2013 Lake Water Quality Study

Northwood Lake, North Rice Pond, and South Rice Pond

Prepared for
Bassett Creek Watershed Management Commission

April 2014

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Executive Summary

The Bassett Creek Watershed Management Commission (BCWMC) adopted its current watershed management plan (Plan) in 2004. The Plan complies with the provisions of Minnesota Rules Chapter 8410, the Metropolitan Surface Water Management Act, the Water Resources Management Policy Plan, and other regional plans. The BCWMC's Plan sets the vision and guidelines for managing surface water within the boundaries of the BCWMC. The Plan calls for the BCWMC to monitor, or coordinate with others to monitor, the water quality of the lakes and streams in the watershed.

Since 1970, water quality has been monitored in 10 major lakes and six ponds under the management of the BCWMC. The main objective of this program is to detect changes or trends in lake or pond water quality over time. These observations help identify the effects of changing land-use patterns within the watershed. They also help assess the effectiveness of the BCWMC's and the member cities' efforts to maintain and improve water quality.

This report summarizes the results of water quality monitoring during 2013 in Northwood Lake (city of New Hope), North Rice Pond (city of Robbinsdale), and South Rice Pond (cities of Golden Valley and Robbinsdale). The conclusions from the 2013 water quality monitoring are outlined below.

Northwood Lake

Use of barley straw from 2000 through 2003 improved water transparency in Northwood Lake by enabling sunlight to reach the bottom of the lake and macrophytes (large aquatic plants) to become established. The abundance of coontail in the lake has also contributed to improved transparency, despite high phosphorus levels and the discontinuation of barley straw use in 2003. Coontail releases biochemicals (called allelochemicals) that inhibit the growth of algae, especially blue-green algae (Korner et al. 2002, Gross et al. 2003, and Wium-Anderson 1983).

Prior to 2000, during about two-thirds of sampling events, high blue-green algae levels posed either a low or moderate risk of adverse health effects. Since 2000, when coontail became well established, blue-green algae numbers have consistently been below risk levels for adverse health effects. (One exception was a late summer 2009 sampling event when numbers indicated a low risk of adverse health effects.) This data provides further affirmation of the benefits provided by the established macrophyte community.

Conclusions of the 2013 study of Northwood Lake include:

- Total phosphorus, chlorophyll *a*, and Secchi disc transparency summer averages failed to meet BCWMC water quality goals and Minnesota water quality standards for shallow lakes in 2013.
- Trend analyses indicate that apparent improvements in water quality since 2000 are not considered significant, likely due to the influence of the large number of measurements since 2000 (14) relative to pre-2000 measurements (4). Nonetheless, most pre-2000 total phosphorus

values and all pre-2000 average summer chlorophyll concentrations were higher and all pre-2000 average summer Secchi disc transparency depths were lower than post-2000 values.

- While none of the total phosphorus summer averages during the period of record have met the BCWMC goal and Minnesota Pollution Control Agency's (MPCA) water quality standard for shallow lakes, 33 percent of chlorophyll *a*, and 56 percent of Secchi disc summer averages have met BCWMC goals and MPCA standards. All goals and standards met have occurred since 2000.

- Fewer phytoplankton and fewer blue-green algae have been observed since 2000, when coontail became established in the lake. Allelochemicals excreted by coontail appear to have inhibited algal growth, especially the growth of blue-green algae, which has comprised a smaller percentage of the algal community since 2000.

- Compared with previous years, higher numbers of zooplankton (microscopic crustaceans) were observed in Northwood Lake during 2013. However, numbers of cladocerans, the larger zooplankters most vulnerable to predation, were reduced; this indicates increased fish predation may have occurred in 2013.

- Since macrophytes became established in the lake in 2000, the number of species has continued to increase and 12 species were observed in 2013.

- Nuisance non-native plants observed in 2013 include curly-leaf pondweed, first observed in 2005, and purple loosestrife, first observed in 2013.

North and South Rice Ponds

Conclusions of the 2013 study of North Rice Pond and South Rice Pond include:

- In 2013, average summer total phosphorus concentrations and Secchi disc transparency values in North Rice Pond and South Rice Pond did not meet BCWMC water quality goals. Average summer chlorophyll *a* concentrations did meet the BCWMC water quality goal.

- Because North Rice Pond (27-644W) and South Rice Pond (27-645W) are wetlands, there are no MPCA water quality standards applicable to the ponds.

- South Rice Pond trend analyses indicate that changes in total phosphorus, chlorophyll *a*, and Secchi disc values during the period of record are not significant. Trend analyses were not performed for North Rice Pond due to insufficient data (i.e., at least 10 years of data are needed, but only 4 years of data have been collected).

- During the period of record, North Rice Pond has met the BCWMC total phosphorus goal 25 percent of the time, chlorophyll *a* goal 100 percent of the time, and Secchi disc goal 50 percent of the time.

- South Rice pond has not met total phosphorus and Secchi disc transparency goals during the period of record. However, the chlorophyll *a* goal has been met 69 percent of the time.
- The numbers of algae in North Rice Pond were generally higher in 2013 than in previous years.
- The numbers of algae in South Rice Pond in 2013 were, generally, similar to previous years, although higher numbers were observed in May.
- The low numbers of blue-green algae observed in North and South Rice Ponds throughout the period of record, despite high phosphorus concentrations, have posed no risk of adverse health effects. The macrophyte communities in North and South Rice Ponds are dominated by coontail, a plant known to secrete allelochemicals that inhibit algal growth, particularly blue-green algal growth.
- North Rice Pond observed higher numbers of zooplankton during spring and late summer of 2013, as compared to previous years.
- South Rice Pond observed higher numbers of zooplankton during late summer of 2013, as compared to previous years.
- A comparison of 2013 macrophyte data with past data indicates the macrophyte communities in North and South Rice Ponds have been stable over time.
- Nuisance non-native plants observed in 2013 include purple loosestrife, surrounding North and South Rice Ponds, and curly-leaf pondweed, observed in South Rice Pond for the first time in 2013.

Recommendations

It is recommended that the BCWMC contact the Minnesota Department of Natural Resources to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding Northwood Lake, North Rice Pond, and South Rice Pond. Introduction of the beetles is expected to control purple loosestrife and protect the native vegetation.

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1.0 Introduction

Since 1970, when the Bassett Creek Flood Control Commission—now known as the Bassett Creek Watershed Management Commission (BCWMC)—was formed, water quality conditions in the 10 major lakes and six ponds have periodically been monitored. Nonpoint source pollution (pollutants transported by stormwater runoff) is the predominant cause of lake/pond water quality degradation. The BCWMC 2004 watershed management plan calls for the BCWMC to monitor, or coordinate with others to monitor, the water quality of the lakes and streams in the watershed. The objective of the lake/pond monitoring program is to detect changes or trends in lake or pond water quality over time. These observations help identify the effects of changing land-use patterns within the watershed. They also help assess the effectiveness of the BCWMC's and the member cities' efforts to maintain and improve water quality.

In 1991, the BCWMC established an annual lake/pond water quality monitoring program that generally followed the recommendations of the Metropolitan Council (Osgood 1989a) for a "Level 1 Survey and Surveillance" data collection effort. The lake/pond sampling program generally involved monitoring the lakes/ponds on a 4-year rotating basis (three or four lakes/ponds per year). However, the BCWMC has dropped some of the lakes/ponds from the program, including Lost Lake and Sunset Hill (Cavanaugh) Lake. Major lakes/ponds monitored by the BCWMC include the following water bodies, with prior monitoring years indicated parenthetically (Table 1):

Table 1 Lakes monitored by the Bassett Creek Watershed Management Commission (years with sampling data are in parenthesis)

· **Crane** (1977, 1982, 1993, 1994, 1997, 2001, 2007[1], 2011)	· **Sunset Hill (Cavanaugh)** (1977, 1982, 1994, 1998)
· **Lost** (1977, 1982, 1993, 1997)	· **Sweeney**[2] (1977, 1982, 1985, 1992, 1996, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)
· **Medicine** (1977, 1982, 1983, 1984, 1988, 1994[1], 1999[1], 2006[1], 2010[1])	· **Twin** (1977, 1982, 1992, 1996, 2000, 2005, 2008, 2009)
· **Northwood**[2] (1972, 1977, 1982, 1992, 1996, 2001, 2002, 2003, 2004, 2005,2006, 2007, 2008, 2009[1], 2010, 2011, 2012, 2013	· **Westwood**[2] **(**1977, 1982, 1993, 1997, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011)
· **North Rice Pond** (1994, 1998, 2009, 2013)	· **South Rice Pond**[2] (1994, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2013)

[1] Monitoring performed jointly with Three Rivers Park District (formerly Suburban Hennepin Regional Park District).

[2] Includes monitoring by citizens as a part of the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP)

Although located within the BCWMC watershed, Wirth Lake is monitored annually by the Minneapolis Park and Recreation Board. Medicine Lake is monitored annually by the Three Rivers Park District (TRPD). However, the BCWMC periodically assists TRPD in monitoring a second Medicine Lake site. Westwood Lake, Sweeney Lake, Northwood Lake, and Parkers Lake have been monitored annually since 2000 by citizen volunteers participating in the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). Crane Lake was monitored nearly annually by Ridgedale Center from 1975 through 1988.

The BCWMC lake sampling program occasionally includes limited monitoring for other water bodies. These are listed below; the year sampled is noted in parenthesis:

- Cortlawn, East Ring, and West Ring Ponds (1993)
- Grimes Pond (1996)

This report presents the results of the 2013 water quality monitoring of Northwood Lake, North Rice Pond, and South Rice Pond (locations shown on Figure 1). The lake and ponds were monitored for water quality and biota, specifically phytoplankton, zooplankton, and macrophytes (aquatic plants). Monitoring results are summarized in the following pages.

The discussion of water quality conditions focuses on the three principal nutrient-related water quality indicators: total phosphorus (TP) concentrations, chlorophyll *a* concentrations, and Secchi disc transparency. Phosphorus is a nutrient that usually limits the growth of algae. Chlorophyll *a* is the primary photosynthetic pigment in lake algae; therefore, the concentration of chlorophyll *a* in a lake/pond sample indicates the amount of algae present. Secchi disc transparency is a measure of water clarity and is inversely related to algal abundance.

The water quality conditions were classified as to trophic state, based on the TP concentration, chlorophyll *a* concentration, and Secchi disc transparency (Table 2).

Table 2 Trophic state classifications for total phosphorus, chlorophyll *a*, and Secchi disc transparency

Trophic State	Total Phosphorus (micrograms/liter)	Chlorophyll *a* (micrograms/liter)	Secchi Disc Transparency (feet and meters)
Oligotrophic (nutrient-poor)	less than 10 µg/L	less than 2 µg/L	greater than 15 ft (4.6 m)
Mesotrophic (moderate nutrient levels)	10 µg/L–24 µg/L	2 µg/L–7.5 µg/L	15 ft–6.6 ft (4.6 m–2.0 m)
Eutrophic (nutrient-rich)	24 µg/L–57 µg/L	7.5 µg/L–26 µg/L	6.6 ft–2.8 ft (2.0 m–0.85 m)
Hypereutrophic (extremely nutrient rich)	greater than 57 µg/L	greater than 26 µg/L	less than 2.8 ft (0.85 m)

In addition to chemically based water quality parameters, biological data were collected and evaluated. Phytoplankton, zooplankton, and macrophyte (aquatic plant) data can help determine the health of aquatic systems and can also indicate changes in nutrient status over time. Biological communities in lakes interact with each other and influence both short- and long-term variations in observed water quality.

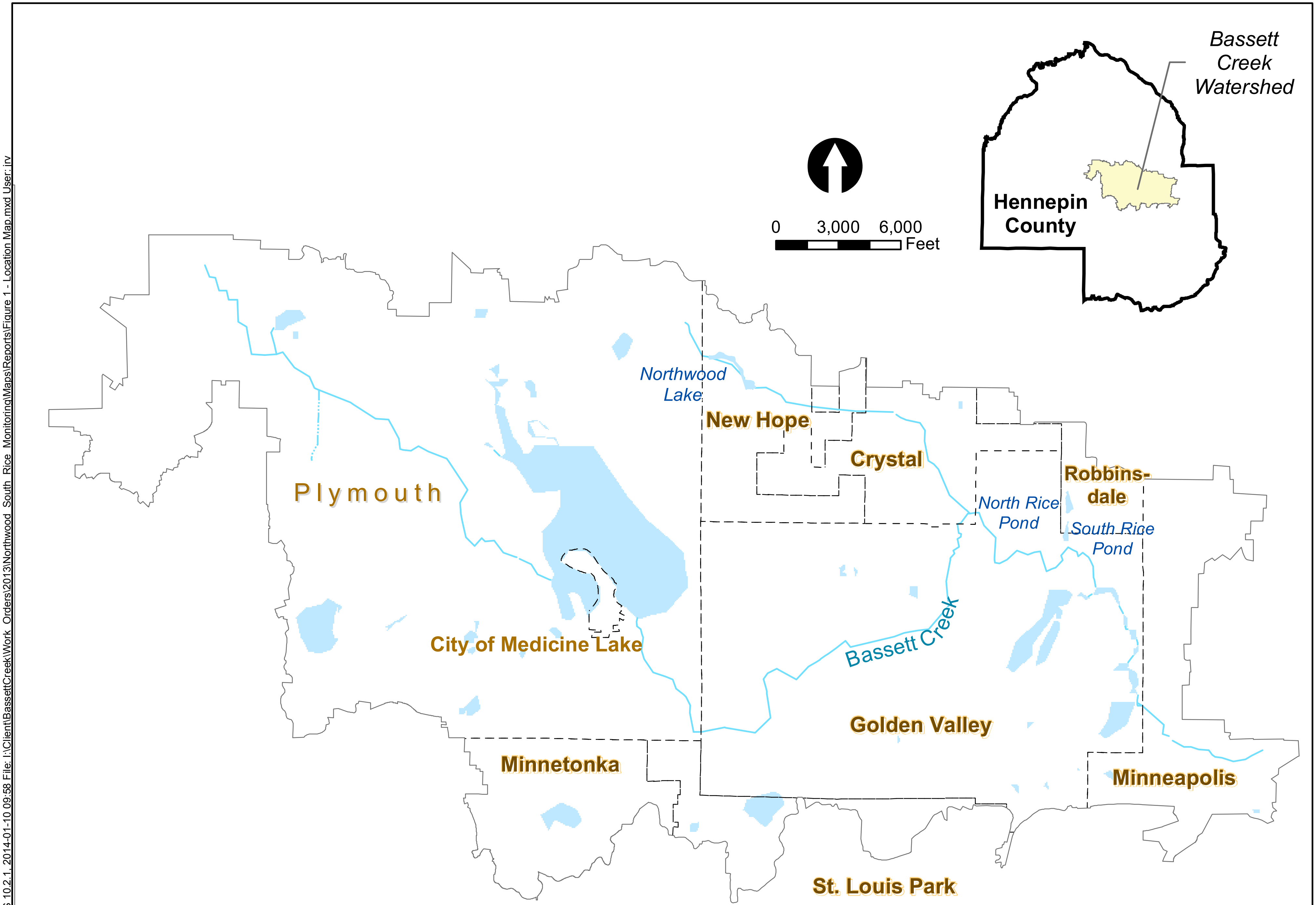

Figure 1: Location of Lakes/Ponds included in 2013 Water Quality Study (Northwood Lake, North Rice Pond, and South Rice Pond)

Phytoplankton (algae) form the base of the food web in lakes and directly influences fish production and recreational use. Chlorophyll *a*, the main pigment found in algae, is a general indicator of algal biomass in lake water. The identification of species and their abundance provides additional information about the health of a lake and can indicate changes in lake status as algal populations change over time. In addition, knowing the types of algae in a lake indicates the quality of food available for the small animals living in the lake. Larger algal species that are difficult to consume or those of low food quality are less desirable for zooplankton (microscopic crustaceans) and can limit overall productivity in a lake.

Zooplankton (microscopic crustaceans) are vital to the health of a lake ecosystem because they feed upon the phytoplankton and provide food for many fish species. Protection of the lake's zooplankton community, through proper water quality management practices, protects the lake's fishery. Zooplankton are also important to lake water quality. The zooplankton community is comprised of three groups: Cladocera, Copepoda, and Rotifera. If present in abundance, large Cladocera can decrease the number of algae and improve water transparency.

pictured above, are vital to the health of a lake ecosystem because they feed upon the phytoplankton and provide food for fish.

Macrophytes (large aquatic plants) grow in the shallow (littoral) area of a lake. Macrophytes are a natural part of lake communities and provide many benefits to fish, wildlife, and people. Macrophytes are primary producers in the aquatic food web, providing food for other life forms in and around the lake.

2.0 Methods

2.1 Water Quality Sampling

The Bassett Creek Watershed Management Commission (BCWMC) collected samples from Northwood Lake, North Rice Pond, and South Rice Pond sampling stations. These samples were taken at the deepest location in each lake/pond basin on six occasions. The lake and ponds were monitored from April through September as follows:

- One sample was collected within 2 weeks of ice out (mid-May)
- One sample was collected in mid-June
- One sample was collected in mid-July
- One sample was collected in mid-August
- One sample was collected in late August
- One sample was collected in early September

Table 3 lists the water quality parameters and specifies at what depths the samples or measurements were collected. Dissolved oxygen, temperature, specific conductance, pH, oxidation reduction potential (ORP), and Secchi disc transparency (Secchi depth) were measured in the field and water samples were analyzed in the laboratory for total phosphorus, soluble reactive phosphorus, total nitrogen, and chlorophyll *a*.

Northwood Lake was included in the Citizen Assisted Monitoring Program (CAMP) operated by the Metropolitan Council's Environmental Services Division (MCES). A citizen volunteer collected samples from a representative lake sampling location on 10 occasions between May and October. Samples were collected monthly in June and July and twice per month in May, August, September, and October. Samples were analyzed for total phosphorus and chlorophyll *a* on each occasion. A Secchi disc transparency depth measurement was taken on each sample occasion. Secchi disc transparency measurements and chlorophyll *a* data are included in this report. The MCES had not released the CAMP total phosphorus data when this report was prepared.

Table 3 Lake/Pond water quality parameters

Parameters	Depth (meters)	Sampled or Measured during Each Sample Event
Dissolved Oxygen	Surface-to-bottom profile at 1-meter intervals	X
Temperature	Surface-to-bottom profile at 1-meter intervals	X
Specific Conductance	Surface-to-bottom profile at 1-meter intervals	X
pH	Surface-to-bottom profile at 1-meter intervals	X

Parameters	Depth (meters)	Sampled or Measured during Each Sample Event
Oxidation Reduction Potential (ORP)	Surface-to-bottom profile at 1-meter intervals	X
Secchi Disc	—	X
Total Phosphorus	0–1 meter composite	X
Total Phosphorus	1 meter	X
Soluble Reactive Phosphorus	0–1 meter composite	X
Total Nitrogen	0–1 meter composite	X
Chlorophyll *a*	0–1 meter composite	X
Turbidity	0–1 meter composite	X

2.2 Ecosystem Data

Ecosystem data were collected from May to September 2013.

Phytoplankton—A 0–1 meter water sample was collected during each water quality sampling event from Northwood Lake, North Rice Pond, and South Rice Pond during the May through September period. Sample analysis included identification and enumeration of phytoplankton species.

Zooplankton—A zooplankton sample was collected (bottom to surface tow) during each water quality sampling event from Northwood Lake, North Rice Pond, and South Rice Pond during the May through September period. Sample analysis included identification and enumeration of species.

Macrophytes—Macrophyte (aquatic plant) surveys were completed during June and August.

3.0 Northwood Lake

3.1 Site Description

Northwood Lake (DOW #627P) is located along the North Branch of Bassett Creek, south of Rockford Road and immediately east of Highway 169 in the city of New Hope (Figure 1). It has a water surface area of 15 acres (6.1 hectares), a maximum depth of 5 feet (1.5 meters), and a mean depth of 2.7 feet (0.8 meters). The entire lake area is considered to be littoral (shallow).

The Northwood Lake watershed area is approximately 1,341 acres (543 hectares), excluding the Northwood Lake water surface area. The watershed lies within the cities of Plymouth and New Hope, and is fully developed. The lake formerly consisted of the North Branch of Bassett Creek and surrounding wetland area. During the early 1960s the basin was dredged and the water level rose, creating Northwood Lake.

The Northwood Lake shoreline is developed with single family homes, except for a short stretch that abuts Highway 169 and a section within Northwood Park on the northeastern shore. Most of the residential lawns extend to the water's edge, and approximately 15 to 30 percent of lakeshore property owners have installed riprap. The Northwood Lake outlet consists of a two-stage weir and a 48-inch reinforced-concrete pipe that discharges from the southeast side of the lake under Boone Avenue.

Most of the lakeshore residents use Northwood Lake for aesthetics and wildlife viewing; however, the lake is also used for fishing and boating. Geese and duck populations have summered on Northwood Lake in the past and appear to graze heavily on Northwood Park lawns.

3.2 BCWMC Water Quality Goal

The Bassett Creek Watershed Management Commission's (BCWMC) goal for Northwood Lake is a management classification of Level II, meaning its water quality should support recreational, non-body contact activities. Level II goals are: (1) average summer total phosphorus concentration not to exceed 45 µg/L, (2) average summer chlorophyll *a* concentration not to exceed 20 µg/L, and (3) average summer Secchi disc transparency of at least 1 meter (at least 3.3 feet) (BCWMC 2004). As shown in Figures 2 through 4, 2013 Northwood Lake average summer total phosphorus, chlorophyll *a*, and Secchi disc failed to meet the BCWMC water quality goal.

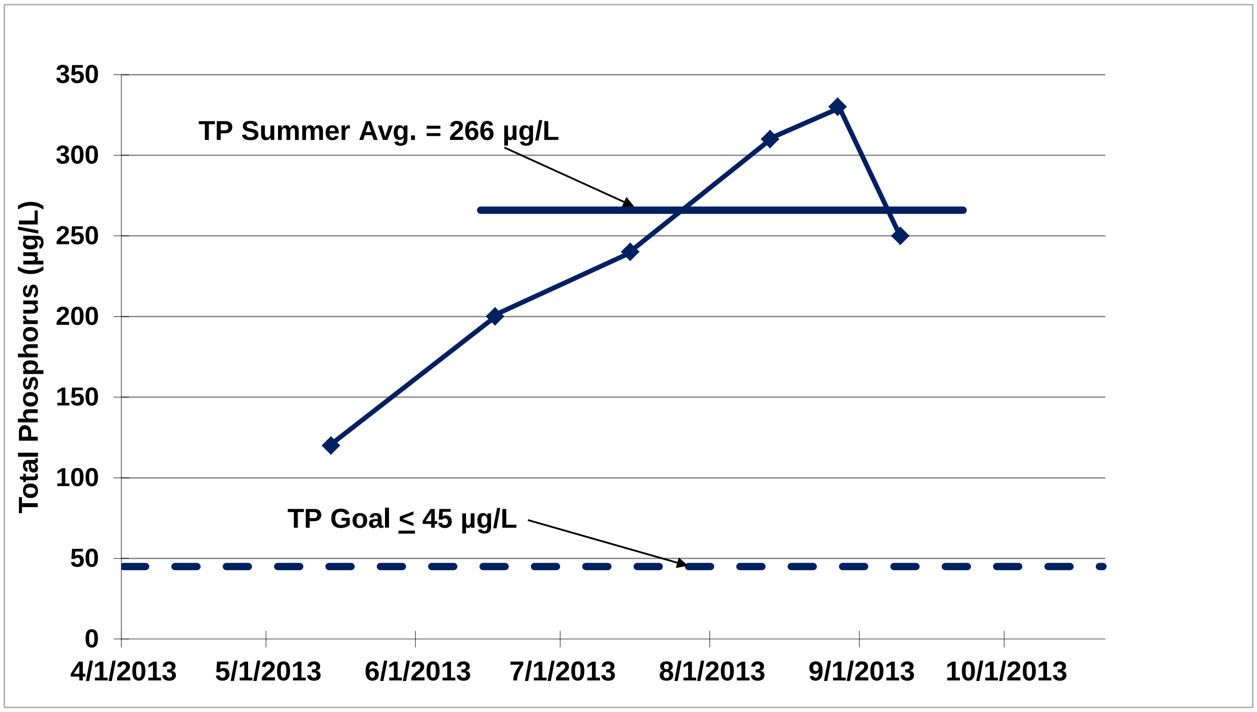

Figure 2 **2013 Northwood Lake total phosphorus concentrations compared with BCWMC total phosphorus goal**

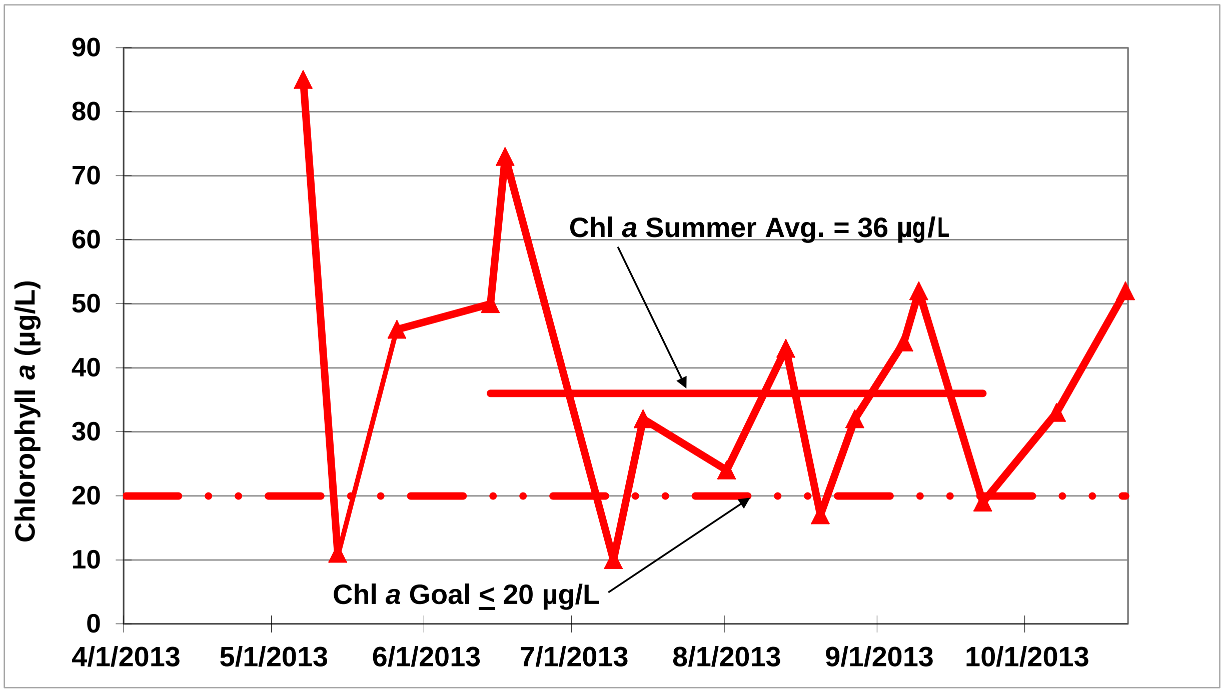

Figure 3 **2013 Northwood Lake chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

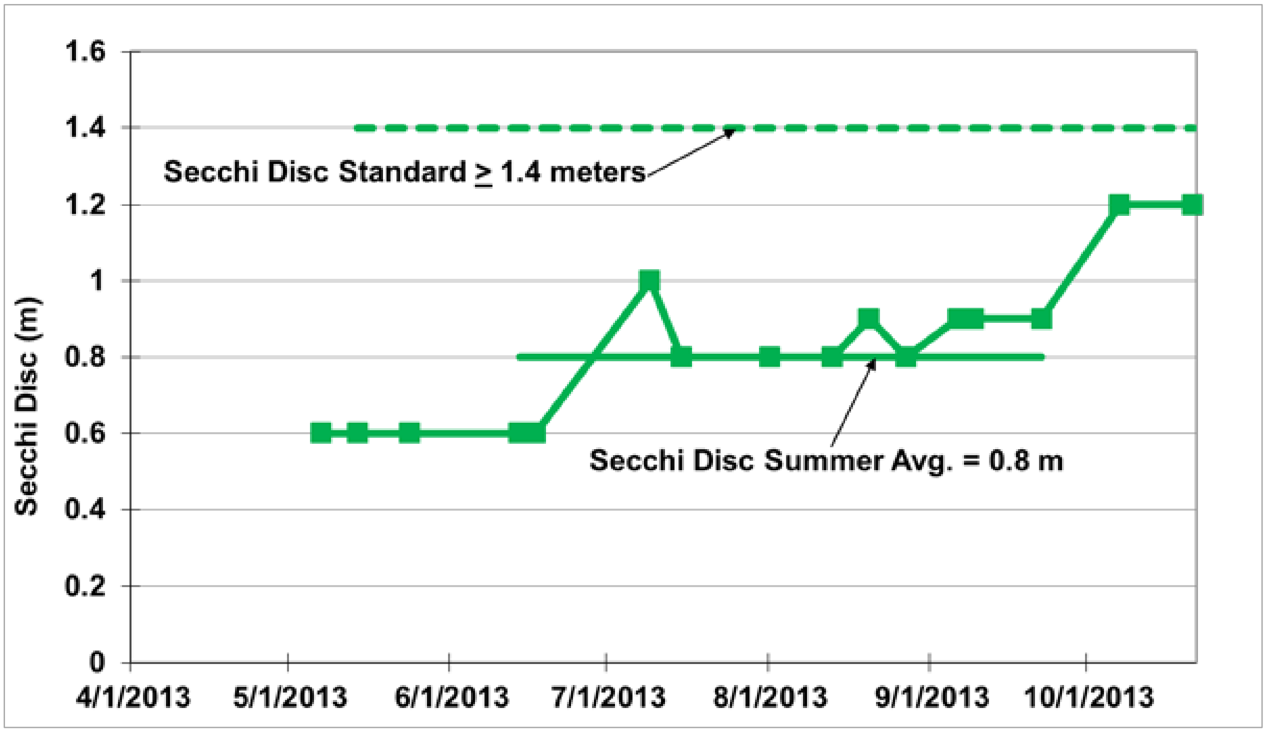

Figure 4 **2013 Northwood Lake Secchi disc depths compared with BCWMC Secchi disc goal**

3.3 Minnesota Pollution Control Agency (MPCA) Water Quality Standards

The federal Clean Water Act (CWA) requires states to adopt water quality standards to protect waters from pollution. These standards define how much of a pollutant can be in water designated for uses such as drinking, fishing, and swimming. The standards are set for a wide range of pollutants, including bacteria, nutrients, turbidity, and mercury. A water body is "impaired" if it fails to meet one or more water quality standards. The MPCA water quality standards applicable to Northwood Lake are shallow lake standards: (1) average summer total phosphorus concentration not to exceed 60 µg/L, (2) average summer chlorophyll *a* concentration not to exceed 20 µg/L, and (3) average summer Secchi disc transparency of at least 1.0 meter (Minn. R. Ch. 7050.0222 Subp. 4). Because Northwood Lake is a shallow lake, the water quality standards for the lake are less stringent than those for deep lakes (e.g., Sweeney Lake and Twin Lake). As shown in Figures 5 through 7, 2013 Northwood Lake water quality failed to meet state shallow lake water quality standards.

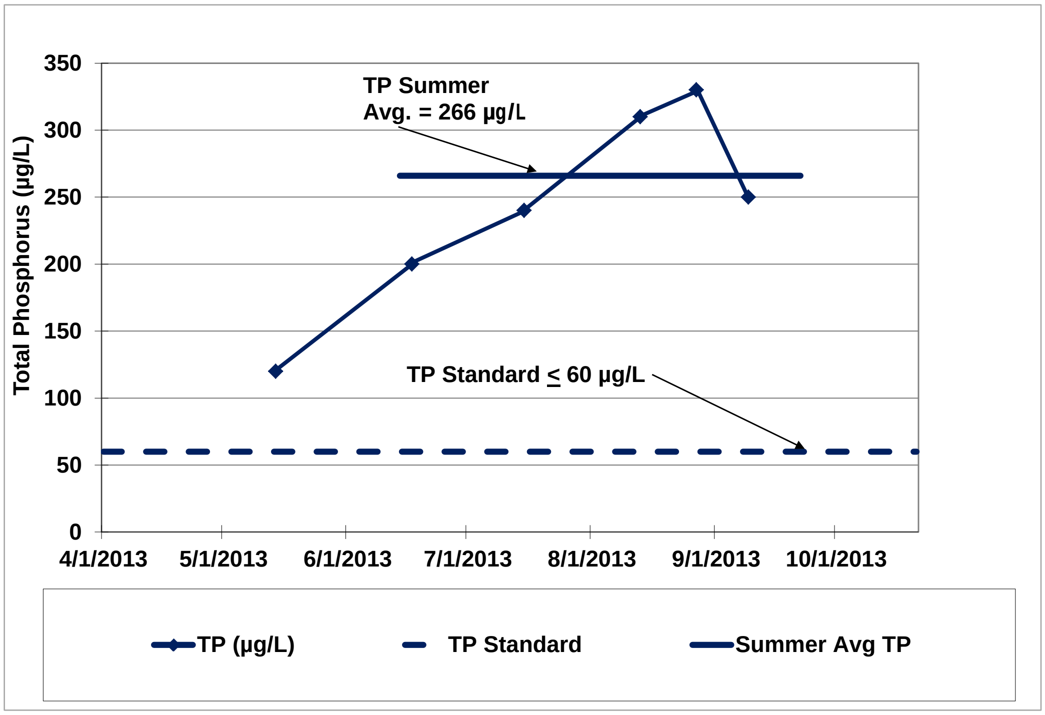

Figure 5 2013 Northwood Lake total phosphorus concentrations compared with MPCA total phosphorus standard

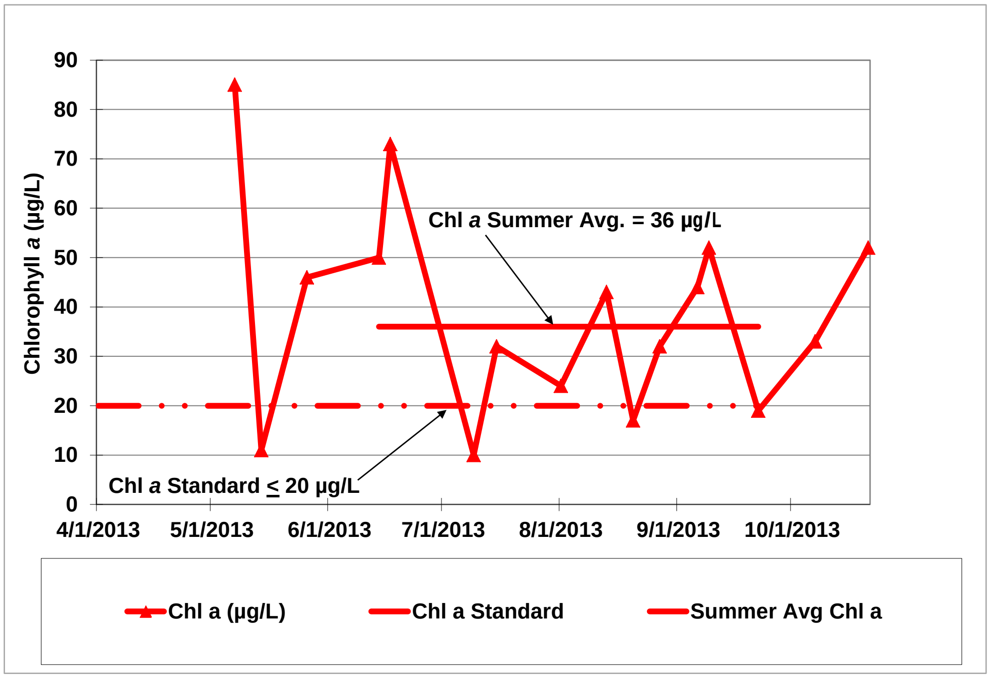

Figure 6 2013 Northwood Lake chlorophyll *a* compared with MPCA chlorophyll *a* standard

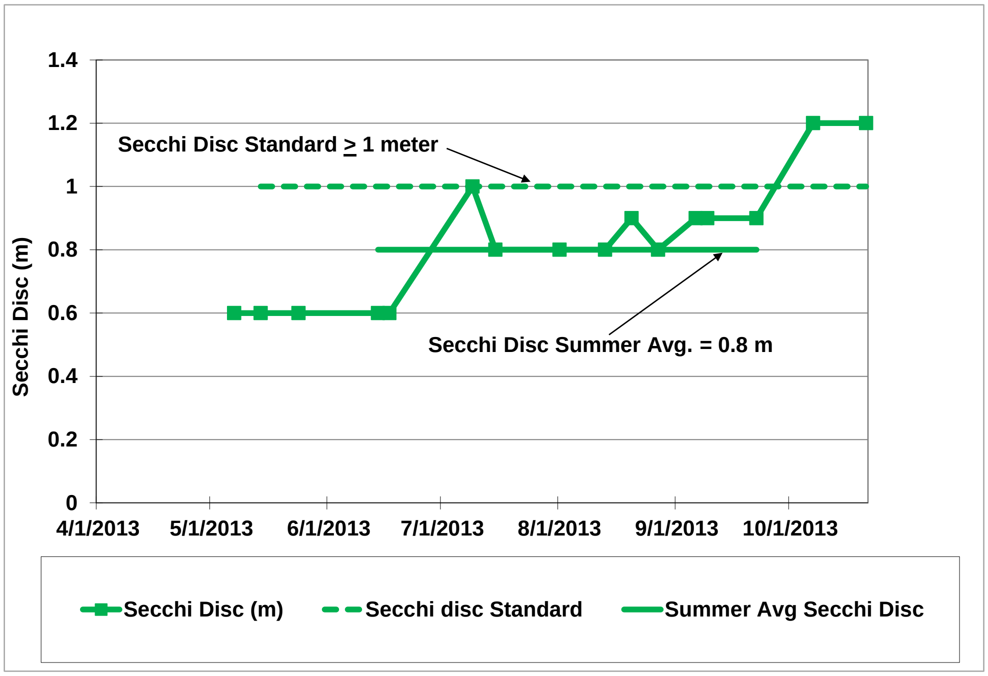

Figure 7 2013 Northwood Lake Secchi disc depths compared with MPCA Secchi disc standard

3.4 Watershed and Lake Management Plan

The BCWMC Watershed Management Plan (2004) incorporated the study results of the Northwood Lake Watershed and Lake Management Plan (1996). The Northwood Lake Watershed and Lake Management Plan (1996) divided the watershed of the lake into four drainage districts to help evaluate nutrient loading to the lake and determine recommendations for appropriate best management practices. Recommendations included: (1) construction or improvement of wet-detention basins within each drainage district to increase the removal of phosphorus from stormwater, (2) a study of the lake's fishery to estimate phosphorus loading by benthivorous (bottom-feeding) fish, (3) a study of waterfowl which reside in Northwood Lake to calculate the dissolved phosphorus load entering the lake from waterfowl, and (4) monitoring to estimate the internal phosphorus load released from the lake's sediments. The Northwood Lake Watershed and Lake Management Plan (1996) indicated BCWMC water quality goal attainment may not be possible for Northwood Lake.

In 2000, the city of New Hope implemented a new management technique for clearing lake waters to improve the water clarity of Northwood Lake. Barley straw was carefully placed at predetermined locations throughout the lake. As barley straw decays, it apparently adds a substance to the water which inhibits algal growth, despite the presence of high concentrations of phosphorus. The use of barley straw during 2000 greatly improved the lake's transparency. Sunlight could reach the lake's bottom, enabling aquatic plants to become established. Two species of aquatic plants were observed in 2000 and visual inspection of the lake during the growing season indicated a substantial decline in algal mats compared to previous years. Barley straw treatment of Northwood Lake continued annually from 2000 through the 2003 growing season. The aquatic plant community established during that time has flourished and water clarity has consistently been better.

3.5 Water Quality Monitoring Results

The following paragraphs summarize the water quality monitoring results for temperature, dissolved oxygen, specific conductance, total phosphorus, chlorophyll *a*, and Secchi disc transparency.

3.5.1 Temperature

Vertical profiles of temperature collected during 2013 (Figure 8) show the lake was stratified during the summer (the near-bottom temperature was about 2 degrees Celsius (3.6 degrees Fahrenheit) less than the surface temperature). In the summers of 2000, 2005, and 2009, the lake was generally well-mixed, but it was stratified in the summer of 1996. Since the density of water increases (water becomes heavier) as the temperature decreases, the cool bottom water formed a barrier to wind-mixing of the lake water column. The oxygen in the near-bottom water was depleted by decomposition of organic matter, but the temperature difference between the bottom and surface water prevented the lake from mixing. Hence, while wind mixing of surface water consistently added fresh oxygen throughout the growing season, oxygen in the bottom water was depleted and had no opportunity for replenishment.

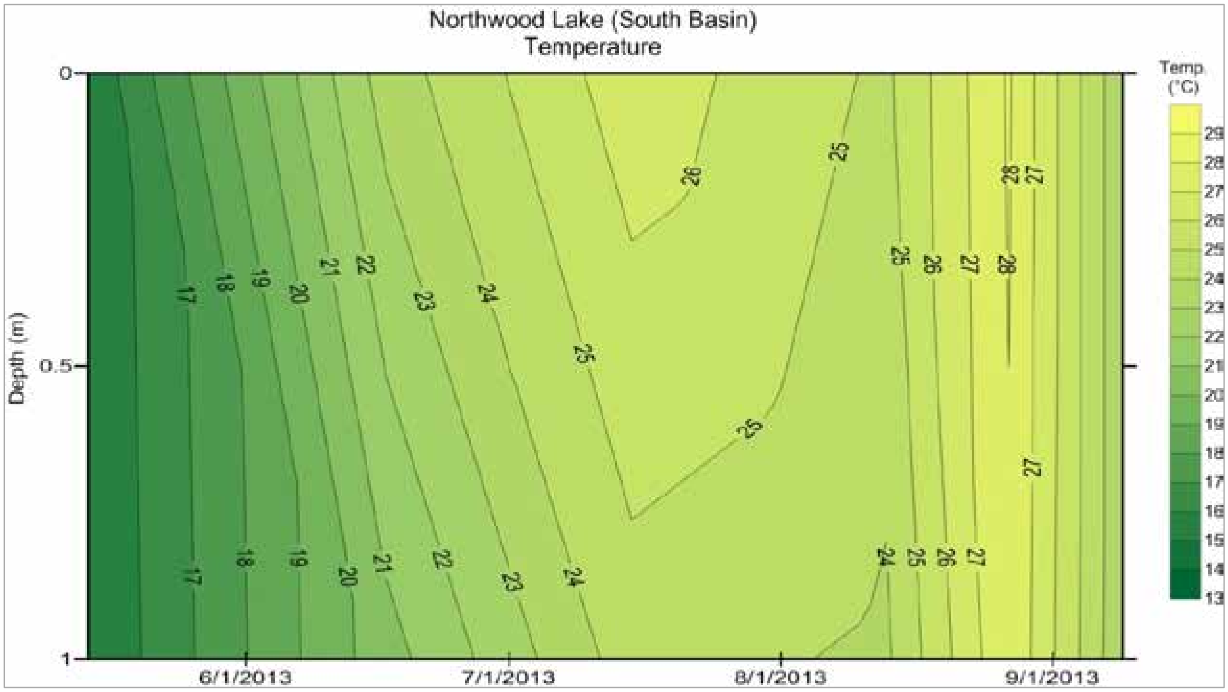

Figure 8 **2013 Northwood Lake temperature isopleth**

3.5.2 Dissolved Oxygen

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 the lake (2004 Shaw et al.).

As shown in Figure 9, Northwood Lake experienced oxygen depletion in late summer when oxygen concentrations were less than 2 mg/L from 1 meter to the bottom. This condition is typical of a highly productive system during the summer months as the microbial decomposition of dead biota depresses the dissolved oxygen in the water above the sediments. In September, low dissolved oxygen concentrations were noted throughout the water column. The very low levels of dissolved oxygen throughout the lake are indicative of a very productive system, where decomposition of algae consumes most of the available oxygen by bacterial respiration.

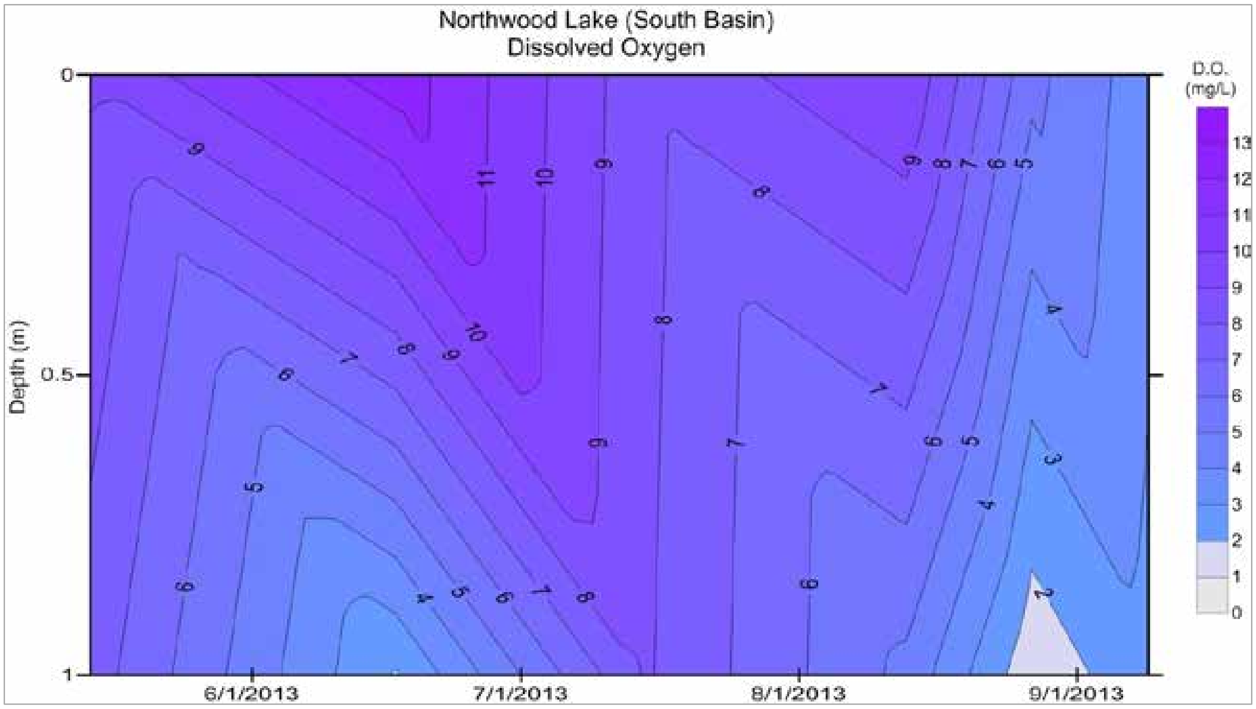

Figure 9 **2013 Northwood Lake dissolved oxygen isopleths**

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4.5.3 Specific Conductance

Conductivity is the measure of a material's ability to conduct an electrical current. In the case of water, it also serves as an indicator of total dissolved inorganic chemicals. Since conductivity is temperature related, reported values are normalized at 25 degrees Celsius and termed "specific conductance." Specific conductance increases as the concentration of dissolved minerals in a lake increase (Shaw et al. 2004).

Northwood Lake observed a high specific conductance value in the spring (1,484 µmhos/cm @ 25 C). The high spring value was most likely related to the application of deicing chemicals to streets and parking lots in the lake's watershed the previous winter. Specific conductance values declined steadily from spring to summer (Figure 10).

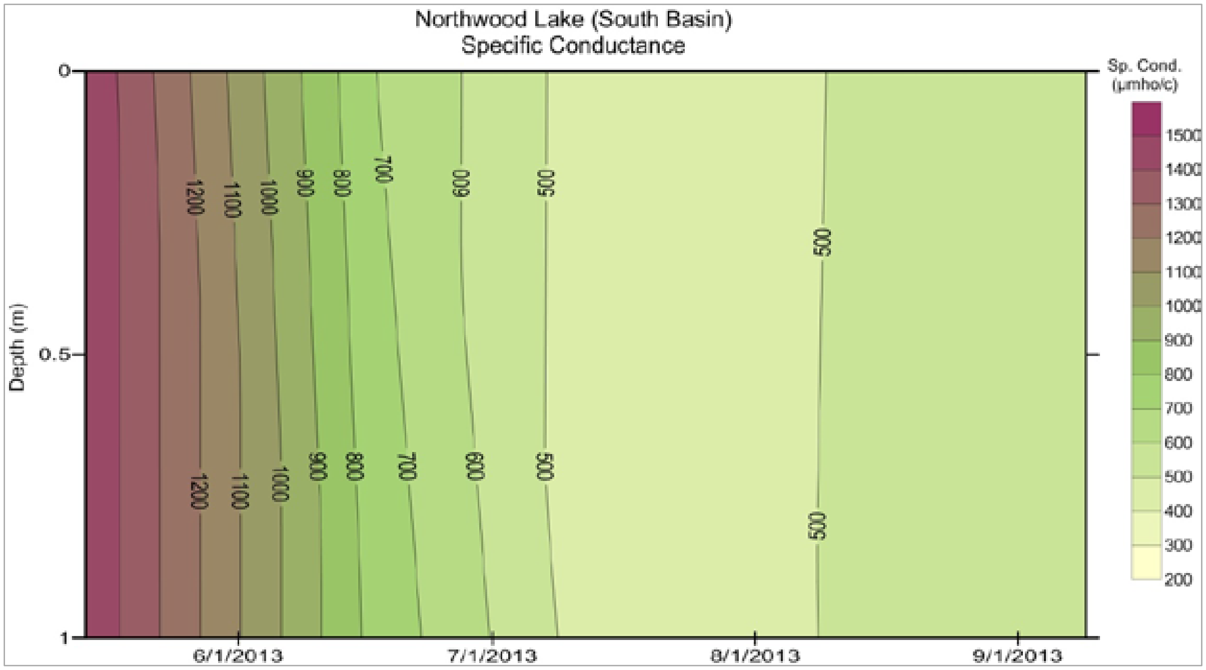


Figure 10 2013 Northwood Lake specific conductance isopleths

3.5.3 Total Phosphorus

Phosphorus is necessary for plant and algae growth in lakes. It occurs naturally in soils, rocks, and the atmosphere and can make its way into lakes through groundwater and runoff from the lake's watershed. While phosphorus is necessary for plant and animal growth, excessive amounts lead to an overabundance of growth which can decrease water clarity and lead to water quality impairment (Shaw et al. 2004). Minnesota has selected phosphorus criteria for shallow lakes to prevent nuisance algal blooms. The phosphorus limit for shallow lakes, such as Northwood Lake, is 60 µg/L (Minn. R. Ch. 7050.0222 Subp. 4).

Total phosphorus concentrations, measured by the 0–1 meter composite sample, are graphically summarized in Figure 11 Northwood Lake exhibited high phosphorus concentrations throughout 2013. Total phosphorus concentrations increased from a low of 120 µg/L in May to a high of 330 µg/L in August; the summer average was 266 µg/L. All observed 2013 total phosphorus concentrations were within the hypereutrophic category (very poor water quality) and none of the total phosphorus concentrations met the MPCA standard for shallow lakes (60 µg/L).

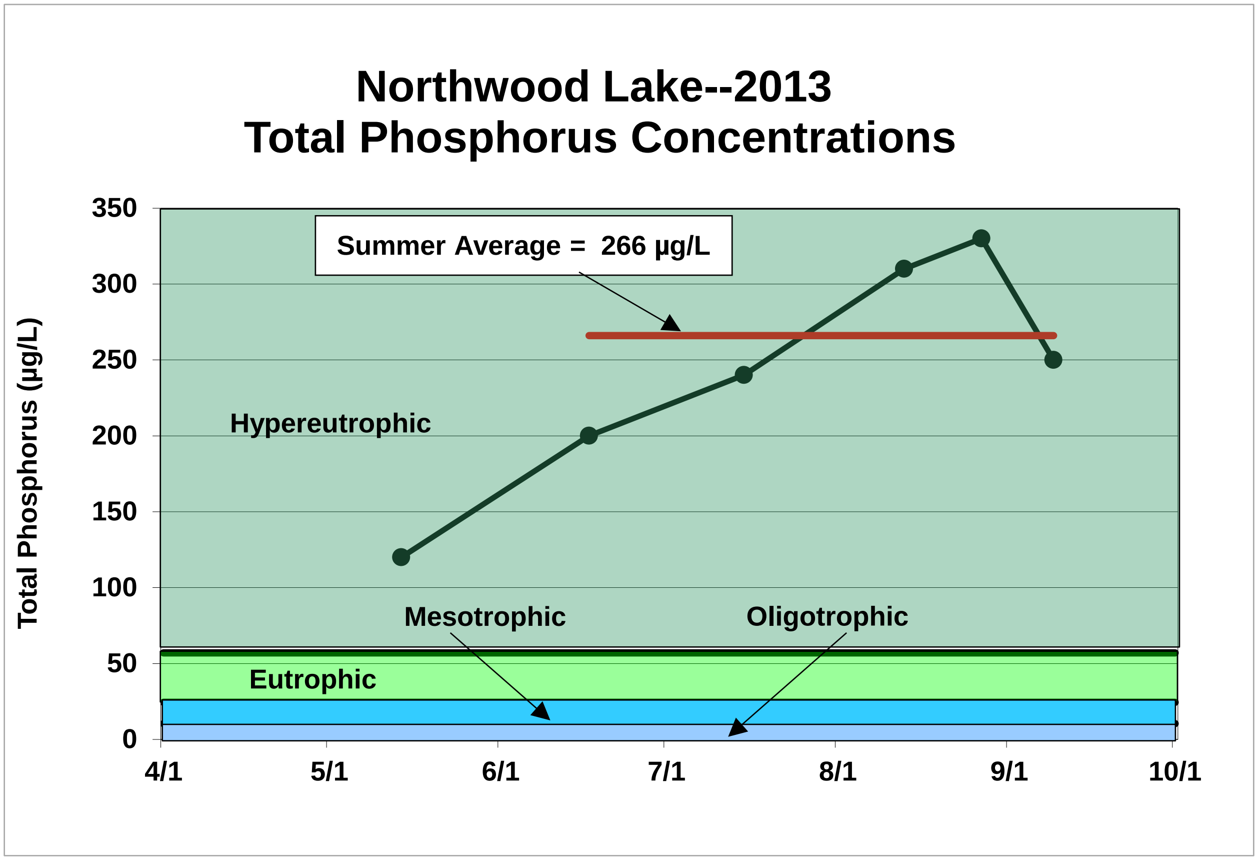


Figure 11 2013 Northwood Lake total phosphorus data

A comparison of bottom phosphorus concentrations and 0–1 meter composite phosphorus concentrations, indicates internal phosphorus loading from sediment. As shown in Figure 12 slight internal loading from sediment occurred in mid-July and early August and substantial loading from sediment occurred in late August.

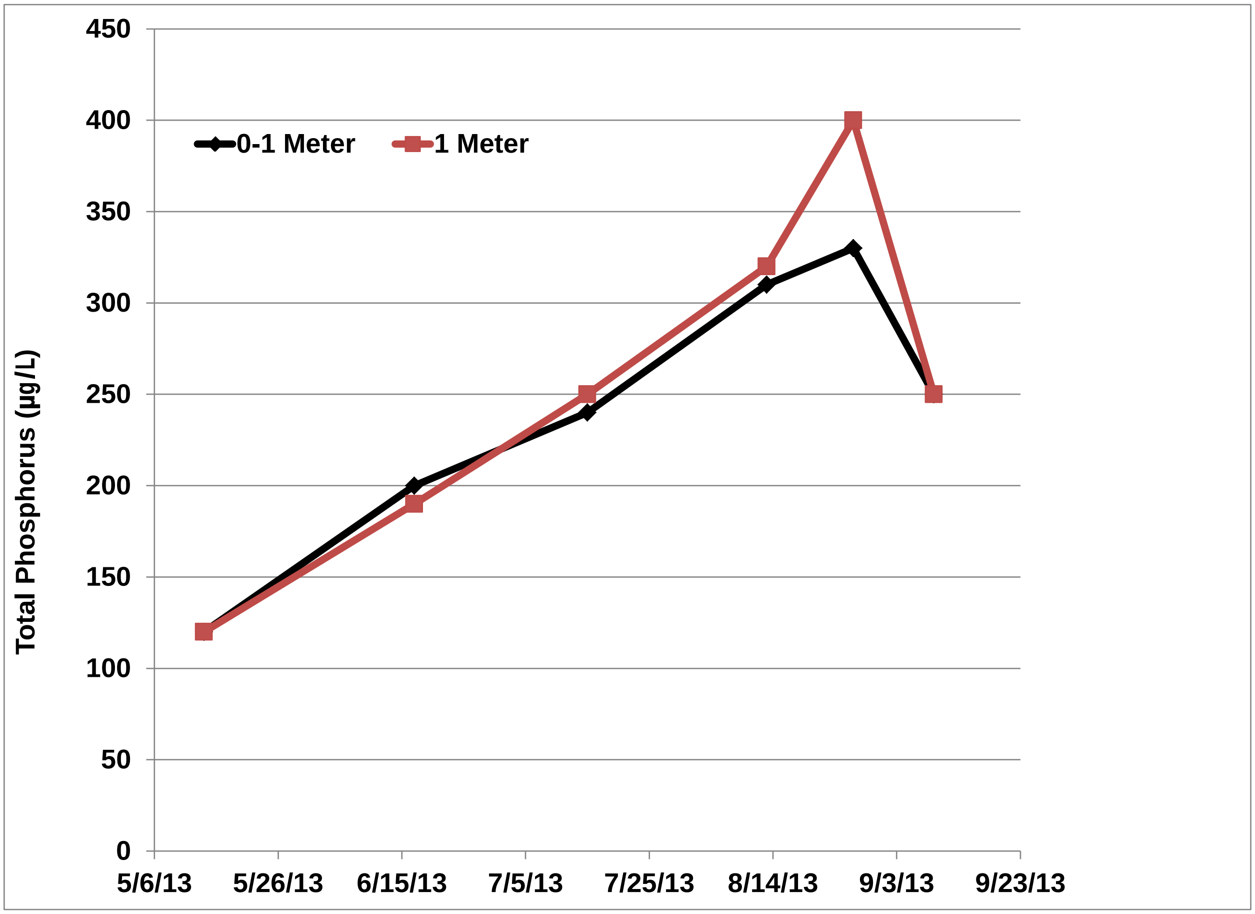


Figure 12 **Comparison of 2013 Northwood Lake 0–1 meter composite and bottom total phosphorus concentrations**

3.5.4 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. Chlorophyll *a* gives a general indication of the amount of algae growth in a lake, with greater chlorophyll *a* values indicating greater amounts of algae. Lakes which appear clear generally have chlorophyll *a* levels less than 15 µg/L (Shaw et al. 2004). The chlorophyll *a* limit for shallow lakes in Minnesota, such as Northwood Lake, is 20 µg/L (Minn. R. Ch. 7050.0222 Subp. 4). This criteria has been selected to limit algal grown and prevent nuisance algal blooms.

Chlorophyll *a* concentrations, measured by 0–1 meter composite samples, are graphically summarized in Figure 13. 2013 chlorophyll *a* concentrations ranged from a low of 10 µg/L in July to a high of 85 µg/L in May. About two-thirds of the values, as well as the summer average, were within the hypereutrophic category (very poor water quality). The remaining values were within the eutrophic category (poor water quality). The summer average of 36 µg/L failed to meet the Minnesota standard for shallow lakes (20 µg/L).

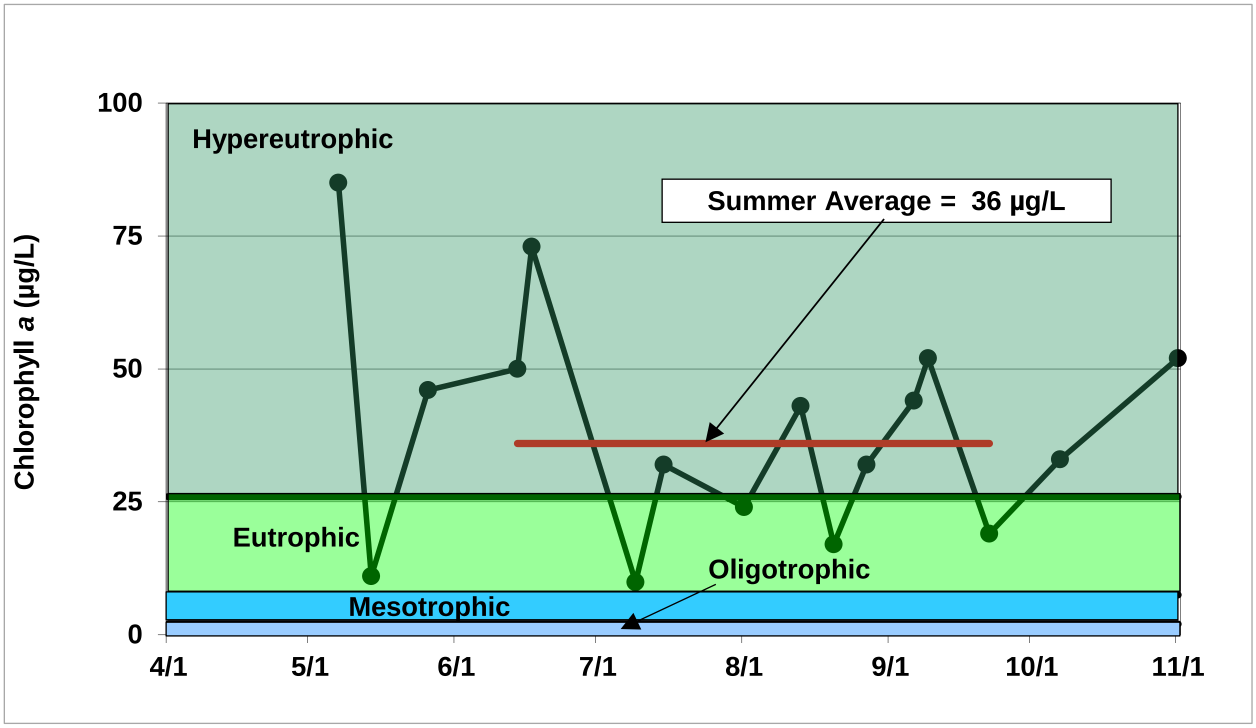


Figure 13 2013 Northwood Lake chlorophyll *a* data

3.5.5 Secchi Disc

The depth to which light can penetrate water is affected by suspended particles, dissolved pigments, and absorbance. Often, the ability of light to penetrate the water column is determined by the abundance of algae or other photosynthetic organisms in a lake. One method of measuring light penetration is with a Secchi disc—a black-and-white disc mounted on a pole or a line. The depth at which the pattern on the disc is no longer visible after being lowered into the water is considered a measure of the water's transparency (i.e., Secchi disc transparency depth). A greater Secchi disc transparency depth indicates greater water clarity (Shaw et al. 2004). Minnesota's Secchi disc transparency criteria for shallow lakes, designed to protect water clarity, is at least 1 meter (Minn. R. Ch. 7050.0222 Subp. 4).

Secchi disc data are graphically summarized in Figure 14. Secchi disc transparency was very poor throughout 2013 and ranged from a low of 0.6 meters in May and June to a high of 1.2 meters in October. During the early September reading, the Secchi disc was obscured by submerged plants (rather than algal turbidity). More than half of the Secchi disc measurements, as well as the summer average, were in the hypereutrophic category (very poor water quality). The remaining values were within the eutrophic category (poor water quality). The average summer Secchi disc transparency of 0.8 meters failed to meet the Minnesota standard for shallow lakes (at least 1 meter).

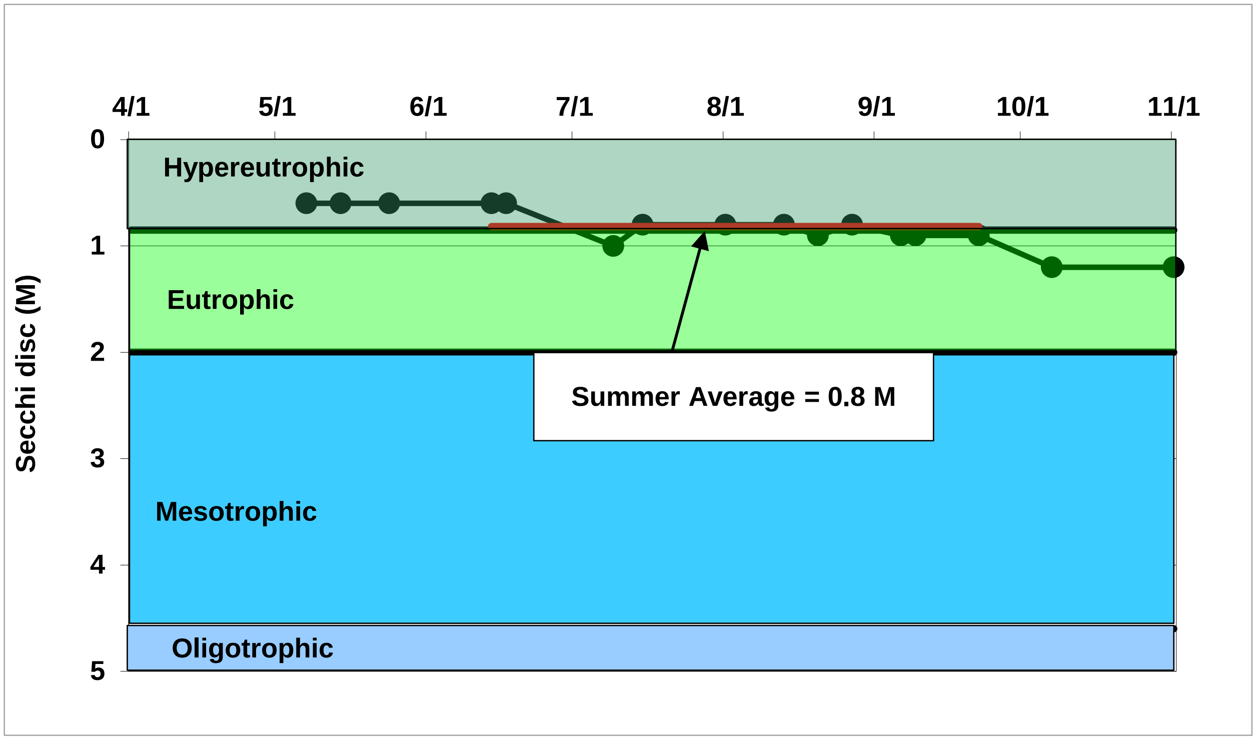


Figure 14 2013 Northwood Lake Secchi disc transparency data

3.6 Historical Trends

Historical water quality trends are shown on Figures 15 through 17. The black diamonds on the figures show the average summer values during the period of record (i.e., average summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency depths). The line on each figure shows the long-term trend; the slope of the line shows the rate of change over time.

Despite apparent improvements in water quality since 2000, changes in total phosphorus, chlorophyll *a*, and Secchi disc transparency values during the period of record are not significant because there is more than a 5 percent probability that the changes are due to chance (Figures 15 through 17). The high number of measurements since 2000 (14) compared with pre-2000 measurements (4) influenced the outcome of the trend analysis. Although changes since 2000 are not considered significant, it is worth noting that:

- Most pre-2000 total phosphorus values were higher than post-2000 values.
- All pre-2000 average summer chlorophyll *a* concentrations were higher than post-2000 concentrations.
- All pre-2000 average summer Secchi disc transparency depths were lower than post-2000 depths.

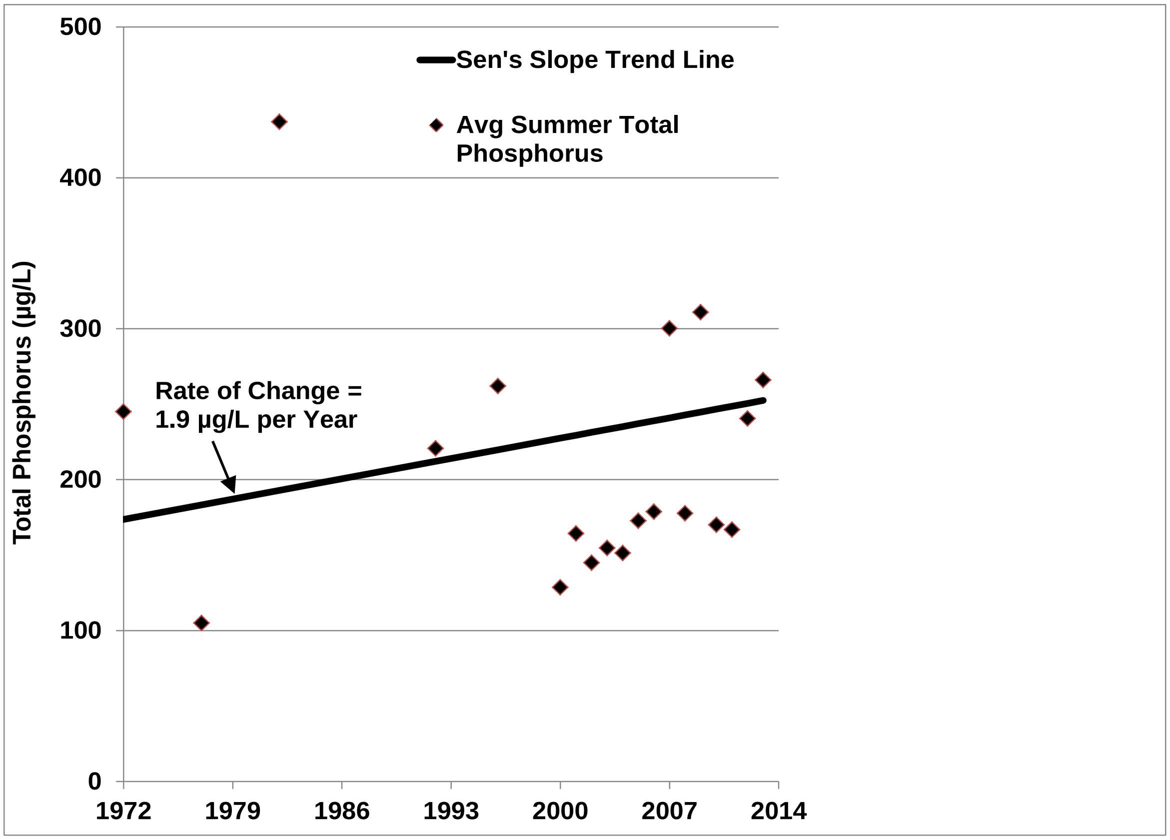


Figure 15 Northwood Lake total phosphorus trend analysis: 1972-2013

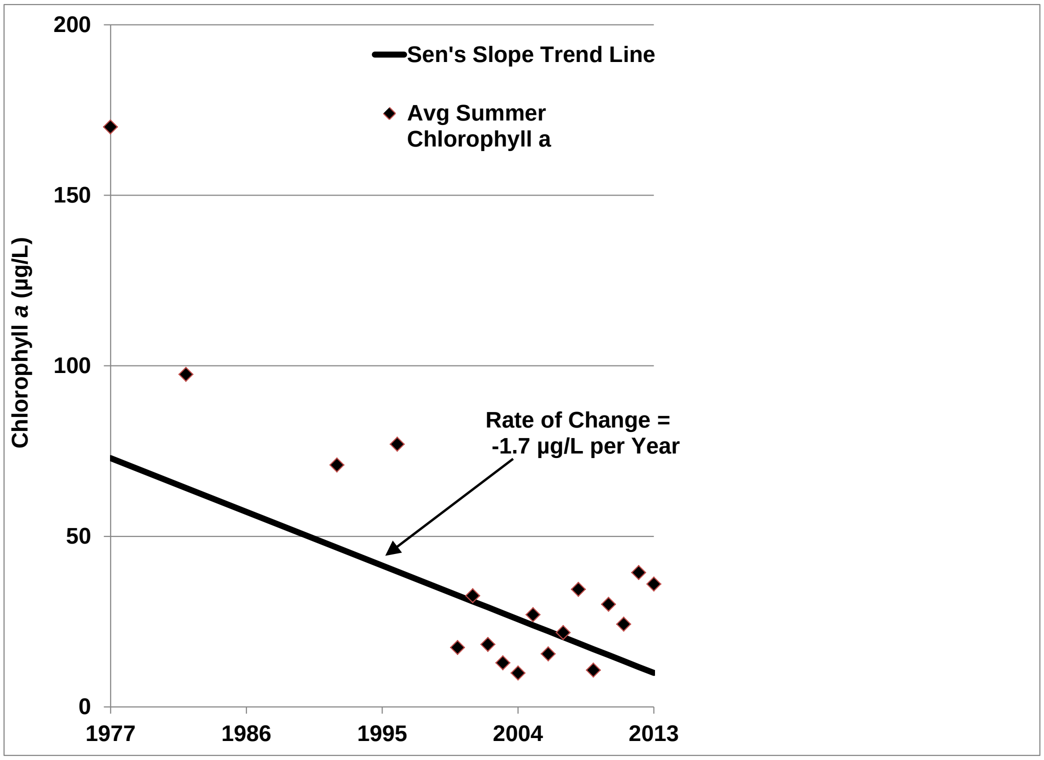


Figure 16 **Northwood Lake chlorophyll *a* trend analysis: 1977-2013**

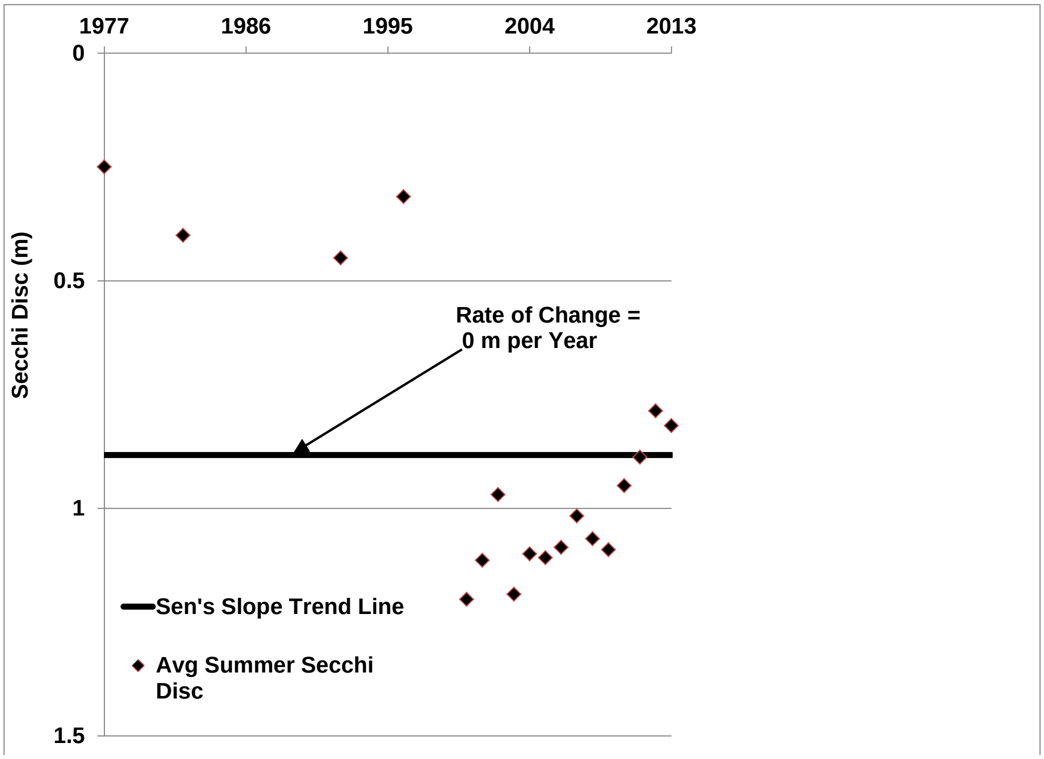


Figure 17 **Northwood Lake Secchi disc trend analysis: 1977-2013**

3.7 Historical Attainment of Goals and Standards

Figures 18 through 20 compare historical water quality data from Northwood Lake for the period 1972 through 2013 with BCWMC's lake water quality goals. Figures 21 through 23 compare historical water quality data from Northwood Lake for the period 1972 through 2013 with MPCA water quality standards for shallow lakes. None of the summer averages for total phosphorus concentrations met the BCWMC goal or total phosphorus standard for shallow lakes. Chlorophyll *a* summer averages met the BCWMC goal and state standard during 2000, 2002, 2003, 2004, 2006, and 2009 (33 percent of the time). Secchi disc transparency summer averages met the BCWMC goal and standard in 2000 and 2001 and from 2003 through 2009 (56 percent of the time).

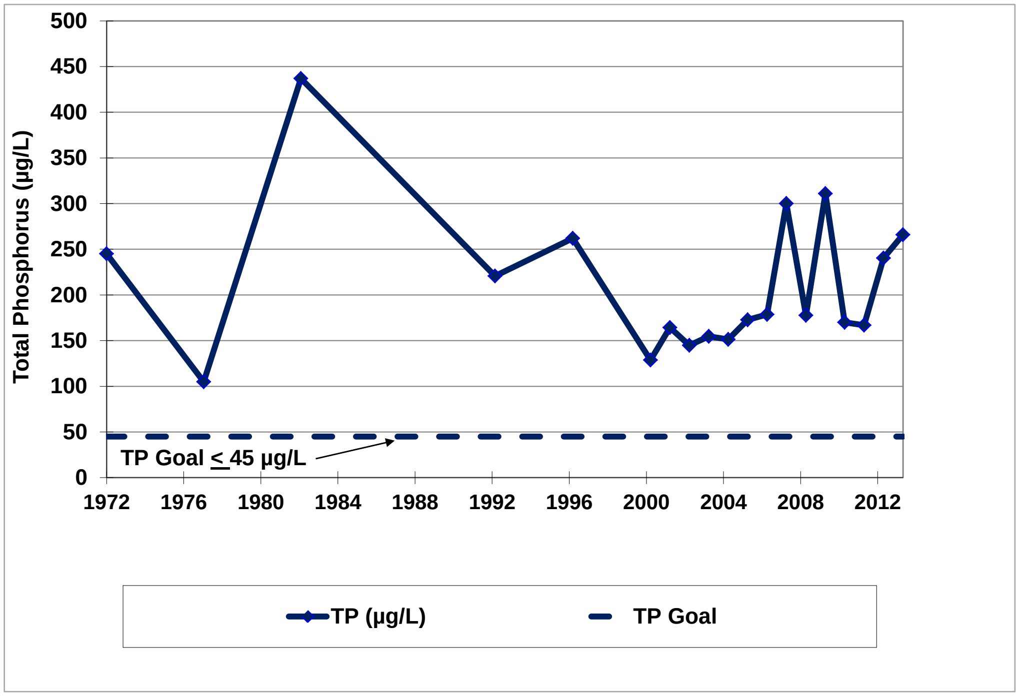


Figure 18 **Northwood Lake historical total phosphorus concentrations compared with BCWMC total phosphorus goal**

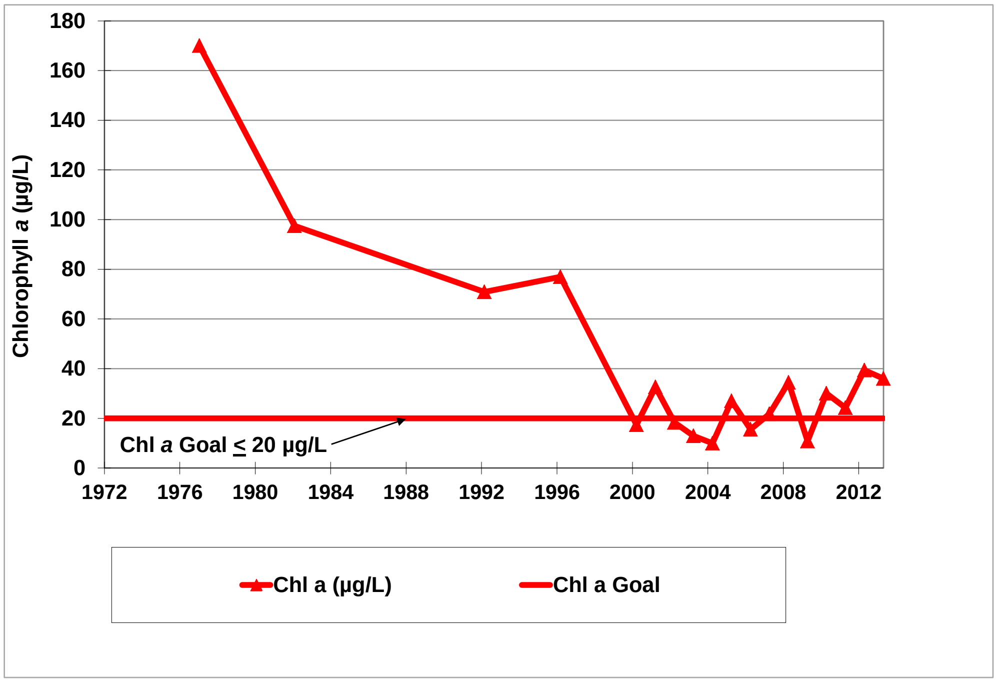


Figure 19 **Northwood Lake historical chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

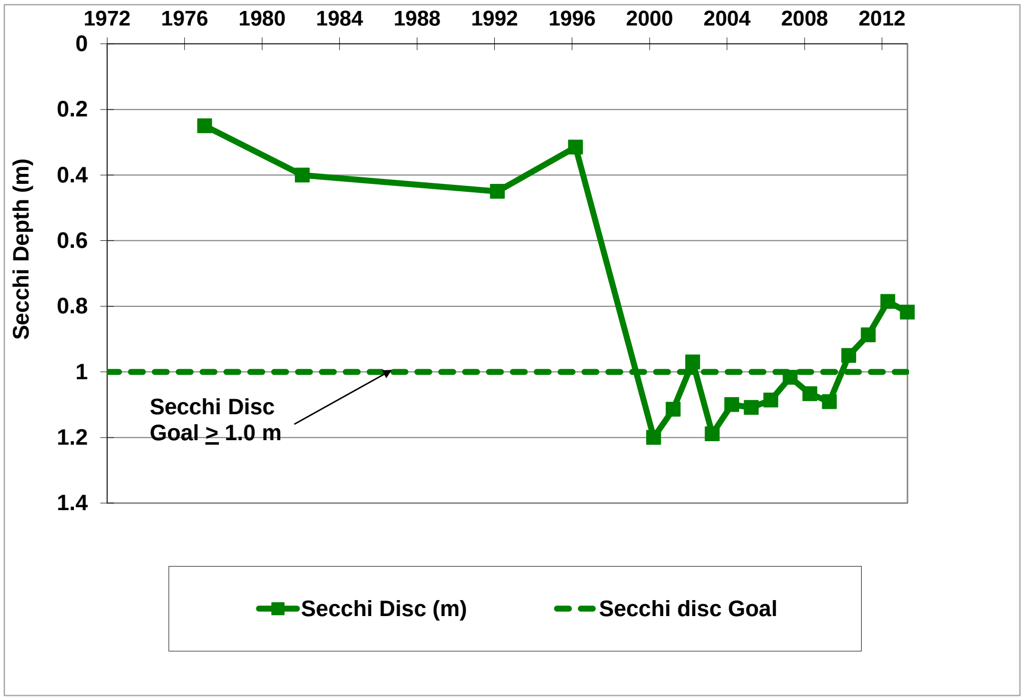


Figure 20 **Northwood Lake historical Secchi disc depths compared with BCWMC Secchi disc goal**

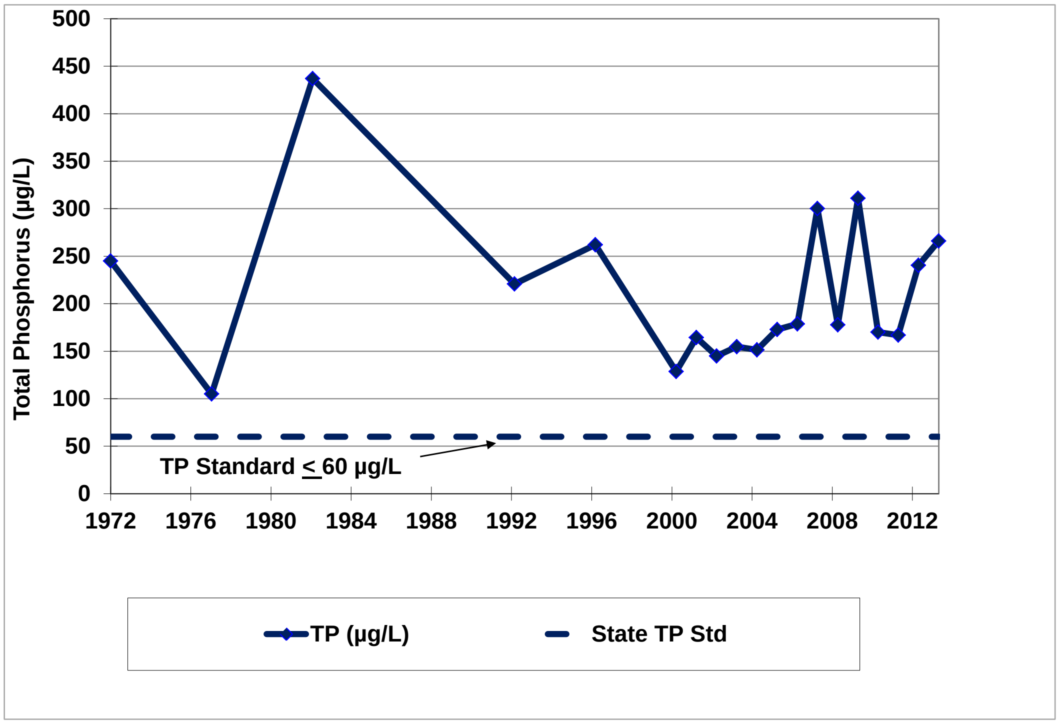


Figure 21 **Northwood Lake historical total phosphorus concentrations compared with Minnesota total phosphorus standard for shallow lakes**

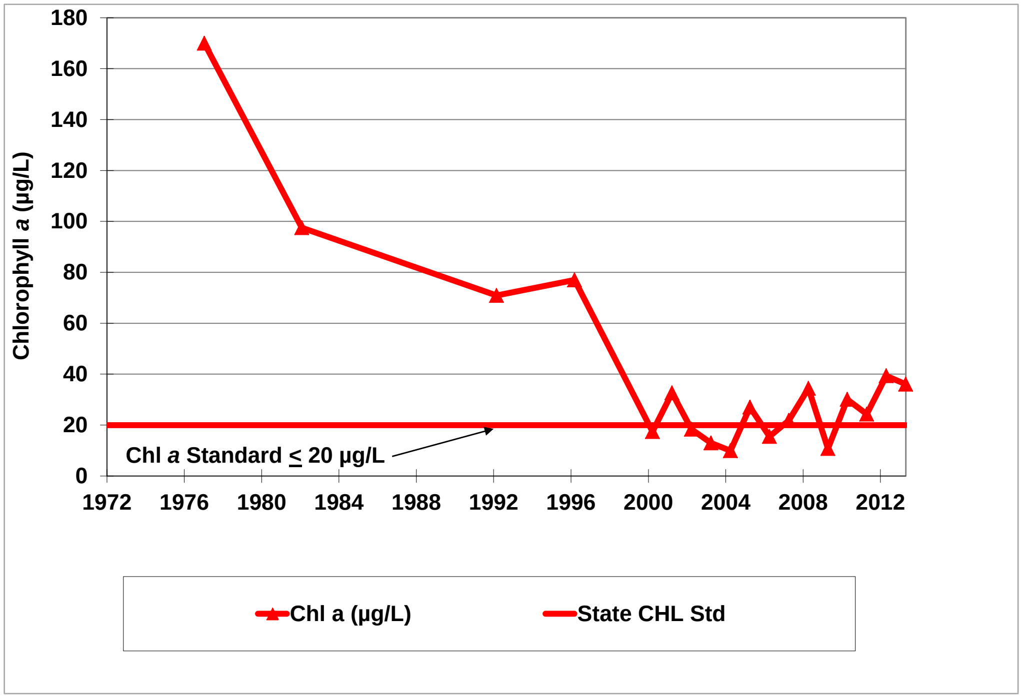


Figure 22 **Northwood Lake historical chlorophyll *a* concentrations compared with Minnesota chlorophyll *a* standard for shallow lakes**

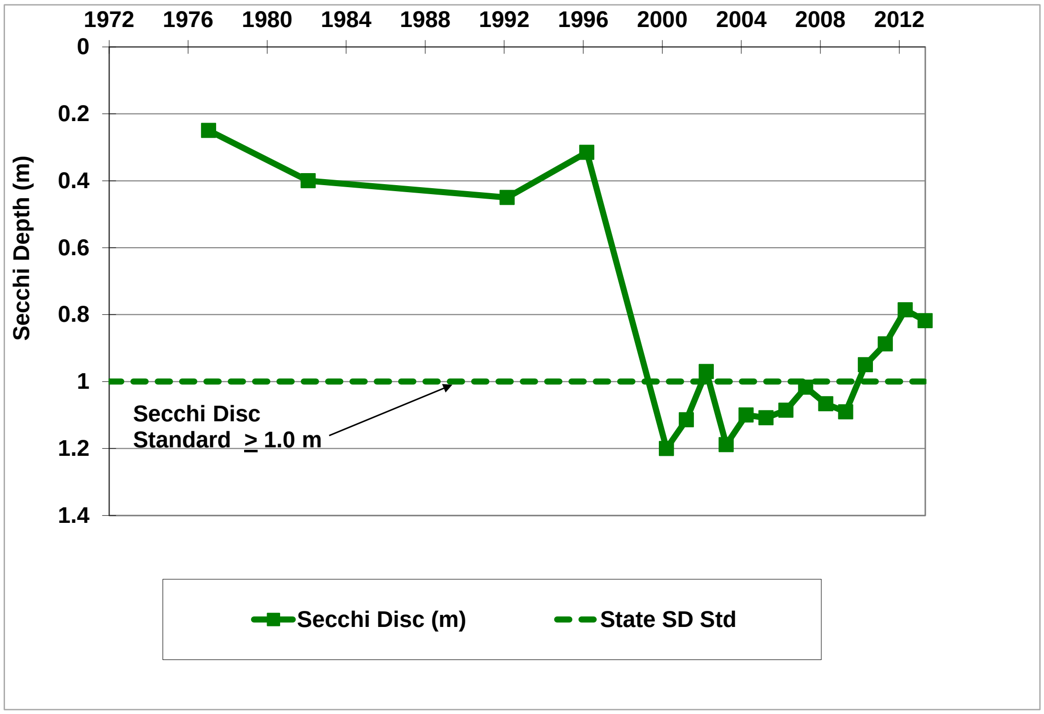


Figure 23 **Northwood Lake historical Secchi disc depth compared with Minnesota Secchi disc standard for shallow lakes**

3.8 Biota

Three components of lake biota are presented: macrophytes, phytoplankton, and zooplankton. Fisheries status is managed by the Minnesota Department of Natural Resources (MDNR) and is not covered in this report.

3.8.1 Macrophytes

Macrophytes are aquatic plants that are large enough to be visible to the naked eye. Macrophytes are divided into three groups:

- Submerged—grow beneath the water surface
- Floating leaf—leaves float on the water surface
- Emergent—stem and leaves are above the water surface

Prior to 2000, macrophytes were not observed in Northwood Lake during lake surveys completed by the BCWMC. It is believed that the dense algal blooms shaded the lake bottom and prevented plants from growing. The use of barley straw from 2000 through 2003 appeared to greatly improve the lake's water transparency. Sunlight reaching the lake's bottom enabled macrophytes to become established. In 2000, two submerged species of macrophytes were observed. Light growth of a narrow-leaf pondweed (*Potamogeton sp.*) was found throughout the lake and coontail (*Ceratophyllum demersum*) was found primarily in the northern portion of the lake. An evaluation of the lake by the city of New Hope on August 6, 2003, showed the same two plant species. However, coontail had expanded its coverage and was observed throughout the lake.

In 2005, the number of submerged plant species in the lake doubled. In addition to narrow-leaf pondweed and coontail, elodea and curly-leaf pondweed were observed throughout the lake. Four emergent species (bulrush, cattail, giant bur-reed and narrow-leaf sedge) were also observed for the first time.

In 2013 a total of 12 macrophyte species were observed (macrophytes first observed in 2013 are noted, below, in italics):

- Five submerged (narrow-leaf pondweed, coontail, elodea, curly-leaf pondweed, and *flat-stem pondweed*)
- Two floating leaf (*great duckweed* and *water knotweed*)
- Five emergent (cattail, narrow-leaf sedge, two bulrush species, *purple loosestrife*)

Although the two emergent bulrush species listed may have been present in 2005, bulrush was not identified to the species level at that time. The locations of these macrophytes are shown in Figures 24 and 25.

Purple loosestrife (*Lythrum salicaria*) is undesirable because it displaces native species that provide a better quality habitat. It is recommended that BCWMC contact MDNR to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding Northwood Lake. Introduction of the beetles is expected to control purple loosestrife and protect the native vegetation.

The growth of macrophytes in Northwood Lake has sustained the lake's improved water transparency after discontinuation of barley straw in 2003. Algae has been reduced by abundant coontail, which releases allelochemicals that inhibit algae growth—particularly blue-green algae (Korner et al. 2002, Gross et al. 2003, Wium-Anderson 1983).

Since 2000, improved water transparency has enabled the lake to support the growth of algal mats associated with submerged plants. The algal mats are comprised of filamentous algae, generally green algae that begin their growth on plants or on the lake bottom. As the algae grow, they stick together and form dense mats; eventually, oxygen produced by the algae becomes trapped within the mats, causing them to float toward the lake's surface. Caught on aquatic vegetation, such as coontail, the mats are prevented from washing out of the lake via its outlet and therefore they increase in coverage throughout the growing season.

Algal mats associated with aquatic plants have been observed in Northwood Lake since 2003. However, in 2013 the algal mats appeared later and were less dense than those observed in 2003. The delay in mat formation and the reduction in mat density are likely due to the allelochemicals secreted by coontail. These inhibit the green algae that form the algal mats.

Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Curly-leaf Pondweed	***Potamogeton crispus***
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Flatstem Pondweed	*Potamogeton zosteriformis*

Floating Leaf Plants

Common Name	Scientific Name
Great Duckweed	*Spirodela polyrhiza*

Emergent Plants

Common Name	Scientific Name
Narrowleaf Sedge	*Carex sp.*
Purple Loosestrife	***Lythrum salicaria***
River Bulrush	*Schoenoplectus fluviatilis*
Cattail	*Typha sp.*
Hardstem Bulrush	*Schoenoplectus acutus*

*Note: Bold red name indicates extremely aggressive/invasive species.

FIELD NOTES:

- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy
- Macrophytes found throughout the entire water body.
- Algal mats present.
- Coontail is denser near the center of the pond and is at the surface in some locations.
- Algal mats growing on Coontail, which is at the surface.
- Light density of Great Duckweed mixed in with Coontail/Floating on top.

Water Quality Monitoring Location
Emergent Plants
Submerged Aquatic Plants

N

0 400 800
Feet

0 100 200
Meters

Imagery Source: 2009 AE

BARR

Figure 24

NORTHWOOD LAKE MACROPHYTE SURVEY

June 17, 2013
Bassett Creek Watershed Management Commission

Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Curly-leaf Pondweed	***Potamogeton crispus***
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Flatstem Pondweed	*Potamogeton zosteriformis*

Floating Leaf Plants

Common Name	Scientific Name
Water Knotweed	*Polygonum amphibium*
Great Duckweed	*Spirodela polyrhiza*

Emergent Plants

Common Name	Scientific Name
Narrowleaf Sedge	*Carex sp.*
Purple Loosestrife	***Lythrum salicaria***
River Bulrush	*Schoenoplectus fluviatilis*
Cattail	*Typha sp.*
Hardstem Bulrush	*Schoenoplectus acutus*

*Note: Bold red name indicates extremely aggressive/invasive species.

FIELD NOTES:

- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy

- Macrophytes found throughout the entire water body.

- Algal mats present.

- Coontail is denser near the center of the pond and is at the surface in some locations.

- Algal mats growing on Coontail, which is at the surface.

- **Curly-leaf Pondweed** still present.

- Light density of Great Duckweed mixed in with Coontail/Floating on top.

Water Quality Monitoring Location

Emergent Plants

Floating Leaf Plants

Submerged Aquatic Plants

N

0 400 800
Feet

0 100 200
Meters

Imagery Source: 2009 AE

BARR

Figure 25

NORTHWOOD LAKE MACROPHYTE SURVEY

August 21, 2013
Bassett Creek Watershed Management Commission

3.8.2 Phytoplankton

Algae are microscopic plants that convert sunlight and nutrients into biomass. They can live on the bottom sediments and substrates (filamentous algae), on plants and leaves (periphyton), or in the water column (phytoplankton). Since 1982, phytoplankton samples have been collected periodically from Northwood Lake to evaluate the lake's water quality and determine the quality of food available to the lake's small animals (zooplankton). Filamentous algae and periphyton are present in Northwood Lake, but have not been sampled.

Algae have short life cycles. As a result, changes in water quality are often reflected by changes in the algal community within a few days or weeks. The types of algae in a lake will change over the course of a year. Typically, there are fewer algae in winter and spring because of ice cover and cold temperatures. As a lake warms up and sunlight increases, algae communities begin to increase. Their short life span quickly cycles the nutrients in a lake and affects nutrient dynamics.

There are seven divisions of algae found in typical lakes of Minnesota (Table 4) and all seven divisions have been observed in Northwood Lake during the period of record (Figures 26 and 27).

Table 4 Characteristics of algae observed in Northwood Lake from 1982 through 2013 (Shaw et al. 2004, Brown 2002, Guedes et al. 2012)

Algal Division	Common Name	Characteristics
Chlorophyta	Green algae	Provide high nutritional value to consumers. Can be single-celled, colonial, or filamentous. Filamentous often intermingle with macrophytes.
Bacillariophyta	Diatoms	Provide high nutritional value to consumers. Sensitive to chloride, pH, color, and total phosphorus in water. As total phosphorus increases, diatoms decrease. Generally larger in size. Tend to be highly present in spring and late spring.
Cryptophyta	Cryptomonads	Provide high nutritional value to consumers. Bloom-forming and used to feed small zooplankton.
Cyanophyta	Blue-green algae	Provide low nutritional value to consumers. 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. Colonies and filaments are often too large to be ingested by zooplankton.
Pyrrophyta	Dinoflagellates	Have starch reserves and serve as food for grazers.
Chrysophyta	Golden-brown algae	A genus of single-celled algae with ovoid cells and a distinctive golden color.
Euglenophyta	Euglenoids	Commonly found in freshwater that is rich in organic materials. Most are unicellular.

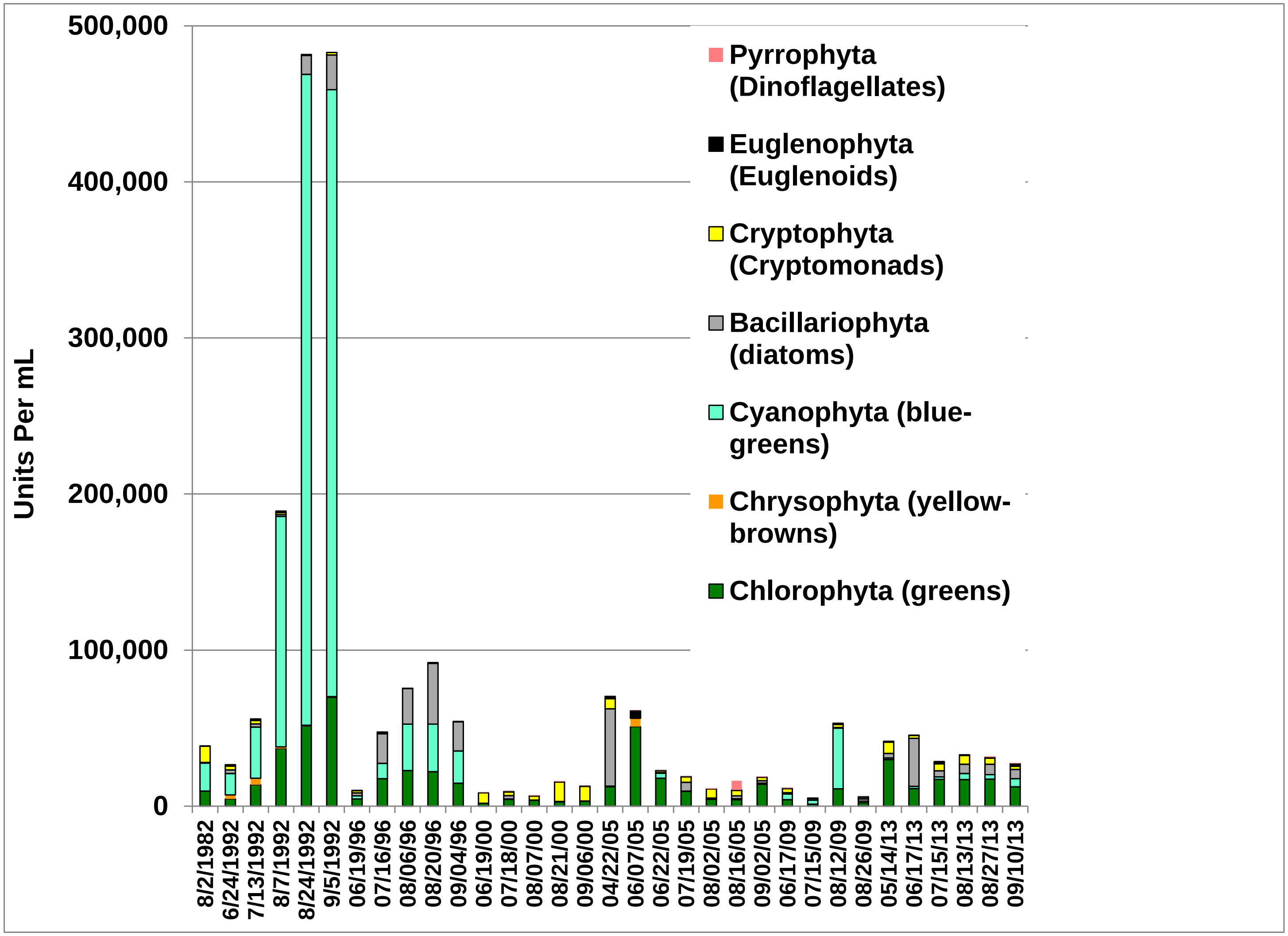


Figure 26 **1982-2013 Northwood Lake phytoplankton data summary**

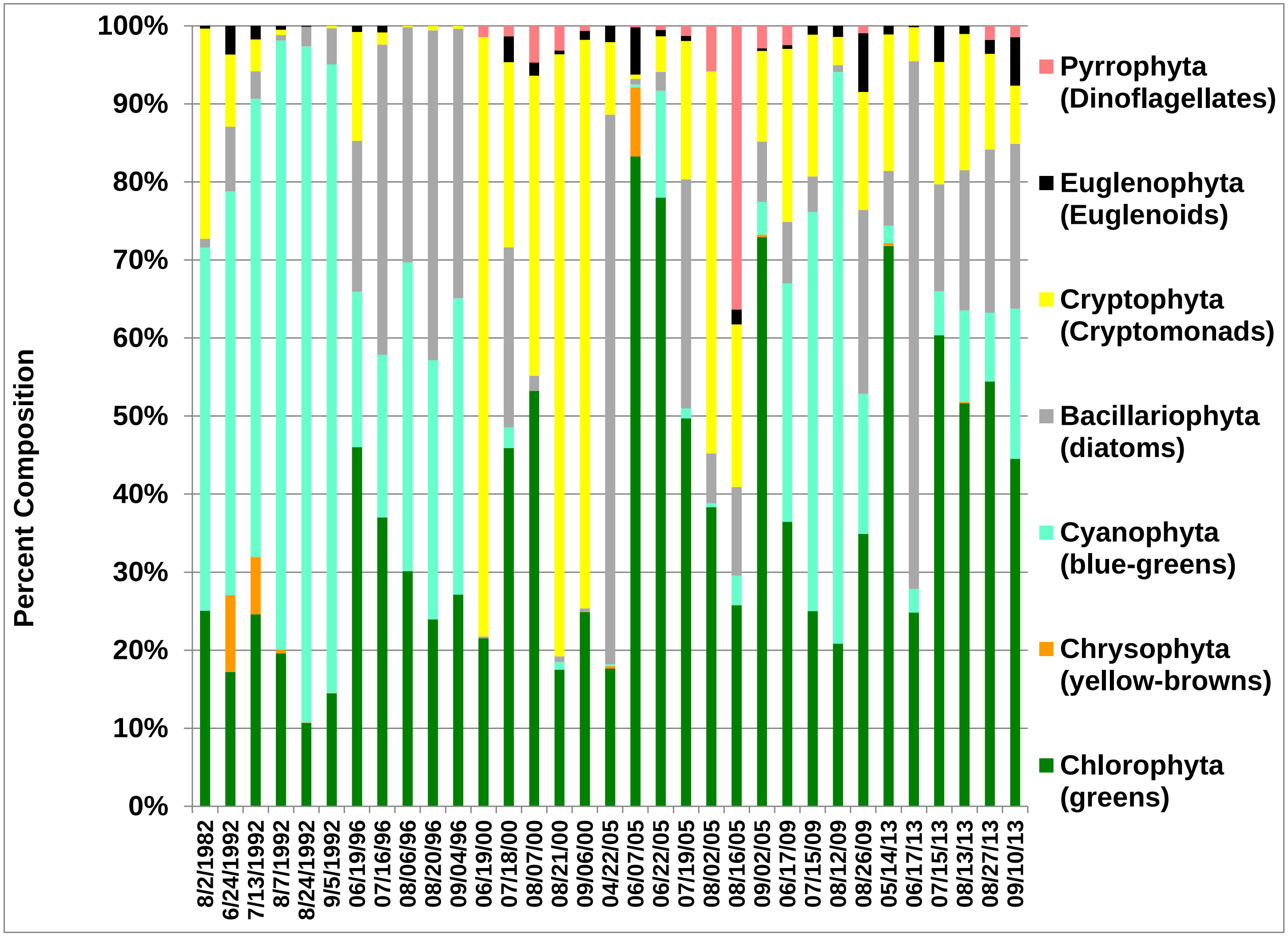
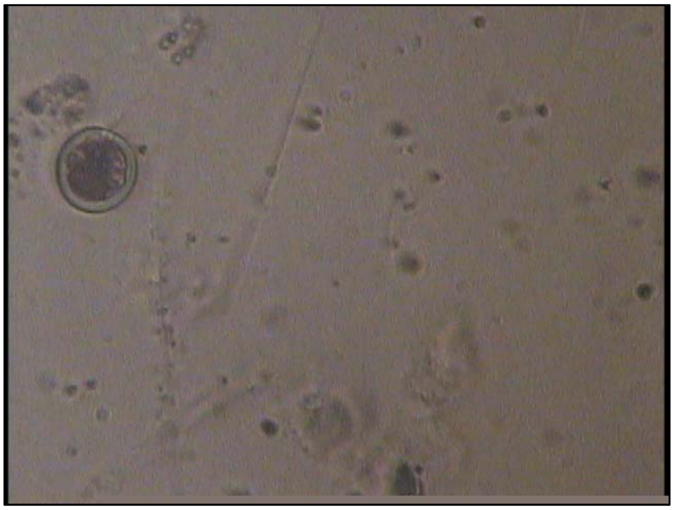


Figure 27 1982-2013 Northwood Lake phytoplankton composition by division

The 2013 phytoplankton community was generally dominated by green algae, although diatoms dominated during June (Figures 26 and 27). Green algae are indicative of a fertile system. Both green algae and diatoms provide high nutritional value to consumers.



The numbers of phytoplankton have generally been lower since 2000. In addition, fewer blue-green algae have been observed and blue-green algae have comprised a smaller percentage of the algal community (Figures 26 and 27). The reduction in algae numbers, particularly numbers of blue-green algae (despite extremely high phosphorus concentrations) are attributed to the excretion of allelopathic chemicals by coontail. As noted previously, the chemicals inhibit algal growth, particularly blue-green algae (Korner et al. 2002, Gross et al. 2003). Because blue-green algae provide poor nutrition and many species are unable to be ingested by consumers, the reduction in blue-green algae has improved the quality of the food supply in Northwood Lake.

The 2013 Northwood phytoplankton community was generally dominated by green algae, pictured above, although diatoms (pictured below) dominated the community during June.

Some blue-green algae produce toxins that, when ingested or inhaled, can cause short- and long-term health effects. These effects range from tingling, burning, numbness, drowsiness, and dermatitis to liver or respiratory failure—possibly leading to death. Not all blue-green algae produce toxins, but the presence of blue-green algae is a marker for a potential hazard. The World Health Organization (WHO) developed guidelines to determine risks from blue-green algae. No adverse health effects are expected when fewer than 20,000 blue-green algae per milliliter are observed. Low adverse health effects, such as skin irritations and/or gastrointestinal illness may occur when numbers are between 20,000 and 100,000 per milliliter. When blue-green algae numbers exceed 100,000 per milliliter, moderately adverse health effects, including the potential for long-term illness, may occur (WHO 2003).

Data from Northwood Lake during the period of record indicate substantially reduced numbers of blue-green algae since 2000 (Figure 28). The excretion of allelochemicals by coontail has, apparently, inhibited the growth of blue-green algae despite high phosphorus concentrations in the lake. With the reduced numbers of blue-green algae in Northwood Lake have come reduced risks of adverse health effects. Since 2000, blue-green algae levels have been found to pose a risk (low) in only one of 20 sample events (August 2009). Prior to 2000, blue-green algae levels found during 63 percent of sample events posed some risk of adverse health effects (36 percent low risk and 27 percent moderate risk). (Figure 28).

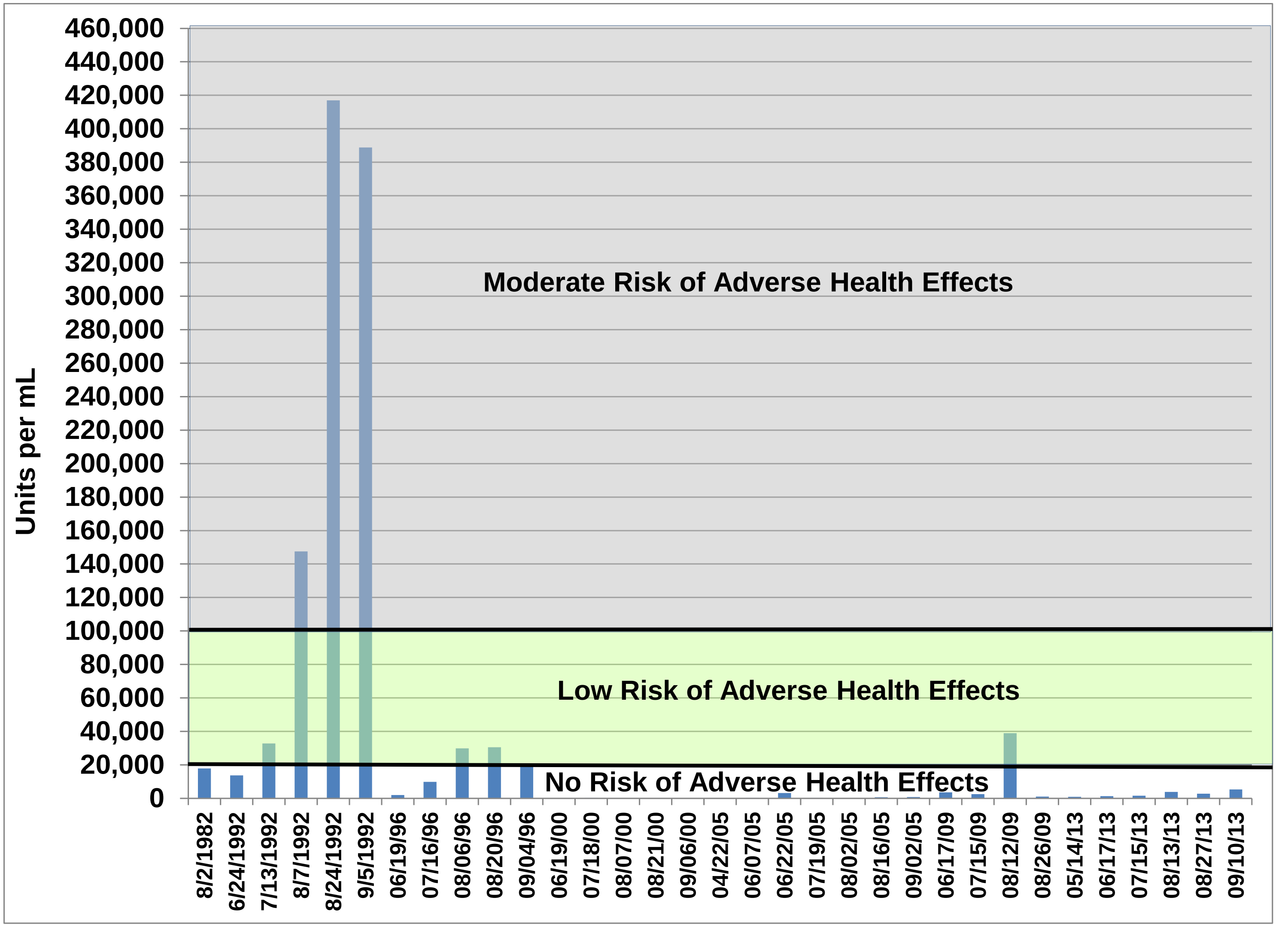


Figure 28 1982–2013 Northwood Lake blue-green algae compared with risk of adverse health effects

3.8.3 Zooplankton

Zooplankton are small aquatic animals that feed on algae and are eaten by fish. They are divided into three main groups: rotifers, copepods, and cladocerans.

- **Rotifers** eat algae, other zooplankton, and sometimes each other. 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 (Shaw et al. 2004).
- **Copepods** feed on algae and other plankton. They are eaten by larger plankton and are preyed heavily upon by panfish, minnows, and the fry of larger fish (Shaw et al. 2004).
- **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 clear water in lake ecosystems (Shaw et al. 2004).

Changes in the aquatic plant community can impact zooplankton populations. This occurs because aquatic plants help zooplankton avoid predation by taking refuge within the plant community (Shaw et al. 2004). Thus, the establishment of an aquatic plant community since 2000 has aided the survival of zooplankton in Northwood Lake.

During the period of record, all three groups of zooplankton were represented in Northwood Lake**.** However, small rotifers have generally dominated the community (Figures 29 and 30). The rotifers graze primarily on extremely small particles of plant matter and do not significantly affect the lake's water quality. The abundance of small-bodied zooplankters is indicative of fish predation on larger-bodied animals. Fish "sight feed," selecting and depleting the number of large-bodied zooplanters in the water body.

Compared with previous years, higher numbers of zooplankton were observed in Northwood Lake during 2013 (Figure 29). Despite the higher numbers of zooplankton, fewer cladocera were observed. Cladocerans tend to be larger than rotifers and copepods and have a greater impact on the lake's water quality. The reduced numbers of cladocerans indicates increased predation by fish may have occurred in 2013.

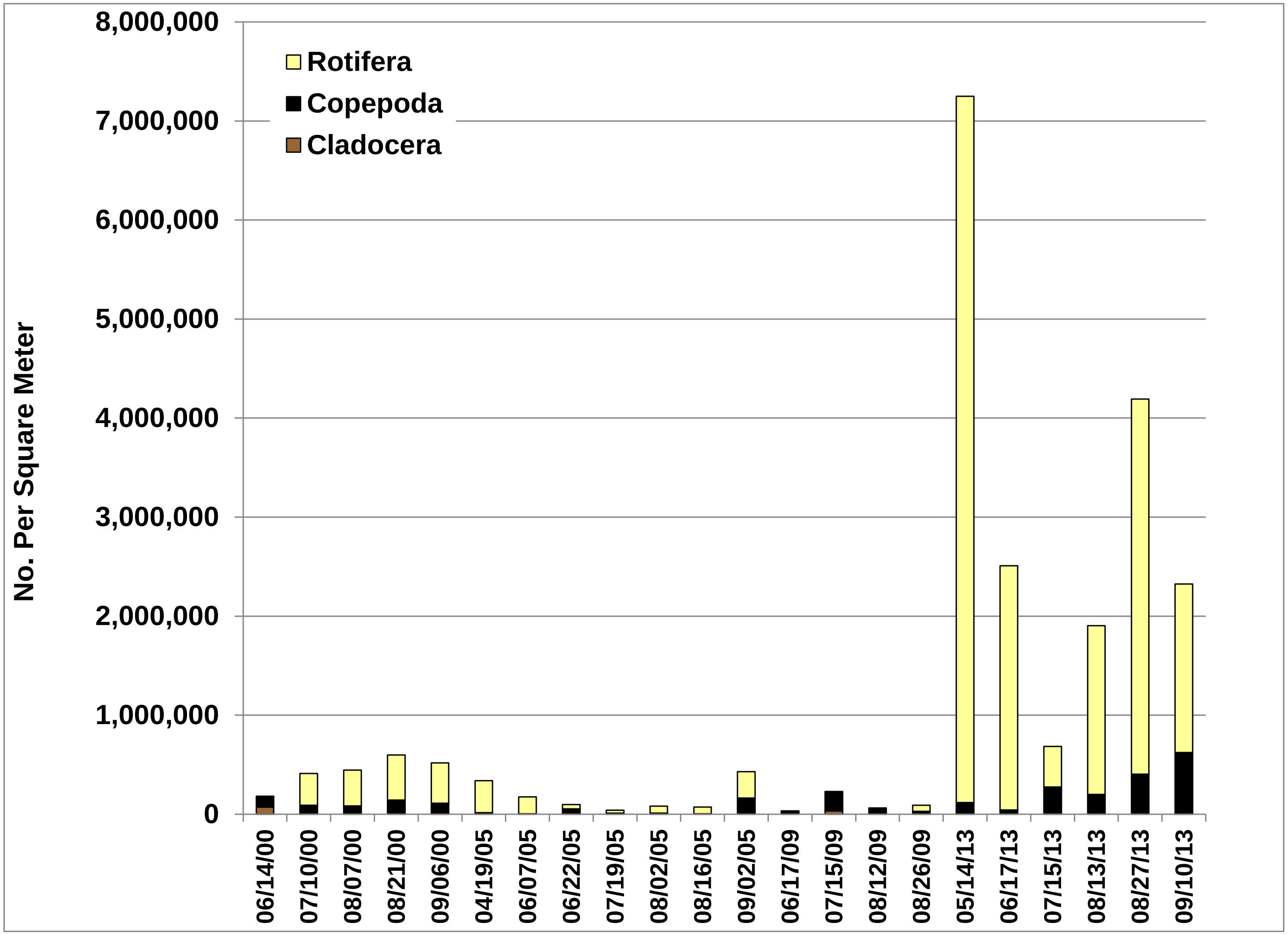


Figure 29 **2000–2013 Northwood Lake zooplankton data summary by division**

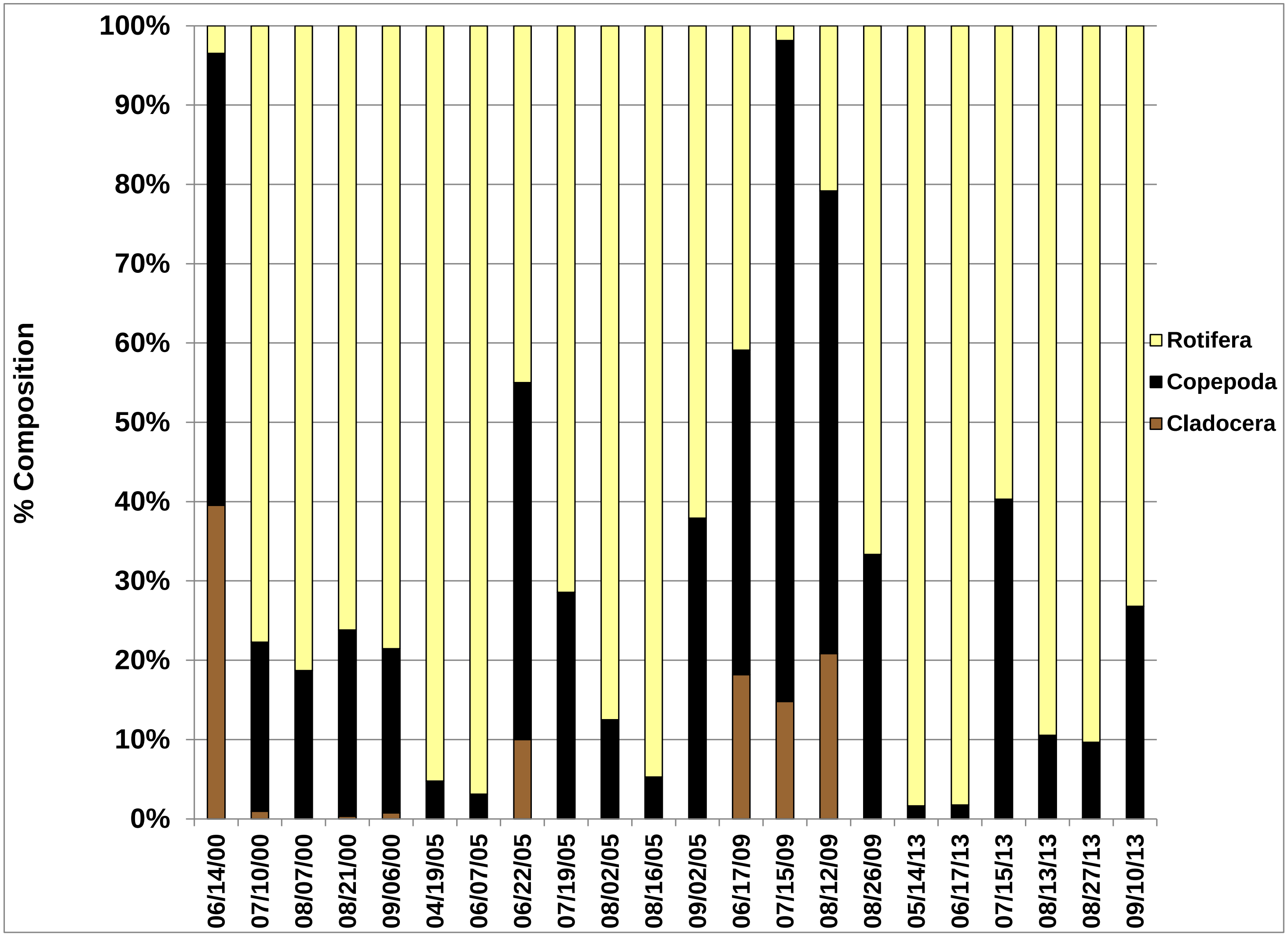


Figure 30 **2000-2013 Northwood Lake zooplankton composition by group**

3.9 Conclusions and Recommendation

3.9.1 Conclusions

Use of barley straw from 2000 through 2003 improved water transparency in Northwood Lake, enabling sunlight to reach the bottom and macrophytes to become established—including coontail. Coontail releases allelochemicals that inhibit the growth of algae, especially blue-green algae (Korner et al. 2002, Gross et al. 2003, and Wium-Anderson 1983). Hence, the lake's abundant coontail has contributed to continued improvement in water transparency, despite the high phosphorus levels seen since barley straw was discontinued in 2003. Since 2000, blue-green algae numbers have consistently been below risk levels for adverse health effects, with only one 2009 sample indicating a low risk of adverse health effects. Prior to 2000, blue-green algae levels seen in two-thirds of the sampling events posed either a low or moderate risk of adverse health effects. The data provide further affirmation of the benefits provided by the macrophyte community established in the lake since 2000.

Conclusions of the 2013 study of Northwood Lake include:

- Total phosphorus, chlorophyll a, and Secchi disc transparency summer averages failed to meet BCWWMC goals and MPCA water quality standards for shallow lakes in 2013.
- According to trend analyses results, apparent improvements in water quality since 2000 are not significant. This is likely due to the influence of the large number of measurements since 2000 (14) relative to pre-2000 measurements (4). Nonetheless, most pre-2000 total phosphorus values and all pre-2000 average summer chlorophyll *a* concentrations were higher and all pre-2000 average summer Secchi disc transparency depths were lower than post-2000 values.
- While none of the total phosphorus summer averages during the period of record have met the BCWMC goal and MPCA water quality standard for shallow lakes, 33 percent of chlorophyll *a*, and 56 percent of Secchi disc transparency summer averages have met BCWMC goals and MPCA standards. All standards attainments have occurred since 2000.
- Fewer phytoplankton and blue-green algae have been observed, and blue-green algae have comprised a smaller percentage of the algal community since 2000. Allelochemicals excreted by coontail, which became established in the lake in 2000, appear to have inhibited algal growth—especially blue-green algal growth.
- Compared with previous years, higher numbers of zooplankton were observed in Northwood Lake during 2013 (Figure 29). However, numbers of cladocerans were reduced, indicating increased fish predation may have occurred.
- Since macrophytes became established in the lake in 2000, the number of species has continued to increase; 12 species were observed in 2013.
- Nuisance non-native plants observed in 2013 include curly-leaf pondweed, first observed in 2005, and purple loosestrife, first observed in 2013.

3.9.2 Recommendation

It is recommended that BCWMC contact the MDNR to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding Northwood Lake. Introduction of the beetles is expected to control purple loosestrife and protect the native vegetation.

4.0 North and South Rice Ponds

4.1 Site Description

North Rice Pond, located in the city of Robbinsdale (Figure 1), has a surface area of approximately 3.7 acres and a maximum depth of 5 feet (1.5 meters). South Rice Pond, located in the cities of Golden Valley and Robbinsdale (Figure 1), receives the overflow from North Rice Pond. It has a surface area of approximately 3.2 acres and a maximum depth of 3 feet (0.9 meters). North Rice Pond (27-644W) and South Rice Pond (27-645W) are designated by the Minnesota Department of Natural Resources (MDNR) as public waters wetlands.

4.2 BCWMC Water Quality Goals

The Bassett Creek Watershed Management Commission's (BCWMC) goal for North Rice Pond and South Rice Pond is a management classification of Level III, meaning its water quality should support aesthetic viewing. Level III goals are: (1) maximum total phosphorus concentration of 75 µg/L, (2) maximum chlorophyll *a* concentration of 40 µg/L, and (3) minimum Secchi disc transparency of 1.0 meters (about 3 feet) (BCWMC 2004). As shown in Figures 31 through 36, 2013 North Rice Pond and South Rice Pond average summer chlorophyll *a* concentrations met the BCWMC water quality goal, while average summer total phosphorus concentrations and Secchi disc transparency values did not.

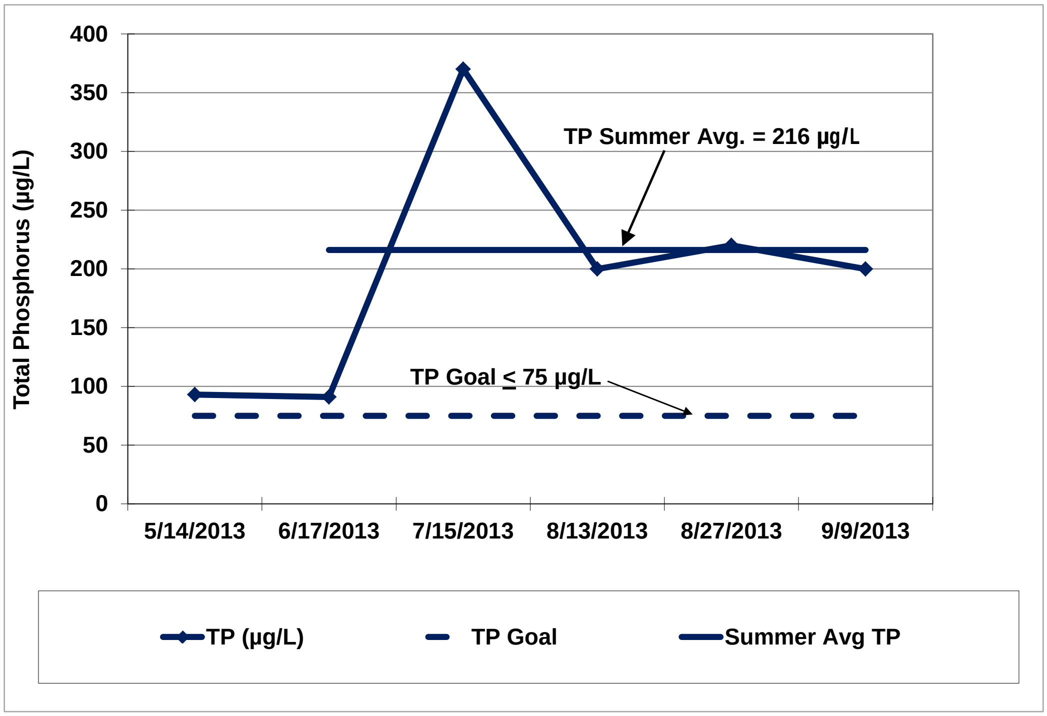


Figure 31 **2013 North Rice Pond total phosphorus concentrations compared with BCWMC total phosphorus goal**

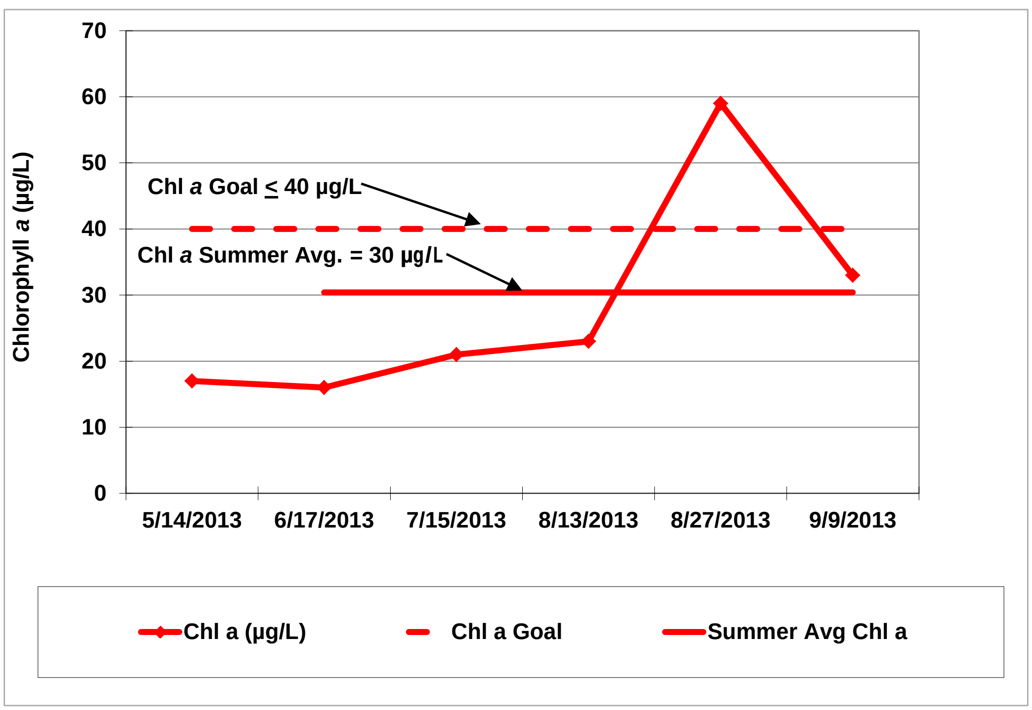


Figure 32 **2013 North Rice Pond chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

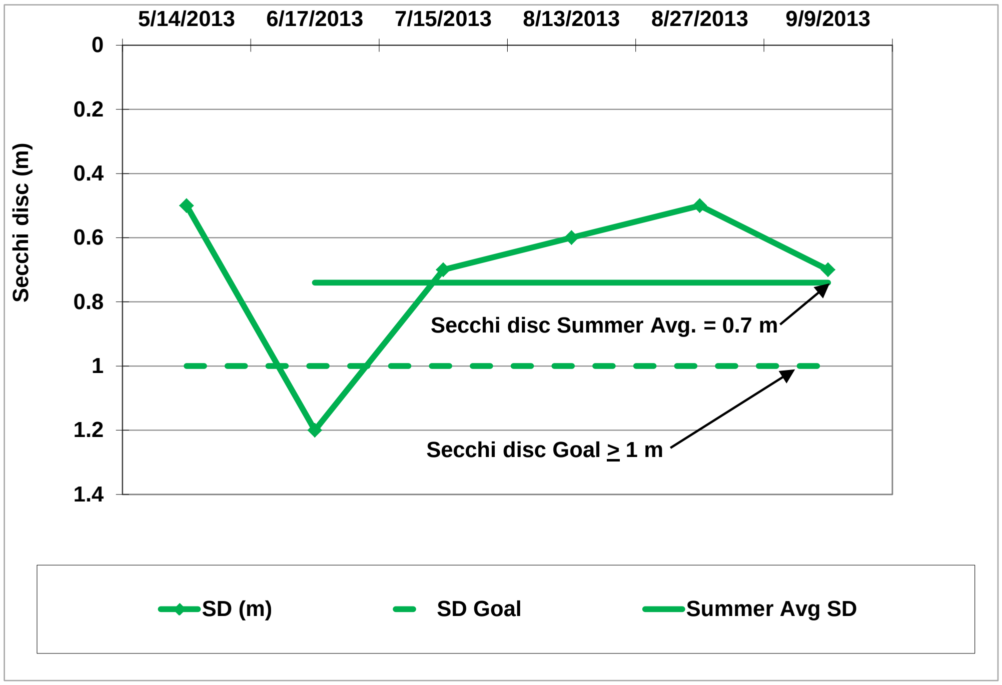


Figure 33 **2013 North Rice Pond Secchi disc depths compared with BCWMC Secchi disc goal**

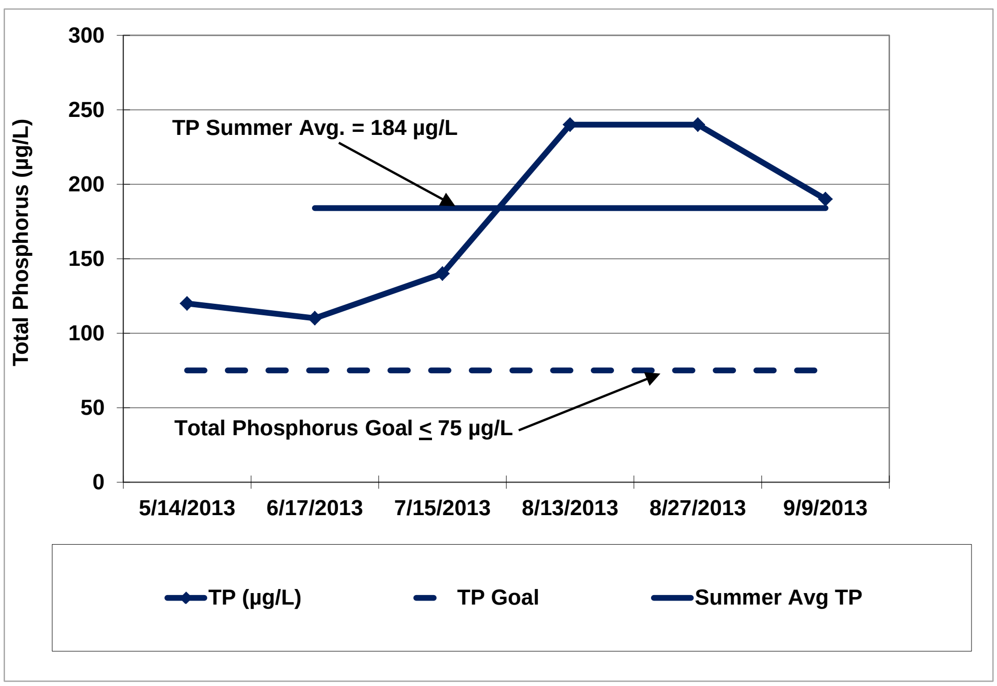


Figure 34 **2013 South Rice Pond total phosphorus concentrations compared with BCWMC total phosphorus goal**

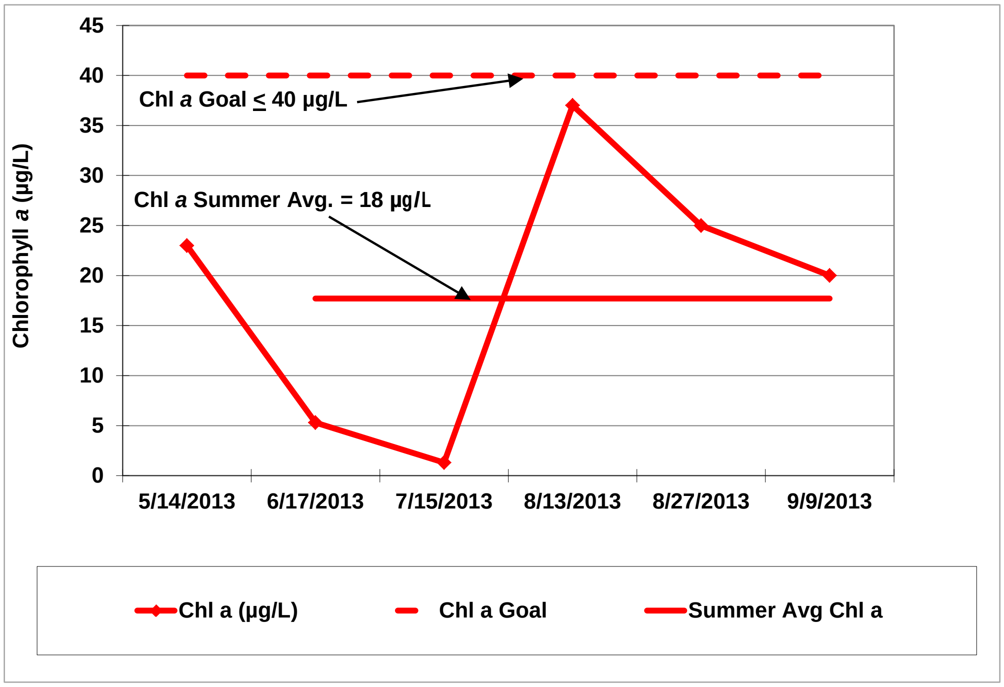


Figure 35 **2013 South Rice Pond chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

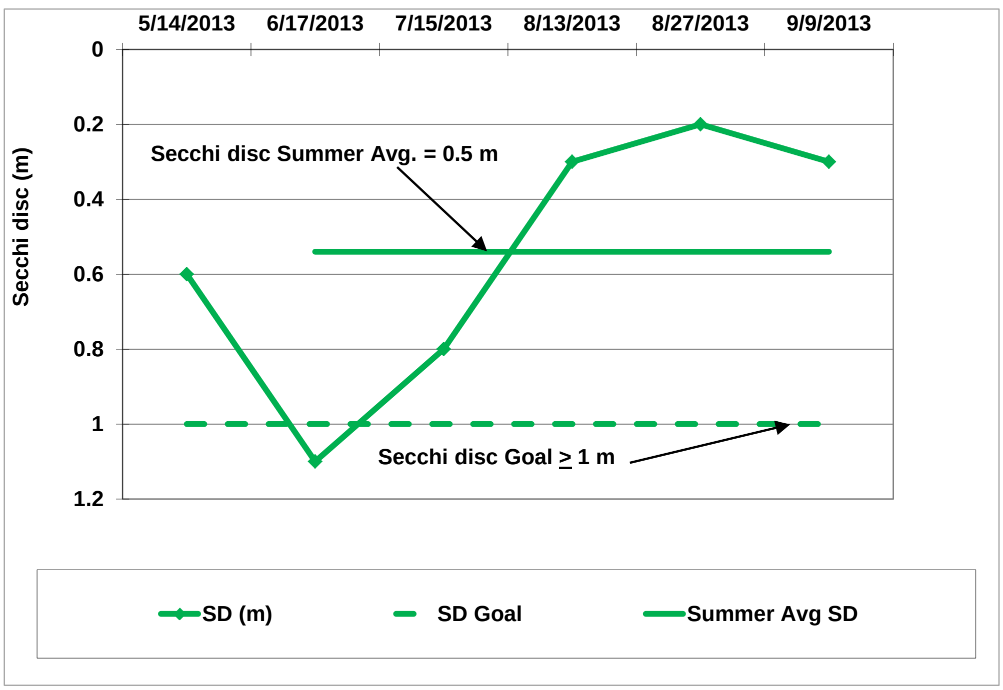


Figure 36 **2013 South Rice Pond Secchi disc depths compared with BCWMC Secchi disc goal**

4.3 Minnesota Pollution Control Agency (MPCA) Water Quality Standards

North Rice Pond (27-644W) and South Rice Pond (27-645W) are considered wetlands. As such, there are no MPCA water quality standards that apply.

4.4 Watershed and Lake Management Plan

The BCWMC Watershed Management Plan (BCWMC 2004) has incorporated the North Rice, South Rice, and Grimes Ponds Watershed and Lake Management Plan (BCWMC 1997). The North Rice, South Rice, and Grimes Ponds Watershed and Lake Management Plan included several recommendations to improve the water quality of the ponds. Recommendations included:

1. **Macrophyte harvesting and removal:** North Rice and South Rice Ponds receive a portion of their annual phosphorus loads from decaying aquatic plants that release phosphorus. Macrophyte harvesting would remove the aquatic plants from the open-water portions of each pond. Aquatic plant removal would likely be necessary to ensure the effectiveness of an areal application of aluminum sulfate (alum) to each pond.
2. **In-pond alum treatment:** North Rice and South Rice Ponds receive a majority of their annual phosphorus loads from phosphorus released from bottom sediments. Areal application of alum to the pond water could be used long-term to control phosphorus released from bottom sediments.
3. **Wetland inspection to optimize treatment effectiveness:** Inspection of a wetland (Basin K located in the Sunset Hill Drainage District) was recommended. The wetland has significant infiltration capacity, removing about 86 percent of total phosphorus, and receives all stormwater runoff from this drainage district. Inspection of this wetland on a regular basis, during both dry- and wet-weather periods, would ensure that it continues to function as an infiltration/wet-detention basin.

4.5 Water Quality Monitoring Results

The following paragraphs summarize the water quality monitoring results for temperature, dissolved oxygen, specific conductance, total phosphorus, chlorophyll a, and Secchi disc transparency.

4.5.1 Temperature and Dissolved Oxygen

2013 temperature isopleths shown on Figure 37 (North Rice Pond) and Figure 38 (South Rice Pond) indicate stratification occurred in both ponds during the summer. Since the density of water increases as the temperature decreases, the cool bottom water formed a barrier to wind-mixing of the pond water columns. Since the density of water increases (water becomes heavier) as the temperature decreases, the cool bottom water formed a barrier to wind-mixing of the lake water column. The oxygen in the near-bottom water was depleted by decomposition of organic matter, but the temperature difference between the bottom and surface water prevented the lake from mixing. Hence, while wind mixing of surface water consistently added fresh oxygen throughout the growing season, oxygen in the bottom water was depleted and had no opportunity for replenishment..

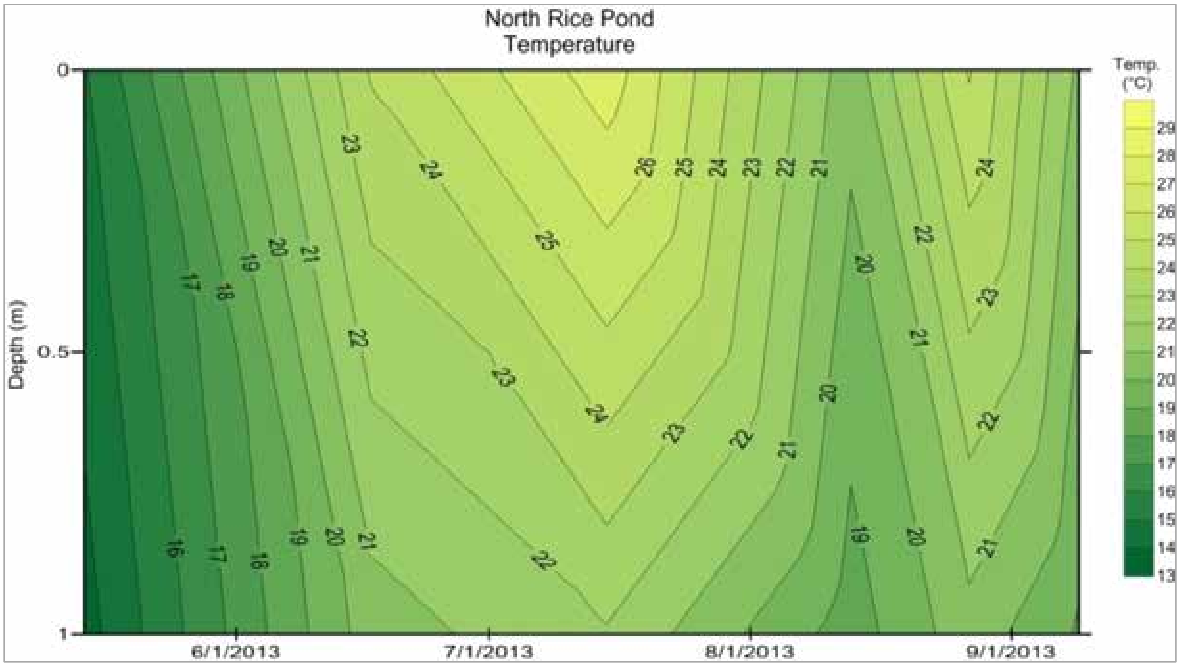


Figure 37 **2013 North Rice Pond temperature isopleth**

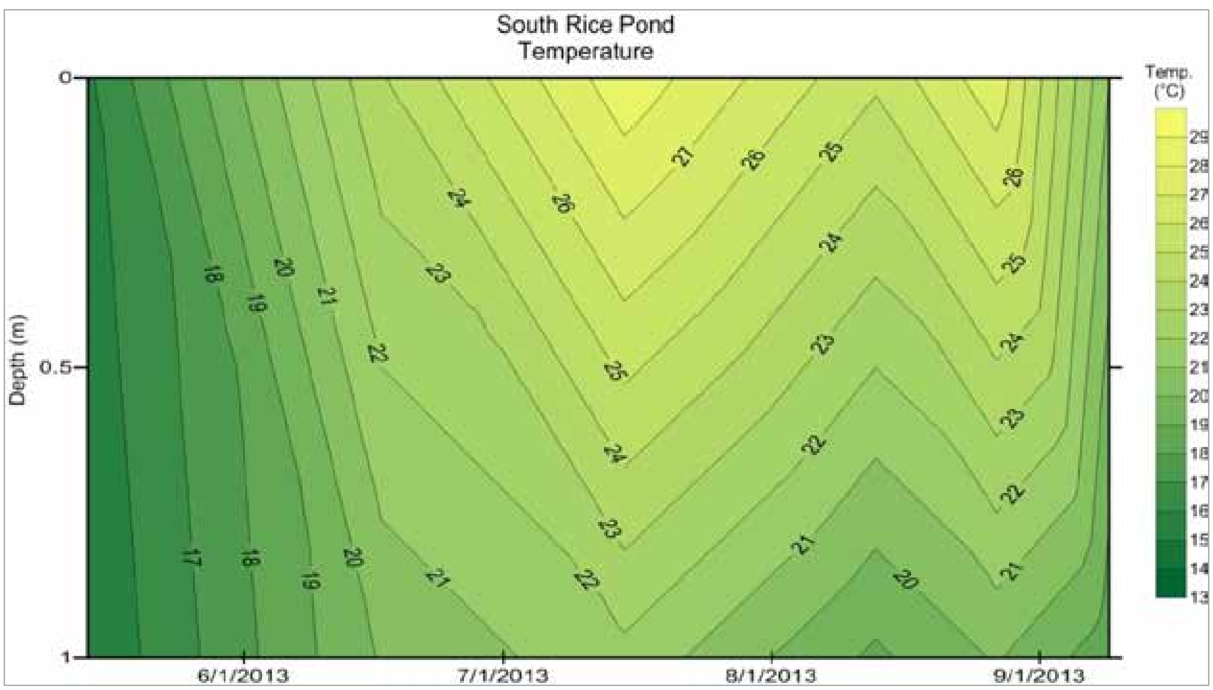


Figure 38 **2013 South Rice Pond temperature isopleth**

The dissolved oxygen isopleths for the ponds are shown on Figure 39 (North Rice Pond) and Figure 40 (South Rice Pond). Vertical profiles of dissolved oxygen collected during 2013 show that oxygen depletion occurred throughout the growing season in both ponds, but that North Rice Pond had more severe depletion than South Rice Pond. Dissolved oxygen concentrations were less than 5 mg/L throughout the summer in North Rice Pond and oxygen was not present during September. The low oxygen levels are indicative of decomposition throughout a very productive system, resulting in dissolved oxygen depression throughout the water column. Low and absent oxygen levels also indicate that the oxygen demand within the pond exceeded oxygen additions from wind mixing or photosynthesis.

Severe oxygen depletion occurred in North Rice Pond, pictured above, during 2013; oxygen was not present in the pond during September.

South Rice Pond oxygen concentrations were greater than 5 mg/L near the surface from May through August, but oxygen concentrations were less than 1 mg/L near the surface in September. Near-bottom oxygen concentrations were less than 1 mg/L in July and no oxygen was present during August and September. The low oxygen levels are indicative of decomposition throughout a very productive system, resulting in dissolved oxygen depression in the bottom waters during July and August and depression throughout the water column in September. Low oxygen levels throughout the pond in September also indicate that oxygen demand exceeded oxygen additions from wind mixing or photosynthesis.

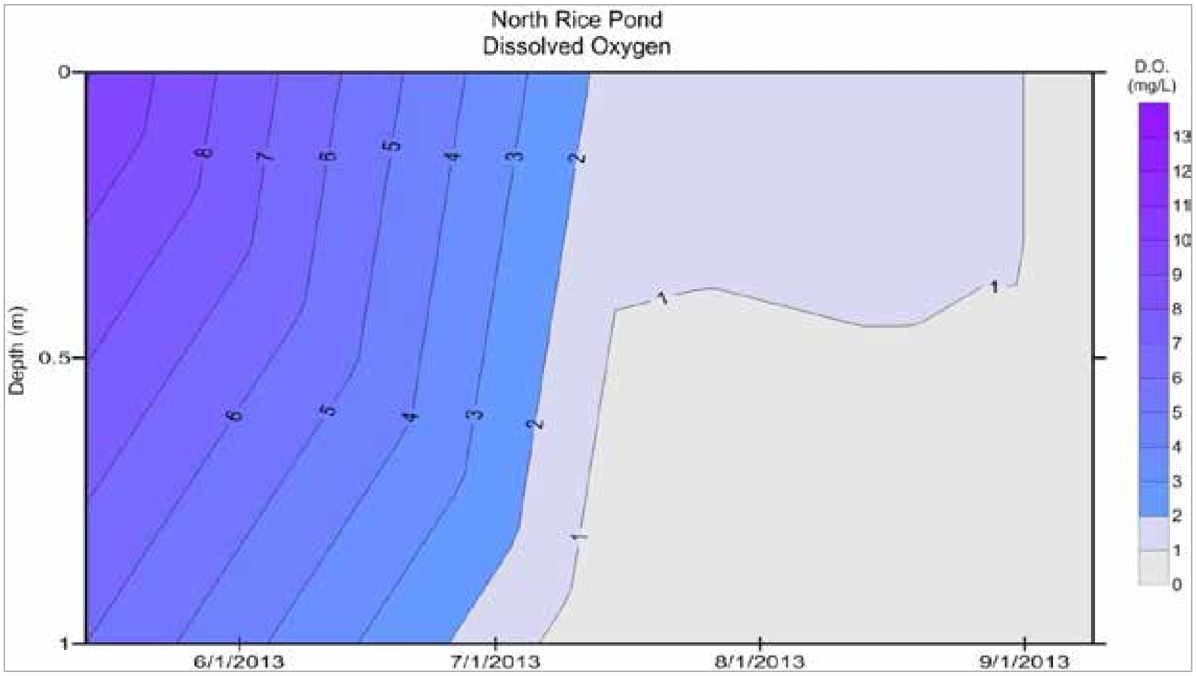


Figure 39 2013 North Rice Pond dissolved oxygen isopleth

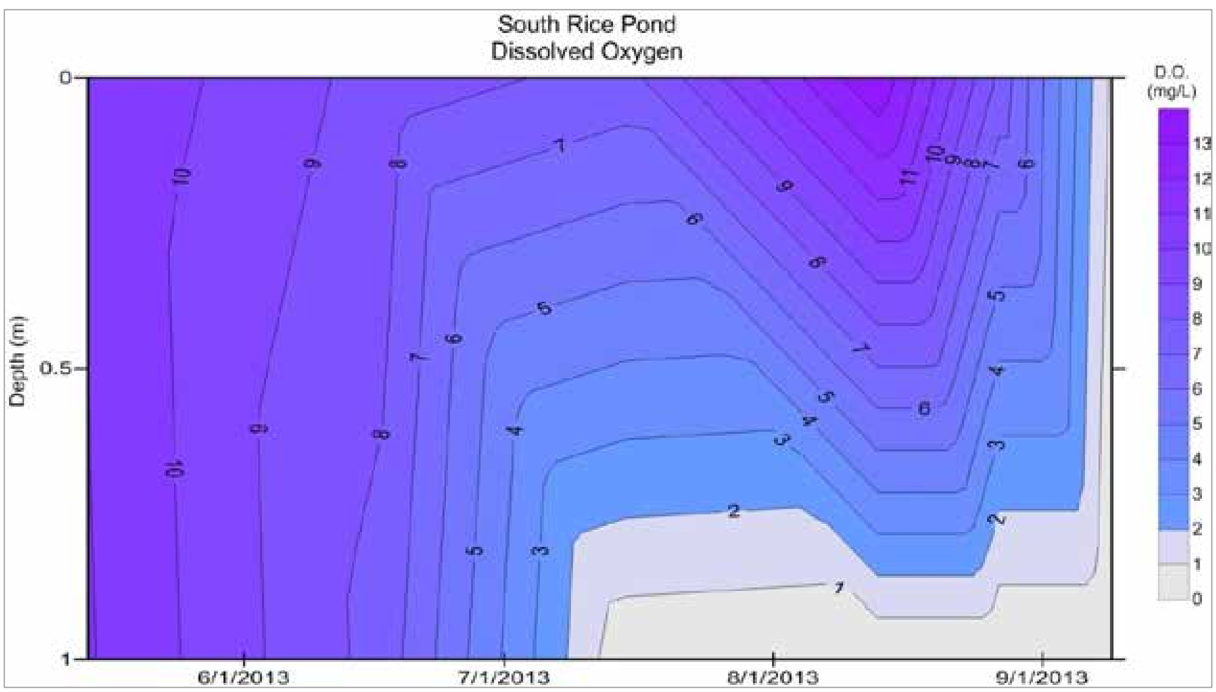


Figure 40 2013 South Rice Pond dissolved oxygen Isopleth

4.5.2 Specific Conductance

Specific conductance is a measure of water's ability to conduct electricity and is linked to the total dissolved inorganic chemicals in the water. Specific conductance increases as the concentration of dissolved minerals in a lake increase (Shaw et al. 2004). North and South Rice Ponds observed high specific conductance values in the spring of 2013 (i.e., 1,001 and 1,045 µmhos/cm @ 25 C, respectively). These high values were most likely the result of deicing chemicals applied to streets and parking lots in the lake's watershed during the previous winter. Specific conductance values declined steadily from spring to summer (Figures 41 and 42).

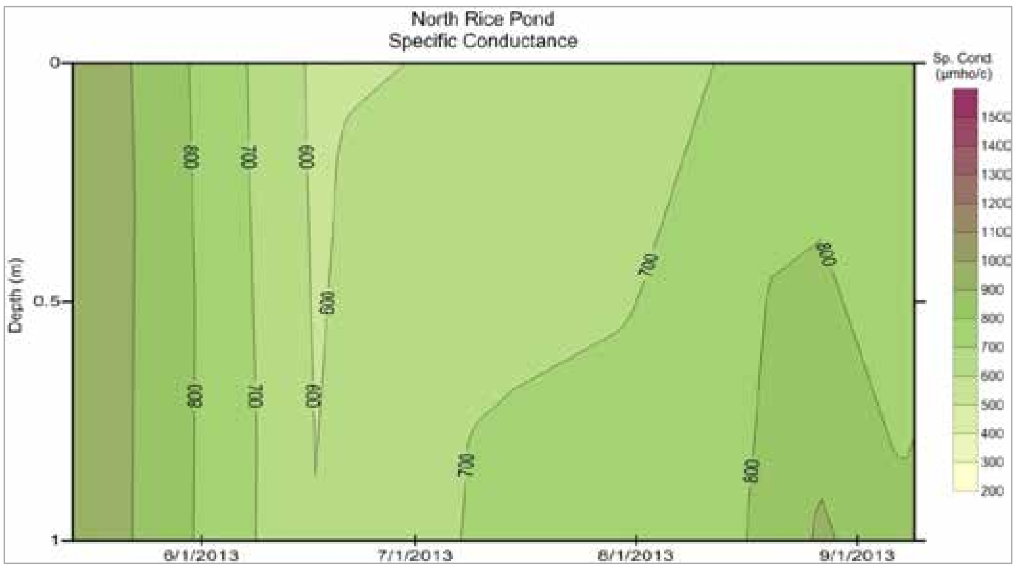


Figure 41 2013 North Rice Pond specific conductance isopleth

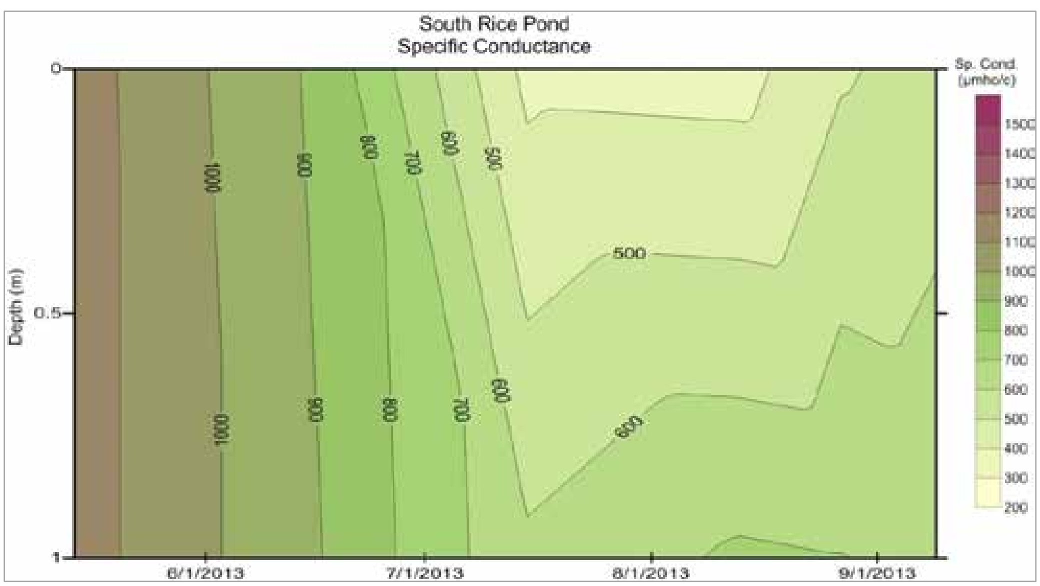


Figure 42 2013 South Rice Pond specific conductance isopleth

4.5.3 Total Phosphorus

Total phosphorus concentrations from North Rice Pond, measured by the 0–1 meter composite sample, are graphically summarized in Figure 43. North Rice Pond experienced high total phosphorus concentrations throughout 2013. Total phosphorus concentrations ranged from a low of 93 µg/L in May to a high of 370 µg/L in July and averaged 216 µg/L during the summer. All observed 2013 total phosphorus concentrations were within the hypereutrophic category (very poor water quality).

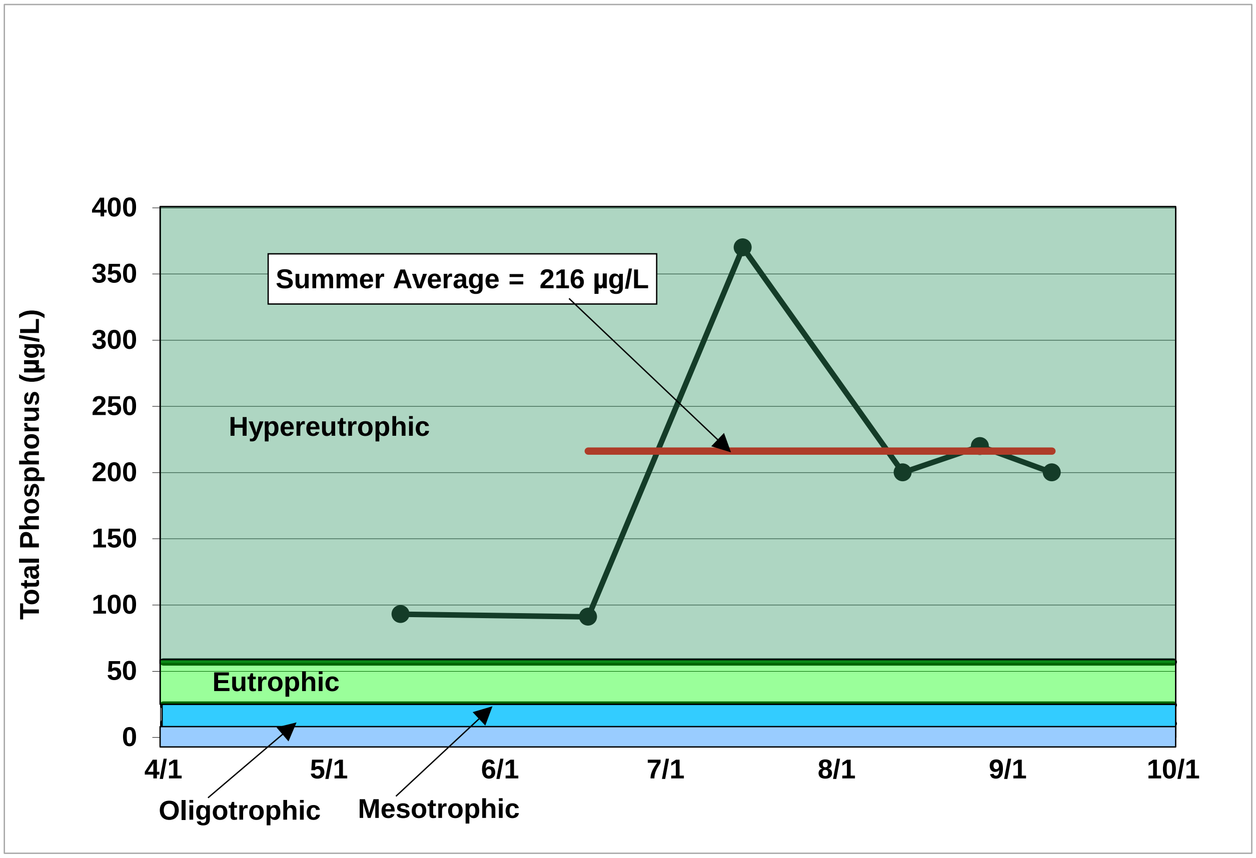


Figure 43 2013 North Rice Pond total phosphorus data

A comparison of North Rice Pond bottom phosphorus concentrations with concentrations measured by the 0–1 meter composite sample indicate internal phosphorus loading from sediment occurred in summer. As shown in Figure 44, the pond experienced slight internal loading during May and June and substantial internal loading during July and August. Internal phosphorus loading from sediments was further verified by higher specific conductance values near the sediment than observed near the surface in late summer (Figure 41).

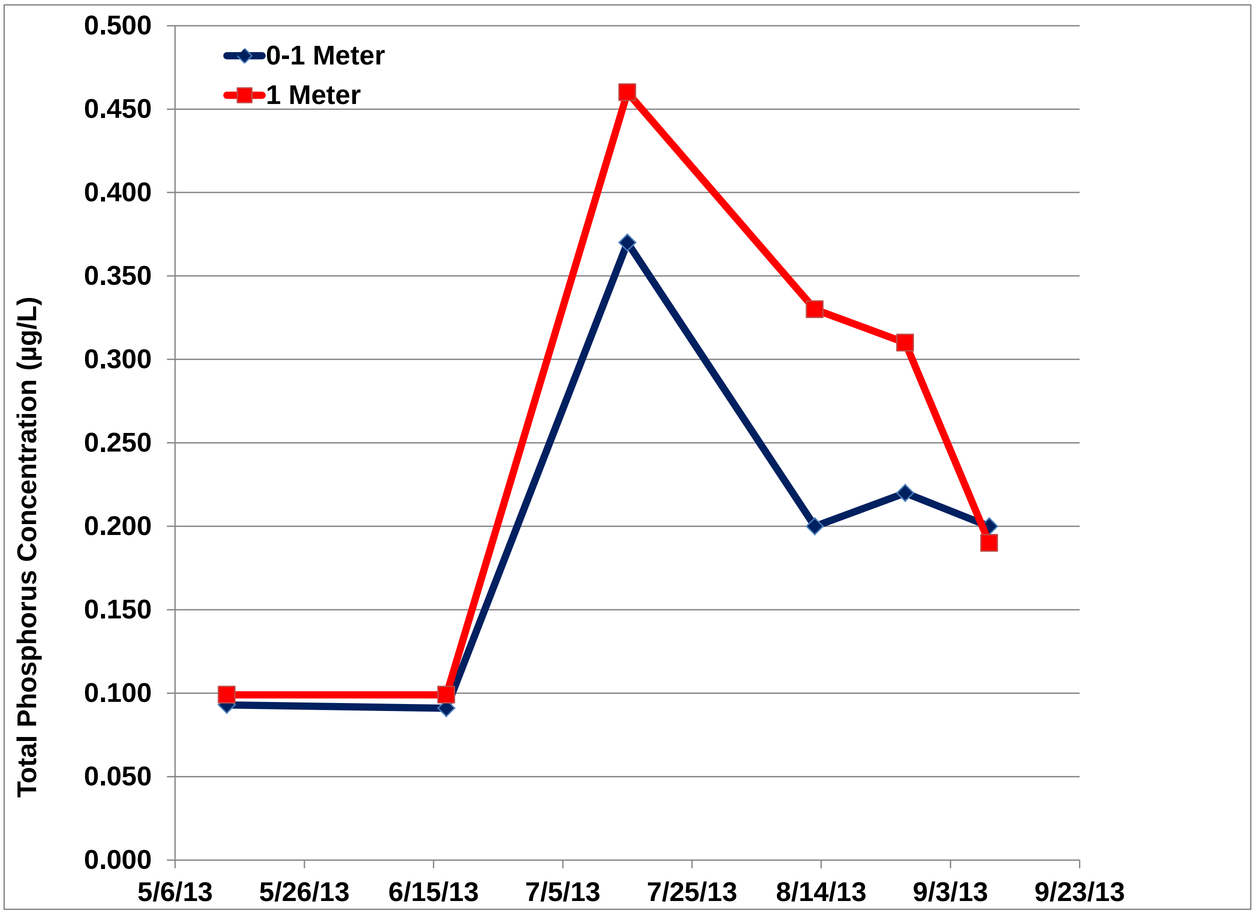


Figure 44 **Comparison of 2013 North Rice Pond 0–1 meter composite and bottom total phosphorus concentrations**

Total phosphorus concentrations for South Rice Pond, measured by the 0–1 composite sample, are graphically summarized in Figure 45. South Rice Pond experienced high total phosphorus concentrations throughout 2013. Total phosphorus concentrations ranged from a low of 120 µg/L in May to a high of 240 µg/L in August and averaged 184 µg/L during the summer. All observed 2013 total phosphorus concentrations were within the hypereutrophic category (very poor water quality).

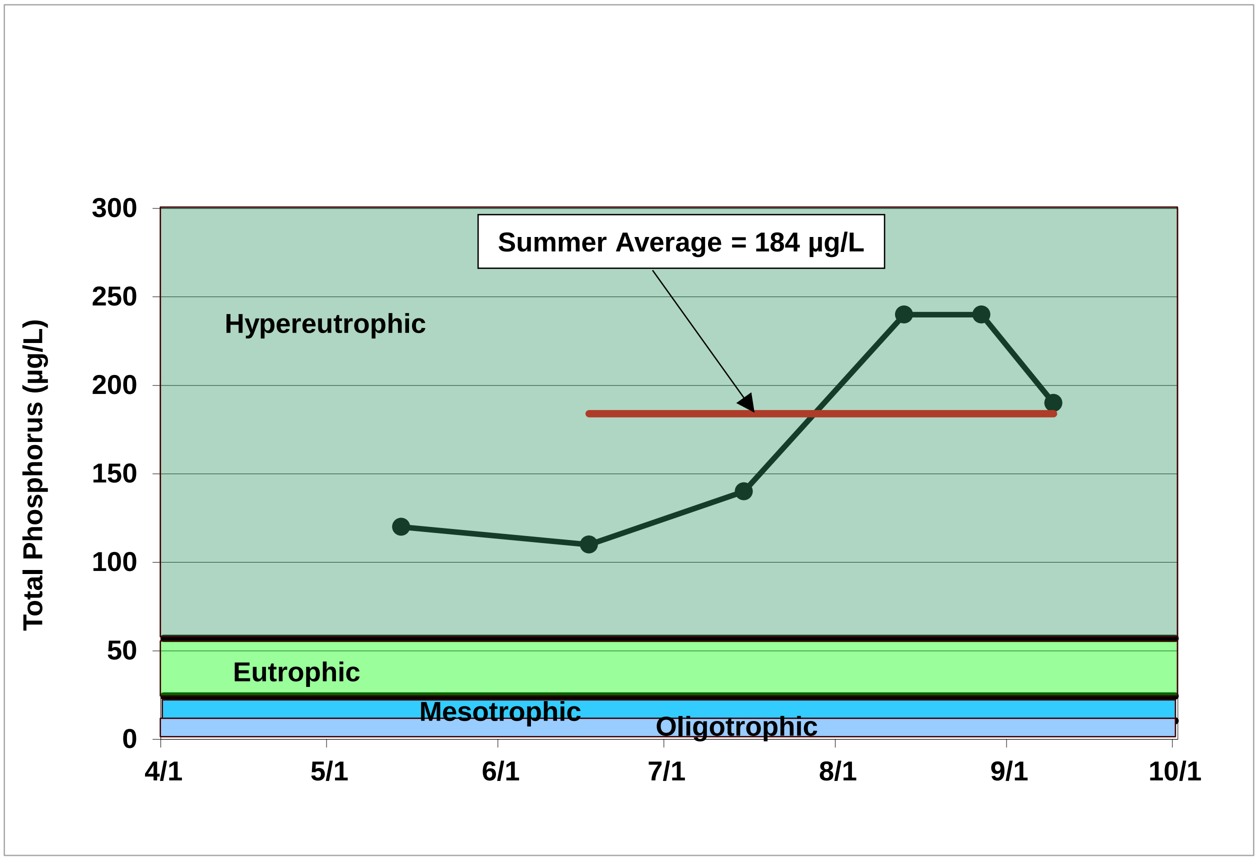


Figure 45 **2013 South Rice Pond total phosphorus data**

A comparison of South Rice Pond bottom phosphorus concentrations with concentrations measured by the 0–1 meter composite sample indicate internal phosphorus loading from sediment occurred in the summer. The data suggest that both periods of stratification and mixing occurred. During periods of stratification, phosphorus released from sediments accumulated in the bottom waters. During mixing events, phosphorus was distributed throughout the water column. As shown in Figure 46, slight internal loading from sediment occurred in May and June, while substantial internal loading from sediments occurred in July and late August. A mixing event occurred prior to early August sampling, lowering the bottom phosphorus concentration and increasing the 0–1 meter phosphorus concentration. Internal phosphorus loading from sediments was further verified by higher specific conductance values near the sediment than observed near the surface in late summer (Figure 42).

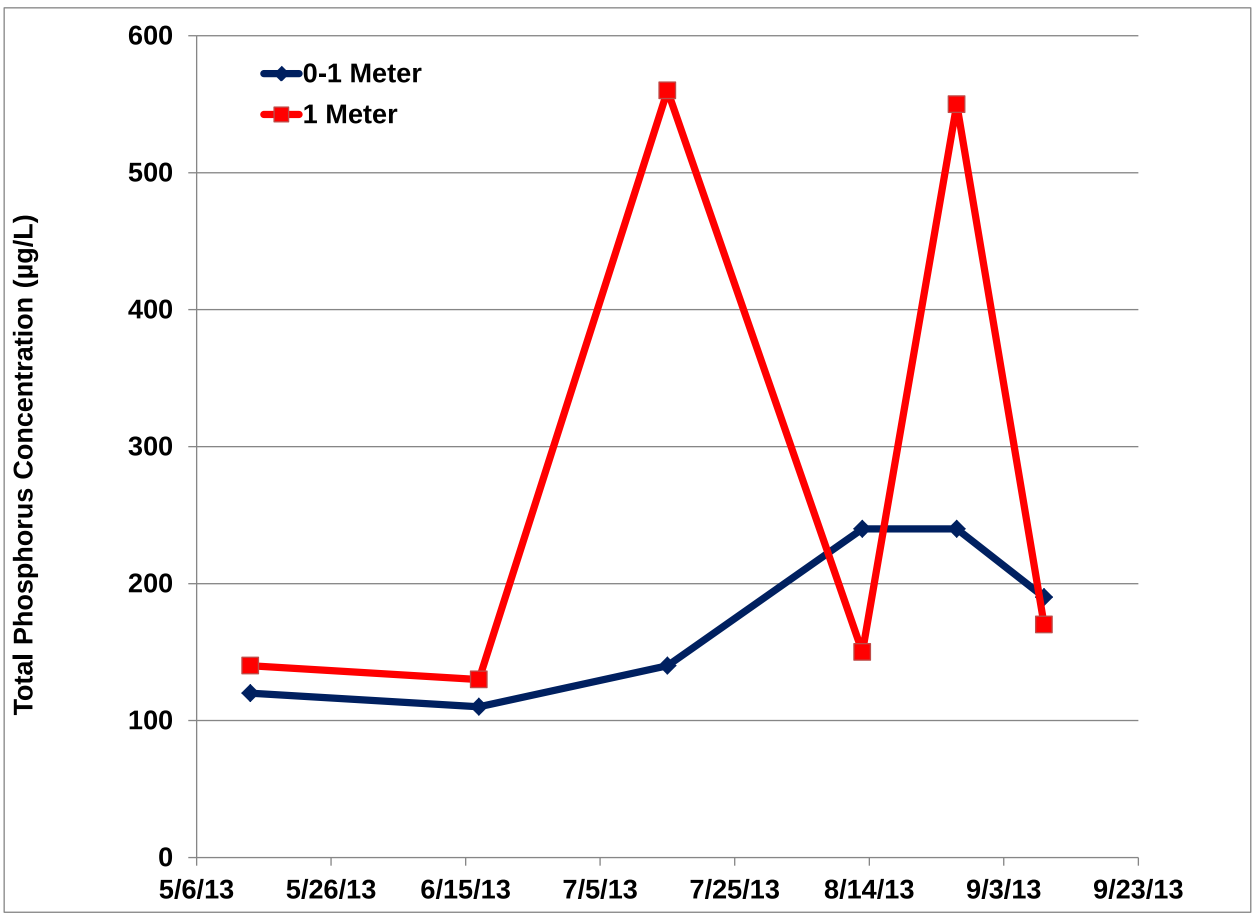


Figure 46 **Comparison of 2013 South Rice Pond 0–1 meter composite and bottom total phosphorus concentrations**

4.5.4 Chlorophyll *a*

Chlorophyll *a* concentrations in 2013 for North Rice Pond, measured by the 0–1 meter composite sample, are graphically summarized in Figure 47. 2013 chlorophyll *a* concentrations gradually increased from June through early August, rapidly increased in late August, and then decreased from late August through early September. Concentrations ranged from a low of 16 µg/L during June to a high of 59 µg/L in late August. The average summer concentration was 30 µg/L. Concentrations were in the eutrophic category (poor water quality) from May through early August and were in the hypereutrophic category (very poor water quality) from late August through September. The average summer concentration was in the hypereutrophic category.

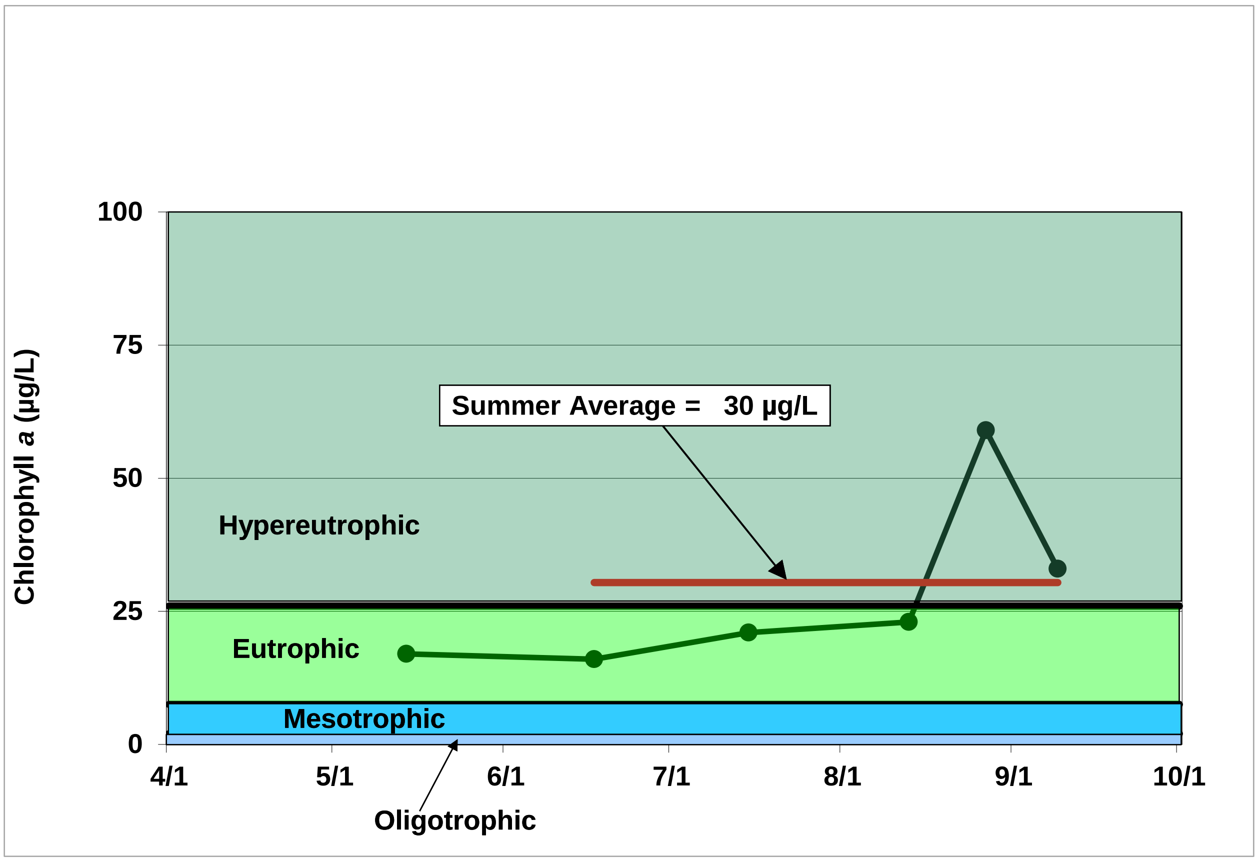


Figure 47 2013 North Rice Pond chlorophyll *a* data

Chlorophyll *a* concentrations for South Rice Pond, measured by the 0-1 meter composite sample, are graphically summarized in Figure 48. 2013 chlorophyll *a* concentrations declined from May through July, increased rapidly in early August, then declined from early August through early September. Chlorophyll *a* concentrations ranged from a low of 1.3 µg/L during July to a high of 37 µg/L in early August. The average summer concentration was 18 µg/L. Concentrations ranged from oligotrophic (excellent water quality) to hypereutrophic (very poor water quality). The average summer concentration was in the eutrophic category (poor water quality).

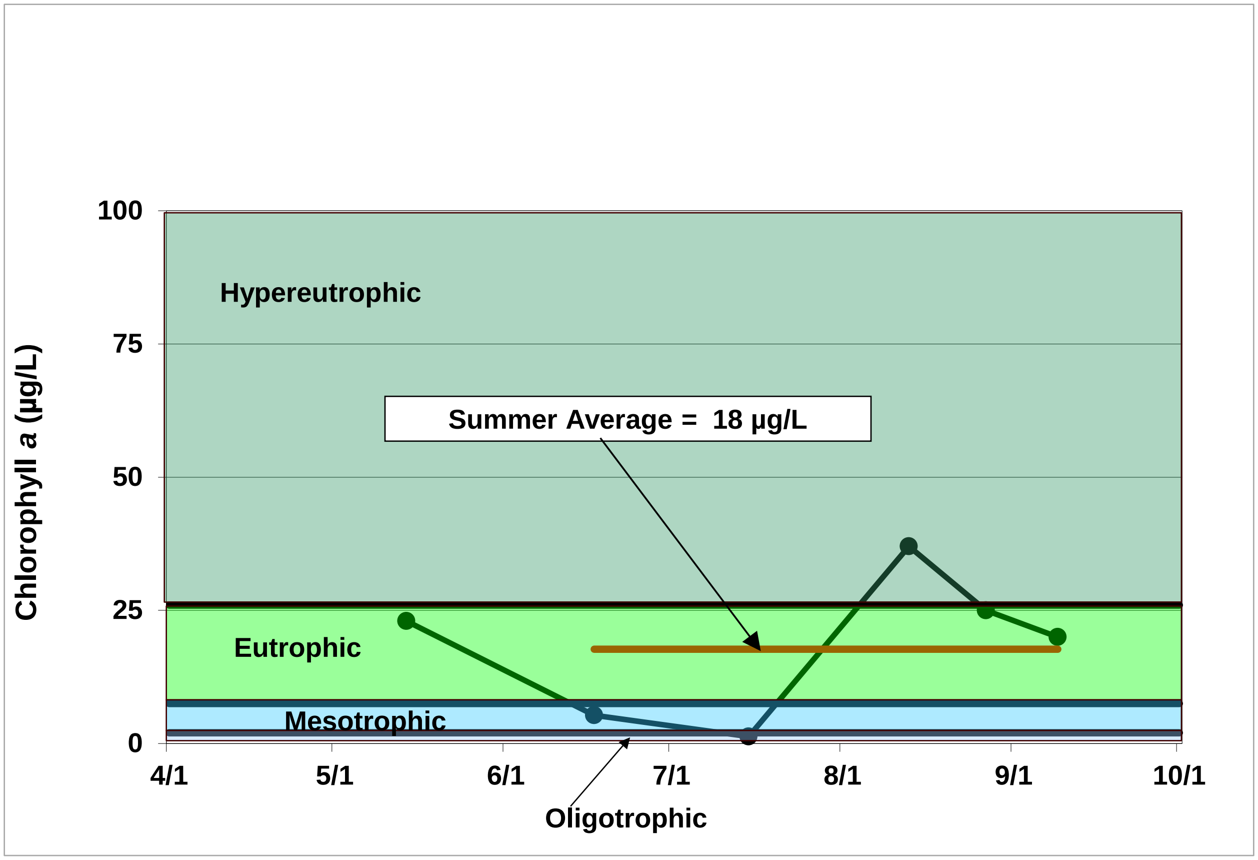


Figure 48 **2013 South Rice Pond chlorophyll *a* data**

4.5.5 Secchi Disc

Secchi disc transparency data for North Rice Pond are graphically summarized in Figure 49. Secchi disc transparency improved from May to June, declined from June through August, and then improved slightly in September. Secchi disc transparency ranged from a low of 0.5 meters in May and late August to a high of 1.2 meters in June, when the Secchi disc was seen to the bottom of the pond. The average summer Secchi disc transparency was 0.7 meters. The summer average and all Secchi disc transparency measurements (except June) were in the hypereutrophic category (very poor water quality).

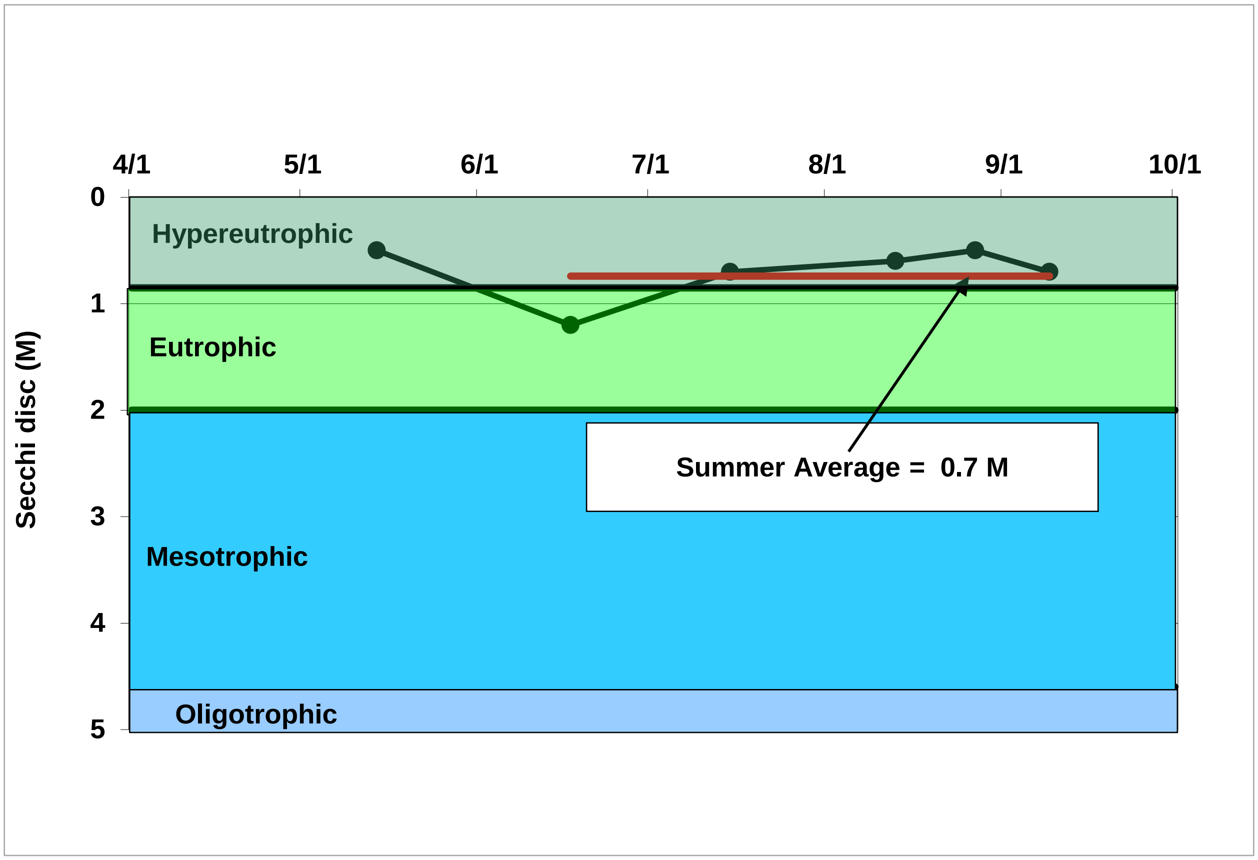


Figure 49 **2013 North Rice Pond Secchi disc transparency data**

Secchi disc transparency data for South Rice Pond are graphically summarized in Figure 50. Secchi disc transparency in South Rice Pond followed a pattern similar to North Rice Pond. Secchi disc transparency improved from May to June, declined from June through August, and then improved slightly in September. However, the August and early September Secchi disc transparency depths were limited by submerged plants (rather than algal turbidity). 2013 Secchi disc measurements ranged from a low of 0.2 meters in late August to a high of 1.1 meters in June. The summer average measurement was 0.5 meters, which is in the hypereutrophic category (very poor water quality).

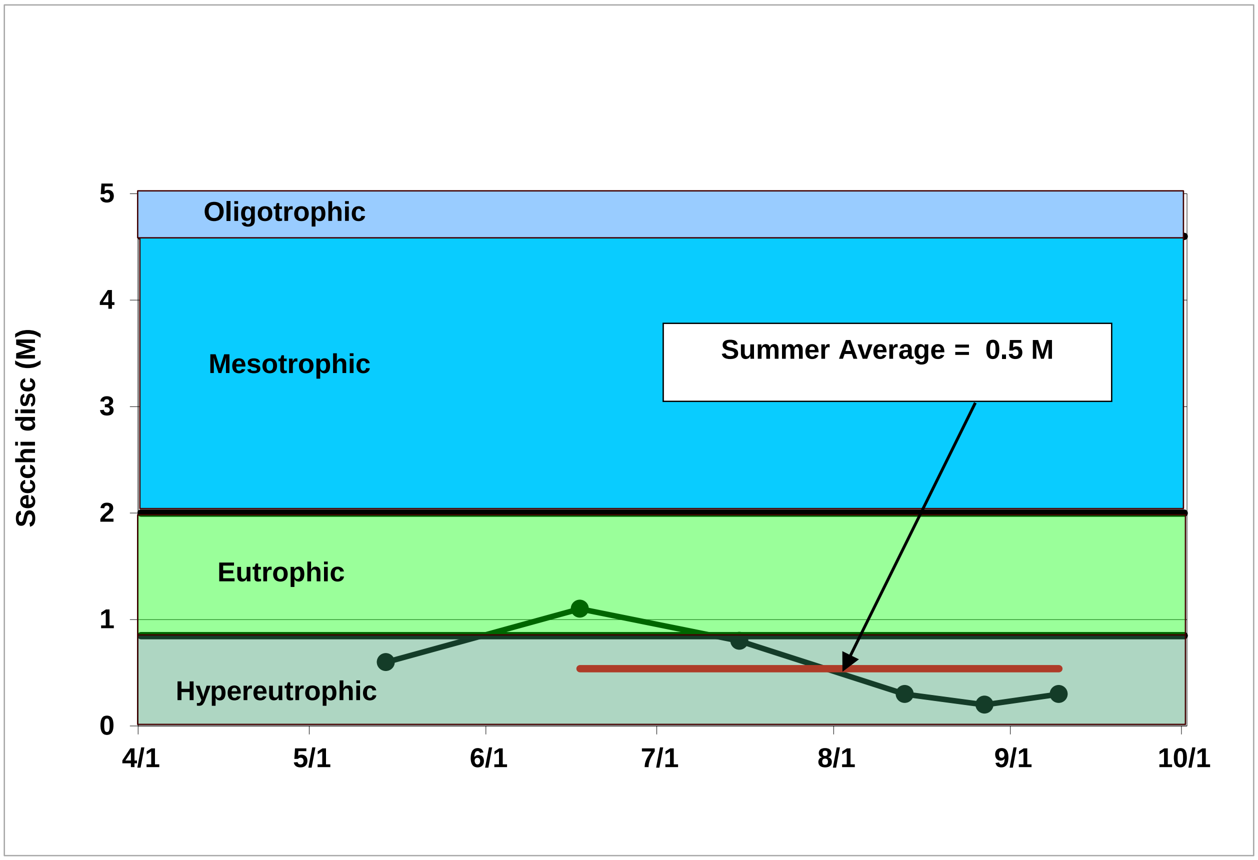


Figure 50 **2013 South Rice Pond Secchi disc transparency data**

4.6 Historical Trends

Historical water quality trends for South Rice Pond are shown on Figures 51 through 53. The black diamonds on the figures show the average summer values during the period of record (i.e., average summer total phosphorus and chlorophyll *a* concentrations and Secchi disc transparency depths). The line on each figure shows the long-term trend; the slope of the line shows the rate of change over time. The changes in total phosphorus, chlorophyll *a*, and Secchi disc transparency values for South Rice Pond during the period of record are not significant, indicating that the water quality has remained relatively stable.

A trend analyses was not performed for North Rice Pond due to insufficient data (at least 10 years of data are needed; only 4 years have been collected).

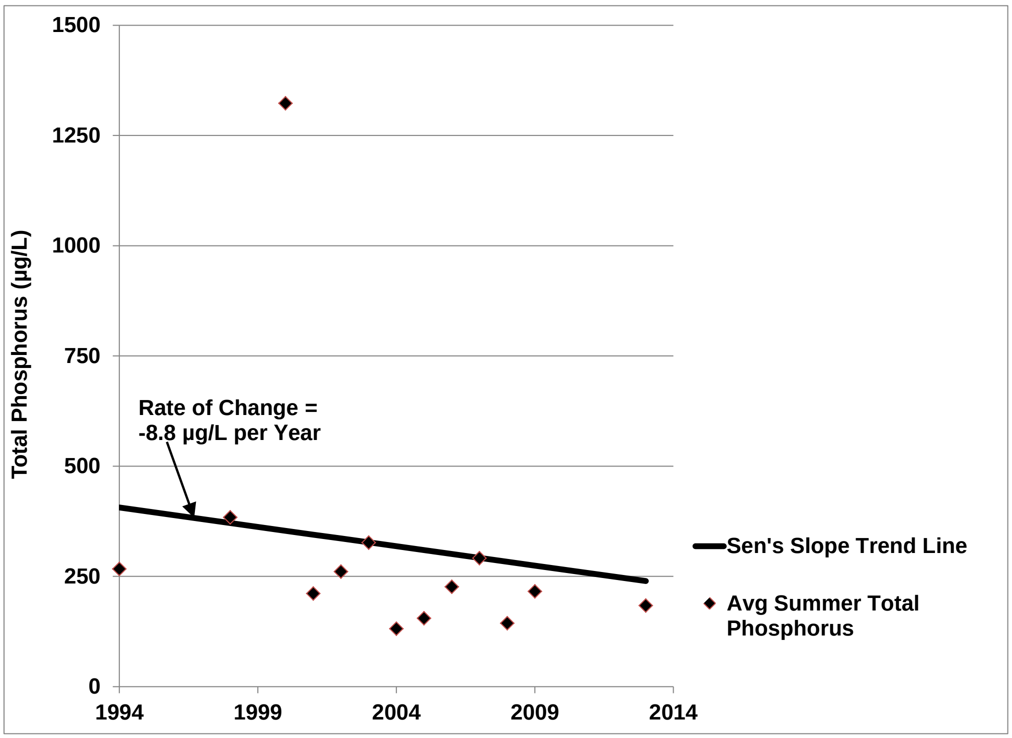


Figure 51 South Rice Pond total phosphorus trend analysis: 1994–2013

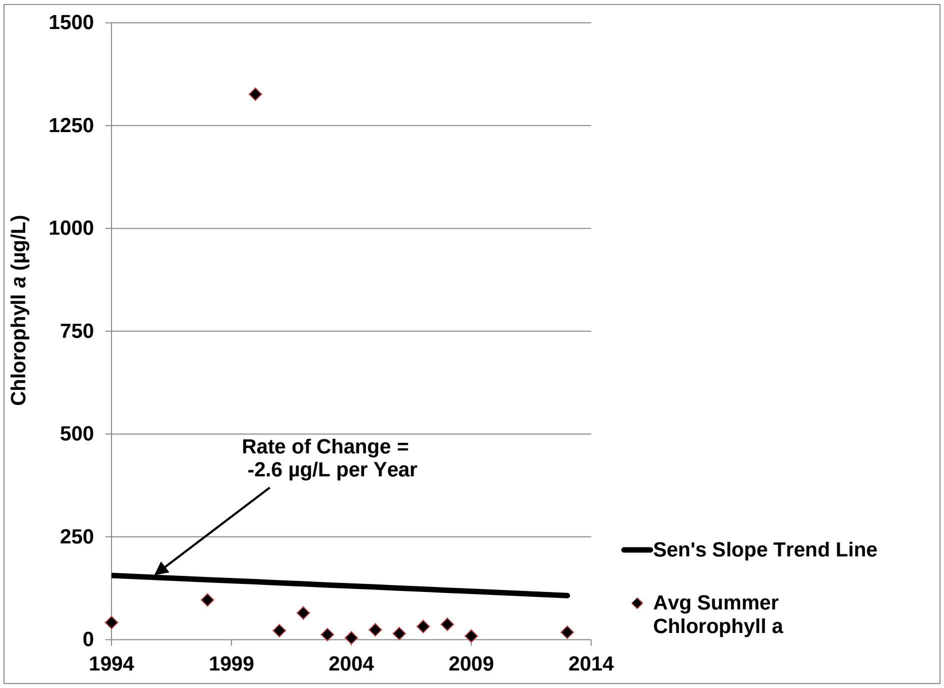


Figure 52 **South Rice Pond chlorophyll *a* trend analysis: 1994–2013**

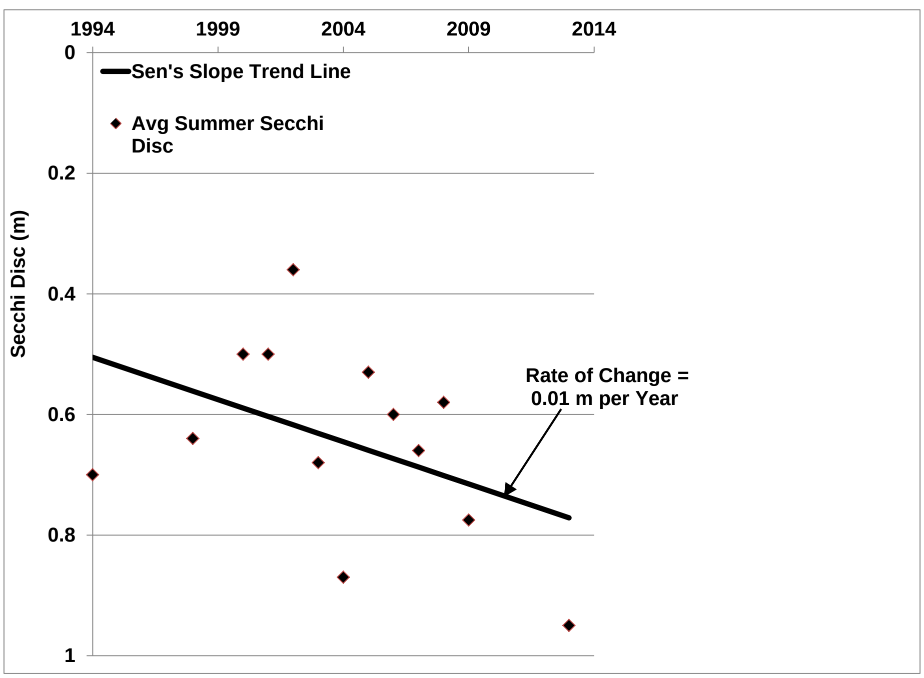


Figure 53 **South Rice Pond Secchi disc transparency trend analysis: 1994–2013**

4.7 Historical Attainment of Goals

4.7.1 North Rice Pond

Historical water quality data from North Rice Pond for the period 1994 through 2013 are compared with BCWMC's water quality goals in Figures 54 through 56. North Rice Pond has met the BCWMC total phosphorus goal 25 percent of the time, chlorophyll *a* goal 100 percent of the time, and Secchi disc goal 50 percent of the time. In 2013, the chlorophyll *a* goal was met, but total phosphorus and Secchi disc goals were not met.

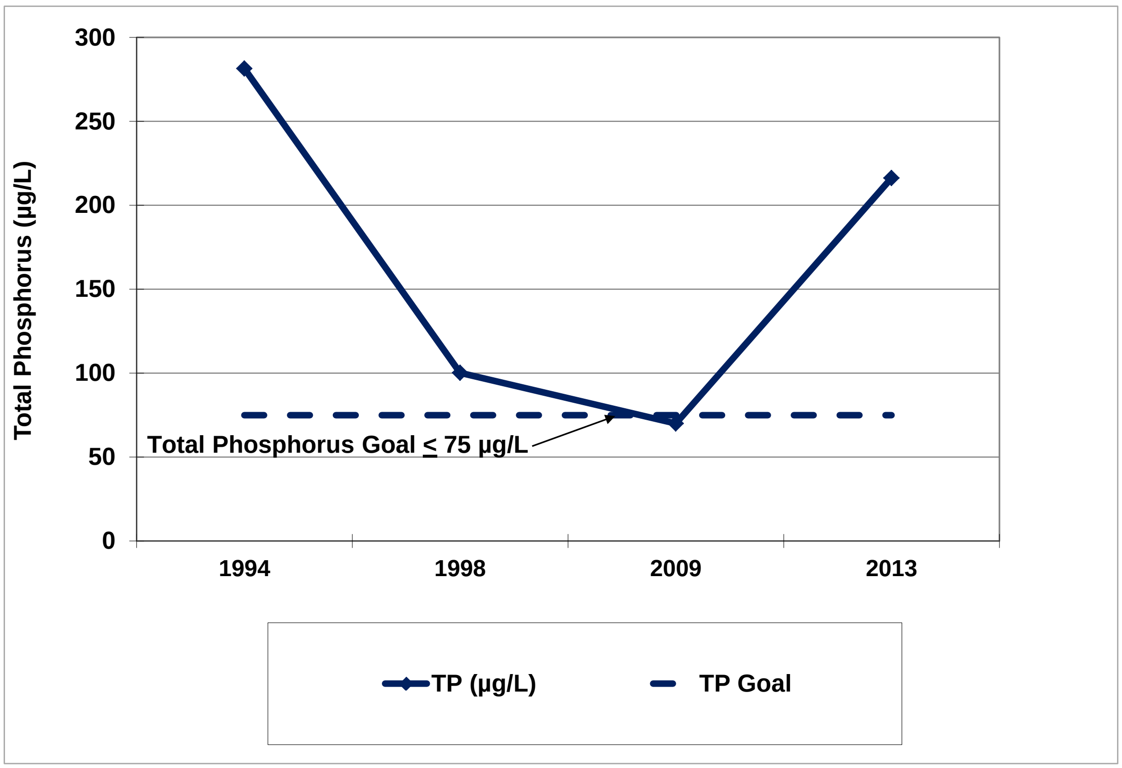


Figure 54 **1994–2013 North Rice Pond total phosphorus concentrations compared with BCWMC total phosphorus goal**

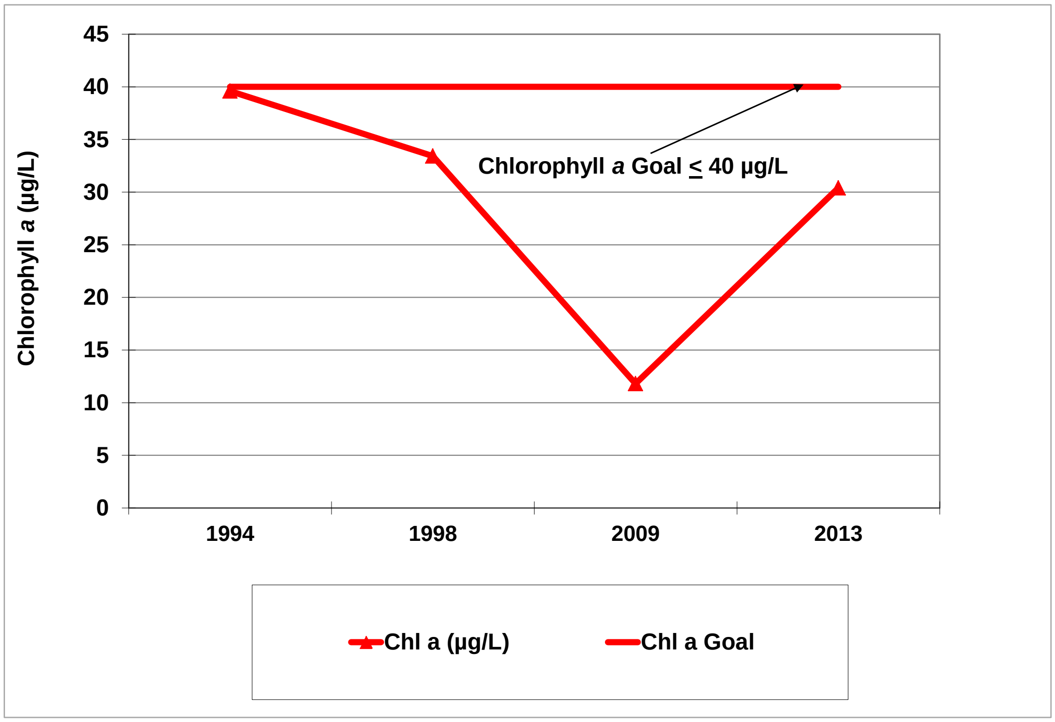


Figure 55 **1994–2013 North Rice Pond chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

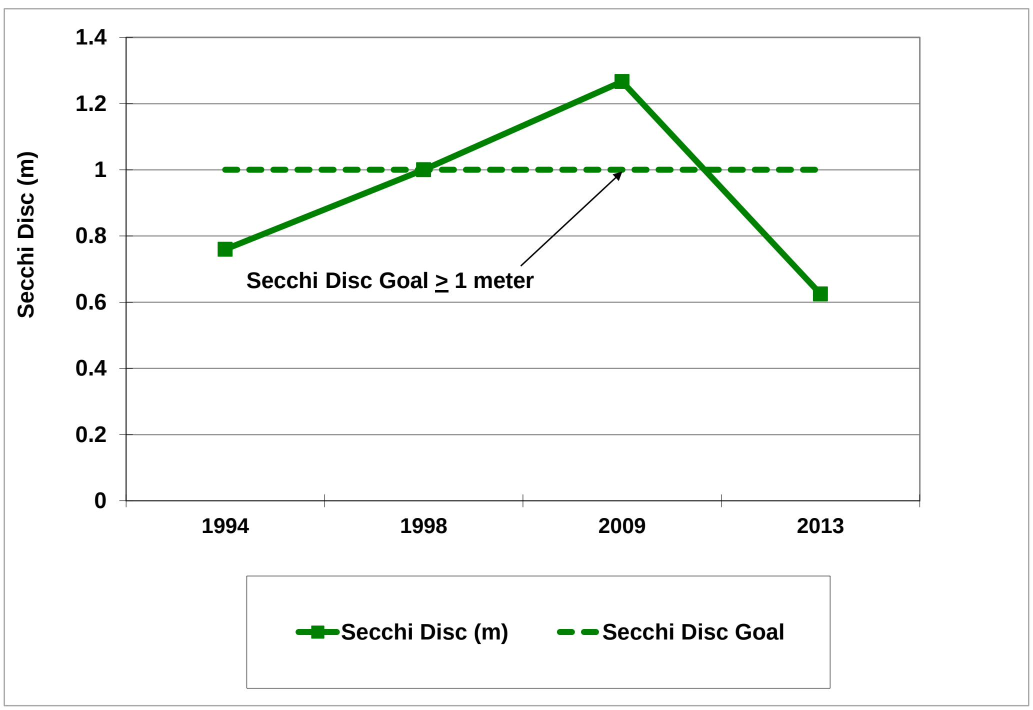


Figure 56 **1994–2013 North Rice Pond Secchi disc depths compared with BCWMC Secchi disc goal**

4.7.2 South Rice Pond

Historical water quality data from South Rice Pond for the period 1994 through 2013 are compared with BCWMC's water quality goals in Figures 57 through 59.

South Rice pond has not met total phosphorus and Secchi disc transparency goals during the period of record. However, the chlorophyll *a* goal has been met 69 percent of the time.

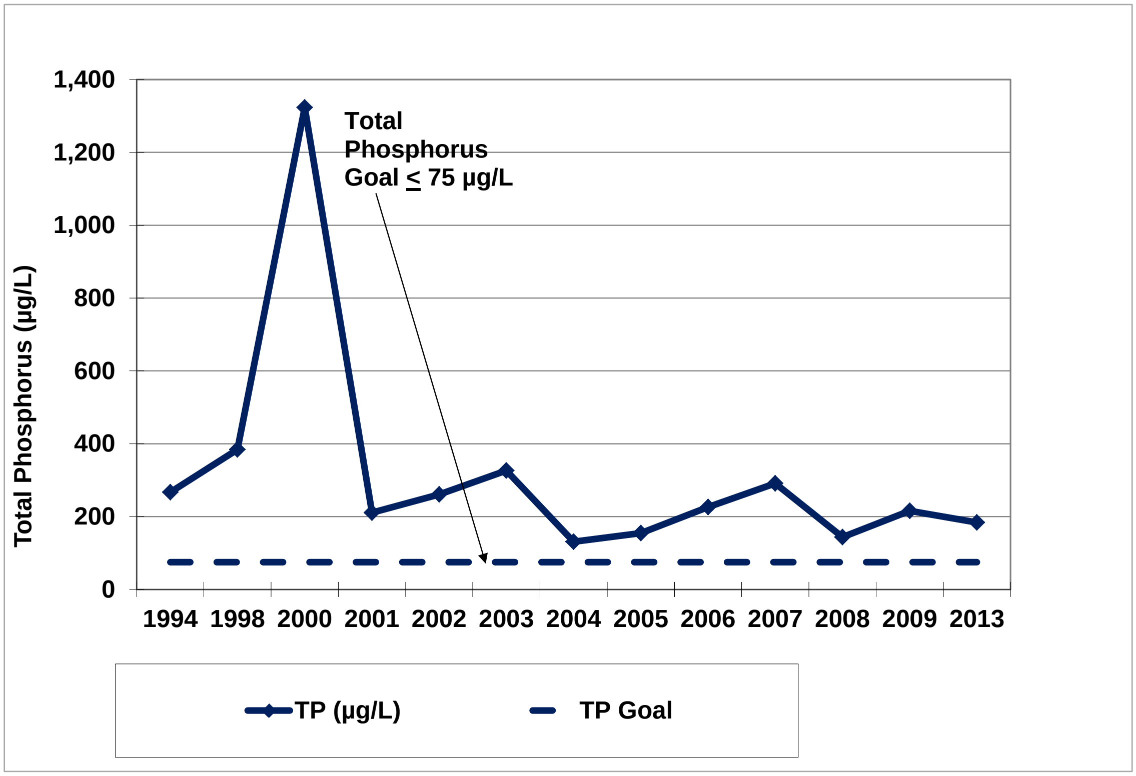


Figure 57 1994-2013 South Rice Pond total phosphorus concentrations compared with BCWMC total phosphorus goal

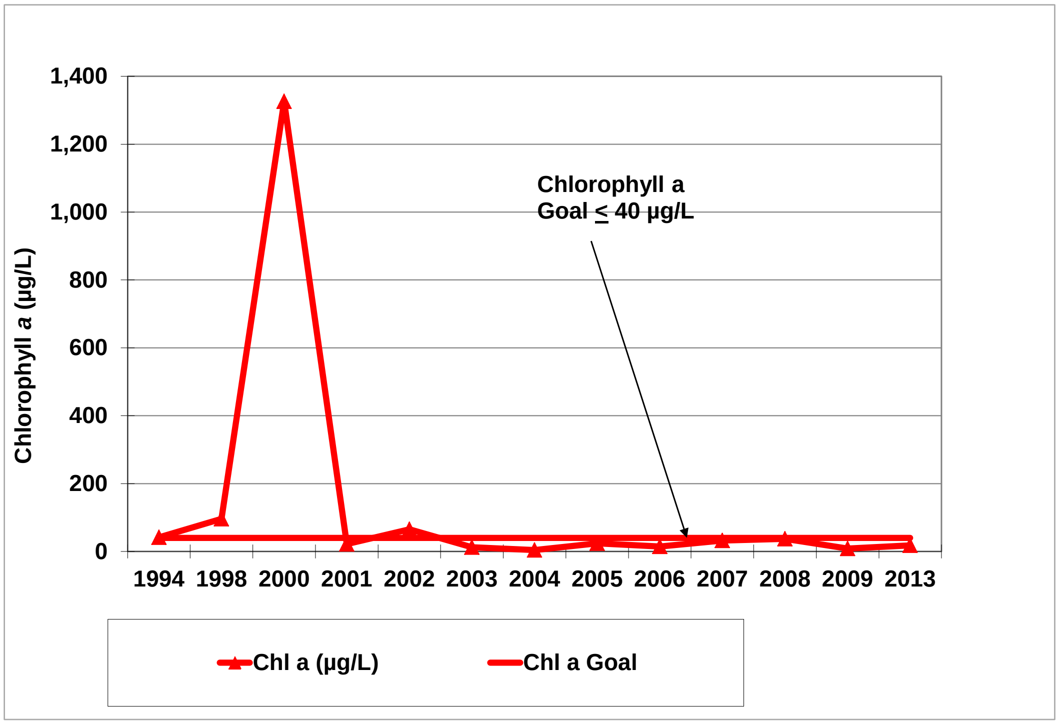


Figure 58 **1994-2013 South Rice Pond chlorophyll *a* concentrations compared with BCWMC chlorophyll *a* goal**

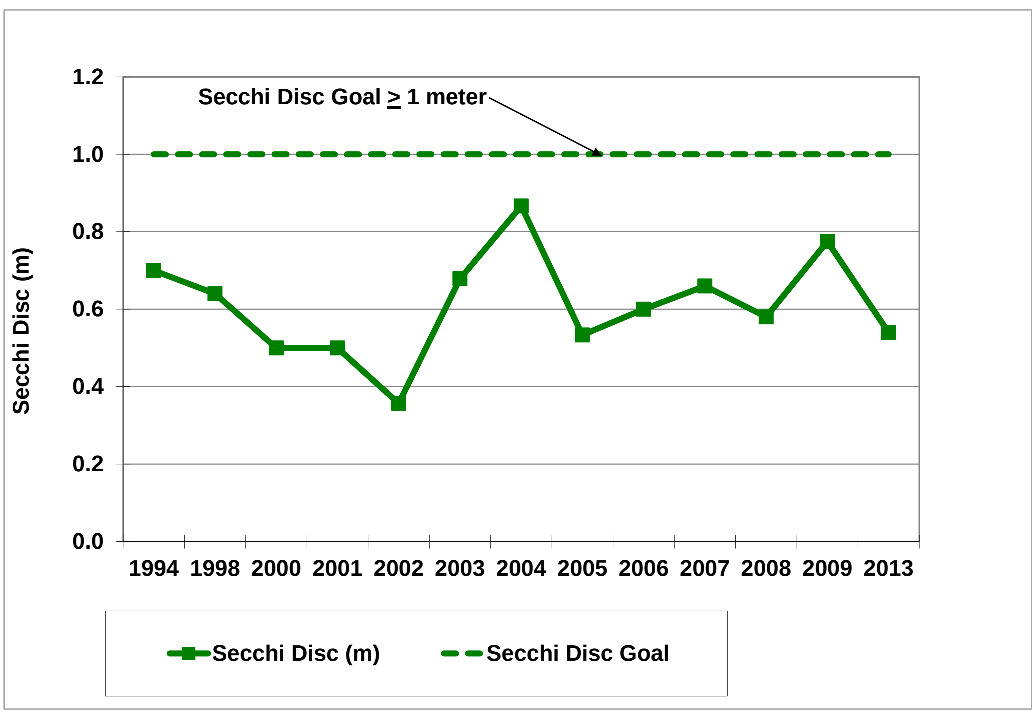


Figure 59 **1994-2013 South Rice Pond Secchi disc depths compared with BCWMC Secchi disc goal**

4.8 Biota

Three components of lake biota are presented: macrophytes, phytoplankton, and zooplankton. Fisheries status is managed by the MDNR and is not covered in this report.

4.8.1 Macrophytes

4.8.1.1 North Rice Pond

A total of eight aquatic plant species were noted in North Rice Pond, indicating relatively low diversity. With the exception of a section of the west shore, the pond was surrounded by cattail (*Typha sp.*) and purple loosestrife (*Lythrum salicaria*). Areas containing cattail and purple loosestrife were also noted within the body of water. During June and August, the pond was covered with floating-leaf plants: star duckweed (*Lemna trisulca*), great duckweed (*Spirodela polyrhiza*), and watermeal (*Wolffia sp.*). Submerged aquatic plants were present throughout the pond and primarily consisted of coontail (*Ceratophyllum demersum*). Sago pondweed (*Stuckenia pectinata*) and leafy/narrow-leaf pondweed (*Potamogeton sp.*) were also seen (Figures 60 and 61). A comparison of the 1998 and 2013 plant communities indicates the plant community has been stable over time.

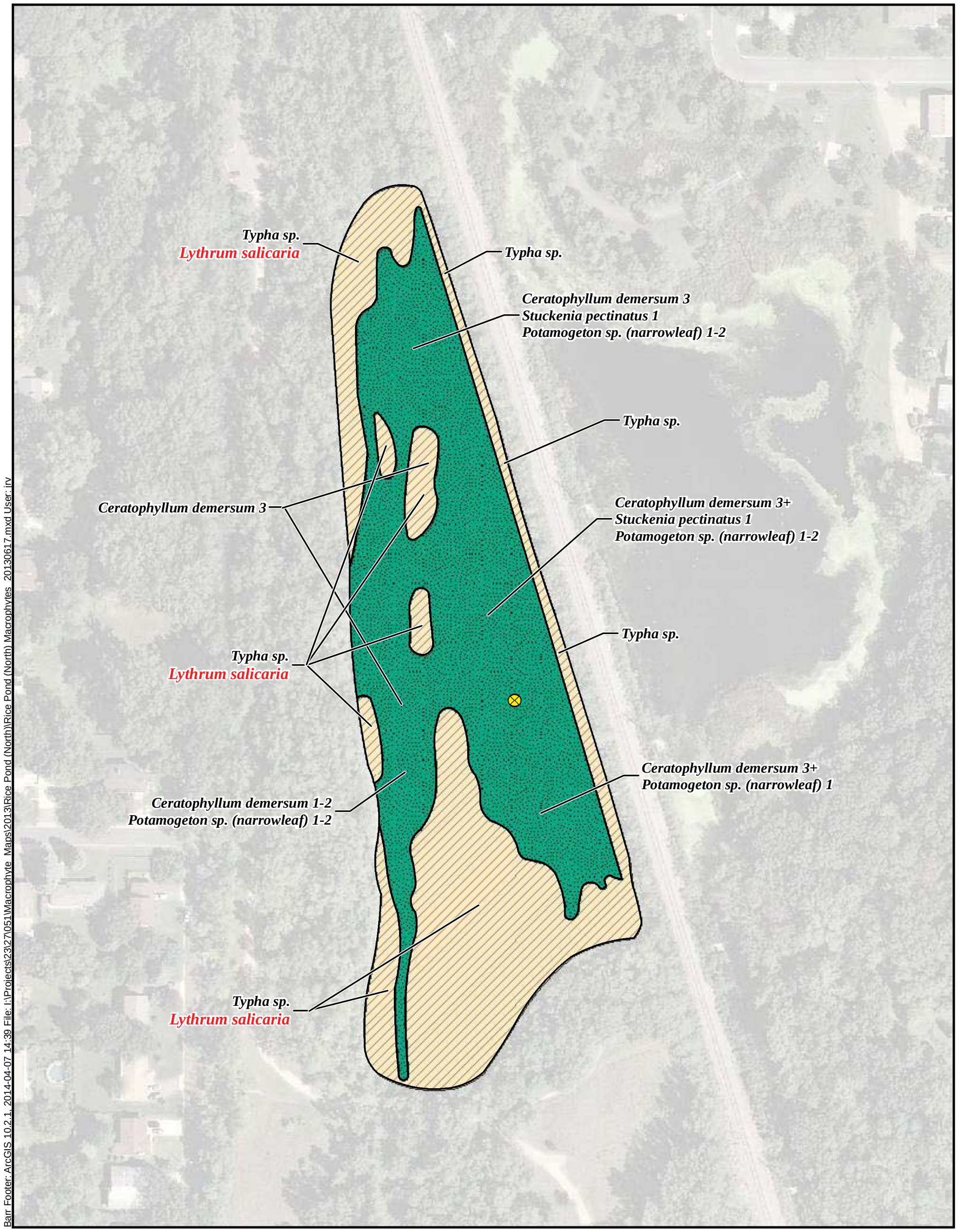
Purple loosestrife *(Lythrum salicaria*) is undesirable because it displaces native species that provide higher-quality habitat. It is recommended that BCWMC contact the MDNR to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding North Rice Pond.

4.8.1.2 South Rice Pond

The pond was completely surrounded by cattail (*Typha sp.*) and purple loosestrife (*Lythrum salicaria*) during both June and August. In addition, the pond was covered with floating-leaf plants: little duckweed (*Lemna sp.*), great duckweed (*Spirodela polyrhiza*), and watermeal (*Wolffia sp.*). Submerged aquatic plants were present throughout the pond. Coontail (*Ceratophyllum demersum*) dominated the submerged plant community. Sago pondweed (*Stuckenia pectinata*), leafy/narrow-leaf pondweed (*Potamogeton sp.*), elodea (*Elodea canadensis*), and curly-leaf pondweed (*Potamogeton crispus*) were also present (Figures 62 and 63). A comparison of the 1998 and 2013 plant communities indicates the plant community has been stable over time. However, curly-leaf pondweed, a nuisance non-native plant, was observed in South Rice Pond for the first time in 2013.

Purple loosestrife *(Lythrum salicaria*) is undesirable because it displaces native species which provide a higher-quality habitat. It is recommended that BCWMC contact the MDNR to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding South Rice Pond.


In 2013 South Rice Pond, pictured in June (above left) and August (above right), was completely surrounded by cattail and purple loosestrife and covered with floating-leaf plants.



Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Sago Pondweed	*Stuckenia pectinatus*

Floating Leaf Plants

Common Name	Scientific Name
Star Duckweed	*Lemna trisulca*
Great Duckweed	*Spirodela polyrhiza*
Watermeal	*Wolffia sp.*

- Star Duckweed, Great Duckweed, and Watermeal were found to cover 90% of the open water basin. These free floating plants are not depicted on the map in order to indicate submerged aquatic macrophyte coverage.

Emergent Plants

Common Name	Scientific Name
Purple Loosestrife	***Lythrum salicaria***
Cattail	*Typha sp.*

*Note: Bold red name indicates extremely aggressive/invasive introduced species.

Water Quality Monitoring Location

Emergent Plants

Submerged Aquatic Plants

N

0 150 300
Feet

0 50 100
Meters

Imagery Source: 2009 AE

BARR

FIELD NOTES:
- Macrophyte densities estimated as follows:
1=light; 2=moderate; 3=heavy

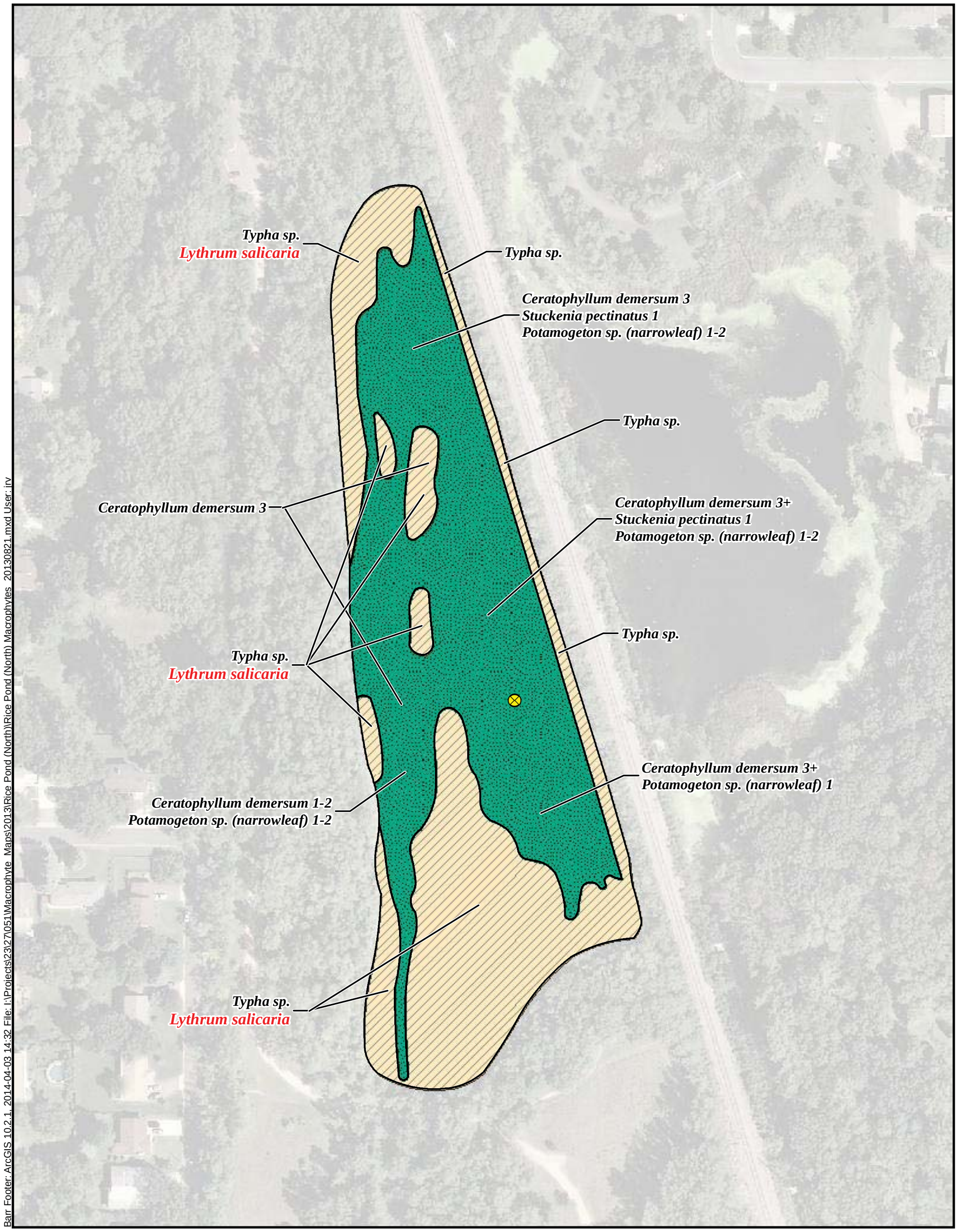
- Submerged aquatic macrophytes cover the entire open water basin.

- Algal mats are present.

Figure 60

NORTH RICE POND MACROPHYTE SURVEY

June 17, 2013
Bassett Creek Watershed Management Commission



Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Sago Pondweed	*Stuckenia pectinatus*

Floating Leaf Plants

Common Name	Scientific Name
Star Duckweed	*Lemna trisulca*
Great Duckweed	*Spirodela polyrhiza*
Watermeal	*Wolffia sp.*

- Star Duckweed, Great Duckweed, and Watermeal were found to cover 90% of the open water basin. These free floating plants are not depicted on the map in order to indicate submerged aquatic macrophyte coverage.

Emergent Plants

Common Name	Scientific Name
Purple Loosestrife	***Lythrum salicaria***
Cattail	*Typha sp.*

*Note: Bold red name indicates extremely aggressive/invasive species.

FIELD NOTES:

- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy

- Submerged aquatic macrophytes cover the entire open water basin.

- Algal mats are present.

Plant species/densities same as June. Watermeal, Star Duckweed, Great Duckweed densities increased.

Water Quality Monitoring Location

Emergent Plants

Submerged Aquatic Plants

N

0 150 300

Feet

0 50 100

Meters

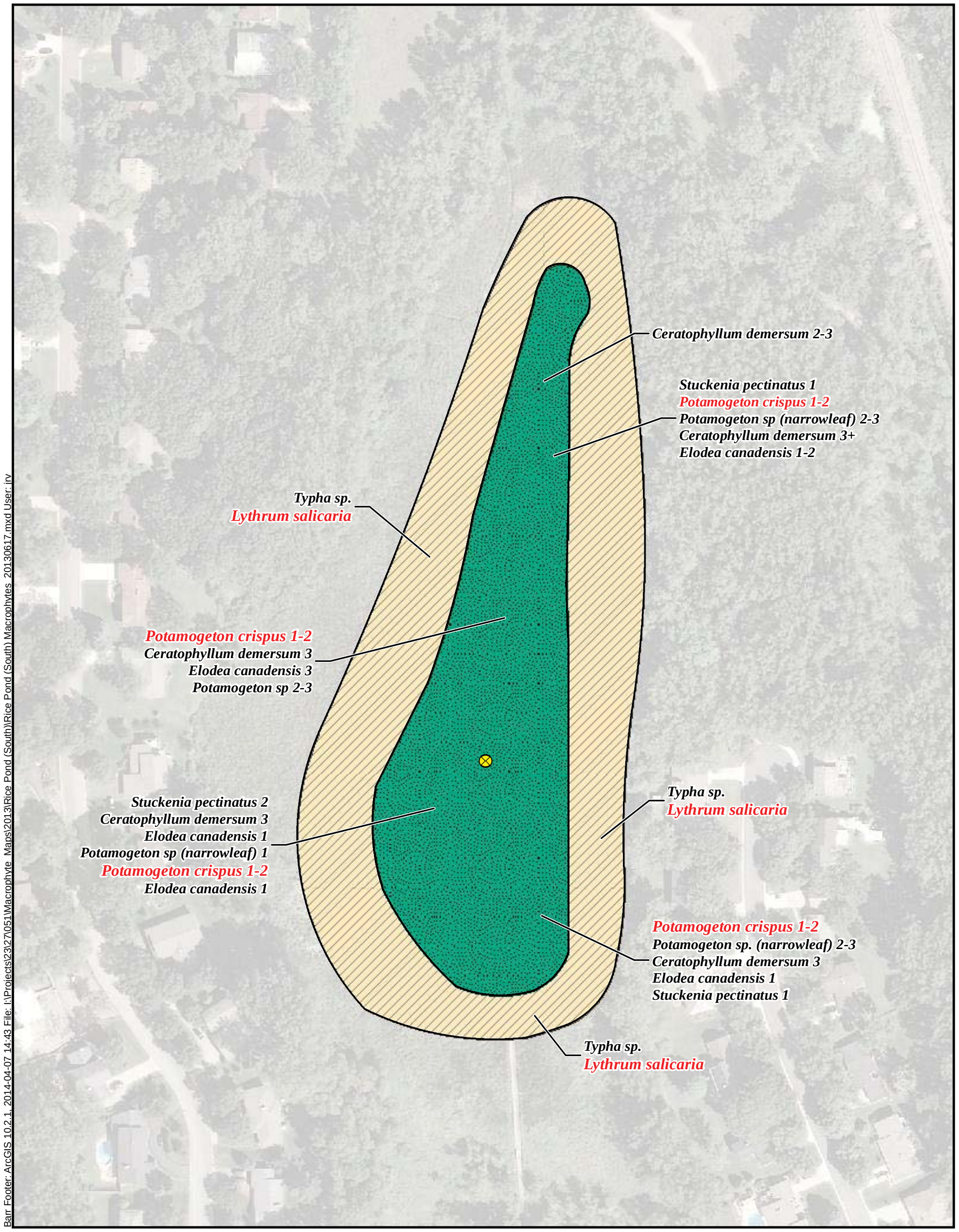
Imagery Source: 2009 AE

BARR

Figure 61

NORTH RICE POND MACROPHYTE SURVEY

August 21, 2013
Bassett Creek Watershed Management Commission



Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Curly-leaf Pondweed	***Potamogeton crispus***
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Sago Pondweed	*Stuckenia pectinatus*

Floating Leaf Plants

Common Name	Scientific Name
Little Duckweed	*Lemna sp.*
Star Duckweed	*Lemna trisulca*
Watermeal	*Wolffia sp.*

- Star Duckweed, Little Duckweed, and Watermeal were present in the open water basin. Due to their extensive coverage, these free floating plants were not shown on the map in order to indicate submerged aquatic macrophyte coverage.

Emergent Plants

Common Name	Scientific Name
Purple Loosestrife	***Lythrum salicaria***
Cattail	*Typha sp.*

*Note: Bold red name indicates extremely aggressive/invasive species.

FIELD NOTES:

- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy

- Submerged aquatic macrophytes cover the entire open water basin in heavy densities.

Water Quality Monitoring Location

Emergent Plants

Submerged Aquatic Plants

N

0 150 300

Feet

0 50 100

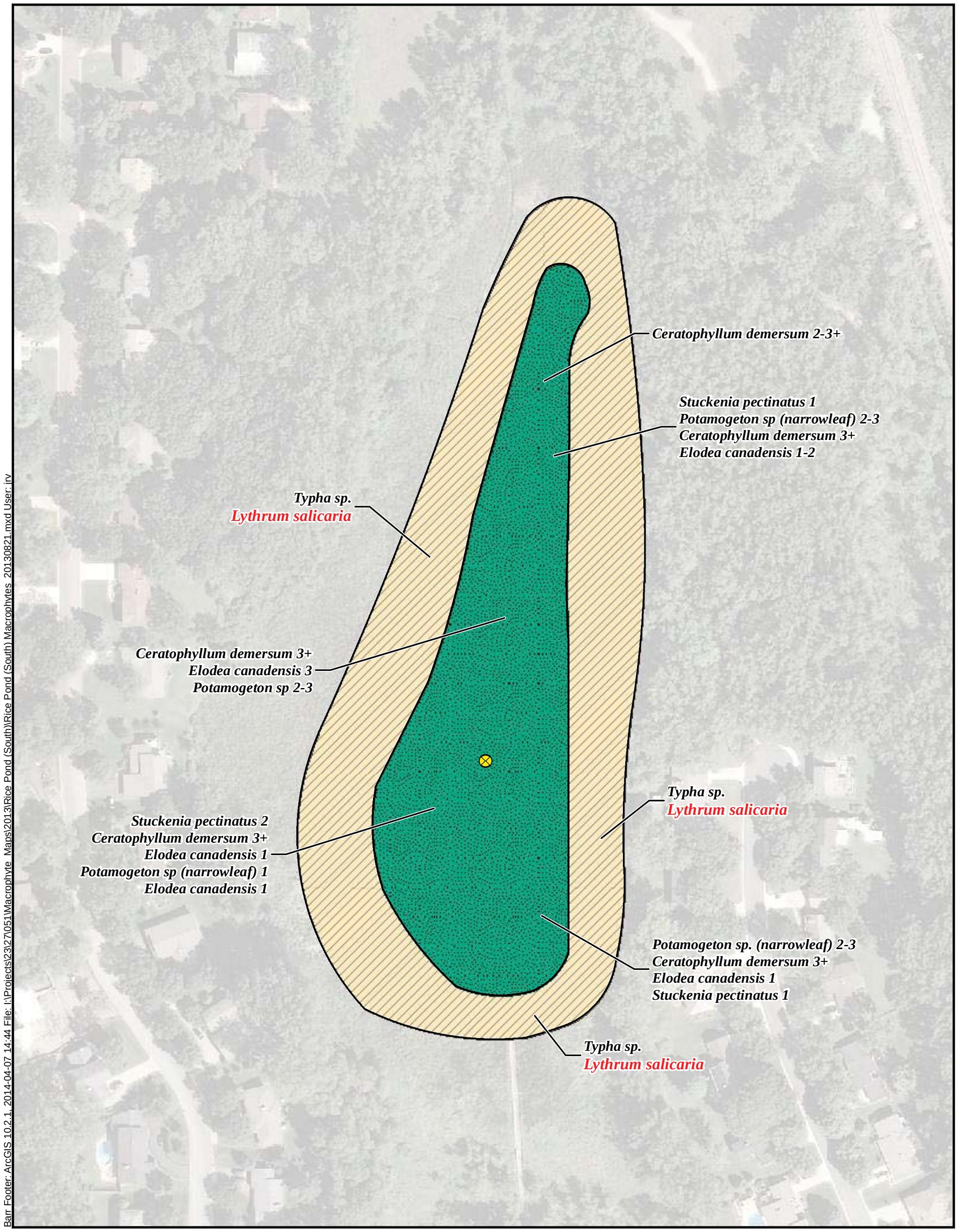
Meters

Imagery Source: 2009 AE

Figure 62

SOUTH RICE POND MACROPHYTE SURVEY

June 17, 2013
Bassett Creek Watershed Management Commission



Submerged Aquatic Plants

Common Name	Scientific Name
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Narrow-leaf Pondweed	*Potamogeton sp. (Narrowleaf)*
Sago Pondweed	*Stuckenia pectinatus*

Floating Leaf Plants

Common Name	Scientific Name
Little Duckweed	*Lemna sp.*
Star Duckweed	*Lemna trisulca*
Watermeal	*Wolffia sp.*

- Star Duckweed, Little Duckweed, and Watermeal were present in the open water basin. Due to their extensive coverage, these free floating plants were note shown on the map in order to indicate submerged aquatic macrophyte coverage.

Emergent Plants

Common Name	Scientific Name
Purple Loosestrife	***Lythrum salicaria***
Cattail	*Typha sp.*

*Note: Bold red name indicates extremely aggressive/invasive species.

FIELD NOTES:

- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy

- Submerged aquatic macrophytes cover the entire open water basin in heavy densities.

- Algal mats present.

Water Quality Monitoring Location

Emergent Plants

Submerged Aquatic Plants

N

0 150 300
Feet

0 50 100
Meters

Imagery Source: 2009 AE

BARR

Figure 63

SOUTH RICE POND MACROPHYTE SURVEY

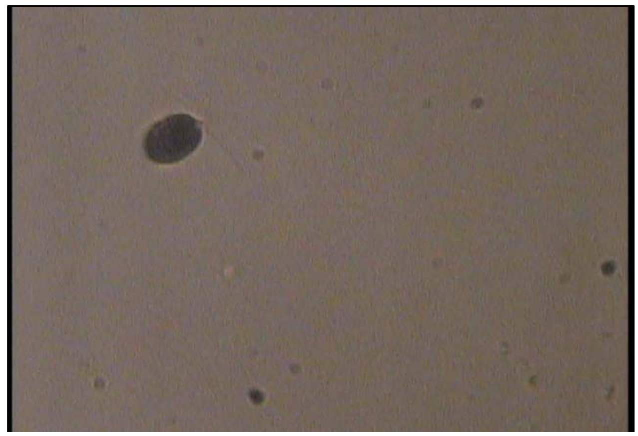
August 21, 2013
Bassett Creek Watershed Management Commission

4.8.2 Phytoplankton

Phytoplankton (algae) are single-celled aquatic plants naturally present in lakes. They derive energy from sunlight (through photosynthesis) and dissolved nutrients found in lake water. They provide food for several types of animals, including zooplankton, which are eaten by fish. A phytoplankton population in balance with the lake's zooplankton is ideal for fish production. An inadequate phytoplankton population reduces the lake's zooplankton population and adversely impacts the lake's fishery. Excess phytoplankton, however, reduce the lake's water clarity.

4.8.2.1 North Rice Pond

The phytoplankton community of North Rice Pond was dominated by green and blue-green algae in 2013 (Figures 64 and 65). Green algae and blue-green algae are indicative of a productive (eutrophic or hypereutrophic) system. Compared with previous years, the numbers of algae in North Rice Pond were generally higher in 2013. The phytoplankton community in North Rice Pond provides food for several types of animals, including zooplankton which, in turn, are eaten by fish. With the exception of blue-green algae, the algae observed in North Rice Pond are generally considered edible.



In 2013, the phytoplankton community of North Rice Pond was dominated by green algae, (pictured above) and blue-green algae. Both are indicative of a fertile system.

Several types of blue-green algae produce toxins that can pose health threats to humans and animals when concentrations exceed safe thresholds. The World Health Organization (WHO) established guidelines for determining the risk of adverse health effects from blue-green algae. The numbers of blue-green algae in North Rice Pond were compared with these WHO guidelines. As shown in Figure 66, the low numbers of blue-green algae observed in North Rice Pond throughout the period of record have posed no risk of adverse health effects.

As noted previously, the macrophyte community in North Rice Pond is dominated by coontail, a plant known to secrete allelochemicals that inhibit algal growth—particularly blue-green algal growth. The low numbers of blue-green algae observed in North Rice Pond during the period of record (Figure 66), despite generally high phosphorus concentrations (Figure 54), are likely the result of abundant coontail.

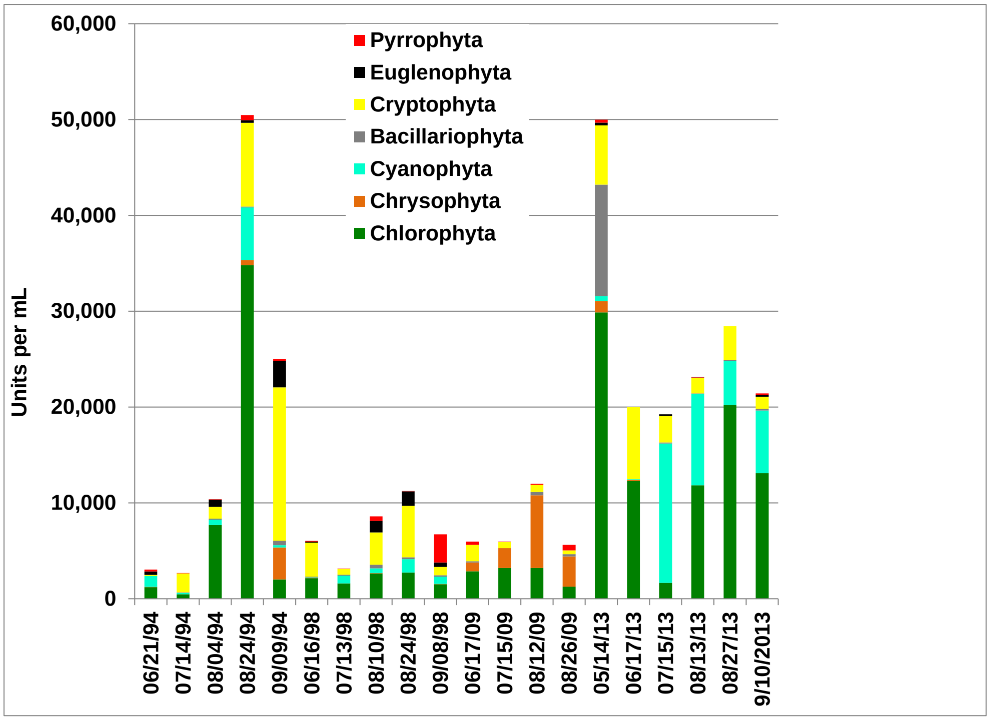


Figure 64 **1994–2013 North Rice Pond phytoplankton data summary**

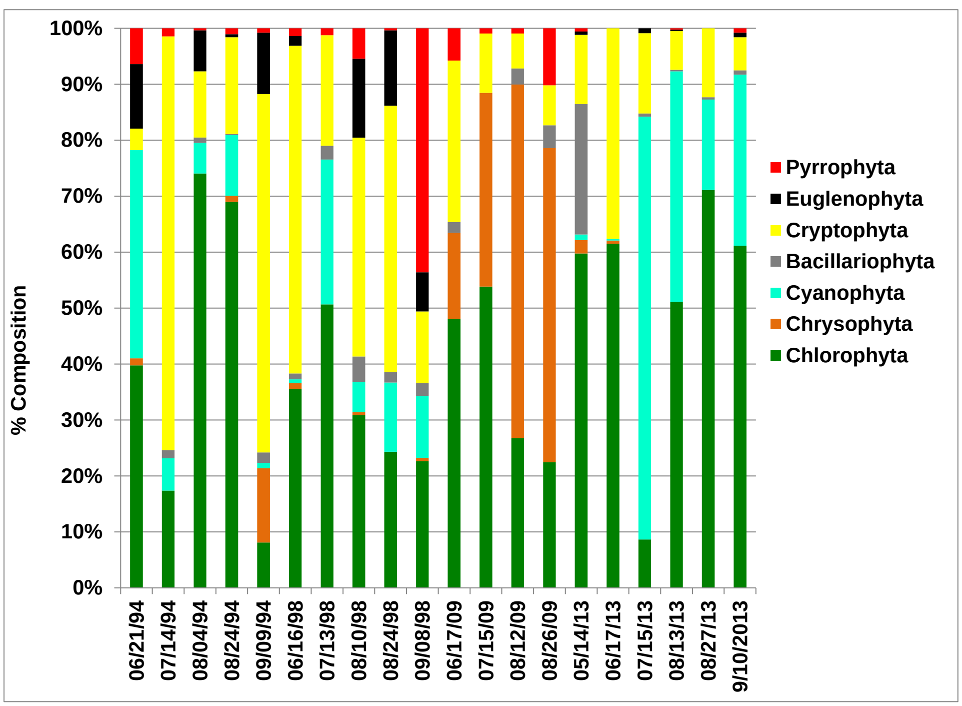


Figure 65 **1994–2013 North Rice Pond phytoplankton composition by division**

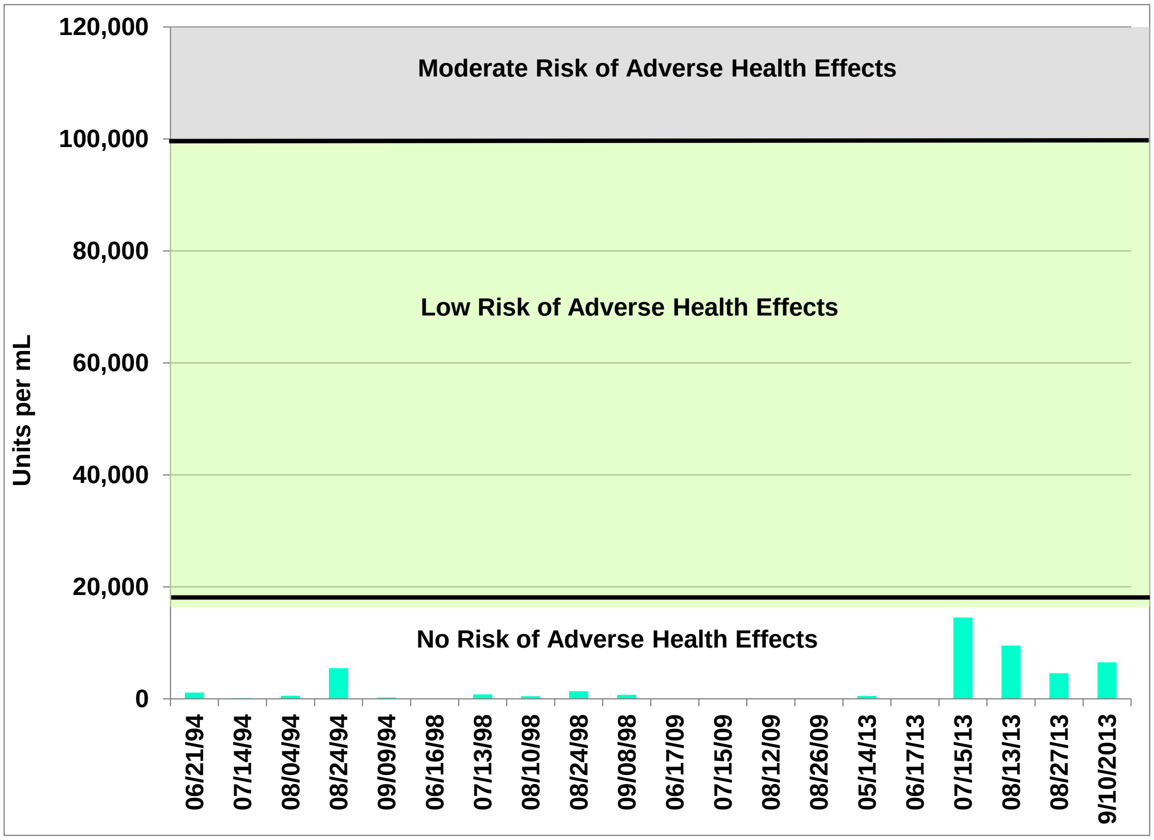


Figure 66 **1994–2013 North Rice Pond blue-green algae compared with risk of adverse health effects**

4.8.2.2 South Rice Pond

The phytoplankton community in South Rice Pond was dominated by diatoms in May, cryptomonads in June, blue-green algae from July through August, and green algae in September (Figures 67 and 68). Green and blue-green algae are characteristic of fertile systems. Although little is known of cryptomonad ecology, they are commonly noted in Minnesota lakes of varying water quality. The presence of high numbers of diatoms in the spring indicates the presence of silica, a substance needed by diatoms. The phytoplankton community in South Rice Pond provides food for several types of animals, including zooplankton which, in turn, are eaten by fish. Green algae, diatoms, and cryptomonads are edible and provide high nutritional value to consumers; blue-green algae are generally considered inedible. The numbers of phytoplankton in South Rice Pond in 2013 were generally similar to previous years, although higher numbers were observed in May (Figure 67).

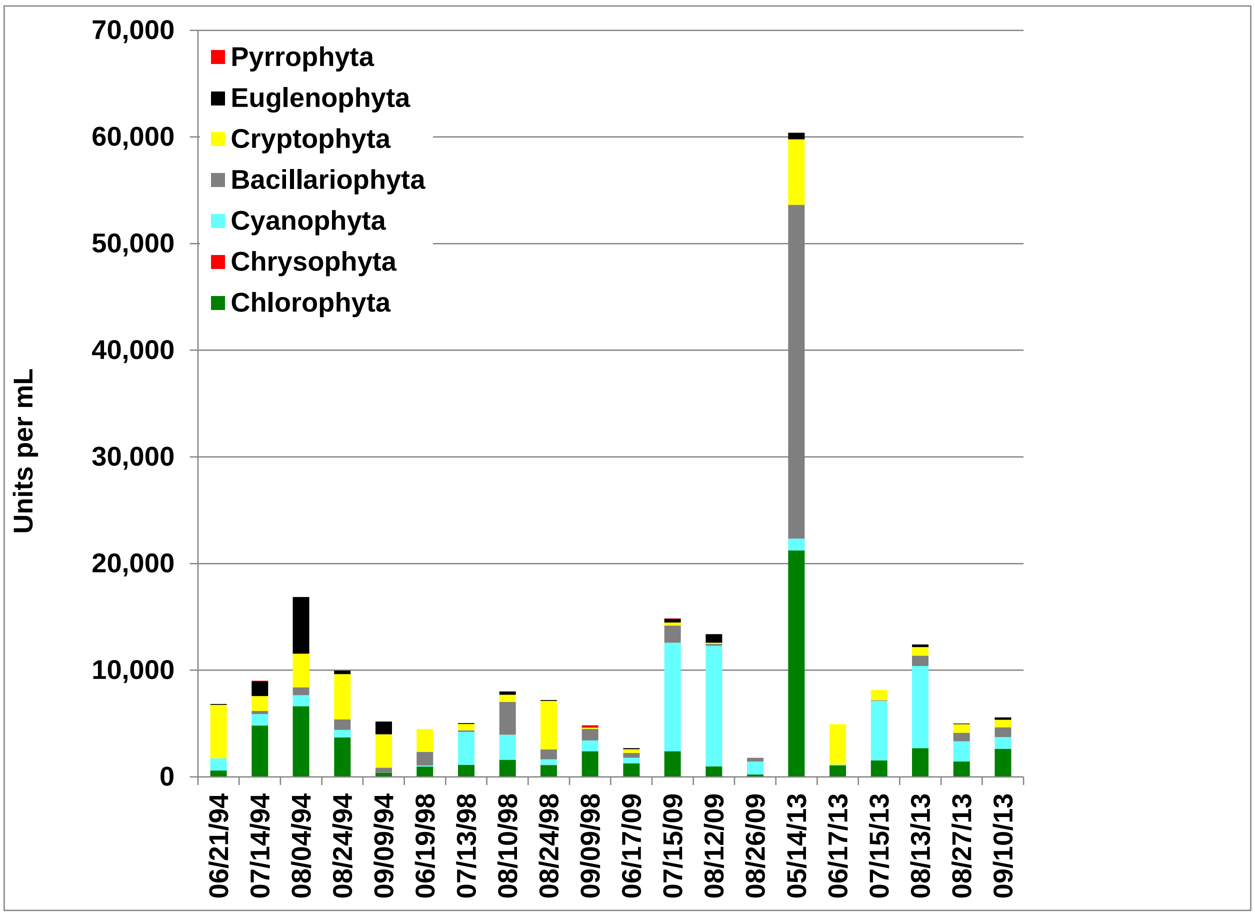


Figure 67 **1994–2013 South Rice Pond phytoplankton data summary**

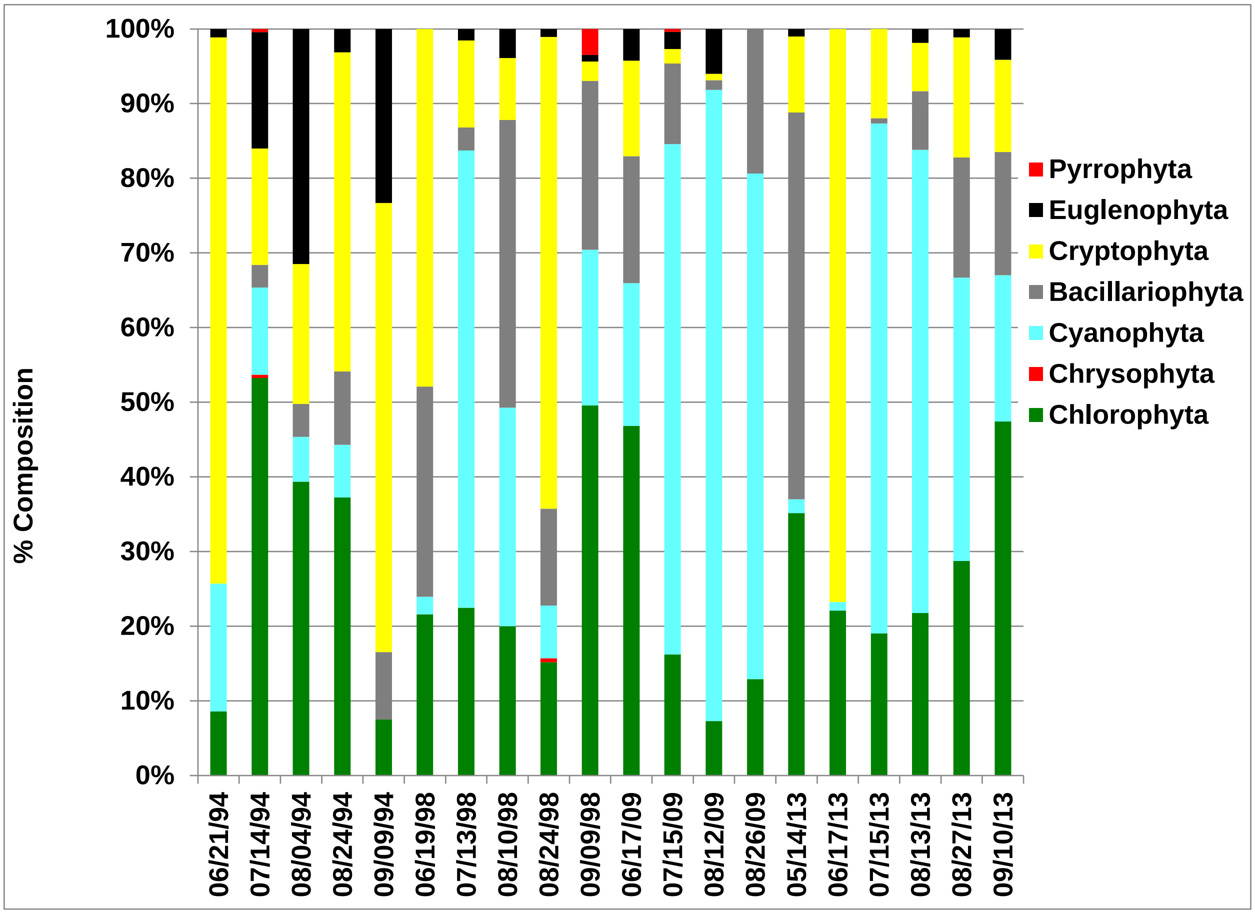


Figure 68 **1994–2013 South Rice Pond phytoplankton composition by division**

The numbers of blue-green algae in South Rice Pond were compared with WHO guidelines to determine the risk of adverse health effects. As shown in Figure 69, the low numbers of blue-green algae observed in South Rice Pond throughout the period of record have posed no risk of adverse health effects. As noted previously, the macrophyte community in South Rice Pond is dominated by coontail, a plant known to secrete allelochemicals that inhibit algal growth, particularly blue-green algal growth. The low numbers of blue-green algae observed in South Rice Pond during the period of record (Figure 69), despite high phosphorus concentrations (Figure 57), are likely the result of abundant coontail.

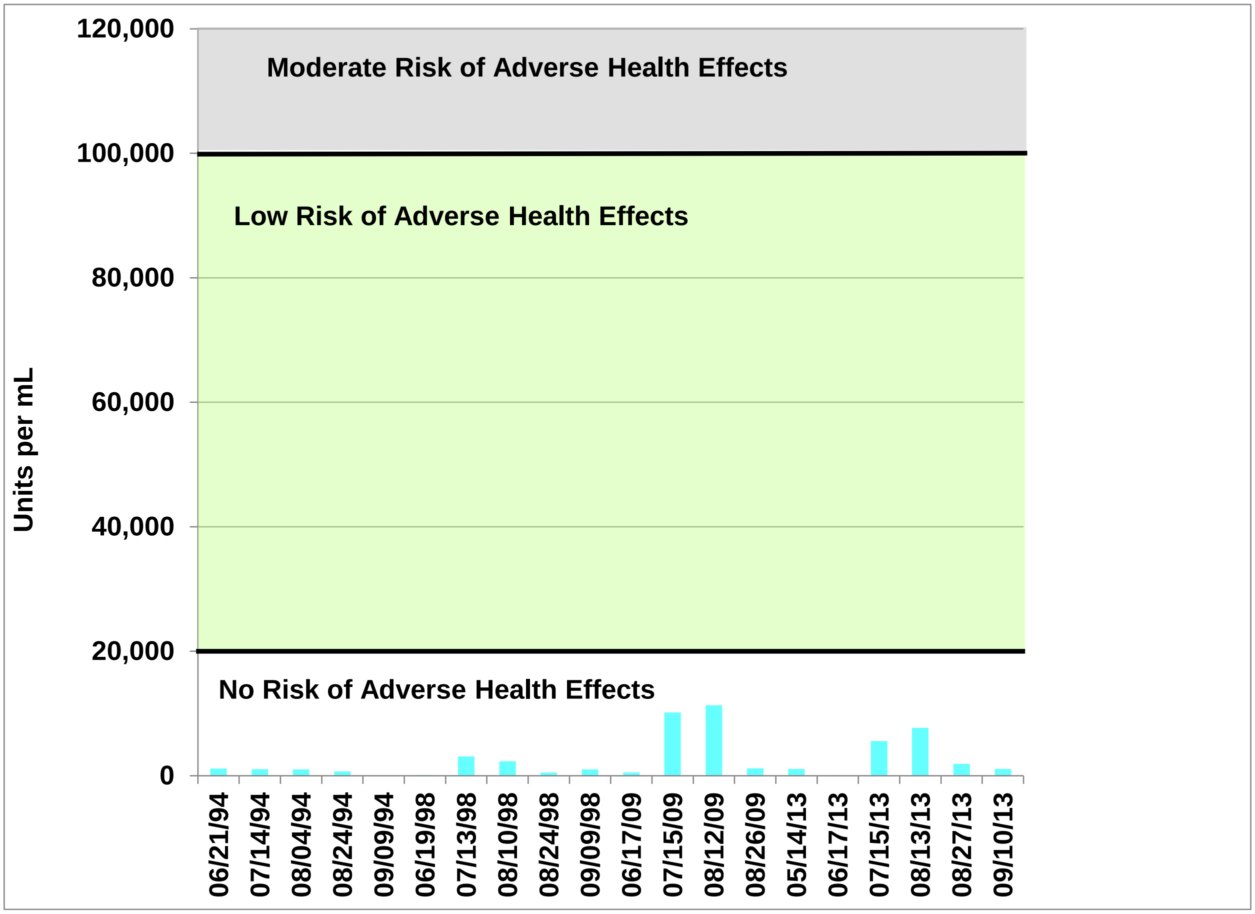


Figure 69 **1994–2013 South Rice Pond blue-green algae compared with risk of adverse health effects**

4.8.3 Zooplankton

4.8.3.1 North Rice Pond

The zooplankton community in North Rice Pond provides food for the lake's fishery, but has little predatory impact on the lake's algal community. In 2013, the pond's zooplankton community primarily consisted of rotifers and immature copepods (Figures 70 and 71). Both are small-bodied forms that do not significantly affect the pond's water quality. The grazing abilities of zooplankton are based on their size: large-bodied forms are capable of grazing significant quantities of algae, while small-bodied forms have very limited grazing ability. Given that the small-bodied rotifers and immature copepods dominate, little grazing occurs in North Rice Pond. Subsequently, the size of the phytoplankton community is primarily affected by nutrient loading from the pond's watershed or internal load, rather than zooplankton predation.

Compared with previous years, North Rice Pond observed higher numbers of zooplankton during the spring and late summer of 2013 (Figure 70).

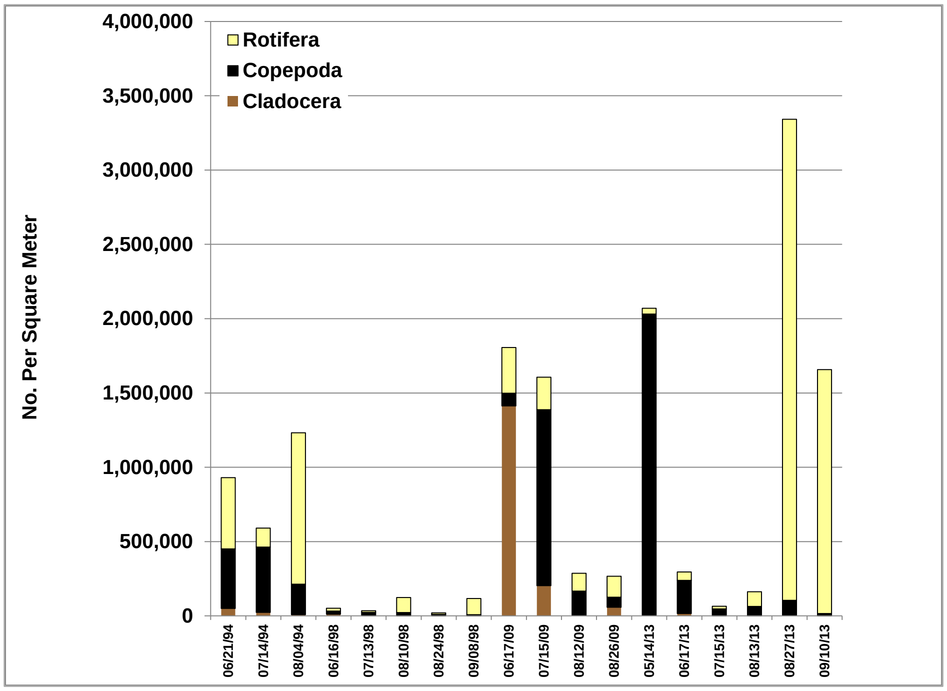


Figure 70 1994–2013 North Rice Pond zooplankton data summary by division

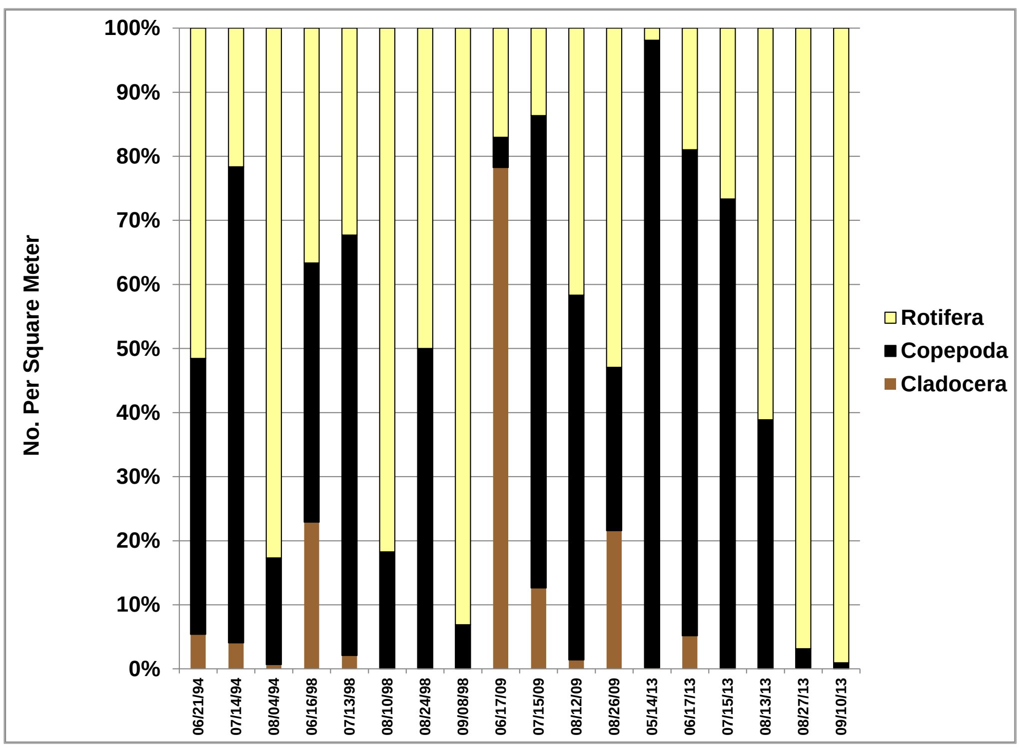


Figure 71 1994–2013 North Rice Pond zooplankton composition by group

4.8.3.2 South Rice Pond

The zooplankton community in South Rice Pond provides food for the pond's fishery, but has little predatory impact on the pond's algal community. The community was dominated by immature copepods and rotifers throughout 2013 (Figures 72 and 73). Immature copepods and rotifers graze upon extremely small particles of plant matter and do not significantly affect the pond's water quality. The abundance of small-bodied zooplankters is indicative of fish predation upon larger-bodied animals. Fish "sight feed," selecting and depleting the number of large-bodied zooplankters in a water body. Escape from predation by the larger-bodied zooplankters is dependent upon the presence of a "refuge" within a lake. The shallow South Rice Pond does not provide a refuge. Consequently, only smaller-bodied zooplankters survive predation from the pond's fisheries.

Compared with previous years, South Rice Pond observed higher numbers of zooplankton during late summer of 2013 (Figure 56).

The zooplankton community in South Rice Pond was dominated by immature copepods (above left) and rotifers (above right).

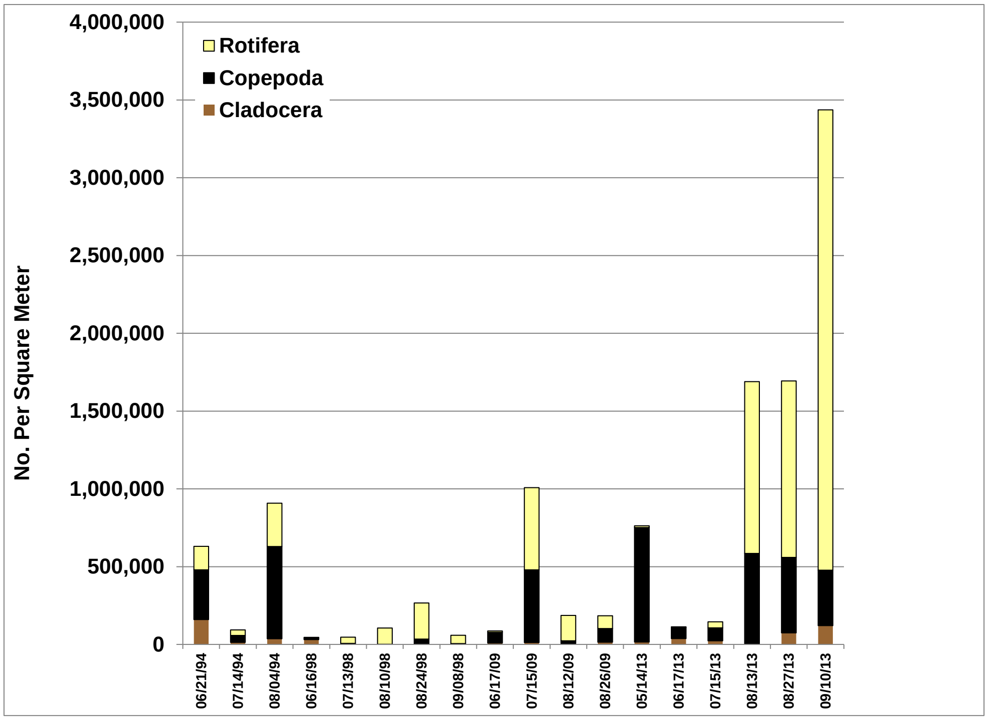


Figure 72 1994–2013 South Rice Pond zooplankton data summary by division

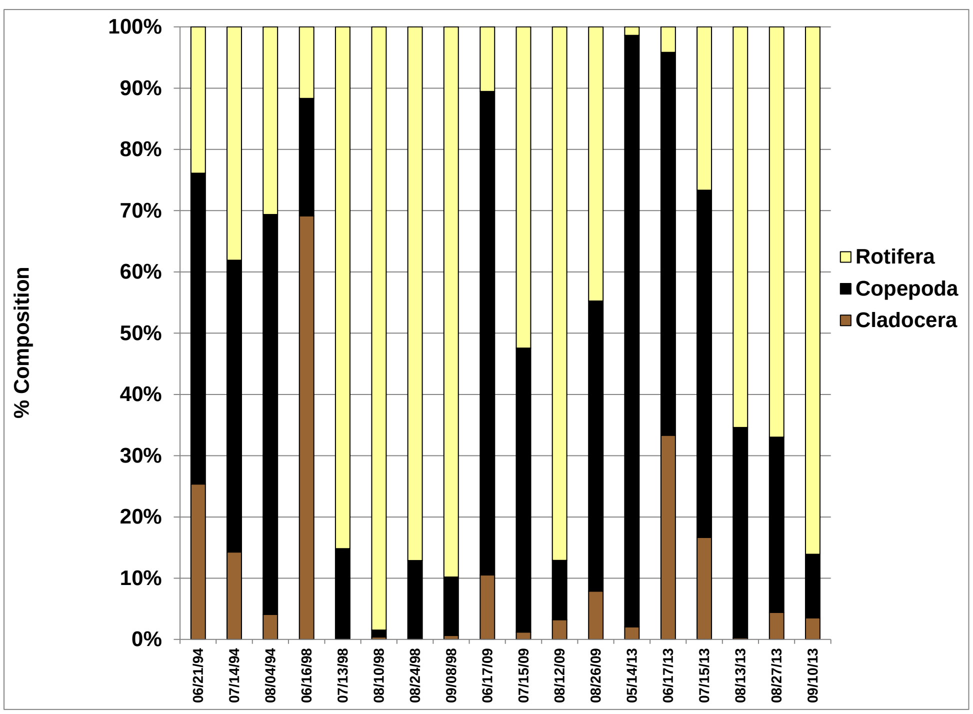


Figure 73 1994–2013 South Rice Pond zooplankton composition by group

4.9 Conclusions and Recommendation

4.9.1 Conclusions

Conclusions of the 2013 study of North Rice Pond and South Rice Pond include:

- In 2013, average summer chlorophyll *a* concentrations in North and South Rice Pond met the BCWMC water quality goal; average summer total phosphorus concentrations and Secchi disc transparency values did not.
- Because North Rice Pond (27-644W) and South Rice Pond (27-645W) are wetlands, there are no applicable state water quality standards.
- Trend analyses indicate that during the period of record, changes in total phosphorus, chlorophyll *a*, and Secchi disc transparency values in South Rice Pond are not significant. Trend analyses were not performed on North Rice Pond due to insufficient data (at least 10 years of data are needed and only 4 years were available).
- During the period of record, North Rice Pond has met the BCWMC total phosphorus goal 25 percent of the time, chlorophyll *a* goal 100 percent of the time, and Secchi disc transparency goal 50 percent of the time.
- South Rice Pond has not met total phosphorus and Secchi disc transparency goals during the period of record. However, the chlorophyll *a* goal has been met 69 percent of the time.
- Compared with previous years, the numbers of algae in North Rice Pond were generally higher in 2013.
- Compared with previous years, the numbers of algae in South Rice Pond were generally similar in 2013, although higher numbers were observed in May.
- Due to low numbers, the blue-green algae observed in North and South Rice Ponds throughout the period of record have posed no risk of adverse health effects. The macrophyte communities in North and South Rice Ponds are dominated by coontail, a plant known to secrete allelochemicals that inhibit algal growth—particularly blue-green algal growth. The low numbers of blue-green algae observed in North and South Rice Ponds during the period of record, despite high phosphorus concentrations, are likely the result of abundant coontail.
- Compared with previous years, North Rice Pond observed higher numbers of zooplankton during spring and late summer of 2013.
- Compared with previous years, South Rice Pond observed higher numbers of zooplankton during late summer of 2013.

- A comparison of 2013 macrophyte data with past data indicates the macrophyte communities in North and South Rice Ponds have been stable over time.
- Nuisance non-native plants observed in 2013 include purple loosestrife, surrounding North and South Rice Ponds, and curly-leaf pondweed, observed in South Rice Pond for the first time.

4.9.2 Recommendation

It is recommended that BCWMC contact the MDNR to request that purple loosestrife-eating beetles be introduced to the infested areas surrounding North and South Rice Ponds. Introduction of the beetles is expected to control purple loosestrife and protect the native vegetation.

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