2	9	0.6
	Schroederia sp.	Chlorophyta	19	87	6.3
	Staurastrum sp.	Chlorophyta	2	9	0.6
	Cryptomonas sp.	Cryptophyta	10	46	3.3
	Komma caudata	Cryptophyta	116	534	38.4
	Anabaena sp.	Cyanophyta	36	166	11.9
	Aphanizomenon sp.	Cyanophyta	59	272	19.6
	Aphanocapsa sp.	Cyanophyta	32	147	10.6
	Planktolyngbya sp.	Cyanophyta	9	41	2.9
	Ceratium hirundinella	Pyrrhophyta	1	5	0.4
	Peridinium sp.	Pyrrhophyta	1	5	0.4
	Total			1390	100.0
7/31/2009	*Aulacoseria sp.*	Bacillariophyta	33	261	10.9
	Fragilaria sp.	Bacillariophyta	51	404	16.9
	Pennales Diatoms	Bacillariophyta	10	79	3.3
	Gloeocystis sp.	Chlorophyta	2	16	0.7
	Oocystis sp.	Chlorophyta	1	8	0.3
	Scenedesmus sp.	Chlorophyta	1	8	0.3
	Schroederia sp.	Chlorophyta	3	24	1.0
	Cryptomonas sp.	Cryptophyta	14	111	4.6
	Komma caudata	Cryptophyta	41	325	13.6
	Anabaena sp.	Cyanophyta	40	317	13.2
	Aphanizomenon sp.	Cyanophyta	87	689	28.8
	Aphanocapsa sp.	Cyanophyta	15	119	5.0
	Planktolyngbya sp.	Cyanophyta	3	24	1.0
	Planktothrix sp.	Cyanophyta	1	8	0.3
	Total			2393	100.0

8/28/2009	*Fragilaria sp.*	Bacillariophyta	3	73	1.0
	Pennales Diatoms	Bacillariophyta	18	438	5.8
	Oocystis sp.	Chlorophyta	1	24	0.3
	Quadrigula sp.	Chlorophyta	2	49	0.6
	Scenedesmus sp.	Chlorophyta	1	24	0.3
	Schroederia sp.	Chlorophyta	3	73	1.0
	Cryptomonas sp.	Cryptophyta	14	341	4.5
	Komma caudata	Cryptophyta	7	170	2.2
	Anabaena sp.	Cyanophyta	20	487	6.4
	Aphanizomenon sp.	Cyanophyta	199	4842	64.0
	Aphanocapsa sp.	Cyanophyta	1	24	0.3
	Microcystis sp.	Cyanophyta	4	97	1.3
	Planktolyngbya sp.	Cyanophyta	15	365	4.8
	Planktothrix sp.	Cyanophyta	19	462	6.1
	Peridinium sp.	Pyrrhophyta	4	97	1.3
	Total			7566	100.0
10/5/2009	*Aulacoseria sp.*	Bacillariophyta	5	14	4.1
	Centrales Diatoms	Bacillariophyta	1	3	0.9
	Pennales Diatoms	Bacillariophyta	1	3	0.9
	Schroederia sp.	Chlorophyta	43	117	33.9
	Cryptomonas sp.	Cryptophyta	42	114	33.0
	Komma caudata	Cryptophyta	5	14	4.1
	Anabaena sp.	Cyanophyta	5	14	4.1
	Aphanizomenon sp.	Cyanophyta	12	33	9.6
	Aphanocapsa sp.	Cyanophyta	1	3	0.9
	Coelosphaerium sp.	Cyanophyta	3	8	2.3
	Microcystis sp.	Cyanophyta	2	5	1.4
	Planktothrix sp.	Cyanophyta	5	14	4.1
	Peridinium sp.	Pyrrhophyta	1	3	0.9
	Total			345	100.0

Big Butternut Lake Management Plan

Zooplankton Report and Data

Appendix F

Toben Lafrançois
12/31/2011

Zooplankton abundance and biomass estimates for Big Butternut and Coon Lakes, Polk Co., WI, 2009 with taxonomic and ecological notes.

Cladoceran (Bosmina sp.) from Coon Lake, Polk Co., WI.

Toben Lafrançois, Assistant Scientist
St. Croix Watershed Research Station
16910 152nd Street North
Marine on St. Croix, MN 55047
651.433.5953 x38
toben@smm.org

Citation: Lafrançois, T. 2011. Zooplankton abundance and biomass estimates for Big Butternut and Coon Lakes, Polk Co., WI, 2009 with taxonomic and ecological notes. Report to the Polk County Land and Water Resources Department, Polk Co., WI.

Contents

List of figures

List of tables

1. Summary

Zooplankton form a critical link between bottom-up and top-down processes in lakes. They are voracious consumers of algae and bacteria, and are also a favorite fish food of planktivorous pan fish, minnows and fry of larger fish. In this way, zooplankton connect two of the most important features of lake management- water clarity and fishing. Examining zooplankton community composition, abundances, and presence of sensitive or tolerant organisms is like looking under the hood of a car because it shows how important lake processes are mechanically connected.

Zooplankton were sampled from Big Butternut and Coon Lakes during the 2009 ice free season by Polk County Land and Water Resources Department. Samples were counted and identified at the St. Croix Watershed Research Station of the Science Museum of Minnesota. Results are reported below and data are included in an attached Microsoft Excel file (including all graphs and tables). In the absence of other data regarding fish presence or trophic status, some of the zooplankton phenology is difficult to interpret, but the patterns within each lake and the comparison between them are by themselves very informative. Basic information is summarized below, correlation with other environmental factors to explain differences in water quality will require further analysis.

Big Butternut Lake shows a clear pattern of large cladoceran biomass (primarily Daphnia mendotae) dominating the early season, followed by a precipitous decline. Other community data does not suggest interspecific competition or invertebrate predation as the cause. Neither is it likely the result of normal phenology, which leaves a fish predation event (stocking of fry or pan fish) as a primary cause. This decline represents a large reduction in grazing capacity of the zooplankton community. Conclusions must be corroborated with data on other aspects of the community (fish, temperature, nutrients, algae).

Coon Lake zooplankton follow a complicated phenology that includes competetive replacement and several shifts in biomass. It is difficult from the zooplankton data alone to make any inferences about lake processes in Coon Lake, but when incorporated with other data the zooplankton community data should be illuminating. In general, Coon Lake supported an order of magnitude less biomass of zooplankton than Big Butternut Lake and showed greater fluctuation in species composition, biomass, and diversity over the sampling year.

2. Laboratory methods

Zooplankton were identified at the St. Croix Watershed Research Station, Marine on St. Croix MN (a non-profit research branch of the Science Museum of Minnesota). Samples were rinsed in a 35um net and placed in Falcon centrifuge tubes with 30 to 35 ml of 80% ETOH (depending on the density of sample). The Falcon tube was vigorously agitated and sub-sampled with a 1ml Hempsten-Stempel pipette. This subsample was placed in a Sedgwick rafter cell for counting. The portion of the subsample counted (number of rows within the rafter) was determined on a per sample basis relative to the density of the sample. Numbers were then converted to back to lake density (numbers per liter) based on the Falcon tube volume and vertical tow volume. The methods listed here reflect the particular conditions of these lakes and sampling design. They were tested for sufficiency but should not be reproduced in other systems without re-testing adequacy.

An Olympus BX50F4 Microscope was used for counting and digital pictures of whole organisms. The most widely accepted taxonomic keys were used (Balcer et al., 1984; Thorp et al., 1997; Smith et al., 2001) as well as the most recent or most informative species accounts (Stemberger 1979, De Melo et al. 1994, Hebert 1995, Kotov et al. 2009). It should be noted that available keys are not always in agreement, and many contain errors (particularly Torke 1976). Results from the present analysis should be consistent with other studies of zooplankton because these keys represent the best available taxonomy to date. Biomass estimates follow Doohan 1973, Dumont et al. 1975, Bottrell et al. 1976, Pace et al. 1981, and McCauley 1984.

3. Big Butternut Lake Zooplankton Ecology, 2009

Zooplankton taxa found in Butternut Lake in 2009 are listed in Table 1. Analyzed and raw data are included in an attached Microsoft Excel file "PolkCoZoop2009". In 2009, the densities of cladocerans and copepods remained fairly stable with a mid-July increase, while rotifers increased dramatically in mid-July (Figure 1). The biomass estimates tell the real story here, however (Figure 2). Rotifer biomass followed density very closely, which is no surprise since body size within most species and between many of the species present is relatively similar. Copepod biomass also tracks density.

Cladoceran biomass, however, shows the opposite trend as cladoceran density, crashing from very high levels in spring and climbing again in fall. This strongly indicates a size selective predation event. In the absence of large copepods and no evidence of chaoboridae or other invertebrate predators in the samples, it seems very likely that this is a major fish predation event rather than competition or invertebrate predation. The change in cladoceran biomass results in a very strong drop in algal grazing capacity in July. Taking the rotifers out of the graph shows this trend in much greater detail. Cladoceran and copepod numbers track each other, increasing over summer and dropping of in late summer to early fall (Figure 3). Cladoceran biomass, on the other hand, follows a different pattern, indicating fewer, larger species in spring followed by a rapid decline in numbers and size, with some late summer recovery (Figure 4).

A closer look at the most common species from each group shows that *Daphnia mendotae* is the cladoceran responsible both for the high numbers and biomass in spring to early summer and late fall (Figures 5 and 6). However, not all the autumn recovery of cladoceran biomass is *D. mendotae*, but includes other, smaller cladocerans. This pattern confirms the hypothesis that fish predation in midsummer is responsible for the major loss in cladoceran biomass, as *D. mendotae* are favorite prey of pan fishes. Given the late occurrence, it is unlikely to be fry predating on the plankton (which would normally produce a dip in spring rather than midsummer) unless stocking of fry or more pan fish took place. It is also possible that a major algal bloom good knock *Daphnia* back if it there was a corresponding algal species shift away from the normal grazing preferences of the species.

4. Coon Lake Zooplankton Ecology, 2009 with comparison between Big Butternut and Coon Lakes

Zooplankton taxa found in Coon Lake in 2009 are listed in Table 1. Analyzed and raw data are included in an attached Microsoft Excel file "PolkCoZoop2009". The abundance of the three major zooplankton groups follow a different and more complex pattern than shown in Big Butternut Lake. Cladoceran abundance shows an inverse pattern to Big Butternut- low throughout the year but peaking in mid-August (Figure 7). Rotifers and copepods follow each other, with relatively low numbers that peak in fall. Rotifer and copepod biomass follow similar trends as their abundance, while like Big Butternut the cladocera biomass follows an inverse patter to abundance (Figure 8). The high cladoceran numbers and biomass in August are due to an increase in *Bosmina* spp. and *Chydorus* sp. (Figures 9 and 10), while spring and midsummer cladoceran numbers are dominated by *Daphnia* species and to some extent *Diaphanosoma brachyurum* (Figures 11 and 12). Taken together the data show a shift from spring dominance of zooplankton biomass (but not density) by *Daphnia* replaced by greater numbers of smaller cladocerans in late summer and fall. Looking more closely at the relationship among the cladoceran groups shows low densities of all cladocerans until August, when *Bosmina* species increase remarkably (Figure 13). Large *Daphnia* species dominate the biomass of the cladocera (as well as the entire zooplankton assemblage) in spring and early summer, to be replaced by *Bosmina* spp. in August (Figure 14), with a net reduction in cladoceran biomass (and consequently grazing capacity of the zooplankton community).

It is difficult to interpret these patterns as a top-down or bottom-up response without other information. However, it is likely a combination of fish predation and competition between cladoceran groups. This is indicated (but not proven) by the relationship of *Daphnia* being replaced by *Ceriodaphnia* in August (Figures 15 and 16). The replacement looks very much like a competitive shift looking at densities, and this shift has large consequences on the grazing capacity as shown by changes in biomass. This is a complex system and further work on the zooplankton dynamics is necessary to untangle the relationship between food web changes and water quality.

There are more differences between the two study lakes that are important to note. First, Coon lake supports far lower (almost two orders of magnitude) densities of zooplankton with the exception of the bosminid bloom in August (Figure 17). This relationship is made more distinct when looking at biomass, with an order of magnitude difference in spring biomass (Big Butternut supporting the larger zooplankton mass) with a startling reversal in mid-August (Figure 18). The two lakes support similar numbers of cladocerans, with Coon lake showing a leap in cladoceran numbers in August due to the bosminid bloom (Figure 19).

Raw species richness is more stable in Big Butternut than Coon (Figure 20). The fluctuations in Coon can be from several factors that are not identifiable with this data set. Number of genera (Figure 21) show a similar pattern as species for Coon Lake, reflecting the complex phenology. The pattern for Big Butternut Lake is more exaggerated than the species pattern in large part due to a shifts between species rich genera like *Daphnia* and genera-rich groups like the rotifers.

Looking just at the zooplankton data, it can be concluded that Big Butternut in general supports more and larger zooplankton. However, some event in mid-summer dramatically changes the zooplankton community in Big Butternut and this event does not seem to be competition or invertebrate predation. Coon lake supports far fewer zooplankton as well as smaller species, but the community seems far more stable other than what appear to be changes expected from normal community phenology.

5. Taxonomic notes

The calanoid copepods were not identifiable as species due to a lack of male specimens. Cyclopoids did not always key very well for several reasons. It is a rare and happy occasion to obtain a regionally specific guide to these groups, but TORKE contains several errors and omissions that are not easily corrected with other keys. Generic attributions of the cyclopoids are made with confidence, but species names used only when certain (otherwise they are in parentheses).

Testate and ciliate species were not discussed here, but my provide useful clues to the ecology of these lakes. Identifications were confirmed with the help of Dr. Stephen Wickham, Dept. of Organismic Biology, University of Salzburg, Austria.

Finally, despite the major role bosminidae play and the taxonomic patience of the author, it was very difficult to identify the bosminidae of these two lakes. *Bosmina longirostrus* was present (with certainty) but several characters of other genera and genera were seen but the specimens were not fully intact so complete identification was not possible. It does not help that there is much disagreement in the recent literature (reviewed in Kotov et al. 2009). Digital images of taxonomic characters were taken when possible, particularly some shots of several lateral pores and pectin fringes. These images will be archived at the SCWRS. No genera or species that are different from *Bosmina longirostrus* in ecologically meaningful ways were found (such as *E. coregoni*).

6. Works cited

Stemberger 1979, De Melo et al. 1994, Hebert 1995, Kotov et al. 2009

Balcer, M.D., N.L. Korda, and S.I. Dodson. 1984. Zooplankton of the Great Lakes: a guide to the identification and ecology of the common crustacean species. Univ. Wis. Press., Madison.

Bottrell, H.H., A. Duncan, Z.M. Gliwicz, E. Grygierek, A. Herzig, A. Hillbricht-Ilkowska, H. Kurasawa, P. Larsson, and T. Weglenska. 1976. A review of some problems in zooplankton production studies. Norwegian Journal of Zoology 24:419-456.

De Melo, R. and P.D.N. Hebert. 1994. A taxonomic reevaluation of North American Bosminidae. Can. J. Zool. 72: 1808-1825.

Doohan, M. 1973. An energy budget for adult Branchionus plicatilis Muller (Rotatoria). Oecologia 13: 351-362.

Dumont, H.J., I. Van de Velde, S. Dumont. 1975. The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the Plankton, Periphyton and Benthos of Continental waters. Oecologia 19:75-97.

Hebert, P.D.N. 1995. The Daphnia of North America – An Illustrated Fauna. CD-ROM and website (http://www.cladocera.uoguelph.ca/taxonomy/daphnia/default.htm). University of Guelph, Guelph, Canada.

Kotov, A.A., S. Ishida, D.J. Taylor. 2009. Revision of the genus Bosmina Baird, 1845 (Cladocera: Bosminidae), based on evidence from male morphological characters and molecular phylogenetics. Zool. J. of the Linnaean Soc. 156: 1-51.

McCauley, E. 1984. The estimation of the abundance and biomass of zooplankton in samples. Chapter 7 in A manual of methods for the assessment of secondary productivity in freshwaters. 2nd Ed. Blackwell Scientific Publishers, Oxford.

Pace, M.L., and J.D. Orcutt, Jr. 1981. The relative importance of protozoans, rotifers and crustaceans in a freshwater zooplankton community. Limnology and Oceanography 26:822-830.

Sandercock, G.A. and G.G.E. Scudder. 1996. Key to the species of freshwater calanoid copepods of British Columbia. Resources Inventory Committee. Province of British Columbia.

Smith, D.G. 2001. Pennak's Freshwater Invertebrates of the United States: Porifera to Crustacea, 4th Ed. Wiley, New York.

Stemberger, R.S. 1979. A guide to the rotifers of the Laurentian Great Lakes. EPA 600/4-79-021.

Thorp, J.H., and A.P. Covich. 1997. Ecology and classification of North American Freshwater Invertebrates, 2nd ed.. Academics, San Diego.

Torke, B.G. 1976. A key to the identification of the cyclopoid copepods of Wisconsin with notes on their distribution and ecology. Wisconsin Department of Natural Resources Research Report No. 88. Madison, Wisconsin.

7. Figures

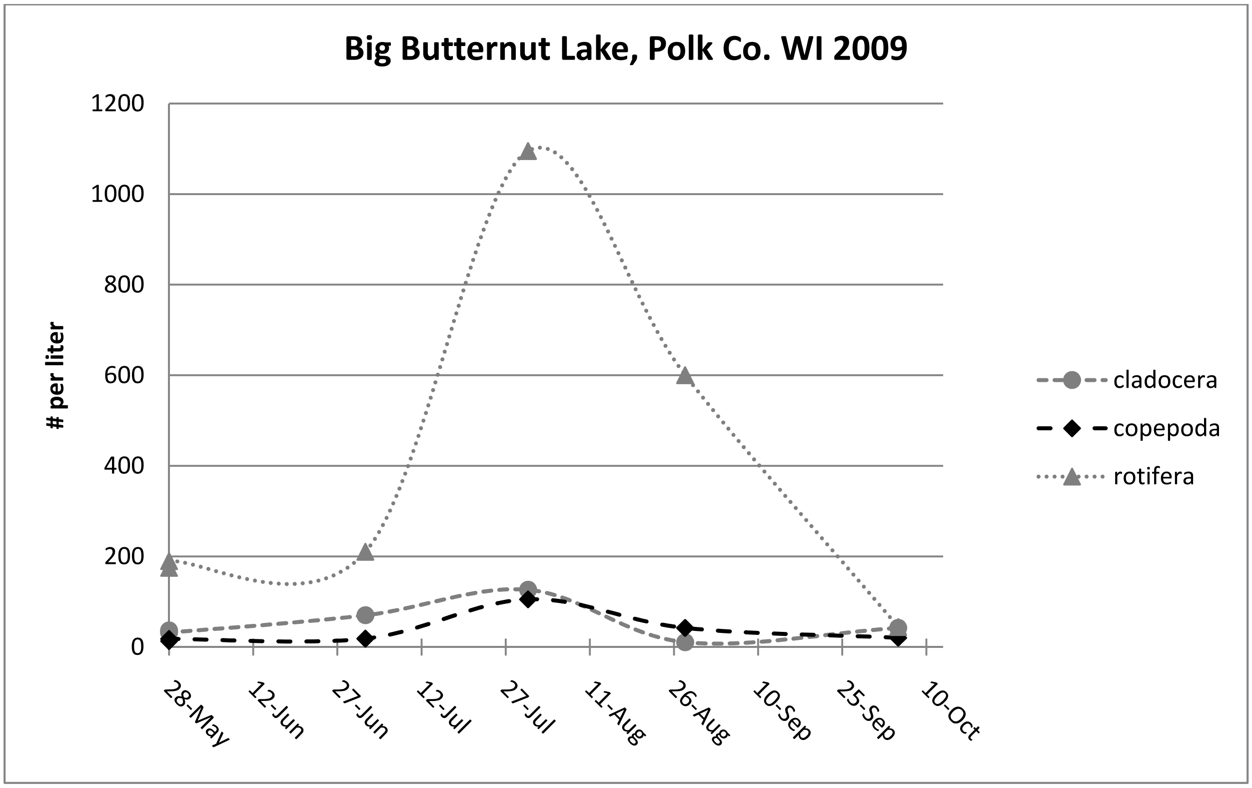


Figure 1. Abundance (#/l) of major zooplankton groups, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

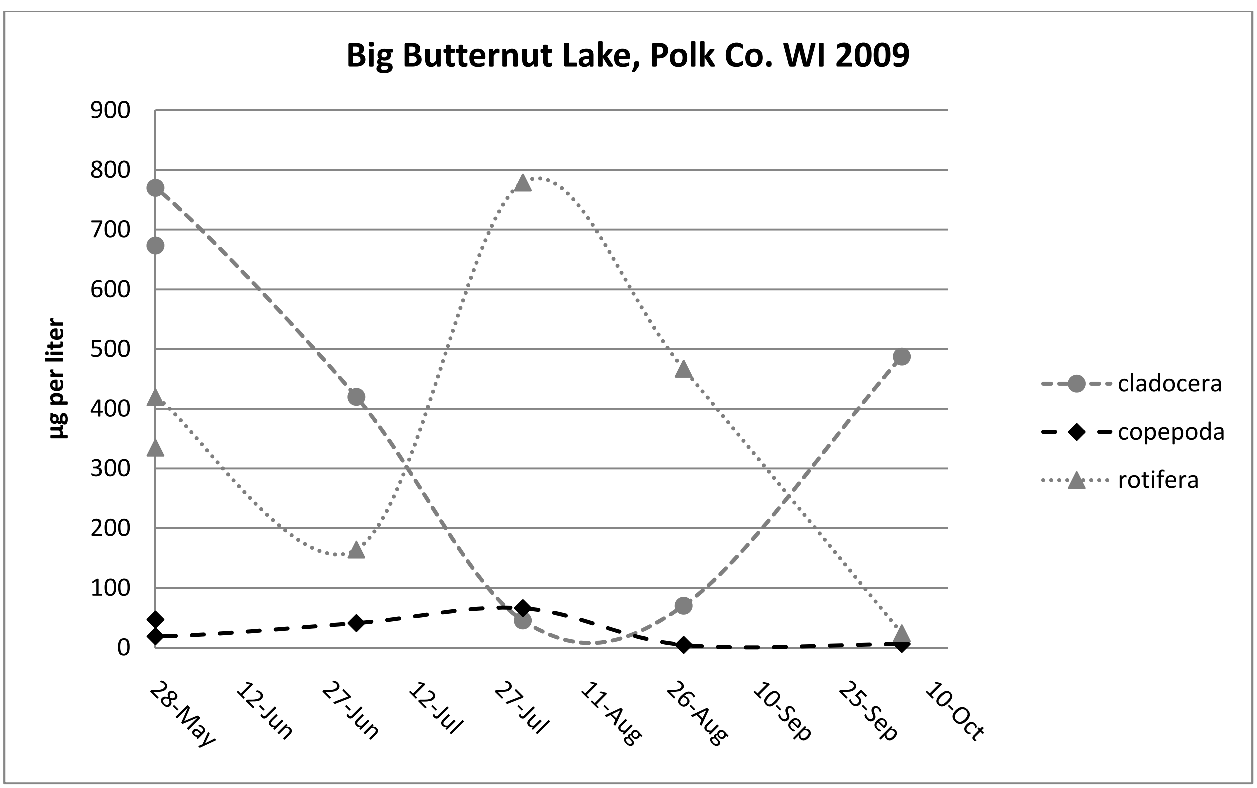


Figure 2. Biomass estimates (µg/l) of major zooplankton groups, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

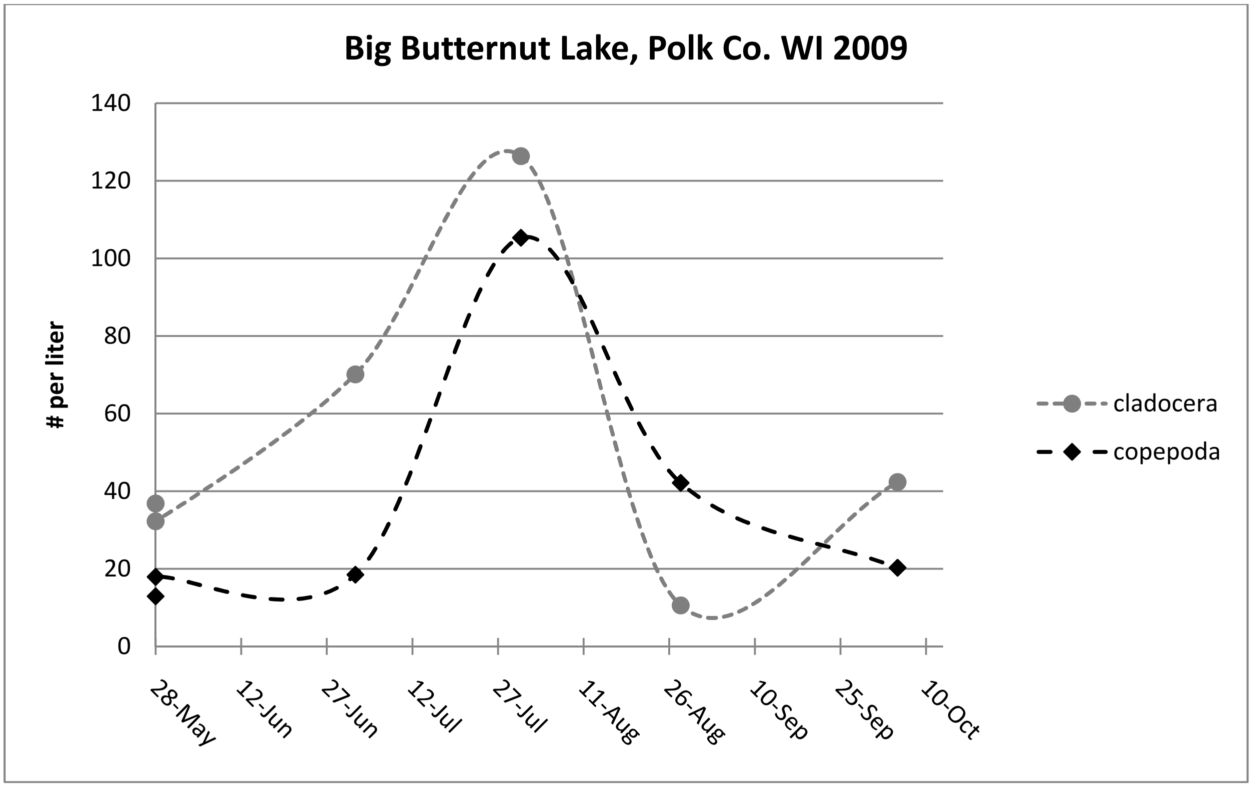


Figure 3. Abundance (#/l) of cladocera and copepoda, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

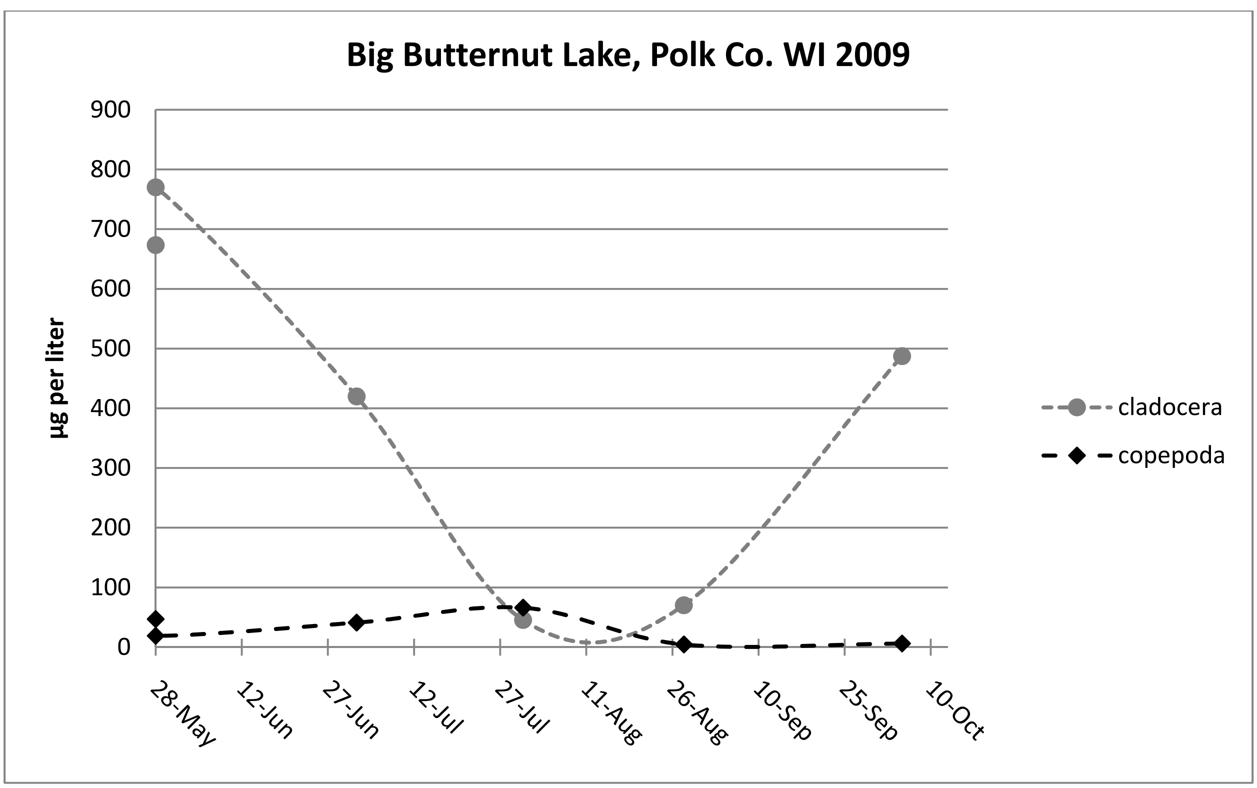


Figure 4. Biomass estimates (µg/l) of cladocera and copepoda, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

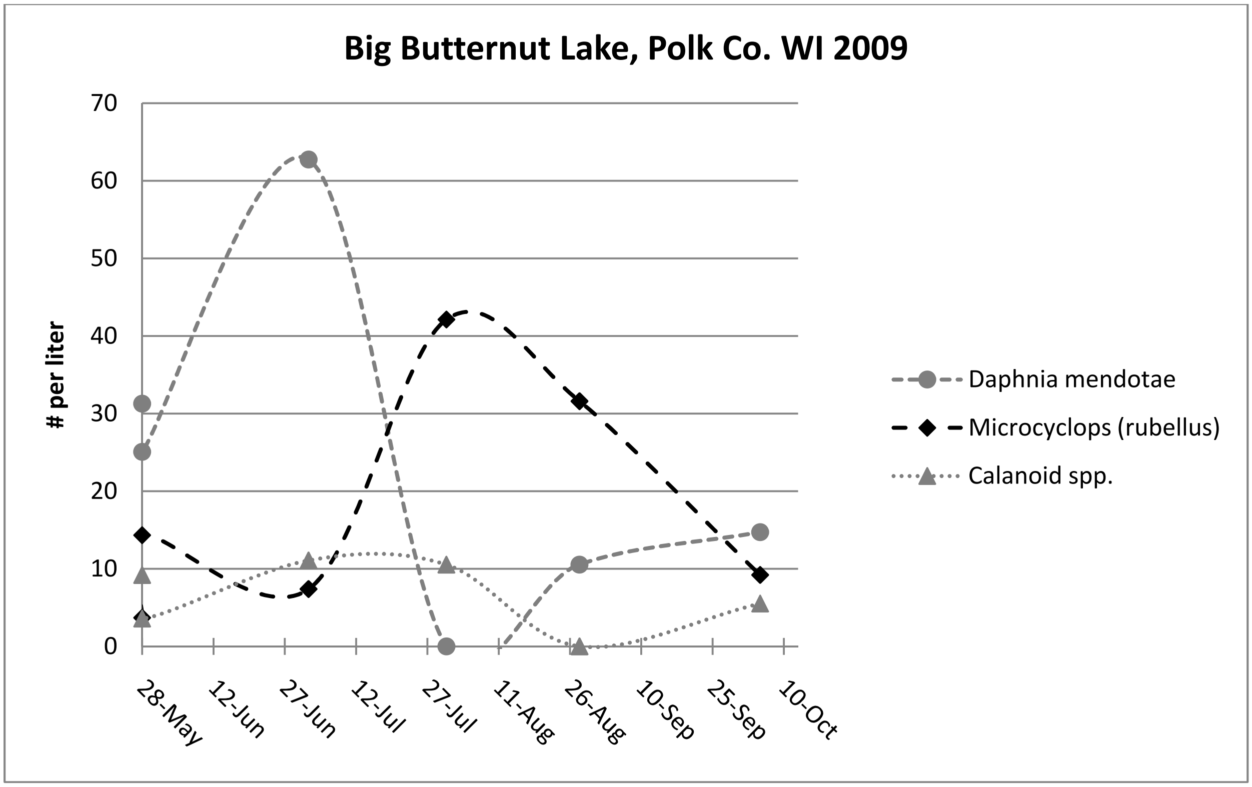


Figure 5. Abundance (#/l) of three key taxa, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

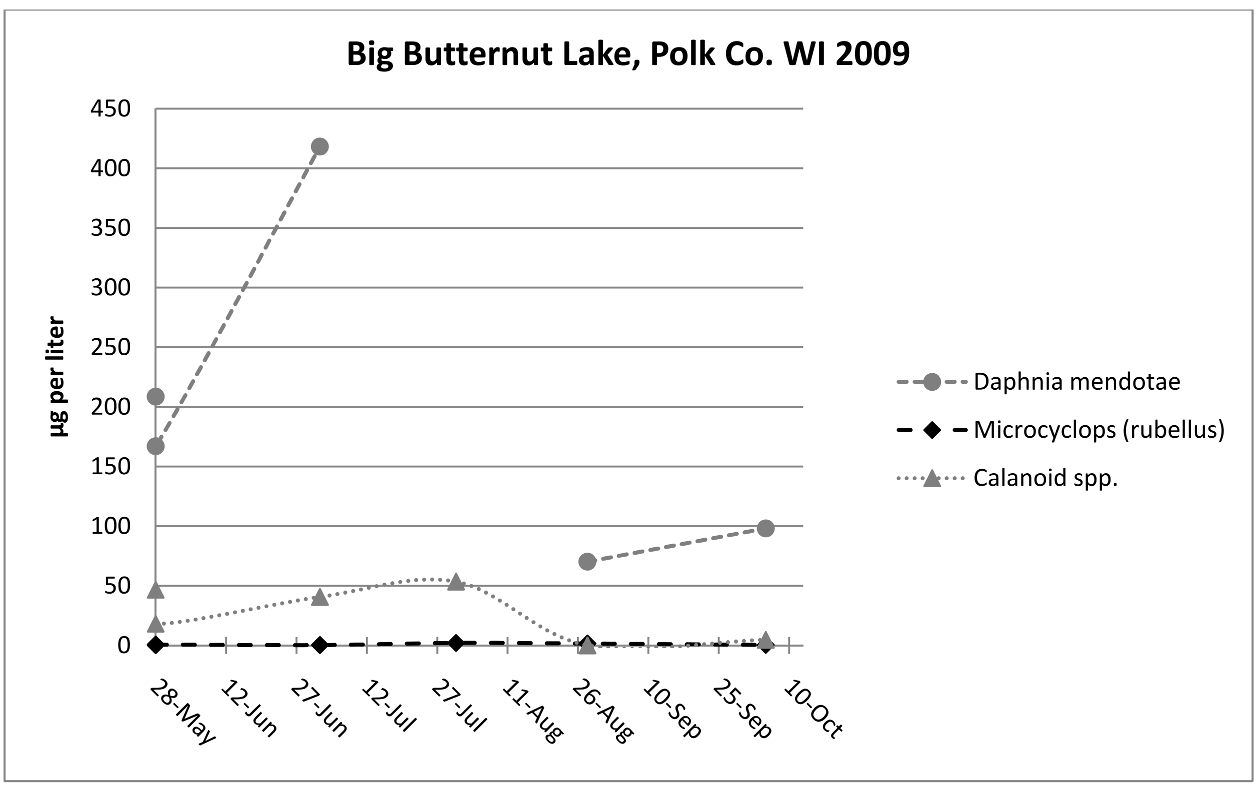


Figure 6. Biomass estimates (µg/l) of three key taxa, Big Butternut Lake, Polk Co. WI, 2009. May sample shows lab duplicate.

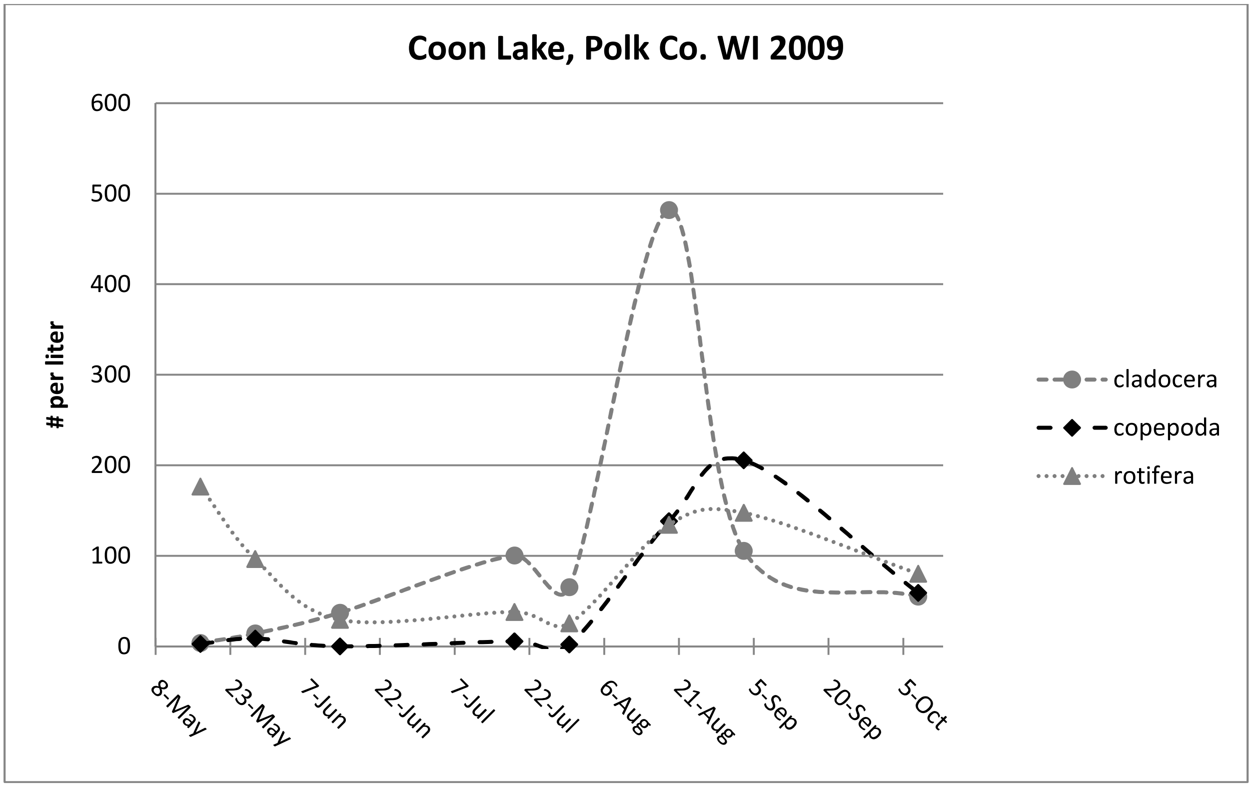


Figure 7. Abundance (#/l) of major zooplankton groups, Coon Lake, Polk Co. WI, 2009.

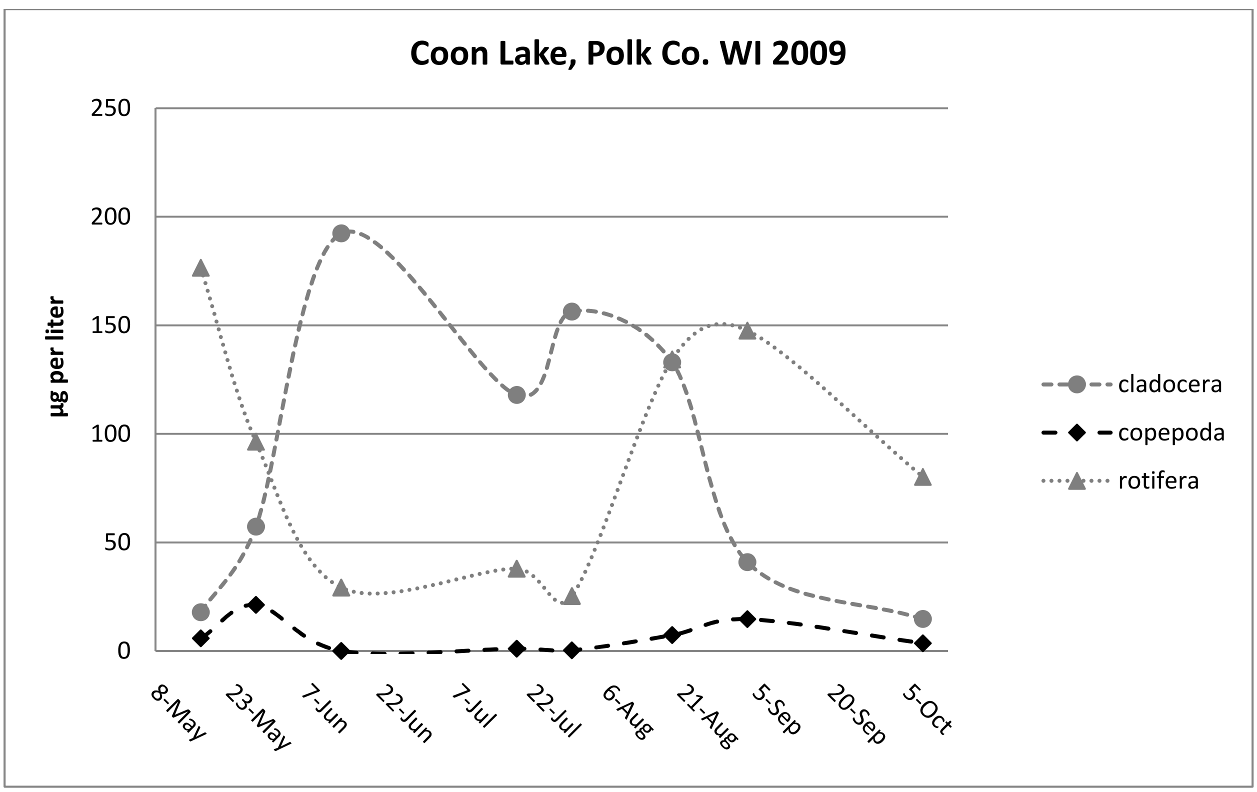


Figure 8. Biomass estimates (µg/l) of major zooplankton groups, Coon Lake, Polk Co. WI, 2009.

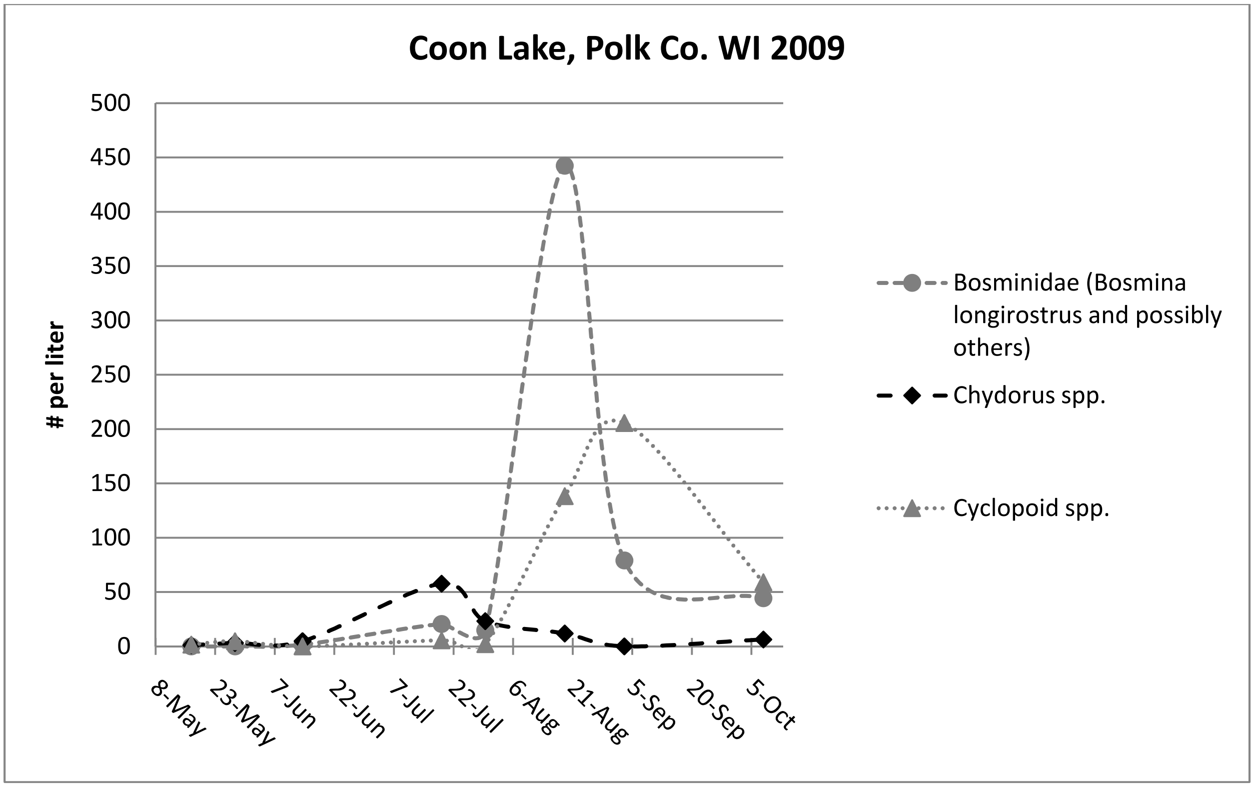


Figure 9. Abundance (#/l) of key taxa (group 1), Coon Lake, Polk Co. WI, 2009.

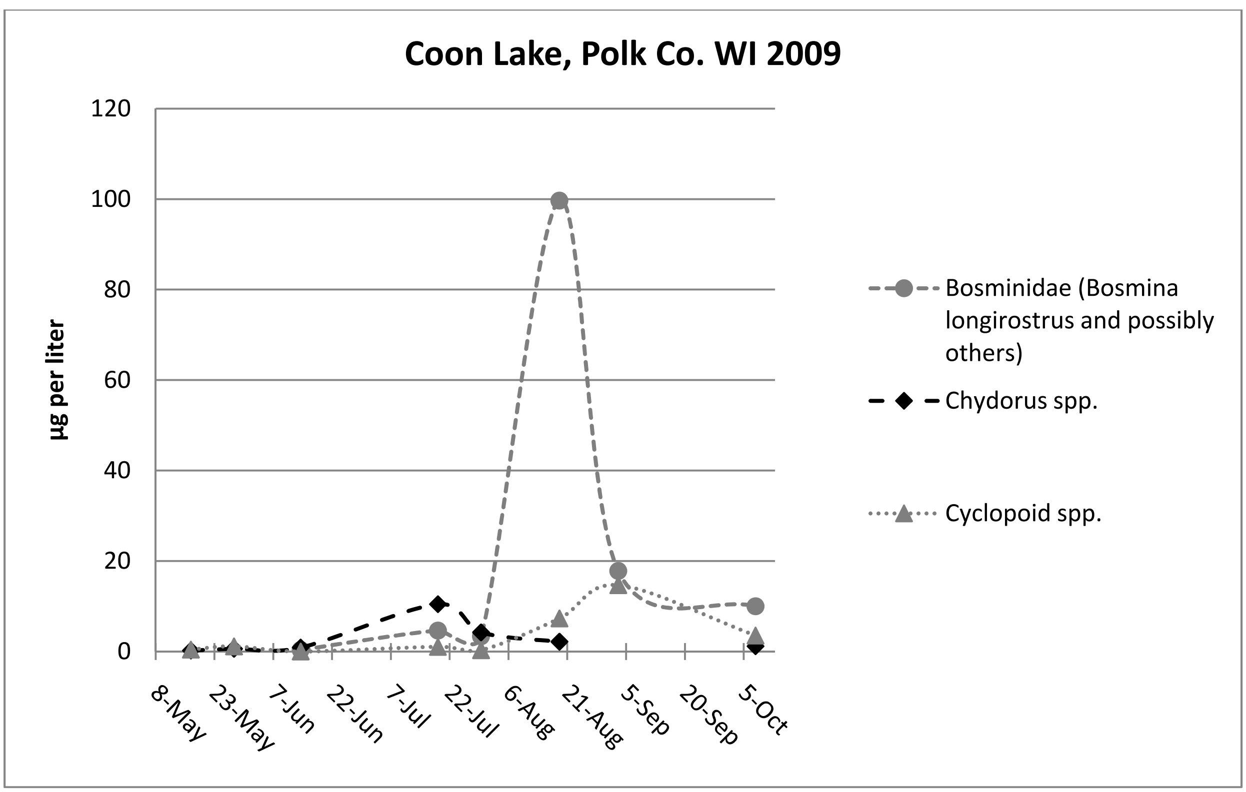


Figure 10. Biomass estimates (µg/l) of key taxa (group 1), Coon Lake, Polk Co. WI, 2009.

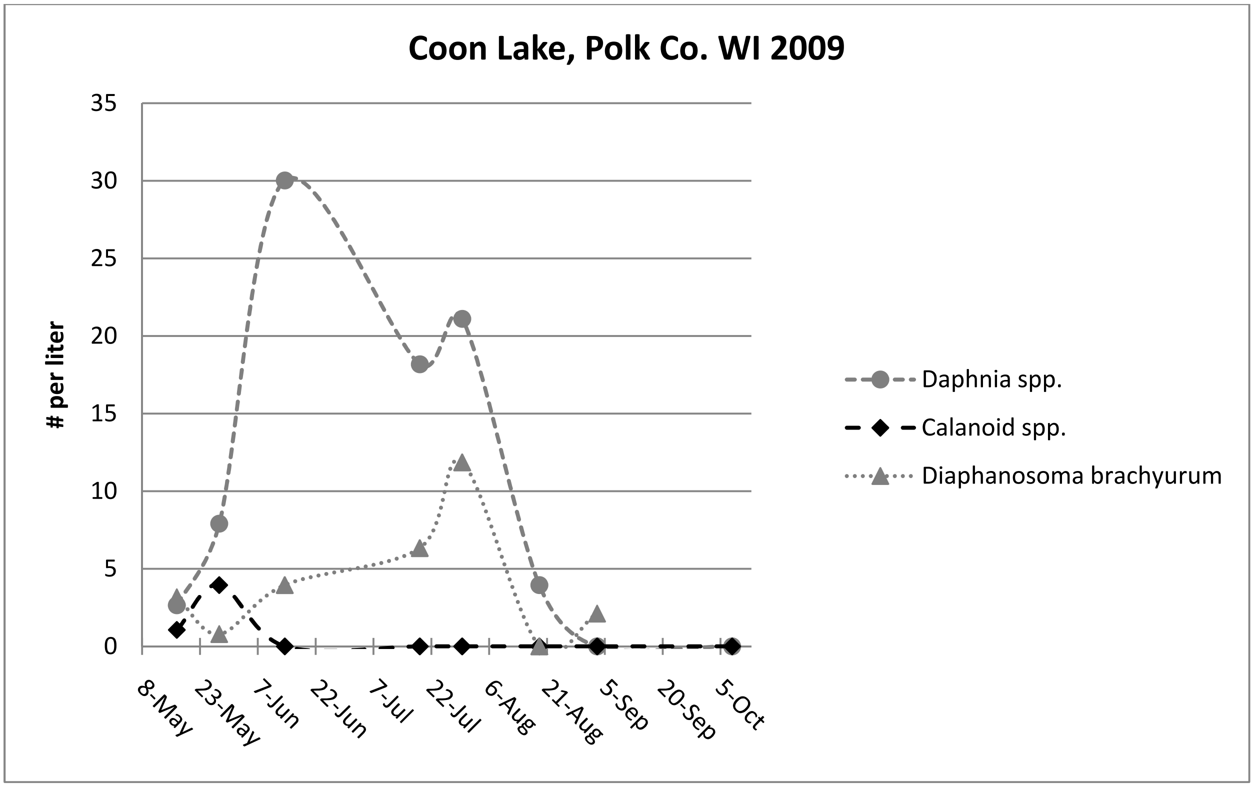


Figure 11. Abundance (#/l) of key taxa (group 2), Coon Lake, Polk Co. WI, 2009.

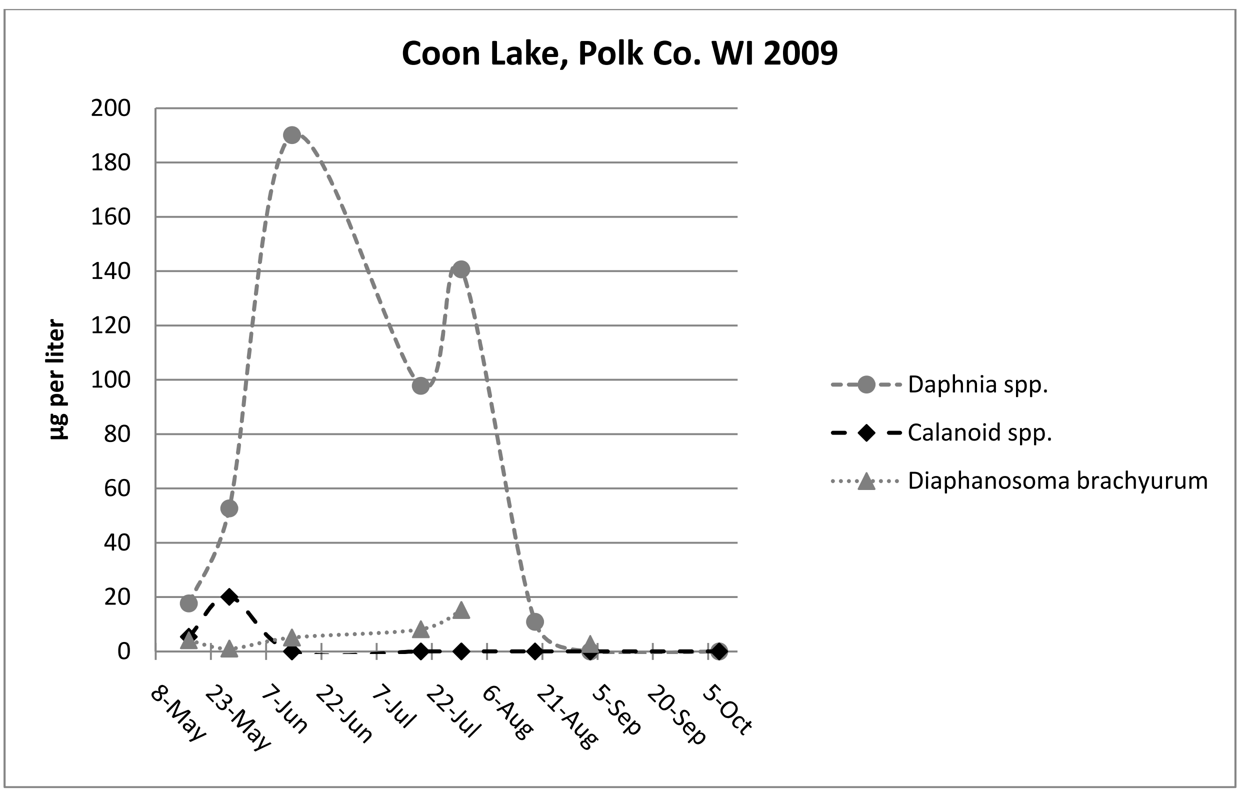


Figure 12. Biomass estimates (µg/l) of key taxa (group 2), Coon Lake, Polk Co. WI, 2009.

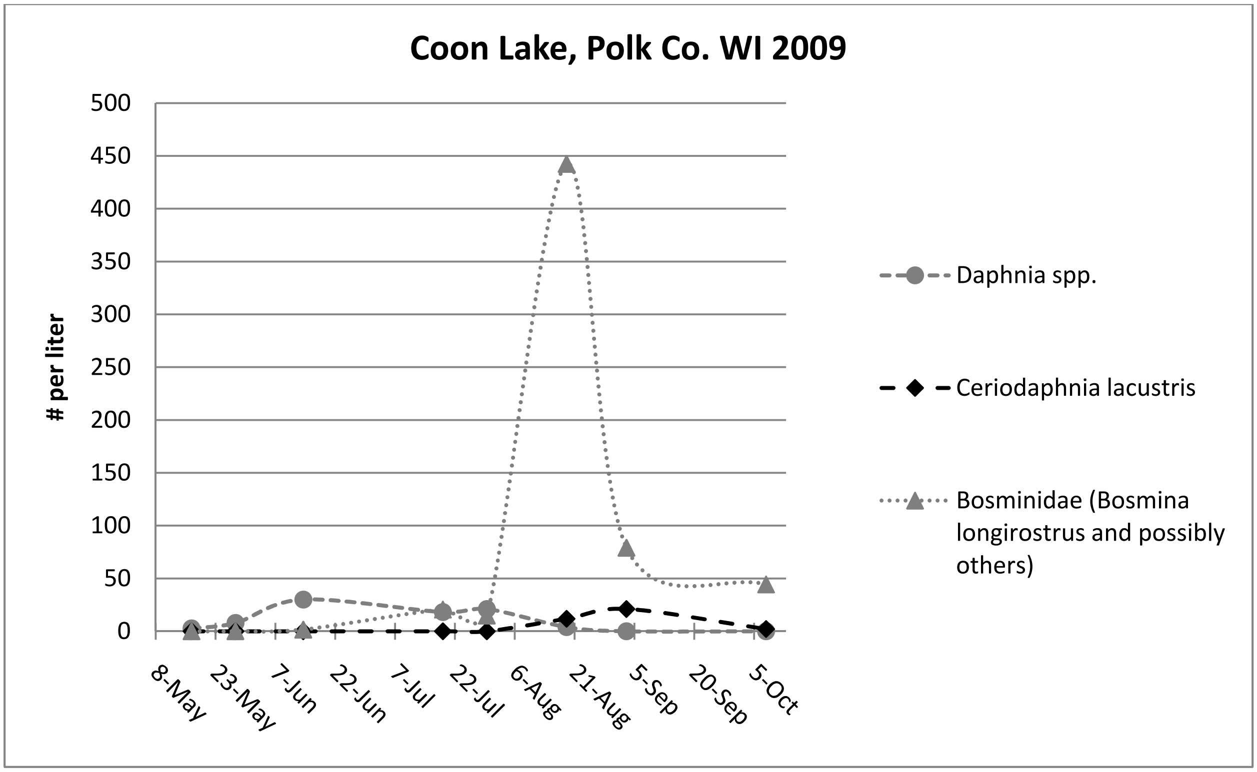


Figure 13. Abundance (#/l) of three cladoceran groups, Coon Lake, Polk Co. WI, 2009.

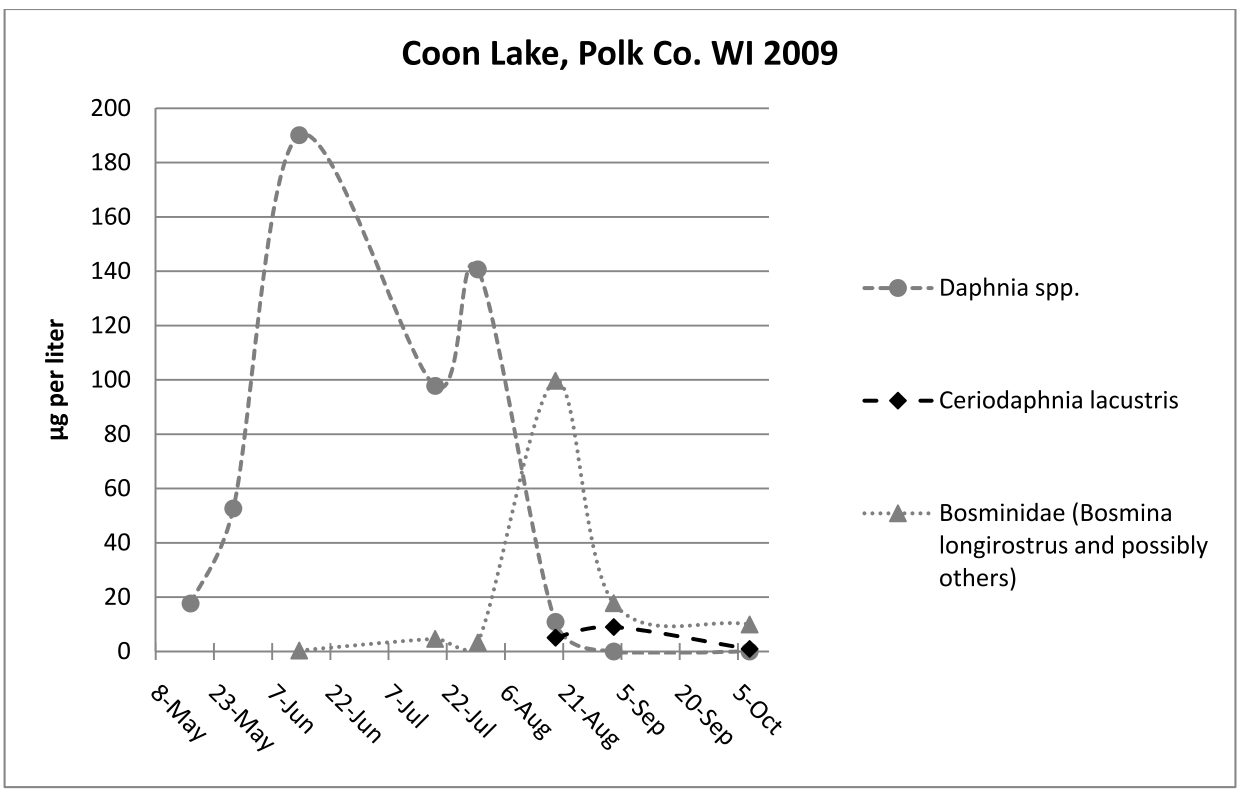


Figure 14. Biomass estimates (µg/l) of three cladoceran groups, Coon Lake, Polk Co. WI, 2009.

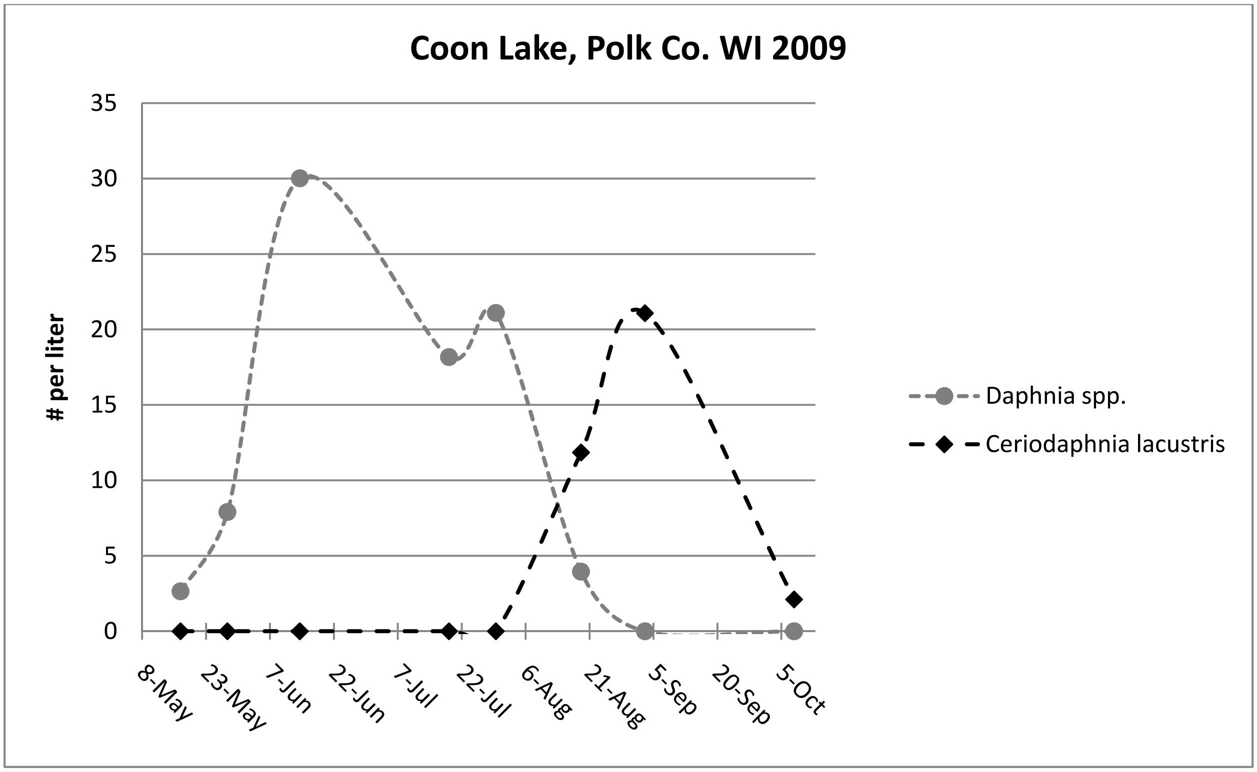


Figure 15. Detail of (Figure 14), abundance (#/l) of two cladoceran groups, Coon Lake, Polk Co. WI, 2009.

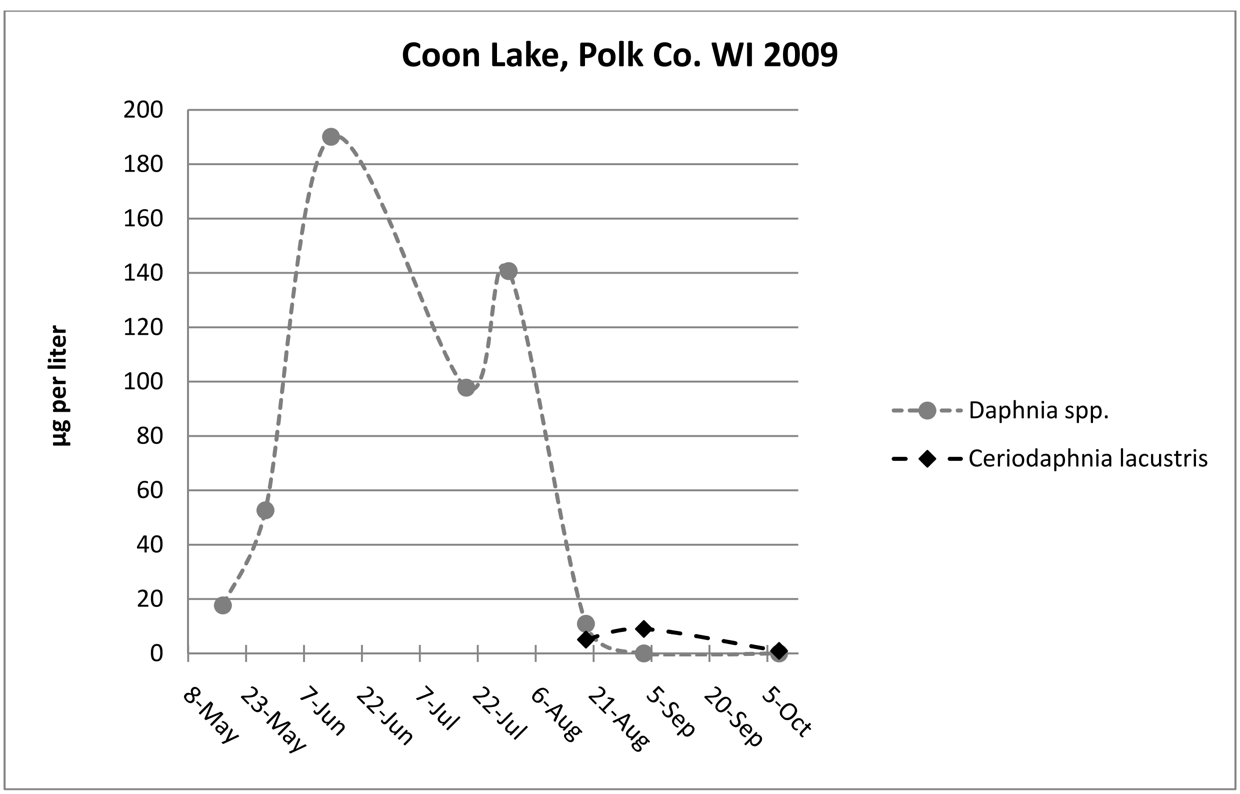


Figure 16. Detail of (Figure 14), biomass estimates (µg/l) of two cladoceran groups, Coon Lake, Polk Co. WI, 2009.

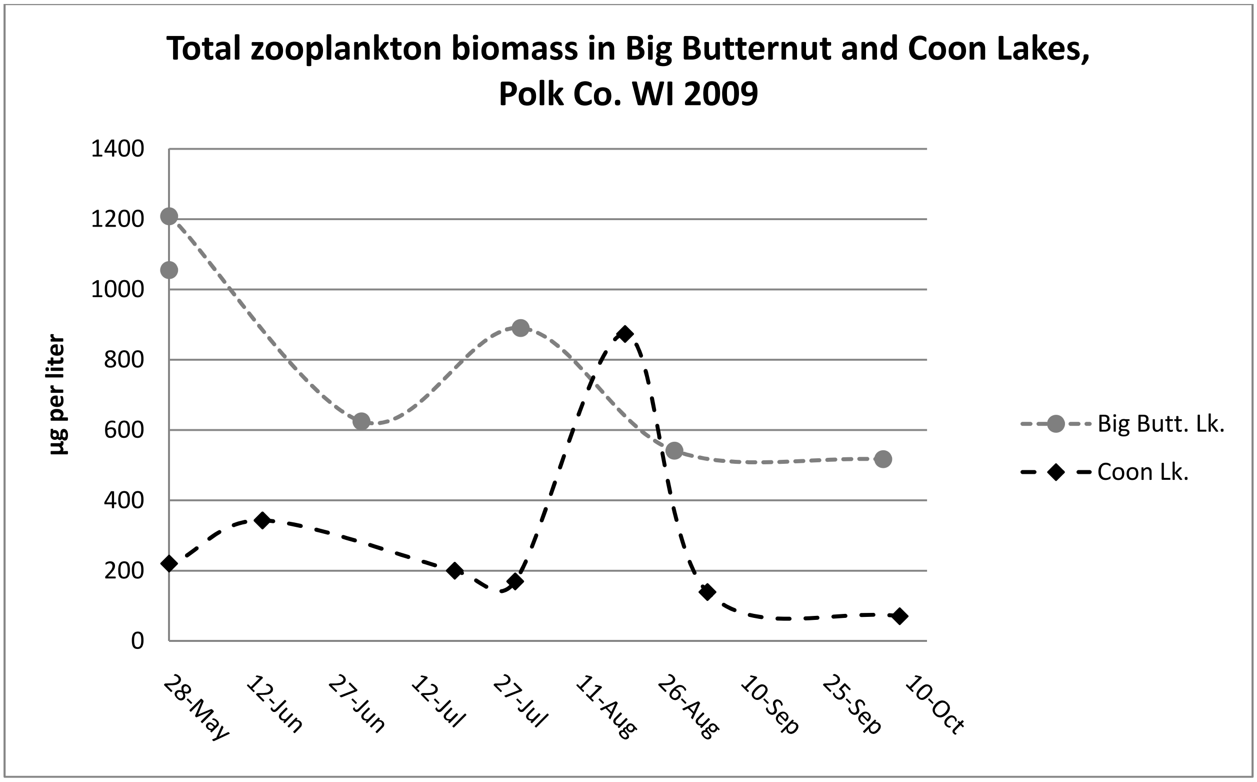


Figure 17. Comparison of total zooplankton biomass between Big Butternut and Coon Lakes, Polk Co. WI, 2009.

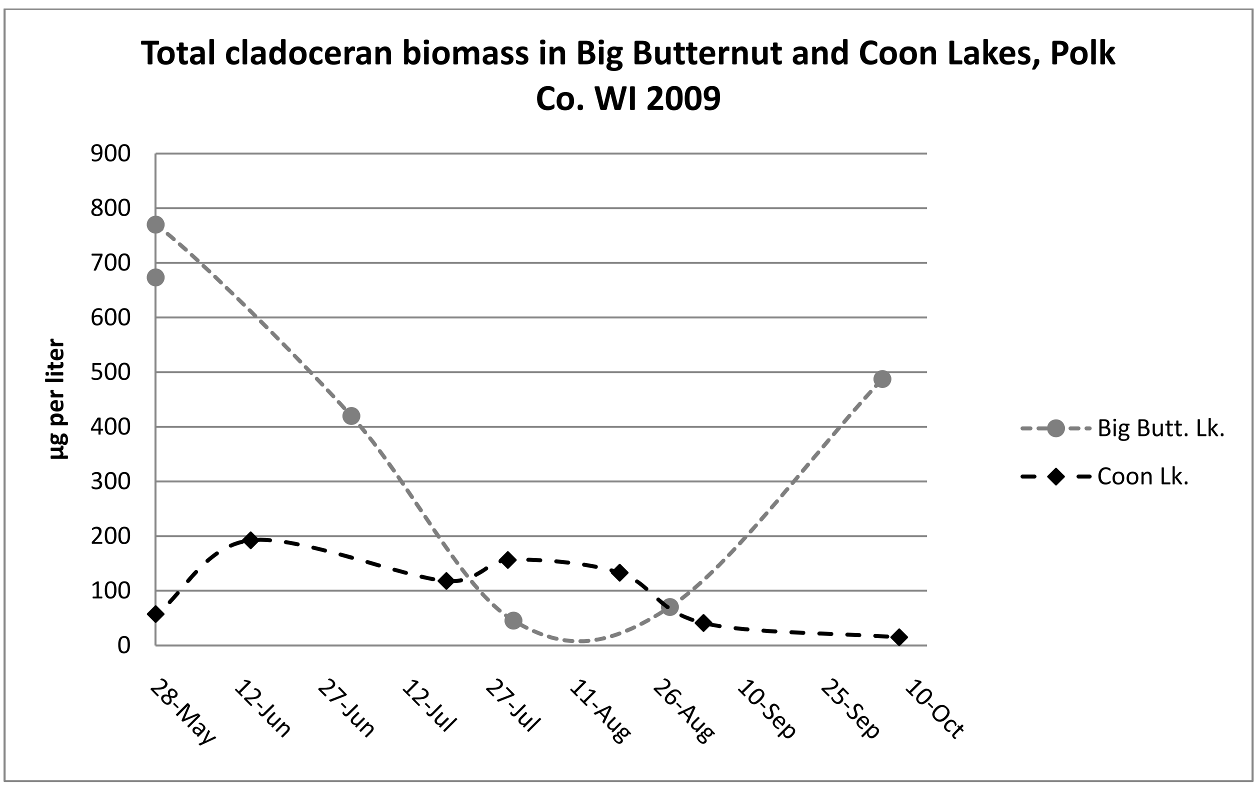


Figure 18. Comparison of total cladoceran biomass between Big Butternut and Coon Lakes, Polk Co. WI, 2009.

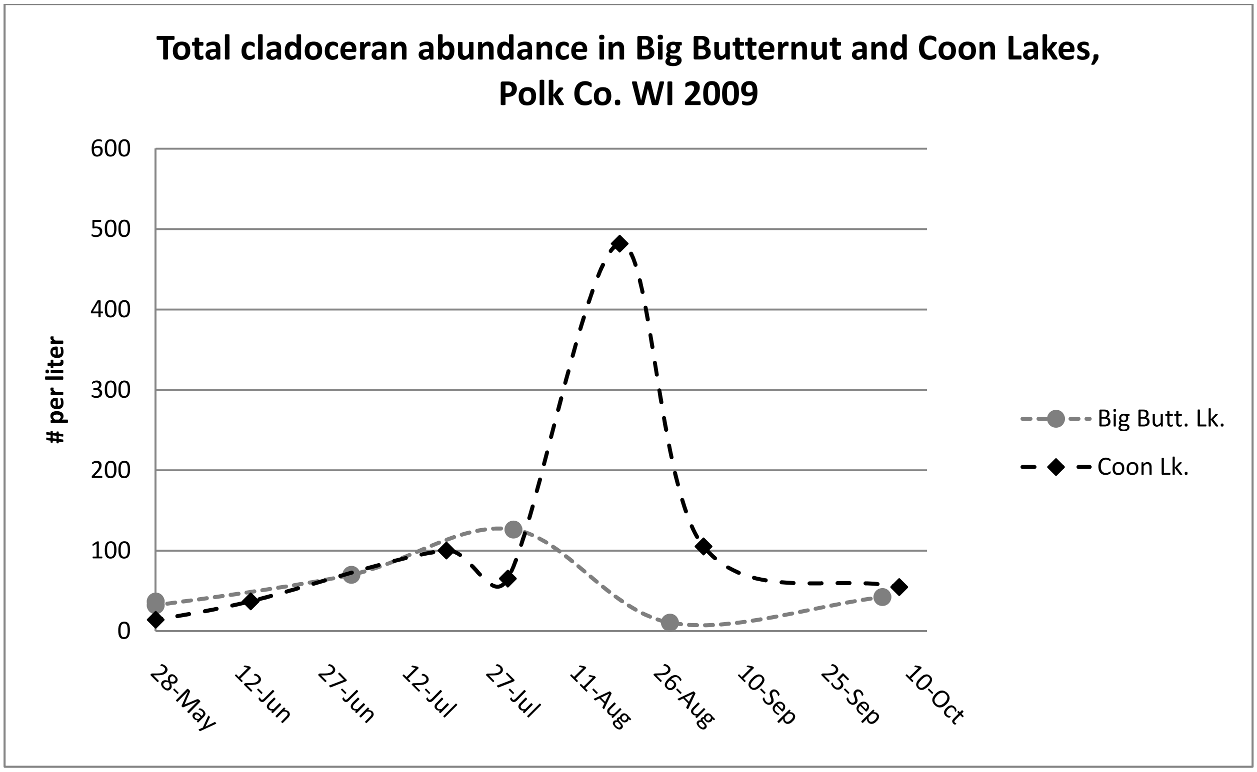


Figure 19. Comparison of cladoceran density between Big Butternut and Coon Lakes, Polk Co. WI, 2009.

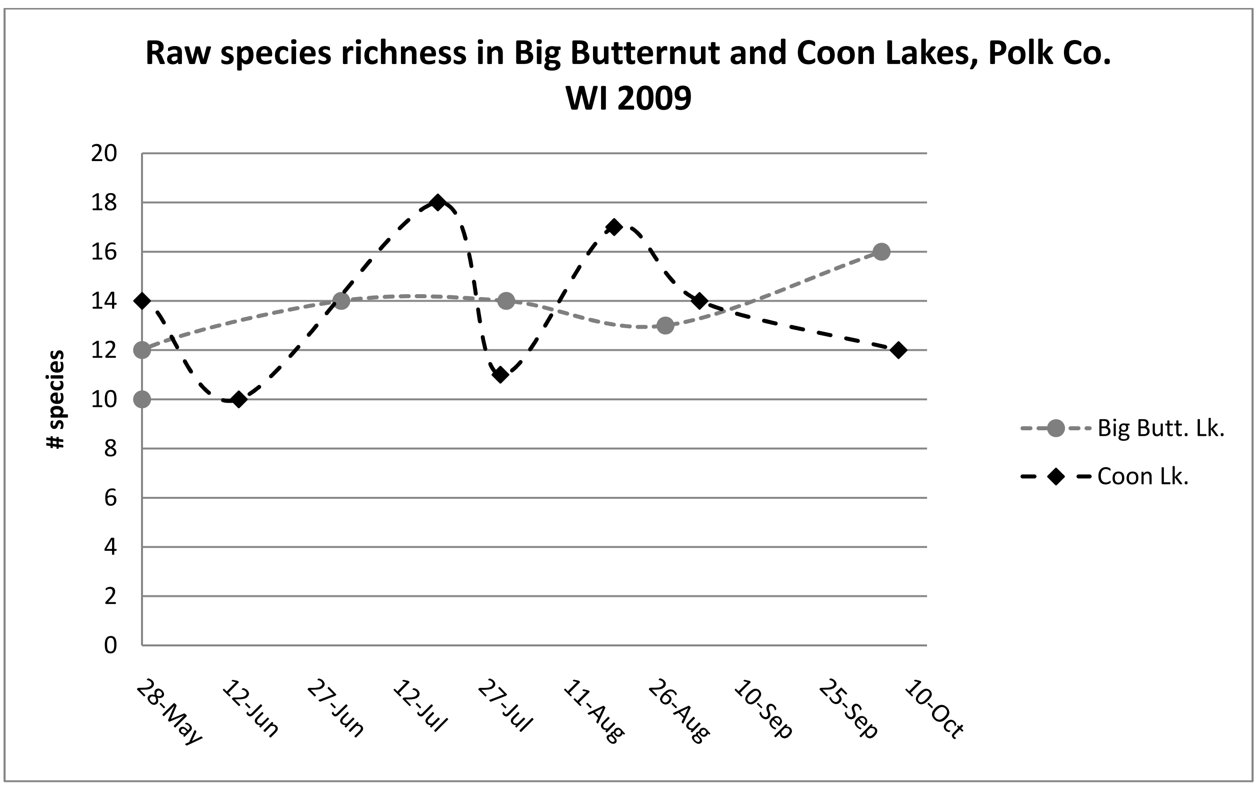


Figure 20. Comparison of total number of zooplankton species between Big Butternut and Coon Lakes, Polk Co. WI, 2009.

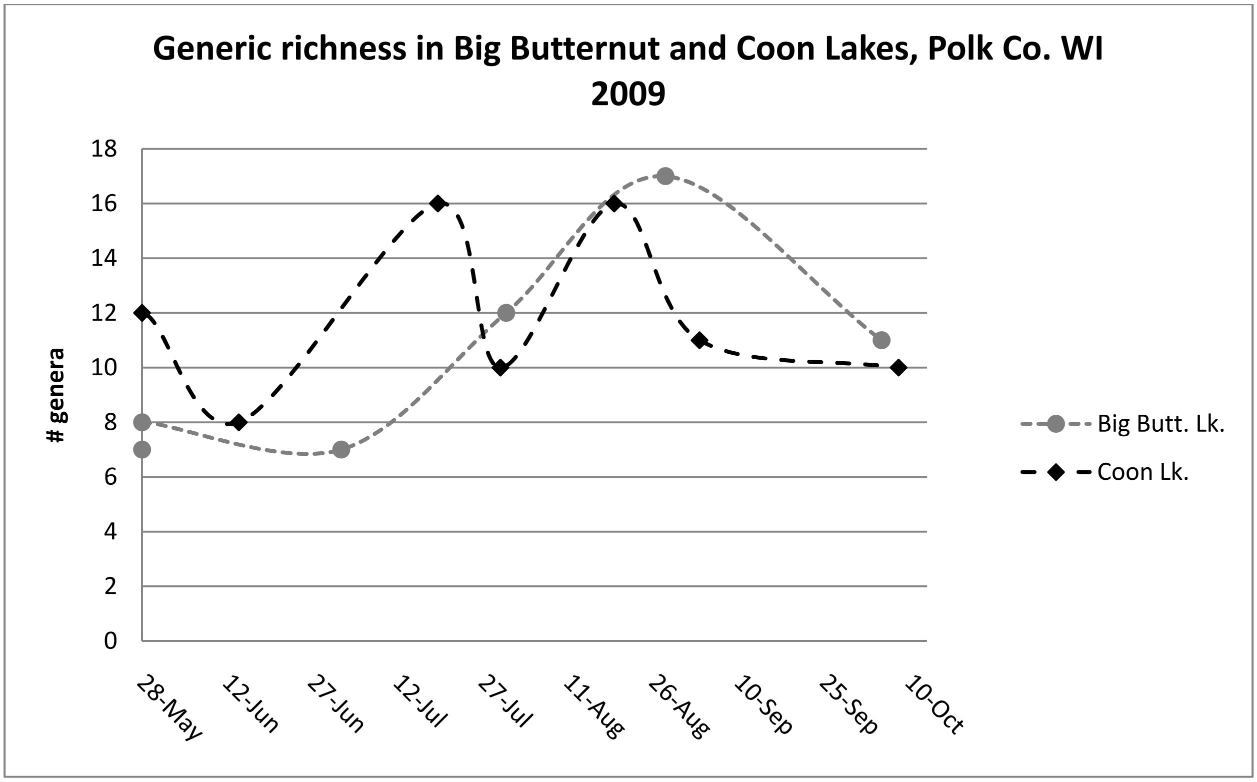


Figure 21. Comparison of total zooplankton genera between Big Butternut and Coon Lakes, Polk Co. WI, 2009.

8. Tables

Table 1. Taxa present in 2009 sampling of Big Butternut and Coon Lakes, Polk Co., WI (2 pages).

Taxa	Big Butternut Lake	Coon Lake
Bosminidae (*Bosmina longirostrus* confirmed)	X	X
Chydorus spp.		X
Ceriodaphnia lacustris	X	X
Daphnia spp.	X	X
Daphnia ambigua		X
Daphnia catawba	X	
Daphnia longiremus		X
Daphnia mendotae	X	X
Daphnia retrocurva	X	
Diaphanosoma brachyurum		X
Holopedium gibberum		X
Calanoid female- Diaptomidae	X	X
Calanoid female- Epischura	X	
Calanoid nauplius	X	X
Cyclopoid nauplius	X	X
copepodid	X	X
Acanthocyclops (*venustoides* or *brevispinosus*)	X	
Diacyclops albus	X	
Diacyclops spp.	X	X
(*Homocyclops* sp.)		X
Microcyclops (*rubellus*)	X	X
Anuraeopsis sp.	X	X
Ascomorpha saltans	X	X
Asplanchna brightwelli		X
Asplanchna priodonta	X	X
Brachyonus havanaensis		X
Conochilus sp.	X	X
Conochiloides sp.	X	X
Euchlanis sp.	X	
Filinia longiseta	X	
Gastropus sp.	X	
Kellicottia bostoniensis		X
Keratella spp.	X	X
Keratella cochlearis	X	X
Keratella earlinae	X	
Lecane ungulata		X
Monostyla bulla	X	
Polyarthra spp.	X	X

Polyarthra dolichoptera	x	
Polyarthra euryptera	x	x
Polyarthra remata	x	
Polyarthra vulgaris	x	x
Pompholyx sulcata	x	x
Synchaeta oblonga		x
Trichocerca cylindrica	x	x
Trichocerca lata	x	
Trichocerca pusilla		x
unidentifiable rotifer	x	
testate protozoa	x	x
Cucurbitella sp.	x	x
tintinnid ciliate *Codonella* sp.	x	x
Difflugia sp.		x

9. Appendix: Zooplankton background information

(from Lafrançois, T. 2009. Zooplankton of Wild Goose and Ward Lakes, Polk Co. WI, 2008. Final report to Polk County Land and Water Resources Dept., March 2009.)

Zooplankton are small aquatic animals (specimens from this study range from 0.03 mm long to 3 mm long). Three primary components of the zooplankton community are rotifers, copepods, and cladocerans. Single celled organisms were not found in this survey, most likely due to over-desiccation in sample preservative. Organisms of the phylum Rotifera are either soft-bodied or have a hard lorica (shell). All rotifers have mouthparts with bristles that undulate like two little wheels, giving this group their name. Rotifers are small, ranging from 0.03 mm to 1.00 mm long, depending on the species. They are size-selective omnivores that eat algae, protozoa, and sometimes each other. Rotifers are preyed on by other plankton but only incidentally by fish. Some have long spines or gelatinous sheaths to deter predators.

Copepods are crustaceans (phylum Arthropoda, subphylum Crustacea) of two orders (Calanoida and Cyclopoida). Other orders of copepods are benthic (live in the sediments) or parasitic on fish and are not usually included in studies of plankton. Copepods are multi-segmented animals that are size selective omnivores, eating algae and other plankton. Some have more specific feeding habits. Copepods are highly variable in size, depending on the species, ranging from 0.3 mm to 3.0 mm long (and even larger in some cases). They can be eaten by larger plankton and are a favorite fish food (either planktivores like pan fish and minnows or fry of larger fish).

Cladocerans are also crustaceans (phylum Arthropoda, subphylum Crustacea) of similar size range than copepods but very distinct morphologically. Cladocerans filter-feed by creating a current with fan-like legs protected by a hard but un-segmented carapace. Most cladocerans are parthogenetic, females producing clonal eggs. Males are produced in times of environmental stress and sexual reproduction occurs for one or two generations. Cladocerans are voracious consumers of algae and are also a favorite food of fish.

Zooplankton are often an overlooked component of aquatic systems, but their role in ecosystem function is extremely important. Lake systems are valued primarily for water clarity and fishing or other recreation. Both of these values are strongly linked to water quality and ecosystem health. Zooplankton are the primary link between the 'bottom up' processes and 'top down' processes of the ecosystem. Bottom up processes, like increased nutrients, can cause noxious algal blooms. Zooplankton can mediate these blooms by heavy grazing. On the other hand, shifts in algal composition caused by increased nutrients can change zooplankton community composition, exacerbating algal blooms and stressing planktivorous fish and / or the development of fry. Top down processes include fish predation, where increased planktivorous fishes (e.g. pan fish) can drastically reduce zooplankton populations and lead to algal blooms. In some lakes a trophic cascade is used to manage this effect, using piscivorous fish to reduce planktivorous fish populations, increasing plankton to reduce algae— and consequently improving water clarity.

Zooplankton also respond to changes in watershed and lakeshore management. Changes in aquatic plants, landscape use in the watershed, and buffer zones around a lake impact plankton directly or indirectly. Understanding the plankton in a lake (both algae and zooplankton) is like looking under the hood of a car, showing the mechanisms that connect lake management, ecosystem effects, water clarity, and fishing.

Zooplankton Abundance										
site	**date**	**diversity (Genera)**	**diversity (taxa)**	***cladocera***	***copepoda***	***rotifera***	***total* #**	**Bosminidae (Bosmina longirostrus and possibly others)**	**Chydorus spp.**	**Ceriodaphnia lacustris**
italics = summary data										
Butternut	28-May-09	7	10	36.8	12.9	174.8	224.5			
Lab Dupe	28-May-09	8	12	32.2	17.9	189.7	239.9			
Butternut	2-Jul-09	7	14	70.1	18.5	210.3	298.9	7.4		
Butternut	31-Jul-09	12	14	126.4	105.3	1095.1	1326.8	42.1		84.2
Butternut	28-Aug-09	17	13	10.5	42.1	600.2	652.9			
Butternut	5-Oct-09	11	16	42.3	20.2	44.2	106.7	1.8		

Daphnia spp.	**Daphnia ambigua**	**Daphnia catawba**	**Daphnia longiremus**	**Daphnia mendotae**	**Daphnia retrocurva**	**Diaphanosoma brachyurum**	**Holopedium gibberum**
36.8		5.5		31.3			
32.2		7.2		25.1			
62.7				62.7			
10.5				10.5			
40.5				14.7	25.8		

Cyclopoid spp.	*Calanoid spp.*	*total nauplii and copepodids (not included in copepoda total)*	**Calanoid female-Diaptomidae**	**Calanoid female-Epischura**	**Calanoid nauplius**	**Cyclopoid nauplius**	**copepodid**	**Acanthocyclops (venustoides or brevispinosus)**
3.7	9.2	25.8	9.2			25.8		
14.3	3.6	17.9	3.6		7.2	10.7		
7.4	11.1	29.5	7.4	3.7	3.7	25.8		
94.8	10.5	10.5	10.5			10.5		10.5
42.1		10.5				10.5		
14.7	5.5	27.6		5.5	11.0	14.7	1.8	

Diacyclops albus	**Diacyclops spp.**	**(Homocyclops sp.)**	**Microcyclops (rubellus)**	**Anuraeopsis sp.**	**Ascomorpha saltans**	**Asplanchna brightwelli**	**Asplanchna priodonta**
			3.7				5.5
			14.3				7.2
			7.4				
	42.1		42.1		31.6		
10.5			31.6	31.6	21.1		
	5.5		9.2				

Brachyonus havanaensis	**Conochilus sp.**	**Conochiloides sp.**	**Euchlanis sp.**	**Filinia longiseta**	**Gastropus sp.**	**Kellicottia bostoniensis**	**Keratella spp (sum)**	**Keratella cochlearis**
					3.7			127.0
					14.3			128.9
				11.1				73.8
	673.9	21.1						168.5
	10.5		21.1		31.6			221.1
								31.3

Keratella earlinae	**Keratella sp.**	**Lecane ungulata**	**Monostyla bulla**	***Polyarthra spp. (sum)***	**Polyarthra dolichoptera**	**Polyarthra euryptera**	**Polyarthra remata**	**Pompholyx sulcata**
38.6								
35.8								
62.7				62.7	7.4		33.2	3.7
				179.0			158.0	
94.8				63.2		10.5	52.7	
1.8			1.8	5.5			3.7	

Polyarthra vulgaris	**Synchaeta oblonga**	**Trichocerca cylindrica**	**Trichocerca lata**	**Trichocerca pusilla**	**unidentifiable rotifer**	**testate protozoa**	***Cucurbitella* sp.**
						1.8	
		3.6				3.6	
18.5							
21.1			21.1				
		21.1	63.2		21.1	10.5	
1.8			3.7			1.8	1.8

tintinnid ciliate *Codonella* sp.	***Difflugia* sp.**
1.8	
3.6	
10.5	

Abundance Calculations

site	date	date code	*totals -->*	diversity (Genera)	diversity (taxa)	cladocera	copepoda	rotifera	*taxa --->*
Butternut	28-May-09	39961		7.0	10.0	36.8	12.9	174.8	
Lab Dupe	28-May-09	39961		8.0	12.0	32.2	17.9	189.7	
Butternut	2-Jul-09	39996		7.0	14.0	70.1	18.5	210.3	
Butternut	31-Jul-09	40025		12.0	14.0	126.4	105.3	1095.1	
Butternut	28-Aug-09	40053		17.0	13.0	10.5	42.1	600.2	
Butternut	5-Oct-09	40091		11.0	16.0	42.3	20.2	44.2	

Bosminidae (Bosmina longirostrus and possibly others)	Chydorus spp.	Ceriodaphnia lacustris	*Total Daphnia spp.*	Daphnia ambigua	Daphnia catawba	Daphnia longiremus	Daphnia mendotae	Daphnia retrocurva
0.0	0.0	0.0	36.8	0.0	5.5	0.0	31.3	0.0
0.0	0.0	0.0	32.2	0.0	7.2	0.0	25.1	0.0
7.4	0.0	0.0	62.7	0.0	0.0	0.0	62.7	0.0
42.1	0.0	84.2	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	10.5	0.0	0.0	0.0	10.5	0.0
1.8	0.0	0.0	40.5	0.0	0.0	0.0	14.7	25.8

Diaphanosoma brachyurum	**Holopedium gibberum**	***total Cyclopoid spp.***	***total Calanoid spp.***	***Total nauplii and copepodids (not included in copepoda total)***	**Calanoid female-Diaptomidae**	**Calanoid female-Epischura**	**Calanoid nauplius**
0.0	0.0	3.7	9.2	25.8	9.2	0.0	0.0
0.0	0.0	14.3	3.6	17.9	3.6	0.0	7.2
0.0	0.0	7.4	11.1	29.5	7.4	3.7	3.7
0.0	0.0	94.8	10.5	10.5	10.5	0.0	0.0
0.0	0.0	42.1	0.0	10.5	0.0	0.0	0.0
0.0	0.0	14.7	5.5	27.6	0.0	5.5	11.0

Cyclopoid nauplius	**copepodid**	**Acanthocyclops (venustoides or brevispinosus)**	**Diacyclops albus**	**Diacyclops spp.**	**(Homocyclops sp.)**	**Microcyclops (rubellus)**	**Anuraeopsis sp.**
25.8	0.0	0.0	0.0	0.0	0.0	3.7	0.0
10.7	0.0	0.0	0.0	0.0	0.0	14.3	0.0
25.8	0.0	0.0	0.0	0.0	0.0	7.4	0.0
10.5	0.0	10.5	0.0	42.1	0.0	42.1	0.0
10.5	0.0	0.0	10.5	0.0	0.0	31.6	31.6
14.7	1.8	0.0	0.0	5.5	0.0	9.2	0.0

Ascomorpha saltans	**Asplanchna brightwelli**	**Asplanchna priodonta**	**Brachyonus havanaensis**	**Conochilus sp.**	**Conochiloides sp.**	**Euchlanis sp.**	**Filinia longiseta**	**Gastropus sp.**
0.0	0.0	5.5	0.0	0.0	0.0	0.0	0.0	3.7
0.0	0.0	7.2	0.0	0.0	0.0	0.0	0.0	14.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
31.6	0.0	0.0	0.0	673.9	21.1	0.0	0.0	0.0
21.1	0.0	0.0	0.0	10.5	0.0	21.1	0.0	31.6
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Kellicottia bostoniensis	Keratella spp (sum)	Keratella cochlearis	Keratella earlinae	Keratella sp.	Lecan ungulata	Monstyla bulla	*Polyarthra spp. (sum)*	Polyarthra dolichoptera
0.0	0.0	127.0	38.6	0.0	0.0	0.0	0.0	0.0
0.0	0.0	128.9	35.8	0.0	0.0	0.0	0.0	0.0
0.0	0.0	73.8	62.7	0.0	0.0	0.0	62.7	7.4
0.0	0.0	168.5	0.0	0.0	0.0	0.0	179.0	0.0
0.0	0.0	221.1	94.8	0.0	0.0	0.0	63.2	0.0
0.0	0.0	31.3	1.8	0.0	0.0	1.8	5.5	0.0

Polyarthra euryptera	Polyarthra remata	Pompholyx sulcata	Polyarthra vulgaris	Synchaeta oblonga	Trichocerca cylindrica	Trichocerca lata	Trichocerca pusilla	unidentifiable rotifer
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
0.0	33.2	3.7	18.5	0.0	0.0	0.0	0.0	0.0
0.0	158.0	0.0	21.1	0.0	0.0	21.1	0.0	0.0
10.5	52.7	0.0	0.0	0.0	21.1	63.2	0.0	21.1
0.0	3.7	0.0	1.8	0.0	0.0	3.7	0.0	0.0

testate amoebae	testate 1 (sphere)	testate 2 (amphora)	testate 3 (vase)
1.8	0.0	1.8	0.0
3.6	0.0	3.6	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
10.5	0.0	10.5	0.0
1.8	1.8	0.0	0.0

Zooplankton biomass							
site	date	diversity (Genera)	diversity (taxa)	*cladocera*	*copepoda*	*rotifera*	Big Butt. Lk.
italics = summary data							
TOTAL MICROGRAMS PER LITER							
Butternut	28-May-09	7	10	673.3	46.9	334.8	1055.0
Lab Dupe	28-May-09	8	12	769.9	18.9	419.4	1208.3
Butternut	2-Jul-09	7	14	419.9	41.0	164.1	625.0
Butternut	31-Jul-09	12	14	45.4	66.0	778.9	890.4
Butternut	28-Aug-09	17	13	70.2	4.4	467.0	541.6
Butternut	5-Oct-09	11	16	487.4	6.0	24.0	517.3

Bosminidae (Bosmina longirostrus and possibly others)	**Chydorus spp.**	**Ceriodaphnia lacustris**	***Daphnia spp.***	**Daphnia ambigua**	**Daphnia catawba**	**Daphnia longiremus**	**Daphnia mendotae**	**Daphnia retrocurva**
			673.3226		464.7944		208.5282	
			769.9481		602.8855		167.0626	
1.6628			418.1897				418.1897	
9.4903		35.8738	0.0000					
			70.1983				70.1983	
0.4146			486.9669				98.1309	388.8360

Diaphanosoma brachyurum	**Holopedium gibberum**	***Cyclopoid spp.***	***Calanoid spp.***	***total nauplii and copepodids (not included in copepoda total)***	**Calanoid female-Diaptomidae**	**Calanoid female-Epischura**	**Calanoid nauplius**
		0.1851	46.7310	21.5082	46.7310		
		0.7201	18.1845	16.8345	18.1845		7.8672
		0.3711	40.6621	25.6211	37.4864	3.1757	4.0545
		12.5535	53.4867	8.7920	53.4867		

		4.4359	0.0000	8.7920			
		1.2439	4.7506	24.5660		4.7506	12.1304

Cyclopoid nauplius	**copepodid**	**Acanthocyclops (venustoides or brevispinosus)**	**Diacyclops albus**	**Diacyclops spp.**	**(Homocyclops sp.)**	**Microcyclops (rubellus)**	**Anuraeopsis sp.**
21.5082						0.1851	
8.9673						0.7201	
21.5666						0.3711	
8.7920		4.4743		5.9612		2.1180	
8.7920			2.8474			1.5885	26.9501
12.2904	0.1452			0.7812		0.4626	

Ascomorpha saltans	**Asplanchna brightwelli**	**Asplanchna priodonta**	**Brachyonus havanaensis**	**Conochilus sp.**	**Conochiloides sp.**	**Euchlanis sp.**	**Filinia longiseta**	**Gastropus sp.**
		247.4925						4.0647
		321.0229						15.8169
							5.3565	
52.4628				473.1982	26.5009			
34.9752				7.3937		27.8695		34.8922

Kellicottia bostoniensis	**Keratella spp (sum)**	**Keratella cochlearis**	**Keratella earlinae**	**Keratella sp.**	**Lecan ungulata**	**Monstyla bulla**	***Polyarthra spp. (sum)***	**Polyarthra dolichoptera**
	83.2174	43.9060	39.3114				0.0000	
	80.9921	44.5700	36.4220				0.0000	
	89.3419	25.5219	63.8200				41.5706	18.8647
	58.2647	58.2647					107.9915	
	172.8891	76.4724	96.4167				54.7510	
	12.6894	10.8174	1.8720			0.6132	2.5160	

Polyarthra euryptera	**Polyarthra remata**	**Pompholyx sulcata**	**Polyarthra vulgaris**	**Synchaeta oblonga**	**Trichocerca cylindrica**	**Trichocerca lata**	**Trichocerca pusilla**	**unidentifiable rotifer**
					1.5886			
	22.7059	3.3611	24.4408					
	107.9915		27.8983			32.6304		
18.7538	35.9972				9.3454	97.8912		0.0000
	2.5160		2.4375			5.7018		

testate protozoa	***Cucurbitella* sp.**	**tintinnid ciliate *Codonella* sp.**	***Difflugia* sp.**
0.2425		0.2425	
0.4718		0.4718	
0.0000			
0.0000			
1.3877		1.3877	
0.5361	0.5361		

Biomass Calculations by Length

Bosminidae (Bosmina longirostrus and possibly others)	Chydorus spp.	Ceriodaphnia lacustris	*Daphnia spp.*	Daphnia ambigua	Daphnia catawba	Daphnia longiremus
2.946969697	2.713333333	3.746153846	#DIV/0!	6.35	19.9	6.6
2.3	3	6.7		7.2	19.9	6.6
3.2	2.7	2.7		7.2		
2.4	1.8	5		7.1		
2.6	2	2.8		11.4		
2	2.8	4.5		5.4		
2	3	3		5.4		
2.2	2	5.2		3.5		
3.4	3	2.7		5		
3.4	3.1	2		4.9		
3.6	3	3.1		6.4		
2.3	3.1	2				
3.7	3.2	5.2				
3.6	2.8	3.8				
3.6	3					
3.6	2.2					
3.5						
2.7						
1.3						
3						
3						
2.9						
3.2						
3						
3.2						
3.4						
3.3						
2.5						
2.8						
2.4						
3.2						
3.9						
2.1						
3.2						
2.9						
3.3						
3.4						
3.2						
3.1						
2.1						
3.1						
2.8						
3.5						
2.6						
3.2						
2.4						
2.8						
3.4						

3
2.4
3.1
2.8
3.5
2.6
3.2
2.4
2.8
3.4
3
2.4
4
3.4
2.1
3.6
2.2
3.5
2.8

Daphnia mendotae	Daphnia retrocurva	Diaphanosoma brachyurum	Holopedium gibberum		*Cyclopoid spp.*	*Calanoid spp.*
8.78122449	11.43	5.678947368	7.5	#DIV/0!	#DIV/0!	#DIV/0!
13.28	10.6	6.9	7.5			
9.1	13.6	7.6				
4.5	8.5	7.3				
5.3	12.1	3.8				
10.6	12	3.8				
5.7	12.2	4.3				
6.2	8.9	5.5				
7	13.8	6				
8.2	10.1	5.1				
7.2	12.5	7.4				
8.6		5.4				
6.4		6.3				
9		3				
7.6		5.4				
7.8		6.3				
5.8		3				
7.7		8.8				
12.4		6.5				
10.2		5.5				
9.1						
8.5						
13.2						
13.8						
11.7						
11.5						
8.3						
10.6						
7.1						
11.1						
10.5						
9.5						
12.4						
10.8						
6.2						
8.5						
7.9						
7.8						
5.2						
6						
7.2						
8.1						
9.1						
7.1						
6.5						
9.1						
12.1						
7.1						
9.5						
12.2						

total nauplii and copepodids (not included in copepoda total)	**Calanoid female-Diaptomidae**	**Calanoid female-Epischura**	**Calanoid nauplius**	**Cyclopoid nauplius**	**copepodid**	**Acanthocyclops (venustoides or brevispinosus)**
#DIV/0!	8.355454545	3.9	2.761538462	1.537755102	4.611764706	9.5
	9.51	3.9	2.8	2.05	6.2	9.5
	6.8		2.7	1.1	1.8	
	5.2		2.7	1	2.5	
	13.5		3	1.1	2.2	
	4.8		2.7	1.3	2.1	
	7.8		3	1.1	2.7	
	5.8		2.8	1.6	3.9	
	10.2		2.5	1.8	5	
	9.6		5.2	1.1	4.5	
	9.8		1.3	1.6	5.5	
	8.9		2.8	2.2	6.3	
			2	1.7	4.5	
			2.4	0.9	5.8	
				1.9	5.1	
				1.3	9.2	
				1.4	5.1	
				1.1	6	
				1.6		
				1.2		
				1.3		
				1.3		
				2		
				1.9		
				1.4		
				1.8		
				1.8		
				1.4		
				2		
				1		
				3.4		
				1.3		
				1.3		
				1		
				1.1		
				1.1		
				0.9		
				1.4		
				1.7		
				1.5		
				2.5		
				1.3		
				2		
				1.6		
				1.5		
				1.4		

2
1.5
1.8
2.1

Diacyclops albus	**Diacyclops spp.**	**(Homocyclops sp.)**	**Microcyclops (rubellus)**		**Anuraeopsis sp.**	**Ascomorpha saltans**
7.825	5.926666667	8.975	3.801333333	#DIV/0!	1	1.946666667
7.4	8.2	8.4	3.76		1	1.6
6.5	9.4	7.5	4.6			1.4
7	5.6	12	4.4			1.8
10.4	6.1	8	3			1.5
	4.2		4.2			0.8
	5.1		6.2			0.9
	4.8		3.7			1.5
	4		4.2			1
	8.2		4			1
	5.4		4.3			1.5
	5.2		2.4			12
	5.2		3.6			1
	5.1		1.6			1.2
	7.1		3.7			1
	5.3		4.4			1
			4			
			4.6			
			3			
			2.8			
			4			
			2.6			
			3.2			
			4.1			
			3.6			
			2.4			
			2.2			
			3.5			
			3.5			
			4.3			
			4			
			7.1			
			5.7			
			5.6			
			6.6			
			4.8			
			3			
			2.4			
			4.8			
			3			
			2.5			
			2.4			
			3.1			

3.6
3
3.6

Asplanchna brightwelli	**Asplanchna priodonta**	**Brachyonus havanaensis**	**Conochilus sp.**	**Conochiloides sp.**	**Euchlanis sp.**	**Filinia longiseta**
6.05	4.18	1.1	1.075	1.475	1.1	1.2
	3.23					
6.5	5.02	1.1				
5.6	3.5		1.4	2.5	1.2	1.5
6.5	6		1	1.1	1	0.9
5.6	5.1		1.1	1.3		1.1
	5		1.1	1		1.3
	1		1			
	4.4		1.3			
	4.8		0.6			
	2.8		1.1			

Gastropus sp.	Kellicottia bostoniensis	Keratella spp (sum)	Keratella cochlearis	Keratella earlinae	Keratella sp.	Lecan ungulata
1.07	0.9075	#DIV/0!	0.855625	1.161904762	#DIV/0!	1.2
0.88			0.77	0.92		
1.07			0.8	1.1		1.2
	0.9		0.8	1		
	0.8		0.7	1		
	0.8		0.9	1.2		
	1		0.8	1.2		
	1		0.7	1.3		
	0.9		0.8	1.1		
	0.7		0.8	1		
	0.8		1	1.3		
	1.1		1.1	1.2		
	0.7		0.9	1		
	0.8		0.7	1.2		
	0.8		0.8	1.1		
	0.9		0.8	1.2		
	0.7		0.8	1		
	0.9		0.7	1.3		
	1		0.8	1.3		
	1		0.8	1.2		
	0.9		0.8	1.2		
	0.9		0.8	1.2		
	0.9		0.8	1.3		
	1		1			
	0.9		1.2			
	1		1			
	0.7		0.8			
	0.8		0.8			
	1		1			
	0.9		1			
	1		0.8			
	1.1		0.8			
	1		0.7			
	1		1.18			
	0.9					
	1					
	0.7					
	0.8					
	1					
	0.9					
	1					
	1.1					
	1					

Monstyla bulla	*Polyarthra spp. (sum)*	Polyarthra dolichoptera	Polyarthra euryptera	Polyarthra remata	Pompholyx sulcata	Polyarthra vulgaris
1	#DIV/0!	1.45	1.42	1.118181818	1.085714286	1.292307692
1						
		1.3	2		2.5	
		1.6	1.2	1	0.8	1.5
			1.2	1	0.9	1.3
			1.8	1	1	1.3
			1.4	1	0.8	1.3
			1.5	1.1	1	1.8
			2	1	1	1.2
			1.1	1.2	1.2	1.1
			0.9	1.1	1	2
			1.1	1	1.1	1
				1.2	1	1.1
				1	1.1	1
				1	0.8	1.1
				1.8	1	1.1
				1		
				1		
				1		
				1.2		
				1.1		
				0.9		
				1.3		
				1.5		
				1.2		

Synchaeta oblonga	Trichocerca cylindrica	Trichocerca lata	Trichocerca pusilla	unidentifiable rotifer
1	1.425	1.366666667	0.933333333	
	0.6			
		1.5	0.9	
1	1.7	1.1	0.9	
	1.6	1.5	1	
	1.4	1.3		
	1.2	1.7		
	1.6	1.5		
	1.3	1.5		
	1.3	1.1		
	1.5	1.1		
	1.5			
	1.4			
	1.3			
	1.3			

testate amoebae	testate 1 (sphere)	testate 2 (amphora)	testate 3 (vase)
	0.607142857	0.65	0.744444444
		0.35	
	0.8	0.7	0.7
	0.7	0.7	0.8
	0.4	0.6	0.8
	0.6	0.8	0.7
	0.6	0.6	0.7
	0.5	0.7	0.8
	0.6	0.8	0.8
	0.5	0.8	0.7
	0.5	0.6	0.7
	0.7	0.6	
	0.7	0.6	
	0.6	0.6	
	0.6	0.7	
	0.7	0.6	
		0.7	
		0.7	
		0.5	
		0.8	
		0.6	
		0.5	
		0.6	
		0.6	
		0.6	
		0.6	

Biomass Calculations by Length & Width

Bosminidae (Bosmina longirostrus and possibly others)	Chydorus spp.	Ceriodaphnia lacustris	Daphnia spp.	Daphnia ambigua	Daphnia catawba	Daphnia longiremus
2.9469697	2.7133333	3.7461538		6.35	19.9	6.6

Daphnia mendotae	Daphnia retrocurva	Diaphanosoma brachyurum	Holopedium gibberum	Cyclopoid spp.	Calanoid spp.
8.7812245	11.43	5.6789474	7.5		

total nauplii and copepodids (not included in copepoda total)	Calanoid female-Diaptomidae	Calanoid female-Epischura	Calanoid nauplius	Cyclopoid nauplius	copepodid	Acanthocyclops (venustoides or brevispinosus)
	8.3554545	3.9	2.7615385	1.5377551	4.6117647	9.5

Diacyclops albus	Diacyclops spp.	(Homocyclops sp.)	Microcyclops (rubellus)	Anuraeopsis sp.	Ascomorpha saltans
7.825	5.9266667	8.975	3.8013333	1	1.9466667
				0.8	0.8

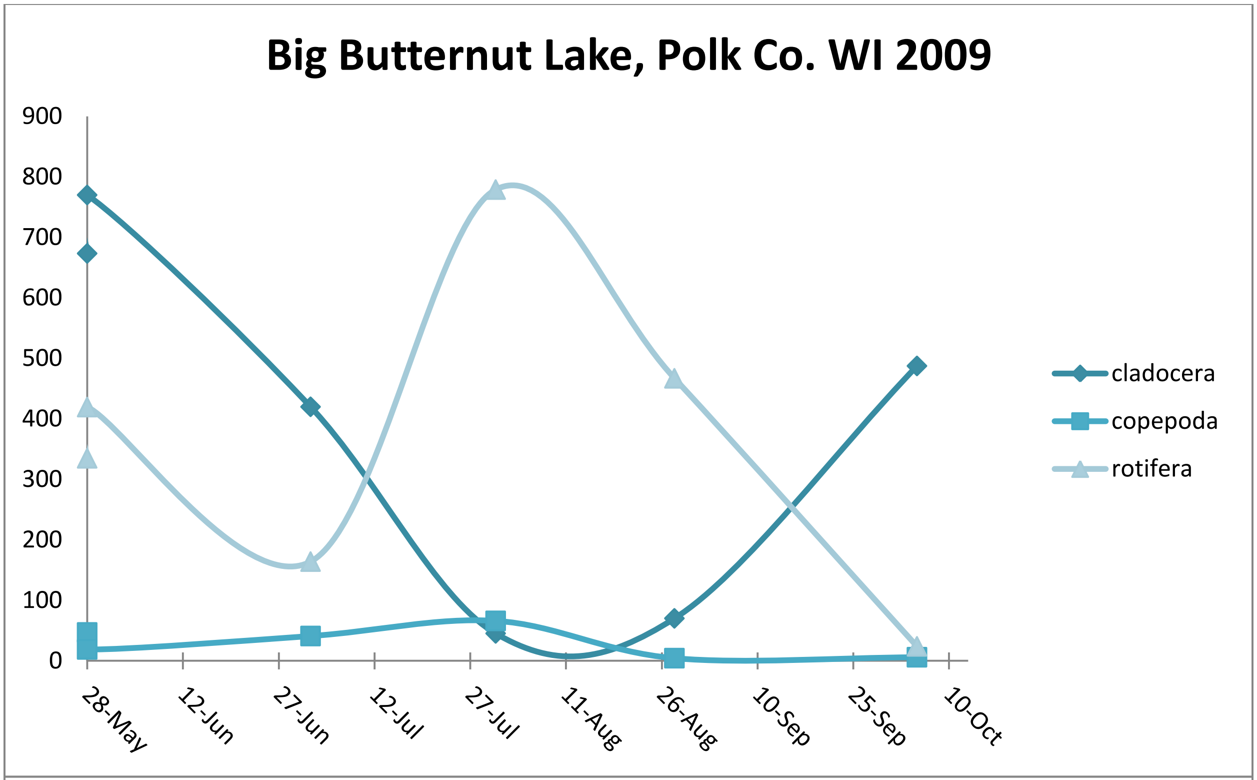
Asplanchna brightwelli	Asplanchna priodonta	Brachyonus havanaensis	Conochilus sp.	Conochiloides sp.	Euchlanis sp.	Filinia longiseta
6.05	4.18	1.1	1.075	1.475	1.1	1.2
3.2	2.8366667	0.6	0.7	0.8	0.95	0.55

Gastropus sp.	Kellicottia bostoniensis	Keratella spp (sum)	Keratella cochlearis	Keratella earlinae	Keratella sp.	Lecan ungulata
1.07	0.9075		0.855625	1.1619048		1.2
0.88	0.4475		0.5506452	0.8104762		1

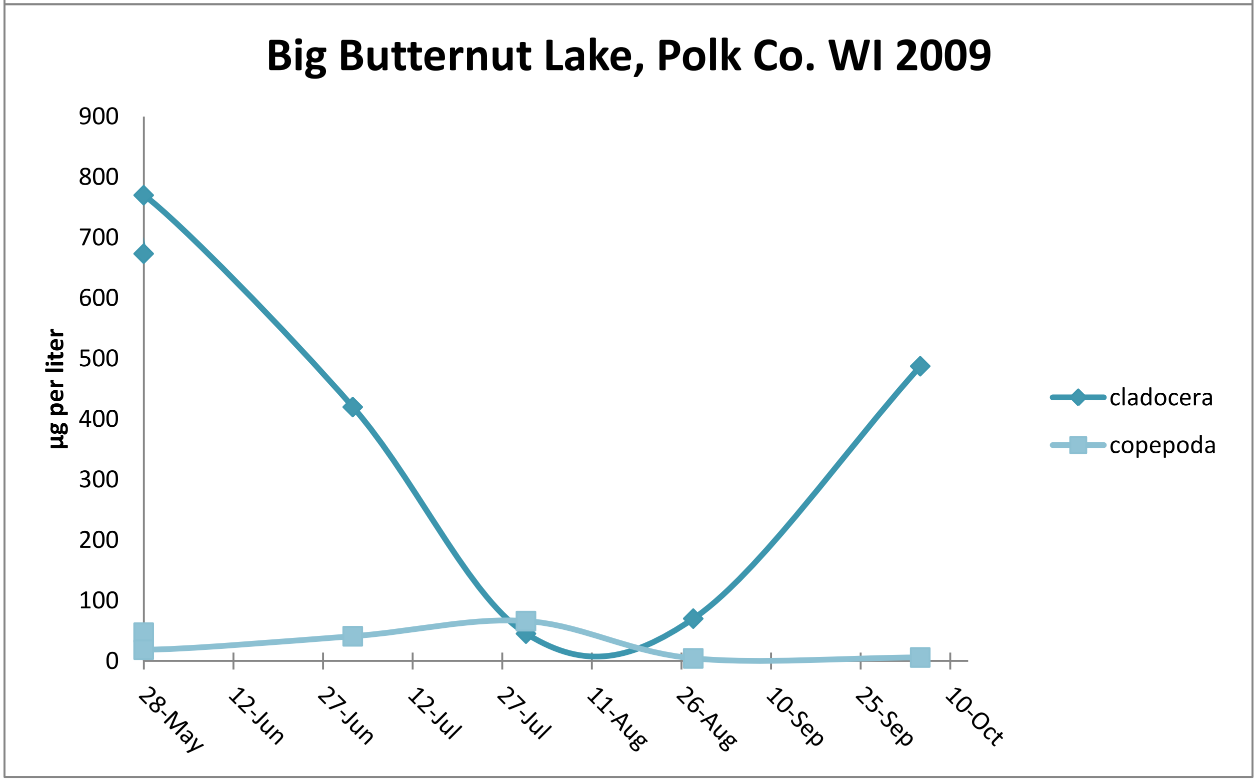
Monstyla bulla	Polyarthra spp. (sum)	Polyarthra dolichoptera	Polyarthra euryptera	Polyarthra remata	Pompholyx sulcata	Polyarthra vulgaris
1		1.45	1.42	1.1181818	1.0857143	1.2923077
0.5		1.15	0.97	0.6772727	0.7933333	0.8769231

Synchaeta oblonga	Trichocerca cylindrica	Trichocerca lata	Trichocerca pusilla	unidentifiable rotifer
1	1.425	1.3666667	0.9333333	
0.9	0.4833333	0.9222222	0.4	

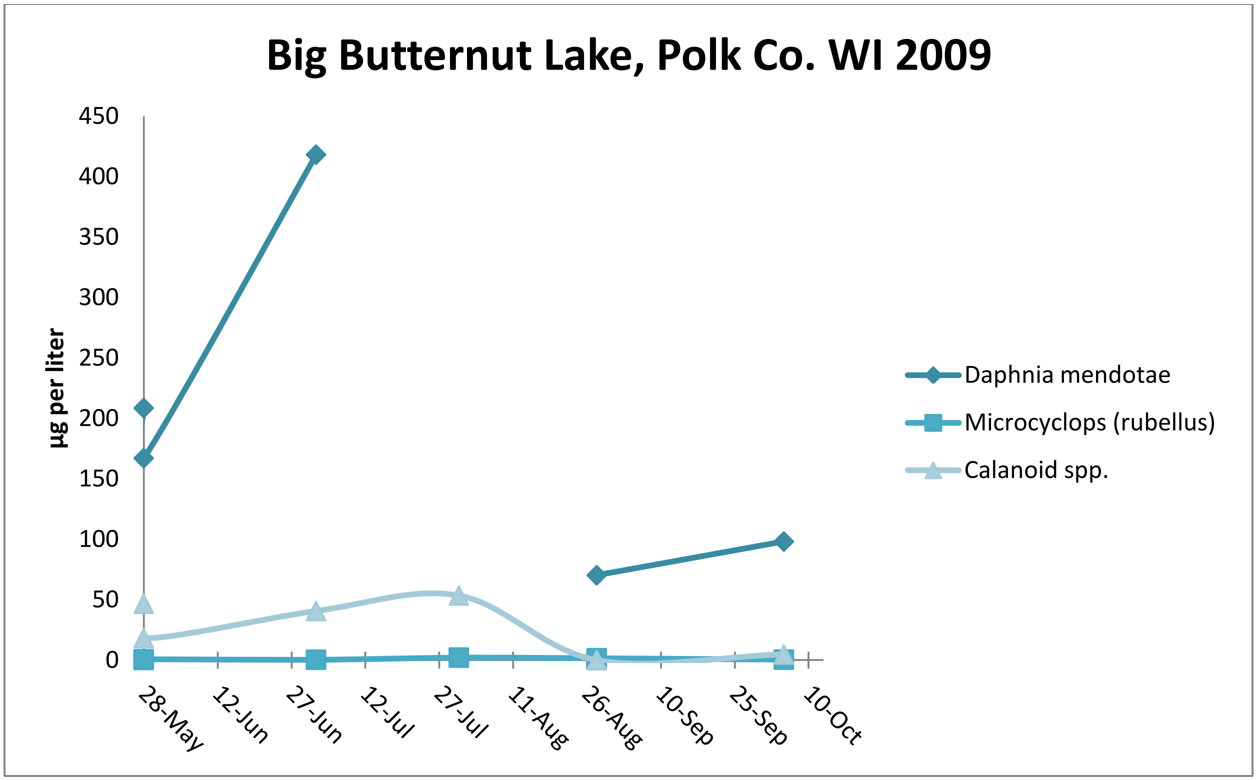
testate amoebae	testate 1 (sphere)	testate 2 (amphora)	testate 3 (vase)
	0.6071429	0.65	0.7444444
	0.6	0.39	0.6



Big Butternut Lake, Polk Co. WI 2009
900
800
700
600
500
400
300
200
100
0
28-May
12-Jun
27-Jun
12-Jul
27-Jul
11-Aug
26-Aug
10-Sep
25-Sep
10-Oct
cladocera
copepoda
rotifera



Big Butternut Lake, Polk Co. WI 2009
µg per liter
900
800
700
600
500
400
300
200
100
0
28-May
12-Jun
27-Jun
12-Jul
27-Jul
11-Aug
26-Aug
10-Sep
25-Sep
10-Oct
cladocera
copepoda



Big Butternut Lake, Polk Co. WI 2009
µg per liter
450
400
350
300
250
200
150
100
50
0
28-May
12-Jun
27-Jun
12-Jul
27-Jul
11-Aug
26-Aug
10-Sep
25-Sep
10-Oct
Daphnia mendotae
Microcyclops (rubellus)
Calanoid spp.

Big Butternut Lake Management Plan

Lake Level and Precipitation Data

Appendix G

Polk County Land and Water Resources Department
12/31/2011

Date	Lake level (feet)	Precipitation (inches)	Notes
4/21/2009	4.51	0	
4/22/2009	4.48	0	
4/23/2009	4.48	T	
4/24/2009	4.46	0	
4/25/2009	4.46	T	
4/26/2009	4.40	T	
4/27/2009	4.40	0.5	
4/28/2009	4.46	0	
4/29/2009	4.46	0	
4/30/2009	4.44	0.0625	
5/1/2009	4.40	0	
5/2/2009	4.40	0	
5/3/2009	4.39	0	
5/4/2009	4.39	0	
5/5/2009	4.39	0	
5/6/2009	4.39	0.25	
5/7/2009	4.39	T	
5/8/2009	4.39	0	
5/9/2009	4.37	0	
5/10/2009	4.36	T	
5/11/2009	4.35	0	
5/12/2009	4.35	0	
5/13/2009	4.30	T	
5/14/2009	4.30	0.25	
5/15/2009	4.30	0	
5/16/2009	4.30		
5/17/2009	4.30	0	
5/18/2009	4.30	0	
5/19/2009	4.30	0	
5/20/2009	4.29	0	
5/21/2009	4.27	T	
5/22/2009	4.25	0	
5/23/2009	4.23	0	
5/24/2009	4.20	0	
5/25/2009	4.20	0	
5/26/2009	4.17	0	
5/27/2009	4.15	0	
5/28/2009	4.10	0	
5/29/2009	4.10	T	
5/30/2009	4.08	T	
5/31/2009	4.08	T	
6/1/2009	4.06	T	
6/2/2009	4.04	0	
6/3/2009	4.00	0	
6/4/2009	4.00	0	
6/5/2009	4.00	0	
6/6/2009	3.80	0	
6/7/2009	4.00	0.1	
6/8/2009	4.00	0.25	
6/9/2009	4.00	0.25	
6/10/2009	3.90	0	
6/11/2009	3.94	0	
6/12/2009	3.94	0	
6/13/2009	3.94	0	
6/14/2009	3.94	0	

6/15/2009	3.94	0
6/16/2009	3.94	0
6/17/2009	3.94	0
6/18/2009	3.92	0
6/19/2009	3.90	0
6/20/2009	3.90	0
6/21/2009	3.90	0
6/22/2009	3.90	0
6/23/2009	3.90	0
6/24/2009	3.90	0
6/25/2009	3.90	0
6/26/2009	3.88	0
6/27/2009	3.88	0
6/28/2009	3.88	T
6/29/2009	3.87	0
6/30/2009	3.86	T
7/1/2009	3.86	T
7/2/2009	3.84	0
7/3/2009	3.82	0
7/4/2009	3.80	0
7/5/2009	3.78	0
7/6/2009	3.76	0
7/7/2009	3.76	0
7/8/2009	3.76	0
7/9/2009	3.74	0
7/10/2009	3.72	0
7/11/2009	3.70	0
7/12/2009	3.70	0
7/13/2009	3.70	0
7/14/2009	3.70	0
7/15/2009	3.70	0
7/16/2009	3.68	0
7/17/2009	3.66	0
7/18/2009	3.64	0
7/19/2009	3.64	T
7/20/2009	3.64	0
7/21/2009	3.65	0
7/22/2009	3.66	0
7/23/2009	3.66	1.25
7/24/2009	3.68	0
7/25/2009	3.70	0.25
7/26/2009	3.72	0
7/27/2009	3.74	0.75
7/28/2009	3.74	0
7/29/2009	3.74	0.1
7/30/2009	3.72	T
7/31/2009	3.70	T
8/1/2009	3.70	0
8/2/2009	3.70	0.1
8/3/2009	3.70	T
8/4/2009	3.70	0
8/5/2009	3.70	0
8/6/2009	3.70	0
8/7/2009	3.70	T
8/8/2009	3.68	T
8/9/2009	3.68	T

8/10/2009	3.66	0	
8/11/2009	3.66	0	
8/12/2009	3.64	0	
8/13/2009	3.64	0	
8/14/2009	3.69	0	
8/15/2009	3.66	T	
8/16/2009	3.68	1.25	
8/17/2009	3.68	T	
8/18/2009	3.68	0	
8/19/2009	3.70	0.25	
8/20/2009	3.76	1	
8/21/2009	3.80	1.25	
8/22/2009	3.78	0	
8/23/2009	3.78		
8/24/2009	3.76	0	
8/25/2009	3.76	0.25	
8/26/2009	3.80	0	
8/27/2009	3.80	0	
8/28/2009	3.78	0	
8/29/2009	3.78	0	
8/30/2009	3.78	0	
8/31/2009	3.76	0	
9/1/2009	3.76	0	
9/2/2009	3.76	0	
9/3/2009	3.74	0	
9/4/2009	3.74	0	
9/5/2009	3.74	0	
9/6/2009	3.74	0	green
9/7/2009	3.74	0	green
9/8/2009	3.72	0	
9/9/2009	3.72	0	
9/10/2009	3.70	0	
9/11/2009	3.70	0	
9/12/2009	3.70	0	
9/13/2009	3.68	0	
9/14/2009	3.68	0	
9/15/2009	3.66	0	
9/16/2009	3.66	0	
9/17/2009	3.66	0	
9/18/2009	3.64	0	
9/19/2009	3.64	0	
9/20/2009	3.64	0	
9/21/2009	3.62	T	
9/22/2009	3.60	0	
9/23/2009	3.60	0	
9/24/2009	3.60	0	
9/25/2009	3.60	0	
9/26/2009	3.60	0	
9/27/2009	3.60	0	
9/28/2009	3.62	1	
9/29/2009	3.62	0	
9/30/2009	3.62	0	
10/1/2009	3.64	0	
10/2/2009	3.68	1	
10/3/2009	3.90	1.5	
10/4/2009	4.00	1	

10/5/2009	4.00	0.5	
10/6/2009	4.00	0.5	
10/7/2009	4.00	0	
10/8/2009	4.00	0	
10/9/2009	4.00	1	
10/10/2009	4.00		
10/11/2009	4.00	0	
10/12/2009	4.00		snow
10/13/2009	4.00	0	
10/14/2009	3.90	T	
10/15/2009	3.90		snow/rain
10/16/2009	3.90	T	
10/17/2009	3.96		
10/18/2009	3.96		put rain gage away
10/19/2009	3.96		
10/20/2009	4.00		
10/21/2009	4.00		
10/22/2009	4.00		
10/23/2009	4.00		
10/24/2009	4.00		
10/25/2009	4.20		
10/26/2009	4.20		
10/27/2009	4.20		
10/28/2009	4.20		
10/29/2009	4.20		
10/30/2009	4.20		
10/31/2009	4.20		

Big Butternut Lake Management Plan

Property Owner Survey

Appendix H

Polk County Land and Water Resources Department
12/31/2011

Big Butternut Lake Watershed – Property Owner Survey 2009

The Big Butternut Lake Protections and Rehabilitation District, requested that the Polk County Land and Water Resources Department (LWRD) conduct a water quality and biological integrity study on Big Butternut Lake. The LWRD obtained 2 grants from the DNR for this purpose and will be sampling and surveying the watershed in 2009. We would like to have your input on the lake and invite you to participate in future activities with the P&R District. Following is a survey inquiring about demographic data of the residents, the lake's current condition, and its intended use to direct future management decisions. Please fill out this survey and return it to LWRD. The results will be compiled in the final lake report available in 2010 from LWRD. If you have questions, feel free to contact Jeremy Williamson, Water Quality Specialist at LWRD, at 485-8639 or jeremyw@co.polk.wi.us. Surveys should be returned by December 5, 2009 to

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

Thank you!

---

1. ***How many years have you owned property on or near the lake?***
   - ◇ Less than 2 years
   - ◇ 2-5 years
   - ◇ 6-10 years
   - ◇ 11-20 years
   - ◇ More than 20 years

2. ***Do you own shoreline property on Big Butternut Lake?***
   - ◇ Yes
   - ◇ No

3. ***What is the age of the primary wage earner of the household?***
   - ◇ 20-29
   - ◇ 30-39
   - ◇ 40-49
   - ◇ 50-59
   - ◇ 60-69
   - ◇ 70+

4. ***How many days in an average year is your property occupied?***
   - ◇ 0-1 month
   - ◇ 1-3 months
   - ◇ 3-6 months
   - ◇ 6-9 months
   - ◇ 9-12 months

5. ***What are the most important reasons you own property on or near Big Butternut Lake?***
(List your top three reasons in order of importance with 1st being most important.)
1st ___
2nd ___
3rd ___

A) Scenic beauty/ being near nature
B) Financial investment
C) Lake lifestyle
D) Fishing
E) Hunting
F) Non-motorized water sports (swimming, birding, canoeing)
G) Motorized water sports (PWC, boating, water skiing)
H) Farming
I) Rural lifestyle
J) Sense of Community
K) Non-motorized winter activities (skiing, snowshoeing)
L) Motorized winter activities (ATV, snowmobile)
M) Other ____________

6. ***Which best describes the landscape of your property?***
◇ Mostly agriculture
◇ Mostly mowed grass
◇ An even mix of grass and trees
◇ Mostly trees, shrubs, or meadow (wild and un-mowed)
◇ Mostly rooftops, driveways, patios, and hard surfaces

7. ***Are you aware that there is a ban on using fertilizers containing phosphorus within shoreland areas (1000 feet of a lake, 300 feet of a river or stream) in Polk County?***
◇ Yes
◇ No

8. ***On an average day that your property is occupied, how many people occupy the property?***
◇ 1-2 people
◇ 3-4 people
◇ 5-6 people
◇ 7-8 people
◇ More than 8 people

9. ***What activities on Big Butternut Lake would you like to see encouraged?***

10. ***What uses of Big Butternut Lake would you like to see limited?***

11. ***<u>How many</u> of the following watercraft are kept on your property for use on/in Big Butternut Lake?***

- ___ Jet skis
- ___ Motorboats and pontoons between 1-20 HP
- ___ Motorboats and pontoons between 21-50 HP
- ___ Motorboats and pontoons more than 50 HP
- ___ Canoes and kayaks
- ___ Paddleboats and rowboats
- ___ Other ________________

12. ***What impacts concern you most about Big Butternut Lake?***
(List your top three reasons in order of importance with 1st being most important.)

1st ___
2nd ___
3rd ___

A) **Pollution** *(chemical inputs, septic systems, agriculture, erosion, storm water runoff)*
B) **Development** *(population density, loss of wildlife habitat)*
C) **Quality of life** *(noise, property value, taxes)*
D) **Safety** *(boat traffic, no wake zones)*
E) **Water Quality**
F) **Aquatic plants** *("weeds")*
G) **Level of environmental awareness and education**
H) **Fisheries**
I) **Other** (please describe)

13. ***What do you like most about Big Butternut Lake?***

14. ***What do you like least about Big Butternut Lake?***

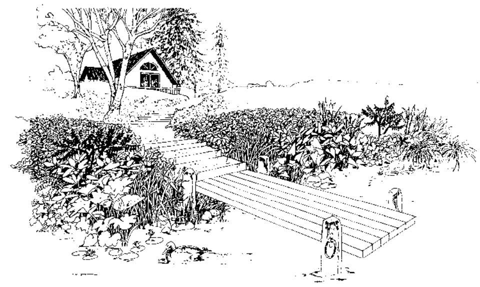
15. ***How would you describe the current water quality on Big Butternut Lake?***

- ◇ Above average
- ◇ Average
- ◇ Below average
- ◇ No opinion, unsure

16. ***Do you think you have an impact on the lake and the water quality?***

- ◇ Yes
- ◇ No

17. ***How would you describe the amount of current shoreline vegetation on Big Butternut Lake (starting at the water and going landward)?***



- ◇ Too much
- ◇ Just right
- ◇ Not enough
- ◇ No opinion, unsure

18. ***How would you describe the current amount of aquatic vegetation (plants in the water) on/in Big Butternut Lake?***

- ◇ Too much
- ◇ Just right
- ◇ Not enough
- ◇ No opinion, unsure

19. ***What management practices do you use to protect Big Butternut Lake?***

20. ***Would you be willing to provide financial support to maintain or improve the quality of Big Butternut Lake and its associated land resources?***

- ◇ Yes
- ◇ No

21. ***<u>If you answered yes to question 21</u>, how much would you be willing to contribute each year?***

- ◇ $1-10 per year
- ◇ $11-50 per year
- ◇ $51-100 per year
- ◇ $101-500 per year
- ◇ $501-1,000 per year
- ◇ $1,001- 5,000 per year
- ◇ More than $5,000 per year

22. ***What do you see as the lake association's purpose or function in respect to Big Butternut Lake?***

23. ***Please list any additional comments you have regarding Big Butternut Lake and its surrounding land resources. (Attach another sheet of paper if necessary.)***

Big Butternut Lake Management Plan

Property Owner Survey Results

Appendix I

Polk County Land and Water Resources Department
12/31/2011

Big Butternut Lake Watershed – Property Owner Survey 2009 Results

1. ***How many years have you owned property on or near the lake?***
   Less than 2 years **0 respondents, 0%**
   2-5 years **22 respondents, 24%**
   6-10 years **13 respondents, 14%**
   11-20 years **19 respondents, 21%**
   More than 20 years **36 respondents, 40%**

2. ***Do you own shoreline property on Big Butternut Lake?***
   Yes **47 respondents, 52%**
   No **44 respondents, 48%**

3. ***What is the age of the primary wage earner of the household?***
   20-29 **1 respondent, 1%**
   30-39 **2 respondents, 2%**
   40-49 **13 respondents, 14%**
   50-59 **28 respondents, 31%**
   60-69 **21 respondents, 23%**
   70+ **25 respondents, 28%**

4. ***How many days in an average year is your property occupied?***
   0-1 month **4 respondents, 4%**
   1-3 months **9 respondents, 10%**
   3-6 months **15 respondents, 16%**
   6-9 months **5 respondents, 5%**
   9-12 months **58 respondents, 64%**

5. ***What are the most important reasons you own property on or near Big Butternut Lake?*** *(List your top three reasons in order of importance with 1st being most important.)*

1st Scenic beauty/being near nature
2nd Lake lifestyle
3rd Fishing

A) Scenic beauty/ being near nature **127 points**
B) Financial investment **46 points**
C) Lake lifestyle **83 points**
D) Fishing **66 points**
E) Hunting **3 points**
F) Non-motorized water sports (swimming, birding, canoeing) **16 points**
G) Motorized water sports (PWC, boating, water skiing) **23 points**
H) Farming **5 points**
I) Rural lifestyle **39 points**
J) Sense of Community **42 points**
K) Non-motorized winter activities (skiing, snowshoeing) **1 points**
L) Motorized winter activities (ATV, snowmobile) **6 points**
M) Other **56 points**

Hometown, cheap price, close to schools, location to job, inherited from family, family time, used to partake in those activities, sense of history grandparents helped found town, own business, location, house was affordable, bought house for house, family built house, close to work, family traditions, love living close to the lake, location

6. ***Which best describes the landscape of your property?***
Mostly agriculture **2 respondents, 2%**
Mostly mowed grass **30 respondents, 33%**
An even mix of grass and trees **43 respondents, 47%**
Mostly trees, shrubs, or meadow (wild and un-mowed) **9 respondents, 10%**
Mostly rooftops, driveways, patios, and hard surfaces **7 respondents, 8%**

7. ***Are you aware that there is a ban on using fertilizers containing phosphorus within shoreland areas (1000 feet of a lake, 300 feet of a river or stream) in Polk County?***
Yes **81 respondents, 88%**
No **11 respondents, 12%**

8. ***On an average day that your property is occupied, how many people occupy the property?***
1-2 people **63 respondents, 71%**
3-4 people **17 respondents, 19%**
5-6 people **9 respondents, 10%**
7-8 people **0 respondents, 0%**
More than 8 people **0 respondents, 0%**

9. ***What activities on Big Butternut Lake would you like to see encouraged?***
4th of July Fireworks
Waterski/water sport show
No wake zone to reduce shore erosion
Continued low use
Swimming (9)
Fishing (26)
Boating (5)
Waterskiing (2)
Non-motorized boating (7)
Boat parade in early July
Buffer zones
Pay for use of landing to non-residents
Recreation (4)
Scenic beauty
Conservation (2)
New better boat launch set up (3)
Beach (2)
Birding
More shoreline preservation
More planted fish (2)
Wild life management
Limit chemicals on lawn
Clean up water/weed removal (3)

10. ***What uses of Big Butternut Lake would you like to see limited?***
Fishing tournaments (3)
Jet skis (16)
Fast, noisy craft (17)
Garbage/waste (3)
Chemicals on golf course
Land use restrictions

Education on land use
Spearing of fish (5)
Too many motors
Anything that pollutes (2)
Land development (4)
Fish houses close to shoreline
Speed of snowmobiles on ice (2)
Golf course takes lake water (2)

11. *<u>How many</u> of the following watercraft are kept on your property for use on/in Big Butternut Lake?*
7 Jet skis
19 Motorboats and pontoons between 1-20 HP
18 Motorboats and pontoons between 21-50 HP
32 Motorboats and pontoons more than 50 HP
39 Canoes and kayaks
18 Paddleboats and rowboats
14 None
2 sail boats
1 catomaran

12. *What impacts concern you most about Big Butternut Lake?* *(List your top three reasons in order of importance with 1st being most important.)*

1st Water quality
2nd Pollution
3rd Aquatic plants

A) **Pollution** *(chemical inputs, septic systems, agriculture, erosion, storm water runoff)* **137 points**
B) **Development** *(population density, loss of wildlife habitat)* **44 points**
C) **Quality of life** *(noise, property value, taxes)* **47 points**
D) **Safety** *(boat traffic, no wake zones)* **8 points**
E) **Water Quality 148 points**
F) **Aquatic plants** *("weeds")* **82 points**
G) **Level of environmental awareness and education 16 points**
H) **Fisheries 20 points**
I) **Other 9 points**
Jet skis, low water, geese

13. *What do you like most about Big Butternut Lake?*
Semi rural feel (2)
Quality of fish stock (1)
Small size, not busy (21)
Lake life style (1)
Wildlife, beauty, sunsets, serenity, sunrises (27)
Activities (fishing, boating, swimming) (19)
Location (15)
Lake access with city water and sewer (1)
Accessibility (6)
Community (2)
Neighbors (1)

14. ***What do you like least about Big Butternut Lake?***

The water front lots have been allowed to be broken down (1)
Occupancy densities increase on lake shore (3)
Water quality (12)
Green water (17)
Algae (19)
Water clarity (1)
Weeds (21)
Geese (2)
High bass population, should be no limit (1)
Noise (4)
Litterers (1)
Jet skis (1)
Lack of walleye (1)
No beach or park (2)
Size too small (1)
Lack of biking and hiking (1)
Spearing (1)
Lake itch (2)
Smell (18)

15. ***How would you describe the current water quality on Big Butternut Lake?***

Above average **4 respondents, 5%**
Average **22 respondents, 25%**
Below average **48 respondents, 55%**
No opinion, unsure **14 respondents, 16%**

16. ***Do you think you have an impact on the lake and the water quality?***

Yes **45 respondents, 52%**
No **42 respondents, 48%**

17. ***How would you describe the amount of current shoreline vegetation on Big Butternut Lake (starting at the water and going landward)?***

Too much **2 respondents, 2%**
Just right **38 respondents, 43%**
Not enough **21 respondents, 24%**
No opinion, unsure **28 respondents, 31%**

18. ***How would you describe the current amount of aquatic vegetation (plants in the water) on/in Big Butternut Lake?***

Too much **56 respondents, 62%**
Just right **13 respondents, 14%**
Not enough **1 respondent, 1%**
No opinion, unsure **21 respondents, 23%**

19. ***What management practices do you use to protect Big Butternut Lake?***

No fertilizer (32)
Careful about runoff (4)
Do not cut grass along shoreline (7)
Planting natural grassland and flowers (2)
Shoreline is in natural state (5)

Not throwing anything in lake, pick up garbage (3)
Recycle (2)
Use eco-friendly products (2)
Shoreline erosion protection (5)
Protect bulrushes (1)
City sewer (1)
None (3)
Buffer zone (1)
No wake near shore (1)
Restoring shoreline on parts of the lot (1)
Landscaping (1)
Retain runoff water on my property (1)
Clean boat of debris (8)
Catch and release (2)
Don't fuel up boat while in water (1)
I don't pollute (4)
Clean up dead leaves (1)
Clear weeds (4)
Cut and rake shoreline (1)
Use of 4 stroke motor (1)
Holding tank for septic (1)

20. *Would you be willing to provide financial support to maintain or improve the quality of Big Butternut Lake and its associated land resources?*
Yes **46 respondents, 53%**
No **36 respondents, 41%**
Depends **5 respondents, 6%**

21. *If you answered yes to question 21, how much would you be willing to contribute each year?*
$1-10 per year **7 respondents, 15%**
$11-50 per year **13 respondents, 27%**
$51-100 per year **21 respondents, 44%**
$101-500 per year **7 respondents, 15%**
$501-1,000 per year **0 respondents, 0%**
$1,001- 5,000 per year **0 respondents, 0%**
More than $5,000 per year **0 respondents, 0%**

22. *What do you see as the lake association's purpose or function in respect to Big Butternut Lake?*

Pro-active service projects and interactive conservation groups (5)
Education owners to find ways to clean up the quality of water (12)
Improve water quality (31)
Enforce regulations (3)
Get rid of geese (1)
Help control runoff and storm sewers (1)
To preserve environment, beauty and enjoyment (5)
Protect lake (8)
Don't know (2)
Represent owners on lake, views, wants, and needs (1)
Keep fish population up (1)
Monitor and manage lake (5)

Increase tourism (1)
Control noise (1)
Vegetation control (10)

23. ***Please list any additional comments you have regarding Big Butternut Lake and its surrounding land resources. (Attach another sheet of paper if necessary.)***

Strong public information campaign every spring (fertilizers and issues affecting water quality).
Hope lake will not become over built.
Fish management to restore balance of walleye vs. bass.
Happy to have a positive and active lake association.
This is a natural resource and it should be protected and managed.
Nice to have clean-up of leaves out of curb and gutters and storm drains, needs to be done more often.
Promote bulrush reeds mostly along south shore.
LWRD and P&R District should get together and produce a quarterly newsletter with information to send to land owners.
Like to see the Village take advantage of a great resource for economic development to increase tourism.
It would be nice if they did not allow back lots or multi density development with lake access. There is more than enough now.
It is not being used to its capability. Not drawing any tourism to town, make it a recreation area.
The lake is a great asset to the community, all Village residents should be concerned about doing things to preserve the lake.
Don't build new construction closer than 75 feet from shore, terrible management of new homes in past 10 years.
Beautiful area and we need to keep it that way.
It is a quiet and a good place to relax and have the grandchildren play etc.
Long time lake association, have done a great job and have improved our lake greatly from the 1970s when it was almost a sludge pool. Hope we can continue to protect the lake with natural protection.
Love the area and want to keep it beautiful.
Moving docks/lifts across street on lake to their own yard, not leaving them next to the lake.
Would like to see no more development or home construction.
Chemical run off from golf course should be closely monitored and/or eliminated. Lakeshore homeowners should not be allowed to pump water out of the lake for their lawns/yards. Additional shoreline plantings near the school should be encouraged, create a larger buffer zone.
Stop use of golf course chemicals, fine people for using fertilizer on lawns.
Organizing an annual society informational meeting for land owners.
Valuable resource for our community often taken for granted and underappreciated. Storm water runoff and future development in watershed are major concerns, as are affect on property values if lake quality is allowed to deteriorate.
Lake itch?
Public beach should be maintained better, raking.
Don’t let golf course use lake water, bring walleye back.
The only thing the DNR will allow is to try to see what flows into the lake, money is the big problem.

Big Butternut Lake Management Plan

Point Intercept Aquatic Macrophyte Survey Data

Appendix J

Polk County Land and Water Resources Department
12/31/2011

Big Butternut Polk County, 6/3/09, JW &EW

	Total vegetation	*Potamogeton crispus*,Curly-leaf pondweed	filamentous algae	Ceratophyllum demersum,Coontail	Eleocharis acicularis,needle spikerush	Elodea canadensis,Common waterweed	Heteranthera dubia,Water star-grass	Lemna trisulca,Forked duckweed	Myriophyllum sibiricum,Northern water milfoil	Najas flexilis,Bushy pondweed	Nitella sp.,Nitella	Nuphar variegata,Spatterdock	Potamogeton praelongus,White-stem pondweed	Potamogeton pusillus,Small pondweed	Potamogeton richardsonii,Clasping-leaf pondweed	Potamogeton zosteriformis,Flat-stem pondweed	Ranunculus aquatilis,Stiff water crowfoot	Sagittaria sp.	Vallisneria americana,Wild celery
Frequency of occurrence w/in vegetated areas (%)		71.91	44.94	2.25	1.12	1.12	19.10	21.35	7.87	1.12	4.49		1.12	13.48	12.36	10.11	1.12	3.37	2.25
Frequency of occurrence at sites shallower than max depth of plants		65.98	41.24	2.06	1.03	1.03	17.53	19.59	7.22	1.03	4.12		1.03	12.37	11.34	9.28	1.03	3.09	2.06
Relative Frequency (%)		32.8	20.5	1.0	0.5	0.5	8.7	9.7	3.6	0.5	2.1		0.5	6.2	5.6	4.6	0.5	1.5	1.0
Relative Frequency (squared)	0.18	0.11	0.04	0	0	0	0.01	0.01	0	0	0		0	0	0	0	0	0	0
# of sites where species found		64	40	2	1	1	17	19	7	1	4		1	12	11	9	1	3	2
Ave.Rake Fullness		2	2	1	1	1	1	1	1	1	2		1	1	1	1	1	1	1
# visual sightings		5	2				1		4			2		3	10	2		1	

Total number of points sampled	347
Total number of sites with vegetation	89
Total number of sites shallower than maximum depth of plants	97
Frequency of occurrence at sites shallower than maximum depth of plants	91.75
Simpson Diversity Index	0.82
Maximum depth of plants (ft)	11.00
Number of sites sampled using rake on Rope (R)	15
Number of sites sampled using rake on Pole (P)	84
Average number of all species per site (shallower than max depth)	2.01
Average number of all species per site (veg. sites only)	2.19
Average number of native species per site (shallower than max depth)	0.95
Average number of native species per site (veg. sites only)	2.05
Species Richness	17
Species Richness (including visuals)	18

Total # Species at Site	Total # Species - veg sites only includes exotics	Total # Species - veg sites only No exotics	Total # Species at Site (shallower than max depth) includes exotics	Total # Species at Site (shallower than max depth), no exotics	Depth with some plants	Depths within vegetated range	Sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	*Potamogeton crispus*,Curly-leaf pondweed	filamentous algae	*Ceratophyllum demersum*,Coontail	*Eleocharis acicularis*,needle spikerush	*Elodea canadensis*,Common waterweed	*Heteranthera dubia*,Water star-grass	*Lemna trisulca*,Forked duckweed	*Myriophyllum sibiricum*,Northern water milfoil	*Najas flexilis*,Bushy pondweed	*Nitella* sp.,Nitella	*Nuphar variegata*,Spatterdock	*Potamogeton praelongis*,White-stem pondweed	*Potamogeton pusillus*,Small pondweed	*Potamogeton richardsonii*,Clasping-leaf pondweed	*Potamogeton zosteriformis*,Flat-stem pondweed	*Ranunculus aquatilis*,Stiff water crowfoot	*Sagittaria* sp.	*Vallisneria americana*,Wild celery
							1	45.56871703	92.47094332	3	S	P		1	3					1	1			V		1	1	1			
							2	45.56811452	92.47091689	6	M	P		3																	
							3	45.56751202	92.47089045	10	M	P		2																	
2	2	1	2	0	5	1	4	45.56690951	92.47086402	5	M	P		2	1																
5	5	5	5	4	2	1	5	45.56692807	92.47000622	2	S	P			3		1		1	1						V				1	
2	2	2	2	1	3	1	6	45.56753058	92.47003265	3	S	P			2											V	1	V			
2	2	1	2	0	8	1	7	45.56813309	92.47005907	8	S	P		2	2																
0							8	45.56873559	92.47008549	12		R																			
0			0	0		1	9	45.5693381	92.47011192	10	M	P																			
1	1		1	0	4	1	10	45.56994061	92.47013835	4	M	P		3																	
5	5	5	5	4	3	1	11	45.57176669	92.46935976	3	S	P		V	1				1		V						1		1	1	
3	3	3	3	2	4	1	12	45.57116418	92.46933334	4	S	P		V	3				1	1	V										
1	1	1	1	0	4	1	13	45.57056167	92.46930692	4	S	P			1												V				
2	2	1	2	1	9	1	14	45.56995917	92.4692805	9	S	P		1									2								
1	1	1	1	0	10	1	15	45.56935666	92.46925408	10		R			1																
0							16	45.56875415	92.46922767	13		R																			
0							17	45.56815164	92.46920125	13			Deep																		
0							18	45.56754913	92.46917484	12		R																			
4	4	3	4	3	5	1	19	45.56694663	92.46914842	5	M	P		3						1	1							2			
0			0	0		1	20	45.56756768	92.46831703	5	S	P			V				V								V			V	
3	3	2	3	1	11	1	21	45.56817019	92.46834343	11		R		2	1								1								
0							22	45.5687727	92.46836984	14			Deep																		
0							23	45.56937521	92.46839625	15			Deep																		
0							24	45.56997772	92.46842265	15			Deep																		
0							25	45.57058023	92.46844906	15			Deep																		
0							26	45.57118273	92.46847547	15			Deep																		
0							27	45.57178524	92.46850188	14			Deep																		
0							28	45.57238775	92.46852829	13			Deep																		
1	1	1	1	1	2	1	29	45.57361131	92.46772322	2	S	P		V													1				
3	3	2	3	1	6	1	30	45.5730088	92.46769681	6			Deep	1	3				1												
0							31	45.5724063	92.46767041	14			Deep																		
0							32	45.57180379	92.46764401	16			Deep																		
0							33	45.57120128	92.46761761	15			Deep																		
0							34	45.57059877	92.46759121	17			Deep																		
0							35	45.56999626	92.46756481	18			Deep																		
0							36	45.56939375	92.46753841	17			Deep																		
0							37	45.56879124	92.46751201	17			Deep																		
0							38	45.56818874	92.46748561	16			Deep																		
0							39	45.56758623	92.46745922	14			Deep																		
3	3	2	3	2	6	1	40	45.56698372	92.46743282	6	M	P		2						1						1	V	V			
2	2	2	2	2	2	1	41	45.56700225	92.46657502	2	S	P								1						V	1				
1	1	1	1	0	7	1	42	45.56760476	92.46660141	7	M	P		V	1																

0							43	45.56820727	92.46662779	14			Deep																		
0							44	45.56880978	92.46665418	16			Deep																		
0							45	45.56941229	92.46668057	16			Deep																		
0							46	45.5700148	92.46670696	18			Deep																		
0							47	45.57061731	92.46673335	18			Deep																		
0							48	45.57121982	92.46675974	18			Deep																		
0							49	45.57182233	92.46678613	19			Deep																		
0							50	45.57242484	92.46681253	18			Deep																		
0							51	45.57302734	92.46683892	16			Deep																		
0							52	45.57362985	92.46686531	14			Deep																		
2	2	1	2	0	5	1	53	45.57423236	92.46689171	5	M	P		3	1																
2	2	1	2	0	6	1	54	45.5742509	92.4660338	6	M	P		1	1																
0							55	45.57364839	92.46600741	13			Deep																		
0							56	45.57304588	92.46598102	16			Deep																		
0							57	45.57244337	92.46595464	16			Deep																		
0							58	45.57184086	92.46592826	17			Deep																		
0							59	45.57123835	92.46590187	20			Deep																		
0							60	45.57063584	92.46587549	20			Deep																		
0							61	45.57003333	92.46584911	19			Deep																		
0							62	45.56943082	92.46582273	19			Deep																		
0							63	45.56882831	92.46579635	18			Deep																		
0							64	45.5682258	92.46576997	17			Deep																		
0							65	45.56762329	92.46574359	15			Deep																		
1	1		1	0	9	1	66	45.56702078	92.46571722	9	M	P		3																	
6	6	6	6	5	3	1	67	45.56641827	92.46569084	3	S	P			3				1	2	1					1	1				
3	3	3	3	3	2	1	68	45.5664368	92.46483305	2	S	P							1							1			1		
2	2	1	2	0	9	1	69	45.56703931	92.46485941	9	M	P		1	1																
0							70	45.56764182	92.46488578	15			Deep																		
0							71	45.56824433	92.46491215	16			Deep																		
0							72	45.56884684	92.46493852	17			Deep																		
0							73	45.56944935	92.46496489	18			Deep																		
0							74	45.57005186	92.46499126	19			Deep																		
0							75	45.57065437	92.46501763	20			Deep																		
0							76	45.57125688	92.46504401	19			Deep																		
0							77	45.57185939	92.46507038	18			Deep																		
0							78	45.5724619	92.46509675	18			Deep																		
0							79	45.5730644	92.46512313	16			Deep																		
0							80	45.57366691	92.46514951	15			Deep																		
0							81	45.57426942	92.46517588	13			Deep																		
1	1		1	0	6	1	82	45.57487193	92.46520226	6	M	P		3																	
0			0	0		1	83	45.57489045	92.46434434	4	S	P																			
0							84	45.57428794	92.46431797	14			Deep																		
0							85	45.57368544	92.4642916	16			Deep																		
0							86	45.57308293	92.46426523	17			Deep																		
0							87	45.57248042	92.46423887	17			Deep																		
0							88	45.57187791	92.4642125	18			Deep																		
0							89	45.5712754	92.46418614	20			Deep																		
0							90	45.57067289	92.46415977	20			Deep																		
0							91	45.57007038	92.46413341	20			Deep																		
0							92	45.56946787	92.46410705	19			Deep																		
0							93	45.56886536	92.46408069	18			Deep																		
0							94	45.56826285	92.46405433	18			Deep																		
0							95	45.56766033	92.46402797	16			Deep																		
0							96	45.56705782	92.46400161	14			Deep																		
0							97	45.56645531	92.46397525	13			Deep																		
2	2	2	2	1	9	1	98	45.56587131	92.46309111	9	R	P			2				1												
0							99	45.56647382	92.46311746	16			Deep																		
0							100	45.56707633	92.4631438	16			Deep																		
0							101	45.56767885	92.46317015	18			Deep																		
0							102	45.56828136	92.4631965	18			Deep																		
0							103	45.56888387	92.46322285	20			Deep																		

0							104	45.56948638	92.46324921	20			Deep																		
0							105	45.57008889	92.46327556	20			Deep																		
0							106	45.5706914	92.46330191	20			Deep																		
0							107	45.57129391	92.46332827	20			Deep																		
0							108	45.57189642	92.46335462	19			Deep																		
0							109	45.57249893	92.46338098	18			Deep																		
0							110	45.57310144	92.46340734	17			Deep																		
0							111	45.57370395	92.46343369	14			Deep																		
0							112	45.57430646	92.46346005	13			Deep																		
3	3	3	3	2	3	1	113	45.57490897	92.46348641	3	S	P			3				1	2							V				
1	1		1	0	11	1	114	45.57492748	92.46262849	11		R		1																	
0							115	45.57432497	92.46260214	17			Deep																		
0							116	45.57372246	92.46257579	17			Deep																		
0							117	45.57311995	92.46254944	17			Deep																		
0							118	45.57251744	92.46252309	19			Deep																		
0							119	45.57191493	92.46249674	20			Deep																		
0							120	45.57131242	92.4624704	21			Deep																		
0							121	45.57070991	92.46244405	21			Deep																		
0							122	45.57010739	92.46241771	20			Deep																		
0							123	45.56950488	92.46239136	19			Deep																		
0							124	45.56890237	92.46236502	18			Deep																		
0							125	45.56829986	92.46233868	18			Deep																		
0							126	45.56769735	92.46231234	17			Deep																		
0							127	45.56709484	92.462286	14			Deep																		
0							128	45.56649233	92.46225966	14			Deep																		
1	1	1	1	1	5	1	129	45.56588982	92.46223332	5	S	P		V					1		V						V				
2	2	1	2	0	10	1	130	45.56590831	92.46137553	10	M	R		1	1																
0							131	45.56651082	92.46140186	16			Deep																		
0							132	45.56711334	92.46142819	18			Deep																		
0							133	45.56771585	92.46145452	19			Deep																		
0							134	45.56831836	92.46148085	20			Deep																		
0							135	45.56892087	92.46150719	20			Deep																		
0							136	45.56952338	92.46153352	21			Deep																		
0							137	45.57012589	92.46155986	20			Deep																		
0							138	45.57072841	92.46158619	20			Deep																		
0							139	45.57133092	92.46161253	19			Deep																		
0							140	45.57193343	92.46163886	18			Deep																		
0							141	45.57253594	92.4616652	17			Deep																		
0							142	45.57313845	92.46169154	17			Deep																		
0							143	45.57374096	92.46171788	15			Deep																		
0							144	45.57434347	92.46174422	14			Deep																		
1	1		1	0	9	1	145	45.57494598	92.46177056	9	M	P		1																	
0			0	0		1	146	45.57496448	92.46091263	3	R	P																			
0							147	45.57436197	92.4608863	14			Deep																		
0							148	45.57375946	92.46085997	16			Deep																		
0							149	45.57315694	92.46083364	19			Deep																		
0							150	45.57255443	92.46080731	21			Deep																		
0							151	45.57195192	92.46078098	20			Deep																		
0							152	45.57134941	92.46075465	20			Deep																		
0							153	45.5707469	92.46072833	20			Deep																		
0							154	45.57014439	92.460702	19			Deep																		
0							155	45.56954188	92.46067568	19			Deep																		
0							156	45.56893936	92.46064935	18			Deep																		
0							157	45.56833685	92.46062303	17			Deep																		
0							158	45.56773434	92.4605967	17			Deep																		
0							159	45.56713183	92.46057038	15			Deep																		
0							160	45.56652932	92.46054406	14			Deep																		
0							161	45.5659268	92.46051774	12			Deep																		
2	2	1	2	0	8	1	162	45.56532429	92.46049142	8	M	P		2	1																
0			0	0		1	163	45.56534277	92.45963364	4	S	P															V				
2	2	1	2	0	6	1	164	45.56594529	92.45965995	6	S	P		2	2																

3	3	2	3	1	6	1	165	45.5665478	92.45968626	6	R	P		2	2								2								
0							166	45.56715031	92.45971257	17			Deep																		
0							167	45.56775282	92.45973889	20			Deep																		
0							168	45.56835534	92.4597652	19			Deep																		
0							169	45.56895785	92.45979152	19			Deep																		
0							170	45.56956036	92.45981783	19			Deep																		
0							171	45.57016287	92.45984415	19			Deep																		
0							172	45.57076539	92.45987046	18			Deep																		
0							173	45.5713679	92.45989678	18			Deep																		
0							174	45.57197041	92.4599231	17			Deep																		
0							175	45.57257292	92.45994942	16			Deep																		
0							176	45.57317543	92.45997574	15			Deep																		
0							177	45.57377794	92.46000206	14			Deep																		
0							178	45.57438046	92.46002838	13			Deep																		
1	1		1	0	8	1	179	45.57498297	92.46005471	8	M	P		3																	
3	3	3	3	3	3	1	180	45.57500145	92.45919678	3	S	P							1								1	1			
2	2	1	2	0	5	1	181	45.57439894	92.45917046	5	R	P		1	2						V										
4	4	3	4	2	5	1	182	45.57379643	92.45914415	5			Deep	1	2			1					1								
0							183	45.57319392	92.45911784	19			Deep																		
0							184	45.5725914	92.45909153	18			Deep																		
0							185	45.57198889	92.45906522	18			Deep																		
0							186	45.57138638	92.45903891	18			Deep																		
0							187	45.57078387	92.4590126	18			Deep																		
0							188	45.57018135	92.45898629	20			Deep																		
0							189	45.56957884	92.45895998	18			Deep																		
0							190	45.56897633	92.45893368	17			Deep																		
0							191	45.56837382	92.45890737	16			Deep																		
0							192	45.5677713	92.45888107	16			Deep																		
0							193	45.56716879	92.45885476	15			Deep																		
0							194	45.56656628	92.45882846	14			Deep																		
1	1		1	0	9	1	195	45.56596377	92.45880216	9	M	P		3																	
2	2	2	2	2	2	1	196	45.56598224	92.45794437	2	S	P							1								1				
3	3	2	3	1	6	1	197	45.56658475	92.45797066	6	R	P		1	1						1										
0							198	45.56718726	92.45799695	15			Deep																		
0							199	45.56778978	92.45802325	16			Deep																		
0							200	45.56839229	92.45804954	16			Deep																		
0							201	45.5689948	92.45807584	17			Deep																		
0							202	45.56959731	92.45810214	17			Deep																		
0							203	45.57019983	92.45812844	17			Deep																		
0							204	45.57080234	92.45815473	17			Deep																		
0							205	45.57140485	92.45818103	17			Deep																		
0							206	45.57200737	92.45820733	16			Deep																		
0							207	45.57260988	92.45823364	16			Deep																		
0							208	45.57321239	92.45825994	15			Deep																		
0							209	45.5738149	92.45828624	14			Deep																		
0							210	45.57441742	92.45831254	13			Deep																		
4	4	3	4	2	5	1	211	45.57501993	92.45833885	5	R	P		2	1						1					1					
1	1	1	1	1	2	1	212	45.5750384	92.45748092	2	S	P															1				
1	1	1	1	0	8	1	213	45.57443589	92.45745462	8	R	P			1																
0							214	45.57383337	92.45742833	15			Deep																		
0							215	45.57323086	92.45740204	16			Deep																		
0							216	45.57262835	92.45737574	12			Deep																		
0							217	45.57202583	92.45734945	16			Deep																		
0							218	45.57142332	92.45732316	16			Deep																		
0							219	45.57082081	92.45729687	17			Deep																		
0							220	45.5702183	92.45727058	17			Deep																		
0							221	45.56961578	92.45724429	16			Deep																		
0							222	45.56901327	92.457218	16			Deep																		
0							223	45.56841076	92.45719171	15			Deep																		
0							224	45.56780824	92.45716543	15			Deep																		
0							225	45.56720573	92.45713914	14			Deep																		

2	2	1	2	1	10	1	226	45.56660321	92.45711286	10	M	P		1												3					
1	1	1	1	1	3	1	227	45.56722419	92.45628133	3	S	P			V				1								V				
0							228	45.5678267	92.45630761	13			Deep																		
0							229	45.56842921	92.45633388	15			Deep																		
0							230	45.56903173	92.45636016	16			Deep																		
0							231	45.56963424	92.45638644	16			Deep																		
0							232	45.57023676	92.45641272	15			Deep																		
0							233	45.57083927	92.456439	16			Deep																		
0							234	45.57144178	92.45646528	16			Deep																		
0							235	45.5720443	92.45649156	16			Deep																		
0							236	45.57264681	92.45651785	16			Deep																		
0							237	45.57324932	92.45654413	15			Deep																		
0							238	45.57385184	92.45657042	15			Deep																		
0							239	45.57445435	92.4565967	14			Deep																		
0							240	45.57505686	92.45662299	13			Deep																		
6	6	5	6	4	6	1	241	45.57507532	92.45576506	6	M	P		1	2				1	1	1							1			
0							242	45.57447281	92.45573878	13		R																			
0							243	45.57387029	92.4557125	15			Deep																		
0							244	45.57326778	92.45568623	15			Deep																		
0							245	45.57266527	92.45565995	15			Deep																		
0							246	45.57206275	92.45563368	15			Deep																		
0							247	45.57146024	92.45560741	15			Deep																		
0							248	45.57085772	92.45558113	15			Deep																		
0							249	45.57025521	92.45555486	15			Deep																		
0							250	45.5696527	92.45552859	15			Deep																		
0							251	45.56905018	92.45550232	15			Deep																		
0							252	45.56844767	92.45547605	15			Deep																		
0							253	45.56784515	92.45544979	14			Deep																		
4	4	3	4	2	10	1	254	45.56724264	92.45542352	10	S	P		1	1					1						1					
2	2	1	2	1	2	1	255	45.5678636	92.45459196	2	S	P		1								1					V				
2	2	1	2	0	5	1	256	45.56846612	92.45461822	5	S	P		1	1																
0							257	45.56906863	92.45464448	13			Deep																		
0							258	45.56967114	92.45467074	15			Deep																		
0							259	45.57027366	92.454697	14			Deep																		
0							260	45.57087617	92.45472327	14			Deep																		
0							261	45.57147869	92.45474953	15			Deep																		
0							262	45.5720812	92.45477579	15			Deep																		
0							263	45.57268372	92.45480206	15			Deep																		
0							264	45.57328623	92.45482832	14			Deep																		
0							265	45.57388874	92.45485459	14			Deep																		
0							266	45.57449126	92.45488086	15			Deep																		
0							267	45.57509377	92.45490712	15			Deep																		
3	3	2	3	2	6	1	268	45.57569628	92.45493339	6	R	P		1		1										1					
3	3	2	3	1	4	1	269	45.57571473	92.45407545	4	M	P		1	2											1					
4	4	3	4	2	6	1	270	45.57511222	92.45404919	6	M	P		2	1					1						1					
0							271	45.5745097	92.45402293	13			Deep																		
0							272	45.57390719	92.45399667	13			Deep																		
0							273	45.57330467	92.45397042	14			Deep																		
0							274	45.57270216	92.45394416	14			Deep																		
0							275	45.57209964	92.4539179	13			Deep																		
0							276	45.57149713	92.45389165	14			Deep																		
0							277	45.57089461	92.4538654	15			Deep																		
0							278	45.5702921	92.45383914	16			Deep																		
0							279	45.56968959	92.45381289	14			Deep																		
0							280	45.56908707	92.45378664	14			Deep																		
4	4	3	4	2	7	1	281	45.56848456	92.45376039	7	R	P		1	2	1			1												
2	2	1	2	1	3	1	282	45.5691055	92.4529288	3	M	P		2						1											
1	1		1	0	8	1	283	45.56970802	92.45295504	8	M	P		3																	
1	1	1	1	0	11	1	284	45.57031054	92.45298128	11			Deep		1																
0							285	45.57091305	92.45300753	13			Deep																		
0							286	45.57151557	92.45303377	13			Deep																		

0							287	45.57211808	92.45306002	13			Deep																		
0							288	45.5727206	92.45308626	14			Deep																		
0							289	45.57332311	92.45311251	14			Deep																		
0							290	45.57392562	92.45313876	13			Deep																		
0							291	45.57452814	92.45316501	14			Deep																		
0							292	45.57513065	92.45319126	14			Deep																		
0							293	45.57573317	92.45321751	14			Deep																		
1	1	1	1	1	8	1	294	45.57633568	92.45324376	8	S	P																1			
1	1		1	0	4	1	295	45.57635412	92.4523858	4	M	P		3																	
1	1		1	0	8	1	296	45.5757516	92.45235956	8	M	P		3																	
1	1		1	0	10	1	297	45.57514909	92.45233332	10	M	P		1																	
0							298	45.57454657	92.45230708	16			Deep																		
0							299	45.57394406	92.45228084	15			Deep																		
0							300	45.57334154	92.4522546	14			Deep																		
0							301	45.57273903	92.45222836	13			Deep																		
0							302	45.57213651	92.45220213	14			Deep																		
0							303	45.57153399	92.45217589	14			Deep																		
0							304	45.57093148	92.45214965	15			Deep																		
0							305	45.57032896	92.45212342	15			Deep																		
0			0	0		1	306	45.56972645	92.45209719	9	S	R																			
2	2	2	2	2	4	1	307	45.5709499	92.45129178	4	S	P													1		1				
1	1		1	0	7	1	308	45.57155242	92.45131801	7	M	P		3																	
1	1		1	0	8	1	309	45.57215493	92.45134424	8	M	P		3																	
2	2	1	2	1	11	1	310	45.57275745	92.45137046	11		R		1														1			
0							311	45.57335996	92.45139669	12			Deep																		
0							312	45.57396248	92.45142292	13			Deep																		
0							313	45.574565	92.45144915	13			Deep																		
0							314	45.57516751	92.45147538	13			Deep																		
0							315	45.57577003	92.45150162	15			Deep																		
0							316	45.57637254	92.45152785	12			Deep																		
5	5	4	5	4	3	1	317	45.57639096	92.45066989	3	S	P		1					1	1						1		1			
3	3	3	3	2	5	1	318	45.57578845	92.45064367	5	S	P			3				1	1											
1	1		1	0	7	1	319	45.57518593	92.45061745	7	S	P		3																	
1	1		1	0	10	1	320	45.57458341	92.45059123	10	S	P		1																	
0							321	45.5739809	92.450565	13		R																			
0							322	45.57337838	92.45053878	14			Deep																		
0							323	45.57277587	92.45051256	14			Deep																		
0							324	45.57217335	92.45048634	14			Deep																		
0			0	0		1	325	45.57157083	92.45046013	5	S	P																			
3	3	3	3	2	5	1	326	45.57158924	92.44960224	5	S	P			2					1								1			
3	3	2	3	1	6	1	327	45.57219176	92.44962845	6	S	P		1	1					1											
1	1		1	0	9	1	328	45.57279428	92.44965466	9	M	P		3																	
0							329	45.57339679	92.44968087	12			Deep																		
0							330	45.57399931	92.44970708	13			Deep																		
0							331	45.57460183	92.4497333	12			Deep																		
1	1		1	0	11	1	332	45.57520434	92.44975951	11		R		1																	
2	2	1	2	1	3	1	333	45.57580686	92.44978572	3	S	P		1										V		1	V				
4	4	3	4	2	4	1	334	45.57522275	92.44890157	4	S	P		1	1				1	1											
1	1		1	0	7	1	335	45.57462023	92.44887537	7		P		3																	
1	1		1	0	10	1	336	45.57401772	92.44884916	10		P		2																	
0			0	0		1	337	45.5734152	92.44882296	11		R																			
1	1		1	0	11	1	338	45.57281268	92.44879676	11		R		1																	
1	1		1	0	10	1	339	45.57221017	92.44877056	10	M	P		1																	
2	2	2	2	1	6	1	340	45.57222856	92.44791267	6	S	P			2					1											
2	2	1	2	1	8	1	341	45.57283108	92.44793886	8	M	P		3						1											
1	1		1	0	9	1	342	45.5734336	92.44796505	9	M	P		3																	
2	2	1	2	0	10	1	343	45.57403611	92.44799124	10		R		2	1																
1	1		1	0	9	1	344	45.57463863	92.44801744	9	M	P		3																	
2	2	1	2	1	4	1	345	45.57405451	92.44713332	4	S	P		1													V				1
3	3	2	3	2	5	1	346	45.57345199	92.44710714	5	S	P		1												1					1
3	3	2	3	2	4	1	347	45.57284947	92.44708095	4	S	P		2							1					1					

Big Butternut Lake, 9/1/09, JW & EW

	Total vegetation	*Potamogeton crispus*, Curly-leaf pondweed	filamentous algae	Ceratophyllum demersum, Coontail	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Lemna trisulca, Forked duckweed	Myriophyllum sibiricum, Northern water milfoil	Najas flexilis, Bushy pondweed	Nuphar variegata, Spatterdock	Potamogeton praelongis, White-stem pondweed	Potamogeton pusillus, Small pondweed	Potamogeton richardsoni, Clasping-leaf pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Ranunculus aquatilis, Stiff water crowfoot	Sagittaria sp.	Vallisneria americana, Wild celery
Individual species stats:																	
Frequency of occurrence w/in vegetated areas (%)		18.64	11.86	8.47	6.78	27.12	22.03	23.73	13.56	1.69	3.39	1.69	28.81	30.51	10.17	5.08	23.73
Frequency of occurrence at sites shallower than max depth of plants		12.50	7.95	5.68	4.55	18.18	14.77	15.91	9.09	1.14	2.27	1.14	19.32	20.45	6.82	3.41	15.91
Relative Frequency (%)		7.9	5.0	3.6	2.9	11.4	9.3	10.0	5.7	0.7	1.4	0.7	12.1	12.9	4.3	2.1	10.0
Relative Frequency (squared)	0.09	0.01	0	0	0	0.01	0.01	0.01	0	0	0	0	0.01	0.02	0	0	0.01
# of sites where species found		11	7	5	4	16	13	14	8	1	2	1	17	18	6	3	14
Average Rake Fullness		1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1
#visual sightings								11		1			1				

Summary stats:	
Total number of points sampled	347
Total number of sites with vegetation	59
Total number of sites shallower than maximum depth of plants	88
Frequency of occurrence at sites shallower than maximum depth of plants	67.05
Simpson Diversity Index	0.91
Maximum depth of plants (ft)	10.00
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	83
Average number of all species per site (shallower than max depth)	1.59
Average number of all species per site (veg. sites only)	2.37
Average number of native species per site (shallower than max depth)	1.39
Average number of native species per site (veg. sites only)	2.35
Species Richness	16
Species Richness (including visuals)	16

Total Number Species at Site	Total Number Species veg sites only includes exotics	Total Number Species veg sites only No exotics	Total Number Species at Site (shallower than max depth) includes exotics	Total Number Species at Site (shallower than max depth), no exotics	Depth with some plants	Depths within vegetated range	Sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	*Potamogeton crispus*,*Curlyleaf pondweed*	filamentous algae	*Ceratophyllum demersum*,Coontail	*Elodea canadensis*,Common waterweed	*Heteranthera dubia*,*Water stargrass*	*Lemna trisulca*,Forked duckweed	*Myriophyllum sibiricum*,Northern water milfoil	*Najas flexilis*,Bushy pondweed	*Nuphar variegata*,Spatterdock	*Potamogeton praelongis*,*Whitestem pondweed*	*Potamogeton pusillus*,Small pondweed	*Potamogeton richardsonii*,*Claspingleaf pondweed*	*Potamogeton zosteriformis*,*Flatstem pondweed*	*Ranunculus aquatilis*,Stiff water crowfoot	*Sagittaria* sp.	*Vallisneria americana*,Wild celery
							1	45.56871703	92.47094332	2	M	P						1									1		
							2	45.56811452	92.47091689	8	S	P		1															
							3	45.56751202	92.47089045	10	M	P																	
							4	45.56690951	92.47086402	4	M	P		1		1				1		2					1		1
							5	45.56994061	92.47013835	2	S	P								1						1			
							6	45.5693381	92.47011192	2	S	P							1										
2	2	2	2	1	10	1	7	45.56873559	92.47008549	10	M	P			2				1										
0							8	45.56813309	92.47005907	12			Deep																
2	2	2			11		9	45.56753058	92.47003265	11			Deep												1				1
3	3	2	3	2	2	1	10	45.56692807	92.47000622	2	M	P		1		3													1
3	3	3	3	3	2	1	11	45.57176669	92.46935976	2	S	P						1										1	1
0			0	0		1	12	45.57116418	92.46933334	3	S	P								V					V				
1	1	1	1	1	3	1	13	45.57056167	92.46930692	3	S	P								V					2				
1	1	1	1	1	7	1	14	45.56995917	92.4692805	7	S	P								2									
0			0	0		1	15	45.56935666	92.46925408	10	S	P																	
0							16	45.56875415	92.46922767	13			Deep																
0							17	45.56815164	92.46920125	12			Deep																
0							18	45.56754913	92.46917484	13			Deep																
4	4	4	4	4	1	1	19	45.56694663	92.46914842	1	M	P					1	1		1		V							1
1	1	1	1	1	5	1	20	45.57238775	92.46852829	5	S	P						2											
0							21	45.57178524	92.46850188	11			Deep																
0							22	45.57118273	92.46847547	14			Deep																
0							23	45.57058023	92.46844906	15			Deep																
0							24	45.56997772	92.46842265	16			Deep																
0							25	45.56937521	92.46839625	15			Deep																
0							26	45.5687727	92.46836984	15			Deep																
0							27	45.56817019	92.46834343	14			Deep																
2	2	2			14		28	45.56756768	92.46831703	14			Deep								1						1		
1	1	1	1	1	2	1	29	45.57361131	92.46772322	2	S	P																1	
3	3	3	3	2	6	1	30	45.5730088	92.46769681	6	S	P			1				1							1			
0							31	45.5724063	92.46767041	14			Deep																
0							32	45.57180379	92.46764401	14			Deep																
0							33	45.57120128	92.46761761	17			Deep																
0							34	45.57059877	92.46759121	17			Deep																
0							35	45.56999626	92.46756481	17			Deep																
0							36	45.56939375	92.46753841	17			Deep																
0							37	45.56879124	92.46751201	16			Deep																
0							38	45.56818874	92.46748561	16			Deep																
0							39	45.56758623	92.46745922	15			Deep																
2	2	2	2	1	3	1	40	45.56698372	92.46743282	3	M	P			1					V					1				

3	3	3	3	3	1	1	41	45.57423236	92.46689171	1	S	P									1							1	1
0			0	0		1	42	45.57362985	92.46686531	7	S	P																	
0							43	45.57302734	92.46683892	14			Deep																
0							44	45.57242484	92.46681253	17			Deep																
0							45	45.57182233	92.46678613	17			Deep																
0							46	45.57121982	92.46675974	18			Deep																
0							47	45.57061731	92.46673335	18			Deep																
0							48	45.5700148	92.46670696	18			Deep																
0							49	45.56941229	92.46668057	18			Deep																
0							50	45.56880978	92.46665418	17			Deep																
0							51	45.56820727	92.46662779	16			Deep																
0							52	45.56760476	92.46660141	14			Deep																
1	1	1	1	1	6	1	53	45.56700225	92.46657502	6	R	P								3									
4	4	4	4	4	7	1	54	45.5742509	92.4660338	7	S	P							1	1					1				1
0							55	45.57364839	92.46600741	14			Deep																
0							56	45.57304588	92.46598102	16			Deep																
0							57	45.57244337	92.46595464	17			Deep																
0							58	45.57184086	92.46592826	18			Deep																
0							59	45.57123835	92.46590187	15			Deep																
0							60	45.57063584	92.46587549	19			Deep																
0							61	45.57003333	92.46584911	17			Deep																
0							62	45.56943082	92.46582273	18			Deep																
0							63	45.56882831	92.46579635	18			Deep																
0							64	45.5682258	92.46576997	17			Deep																
0							65	45.56762329	92.46574359	15			Deep																
0			0	0		1	66	45.56702078	92.46571722	10			Deep																
3	3	3	3	3	3	1	67	45.56641827	92.46569084	3	M	P				1				1							1		
7	7	7	7	6	2	1	68	45.57487193	92.46520226	2	S	P			1			2						1	1	1	1		1
0			0	0		1	69	45.57426942	92.46517588	10	R	P																	
0							70	45.57366691	92.46514951	15			Deep																
0							71	45.5730644	92.46512313	17			Deep																
0							72	45.5724619	92.46509675	18			Deep																
0							73	45.57185939	92.46507038	18			Deep																
0							74	45.57125688	92.46504401	19			Deep																
0							75	45.57065437	92.46501763	19			Deep																
0							76	45.57005186	92.46499126	19			Deep																
0							77	45.56944935	92.46496489	20			Deep																
0							78	45.56884684	92.46493852	18			Deep																
0							79	45.56824433	92.46491215	17			Deep																
0							80	45.56764182	92.46488578	16			Deep																
0							81	45.56703931	92.46485941	15			Deep																
1	1		1	0	8	1	82	45.5664368	92.46483305	8	S	P		1															
0			0	0		1	83	45.57489045	92.46434434	4	R	P																	
0							84	45.57428794	92.46431797	14			Deep																
0							85	45.57368544	92.4642916	17			Deep																
0							86	45.57308293	92.46426523	17			Deep																
0							87	45.57248042	92.46423887	19			Deep																
0							88	45.57187791	92.4642125	20			Deep																
0							89	45.5712754	92.46418614	19			Deep																
0							90	45.57067289	92.46415977	20			Deep																
0							91	45.57007038	92.46413341	19			Deep																
0							92	45.56946787	92.46410705	19			Deep																
0							93	45.56886536	92.46408069	19			Deep																
0							94	45.56826285	92.46405433	18			Deep																
0							95	45.56766033	92.46402797	17			Deep																
0							96	45.56705782	92.46400161	15			Deep																
0							97	45.56645531	92.46397525	12			Deep																
0			0	0		1	98	45.57490897	92.46348641	4	S	P																	
0							99	45.57430646	92.46346005	16			Deep																
0							100	45.57370395	92.46343369	17			Deep																
0							101	45.57310144	92.46340734	17			Deep																

0							102	45.57249893	92.46338098	19			Deep																
0							103	45.57189642	92.46335462	19			Deep																
0							104	45.57129391	92.46332827	20			Deep																
0							105	45.5706914	92.46330191	20			Deep																
0							106	45.57008889	92.46327556	20			Deep																
0							107	45.56948638	92.46324921	19			Deep																
0							108	45.56888387	92.46322285	19			Deep																
0							109	45.56828136	92.4631965	18			Deep																
0							110	45.56767885	92.46317015	19			Deep																
0							111	45.56707633	92.4631438	16			Deep																
0							112	45.56647382	92.46311746	13			Deep																
4	4	4	4	4	3	1	113	45.56587131	92.46309111	3			Deep						1	V					1	1			1
0							114	45.57492748	92.46262849	11			Deep							V									
0							115	45.57432497	92.46260214	16			Deep																
0							116	45.57372246	92.46257579	17			Deep																
0							117	45.57311995	92.46254944	17			Deep																
0							118	45.57251744	92.46252309	19			Deep																
0							119	45.57191493	92.46249674	20			Deep																
0							120	45.57131242	92.4624704	21			Deep																
0							121	45.57070991	92.46244405	20			Deep																
0							122	45.57010739	92.46241771	20			Deep																
0							123	45.56950488	92.46239136	20			Deep																
0							124	45.56890237	92.46236502	19			Deep																
0							125	45.56829986	92.46233868	18			Deep																
0							126	45.56769735	92.46231234	17			Deep																
0							127	45.56709484	92.462286	16			Deep																
0							128	45.56649233	92.46225966	14			Deep																
0			0	0		1	129	45.56588982	92.46223332	4	R	P																	
0			0	0		1	130	45.57494598	92.46177056	10	S	P																	
0							131	45.57434347	92.46174422	16			Deep																
0							132	45.57374096	92.46171788	17			Deep																
0							133	45.57313845	92.46169154	19			Deep																
0							134	45.57253594	92.4616652	19			Deep																
0							135	45.57193343	92.46163886	19			Deep																
0							136	45.57133092	92.46161253	20			Deep																
0							137	45.57072841	92.46158619	19			Deep																
0							138	45.57012589	92.46155986	20			Deep																
0							139	45.56952338	92.46153352	19			Deep																
0							140	45.56892087	92.46150719	19			Deep																
0							141	45.56831836	92.46148085	18			Deep																
0							142	45.56771585	92.46145452	17			Deep																
0							143	45.56711334	92.46142819	16			Deep																
0							144	45.56651082	92.46140186	14			Deep																
0			0	0		1	145	45.56590831	92.46137553	10			Myr si near shore																
1	1	1	1	1	3	1	146	45.57496448	92.46091263	3	R	P						2											
0							147	45.57436197	92.4608863	14			Deep																
0							148	45.57375946	92.46085997	17			Deep																
0							149	45.57315694	92.46083364	19			Deep																
0							150	45.57255443	92.46080731	20			Deep																
0							151	45.57195192	92.46078098	20			Deep																
0							152	45.57134941	92.46075465	20			Deep																
0							153	45.5707469	92.46072833	20			Deep																
0							154	45.57014439	92.460702	20			Deep																
0							155	45.56954188	92.46067568	19			Deep																
0							156	45.56893936	92.46064935	19			Deep																
0							157	45.56833685	92.46062303	18			Deep																
0							158	45.56773434	92.4605967	17			Deep																
0							159	45.56713183	92.46057038	17			Deep																
0							160	45.56652932	92.46054406	15			Deep																
0							161	45.5659268	92.46051774	13			Deep																

1	1	1	1	1	6	1	162	45.56532429	92.46049142	6	M	P									1								
2	2	2	2	2	3	1	163	45.57498297	92.46005471	3	S	P									1						1		
2	2	1	2	1	7	1	164	45.57438046	92.46002838	7	S	P		1						1									
0			0	0		1	165	45.57377794	92.46000206	7	S	P																	
0							166	45.57317543	92.45997574	14			Deep																
0							167	45.57257292	92.45994942	19			Deep																
0							168	45.57197041	92.4599231	19			Deep																
0							169	45.5713679	92.45989678	19			Deep																
0							170	45.57076539	92.45987046	20			Deep																
0							171	45.57016287	92.45984415	19			Deep																
0							172	45.56956036	92.45981783	20			Deep																
0							173	45.56895785	92.45979152	19			Deep																
0							174	45.56835534	92.4597652	17			Deep																
0							175	45.56775282	92.45973889	18			Deep																
0							176	45.56715031	92.45971257	16			Deep																
0							177	45.5665478	92.45968626	14			Deep																
0							178	45.56594529	92.45965995	13			Deep																
1	1		1	0	9	1	179	45.56534277	92.45963364	9	M	P		1															
0			0	0		1	180	45.57500145	92.45919678	2	S	P																	
0			0	0		1	181	45.57439894	92.45917046	3	R	P																	
1	1	1	1	1	3	1	182	45.57379643	92.45914415	3	M	P					1												
0							183	45.57319392	92.45911784	19			Deep																
0							184	45.5725914	92.45909153	18			Deep																
0							185	45.57198889	92.45906522	18			Deep																
0							186	45.57138638	92.45903891	18			Deep																
0							187	45.57078387	92.4590126	19			Deep																
0							188	45.57018135	92.45898629	20			Deep																
0							189	45.56957884	92.45895998	18			Deep																
0							190	45.56897633	92.45893368	18			Deep																
0							191	45.56837382	92.45890737	17			Deep																
0							192	45.5677713	92.45888107	16			Deep																
1	1	1			15		193	45.56716879	92.45885476	15			Deep												1				
1	1	1			14		194	45.56656628	92.45882846	14			Deep							3									
2	2	2	2	2	9	1	195	45.56596377	92.45880216	9	M	P	Myr si near shore												1				1
3	3	3	3	3	2	1	196	45.57501993	92.45833885	2	S	P						1		V					2				1
0			0	0		1	197	45.57441742	92.45831254	5	R	P								V									
0							198	45.5738149	92.45828624	13			Deep																
0							199	45.57321239	92.45825994	17			Deep																
0							200	45.57260988	92.45823364	14			Deep																
0							201	45.57200737	92.45820733	17			Deep																
0							202	45.57140485	92.45818103	17			Deep																
0							203	45.57080234	92.45815473	18			Deep																
0							204	45.57019983	92.45812844	18			Deep																
0							205	45.56959731	92.45810214	18			Deep																
0							206	45.5689948	92.45807584	17			Deep																
0							207	45.56839229	92.45804954	16			Deep																
0							208	45.56778978	92.45802325	15			Deep																
0							209	45.56718726	92.45799695	14			Deep																
0							210	45.56658475	92.45797066	13			Deep																
4	4	3	4	2	5	1	211	45.56598224	92.45794437	5	S	P		1	1			2		V					1				
1	1	1	1	1	3	1	212	45.5750384	92.45748092	3	M	P						1											
0							213	45.57443589	92.45745462	12			Deep																
0							214	45.57383337	92.45742833	16			Deep																
0							215	45.57323086	92.45740204	15			Deep																
0							216	45.57262835	92.45737574	12			Deep																
0							217	45.57202583	92.45734945	16			Deep																
0							218	45.57142332	92.45732316	17			Deep																
0							219	45.57082081	92.45729687	17			Deep																
0							220	45.5702183	92.45727058	18			Deep																
0							221	45.56961578	92.45724429	17			Deep																

0							222	45.56901327	92.457218	16			Deep																
0							223	45.56841076	92.45719171	16			Deep																
0							224	45.56780824	92.45716543	15			Deep																
0							225	45.56720573	92.45713914	14			Deep																
3	3	3	3	3	10	1	226	45.56660321	92.45711286	10	M	P								2					1				2
2	2	2	2	2	2	1	227	45.57505686	92.45662299	2	S	P									1				1				
0							228	45.57445435	92.4565967	11			Deep																
0							229	45.57385184	92.45657042	13			Deep																
0							230	45.57324932	92.45654413	17			Deep																
0							231	45.57264681	92.45651785	16			Deep																
0							232	45.5720443	92.45649156	16			Deep																
0							233	45.57144178	92.45646528	16			Deep																
0							234	45.57083927	92.456439	17			Deep																
0							235	45.57023676	92.45641272	17			Deep																
0							236	45.56963424	92.45638644	16			Deep																
0							237	45.56903173	92.45636016	16			Deep																
0							238	45.56842921	92.45633388	16			Deep																
0							239	45.5678267	92.45630761	14			Deep																
0							240	45.56722419	92.45628133	14			Deep																
2	2	2	2	2	6	1	241	45.57507532	92.45576506	6	S	P					1									1			
0							242	45.57447281	92.45573878	12			Deep																
0							243	45.57387029	92.4557125	14			Deep																
0							244	45.57326778	92.45568623	15			Deep																
0							245	45.57266527	92.45565995	15			Deep																
0							246	45.57206275	92.45563368	15			Deep																
0							247	45.57146024	92.45560741	16			Deep																
0							248	45.57085772	92.45558113	16			Deep																
0							249	45.57025521	92.45555486	15			Deep																
0							250	45.5696527	92.45552859	16			Deep																
0							251	45.56905018	92.45550232	15			Deep																
0							252	45.56844767	92.45547605	15			Deep																
0							253	45.56784515	92.45544979	14			Deep																
2	2	2	2	1	8	1	254	45.56724264	92.45542352	8	M	P			1					V						2			
3	3	3	3	3	2	1	255	45.57569628	92.45493339	2	S	P						1							2				1
0			0	0		1	256	45.57509377	92.45490712	5	R	P																	
0							257	45.57449126	92.45488086	14			Deep																
0							258	45.57388874	92.45485459	14			Deep																
0							259	45.57328623	92.45482832	15			Deep																
0							260	45.57268372	92.45480206	16			Deep																
0							261	45.5720812	92.45477579	16			Deep																
0							262	45.57147869	92.45474953	17			Deep																
0							263	45.57087617	92.45472327	15			Deep																
0							264	45.57027366	92.454697	16			Deep																
0							265	45.56967114	92.45467074	15			Deep																
0							266	45.56906863	92.45464448	15			Deep																
1	1	1	1	0	8	1	267	45.56846612	92.45461822	8	R	P			1					V									
2	2	2	2	2	4	1	268	45.5678636	92.45459196	4	S	P									1				1				
2	2	2	2	2	3	1	269	45.57571473	92.45407545	3	S	P						1		3									
1	1	1	1	1	6	1	270	45.57511222	92.45404919	6	M	P							1										
0							271	45.5745097	92.45402293	13			Deep																
0							272	45.57390719	92.45399667	14			Deep																
0							273	45.57330467	92.45397042	14			Deep																
0							274	45.57270216	92.45394416	14			Deep																
0							275	45.57209964	92.4539179	15			Deep																
0							276	45.57149713	92.45389165	15			Deep																
0							277	45.57089461	92.4538654	16			Deep																
0							278	45.5702921	92.45383914	17			Deep																
0							279	45.56968959	92.45381289	14			Deep																
1	1	1			14		280	45.56908707	92.45378664	14			Deep													1			
3	3	3	3	3	3	1	281	45.56848456	92.45376039	3	M	P				1	2									2			
2	2	1	2	1	4	1	282	45.57633568	92.45324376	4	M	P		1					1										

0			0	0		1	283	45.57573317	92.45321751	9	M	P																	
0							284	45.57513065	92.45319126	11			Deep															
0							285	45.57452814	92.45316501	12			Deep															
0							286	45.57392562	92.45313876	13			Deep															
0							287	45.57332311	92.45311251	13			Deep															
0							288	45.5727206	92.45308626	14			Deep															
0							289	45.57211808	92.45306002	15			Deep															
0							290	45.57151557	92.45303377	14			Deep															
0							291	45.57091305	92.45300753	16			Deep															
0							292	45.57031054	92.45298128	15			Deep															
0							293	45.56970802	92.45295504	13			Deep															
3	3	3	3	3	6	1	294	45.5691055	92.4529288	6	R	P						1			1					1			
0			0	0		1	295	45.57635412	92.4523858	4	M	P																	
1	1		1	0	8	1	296	45.5757516	92.45235956	8	M	P		1															
0							297	45.57514909	92.45233332	11			Deep															
0							298	45.57454657	92.45230708	12			Deep															
0							299	45.57394406	92.45228084	12			Deep															
0							300	45.57334154	92.4522546	15			Deep															
0							301	45.57273903	92.45222836	13			Deep															
0							302	45.57213651	92.45220213	14			Deep															
0							303	45.57153399	92.45217589	14			Deep															
0							304	45.57093148	92.45214965	14			Deep															
0							305	45.57032896	92.45212342	15			Deep															
1	1	1	1	1	8	1	306	45.56972645	92.45209719	8	R	P														2			
2	2	2	2	2	1	1	307	45.57637254	92.45152785	1	M	P													3	1			
0			0	0		1	308	45.57577003	92.45150162	6	M	P																	
0			0	0		1	309	45.57516751	92.45147538	9	M	P																	
0							310	45.574565	92.45144915	11			Deep															
0							311	45.57396248	92.45142292	12			Deep															
0							312	45.57335996	92.45139669	14			Deep															
0							313	45.57275745	92.45137046	12			Deep															
0							314	45.57215493	92.45134424	13			Deep															
0							315	45.57155242	92.45131801	15			Deep															
0							316	45.5709499	92.45129178	14			Deep															
2	2	2	2	2	3	1	317	45.57639096	92.45066989	3	S	P						1	1									
1	1	1	1	1	5	1	318	45.57578845	92.45064367	5	S	P							1									
1	1		1	0	7	1	319	45.57518593	92.45061745	7	M	P		1															
0			0	0		1	320	45.57458341	92.45059123	9	M	P																	
0							321	45.5739809	92.450565	13			Deep															
0							322	45.57337838	92.45053878	14			Deep															
2	2	2			13		323	45.57277587	92.45051256	13			Deep							1					2			
0							324	45.57217335	92.45048634	13			Deep															
3	3	3	3	3	7	1	325	45.57157083	92.45046013	7	R	P								1			1			1			
1	1	1	1	1	4	1	326	45.57580686	92.44978572	4	S	P														1			
1	1	1	1	1	5	1	327	45.57520434	92.44975951	5	S	P							1	V									
1	1	1	1	1	8	1	328	45.57460183	92.4497333	8	S	P											1					
0							329	45.57399931	92.44970708	11			Deep															
0							330	45.57339679	92.44968087	13			Deep															
0							331	45.57279428	92.44965466	12			Deep															
0			0	0		1	332	45.57219176	92.44962845	10			Deep															
3	3	3	3	3	2	1	333	45.57158924	92.44960224	2	S	P						1			3				1				
1	1	1	1	1	2	1	334	45.57522275	92.44890157	2	R	P						2										
0			0	0		1	335	45.57462023	92.44887537	6	S	P																	
0			0	0		1	336	45.57401772	92.44884916	10			Deep															
0							337	45.5734152	92.44882296	11			Deep															
0							338	45.57281268	92.44879676	12			Deep															
0							339	45.57221017	92.44877056	12			Deep															
2	2	2	2	2	5	1	340	45.57463863	92.44801744	5	S	P							1						1			
3	3	3	3	3	7	1	341	45.57403611	92.44799124	7	S	P				1			1						1			
0			0	0		1	342	45.5734336	92.44796505	9	M	P																	
0			0	0		1	343	45.57283108	92.44793886	9	M	P																	

0			0	0		1	344	45.57222856	92.44791267	9	M	P																	
3	3	3	3	3	1	1	345	45.57405451	92.44713332	1	S	P						1		1						1			
2	2	2	2	2	4	1	346	45.57345199	92.44710714	4	S	P							1							3			
3	3	2	3	2	6	1	347	45.57284947	92.44708095	6	S	P		1											1				1

Big Butternut Lake Management Plan

Floristic Quality Index (FQI) Data

Appendix K

Polk County Land and Water Resources Department
12/31/2011

Big Butternut Lake				
		Year	2009	
		County	Polk	
Species	Common Name	C	species present=1	
Acorus calamus	Sweet Flag	7		0
Alisma triviale	Water plantains	4		0
Bolboschoenus fluviatilis	River Bulrush	5		0
Brasenia schreberi	Watershield	7		0
Calla palustris	Wild Calla	9		0
Callitriche hermaphroditica	Autumnal water starwort	9		0
Callitriche heterophylla	Large water starwort	9		0
Callitriche palustris	Common water starwort	8		0
Carex comosa	Bottle brush sedge	5		0
Catabrosa aquatica	Brook grass	10		0
Ceratophyllum demersum	Coontail	3	1	3
Ceratophyllum echinatum	Spiny coontail	10		0
Chara	Muskgrasses	7		0
Dulichium arundinaceum	Three-way sedge	9		0
Elatine minima	Waterwort	9		0
Elatine triandra	Matted waterwort	9		0
Eleocharis acicularis	Needle spikerush	5	1	5
Eleocharis erythropoda	Bald spike-rush	3		0
Eleocharis palustris	Creeping spikerush	6		0
Elodea canadensis	Common waterweed	3	1	3
Elodea nuttallii	Slender waterweed	7		0
Equisetum fluviatile	Water horsetail	7		0
Eriocaulon aquaticum	Pipewort	9		0
Glyceria borealis	Northern manna grass	8		0
Gratiola aurea	Dwarf hyssop	10		0
Isoetes echinospora	Spiny-spored quillwort	8		0
Isoetes lacustris	Large quillwort	8		0
Juncus palocarpus f. submersus	Brown-fruited rush	8		0
Juncus torreyi	Torrey's rush	4		0
Lemna minor	Small duckweed	5		0
Lemna perpusilla	Least duckweed	10		0
Lemna trisulca	Forked Duckweed	6	1	6
Littorella americana	Littorella	10		0
Lobelia dortmanna	Water lobelia	10		0
Ludwigia palustris	marsh purslane	4		0
Megalodonta beckii	Water marigold	8		0
Myriophyllum alterniflorum	Alternate-flowered water-milfoil	10		0
Myriophyllum farwellii	Farwell's water-milfoil	9		0
Myriophyllum heterophyllum	Various-leaved water-milfoil	7		0
Myriophyllum sibericum	Northern water-milfoil	7	1	7

Myriophyllum tenellum	Dwarf water-milfoil	10		0
Myriophyllum verticillatum	Whorled water-milfoil	8		0
Najas flexilis	Bushy pondweed	6	1	6
Najas gracillima	Slender water-nymph	7		0
Najas guadalupensis	Southern water-nymph	7		0
Nelumbo lutea	American lotus-lily	8		0
Nitella	Nitella	7	1	7
Nuphar advena	Yellow pond lily	8		0
Nuphar microphylla	Small pond lily	9		0
Nuphar x rubrodisca	Intermediate pond lily	9		0
Nuphar variegata	Spatterdock	6	1	6
Nymphaea odorata	White water lily	6		0
Phragmites australis	Common reed	1		0
Polygonum amphibium	Water smartweed	5		0
Polygonum punctatum	Dotted smartweed	5		0
Pontederia cordata	Pickerelweed	9		0
Potamogeton alpinus	Alpine pondweed	9		0
Potamogeton amplifolius	Large-leaf pondweed	7		0
Potamogeton confervoides	Algal-leaved pondweed	10		0
Potamogeton diversifolius	Common snail-seed pondweed	8		0
Potamogeton epihydrus	Ribbon-leaf pondweed	8		0
Potamogeton foliosus	Leafy pondweed	6		0
Potamogeton friesii	Frie's pondweed	8		0
Potamogeton gramineus	Variable pondweed	7		0
Potamogeton hillii	Hill's pondweed	9		0
Potamogeton illinoensis	Illinois pondweed	6		0
Potamogeton natans	Floating-leaf	5		0
Potamogeton nodosus	Long-leaf pondweed	7		0
Potamogeton oakesianus	Oake's pondweed	10		0
Potamogeton obtusifolius	Blunt-leaf pondweed	9		0
Potamogeton praelongis	White-stem pondweed	8	1	8
Potamogeton pulcher	Spotted pondweed	10		0
Potamogeton pusillus	Small pondweed	7	1	7
Potamogeton richardsonii	Clasping-leaf pondweed	5	1	5
Potamogeton robbinsii	Robbins pondweed	8		8
Potamogeton spirillus	Spiral-fruited pondweed	8		0
Potamogeton strictifolius	Stiff pondweed	8		0
Potamogeton vaseyi	Vasey's pondweed	10		0
Potamogeton zosteriformis	Flat-stem pondweed	6	1	6
Ranunculus aquatilis	Stiff water crowfoot	7	1	7
Ranunculus flabellaris	Yellow water buttercup	8		0
Ranunculus flammula	Creeping spearwort	9		0
Riccia fluitans	Slender riccia	7		0
Ruppia maritima	Ditch grass	8		0
Sagittaria brevirostrata	Arum-leaved arrowhead	9		0
Sagittaria cuneata	Midwestern arrowhead	7		0
Sagittaria graminea	Grass-leaved	9		0

Sagittaria latifolia	Common arrowhead	3	1	3
Sagittaria rigida	Stiff arrowhead	8		0
Schoenoplectus acutus	Hardstem bulrush	5		0
Schoenoplectus heterochaetus	Slender bulrush	10		0
Schoenoplectus pungens	3-square	5		0
Schoenoplectus subterminalis	Water bulrush	9		0
Schoenoplectus tabernaemontani	Softstem bulrush	4		0
Sparganium americanum	American bur-reed	8		0
Sparganium androcladum	Branched bur-reed	8		0
Sparganium angustifolium	Narrow-leaved bur-reed	9		0
Sparganium emersum	Short-stemmed bur-reed	8		0
Sparganium eurycarpum	Common bur-reed	5		0
Sparganium fluctuans	Floating-leaf-bur-reed	10		0
Spirodela polyrhiza	Large Duckweed	5		0
Stuckenia filiformis	Thread-leaf pondweed	8		0
Stuckenia pectinata	Sogo pondweed	3		0
Stuckenia vaginata	Sheathed pondweed	9		0
Typha angustifolium	Narrow-leaved cattail	1		0
Typha latifolia	Broad-leaved cattail	1		0
Utricularia cornuta	Horned bladderwort	10		0
Utricularia geminiscapa	Twin-stemmed bladderwort	9		0
Utricularia gibba	Creeping bladderwort	9		0
Utricularia intermedia	Flat-leaf bladderwort	9		0
Utricularia minor	Small bladderwort	10		0
Utricularia purpurea	Large purple bladderwort	9		0
Utricularia resupinata	Small purple bladderwort	9		0
Utricularia vulgaris	Common bladderwort	7		0
Vallisneria americana	Wild celery	6	1	6
Wolffia columbiana	Common watermeal	5		0
Wolffia punctata	Northern water-meal	6		0
Zannichellia palustris	Common water-meal	7		0
Zizania aquatica	Zizania aquatica	8		0
Zizania palustris	Northern wild rice	8		0
Zosterella dubia	Water star-grass	6	1	6
N			16	
mean C				6.1875
FQI				24.75

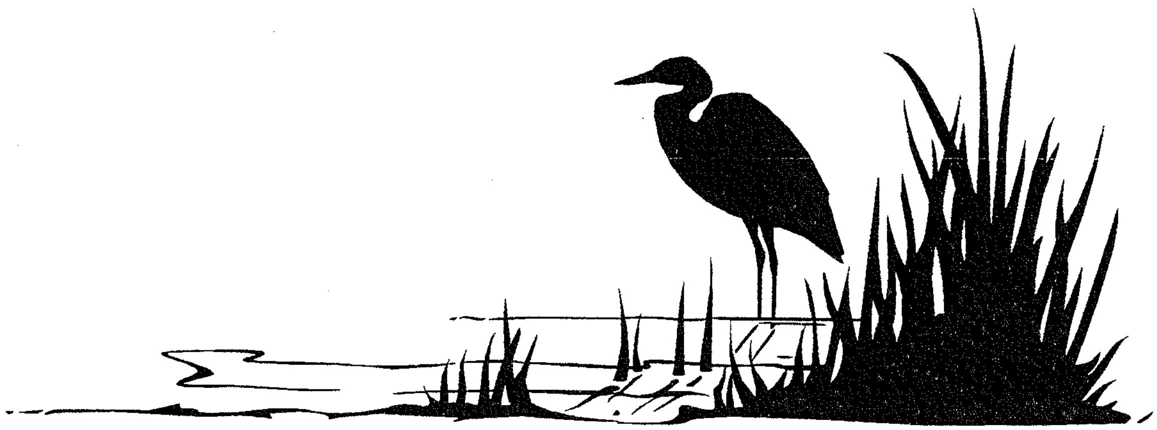
Big Butternut Lake Management Plan

Big Butternut Lake Sensitive Area Survey Report and Management Guidelines

Appendix L

Wisconsin Department of Natural Resources
1/1/2000

BIG BUTTERNUT LAKE
SENSITIVE AREA SURVEY REPORT
AND MANAGEMENT GUIDELINES



**This document is to be used
with its companion document
"Guidelines for protecting, maintaining,
and understanding lake sensitive areas"**

Big Butternut Lake (Polk Co)
Integrated Sensitive Area Survey Report

Date of Survey: 17 August 2000 Number of Sensitive Areas: 8

Site Evaluators: Rick Cornelius, Fisheries Biologist
Kevin Morgan, Wildlife Biologist
Kurt Roblek, Water Resources Biologist
Gary Lund, Fisheries Technician

Lake Sensitive Area Survey results identified eight areas that merit special protection of the aquatic habitat. Overall Big Butternut Lake has very few developed shoreline areas which have proper vegetative buffers.

The reader should consider that any buffer that does not extend back from the waters edge at least 35' is not providing adequate protection for water quality and should be expanded to at least 35'. Local zoning ordinances and lakes classification systems have tried to provide better guidelines pertaining to buffer widths and set backs based on lake type. Landowners are encouraged to go beyond the minimum requirements laid out by zoning and consider extending buffer widths to beyond 35' and integrating other innovative ways to capture and reduce the runoff flowing off from their property while improving critical shoreline habitat. Berms and low head retention areas can greatly increase the effective capture rate from developed portions in addition to that portion captured within the buffer.

Site conditions may dictate that a buffer has to be much wider than 35' to be effective at capturing the sediments and nutrients running off the developed portions of the shoreline. If the shoreline is steeply sloped (>7%slope) greater widths should definitely be used.

No mowing should take place within the buffer area (with the exception of a narrow access trail and small picnic area), and trees and shrubs should not be cut down even when they become old and die; because they provide important woody debris habitat within the buffer zone as well as aquatic habitat when they fall into the lake.

It should be noted that **Purple Loosestrife** was documented in Sensitive area "**B**". Purple loosestrife is an exotic plant with capable means of spreading when not controlled. These plants should be removed immediately before they are allowed to spread to others parts of the lake. The population is very small in this area, therefore allowing hand pulling to be the best means of removal. An alternative to hand pulling is to cut the flower head and spray the remaining stalk with an approved herbicide. A permit is necessary for any type of herbicide treatment near surface water.

The following is a brief summary of the Big Butternut sensitive area sites and the management guidelines. Also, the "Guidelines for Protecting, Maintaining, and Understanding Sensitive Areas" provides management guidelines and considerations for different lake sensitive areas (Attached).

I. Aquatic Plant Sensitive Areas

The following sensitive areas contain aquatic plant communities, which provide important fish and wildlife habitat as well as important shoreline stabilization functional values. Sensitive areas F and H are not considered aquatic plant sensitive areas, but are prime spawning habitat for walleyes. Sensitive area D is considered wild shoreline, providing enough important habitat for the Big Butternut Lake ecosystem that conservation easements, deed restrictions, or zoning should be used to protect it. Management guidelines for aquatic plant sensitive areas are (unless otherwise specifically stated):

1. Limit aquatic vegetation removal to navigational channels no greater than 25 feet wide where necessary, the narrower the better. These channels should be kept as short in length as possible and it is recommended that people do not completely eliminate aquatic vegetation within the navigation channel; but instead only remove what is necessary to prevent fouling of propellers to provide access to open water areas. Chemical treatments should be discouraged and if a navigational channel must be cleared, pulling by hand is preferable over mechanical harvesters where practical.
2. Prohibit littoral zone alterations covered by Wisconsin Statutes Chapter 30, unless there is clear evidence that such alterations

would benefit the lake's ecosystem. Rock rip-rap permits should not be approved for areas that already have a healthy native plant community stabilizing the shoreline and property owners should not view rip-rap as an acceptable alternative in these situations.

3. Leave large woody debris, logs, trees, and stumps, in the littoral zone to provide habitat for fish, wildlife, and other aquatic organisms.
4. Leave an adequate shoreline buffer of un-mowed natural vegetative cover and keep access corridors as narrow as possible (preferable less than 30 feet or 30% of any developed lot which ever is less).
5. Prevent erosion, especially at construction sites. Support the development of effective county erosion control ordinances. The proper use of Best Management Practices (BMP's) will greatly reduce the potential of foreign materials entering the waterway (i.e. silt, nutrients).
6. Strictly enforce zoning ordinances and support development of new zoning regulations where needed.
7. Eliminate nutrient inputs to the lake caused by lawn fertilizers, failing septic systems, and other sources.
8. Control exotic species such as purple loosestrife, marked with an *.

Resource Value of Site A

Sensitive area A is located at the Southwestern end of Big Butternut Lake and covers approximately 1,600 feet of shoreline extending out as far as 150' to 200' in shallower shoreline areas. This area encompasses the boat launch and the headwaters of Butternut Creek. Submersed aquatic plants dominate most of the length with little or no upland buffer due to the impacts of the launching facilities.

This area provides important habitat for centrarchid (bass and panfish) spawning and nursery for young. Esocid (northern pike) spawning and nursery areas are located in Butternut Creek and the adjacent lake portions of this sensitive area. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians benefit from this valuable habitat.

The emergent, floating and submergent plant community structure of Sensitive area A includes: **Emergents;** common bur-reed (*Sparganium eurycarpum*). **Floating leafed**; yellow pond lily (*Nuphar advena*). **Submergents;** coontail (*Ceratophyllum demersum*), northern milfoil (*Myriophyllum sibiricum*), elodea and *curly leaf pondweed (*Potamogeton crispus*).

Chemical treatments and mechanical removal efforts should be located only for the boat ramp and the outlet channel of Butternut Creek. All other chemical treatments or mechanical removal should be strongly discouraged.

Resource Value of Site B

Sensitive area B is located at the Southwestern end of Big Butternut Lake and covers approximately 400 feet of shoreline extending out to 100 feet. Most of this length is dominated by a shallow or open water wetland, which have helped protect it from the negative impacts that can be associated with improperly developed shorelines.

This area provides important habitat for centrarchid (bass and panfish) spawning and nursery areas. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians also benefit from this valuable habitat.

The emergent, floating and submergent plant community structure of Sensitive area B includes: **Emergents;** **purple loosestrife* (*Lythrum salicaria*). **Floating leafed**; yellow pond lily (*Nuphar advena*). **Submergents;** narrow leaf pondweed (*Potamogeton zosteriformis*), eelgrass (*Vallisneria americana*) and *curly leaf pondweed (*Potamogeton crispus*).

No chemical treatments should be allowed in this area and all mechanical removal efforts should be strongly discouraged. Purple Loosestrife was noted as occurring on the shoreline of this sensitive area and should be removed before it is allowed to spread. Because the population of purple loosestrife is very small in this area, hand pulling should be the most effective means of eradication.

Resource Value of Site C

Sensitive area C is located at the Northeastern end of Big Butternut Lake and covers approximately 500 feet of shoreline extending out 150 feet. Most of this length is dominated by a deep marsh and shallow or open water wetland, which have helped protect it from the negative impacts that can be associated with improperly developed shorelines.

This area provides important habitat for centrarchid (bass and panfish) and esocid (northern pike) spawning and nursery areas. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians also benefit from this valuable habitat.

Sensitive area C has a diverse community structure of emergent and submergent aquatic plants including: **Emergents**; arrowhead (*Sagittaria sp.*) **Floating leafed**; yellow pond lily (*Nuphar advena*) **Submergents**; elodea, *curly leaf pondweed (*Potamogeton crispus*), narrow leaf pondweed (*P. zosteriformis*), eel grass (*Vallisneria americana*) and northern milfoil (*Myriophyllum sibiricum*).

Chemical treatments and mechanical removal efforts should only be allowed for navigation channels in this area. All other removal efforts should be strongly discouraged.

Resource Value of Site D

Sensitive area D is located at the Northeastern end of Big Butternut Lake and covers approximately 700 feet of shoreline extending out 200 to 350 feet. This area encompasses the mouth of the feeder stream entering Big Butternut Lake. Most of this length is dominated by a deep marsh and shallow or open water wetland. This shoreline is still considered "wild", with little or no development and high scenic beauty.

This area provides important habitat for centrarchid (bass and panfish) and esocid (northern pike) spawning and nursery areas. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians also benefit from this valuable habitat.

The emergent, floating and submergent plant community structure of Sensitive area D includes: **Emergents;** soft stem bulrush (*Scirpus validus*), common bur-reed (*Sparganium eurycarpum*) and speckled alder (*Alnus sp.*). **Floating leafed**; yellow pond lily (*Nuphar advena*). **Submergents;** elodea, coontail (*Ceratophyllum demersum*), northern milfoil *(Myriophyllum sibiricum*), sago pondweed (*Potamogeton pectinatus*), *curly leaf pondweed (*P. crispus*) and narrow leaf pondweed (*P. zosteriformis*).

No chemical treatments should be allowed in this area and all mechanical removal efforts should be strongly discouraged. Keeping this area in its natural state will aid in filtering out nutrients and silt entering from the feeder stream.

Resource Value of Site E

Sensitive area E is located at the Northeastern end of Big Butternut Lake and covers approximately 350 feet of shoreline extending out to 150 feet. Most of this length is dominated by a shallow and deep marsh wetland, which have helped protect it from the negative impacts that can be associated with improperly developed shorelines.

This area provides important habitat for centrarchid (bass and panfish) and esocid (northern pike) spawning and nursery areas. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians also benefit from this valuable habitat.

The emergent, floating and submergent plant community structure of Sensitive area E includes: **Emergents;** soft stem bulrush (*Scirpus validus*) and **reed canary grass* (*Phalaris arudinacea*). **Submergents;** narrow leaf pondweed (*Potamogeton zosteriformis*) and coontail (*Ceratophyllum demersum*).

Resource Value of Site F

Sensitive area F is located at the Eastern end of Big Butternut Lake and covers approximately 700 feet of shoreline extending out to 200 feet. This area is considered high quality walleye spawning habitat. Consisting of rock and cobble substrate will little or no fine sediment.

No dredging, structures or deposits should occur in this area to retain the high quality spawning habitat characteristics.

Resource Value of Site G

Sensitive area G is located on the Eastern shore of Big Butternut Lake and covers approximately 600 feet of shoreline extending out 200 feet. This area encompasses the mouth of the feeder stream entering Big Butternut Lake on the eastern shore. Most of this length is dominated by a deep marsh and shallow or open water wetland, which have helped protect it from the negative impacts that can be associated with improperly developed shorelines.

This area provides important habitat for centrarchid (bass and panfish). Esocid (northern pike) spawning and nursery areas are located in this area extending into the feeder stream. This area also provides important habitat for forage species. Wildlife are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians also benefit from this valuable habitat.

The emergent, floating and submergent plant community structure of Sensitive area D includes: **Emergents;** arrowhead (*Sagittarius sp.*), common bur-reed (*Sparganium eurycarpum*) and speckled alder (*Alnus sp.*).

Floating leafed; yellow pond lily (*Nuphar advena*). **Submergents;** elodea, coontail (*Ceratophyllum demersum*), *curly leaf pondweed (*Potamogeton crispus*), northern milfoil (*Myriophyllum sibiricum*), sago pondweed (*P. pectinatus*), narrow leaf pondweed (*P. zosteriformis*), slender naiad (*Najas flexilis*) and eelgrass (*Vallisneria americana*).

No chemical treatments should be allowed in this area and all mechanical removal efforts should be strongly discouraged.

Resource Value of Site H

Sensitive area H is located at the Eastern end of Big Butternut Lake and covers approximately 4,000 feet of shoreline extending out 100 to 150 feet. This area is considered high quality walleye spawning habitat. Consisting of rock and cobble substrate will little or no fine sediment.

No dredging, structures or deposits should occur in this area to retain the high quality spawning habitat characteristics.

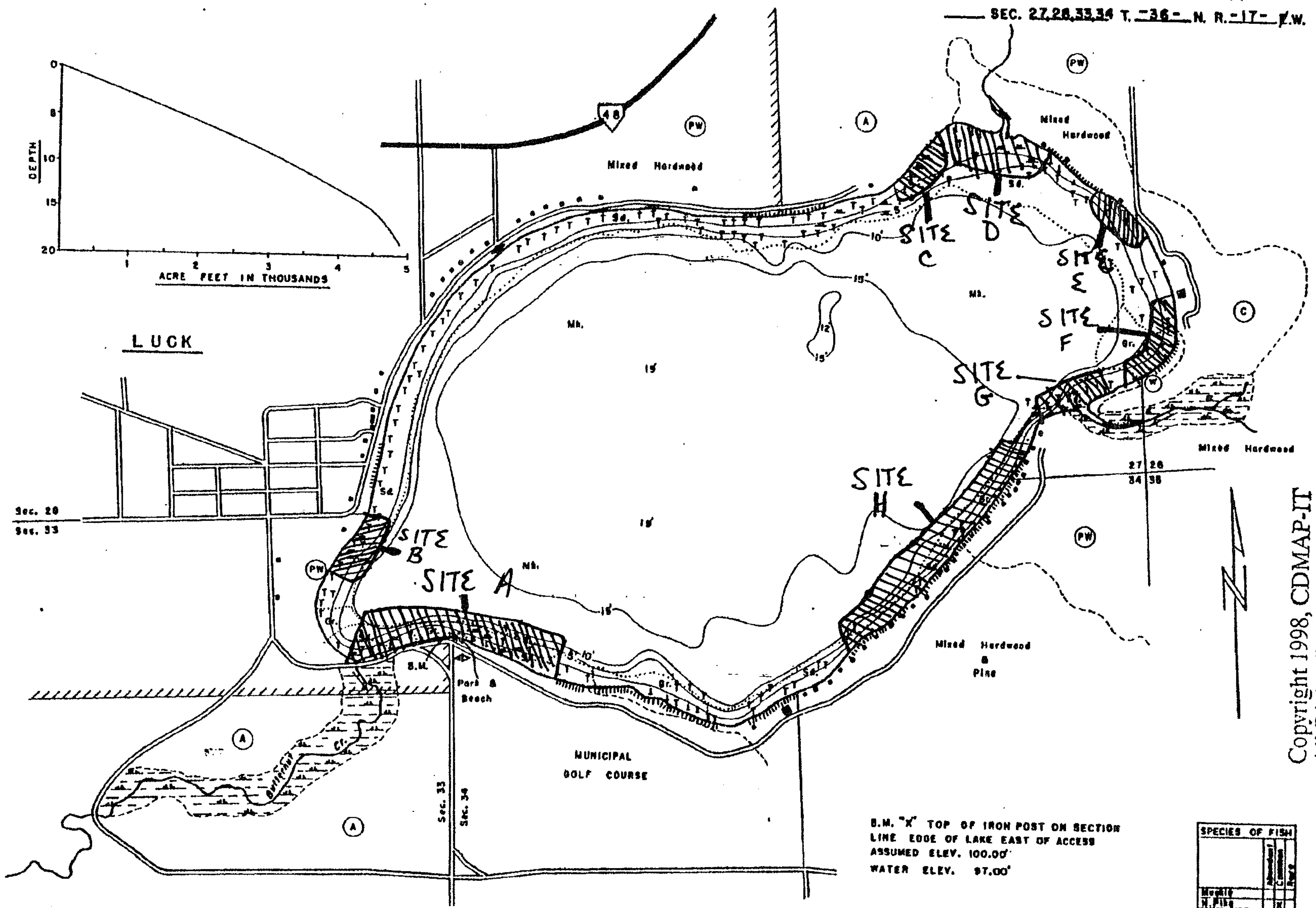
378A

WISCONSIN CONSERVATION DEPARTMENT

LAKE SURVEY MAP

BIG BUTTERNUT LAKE — POLK COUNTY

SEC. 27,28,33,34 T. -36- N. R. -17- W.



B.M. "X" TOP OF IRON POST ON SECTION LINE EDGE OF LAKE EAST OF ACCESS
ASSUMED ELEV. 100.00'
WATER ELEV. 97.00'

SPECIES OF FISH	Abundant	Common	Present
Muskie			
N. Pike		X	
Walleye			
L.M. Bass	X		
S.M. Bass			
Panfish	X		
Trout			

EQUIPMENT RECORDING SONAR MAPPED JULY (MO.) 1965 (YR.)

WATER ELEV. 97.00'

TOPOGRAPHIC SYMBOLS
- (B) Brush
- (PW) Partially wooded
- (W) Wooded
- (C) Cleared
- (P) Pastured
- (A) Agricultural
- B.M. Bench Mark
- Dwelling
- Resort
- Steep slope
- Indefinite shoreline
- Marsh
- Spring
- Intermittent stream
- Permanent inlet
- Permanent outlet
- Dam

LAKE BOTTOM SYMBOLS
- P. Peat
- Mk. Muck
- C. Clay
- M. Marl
- Sd. Sand
- St. Silt
- Gr. Gravel
- R. Rubble
- Br. Bedrock
- T Submergent vegetation
- Emergent vegetation
- Floating vegetation

SCALE: 500' 0' 500' 1,000' 1,500' 2,000' 2,500'

Access — Access with Parking — Boat Livery

Field work by: G.Miller, M.Perkins, L.Sather Drawn by: E.Eston

AREA 378 ACRES
UNDER 3FT. 9 %
OVER 20FT. 0 %
VOLUME 4,676.5 ACRE FT.
TOTAL ALK. 83 P.P.M.
SHORELINE 3.4 MILES
MAX. DEPTH 19 FEET

Big Butternut Lake Management Plan

Watershed Modeling Data

Appendix M

Polk County Land and Water Resources Department
12/31/2011

Date: 11/1/2010   Scenario: 8
Lake Id: Subshed1
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 312.5 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 208.3 acre-ft
Lake Surface Area <As>: 0.0 acre
Lake Volume <V>: 0.0 acre-ft
Lake Mean Depth <z>: 0.00 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 208.3 acre-ft/year
Areal Water Load <qs>: 0.00 ft/year
Lake Flushing Rate <p>: 0.00 1/year
Water Residence Time: 0.00 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 0.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	42.262	0.50	1.00	3.00	20.3	9	17	51
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	94.771	1.00	1.50	2.00	68.3	38	58	77
MD Urban (1/4 Ac)	17.917	0.30	0.50	0.80	4.3	2	4	6
Rural Res (>1 Ac)	5.801	0.05	0.10	0.25	0.3	0	0	1
Wetlands	55.518	0.10	0.10	0.10	2.7	2	2	2
Forest	96.230	0.05	0.09	0.18	4.2	2	4	7
Lake Surface	0.0	0.10	0.30	1.00	0.0	0	0	0

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	117.7	185.7	316.7	100.0
Total Loading (kg)	53.4	84.2	143.7	100.0
Areal Loading (lb/ac-year)	162.22	256.09	437.14	0.0
Areal Loading (mg/m^2-year)	18182.88	28704.52	48997.75	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	117.7	185.7	316.7	100.0
Total NPS Loading (kg)	53.4	84.2	143.7	100.0

Date: 11/1/2010   Scenario: 9
Lake Id: Subshed2
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 163.6 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 109.1 acre-ft
Lake Surface Area <As>: 1.796 acre
Lake Volume <V>: 0.0 acre-ft
Lake Mean Depth <z>: 0.0 ft
Precipitation - Evaporation: 3.3 in.

Hydraulic Loading: 109.6 acre-ft/year
Areal Water Load <qs>: 61.0 ft/year
Lake Flushing Rate <p>: 0.00 1/year
Water Residence Time: 0.00 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 0.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	39.125	0.50	1.00	3.00	32.8	8	16	48
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	48.480	1.00	1.50	2.00	60.9	20	29	39
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	19.461	0.05	0.10	0.25	1.6	0	1	2
Wetlands	1.797	0.10	0.10	0.10	0.2	0	0	0
Forest	54.741	0.05	0.09	0.18	4.1	1	2	4
Lake Surface	1.8	0.10	0.30	1.00	0.5	0	0	1

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	64.3	106.6	206.1	100.0
Total Loading (kg)	29.2	48.3	93.5	100.0
Areal Loading (lb/ac-year)	35.82	59.33	114.77	0.0
Areal Loading (mg/m^2-year)	4015.28	6650.36	12864.00	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	64.2	106.1	204.5	100.0
Total NPS Loading (kg)	29.1	48.1	92.8	100.0

Date: 11/1/2010   Scenario: 11
Lake Id: Subshed3
Watershed Id: 0

Hydrologic and Morphometric Data
Tributary Drainage Area: 1098.1 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 732.1 acre-ft
Lake Surface Area <As>: .328 acre
Lake Volume <V>: 0.0 acre-ft
Lake Mean Depth <z>: 0.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 732.2 acre-ft/year
Areal Water Load <qs>: 2232.2 ft/year
Lake Flushing Rate <p>: 0.00 1/year
Water Residence Time: 0.00 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 0.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	207.700	0.50	1.00	3.00	71.1	42	84	252
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	1.751	1.00	1.50	2.00	0.9	1	1	1
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	31.721	0.05	0.10	0.25	1.1	1	1	3
Wetlands	132.130	0.10	0.10	0.10	4.5	5	5	5
Forest	724.760	0.05	0.09	0.18	22.3	15	26	53
Lake Surface	0.3	0.10	0.30	1.00	0.0	0	0	0

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	139.8	260.6	694.6	100.0
Total Loading (kg)	63.4	118.2	315.1	100.0
Areal Loading (lb/ac-year)	426.16	794.38	2117.70	0.0
Areal Loading (mg/m^2-year)	47767.20	89039.26	237365.14	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	139.8	260.5	694.3	100.0
Total NPS Loading (kg)	63.4	118.1	314.9	100.0

Date: 11/1/2010 Scenario: 12

Lake Id: Subshed4

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 1557.9 acre

Total Unit Runoff: 8 in.

Annual Runoff Volume: 1038.6 acre-ft

Lake Surface Area <As>: 4.016 acre

Lake Volume <V>: 0.0 acre-ft

Lake Mean Depth <z>: 0.0 ft

Precipitation - Evaporation: 3.3 in.

Hydraulic Loading: 1039.7 acre-ft/year

Areal Water Load <qs>: 258.9 ft/year

Lake Flushing Rate <p>: 0.00 1/year

Water Residence Time: 0.00 year

Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3

Observed growing season mean phosphorus (GSM): 0.0 mg/m^3

% NPS Change: 0%

% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	14.277	0.50	1.00	3.00	9.6	3	6	17
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	15.938	1.00	1.50	2.00	16.1	6	10	13
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	10.830	0.05	0.10	0.25	0.7	0	0	1
Wetlands	351.145	0.10	0.10	0.10	23.6	14	14	14
Forest	814.568	0.05	0.09	0.18	49.2	16	30	59
Othe Water	351.145				0.0	0	0	0

Lake Surface	4.0	0.10	0.30	1.00	0.8	0	0	2

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	89.1	132.8	234.8	100.0
Total Loading (kg)	40.4	60.3	106.5	100.0
Areal Loading (lb/ac-year)	22.19	33.08	58.47	0.0
Areal Loading (mg/m^2-year)	2486.70	3707.74	6553.20	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	88.7	131.8	231.2	100.0
Total NPS Loading (kg)	40.3	59.8	104.9	100.0

Date: 11/1/2010 Scenario: 13
Lake Id: Subshed5
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 243.2 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 162.1 acre-ft
Lake Surface Area <As>: 3.588 acre
Lake Volume <V>: 0.0 acre-ft
Lake Mean Depth <z>: 0.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 163.1 acre-ft/year
Areal Water Load <qs>: 45.5 ft/year
Lake Flushing Rate <p>: 0.00 1/year
Water Residence Time: 0.00 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 0.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	28.447	1.00	1.50	2.00	67.2	12	17	23
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	80.327	0.10	0.10	0.10	12.6	3	3	3
Forest	130.386	0.05	0.09	0.18	18.5	3	5	9
Othe Water	4.013				0.0	0	0	0
Lake Surface	3.6	0.10	0.30	1.00	1.7	0	0	1

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %

Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	38.7	56.7	82.1	100.0
Total Loading (kg)	17.5	25.7	37.2	100.0
Areal Loading (lb/ac-year)	10.78	15.79	22.87	0.0
Areal Loading (mg/m^2-year)	1208.45	1770.25	2563.75	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	38.4	55.7	78.9	100.0
Total NPS Loading (kg)	17.4	25.3	35.8	100.0

Date: 11/1/2010 Scenario: 14

Lake Id: Subshed6

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 18.1 acre
Total Unit Runoff: 8 in.
Annual Runoff Volume: 12.1 acre-ft
Lake Surface Area <As>: 2.780 acre
Lake Volume <V>: 0.0 acre-ft
Lake Mean Depth <z>: 0.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 12.8 acre-ft/year
Areal Water Load <qs>: 4.6 ft/year
Lake Flushing Rate <p>: 0.00 1/year
Water Residence Time: 0.00 year
Observed spring overturn total phosphorus (SPO): 0.0 mg/m^3
Observed growing season mean phosphorus (GSM): 0.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	0.0	0.50	1.00	3.00	0.0	0	0	0
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	18.137	1.00	1.50	2.00	97.0	7	11	15
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	0.0	0.05	0.10	0.25	0.0	0	0	0
Wetlands	0.0	0.10	0.10	0.10	0.0	0	0	0
Forest	0.0	0.05	0.09	0.18	0.0	0	0	0
Othe Water	0.0				0.0	0	0	0
Lake Surface	2.8	0.10	0.30	1.00	3.0	0	0	1

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
Site 4	0.0	0.0	0.0	0.0	0.0
Site 5	0.0	0.0	0.0	0.0	0.0

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	16.4	25.0	34.8	100.0
Total Loading (kg)	7.5	11.3	15.8	100.0
Areal Loading (lb/ac-year)	5.91	9.00	12.53	0.0

Areal Loading (mg/m^2-year)	662.43	1008.65	1404.87	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	16.2	24.3	32.4	100.0
Total NPS Loading (kg)	7.3	11.0	14.7	100.0

Date: 1/6/2010 Scenario: Big Butternut Land Use

Lake Id: Big Butternut

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 3068.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2045.7 acre-ft
Lake Surface Area <As>: 378.0 acre
Lake Volume <V>: 4914.0 acre-ft
Lake Mean Depth <z>: 13.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 2149.6 acre-ft/year
Areal Water Load <qs>: 5.7 ft/year
Lake Flushing Rate <p>: 0.44 1/year
Water Residence Time: 2.29 year
Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3
Observed growing season mean phosphorus (GSM): 102.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	307.3	0.50	1.00	3.00	31.2	62	124	373
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	209.2	1.00	1.50	2.00	31.9	85	127	169
MD Urban (1/4 Ac)	17.9	0.30	0.50	0.80	0.9	2	4	6
Rural Res (>1 Ac)	67.8	0.05	0.10	0.25	0.7	1	3	7
Wetlands	620.9	0.10	0.10	0.10	6.3	25	25	25
Forest	1820.6	0.05	0.09	0.18	16.7	37	66	133
Lake Surface	378.0	0.10	0.30	1.00	11.5	15	46	153

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years				
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.01	0.10	0.32	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	504.1	877.8	1931.4	100.0
Total Loading (kg)	228.7	398.2	876.1	100.0
Areal Loading (lb/ac-year)	1.33	2.32	5.11	
Areal Loading (mg/m^2-year)	149.48	260.28	572.72	
Total PS Loading (lb)	0.0	0.0	0.0	0.0

Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	470.4	776.4	1593.5	100.0
Total NPS Loading (kg)	213.4	352.2	722.8	100.0

Wisconsin Internal Load Estimator
Date: 1/6/2011   Scenario: 21

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 91 mg/m^3
Phosphorus Inflow Concentration: 150.2 mg/m^3
Areal External Loading: 260.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.76
Observed Phosphorus Retention Coefficient: 0.39
Internal Load: 321 Lb   146 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 0 Lb   0 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0 acre-ft
Anoxia Sediment Area: 0 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 130 mg/m^3
Lake Volume: 4914.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 0 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 1737 Lb   788 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 0 acre
End of Anoxia Anoxic Sediment Area: 0 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.0 mg/m^2-day
Period of Anoxia: 0 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	0	0	0
Internal Load: (kg)	0	0	0

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 878 Lb 398 kg

	Lb	kg	%
From A Complete Mass Budget:	321	146	26.8
From Growing Season In Situ Phosphorus Increases:	0	0	0
From In Situ Phososphorus Increases In The Fall:	1737	788	66.4
From Phososphorus Release Rate and Anoxic Area:	0	0	0

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	76	185	79

Osgood, 1988 Lake Mixing Index: 3.2

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	321	868.6	0
Internal Load (kg):	146	394.0	0
External Load (Lb):	504	878	1931
External Load (kg):	229	398	876
Total Load (Lb):	825	1746	1931
Total Load (kg):	374	792	876

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2011 Scenario: 16

Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3

Observed growing season mean phosphorus (GSM): 102.0 mg/m^3

Back calculation for SPO total phosphorus: 85 mg/m^3

Back calculation GSM phosphorus: 170 mg/m^3

% Confidence Range: 70%

Nurenberg Model Input - Est. Gross Int. Loading: 185 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	27	48	105	-54	-53
Canfield-Bachmann, 1981 Natural Lake	29	43	72	-59	-58
Canfield-Bachmann, 1981 Artificial Lake	27	37	56	-65	-64
Rechow, 1979 General	11	19	42	-83	-81
Rechow, 1977 Anoxic	57	99	218	-3	-3
Rechow, 1977 water load<50m/year	21	37	82	-65	-64
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	68	150	34	100
Vollenweider, 1982 Combined OECD	28	44	85	-24	-35
Dillon-Rigler-Kirchner	21	37	82	3	9
Vollenweider, 1982 Shallow Lake/Res.	23	37	75	-31	-46
Larsen-Mercier, 1976	34	60	132	26	76
Nurnberg, 1984 Oxic	90	106	149	4	4

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	29	87	Tw	1416	GSM

Canfield-Bachmann, 1981 Natural Lake	13	124	FIT	3503	GSM
Canfield-Bachmann, 1981 Artificial Lake	11	107	FIT	9156	GSM
Rechow, 1979 General	11	35	FIT	3558	GSM
Rechow, 1977 Anoxic	63	179	FIT	685	GSM
Rechow, 1977 water load<50m/year	22	68	FIT	1812	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	36	132	FIT	496	SPO
Vollenweider, 1982 Combined OECD	23	83	FIT	1446	ANN
Dillon-Rigler-Kirchner	23	67	P	906	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	70	FIT	1637	ANN
Larsen-Mercier, 1976	39	107	P Pin	566	SPO
Nurnberg, 1984 Oxic	66	167	P	1108	ANN

Water and Nutrient Outflow Module
Date: 1/6/2011 Scenario: 12
Average Annual Surface Total Phosphorus: 1746mg/m^3
Annual Discharge: 2.15E+003 AF => 2.65E+006 m^3
Annual Outflow Loading: 9751.6 LB => 4423.3 kg

Expanded Trophic Response Module
Date: 1/6/2011 Scenario: 23
Total Phosphorus: 91 mg/m^3
Growing Season
Chorophyll a: 27.5 mg/m^3
Secchi Disk Depth: 1.64 m
Other Prediction Equations:
Rast and Lee, 1978:: Chlorophyll_a = 17.0 mg/m^3 Secchi Disk Depth = 1.3 m
Bartsch and Gaksatter, 1978:: Chlorophyll_a = 24.4 mg/m^3

User Defined: Chlorophyll_a - Total Phosphorus Regression::
Use Total Phosphorus To Predict Chlorophyll_a = 0.0 x 91^0.0 = 0.0 mg/m^3
Use Chlorophyll_a To Predict Secchi Disk Depth = 0.0 x 27.5^0.0 = 0.0 m

Summary Trophic Response Module
Date: 1/6/2011 Scenario: 8
Average Spring Mixed Total Phosphorus:: 34 mg/m^3
Growing Season Chlorophyll_a:: 13.3 mg/m^3
Average Growing Season Chlorophyll_a:: 68 mg/m^3

Natural Lake Secchi Depth (m)		**Impoundment Secchi Depth (m)**	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	91 mg/m^3	TSI = 63
Chlorophyll a::	27.5 mg/m^3	TSI = 60
Secchi Disc Depth::	1.64 m	TSI = 53

Date: 1/6/2010 Scenario: Big Butternut Land Use

Lake Id: Big Butternut

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 3068.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2045.7 acre-ft
Lake Surface Area <As>: 378.0 acre
Lake Volume <V>: 4914.0 acre-ft
Lake Mean Depth <z>: 13.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 2149.6 acre-ft/year
Areal Water Load <qs>: 5.7 ft/year
Lake Flushing Rate <p>: 0.44 1/year
Water Residence Time: 2.29 year
Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3
Observed growing season mean phosphorus (GSM): 102.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	307.3	0.50	1.00	3.00	31.2	62	124	373
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	209.2	1.00	1.50	2.00	31.9	85	127	169
MD Urban (1/4 Ac)	17.9	0.30	0.50	0.80	0.9	2	4	6
Rural Res (>1 Ac)	67.8	0.05	0.10	0.25	0.7	1	3	7
Wetlands	620.9	0.10	0.10	0.10	6.3	25	25	25
Forest	1820.6	0.05	0.09	0.18	16.7	37	66	133
Lake Surface	378.0	0.10	0.30	1.00	11.5	15	46	153

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years				
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.01	0.10	0.32	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	504.1	877.8	1931.4	100.0
Total Loading (kg)	228.7	398.2	876.1	100.0
Areal Loading (lb/ac-year)	1.33	2.32	5.11	
Areal Loading (mg/m^2-year)	149.48	260.28	572.72	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0

Total NPS Loading (lb)	470.4	776.4	1593.5	100.0
Total NPS Loading (kg)	213.4	352.2	722.8	100.0

Wisconsin Internal Load Estimator
Date: 1/6/2011 Scenario: 21

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 91 mg/m^3
Phosphorus Inflow Concentration: 150.2 mg/m^3
Areal External Loading: 260.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.76
Observed Phosphorus Retention Coefficient: 0.39
Internal Load: 321 Lb 146 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day 0 lb/acre-day
Internal Load: 0 Lb 0 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0 acre-ft
Anoxia Sediment Area: 0 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 130 mg/m^3
Lake Volume: 4914.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 0 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day 0 lb/acre-day
Internal Load: 1737 Lb 788 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 0 acre
End of Anoxia Anoxic Sediment Area: 0 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.0 mg/m^2-day
Period of Anoxia: 0 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	0	0	0
Internal Load: (kg)	0	0	0

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 878 Lb 398 kg

	Lb	kg	%
From A Complete Mass Budget:	321	146	26.8
From Growing Season In Situ Phosphorus Increases:	0	0	0
From In Situ Phososphorus Increases In The Fall:	1737	788	66.4
From Phososphorus Release Rate and Anoxic Area:	0	0	0

Predicted Water Column Total Phosphorus Concentration (ug/l)

Nurnberg+ 1984 Total Phosphorus Model:	Low	Most Likely	High
	76	185	79

Osgood, 1988 Lake Mixing Index: 3.2

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	321	868.6	0
Internal Load (kg):	146	394.0	0
External Load (Lb):	504	878	1931
External Load (kg):	229	398	876
Total Load (Lb):	825	1746	1931
Total Load (kg):	374	792	876

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2011 Scenario: 16

Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3

Observed growing season mean phosphorus (GSM): 102.0 mg/m^3

Back calculation for SPO total phosphorus: 85 mg/m^3

Back calculation GSM phosphorus: 170 mg/m^3

% Confidence Range: 70%

Nurenberg Model Input - Est. Gross Int. Loading: 185 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	27	48	105	-54	-53
Canfield-Bachmann, 1981 Natural Lake	29	43	72	-59	-58
Canfield-Bachmann, 1981 Artificial Lake	27	37	56	-65	-64
Rechow, 1979 General	11	19	42	-83	-81
Rechow, 1977 Anoxic	57	99	218	-3	-3
Rechow, 1977 water load<50m/year	21	37	82	-65	-64
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	68	150	34	100
Vollenweider, 1982 Combined OECD	28	44	85	-24	-35
Dillon-Rigler-Kirchner	21	37	82	3	9
Vollenweider, 1982 Shallow Lake/Res.	23	37	75	-31	-46
Larsen-Mercier, 1976	34	60	132	26	76
Nurnberg, 1984 Oxic	90	106	149	4	4

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	29	87	Tw	1416	GSM
Canfield-Bachmann, 1981 Natural Lake	13	124	FIT	3503	GSM

Canfield-Bachmann, 1981 Artificial Lake	11	107	FIT	9156	GSM
Rechow, 1979 General	11	35	FIT	3558	GSM
Rechow, 1977 Anoxic	63	179	FIT	685	GSM
Rechow, 1977 water load<50m/year	22	68	FIT	1812	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	36	132	FIT	496	SPO
Vollenweider, 1982 Combined OECD	23	83	FIT	1446	ANN
Dillon-Rigler-Kirchner	23	67	P	906	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	70	FIT	1637	ANN
Larsen-Mercier, 1976	39	107	P Pin	566	SPO
Nurnberg, 1984 Oxic	66	167	P	1108	ANN

Water and Nutrient Outflow Module
Date: 1/6/2011   Scenario: 12
Average Annual Surface Total Phosphorus: 1746mg/m^3
Annual Discharge: 2.15E+003 AF => 2.65E+006 m^3
Annual Outflow Loading: 9751.6 LB =>   4423.3 kg

Expanded Trophic Response Module
Date: 1/6/2011   Scenario: 23
Total Phosphorus: 91 mg/m^3
Growing Season
Chorophyll a: 27.5 mg/m^3
Secchi Disk Depth: 1.64 m
Other Prediction Equations:
Rast and Lee, 1978::   Chlorophyll_a = 17.0 mg/m^3   Secchi Disk Depth = 1.3 m
Bartsch and Gaksatter, 1978::   Chlorophyll_a = 24.4 mg/m^3

User Defined: Chlorophyll_a - Total Phosphorus Regression::
Use Total Phosphorus To Predict Chlorophyll_a = 0.0 x 91^0.0 = 0.0 mg/m^3
Use Chlorophyll_a To Predict Secchi Disk Depth = 0.0 x 27.5^0.0 = 0.0 m

Summary Trophic Response Module
Date: 1/6/2011   Scenario: 8
Average Spring Mixed Total Phosphorus:: 34 mg/m^3
Growing Season Chlorophyll_a:: 13.3 mg/m^3
Average Growing Season Chlorophyll_a:: 68 mg/m^3

Natural Lake Secchi Depth (m)		Impoundment Secchi Depth (m)	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	91 mg/m^3	TSI = 63
Chlorophyll a::	27.5 mg/m^3	TSI = 60
Secchi Disc Depth::	1.64 m	TSI = 53

Date: 1/6/2010 Scenario: Big Butternut Land Use

Lake Id: Big Butternut

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 3068.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2045.7 acre-ft
Lake Surface Area <As>: 378.0 acre
Lake Volume <V>: 4914.0 acre-ft
Lake Mean Depth <z>: 13.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 2149.6 acre-ft/year
Areal Water Load <qs>: 5.7 ft/year
Lake Flushing Rate <p>: 0.44 1/year
Water Residence Time: 2.29 year
Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3
Observed growing season mean phosphorus (GSM): 102.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	307.3	0.50	1.00	3.00	31.2	62	124	373
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	209.2	1.00	1.50	2.00	31.9	85	127	169
MD Urban (1/4 Ac)	17.9	0.30	0.50	0.80	0.9	2	4	6
Rural Res (>1 Ac)	67.8	0.05	0.10	0.25	0.7	1	3	7
Wetlands	620.9	0.10	0.10	0.10	6.3	25	25	25
Forest	1820.6	0.05	0.09	0.18	16.7	37	66	133
Lake Surface	378.0	0.10	0.30	1.00	11.5	15	46	153

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years				
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.01	0.10	0.32	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	504.1	877.8	1931.4	100.0
Total Loading (kg)	228.7	398.2	876.1	100.0
Areal Loading (lb/ac-year)	1.33	2.32	5.11	
Areal Loading (mg/m^2-year)	149.48	260.28	572.72	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0

Total NPS Loading (lb)	470.4	776.4	1593.5	100.0
Total NPS Loading (kg)	213.4	352.2	722.8	100.0

Wisconsin Internal Load Estimator

Date: 1/6/2011   Scenario: 21

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 91 mg/m^3
Phosphorus Inflow Concentration: 150.2 mg/m^3
Areal External Loading: 260.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.76
Observed Phosphorus Retention Coefficient: 0.39
Internal Load: 321 Lb   146 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres

Just Prior To The End of Stratification

Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 0 Lb   0 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia

Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0 acre-ft
Anoxia Sediment Area: 0 acres

Just Prior To The End of Stratification

Average Water Column Phosphorus Concentration: 130 mg/m^3
Lake Volume: 4914.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 0 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 1737 Lb   788 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 0 acre
End of Anoxia Anoxic Sediment Area: 0 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.0 mg/m^2-day
Period of Anoxia: 0 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	0	0	0
Internal Load: (kg)	0	0	0

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 878 Lb 398 kg

	Lb	kg	%
From A Complete Mass Budget:	321	146	26.8
From Growing Season In Situ Phosphorus Increases:	0	0	0
From In Situ Phososphorus Increases In The Fall:	1737	788	66.4
From Phososphorus Release Rate and Anoxic Area:	0	0	0

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	76	185	79

Osgood, 1988 Lake Mixing Index: 3.2

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	321	868.6	0
Internal Load (kg):	146	394.0	0
External Load (Lb):	504	878	1931
External Load (kg):	229	398	876
Total Load (Lb):	825	1746	1931
Total Load (kg):	374	792	876

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2011 Scenario: 16

Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3

Observed growing season mean phosphorus (GSM): 102.0 mg/m^3

Back calculation for SPO total phosphorus: 85 mg/m^3

Back calculation GSM phosphorus: 170 mg/m^3

% Confidence Range: 70%

Nurenberg Model Input - Est. Gross Int. Loading: 185 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	27	48	105	-54	-53
Canfield-Bachmann, 1981 Natural Lake	29	43	72	-59	-58
Canfield-Bachmann, 1981 Artificial Lake	27	37	56	-65	-64
Rechow, 1979 General	11	19	42	-83	-81
Rechow, 1977 Anoxic	57	99	218	-3	-3
Rechow, 1977 water load<50m/year	21	37	82	-65	-64
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	68	150	34	100
Vollenweider, 1982 Combined OECD	28	44	85	-24	-35
Dillon-Rigler-Kirchner	21	37	82	3	9
Vollenweider, 1982 Shallow Lake/Res.	23	37	75	-31	-46
Larsen-Mercier, 1976	34	60	132	26	76
Nurnberg, 1984 Oxic	90	106	149	4	4

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	29	87	Tw	1416	GSM
Canfield-Bachmann, 1981 Natural Lake	13	124	FIT	3503	GSM

Canfield-Bachmann, 1981 Artificial Lake	11	107	FIT	9156	GSM
Rechow, 1979 General	11	35	FIT	3558	GSM
Rechow, 1977 Anoxic	63	179	FIT	685	GSM
Rechow, 1977 water load<50m/year	22	68	FIT	1812	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	36	132	FIT	496	SPO
Vollenweider, 1982 Combined OECD	23	83	FIT	1446	ANN
Dillon-Rigler-Kirchner	23	67	P	906	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	70	FIT	1637	ANN
Larsen-Mercier, 1976	39	107	P Pin	566	SPO
Nurnberg, 1984 Oxic	66	167	P	1108	ANN

Water and Nutrient Outflow Module
Date: 1/6/2011 Scenario: 12
Average Annual Surface Total Phosphorus: 1746mg/m^3
Annual Discharge: 2.15E+003 AF => 2.65E+006 m^3
Annual Outflow Loading: 9751.6 LB => 4423.3 kg

Expanded Trophic Response Module
Date: 1/6/2011 Scenario: 23
Total Phosphorus: 91 mg/m^3
Growing Season
Chorophyll a: 27.5 mg/m^3
Secchi Disk Depth: 1.64 m
Other Prediction Equations:
Rast and Lee, 1978:: Chlorophyll_a = 17.0 mg/m^3 Secchi Disk Depth = 1.3 m
Bartsch and Gaksatter, 1978:: Chlorophyll_a = 24.4 mg/m^3

User Defined: Chlorophyll_a - Total Phosphorus Regression::
Use Total Phosphorus To Predict Chlorophyll_a = 0.0 x 91^0.0 = 0.0 mg/m^3
Use Chlorophyll_a To Predict Secchi Disk Depth = 0.0 x 27.5^0.0 = 0.0 m

Summary Trophic Response Module
Date: 1/6/2011 Scenario: 8
Average Spring Mixed Total Phosphorus:: 34 mg/m^3
Growing Season Chlorophyll_a:: 13.3 mg/m^3
Average Growing Season Chlorophyll_a:: 68 mg/m^3

Natural Lake Secchi Depth (m)		**Impoundment Secchi Depth (m)**	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	91 mg/m^3	TSI = 63
Chlorophyll a::	27.5 mg/m^3	TSI = 60
Secchi Disc Depth::	1.64 m	TSI = 53

Date: 1/6/2010 Scenario: Big Butternut Land Use

Lake Id: Big Butternut
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 3068.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2045.7 acre-ft
Lake Surface Area <As>: 378.0 acre
Lake Volume <V>: 4914.0 acre-ft
Lake Mean Depth <z>: 13.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 2149.6 acre-ft/year
Areal Water Load <qs>: 5.7 ft/year
Lake Flushing Rate <p>: 0.44 1/year
Water Residence Time: 2.29 year
Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3
Observed growing season mean phosphorus (GSM): 102.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	307.3	0.50	1.00	3.00	31.2	62	124	373
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	209.2	1.00	1.50	2.00	31.9	85	127	169
MD Urban (1/4 Ac)	17.9	0.30	0.50	0.80	0.9	2	4	6
Rural Res (>1 Ac)	67.8	0.05	0.10	0.25	0.7	1	3	7
Wetlands	620.9	0.10	0.10	0.10	6.3	25	25	25
Forest	1820.6	0.05	0.09	0.18	16.7	37	66	133
Lake Surface	378.0	0.10	0.30	1.00	11.5	15	46	153

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years				
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.01	0.10	0.32	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	504.1	877.8	1931.4	100.0
Total Loading (kg)	228.7	398.2	876.1	100.0
Areal Loading (lb/ac-year)	1.33	2.32	5.11	
Areal Loading (mg/m^2-year)	149.48	260.28	572.72	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0

Total NPS Loading (lb)	470.4	776.4	1593.5	100.0
Total NPS Loading (kg)	213.4	352.2	722.8	100.0

Wisconsin Internal Load Estimator
Date: 1/6/2011   Scenario: 21

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 91 mg/m^3
Phosphorus Inflow Concentration: 150.2 mg/m^3
Areal External Loading: 260.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.76
Observed Phosphorus Retention Coefficient: 0.39
Internal Load: 321 Lb   146 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 0 Lb   0 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0 acre-ft
Anoxia Sediment Area: 0 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 130 mg/m^3
Lake Volume: 4914.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 0 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 1737 Lb   788 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 0 acre
End of Anoxia Anoxic Sediment Area: 0 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.0 mg/m^2-day
Period of Anoxia: 0 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	0	0	0
Internal Load: (kg)	0	0	0

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 878 Lb 398 kg

	Lb	kg	%
From A Complete Mass Budget:	321	146	26.8
From Growing Season In Situ Phosphorus Increases:	0	0	0
From In Situ Phososphorus Increases In The Fall:	1737	788	66.4
From Phososphorus Release Rate and Anoxic Area:	0	0	0

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	76	185	79

Osgood, 1988 Lake Mixing Index: 3.2

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	321	868.6	0
Internal Load (kg):	146	394.0	0
External Load (Lb):	504	878	1931
External Load (kg):	229	398	876
Total Load (Lb):	825	1746	1931
Total Load (kg):	374	792	876

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2011 Scenario: 16

Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3

Observed growing season mean phosphorus (GSM): 102.0 mg/m^3

Back calculation for SPO total phosphorus: 85 mg/m^3

Back calculation GSM phosphorus: 170 mg/m^3

% Confidence Range: 70%

Nurenberg Model Input - Est. Gross Int. Loading: 185 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	27	48	105	-54	-53
Canfield-Bachmann, 1981 Natural Lake	29	43	72	-59	-58
Canfield-Bachmann, 1981 Artificial Lake	27	37	56	-65	-64
Rechow, 1979 General	11	19	42	-83	-81
Rechow, 1977 Anoxic	57	99	218	-3	-3
Rechow, 1977 water load<50m/year	21	37	82	-65	-64
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	68	150	34	100
Vollenweider, 1982 Combined OECD	28	44	85	-24	-35
Dillon-Rigler-Kirchner	21	37	82	3	9
Vollenweider, 1982 Shallow Lake/Res.	23	37	75	-31	-46
Larsen-Mercier, 1976	34	60	132	26	76
Nurnberg, 1984 Oxic	90	106	149	4	4

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	29	87	Tw	1416	GSM
Canfield-Bachmann, 1981 Natural Lake	13	124	FIT	3503	GSM

Canfield-Bachmann, 1981 Artificial Lake	11	107	FIT	9156	GSM
Rechow, 1979 General	11	35	FIT	3558	GSM
Rechow, 1977 Anoxic	63	179	FIT	685	GSM
Rechow, 1977 water load<50m/year	22	68	FIT	1812	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	36	132	FIT	496	SPO
Vollenweider, 1982 Combined OECD	23	83	FIT	1446	ANN
Dillon-Rigler-Kirchner	23	67	P	906	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	70	FIT	1637	ANN
Larsen-Mercier, 1976	39	107	P Pin	566	SPO
Nurnberg, 1984 Oxic	66	167	P	1108	ANN

Water and Nutrient Outflow Module
Date: 1/6/2011   Scenario: 12
Average Annual Surface Total Phosphorus: 1746mg/m^3
Annual Discharge: 2.15E+003 AF => 2.65E+006 m^3
Annual Outflow Loading: 9751.6 LB =>   4423.3 kg

Expanded Trophic Response Module
Date: 1/6/2011   Scenario: 23
Total Phosphorus: 91 mg/m^3
Growing Season
Chorophyll a: 27.5 mg/m^3
Secchi Disk Depth: 1.64 m
Other Prediction Equations:
Rast and Lee, 1978::   Chlorophyll_a = 17.0 mg/m^3   Secchi Disk Depth = 1.3 m
Bartsch and Gaksatter, 1978::   Chlorophyll_a = 24.4 mg/m^3

User Defined: Chlorophyll_a - Total Phosphorus Regression::
Use Total Phosphorus To Predict Chlorophyll_a = 0.0 x 91^0.0 = 0.0 mg/m^3
Use Chlorophyll_a To Predict Secchi Disk Depth = 0.0 x 27.5^0.0 = 0.0 m

Summary Trophic Response Module
Date: 1/6/2011   Scenario: 8
Average Spring Mixed Total Phosphorus:: 34 mg/m^3
Growing Season Chlorophyll_a:: 13.3 mg/m^3
Average Growing Season Chlorophyll_a:: 68 mg/m^3

Natural Lake Secchi Depth (m)		**Impoundment Secchi Depth (m)**	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	91 mg/m^3	TSI = 63
Chlorophyll a::	27.5 mg/m^3	TSI = 60
Secchi Disc Depth::	1.64 m	TSI = 53

Date: 1/6/2010   Scenario: Big Butternut Land Use

Lake Id: Big Butternut
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 3068.5 acre
Total Unit Runoff: 8.00 in.
Annual Runoff Volume: 2045.7 acre-ft
Lake Surface Area <As>: 378.0 acre
Lake Volume <V>: 4914.0 acre-ft
Lake Mean Depth <z>: 13.0 ft
Precipitation - Evaporation: 3.3 in.
Hydraulic Loading: 2149.6 acre-ft/year
Areal Water Load <qs>: 5.7 ft/year
Lake Flushing Rate <p>: 0.44 1/year
Water Residence Time: 2.29 year
Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3
Observed growing season mean phosphorus (GSM): 102.0 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	307.3	0.50	1.00	3.00	31.2	62	124	373
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	0.0	0.10	0.30	0.50	0.0	0	0	0
HD Urban (1/8 Ac)	209.2	1.00	1.50	2.00	31.9	85	127	169
MD Urban (1/4 Ac)	17.9	0.30	0.50	0.80	0.9	2	4	6
Rural Res (>1 Ac)	67.8	0.05	0.10	0.25	0.7	1	3	7
Wetlands	620.9	0.10	0.10	0.10	6.3	25	25	25
Forest	1820.6	0.05	0.09	0.18	16.7	37	66	133
Lake Surface	378.0	0.10	0.30	1.00	11.5	15	46	153

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description	Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)	0.30	0.50	0.80	
# capita-years				
% Phosphorus Retained by Soil	98.0	90.0	80.0	
Septic Tank Loading (kg/year)	0.01	0.10	0.32	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	504.1	877.8	1931.4	100.0
Total Loading (kg)	228.7	398.2	876.1	100.0
Areal Loading (lb/ac-year)	1.33	2.32	5.11	
Areal Loading (mg/m^2-year)	149.48	260.28	572.72	
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0

Total NPS Loading (lb)	470.4	776.4	1593.5	100.0
Total NPS Loading (kg)	213.4	352.2	722.8	100.0

Wisconsin Internal Load Estimator
Date: 1/6/2011   Scenario: 21

Method 1 - A Complete Total Phosphorus Mass Budget

Method 1 - A Complete Total Phosphorus Mass Budget 91 mg/m^3
Phosphorus Inflow Concentration: 150.2 mg/m^3
Areal External Loading: 260.3 mg/m^2-year
Predicted Phosphorus Retention Coefficient: 0.76
Observed Phosphorus Retention Coefficient: 0.39
Internal Load: 321 Lb   146 kg

Method 2 - From Growing Season In Situ Phososphorus Increases

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Just Prior To The End of Stratification
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0.0 acre-ft
Anoxia Sediment Area: 0.0 acres
Time Period of Stratification: 1 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 0 Lb   0 kg

Method 3 - From In Situ Phososphorus Increases In The Fall

Start of Anoxia
Average Hypolimnetic Phosphorus Concentration: 0 mg/m^3
Hypolimnetic Volume: 0 acre-ft
Anoxia Sediment Area: 0 acres
Just Prior To The End of Stratification
Average Water Column Phosphorus Concentration: 130 mg/m^3
Lake Volume: 4914.0 acre-ft
Anoxia Sediment Area Just Before Turnover: 0 acres
Time Period Between Observations: 30 days
Sediment Phosphorus Release Rate: 0 mg/m^2-day   0 lb/acre-day
Internal Load: 1737 Lb   788 kg

Method 4 - From Phososphorus Release Rate and Anoxic Area

Start of Anoxia Anoxic Sediment Area: 0 acre
End of Anoxia Anoxic Sediment Area: 0 acre
Phosphorus Release Rate As Calculated In Method 2: 0 mg/m^2-day
Phosphorus Release Rate As Calculated In Method 3: 0 mg/m^2-day
Average of Methods 2 and 3 Release Rates: 0.0 mg/m^2-day
Period of Anoxia: 0 days
Default Areal Sediment Phosphorus Release Rates:

	Low	Most Likely	High
	6	14	24
Internal Load: (Lb)	0	0	0
Internal Load: (kg)	0	0	0

Internal Load Comparison (Percentanges are of the Total Estimate Load)

Total External Load: 878 Lb 398 kg

	Lb	kg	%
From A Complete Mass Budget:	321	146	26.8
From Growing Season In Situ Phosphorus Increases:	0	0	0
From In Situ Phososphorus Increases In The Fall:	1737	788	66.4
From Phososphorus Release Rate and Anoxic Area:	0	0	0

Predicted Water Column Total Phosphorus Concentration (ug/l)

	Low	Most Likely	High
Nurnberg+ 1984 Total Phosphorus Model:	76	185	79

Osgood, 1988 Lake Mixing Index: 3.2

Phosphorus Loading Summary:

	Low	Most Likely	High
Internal Load (Lb):	321	868.6	0
Internal Load (kg):	146	394.0	0
External Load (Lb):	504	878	1931
External Load (kg):	229	398	876
Total Load (Lb):	825	1746	1931
Total Load (kg):	374	792	876

Phosphorus Prediction and Uncertainty Analysis Module

Date: 1/6/2011 Scenario: 16

Observed spring overturn total phosphorus (SPO): 34.0 mg/m^3

Observed growing season mean phosphorus (GSM): 102.0 mg/m^3

Back calculation for SPO total phosphorus: 85 mg/m^3

Back calculation GSM phosphorus: 170 mg/m^3

% Confidence Range: 70%

Nurenberg Model Input - Est. Gross Int. Loading: 185 kg

Lake Phosphorus Model	**Low** Total P (mg/m^3)	**Most Likely** Total P (mg/m^3)	**High** Total P (mg/m^3)	**Predicted** -Observed (mg/m^3)	**% Dif.**
Walker, 1987 Reservoir	27	48	105	-54	-53
Canfield-Bachmann, 1981 Natural Lake	29	43	72	-59	-58
Canfield-Bachmann, 1981 Artificial Lake	27	37	56	-65	-64
Rechow, 1979 General	11	19	42	-83	-81
Rechow, 1977 Anoxic	57	99	218	-3	-3
Rechow, 1977 water load<50m/year	21	37	82	-65	-64
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	39	68	150	34	100
Vollenweider, 1982 Combined OECD	28	44	85	-24	-35
Dillon-Rigler-Kirchner	21	37	82	3	9
Vollenweider, 1982 Shallow Lake/Res.	23	37	75	-31	-46
Larsen-Mercier, 1976	34	60	132	26	76
Nurnberg, 1984 Oxic	90	106	149	4	4

Lake Phosphorus Model	**Confidence** Lower Bound	**Confidence** Upper Bound	**Parameter** Fit?	**Back** Calculation (kg/year)	**Model** Type
Walker, 1987 Reservoir	29	87	Tw	1416	GSM
Canfield-Bachmann, 1981 Natural Lake	13	124	FIT	3503	GSM

Canfield-Bachmann, 1981 Artificial Lake	11	107	FIT	9156	GSM
Rechow, 1979 General	11	35	FIT	3558	GSM
Rechow, 1977 Anoxic	63	179	FIT	685	GSM
Rechow, 1977 water load<50m/year	22	68	FIT	1812	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	36	132	FIT	496	SPO
Vollenweider, 1982 Combined OECD	23	83	FIT	1446	ANN
Dillon-Rigler-Kirchner	23	67	P	906	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	70	FIT	1637	ANN
Larsen-Mercier, 1976	39	107	P Pin	566	SPO
Nurnberg, 1984 Oxic	66	167	P	1108	ANN

Water and Nutrient Outflow Module
Date: 1/6/2011   Scenario: 12
Average Annual Surface Total Phosphorus: 1746mg/m^3
Annual Discharge: 2.15E+003 AF => 2.65E+006 m^3
Annual Outflow Loading: 9751.6 LB =>   4423.3 kg

Expanded Trophic Response Module
Date: 1/6/2011   Scenario: 23
Total Phosphorus: 91 mg/m^3
Growing Season
Chorophyll a: 27.5 mg/m^3
Secchi Disk Depth: 1.64 m
Other Prediction Equations:
Rast and Lee, 1978::   Chlorophyll_a = 17.0 mg/m^3   Secchi Disk Depth = 1.3 m
Bartsch and Gaksatter, 1978::   Chlorophyll_a = 24.4 mg/m^3

User Defined: Chlorophyll_a - Total Phosphorus Regression::
Use Total Phosphorus To Predict Chlorophyll_a = 0.0 x 91^0.0 = 0.0 mg/m^3
Use Chlorophyll_a To Predict Secchi Disk Depth = 0.0 x 27.5^0.0 = 0.0 m

Summary Trophic Response Module
Date: 1/6/2011   Scenario: 8
Average Spring Mixed Total Phosphorus:: 34 mg/m^3
Growing Season Chlorophyll_a:: 13.3 mg/m^3
Average Growing Season Chlorophyll_a:: 68 mg/m^3

Natural Lake Secchi Depth (m)		**Impoundment Secchi Depth (m)**	
Mixed	Stratified	Mixed	Stratified
0.58	0.81	0.61	0.95

Wisconsin Trophic State Index (TSI)

Total Phosphorus::	91 mg/m^3	TSI = 63
Chlorophyll a::	27.5 mg/m^3	TSI = 60
Secchi Disc Depth::	1.64 m	TSI = 53

Big Butternut Lake Management Plan

Stormwater Modeling Data

Appendix N

Polk County Land and Water Resources Department
12/31/2011

P8 Urban Catchment Model, Version 3.4				Run Date	12/28/11
Case	Big_Butternut.p8c	FirstDate	01/01/71	Precip(in)	50.4
Title	Startup Case	LastDate	12/31/72	Rain(in)	40.76
PrecFile	msp_4989.pcp	Events	134	Snow(in)	9.67
PartFile	nurp50.p8p	TotalHrs	16440	TotalYrs	1.88

Case Title	Startup Case
Case Data File	Big_Butternut.p8c
Path	Y:\Lakes Database\Big Butternut\Stormwater\
Case Notes:	simple startup case one device (wet pond) one watershed
Storm Data File	msp_4989.pcp
Particle File	nurp50.p8p
Air Temp File File	msp_4889.tmp

Time Steps Per Hour	4
Minimum Inter-Event Time (hrs)	10
Maximum Continuity Error %	2
Rainfall Breakpoint (inches)	0.8
Precipitation Scale Factor	1
Air Temp Offset (deg-F)	0
Loops Thru Storm File	1
Simulation Dates	
Start	6/1/1970
Keep	1/1/1971
Stop	12/31/1972

Max Snowfall Temperature (deg-f)	32.0
SnowMelt Temperature (deg-f)	32.0
Snowmelt Coef (in/degF-Day)	0.06
Soil Freeze Temp (deg-F)	32.0
Snowmelt Abstraction Factor	1.00
Evapo-Trans. Calibration Factor	1.00
Growing Season Start Month	5
Growing Season End Month	10

5-Day Antecedent Rainfall + Runoff (inches)		
CN Antecedent Moisture Condition	AMC-II	AMC-III
Growing Season	1.40	2.10
NonGrowing Season	0.50	1.10

Watershed Data						
Watershed Name	BBLPRD1	BBLPRD2	BBLPRD3	BBLPRD4	BBLPRD5	BBLPRD6
Runoff to Device	WET_POND	WET_POND	WET_POND	WET_POND	WET_POND	WET_POND
Infiltration to Device						
Watershed Area	21.1	72.9	16.13	10.37	13.8	18.09
SCS Curve Number (Pervious)	80	52	72	72	72	70
Scale Factor for Pervious Runoff Load	1	1	1	1	1	1
Indirectly Connected Imperv Fraction	0	0	0	0	0	0
UnSwept Impervious Fraction	0.25	0.25	0.25	0.25	0	0
UnSwept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02	0.02
UnSwept Imperv. Runoff Coefficient	1	1	1	1	1	1
UnSwept Scale Factor for Particle Loads	1	1	1	1	1	1
Swept Impervious Fraction	0	0	0	0	0	0
Swept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02	0.02
Swept Imperv. Runoff Coefficient	1	1	1	1	1	1
Swept Scale Factor for Particle Loads	1	1	1	1	1	1
Sweeping Frequency	0	0	0.5	0.5	0.5	0.5
Sweeping Efficiency	1	1	1	1	1	1
Sweeping Start Date (MMDD)	101	101	101	101	101	101
Sweeping Stop Date (MMDD)	1231	1231	1231	1231	1231	1231

Device Data						
Device Name	WET_POND					
Device Type	POND					

Infiltration Outlet						
Normal Outlet						
Spillway Outlet						
Particle Removal Scale Factor	1					
Bottom Elevation (ft)	0					
Bottom Area (acres)	2					
Permanent Pool Area (acres)	5					
Permanent Pool Volume (ac-ft)	10					
Perm Pool Infilt Rate (in/hr)	0					
Flood Pool Area (acres)	6					
Flood Pool Volume (ac-ft)	5					
Flood Pool Infilt Rate (in/hr)	0					
Infilt Basin Void Fraction (%)						
Detention Pond Outlet Parameters						
Outlet Type	ORIFICE					
Outlet Orifice Diameter (in)	12					
Orifice Discharge Coef	1					
Outlet Weir Length (ft)						
Weir Discharge Coef						
Perforated Riser Height (ft)						
Number of Holes in Riser						
Holes Diameter						
Flood Pool Drain Time (hrs)						
Swale Parameters						
Length of Flow Path (ft)						
Slope of Flow Path %						
Bottom Width (ft)						
Side Slope (ft-v/ft-h)						
Maximum Depth of Flow (ft)						
Mannings n Constant						
Hydraulic Model						
Pipe, Splitter, Aquifer Parameter						
Hydraulic Res. Time (hrs)						

Particle Data					
Particle File	nurp50.p8p				
Particle Class	P0%	P10%	P30%	P50%	P80%
Filtration Efficiency (%)	90	100	100	100	100
Settling Velocity (ft/hr)	0	0.03	0.3	1.5	15
First Order Decay Rate (1/day)	0	0	0	0	0
2nd Order Decay (1/day-ppm)	0	0	0	0	0
Impervious Runoff Conc (ppm)	1	0	0	0	0
Pervious Runoff Conc (ppm)	1	100	100	100	200
Pervious Conc Exponent	0	1	1	1	1
Accum. Rate (lbs-ac-day)	0	1.75	1.75	1.75	3.5
Particle Removal Rate (1/day)	0	0.25	0.25	0.25	0.25
Washoff Coefficient	0	20	20	20	20
Washoff Exponent	0	2	2	2	2
Sweeper Efficiency	0	0	0	5	15

Water Quality Component Data							
Component Name	TSS	TP	TKN	CU	PB	ZN	HC
Water Quality Criteria (ppm)							
Level 1	5	0.025	2	2	0.02	5	0.1
Level 2	10	0.05	1	0.0048	0.014	0.0362	0.5
Level 3	20	0.1	0.5	0.02	0.15	0.38	1
Content Scale Factor	1	1	1	1	1	1	1
Particle Composition (mg/kg)							
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500
P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	340	180	0	22500

P8 Urban Catchment Model, Version 3.4

Case	Big_Butternut.p8c	FirstDate	01/01/71	Run Date	12/28/11
Title	Startup Case	LastDate	12/31/72	Precip(in)	50.4
PrecFile	msp_4989.pcp	Events	134	Rain(in)	40.76
PartFile	nurp50.p8p	TotalHrs	16440	Snow(in)	9.67
				TotalYrs	1.88

Mass Balance Term: 10 surface outflow

Event Time Series - Loads (lbs)

Event	Device	DateStart	WetHrs	TotalHrs	Rain	Snow Melt	Rain+ Melt	MaxElev Ft	QMaxCfs	QVolAcft	P0%	P10%	P30%	P50%	P80%	TSS	TP	TKN	CU	PB	ZN	HC
0	WET_POND	1/1/71 0:00	2067	16440	40.76	11.66	52.42	3.77	38.23	170.89	464.23	1514.79	445.93	106.67	22.76	2090.14	53.92	309.55	7.02	1.30	300.41	163.09
1	WET_POND	2/16/71 1:00	72	240	0.00	0.24	0.24	2.89	0.13	0.56	1.50	0.11	0.02	0.00	0.00	0.14	0.15	0.90	0.02	0.00	0.96	0.38
2	WET_POND	2/26/71 1:00	24	336	0.00	0.18	0.18	2.90	0.18	0.40	1.08	0.13	0.03	0.01	0.00	0.17	0.11	0.65	0.01	0.00	0.69	0.27
3	WET_POND	3/12/71 1:00	72	216	0.00	0.81	0.81	3.03	0.78	2.84	7.66	4.77	1.00	0.20	0.04	6.00	0.78	4.68	0.11	0.02	4.91	2.05
4	WET_POND	3/21/71 1:00	24	120	0.08	0.06	0.14	2.89	0.15	0.30	0.81	0.24	0.05	0.01	0.00	0.30	0.08	0.49	0.01	0.00	0.52	0.21
5	WET_POND	3/26/71 1:00	144	216	0.12	2.55	2.67	3.77	6.18	18.17	49.26	123.67	36.03	8.01	1.61	169.32	5.52	32.07	0.73	0.13	31.80	16.13
6	WET_POND	4/4/71 1:00	76	149	0.16	0.77	0.93	3.16	1.36	3.54	9.60	15.70	2.71	0.58	0.11	19.09	1.02	6.05	0.14	0.02	6.18	2.83
7	WET_POND	4/10/71 6:00	39	187	0.19	0.00	0.19	2.89	0.15	0.43	1.18	0.76	0.05	0.01	0.00	0.83	0.12	0.72	0.02	0.00	0.76	0.31
8	WET_POND	4/18/71 1:00	1	110	0.03	0.00	0.03	2.86	0.02	0.03	0.07	0.01	0.00	0.00	0.00	0.01	0.01	0.04	0.00	0.00	0.04	0.02
9	WET_POND	4/22/71 15:00	1	71	0.01	0.00	0.01	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	WET_POND	4/25/71 14:00	1	41	0.02	0.00	0.02	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	WET_POND	4/27/71 7:00	3	16	0.10	0.00	0.10	2.89	0.16	0.13	0.35	0.16	0.08	0.02	0.00	0.26	0.04	0.21	0.00	0.00	0.23	0.09
12	WET_POND	4/27/71 23:00	5	55	0.02	0.00	0.02	2.87	0.06	0.07	0.19	0.07	0.00	0.00	0.00	0.07	0.02	0.12	0.00	0.00	0.12	0.05
13	WET_POND	4/30/71 6:00	5	140	0.15	0.00	0.15	2.91	0.24	0.33	0.89	1.30	0.44	0.10	0.01	1.86	0.10	0.56	0.01	0.00	0.57	0.26
14	WET_POND	5/6/71 2:00	31	75	0.51	0.00	0.51	2.97	0.50	1.21	3.30	5.89	1.48	0.29	0.05	7.71	0.36	2.09	0.05	0.01	2.12	1.00
15	WET_POND	5/9/71 5:00	4	35	0.08	0.00	0.08	2.88	0.12	0.15	0.41	0.42	0.03	0.01	0.00	0.46	0.04	0.26	0.01	0.00	0.27	0.11
16	WET_POND	5/10/71 16:00	2	59	0.02	0.00	0.02	2.86	0.01	0.01	0.04	0.02	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.02	0.01
17	WET_POND	5/13/71 3:00	3	315	0.30	0.00	0.30	2.99	0.58	0.70	1.91	6.99	2.54	0.62	0.09	10.24	0.23	1.30	0.03	0.01	1.24	0.71
18	WET_POND	5/26/71 6:00	11	30	0.17	0.00	0.17	2.90	0.21	0.32	0.87	0.48	0.16	0.03	0.01	0.68	0.09	0.53	0.01	0.00	0.56	0.23
19	WET_POND	5/27/71 12:00	33	117	1.09	0.00	1.09	3.10	1.10	2.74	7.45	24.48	6.30	1.18	0.21	32.18	0.86	4.95	0.11	0.02	4.82	2.59
20	WET_POND	6/1/71 9:00	36	188	1.42	0.00	1.42	3.29	1.92	3.88	10.55	42.58	8.94	1.63	0.25	53.40	1.25	7.13	0.16	0.03	6.84	3.84
21	WET_POND	6/9/71 5:00	2	15	0.06	0.00	0.06	2.88	0.08	0.06	0.17	0.09	0.02	0.00	0.00	0.11	0.02	0.10	0.00	0.00	0.11	0.05
22	WET_POND	6/9/71 20:00	18	94	0.44	0.00	0.44	3.03	0.76	1.09	2.96	12.87	4.44	1.03	0.14	18.48	0.36	2.05	0.05	0.01	1.92	1.16
23	WET_POND	6/13/71 18:00	10	55	0.34	0.00	0.34	2.96	0.48	0.79	2.13	5.78	1.00	0.21	0.03	7.02	0.24	1.39	0.03	0.01	1.38	0.69
24	WET_POND	6/16/71 1:00	9	77	0.57	0.00	0.57	3.06	0.90	1.39	3.79	13.07	3.15	0.64	0.10	16.97	0.44	2.53	0.06	0.01	2.45	1.33
25	WET_POND	6/19/71 6:00	16	193	0.35	0.00	0.35	2.98	0.54	0.84	2.27	7.57	1.76	0.40	0.06	9.79	0.26	1.51	0.03	0.01	1.47	0.79
26	WET_POND	6/27/71 7:00	2	23	0.05	0.00	0.05	2.87	0.06	0.06	0.16	0.05	0.01	0.00	0.00	0.05	0.02	0.10	0.00	0.00	0.10	0.04
27	WET_POND	6/28/71 6:00	11	108	0.73	0.00	0.73	3.15	1.29	1.80	4.88	25.11	9.02	1.92	0.17	36.22	0.62	3.47	0.08	0.02	3.18	2.04
28	WET_POND	7/2/71 18:00	8	19	0.26	0.00	0.26	2.95	0.40	0.40	1.10	2.15	0.45	0.09	0.02	2.71	0.12	0.70	0.02	0.00	0.71	0.34
29	WET_POND	7/3/71 13:00	4	101	0.11	0.00	0.11	2.93	0.31	0.43	1.16	1.91	0.14	0.03	0.00	2.08	0.12	0.72	0.02	0.00	0.74	0.34
30	WET_POND	7/7/71 18:00	6	18	0.06	0.00	0.06	2.88	0.09	0.06	0.16	0.10	0.02	0.01	0.00	0.13	0.02	0.10	0.00	0.00	0.10	0.04
31	WET_POND	7/8/71 12:00	9	187	0.69	0.00	0.69	3.13	1.22	1.72	4.68	21.81	6.78	1.37	0.18	30.15	0.58	3.26	0.07	0.01	3.04	1.85

32	WET_POND	7/16/71 7:00	15	76	2.39	0.00	2.39	3.72	3.83	6.29	17.09	73.87	20.37	4.08	0.45	98.77	2.07	11.73	0.27	0.05	11.09	6.49
33	WET_POND	7/19/71 11:00	4	45	0.19	0.00	0.19	2.94	0.37	0.47	1.26	2.69	0.26	0.06	0.01	3.02	0.14	0.80	0.02	0.00	0.81	0.38
34	WET_POND	7/21/71 8:00	3	58	0.33	0.00	0.33	3.00	0.64	0.81	2.21	7.32	1.96	0.46	0.07	9.80	0.26	1.47	0.03	0.01	1.43	0.77
35	WET_POND	7/23/71 18:00	4	96	0.08	0.00	0.08	2.89	0.13	0.16	0.44	0.68	0.03	0.01	0.00	0.71	0.05	0.28	0.01	0.00	0.29	0.13
36	WET_POND	7/27/71 18:00	4	213	0.02	0.00	0.02	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37	WET_POND	8/5/71 15:00	4	31	0.50	0.00	0.50	3.07	0.95	1.06	2.89	16.85	6.98	1.61	0.16	25.60	0.38	2.11	0.05	0.01	1.89	1.30
38	WET_POND	8/6/71 22:00	1	21	0.03	0.00	0.03	2.89	0.14	0.13	0.36	1.38	0.01	0.00	0.00	1.40	0.04	0.23	0.01	0.00	0.23	0.12
39	WET_POND	8/7/71 19:00	4	274	0.40	0.00	0.40	3.02	0.74	0.99	2.69	10.21	1.40	0.29	0.04	11.95	0.31	1.79	0.04	0.01	1.74	0.94
40	WET_POND	8/19/71 5:00	11	196	0.14	0.00	0.14	2.90	0.18	0.30	0.82	0.51	0.15	0.03	0.01	0.70	0.08	0.50	0.01	0.00	0.53	0.22
41	WET_POND	8/27/71 9:00	14	142	0.38	0.00	0.38	3.00	0.63	0.90	2.46	7.32	2.56	0.57	0.08	10.54	0.28	1.63	0.04	0.01	1.59	0.85
42	WET_POND	9/2/71 7:00	1	160	0.01	0.00	0.01	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43	WET_POND	9/8/71 23:00	22	103	1.25	0.00	1.25	3.21	1.56	3.09	8.39	37.96	10.66	1.84	0.30	50.76	1.02	5.79	0.13	0.03	5.45	3.24
44	WET_POND	9/13/71 6:00	6	17	0.45	0.00	0.45	3.02	0.74	0.74	2.00	9.22	3.25	0.72	0.09	13.27	0.25	1.40	0.03	0.01	1.30	0.80
45	WET_POND	9/13/71 23:00	4	95	0.02	0.00	0.02	2.93	0.30	0.35	0.94	3.15	0.11	0.00	0.00	3.26	0.11	0.61	0.01	0.00	0.61	0.31
46	WET_POND	9/17/71 22:00	20	165	0.39	0.00	0.39	2.99	0.57	0.93	2.53	8.24	2.35	0.54	0.08	11.21	0.29	1.68	0.04	0.01	1.63	0.88
47	WET_POND	9/24/71 19:00	1	154	0.01	0.00	0.01	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	WET_POND	10/1/71 5:00	17	78	0.70	0.00	0.70	3.08	0.99	1.69	4.61	15.40	4.95	0.93	0.15	21.43	0.54	3.08	0.07	0.01	2.98	1.63
49	WET_POND	10/4/71 11:00	3	60	0.08	0.00	0.08	2.89	0.13	0.16	0.44	0.63	0.02	0.01	0.00	0.66	0.05	0.27	0.01	0.00	0.28	0.12
50	WET_POND	10/6/71 23:00	2	13	0.11	0.00	0.11	2.90	0.18	0.14	0.37	0.53	0.16	0.04	0.01	0.74	0.04	0.23	0.01	0.00	0.24	0.11
51	WET_POND	10/7/71 12:00	1	31	0.05	0.00	0.05	2.89	0.14	0.15	0.41	0.51	0.04	0.01	0.00	0.56	0.04	0.25	0.01	0.00	0.26	0.11
52	WET_POND	10/8/71 19:00	4	44	0.92	0.00	0.92	3.27	1.84	2.16	5.86	28.94	10.14	2.32	0.22	41.61	0.74	4.14	0.09	0.02	3.82	2.40
53	WET_POND	10/10/71 15:00	2	13	0.11	0.00	0.11	2.92	0.28	0.20	0.55	1.73	0.08	0.02	0.00	1.83	0.06	0.36	0.01	0.00	0.36	0.18
54	WET_POND	10/11/71 4:00	4	155	0.53	0.00	0.53	3.11	1.14	1.42	3.87	16.65	3.42	0.80	0.10	20.96	0.46	2.63	0.06	0.01	2.51	1.44
55	WET_POND	10/17/71 15:00	6	22	0.03	0.00	0.03	2.86	0.02	0.02	0.05	0.02	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.03	0.01
56	WET_POND	10/18/71 13:00	2	72	0.03	0.00	0.03	2.86	0.03	0.03	0.09	0.03	0.00	0.00	0.00	0.03	0.01	0.05	0.00	0.00	0.06	0.02
57	WET_POND	10/21/71 13:00	11	87	0.13	0.00	0.13	2.89	0.16	0.28	0.75	0.33	0.07	0.01	0.00	0.42	0.08	0.46	0.01	0.00	0.48	0.20
58	WET_POND	10/25/71 4:00	9	56	0.22	0.00	0.22	2.95	0.40	0.49	1.33	3.40	1.26	0.29	0.04	4.99	0.15	0.87	0.02	0.00	0.86	0.44
59	WET_POND	10/27/71 12:00	13	54	0.45	0.00	0.45	3.00	0.64	1.06	2.87	11.92	3.16	0.68	0.10	15.86	0.35	1.96	0.04	0.01	1.86	1.08
60	WET_POND	10/29/71 18:00	15	151	0.34	0.00	0.34	2.99	0.58	0.84	2.28	6.91	1.06	0.23	0.04	8.24	0.26	1.49	0.03	0.01	1.47	0.76
61	WET_POND	11/5/71 1:00	16	96	2.22	0.07	2.29	3.77	38.23	14.48	39.37	265.16	126.82	40.85	12.99	445.83	5.56	30.11	0.69	0.16	25.89	19.87
62	WET_POND	11/9/71 1:00	78	1056	0.34	1.55	1.89	3.38	2.33	10.84	29.47	81.88	14.61	2.90	0.52	99.91	3.30	19.17	0.43	0.08	19.02	9.61
63	WET_POND	12/23/71 1:00	24	1896	0.04	0.12	0.16	2.89	0.14	0.35	0.96	0.13	0.03	0.01	0.00	0.17	0.10	0.58	0.01	0.00	0.61	0.24
64	WET_POND	3/11/72 1:00	48	96	0.21	0.15	0.36	2.96	0.45	0.88	2.40	1.87	0.66	0.14	0.02	2.69	0.25	1.48	0.03	0.01	1.54	0.66
65	WET_POND	3/15/72 1:00	192	240	0.01	2.85	2.86	3.58	3.22	20.10	54.63	92.77	18.79	3.91	0.78	116.25	5.85	34.51	0.78	0.13	35.15	16.27
66	WET_POND	3/25/72 1:00	24	168	0.00	0.03	0.03	2.86	0.02	0.05	0.14	0.06	0.00	0.00	0.00	0.06	0.01	0.08	0.00	0.00	0.09	0.04
67	WET_POND	4/1/72 1:00	48	96	0.00	0.33	0.33	2.93	0.33	0.79	2.15	0.74	0.19	0.04	0.01	0.97	0.22	1.31	0.03	0.00	1.38	0.56
68	WET_POND	4/5/72 1:00	48	96	0.17	0.81	0.98	3.17	1.38	3.78	10.28	17.85	3.46	0.66	0.12	22.09	1.10	6.50	0.15	0.02	6.62	3.07
69	WET_POND	4/9/72 1:00	46	74	0.02	0.89	0.91	3.18	1.45	3.23	8.77	16.24	3.49	0.66	0.12	20.51	0.95	5.57	0.13	0.02	5.64	2.65
70	WET_POND	4/12/72 3:00	5	95	0.06	0.00	0.06	2.90	0.21	0.32	0.88	1.09	0.02	0.00	0.00	1.11	0.09	0.54	0.01	0.00	0.56	0.24

71	WET_POND	4/16/72 2:00	5	55	0.16	0.00	0.16	2.91	0.26	0.34	0.94	0.88	0.23	0.05	0.01	1.16	0.10	0.58	0.01	0.00	0.60	0.26
72	WET_POND	4/18/72 9:00	2	54	0.02	0.00	0.02	2.86	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.01
73	WET_POND	4/20/72 15:00	5	24	0.08	0.00	0.08	2.88	0.11	0.12	0.32	0.12	0.02	0.00	0.00	0.14	0.03	0.20	0.00	0.00	0.21	0.08
74	WET_POND	4/21/72 15:00	12	42	0.21	0.00	0.21	2.93	0.33	0.48	1.30	2.23	0.68	0.14	0.02	3.07	0.14	0.82	0.02	0.00	0.83	0.39
75	WET_POND	4/23/72 9:00	9	91	0.06	0.00	0.06	2.88	0.08	0.13	0.36	0.35	0.00	0.00	0.00	0.35	0.04	0.22	0.01	0.00	0.23	0.10
76	WET_POND	4/27/72 4:00	5	19	0.07	0.00	0.07	2.88	0.10	0.08	0.23	0.09	0.01	0.00	0.00	0.10	0.02	0.14	0.00	0.00	0.15	0.06
77	WET_POND	4/27/72 23:00	5	55	0.16	0.00	0.16	2.92	0.27	0.38	1.05	0.97	0.26	0.06	0.01	1.30	0.11	0.65	0.01	0.00	0.67	0.29
78	WET_POND	4/30/72 6:00	26	56	0.74	0.00	0.74	3.08	0.98	1.76	4.79	19.26	5.67	1.08	0.16	26.17	0.57	3.26	0.07	0.01	3.11	1.79
79	WET_POND	5/2/72 14:00	1	131	0.02	0.00	0.02	2.87	0.05	0.05	0.15	0.29	0.00	0.00	0.00	0.29	0.02	0.09	0.00	0.00	0.09	0.04
80	WET_POND	5/8/72 1:00	16	55	0.09	0.00	0.09	2.88	0.10	0.17	0.46	0.19	0.02	0.00	0.00	0.21	0.05	0.28	0.01	0.00	0.30	0.12
81	WET_POND	5/10/72 8:00	23	100	0.47	0.00	0.47	2.99	0.58	1.13	3.08	8.06	2.23	0.47	0.07	10.82	0.35	2.01	0.05	0.01	1.99	1.01
82	WET_POND	5/14/72 12:00	7	185	0.05	0.00	0.05	2.87	0.05	0.08	0.21	0.15	0.00	0.00	0.00	0.15	0.02	0.13	0.00	0.00	0.13	0.06
83	WET_POND	5/22/72 5:00	6	234	0.10	0.00	0.10	2.89	0.15	0.20	0.55	0.16	0.05	0.01	0.00	0.22	0.05	0.33	0.01	0.00	0.35	0.14
84	WET_POND	5/31/72 23:00	3	18	0.08	0.00	0.08	2.88	0.12	0.11	0.29	0.07	0.03	0.01	0.00	0.12	0.03	0.18	0.00	0.00	0.19	0.07
85	WET_POND	6/1/72 17:00	2	22	0.49	0.00	0.49	3.08	1.00	0.97	2.63	15.85	7.01	1.67	0.18	24.71	0.35	1.94	0.04	0.01	1.72	1.21
86	WET_POND	6/2/72 15:00	14	49	0.31	0.00	0.31	2.98	0.56	0.95	2.57	10.46	0.42	0.06	0.01	10.95	0.30	1.71	0.04	0.01	1.66	0.89
87	WET_POND	6/4/72 16:00	2	40	0.06	0.00	0.06	2.88	0.11	0.13	0.36	0.77	0.01	0.00	0.00	0.78	0.04	0.23	0.01	0.00	0.23	0.11
88	WET_POND	6/6/72 8:00	5	25	0.03	0.00	0.03	2.86	0.03	0.03	0.07	0.08	0.00	0.00	0.00	0.08	0.01	0.04	0.00	0.00	0.05	0.02
89	WET_POND	6/7/72 9:00	11	100	0.59	0.00	0.59	3.08	0.98	1.44	3.90	12.60	3.64	0.76	0.12	17.12	0.45	2.60	0.06	0.01	2.53	1.36
90	WET_POND	6/11/72 13:00	1	62	0.06	0.00	0.06	2.88	0.09	0.10	0.27	0.29	0.02	0.01	0.00	0.31	0.03	0.17	0.00	0.00	0.18	0.08
91	WET_POND	6/14/72 3:00	1	159	0.01	0.00	0.01	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
92	WET_POND	6/20/72 18:00	7	47	0.08	0.00	0.08	2.88	0.10	0.14	0.39	0.08	0.02	0.00	0.00	0.11	0.04	0.24	0.01	0.00	0.25	0.10
93	WET_POND	6/22/72 17:00	9	129	0.80	0.00	0.80	3.18	1.42	1.96	5.34	26.94	9.30	1.69	0.21	38.13	0.67	3.77	0.09	0.02	3.48	2.19
94	WET_POND	6/28/72 2:00	30	196	1.18	0.00	1.18	3.17	1.41	2.91	7.92	33.11	6.50	1.39	0.20	41.21	0.94	5.36	0.12	0.02	5.13	2.91
95	WET_POND	7/6/72 6:00	1	13	0.12	0.00	0.12	2.90	0.21	0.15	0.41	0.61	0.26	0.07	0.01	0.95	0.04	0.26	0.01	0.00	0.26	0.12
96	WET_POND	7/6/72 19:00	7	21	0.92	0.00	0.92	3.22	1.61	1.73	4.70	24.31	8.22	1.45	0.18	34.16	0.60	3.33	0.08	0.02	3.06	1.94
97	WET_POND	7/7/72 16:00	2	58	0.14	0.00	0.14	3.02	0.73	0.92	2.50	9.39	0.42	0.05	0.01	9.87	0.29	1.65	0.04	0.01	1.62	0.85
98	WET_POND	7/10/72 2:00	1	36	0.01	0.00	0.01	2.86	0.01	0.01	0.03	0.06	0.00	0.00	0.00	0.06	0.00	0.02	0.00	0.00	0.02	0.01
99	WET_POND	7/11/72 14:00	12	27	0.15	0.00	0.15	2.90	0.21	0.25	0.68	0.89	0.12	0.03	0.00	1.04	0.07	0.42	0.01	0.00	0.43	0.19
100	WET_POND	7/12/72 17:00	1	65	0.02	0.00	0.02	2.87	0.07	0.08	0.21	0.21	0.00	0.00	0.00	0.21	0.02	0.13	0.00	0.00	0.14	0.06
101	WET_POND	7/15/72 10:00	8	48	0.14	0.00	0.14	2.90	0.19	0.29	0.79	0.63	0.12	0.03	0.00	0.78	0.08	0.49	0.01	0.00	0.51	0.21
102	WET_POND	7/17/72 10:00	5	53	0.22	0.00	0.22	2.94	0.36	0.50	1.36	2.08	0.58	0.12	0.02	2.79	0.15	0.86	0.02	0.00	0.88	0.40
103	WET_POND	7/19/72 15:00	1	17	0.06	0.00	0.06	2.88	0.10	0.08	0.21	0.22	0.03	0.01	0.00	0.25	0.02	0.13	0.00	0.00	0.14	0.06
104	WET_POND	7/20/72 8:00	3	19	0.10	0.00	0.10	2.90	0.18	0.17	0.46	0.60	0.12	0.03	0.00	0.76	0.05	0.29	0.01	0.00	0.30	0.13
105	WET_POND	7/21/72 3:00	2	47	0.06	0.00	0.06	2.89	0.13	0.16	0.43	0.45	0.02	0.00	0.00	0.48	0.04	0.27	0.01	0.00	0.28	0.12
106	WET_POND	7/23/72 2:00	5	59	0.04	0.00	0.04	2.87	0.04	0.05	0.15	0.08	0.00	0.00	0.00	0.08	0.02	0.09	0.00	0.00	0.10	0.04
107	WET_POND	7/25/72 13:00	29	86	0.72	0.00	0.72	3.10	1.06	1.74	4.73	20.68	6.28	1.42	0.22	28.60	0.58	3.26	0.07	0.01	3.07	1.83
108	WET_POND	7/29/72 3:00	5	22	0.69	0.00	0.69	3.11	1.14	1.31	3.57	17.14	4.26	0.86	0.09	22.34	0.44	2.47	0.06	0.01	2.32	1.39
109	WET_POND	7/30/72 1:00	3	28	0.28	0.00	0.28	3.03	0.78	0.90	2.45	9.89	0.94	0.20	0.04	11.07	0.28	1.63	0.04	0.01	1.58	0.86

110	WET_POND	7/31/72 5:00	2	16	0.08	0.00	0.08	2.91	0.23	0.20	0.53	1.54	0.05	0.01	0.00	1.60	0.06	0.34	0.01	0.00	0.34	0.17
111	WET_POND	7/31/72 21:00	4	77	1.49	0.00	1.49	3.53	3.00	4.18	11.37	40.35	8.60	1.59	0.14	50.69	1.32	7.58	0.17	0.03	7.36	3.98
112	WET_POND	8/4/72 2:00	7	124	1.00	0.00	1.00	3.30	1.96	2.82	7.68	28.64	7.64	1.35	0.16	37.78	0.90	5.17	0.12	0.02	4.97	2.77
113	WET_POND	8/9/72 6:00	3	144	0.06	0.00	0.06	2.88	0.08	0.10	0.27	0.19	0.01	0.00	0.00	0.20	0.03	0.17	0.00	0.00	0.18	0.07
114	WET_POND	8/15/72 6:00	11	36	0.53	0.00	0.53	3.03	0.76	1.14	3.09	14.76	4.69	0.93	0.13	20.52	0.38	2.16	0.05	0.01	2.01	1.24
115	WET_POND	8/16/72 18:00	3	320	0.30	0.00	0.30	3.01	0.67	0.84	2.30	8.99	1.02	0.25	0.04	10.30	0.27	1.53	0.03	0.01	1.49	0.81
116	WET_POND	8/30/72 2:00	83	107	1.15	0.00	1.15	3.09	1.02	2.80	7.61	35.87	8.74	1.98	0.22	46.81	0.93	5.27	0.12	0.02	4.95	2.96
117	WET_POND	9/3/72 13:00	29	128	0.46	0.00	0.46	3.00	0.62	1.14	3.10	8.26	1.48	0.33	0.06	10.13	0.35	2.01	0.05	0.01	2.00	1.00
118	WET_POND	9/8/72 21:00	8	91	0.04	0.00	0.04	2.87	0.04	0.05	0.14	0.06	0.00	0.00	0.00	0.07	0.01	0.08	0.00	0.00	0.09	0.04
119	WET_POND	9/12/72 16:00	1	26	0.03	0.00	0.03	2.86	0.02	0.02	0.06	0.01	0.00	0.00	0.00	0.01	0.01	0.03	0.00	0.00	0.04	0.01
120	WET_POND	9/13/72 18:00	13	33	0.13	0.00	0.13	2.90	0.21	0.23	0.62	0.76	0.30	0.07	0.01	1.14	0.07	0.39	0.01	0.00	0.40	0.18
121	WET_POND	9/15/72 3:00	13	91	0.35	0.00	0.35	2.98	0.54	0.88	2.39	6.01	1.46	0.30	0.05	7.82	0.27	1.55	0.04	0.01	1.54	0.77
122	WET_POND	9/18/72 22:00	7	68	0.10	0.00	0.10	2.89	0.13	0.20	0.55	0.54	0.05	0.01	0.00	0.61	0.06	0.34	0.01	0.00	0.35	0.15
123	WET_POND	9/21/72 18:00	8	183	0.31	0.00	0.31	2.96	0.44	0.73	1.98	6.12	1.87	0.40	0.06	8.45	0.23	1.32	0.03	0.01	1.28	0.69
124	WET_POND	9/29/72 9:00	11	120	0.41	0.00	0.41	3.01	0.68	0.98	2.66	7.61	2.54	0.53	0.09	10.76	0.30	1.76	0.04	0.01	1.72	0.91
125	WET_POND	10/4/72 9:00	11	70	0.60	0.00	0.60	3.07	0.96	1.44	3.92	15.39	4.75	1.00	0.15	21.29	0.47	2.67	0.06	0.01	2.54	1.46
126	WET_POND	10/7/72 7:00	3	114	0.03	0.00	0.03	2.86	0.03	0.04	0.11	0.17	0.00	0.00	0.00	0.17	0.01	0.07	0.00	0.00	0.07	0.03
127	WET_POND	10/12/72 1:00	13	67	0.13	0.00	0.13	2.89	0.16	0.27	0.74	0.38	0.05	0.01	0.00	0.44	0.08	0.45	0.01	0.00	0.48	0.20
128	WET_POND	10/14/72 20:00	2	125	0.15	0.00	0.15	2.92	0.26	0.33	0.90	1.39	0.46	0.11	0.02	1.98	0.10	0.57	0.01	0.00	0.58	0.27
129	WET_POND	10/20/72 1:00	34	227	0.00	0.23	0.23	2.93	0.32	0.53	1.44	0.77	0.18	0.04	0.01	1.00	0.15	0.88	0.02	0.00	0.92	0.38
130	WET_POND	10/29/72 12:00	12	58	0.62	0.00	0.62	3.09	1.05	1.48	4.01	15.63	5.58	1.12	0.17	22.51	0.48	2.74	0.06	0.01	2.60	1.51
131	WET_POND	10/31/72 22:00	7	178	0.14	0.00	0.14	2.91	0.22	0.33	0.90	1.69	0.05	0.01	0.00	1.76	0.10	0.57	0.01	0.00	0.58	0.26
132	WET_POND	11/8/72 8:00	23	62	0.50	0.00	0.50	3.01	0.69	1.17	3.18	6.13	1.94	0.39	0.07	8.53	0.35	2.04	0.05	0.01	2.05	0.99
133	WET_POND	11/10/72 22:00	19	171	1.00	0.00	1.00	3.18	1.44	2.64	7.19	30.60	7.78	1.43	0.21	40.02	0.86	4.91	0.11	0.02	4.66	2.70
134	WET_POND	11/18/72 1:00	30	1056	0.07	0.02	0.09	2.88	0.11	0.18	0.48	0.18	0.02	0.00	0.00	0.20	0.05	0.29	0.01	0.00	0.31	0.12

P8 Urban Catchment Model, Version 3.4				Run Date	12/28/11
Case	Big_Butternut.p8c	FirstDate	01/01/71	Precip(in)	50.4
Title	Startup Case	LastDate	12/31/72	Rain(in)	40.76
PrecFile	msp_4989.pcp	Events	134	Snow(in)	9.67

PartFile	nurp50.p8p	TotalHrs	16440	TotalYrs	1.88

Concentration Statistics Events with Rainfall + Snowmelt > 0.05 inches

Term: 01 watershed inflows

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
WET_POND	P0%	109	1.000	1.000	0.000	1.000	1.000						
WET_POND	P10%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P30%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P50%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P80%	109	35.835	47.775	0.638	5.263	129.356						
WET_POND	TSS	109	89.588	119.437	0.638	13.156	323.391	100%	100%	99%	5.000	10.000	20.000
WET_POND	TP	109	0.306	0.375	0.470	0.129	0.846	100%	100%	100%	0.025	0.050	0.100
WET_POND	TKN	109	1.406	1.675	0.410	0.718	3.511	28%	83%	100%	2.000	1.000	0.500
WET_POND	CU	109	0.044	0.054	0.478	0.018	0.124	0%	100%	99%	2.000	0.005	0.020
WET_POND	PB	109	0.018	0.023	0.584	0.004	0.060	53%	71%	0%	0.020	0.014	0.150
WET_POND	ZN	109	0.726	0.755	0.097	0.653	0.950	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	109	2.266	2.937	0.584	0.546	7.526	100%	100%	90%	0.100	0.500	1.000

Term: 02 upstream device

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 03 infiltrate

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 04 exfiltrate

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 06 normal outlet

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
WET_POND	P0%	109	0.999	1.000	0.001	0.991	1.000						
WET_POND	P10%	109	3.117	2.385	0.690	0.072	6.592						
WET_POND	P30%	109	0.833	0.598	0.996	0.013	2.667						
WET_POND	P50%	109	0.176	0.128	1.027	0.003	0.634						
WET_POND	P80%	109	0.028	0.018	0.995	0.000	0.122						
WET_POND	TSS	109	4.154	3.129	0.742	0.091	9.819	23%	0%	0%	5.000	10.000	20.000
WET_POND	TP	109	0.115	0.111	0.080	0.098	0.136	100%	100%	96%	0.025	0.050	0.100
WET_POND	TKN	109	0.662	0.646	0.054	0.596	0.745	0%	0%	100%	2.000	1.000	0.500
WET_POND	CU	109	0.015	0.015	0.054	0.014	0.017	0%	100%	0%	2.000	0.005	0.020
WET_POND	PB	109	0.003	0.003	0.163	0.002	0.004	0%	0%	0%	0.020	0.014	0.150
WET_POND	ZN	109	0.646	0.645	0.006	0.635	0.656	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	109	0.343	0.320	0.163	0.250	0.471	100%	0%	0%	0.100	0.500	1.000

Term: 07 spillway outlet

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
WET_POND	P0%	2	1.000	0.999	0.001	0.998	1.000						
WET_POND	P10%	2	6.311	5.178	0.475	3.438	6.918						
WET_POND	P30%	2	3.638	2.699	0.756	1.256	4.142						

WET_POND	P50%	2	1.359	0.938	0.974	0.292	1.584						
WET_POND	P80%	2	0.501	0.327	1.153	0.060	0.594						
WET_POND	TSS	2	11.810	9.142	0.634	5.046	13.238	100%	50%	0%	5.000	10.000	20.000
WET_POND	TP	2	0.143	0.133	0.158	0.118	0.148	100%	100%	100%	0.025	0.050	0.100
WET_POND	TKN	2	0.769	0.732	0.112	0.674	0.790	0%	0%	100%	2.000	1.000	0.500
WET_POND	CU	2	0.018	0.017	0.119	0.015	0.018	0%	100%	0%	2.000	0.005	0.020
WET_POND	PB	2	0.004	0.004	0.287	0.003	0.004	0%	0%	0%	0.020	0.014	0.150
WET_POND	ZN	2	0.658	0.654	0.014	0.647	0.660	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	2	0.516	0.455	0.287	0.363	0.548	100%	50%	0%	0.100	0.500	1.000

Term: 09 total inflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
WET_POND	P0%	109	1.000	1.000	0.000	1.000	1.000						
WET_POND	P10%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P30%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P50%	109	17.918	23.887	0.638	2.631	64.678						
WET_POND	P80%	109	35.835	47.775	0.638	5.263	129.356						
WET_POND	TSS	109	89.588	119.437	0.638	13.156	323.391	100%	100%	99%	5.000	10.000	20.000
WET_POND	TP	109	0.306	0.375	0.470	0.129	0.846	100%	100%	100%	0.025	0.050	0.100
WET_POND	TKN	109	1.406	1.675	0.410	0.718	3.511	28%	83%	100%	2.000	1.000	0.500
WET_POND	CU	109	0.044	0.054	0.478	0.018	0.124	0%	100%	99%	2.000	0.005	0.020
WET_POND	PB	109	0.018	0.023	0.584	0.004	0.060	53%	71%	0%	0.020	0.014	0.150
WET_POND	ZN	109	0.726	0.755	0.097	0.653	0.950	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	109	2.266	2.937	0.584	0.546	7.526	100%	100%	90%	0.100	0.500	1.000

Term: 10 surface outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
WET_POND	P0%	109	0.999	1.000	0.001	0.991	1.000						
WET_POND	P10%	109	3.261	2.387	0.691	0.072	6.736						
WET_POND	P30%	109	0.960	0.605	1.026	0.013	3.222						
WET_POND	P50%	109	0.230	0.132	1.144	0.003	1.038						
WET_POND	P80%	109	0.049	0.020	1.668	0.000	0.330						
WET_POND	TSS	109	4.500	3.144	0.753	0.091	11.325	23%	1%	0%	5.000	10.000	20.000
WET_POND	TP	109	0.116	0.111	0.082	0.098	0.141	100%	100%	96%	0.025	0.050	0.100
WET_POND	TKN	109	0.666	0.647	0.055	0.596	0.765	0%	0%	100%	2.000	1.000	0.500
WET_POND	CU	109	0.015	0.015	0.055	0.014	0.017	0%	100%	0%	2.000	0.005	0.020
WET_POND	PB	109	0.003	0.003	0.166	0.002	0.004	0%	0%	0%	0.020	0.014	0.150
WET_POND	ZN	109	0.647	0.645	0.006	0.635	0.658	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	109	0.351	0.321	0.166	0.250	0.505	100%	1%	0%	0.100	0.500	1.000

Term: 11 groundw outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 12 total outflow

Device	Variable	Cou	FW	Mean	CV	Min	Max	Freq>	Freq	Freq	A	B	C

		nt	M					A	>B	>C	ppm	ppm	ppm
WET_POND	P0%	109	0.999	1.000	0.001	0.991	1.000						
WET_POND	P10%	109	3.261	2.387	0.691	0.072	6.736						
WET_POND	P30%	109	0.960	0.605	1.026	0.013	3.222						
WET_POND	P50%	109	0.230	0.132	1.144	0.003	1.038						
WET_POND	P80%	109	0.049	0.020	1.668	0.000	0.330						
WET_POND	TSS	109	4.500	3.144	0.753	0.091	11.325	23%	1%	0%	5.000	10.000	20.000
WET_POND	TP	109	0.116	0.111	0.082	0.098	0.141	100%	100%	96%	0.025	0.050	0.100
WET_POND	TKN	109	0.666	0.647	0.055	0.596	0.765	0%	0%	100%	2.000	1.000	0.500
WET_POND	CU	109	0.015	0.015	0.055	0.014	0.017	0%	100%	0%	2.000	0.005	0.020
WET_POND	PB	109	0.003	0.003	0.166	0.002	0.004	0%	0%	0%	0.020	0.014	0.150
WET_POND	ZN	109	0.647	0.645	0.006	0.635	0.658	0%	100%	100%	5.000	0.036	0.380
WET_POND	HC	109	0.351	0.321	0.166	0.250	0.505	100%	1%	0%	0.100	0.500	1.000

P8 Urban Catchment Model, Version 3.4					Run Date	12/28/11
Case	Big_Butternut.p8c		FirstDate	01/01/71	Precip(in)	50.4
Title	Startup Case		LastDate	12/31/72	Rain(in)	40.76
PrecFile	msp_4989.pcp		Events	134	Snow(in)	9.67
PartFile	nurp50.p8p		TotalHrs	16440	TotalYrs	1.88

Flow-Wtd-Mean Concs (ppm) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	P0%	P10%	P30%	P50%	P80%	TSS	TP	TKN	CU	PB	ZN	HC
WET_POND	POND	0.13	170.9	1.00	3.26	0.96	0.23	0.05	4.50	0.12	0.67	0.02	0.00	0.65	0.35

Outflow Loads (lbs) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	P0%	P10%	P30%	P50%	P80%	TSS	TP	TKN	CU	PB	ZN	HC
WET_POND	POND	0.13	170.9	464.23	1514.79	445.93	106.67	22.76	2090.14	53.92	309.55	7.02	1.30	300.41	163.09

Removal Efficiency (%)

Device	Type	QoMeancfs	QVolAcft	P0%	P10%	P30%	P50%	P80%	TSS	TP	TKN	CU	PB	ZN	HC
WET_POND	POND	0.13	170.9	0.00	81.80	94.64	98.72	99.86	94.98	62.04	52.59	65.66	84.50	10.87	84.50

Mass Balance Error (%)

Device	Type	QoMeancfs	QVolAcft	P0%	P10%	P30%	P50%	P80%	TSS	TP	TKN	CU	PB	ZN	HC
WET_POND	POND	0.13	170.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P8 Urban Catchment Model, Version 3.4					Run Date	12/28/11
Case	Big_Butternut.p8c		FirstDate	01/01/71	Precip(in)	50.4
Title	Startup Case		LastDate	12/31/72	Rain(in)	40.76
PrecFile	msp_4989.pcp		Events	134	Snow(in)	9.67
PartFile	nurp50.p8p		TotalHrs	16440	TotalYrs	1.88

Mass Balances by Variable

Variable: Flow	Flow ac-ft	
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	170.89	
06 normal outlet	163.16	
07 spillway outlet	7.73	
09 total inflow	170.89	
10 surface outflow	170.89	
12 total outflow	170.89	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	0.00	

Variable: P0%	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	464.48	1.00
06 normal outlet	443.23	1.00
07 spillway outlet	21.00	1.00
09 total inflow	464.48	1.00
10 surface outflow	464.23	1.00
12 total outflow	464.23	1.00
14 storage increase	0.24	
15 mass balance check	0.01	
Load Reduction (%)	0.00	

Variable: P10%	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	8322.46	17.92
06 normal outlet	1382.20	3.12
07 spillway outlet	132.58	6.31
08 sedimen + decay	6807.67	
09 total inflow	8322.46	17.92
10 surface outflow	1514.79	3.26
12 total outflow	1514.79	3.26
13 total trapped	6807.67	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	81.80	

Variable: P30%	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	8322.46	17.92
06 normal outlet	369.49	0.83
07 spillway outlet	76.44	3.64
08 sedimen + decay	7876.53	
09 total inflow	8322.46	17.92
10 surface outflow	445.93	0.96
12 total outflow	445.93	0.96
13 total trapped	7876.53	
14 storage increase	0.00	

15 mass balance check	0.00
Load Reduction (%)	94.64

Variable: P50%	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	8322.46	17.92
06 normal outlet	78.12	0.18
07 spillway outlet	28.55	1.36
08 sedimen + decay	8215.79	
09 total inflow	8322.46	17.92
10 surface outflow	106.67	0.23
12 total outflow	106.67	0.23
13 total trapped	8215.79	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	98.72	

Variable: P80%	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	16644.92	35.84
06 normal outlet	12.23	0.03
07 spillway outlet	10.53	0.50
08 sedimen + decay	16622.16	
09 total inflow	16644.92	35.84
10 surface outflow	22.76	0.05
12 total outflow	22.76	0.05
13 total trapped	16622.16	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	99.86	

Variable: TSS	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	41612.30	89.59
06 normal outlet	1842.04	4.15
07 spillway outlet	248.10	11.81
08 sedimen + decay	39522.15	
09 total inflow	41612.30	89.59
10 surface outflow	2090.14	4.50
12 total outflow	2090.14	4.50
13 total trapped	39522.15	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	94.98	

Variable: TP	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	142.11	0.31
06 normal outlet	50.92	0.11
07 spillway outlet	2.99	0.14
08 sedimen + decay	88.16	
09 total inflow	142.11	0.31
10 surface outflow	53.92	0.12
12 total outflow	53.92	0.12
13 total trapped	88.16	
14 storage increase	0.02	
15 mass balance check	0.00	

Load Reduction (%)	62.04

Variable: TKN	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	653.20	1.41
06 normal outlet	293.38	0.66
07 spillway outlet	16.16	0.77
08 sedimen + decay	343.50	
09 total inflow	653.20	1.41
10 surface outflow	309.55	0.67
12 total outflow	309.55	0.67
13 total trapped	343.50	
14 storage increase	0.14	
15 mass balance check	0.01	
Load Reduction (%)	52.59	

Variable: CU	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	20.47	0.04
06 normal outlet	6.65	0.02
07 spillway outlet	0.37	0.02
08 sedimen + decay	13.44	
09 total inflow	20.47	0.04
10 surface outflow	7.02	0.02
12 total outflow	7.02	0.02
13 total trapped	13.44	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	65.66	

Variable: PB	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	8.42	0.02
06 normal outlet	1.22	0.00
07 spillway outlet	0.09	0.00
08 sedimen + decay	7.11	
09 total inflow	8.42	0.02
10 surface outflow	1.30	0.00
12 total outflow	1.30	0.00
13 total trapped	7.11	
14 storage increase	0.00	
15 mass balance check	0.00	
Load Reduction (%)	84.50	

Variable: ZN	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	337.22	0.73
06 normal outlet	286.59	0.65
07 spillway outlet	13.82	0.66
08 sedimen + decay	36.64	
09 total inflow	337.22	0.73
10 surface outflow	300.41	0.65
12 total outflow	300.41	0.65
13 total trapped	36.64	
14 storage increase	0.15	
15 mass balance check	0.01	
Load Reduction (%)	10.87	

Variable: HC	Loads(lbs)	Concs (ppm)
Mass Balance Term	WET_POND	WET_POND
01 watershed inflows	1052.40	2.27
06 normal outlet	152.25	0.34
07 spillway outlet	10.83	0.52
08 sedimen + decay	889.25	
09 total inflow	1052.40	2.27
10 surface outflow	163.09	0.35
12 total outflow	163.09	0.35
13 total trapped	889.25	
14 storage increase	0.06	
15 mass balance check	0.00	
Load Reduction (%)	84.50	

P-8 Phosphorus

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	170.9	142.1	0.3	0.1	75.8
06 normal outlet	163.2	50.9	0.1	0.1	27.2
07 spillway outlet	7.7	3	0.1	0	1.6
08 sedimen + decay	0	88.2		0	47
09 total inflow	170.9	142.1	0.3	0.1	75.8
10 surface outflow	170.9	53.9	0.1	0.1	28.7
12 total outflow	170.9	53.9	0.1	0.1	28.7
13 total trapped	0	88.2		0	47
14 storage increase	0	0		0	0
15 mass balance check	0	0		0	0
Load Reduction %	0	62			
Mass Balance Error %	0	0			

Stormwater BBLPRD 1

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	33	26.6	0.3	0	14.2
06 normal outlet	33	8.3	0.1	0	4.4
08 sedimen + decay	0	17.3		0	9.2
09 total inflow	33	26.6	0.3	0	14.2
10 surface outflow	33	8.3	0.1	0	4.4
12 total outflow	33	8.3	0.1	0	4.4
13 total trapped	0	17.3		0	9.2
14 storage increase	0	0.9		0	0.5
15 mass balance check	0	0		0	0
Load Reduction %	0	65.1			
Mass Balance Error %	0	0			

Stormwater BBLPRD 2

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	84.6	77.8	0.3	0.1	41.5
06 normal outlet	84.6	25	0.1	0.1	13.3
08 sedimen + decay	0	52.7		0	28.1
09 total inflow	84.6	77.8	0.3	0.1	41.5
10 surface outflow	84.6	25	0.1	0.1	13.3
12 total outflow	84.6	25	0.1	0.1	13.3
13 total trapped	0	52.7		0	28.1
14 storage increase	0	0.2		0	0.1
15 mass balance check	0	0		0	0
Load Reduction %	0	67.7			
Mass Balance Error %	0	0			

Stormwater BBLPRD 3

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	22.7	19	0.3	0	10.1
06 normal outlet	22.7	5.1	0.1	0	2.7
08 sedimen + decay	0	12.7		0	6.8
09 total inflow	22.7	19	0.3	0	10.1
10 surface outflow	22.7	5.1	0.1	0	2.7
12 total outflow	22.7	5.1	0.1	0	2.7
13 total trapped	0	12.7		0	6.8
14 storage increase	0	1.2		0	0.6
15 mass balance check	0	0		0	0
Load Reduction %	0	66.9			
Mass Balance Error %	0	0			

Stormwater BBLPRD 4

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	14.6	12.2	0.3	0	6.5
06 normal outlet	14.6	2.7	0.1	0	1.4
08 sedimen + decay	0	8.2		0	4.4
09 total inflow	14.6	12.2	0.3	0	6.5
10 surface outflow	14.6	2.7	0.1	0	1.4
12 total outflow	14.6	2.7	0.1	0	1.4
13 total trapped	0	8.2		0	4.4
14 storage increase	0	1.3		0	0.7
15 mass balance check	0	0		0	0
Load Reduction %	0	67.2			
Mass Balance Error %	0	0			

Stormwater BBLPRD 5

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	19.4	16.2	0.3	0	8.6
06 normal outlet	19.4	4.1	0.1	0	2.2
08 sedimen + decay	0	10.8		0	5.8
09 total inflow	19.4	16.2	0.3	0	8.6
10 surface outflow	19.4	4.1	0.1	0	2.2
12 total outflow	19.4	4.1	0.1	0	2.2
13 total trapped	0	10.8		0	5.8
14 storage increase	0	1.3		0	0.7
15 mass balance check	0	0		0	0
Load Reduction %	0	67			
Mass Balance Error %	0	0			

Stormwater BBLPRD 6

Term	Flow ac-ft	Load lbs	Conc ppm	Flow cfs	Load lbs/yr
01 watershed inflows	24.9	21	0.3	0	11.2
06 normal outlet	24.9	5.8	0.1	0	3.1
08 sedimen + decay	0	14.1		0	7.5
09 total inflow	24.9	21	0.3	0	11.2
10 surface outflow	24.9	5.8	0.1	0	3.1
12 total outflow	24.9	5.8	0.1	0	3.1
13 total trapped	0	14.1		0	7.5
14 storage increase	0	1.1		0	0.6
15 mass balance check	0	0		0	0
Load Reduction %	0	67.1			
Mass Balance Error %	0	0			

Big Butternut Lake Management Plan

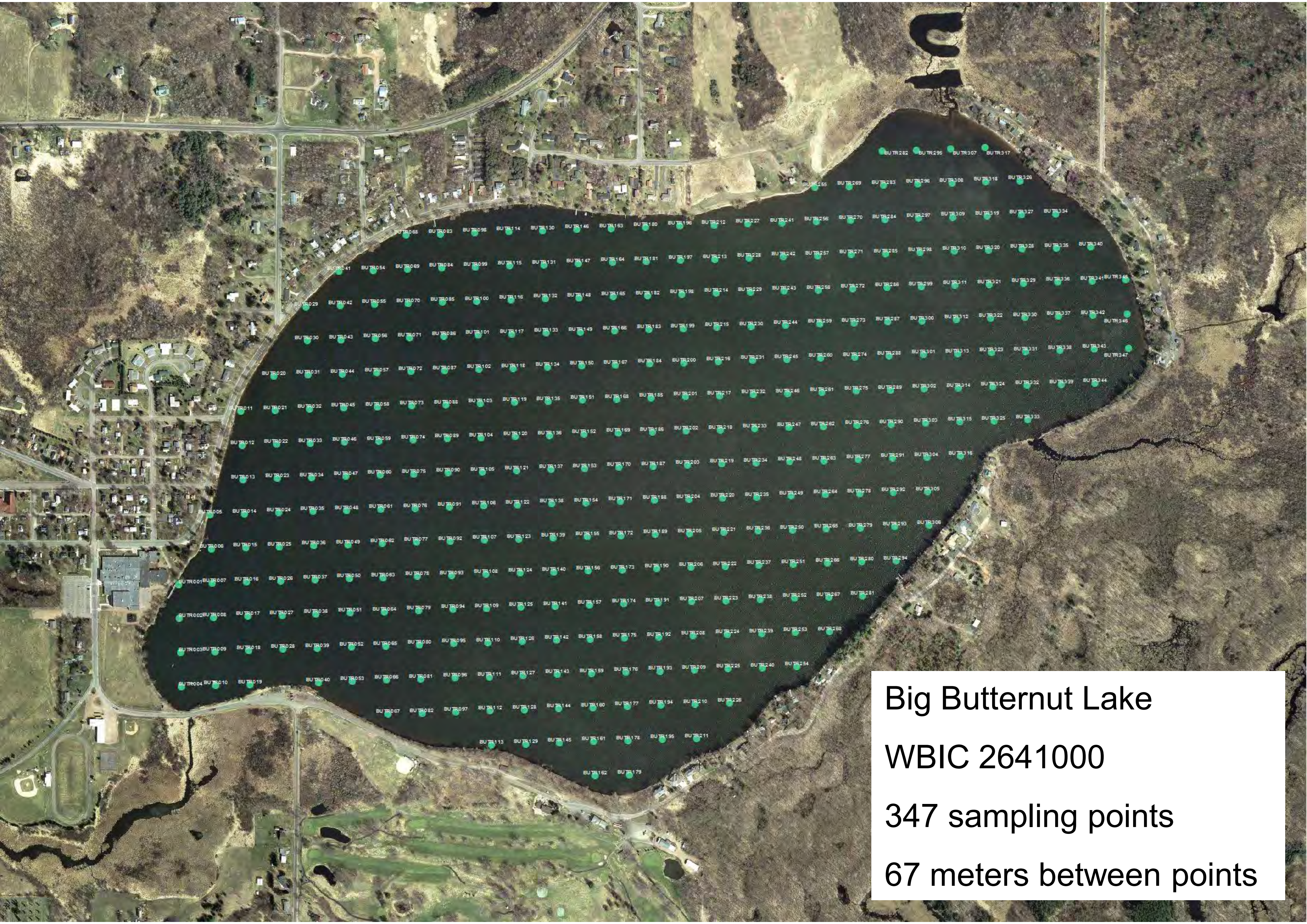
Presentation at Lake District Annual Meeting and Meeting Minutes

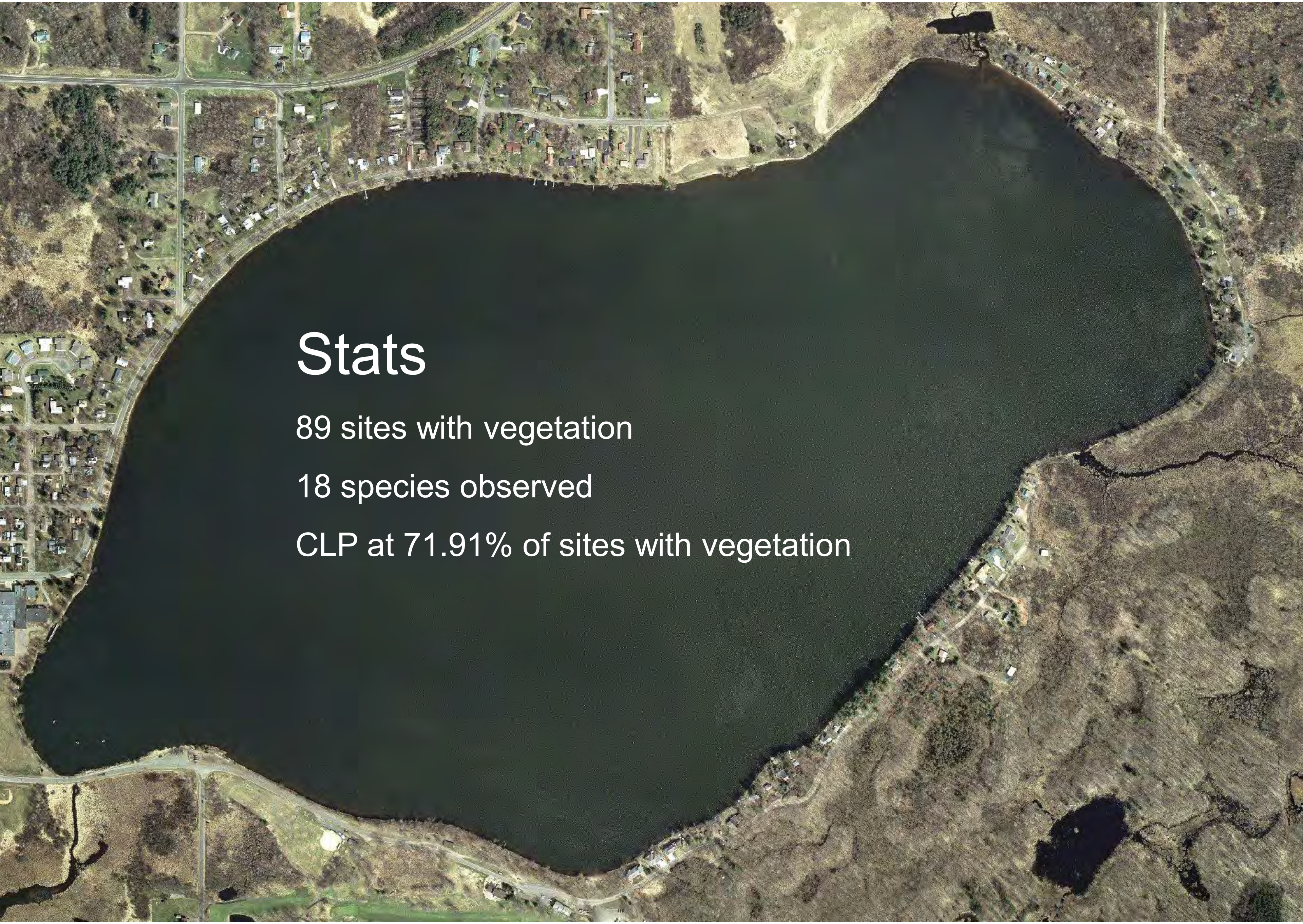
Appendix O

Land and Water Resources Department
12/31/2011

Big Butternut Aquatic Plant Management

Jeremy Williamson
Water Quality Specialist
Aquatic Invasive Species Coordinator


Big Butternut Lake
WBIC 2641000
347 sampling points
67 meters between points


Stats
89 sites with vegetation
18 species observed
CLP at 71.91% of sites with vegetation


41.43 acres CLP


FALL
WINTER
SPRING
SUMMER
FALL
ICE
© Copyright 2005, Freshwater Scientific Services, LLC

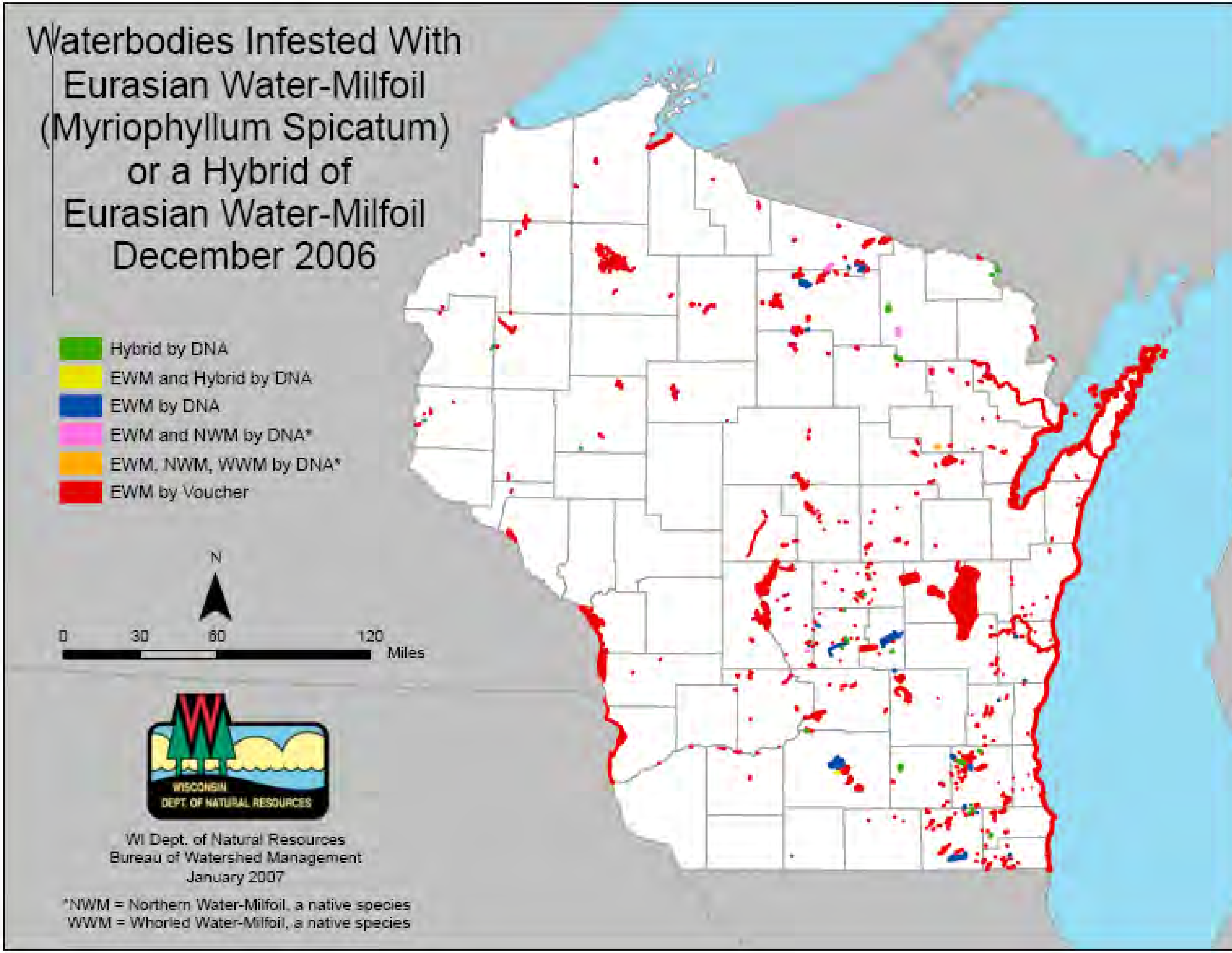
How much to manage?

- Toxic chemical used (diquat, endothall, or fluridone)
- Or purchase harvester
- $$$$$$$$$$
- Timing
- Finding a good applicator
- Must hire someone to monitor treatment pre and post

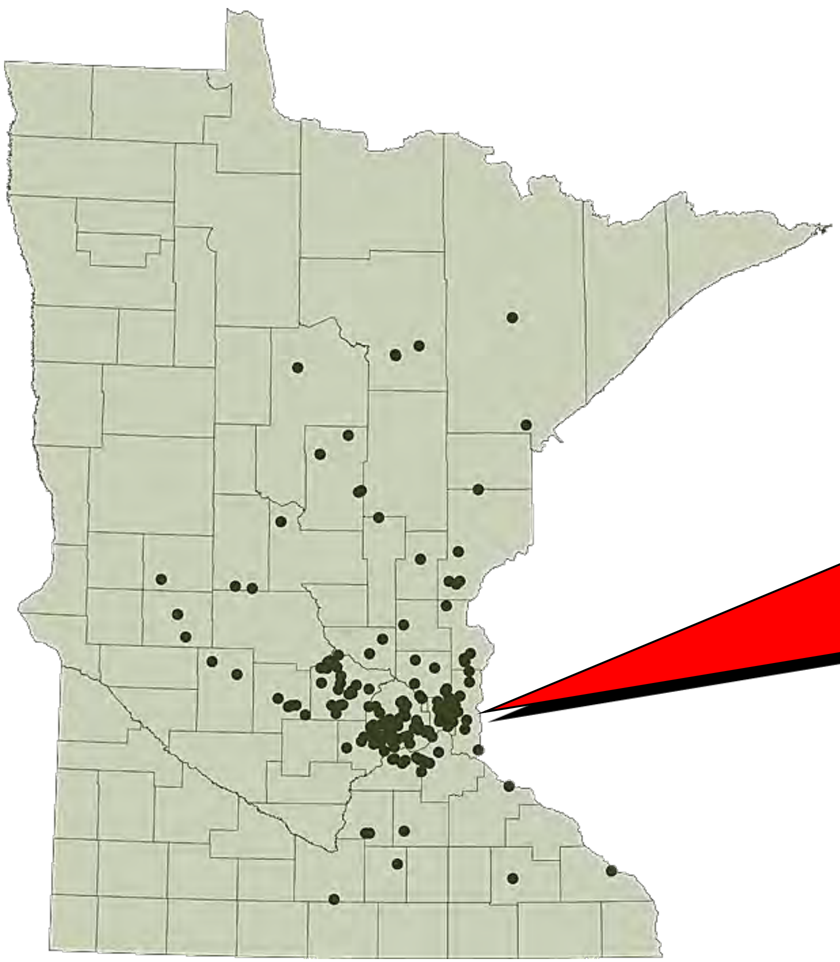
What is the Risk of EWM?

Eurasian Water Milfoil

- Make lakes/rivers unusable by boaters and swimmers
- Reduce native species
- Degrade ecosystems
- Affect human health
- Reduce property values
- Ruin boat engines and steering equipment


Waterbodies Infested With
Eurasian Water-Milfoil
(Myriophyllum Spicatum)
or a Hybrid of
Eurasian Water-Milfoil
December 2006
Hybrid by DNA
EWM and Hybrid by DNA
EWM by DNA
EWM and NWM by DNA*
EWM, NWM, WWM by DNA*
EWM by Voucher
N
0
30
60
120
Miles
WISCONSIN
DEPT. OF NATURAL RESOURCES
WI Dept. of Natural Resources
Bureau of Watershed Management
January 2007
*NWM = Northern Water-Milfoil, a native species
WWM = Whorled Water-Milfoil, a native species

Eurasian water milfoil infestation in Minnesota



128 lakes in the 7-county metro area are infested with EWM


07/20/2010

Clean Boats Clean Water

2007 – Data from 4 Polk County Lakes

<u>1210 Boats Inspected</u>

66% from WI

34% from another state

75% fishing boats

Clean Boats Clean Water

- 115 Boats entered the landing with vegetation attached
- 40 Boats were last used in a water body known to be infested
- 245 Boats were used within last 5 days
- 71 Boaters reported they used no prevention methods

Wisconsin Lakes

Aquatic Plants

Managing Aquatic Plants on Your Lake
- Permit Application Forms
- Rules
- Monitoring Protocols and Worksheets
- Guide to Aquatic Plant Mngt in Wisconsin (UWEX)
- Fact Sheet on Aquatic Plant Management (PDF)
- Contacts

More Wisconsin Resources
- Articles About Aquatic Plants
- Aquatic Plants and Algae in Ponds - Online Booklet
- Controlling Mosquitoes Around Your Home
- West Nile Virus and Wetlands (PDF, 232KB)
- Waterway-Wetland Permits
- Invasive Species
- Critical Habitat Areas
- DATCP
- North American Lake Mgmt. Soc.

Additional Resources
- Aquatic Plant Management

Wisconsin's Aquatic Plant Management and Protection Program

The role that trees play in a forest is much like the role of aquatic plants in a lake. We have become aware of the consequences of poor logging practices on the inhabitants of the forest ecosystem. We need to recognize that poor or irresponsible activities designed to control aquatic plants may have unanticipated and adverse effects on all the creatures that need and use the lake ecosystem... including us. Aquatic plants are the very foundation of a healthy lake ecosystem.

In order to protect diverse and stable communities of native aquatic plants and prevent the spread of invasive aquatic plants, many aquatic plant management and nuisance control activities require a permit issued by the Department. ***Please read the specific exceptions below and/or contact your local aquatic plant management coordinator before engaging in any aquatic plant management or nuisance control activities.***

WHY:

Aquatic plants form the foundation of healthy and flourishing lake ecosystems - both within lakes and rivers and on the shores around them. They not only protect water quality, but they also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake and river bottoms and reduce shoreline erosion by reducing the effect of waves and current. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants like Eurasian watermilfoil.

It makes sense that the best fishing spots are typically near aquatic plant beds. Aquatic plants provide important reproductive, food, and cover habitat for fish, invertebrates, and wildlife. It's aquatic plants that fashion a nursery for all sorts of creatures ranging from birds to beaver to bass to bugs. In order to maintain healthy lakes and rivers, we must maintain healthy native aquatic plant communities.

http://dnr.wi.gov/lakes/plants/

Any Questions?

BIG BUTTERNUT LAKE ASSOCIATION

ANNUAL MEETING

Luck Village Hall, August 22, 2009, 9:30 AM

The 29th Annual Meeting of the Big Butternut Lake Association was called to order by President Marty Messar. There were 18 people present.

Present were: Marty Messar, Ben Kustelski (Vice President), Jeannine Hastert (Treasurer), Gene Cooper (Village Board Member), Chuck McBrayer, Gary Zuckweiler, and Sandy Madsen (Secretary).

Introduction of the Board Members was held.

McBrayer made motion, Cooper seconded approval of the Agenda, approved.

The minutes of the 2008 Annual Meeting were read. Cooper asked for correction to be made to eliminate "railroad bridge" from the minutes, then made motion to accept minutes as read, McBrayer seconded, approved.

Messar introduced Jeremy Williamson, of the Polk County Land & Waters Department. He was here during Lucky Days and gave pontoon classroom tours to inform residents about his findings in Big Butternut Lake.

Williamson continued by giving an update on lake study grant process and progress. He has been on the lake collecting samples, mapping weed areas, etc. to apply for this grant. Until we do these surveys and present findings to the State of WI, no one can do any killing of weeds in Big Butternut. We will be applying for two grants, one for plant survey and one for water quality.

He has found that our sediment ponds are working well, that we have "nutela algae" in our lake, which is a good algae, any lake of less than 30' is very complex and he hopes to come up with a good comprehensive plan. This cannot be done in one year.

Williamson answered many questions asked by residents:

Storm water run off can be handled in residential areas by rain gardens and other areas and industrial areas by holding ponds. We would need engineers for this.
When we find out where our curley leaf areas are, we will address that by asking to spray areas.
Water shed on north side of Hwy. 48 by diverting to Hawkness Wetland Area - has been talked about in past, and will have a study done.
People watering lawns from lakes will be addressed, because they are putting phosphorus back on lawns that comes from the lake. This will be looked at.
What was Williamson's general opinion of our lake - "it was in pretty fair shape, even if everything in the lake was perfect, we would still be getting green in August".

Blood worms in lake, and lake flies that come from the lake are good things.
He quoted John Magnuson a Professor "There is no silver bullet - there is only silver buckshot".
We need certain bugs that attach to weeds for feeding small fish, then larger fish feed on them.
We need to change peoples' behavior and educate them.
If we see Japanese Knotweed & Chinese Lilac, inform our office and they will come out and remove it.
Which lake does he consider "good" in our area - maybe Pipe Lake - but not perfect.
Out sediment ponds are getting weeds growing around edges - they should be removed.
Illinois Pond Weed is a good weed for our lake.
Most lakes had a brown algae in June this year - not sure why it came, but then the spoors fall to the bottom of lake and can last for hundreds of years.
What is our time line - he hopes to set-up a "Plant Committee" by the fall to study problem areas & submit a plan by February 2010, so we could spray by Spring 2010.
His approximate figure we might have to spend (for bugeting purposes) would be between $3,000.00 and $6,000.00. This can be lowered by volunteers doing work needed. The government lowers our amount by $10.00 per man hour worked.
Why do the lakes in northern MN and WI seem to have less "green" - nutrients.
There are less farms up there because of ground quality - more farms here because of phosphorus in our ground, therefore, more "green" in our lakes.
Storm sewer filters - they were costly and now have found out they don't work that well and are not suggesting them anymore.
Polk County will be developing a storm water ordinance, which we could change to fit Big Butternut Lake.
35' is the suggested setback from the lake for vegetation. Start slowly to talk people into starting this program.

The Treasurer's Report was read, funds on hand as of 7-31-09 was $54,466.78. Cooper made motion, seconded by Ken Peterson, approved.

Zuckweiler gave update on Big Butternut Lake testing, and mentioned that Sandy Madsen was assisting him now. He stated there is a very good website to go to for information http://dnr.wi.gov/lakes/clmn/ He started testing in June, due to the fact that he had not received the new equipment until that time. May 21st secchi disc was 8 1/2', June 21st 7', July 3' and August 2'.

Cooper reported he got Swerkstrom to fill in hole at end of boat landing, and Molin Concrete Products to bring 5 or 6 12' concrete sections which were placed at the end of the material already in the lake. He said this worked out well, and total cost was $2,125.00.

Messer passed out copies of letter he wrote to Milltown Dock, asking them not to try out motors at end of our loading area on lake. No comment back from them. Seems as tho there has been no more problems.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]
[illegible]

BIG BUTTERNUT LAKE ASSOCIATION
ANNUAL MEETING
Luck Village Hall, August 21, 2010, 9:30 AM

The 30th Annual Meeting of the Big Butternut Lake Association was called to order by President Marty Massar. There were 32 people present.

Present were: Marty Messar, Gary Zuckweiler (Vice President), Jeannine Hastert (treasurer), Jake Jensen, Ken Peterson and Sandy Madsen (Secretary).
Absent was: Phil Warhol (Village Board Member)

Introduction of the Board Members was held.

Zuckweiler made motion, J. Hastert seconded approval of Agenda, approved.

The minutes of the 2009 Annual Meeting were read. Jensen made motion, _____ seconded, approved.

The Treasurer's Report was read, funds on hand as of 7-31-10 was $63,151.14. Fred Kreitz made motion, Zuckweiler seconded, approved.

Zuckweiler gave report on Big Butternut Lake testing during the summer. Temperatures of lake on 4-18-10 - 3' were 52.8 deg. and 18' were 51.4 deg. On 7-31-10 - 3' were 77 deg. and 18' were 65.6 deg. Secchi disc readings averaged approximately 2 1/2' during the summer.

Messar gave report on closing swimming beach for part of summer dealing with ecoli outbreak. He stated that because our beach is public, Polk County tests it for safety reasons. They test every Wednesday. When they get two good readings they open the lake for swimming. Hopefully it will be this next Wednesday.

Messar stated in talking to Jeremy Williamson (Polk County), he stated our Retention Ponds are working. In talking to Seth Peterson (Village of Luck Street Supervisor), he stated that they test the water in the sewer plant ponds to find out when they need to be dredged. We should have the Retention Ponds tested to see when we should dredge.

Messar stated on 9-25-10 at 9:00 AM at the Luck Village Hall there will be a meeting including Jeremy Williamson, to develop a plan to go forward from the results of the survey taken this past Spring. There needs to be as many members of our Assn. there as possible for input.

Peterson advised he has gone to several PCLAR meetings dealing with lakes, found very informative.

Motion by Bob Winter, seconded by Scott Leveen to have Bob Winters' two sons-in-law build a sign by the boat docking area for information, and the Association will pay for the materials, approved. He will contact Kristina Handt to have the Village Crew help with location & digging holes for posts.

Election of new officers: Marty Messar and Jeannine Hastert were up. Marty stated he was not going to run again, however Jeannine stated she would be willing to run again. Bob Winter was nominated to take Messar's board position. Mary Jo Kreitz made motion to cast a unanimous ballot for both, seconded by Dick Rasmussen, approved.

Jake Jensen volunteered himself & family to help keep the boat docks clear of the geese problems left behind. Kristina Handt volunteered to collect volunteer names from the Lake Association that would be willing to do things such as this that might come up in the future.

Jim Hastert made motion, seconded by Rasmussen to send $25.00 in dues to PCLAR, approved.

J. Hastert made motion, Sue Gilhoi seconded to spend $100.00 to apply for a permit to round-up geese on the lake, approved.

Jerry Kruse made motion, Dennis Kern seconded to spend up to $3,000.00 to "round-up" the geese on the lake in Spring of 2011, approved. Ken Peterson will get costs and present at 9-25-10 meeting.

We need to form an official committee for the meeting on 9-25-10 regarding our approach to clearing out some of the curley leaf weeds. Jensen made motion, Bob Winter seconded the motion to do an agenda and publishing the meeting, approved.

Motion by Zuckweiler, second by Jim Hastert to levy $8,000.00 from the Village of Luck, earmarked for dredging the retention ponds, approved.

Motion by Ken Peterson, seconded by Arlen Johnson to have Martin Dikkers review the financials for the Association, approved. This will go from 8-1-10 to 7-31-11, and will be presented at the 2011 Annual Meeting. The cost should not exceed $250.00.

Jim Hastert asked everyone to give Marty Messar a hand for all the work he has done as President of our Association.

Motion made and seconded to close the meeting, adjourned.

Respectfully submitted,

Sandy Madsen
Secretary

BIG BUTTERNUT LAKE ASSOCIATION
ANNUAL MEETING
Luck Village Hall, August 20,2011, 9:30 AM

The 31st Annual Meeting of the Big Butternut Lake Association was called to order by President Jake Jensen. There were 27 people present.

Present were: Jake Jensen, Gary Zuckweiler (Vice President), Jeannine Hastert (Treasurer), Ken Peterson, Bob Winter and Sandy Madsen (Secretary).
Absent was: Kristine King (Village Board Member)

Introduction of the Board Members was held.

Jensen made correction to the Agenda - After No. 3, Jesse Ashton will be introduced, as our local DNR officer.

Jim Hastert made motion, seconded by Gene Cooper to approve the Agenda, approved.

Jessie Ashton (who is now working the northern part of Polk County) gave update on fish in the lake and stocking lake with walleyes. In the past the DNR was stocking small walleyes and found that the bass were eating them. Now they are stocking 6" to 7" walleyes every other year. 4 years ago when they shocked the lake they found .7 walleyes per acre. When they shocked in the Spring of 2011 they found 3 walleyes per acre. He thought our lake level was ok, and said he knew of other lakes that were low. He stated he knew a few areas in our county that have a bow & arrow shoot for deer, also a shotgun shoot for geese. We would have to have the Village do an ordinance for such programs. His phone # is 715-472-2253.

The Secretary's Report was read, Marty Messar made motion, Gene Cooper seconded, approved.

The Treasurer's Report was read, funds on hand were $69,453.86. Cooper made motion, Joe Braun seconded, approved.

The inspection of the books & records relating to the Financial Report of Big Butternut Lake Association for the period from 8-1-2010 to 7-31-2011, was done by Cardinal Accounting. No material errors or omissions were found. The invoice was for $225.00, $25.00 under his estimate of cost.

Motion made by Sandy Madsen, seconded by Ken Peterson to continue doing the inspection of the books & records not to exceed $225.00 in the future upcoming years, approved.

Gary Zuckweiler gave report on the Clean Boats-Clean Waters program for this past summer. To date young people from the school have worked the Memorial Day and July 4th weekends. They have been trained, and either wear T-shirts or aprons denoting the program. They work shifts from 7:00 am until 5:00 pm. They have recorded 118 boats, 261 people contacted and 112 hours @ $8.00 per hour. So far this is a good program, and they have not run into any problems with people contacted.

Dick Rasmussen stated that 8-19-11 he viewed Milltown Marina power boat loading a boat at the boat dock area. We will write them another letter. It was so noted that the boat landing was in good shape. The Village has put material at the end of the concrete slabs, and someone has put blacktop material in holes on shore.

Messar stated that there were grants to help with the Clean Boats-Clean Waters people working at the boat landing. Motion by Cooper, seconded by Braun, and approved to continue the Clean Boats-Clean Waters Program. We are also looking for adults to take turns at the boat landing. A sign-up sheet will be available if anyone is interested.

Jensen gave Canada Geese Report - Jeannine applied for permit to oil eggs (which has no expiration date on permit), and eggs have been oiled. Mylar strips have been placed in areas to help keep out geese. Comment to contact school to apply to their area for next year. Winter stated he has counted approx. 70 geese this year so far, compared to 200 last fall. Part of the decrease could be from late spring and late ice out.

Winters gave report on new boat landing sign erected by his son-inlaws & himself. They donated labor, materials came to $911.80 and signage $1,097.00. Signage was less due to the fact we left the lower left 1/4 open for current postings.

Zuckweiler gave report on swim beach closing. It closed end of July for about three weeks this year.

The swim beach was not sprayed this summer, because we haven't had the final okay from Jeremy Williamson and the DNR. If we can spray next year, we could either get a hold of Jim Bartlett and the Barron High School (who Messar used to call) or the Acquatic Control Company we used to hire. Motion by Peterson, seconded by Sue Gilhoi to spray the beach in 2012 if we get permission to do so, approved.

Election of new officers: Sandy Madsen, Secretary and Gary Zuckweiler, Vice President are up. Motion by Gilhoi, seconded by Cooper to nominate Madsen, approved. Zuckweiler has decided not to run again. Motion by Winter, seconded by Dick Rasmussen to nominate Sherrie Johnson for this position, approved.

PCLA dues of $25.00 - motion by Peterson, seconded by Mary Jo Kreitz, approved.

"Best Management Practiced Committee" report made by Messar. The committee of five which was formed at the April 2011 meeting met. Much information was gathered, and found that the Village of Luck Comprehensive Plan already addressed our concerns. The Village of Luck Plan Commission will be meeting August 22th, Messar, Ken Peterson & Madsen will appear and present the Big Butternut Lake Associatioin's concern for the protection of the lake. Motion by Messar, seconded by Peterson, and approved to present the following motion to the Plan Commissioin: "I move that the Big Butternut Protention & Rehabilition District send representation to the Monday Luck Plan

Commission meeting, seeking support in establishing specific Village ordinances to protect "Big Butternut Lake from harmful effects of development in the lake's watershed." Hopefully they will establish ordinances now for this protection purpose.

It was decided to have a spring information meeting again, date of April 14, 2012 was set.

Motion by Winter, seconded by Jim Hastert to levy $8,000.00 from the Village of Luck, earmarked for dredging the retention ponds, approved.

Cooper stated when the ponds were built, he placed a pipe in the middle of the largest pond (nearest the lake) to measure the sediment, hopefully to have a guess as to when we need to dredge. He no longer has a boat to check this out, so we will have to find someone with a small boat.

Chuck McBrayer expressed a concern about the level of the lake. Discussion held, motion by Jim Hastert, seconded by Jeannine Hastert that a letter be written, expressing the concern of the Lake Association. Zuckweiler will write a rough draft of letter of concern to Bill Gantz of the DNR.

Jensen stated a concern he had regarding someone contacting the fisheries department about what they are doing to our lake. Sherrie Johnson stated she would contact them and have information at our next meeting.

Hastert made motion, McBrayer seconded to adjourn the meeting.

Respectfully submitted,

Sandy Madsen

Sandy Madsen
Secretary

Village Hall

BIG BUTTERNUT LAKE ASSOCIATION
Informational Meeting
Luck Village Hall, September 25, 2010

Meeting was called to order by newly elected President, Jake Jensen at 9:00 A.M. There were 22 people present. Other Board members present were Gary Zuckweiler, Bob Winter and Jeannine Hastert, Treasurer. Kristina Handt, Village Administrator was also in attendance.
Absent was Ken Peterson, Sandy Madsen, Secretary, and Phil Warhol, Village Board Liaison.

First agenda item discussed was the goose round-up update. Jeannine has received a permit application from the Wisconsin DNR which has a number of conditions pursuant to WI Statutes. It is likely that lakeshore owners will need to attempt an integrated management plan such as fence barriers, shoreline habitat changes, mylar flagging, scare devices, repellants and/or population management through hunter harvest. Before goose nest and egg depredation activities can be done between March 1 and June 30, a public meeting will be required. The current goose count is at 125. It is important that we be proactive.

Second agenda item discussed was the boat inspections program. A $500 anonymous donation was made to help fund the making of the sign at the boat landing by Bob Winter's two son-in-laws. It is imperative that the Big Butternut Lake Assn. be proactive to prevent the introduction of invasive species into our lake. We may need to formalize a program with our Luck High School students similar to the Bone Lake program. Jeremy Williamson said the "Clean Boats/Clean Water" program is very effective. Lake Protection Grants are available.

Our next agenda item was the introduction of Jeremy Williamson, Water Quality Specialist with the Polk County Land and Water Resources Dept. Big Butternut Lake was one of many lakes in Polk County that he surveyed. (There are 437 lakes in Polk County.) He sampled 347 points on the lake w/67 meters between each point. He found:
89 sites with vegetation
18 different species of vegetation
71.9 percent of these sites had CLP (Curly Leaf Pondweed grows in 4'-8' of water.)
It involves about 41 acres or 15 percent of the lake. It can be a navigational problem and a nutrient loading problem.

Discussion on how to manage included: (1.)Toxic chemicals. Timing is extremely important. Must do when water reaches 50 degrees. Once it reaches 60 degrees it is too late as then the good weeds would be killed as well. If we want fish in our lake we want the good weeds. We could hire an applicator to spray at $2,000 an acre. It would be necessary to hire a monitor for before and after the spraying. There would need to be follow up for at least two more years. Very costly.
(Long Lake in Centuria treated 80 acres. They couldn't get a grant.)

(2.) Harvesters are another option. It would be necessary to purchase one for $250,000 with maybe 75 percent covered by a grant. It would be at least a 5-year program. There is commonly a high fish mortality with harvesters. This would also be very costly.

Storm water runoff impacts the amount of CLP. The last 4-5 years have been very dry. 2010 was a high rainfall year so that 2011 will be very interesting. We can probably expect a lot more CLP in 2011 because of the additional storm water runoff.

Amery has a good ordinance for storm water runoff for their village. Pike Lake in Amery has Eurasion Water Milfoil. It has been treated. 2-4D kills EWM.

After much discussion a proposal was suggested by Jeremy that Big Butternut Lake Assn. pay for treating CLP in the beach area and possibly around the boat landing. If individual homeowners wish to spray a navigational channel they will be added to the permit that is required and will pay for their own areas. Weed razors would also work for individual lakeshore owners.

Brad Litz made a motion that we pursue a controlled inspection program of boats or a boat launch fee in order to develop a self sustaining program. Motion was seconded by Eiler Ravanholt. Motion passed.

A public hearing will be set for early next year preceded by a Board meeting perhaps in January, 2011, to be set by Jake Jensen after confirming w/Jeremy Williamson with completeness of study and results of survey. Jeremy was very pleased with the return of the surveys which was at 30 percent.

Respectfully submitted by Jeannine Hastert
Sitting in for Sandy Madsen, Secretary