2008 Lake Water Quality Study

Sweeney Lake and Twin Lake

Prepared by
Bassett Creek Watershed Management Commission

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Executive Summary

Since 1970, water quality has been monitored in ten major lakes under the management of the Bassett Creek Watershed Management Commission (BCWMC). The main objective of this program is to detect changes or trends in lake water quality over time that will help determine the effects from changing land use patterns within the watershed as well as the BCWMC's efforts to maintain and improve water quality. The BCWMC adopted its current watershed management plan in 2004. The second generation plan complies with the provisions of the 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.

This report summarizes the results of water quality monitoring during 2008 in Sweeney and Twin Lakes in Golden Valley. The lakes were monitored for both chemical and biological water quality parameters, the latter including phytoplankton, zooplankton and macrophytes (aquatic plants). Monitoring results are summarized by lake and include a description of the results along with graphical representations of the data.

The conclusions from 2008 water quality monitoring are as follows:

Sweeney Lake

- Water quality status of Sweeney Lake was mesotrophic (moderate nutrients and good water quality) although the summer average phosphorus concentration was mildly eutrophic (nutrient rich and poor water quality) during the 2008 growing season.

- Vegetation (submerged and floating leaf) was found throughout the lake's littoral (shallow) zone to depths of 10 feet during June and 13 feet during August.

- Two undesirable non-native species, curlyleaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*), were observed during 2008. Both were also observed in 2005. No changes in coverage or density since 2005 are apparent.

- Sweeney Lake water quality has improved when compared to 2007 and 2005 because chlorophyll *a* and total phosphorus have decreased while Secchi depth has increased, and water quality is the best since monitoring began in 1972.

- Despite improvements, Sweeney Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L), although the 2008 average summer concentration (32 µg/L) was very close to the goal (within 2 µg/L). Chlorophyll *a* (average summer concentration not to exceed 10 µg/L) and Secchi disc transparency (average summer depth of at least 2.2 meters) goals were met in 2008.

- In 2008, Sweeney Lake water quality met the state water quality standards.

- Phosphorus buildup in the lake's bottom waters during 2008 resulted from internal loading. Because the aeration system was not in operation during 2008, lake mixing did not occur and the phosphorus pool was trapped in the lake's bottom waters during the summer.

- A comparison of 2005 and 2008 water quality data indicate the lake's aeration system causes mixing of the phosphorus from the lake's bottom waters into the surface waters.

- Because phosphorus from internal loading mixes during the fall and spring mixing events, this phosphorus contributes to the lake's annual phosphorus load which affects the lake's water quality during the subsequent growing season. The TMDL study that is underway should evaluate options to minimize internal loading and its impact upon the lake's spring and summer water quality.

To further evaluate the changes in lake water quality observed during 2008, it is recommended that the lake be monitored without the operation of the aeration system during 2009. Samples would be collected prior to ice-out and throughout the growing season.

Twin Lake

- The summer average of the total phosphorus concentrations indicates that Twin Lake is in the eutrophic category, while the summer average chlorophyll *a* concentration and Secchi disc transparency are within the upper limits of the mesotrophic classification. With the exception of the June measurement, 2008 Secchi disc data points are in the eutrophic category.

- In 2008, Twin Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L) or Secchi disc transparency (average summer depth of at least 2.2 meters). The lake's average summer total phosphorus concentration was 44 µg/L and Secchi disc transparency was 2.0 meters. The lake's average summer chlorophyll *a* concentration of 6.7 µg/L met the BCWMC Level I water quality goal (average summer concentration not to exceed 10 µg/L).

- In 2008, Twin Lake did not meet the state water quality standards. The lake's average summer total phosphorus concentration (44 µg/L) exceeded the state standard (maximum of 40 µg/L). However, the lake's average summer chlorophyll *a* (6.7 µg/L) and Secchi disc transparency (2.0 meters) both met the state standard (chlorophyll *a* maximum of 14 µg/L and Secchi disc minimum of 1.4 meters).

- Historical data indicate an improvement in water quality between 1982 and 1992 after which it remained relatively constant from 1992 to 2005. However all three nutrient-related parameters indicate that water quality has decreased greatly between 2005 and 2008 and the water quality of the lake during 2008 was at or near the poorest water quality observed since monitoring began.

- 2008 noted substantially higher numbers of phytoplankton (algae - microscopic plants) during the late summer as compared with 2000 and 2005. The higher numbers indicate the lake's water quality has decreased greatly between 2000 and 2008.

- A substantial decline in large-bodied zooplankters (microscopic crustaceans) occurred from early June to early July of 2008. Large-bodied zooplankters can improve a lake's water quality by eating substantial quantities of algae. A substantial decline in large-bodied zooplankters greatly reduces the quantity of algae that are consumed and results in decreased water quality. The reduced control by zooplankton during this period corresponded with a tripling of the number of phytoplankton in the lake despite declining phosphorus concentrations.

- A comparison of 2000, 2005, and 2008 zooplankton (microscopic crustaceans) indicates substantially higher numbers of zooplankton were observed during June of 2008 than were observed in June of 2000 and 2005. Because zooplankton consume algae, the lake's capacity to control algae through zooplankton consumption was higher during June of 2008 than during June of 2000 and 2005. Declines in zooplankton during June and July of 2008 resulted in similar numbers of zooplankton during August of 2008 as were observed during August of 2000 and 2005. The capacity of the lake's zooplankton to control algae was essentially the same during August of 2000, 2005, and 2008.

- A larger number of plant species was observed in 2008 than during 1996 through 2005. A total of 15 to 19 individual species were observed in 1996 through 2005 compared with 21 to 22 species in 2008.

- Curlyleaf pondweed, an undesirable non-native species, was observed in light density along the northeastern shore during June of 2000, was not observed during 2005, and was observed in light density at a single location along the southeastern shore during August of 2008. The August growth would be a new growth from turions (seeds) since the plant's growth cycle begins in late summer, continues through the winter, and concludes in late June each year.

- Purple loosestrife, an undesirable non-native species, was first observed growing along the south shoreline during 2000 and has been observed at this same location during 2005 and 2008. Although no increase in coverage has been observed, the presence of purple loosestrife is of concern because this plant typically displaces native vegetation and becomes the sole emergent species. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife along Twin Lake's south shoreline.

To determine the cause of the high phosphorus concentration in Twin Lake, additional monitoring is recommended to determine changes in the lake's phosphorus concentrations before and after ice-out. Specifically, it is recommended that samples be collected prior to ice-out and that samples be collected throughout the growing season. In addition, lake level monitoring of both Sweeney Lake and Twin Lake is recommended immediately after ice-out to rule out the possibility that Sweeney flows into Twin during periods of high water levels such as following spring snowmelt.

2008 Lake Water Quality Study
Sweeney Lake and Twin Lake

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1.0 Introduction

Since 1970, when the Bassett Creek Water Management Commission (BCWMC) and its predecessor, the Bassett Creek Flood Control Commission, were formed, water quality conditions in the ten major lakes have been periodically monitored. The BCWMC's policy is to preserve water quality conditions, and to improve them where possible. Nonpoint source pollution (pollutants transported by stormwater runoff) is the predominant cause of lake water quality degradation. The objective of the lake monitoring program is to detect changes or trends in water quality over time, thereby determining the effect of changing land use patterns in the watershed and the effectiveness of the BCWMC's efforts to prevent water quality degradation in the lakes.

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

Table 1 Lakes Monitored in the Basset Creek Watershed BCWMC Area (Years with sampling data are in parenthesis)

• Crane (1977, 1982, 1993, 1997, 2001, 2007[1])	• 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[1], 2007[1], 2008[1])
• Medicine (1977, 1982, 1983, 1984, 1988, 1994[1], 1999[1], 2006[1])	• Twin (1977, 1982, 1992, 1996, 2000, 2005, 2008[1])
• Northwood (1972, 1977, 1982, 1992, 1996, 2000, 2005)	• Westwood[2] (1977, 1982, 1993, 1997, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007[1])

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

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

Wirth Lake is currently monitored annually by the Minneapolis Park and Recreation Board. Hence, Wirth Lake is not included in the BCWMC's lake monitoring program. Medicine Lake is currently monitored annually by the Three Rivers Park District (Three Rivers). The BCWMC periodically participates with Three Rivers to monitor a second site at Medicine Lake. Westwood Lake, Sweeney 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 during 1975 through 1994.

The lake sampling program occasionally includes limited monitoring for other water bodies, which has included the following ponds and the year sampled in parenthesis:

- Cortlawn, East Ring, and West Ring Ponds (1993)
- Grimes Pond (1996)
- North Rice and South Rice Ponds (1994, 1998)

South Rice Pond also has been included in the CAMP since 2000.

This report presents the results of the water quality monitoring in 2008 of Sweeney Lake and Twin Lake (locations shown on Figure 1). The lakes were monitored for water quality and biota, specifically phytoplankton, zooplankton, and macrophytes (aquatic plants). Monitoring results are summarized in the following pages, including a narrative description of the results as well as a graphical summary. More detailed data can be found in the appendices of the report.

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, its concentration in a lake water sample indicates the amount of algae present in the sampled area of the lake. Secchi disc transparency is a measure of water clarity, and is inversely related to algal abundance.

P:\Mpls\23 MN\2327051\WorkFiles\2008 Lake Monitoring Twin Sweeney\Sweeney and Twin Maps\Lakes included in 2008 WQ Study.CDR RLG 02-13-09

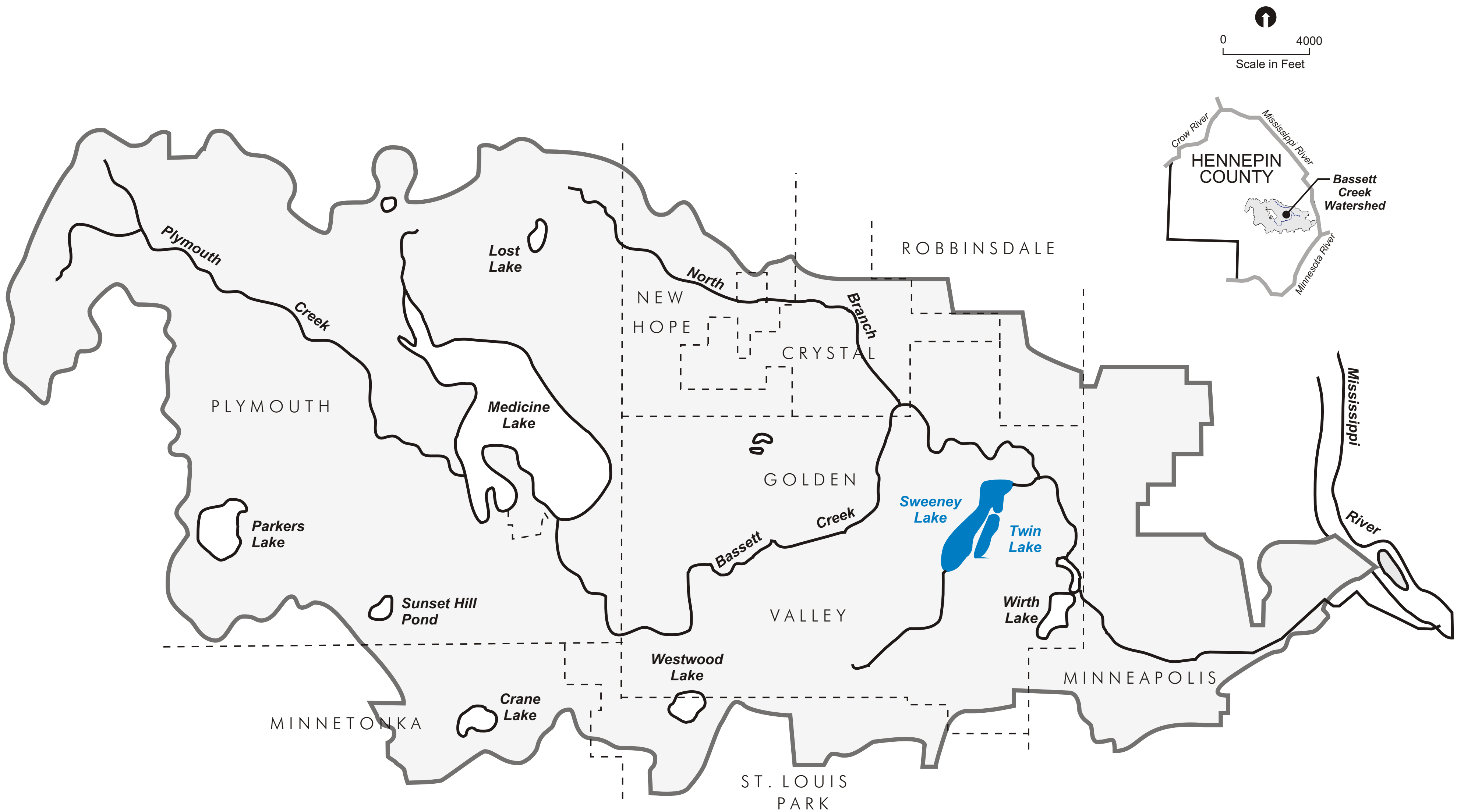

Figure 1

LOCATION OF LAKES INCLUDED IN 2008 WATER QUALITY STUDY (Identified in Blue)

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	Chlorophyll *a*	Secchi Disc Transparency
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 compiled and evaluated in this study as well. 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.

Phytoplankton (algae) – form the base of the food web in lakes and directly influence 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. Different algal species provide varying levels of “food quality” and thus can affect the growth of zooplankton in a lake. Larger algal species that are difficult to consume or those of low food quality are less desirable for zooplankton 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 are food themselves 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 within a lake.

Macrophytes (vascular 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

Samples were collected from representative lake sampling stations (i.e., located at the deepest location(s) in each lake basin) on 13 occasions in Sweeney Lake and 6 occasions in Twin Lake. Twin Lake samples were collected from one basin and Sweeney Lake samples were collected from two basins (North and South). Table 3 lists sampling dates for each lake. Dates marked with an asterisk (*) are included in the summer average computations for comparison to applicable standards and historical records.

Table 3
Sample Collection Dates

Sweeney Lake	Twin Lake
April 30	
May 13	
May 28	
June 9 *	June 9 *
June 23 *	
July 8 *	July 8 *
July 22 *	July 22 *
August 8 *	August 5 *
August 19 *	August 19 *
September 3	September 3
September 17	
September 30	
October 22	

Table 4 lists the water quality parameters and specifies at what depths the samples or measurements were collected. Dissolved oxygen, temperature, specific conductance, pH, and Secchi disc transparency (Secchi depth) were measured in the field, water samples were analyzed in the laboratory for total phosphorus, soluble reactive phosphorus, total nitrogen, and chlorophyll *a*. Sampling and analysis of water quality parameters were completed by Three Rivers. Phytoplankton and zooplankton samples were collected by Three Rivers (see Ecosystem Data) and were delivered to Barr Engineering for analysis.

Table 4
Lake Water Quality Parameters

Parameters	Depth (Meters)	Sampled or Measured During Each Sample Event
Dissolved Oxygen	Surface to bottom profile at one meter intervals	X
Temperature	Surface to bottom profile at one meter intervals	X
Specific Conductance	Surface to bottom profile at one meter intervals	X
Secchi Disc	—	X
Total Phosphorus	0-2 Meter Composite Sample.	X
Total Phosphorus	One sample above the thermocline, one below the thermocline, and one near bottom sample from 0.5 meters above the bottom.	X
Soluble Reactive Phosphorus	0-2 Meter Composite.	X
Total Nitrogen (or Nitrogen Species Needed to Determine Total Nitrogen)	0-2 Meter Composite Sample.	X
pH	0-2 Meter Composite Sample.	X
pH	One sample above the thermocline, one below the thermocline, and one near bottom sample from 0.5 meters above the bottom.	X
Chlorophyll *a*	0-2 Meter Composite Sample.	X

2.2 Ecosystem Data

Ecosystem data were collected from June to August 2008. Phytoplankton and zooplankton samples were collected by Three Rivers and analyzed by Barr Engineering.

- **Phytoplankton—**A surface water sample (composite 0-2 meter sample) was collected during each water quality sampling event from Sweeney Lake and Twin Lake during the period from June through August. Sample analysis included identification and enumeration of species.
- **Zooplankton—**A zooplankton sample was collected (i.e., bottom to surface tow) during each water quality sampling event during the period June through August. Sample analysis included identification and enumeration of species.

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

3.0 Sweeney Lake

3.1 Site Description

Sweeney Lake, located in the City of Golden Valley (Hennepin County), has a water surface area of approximately 67 acres (27.1 hectares), a maximum depth of 27 feet (8.2 meters) and a mean depth of 11.8 feet (3.6 meters). It is surrounded by a 2,400 acre watershed and approximately half of the lake is considered littoral (shallow) area. The Sweeney Lake branch of Bassett Creek flows into the lake on the southern end and it exits at the northern end over a concrete dam. Sweeney Lake is connected to Twin Lake by a meandering channel that runs through a cattail marsh reaching from the northeastern shore of Sweeney Lake to the northern shore of Twin Lake. Privately-owned, single family homes line the entire western and southern shorelines of Sweeney Lake. The Hidden Lakes residential development and park land borders the eastern shore and the northern shore is bordered by the Golden Valley Health Center. The lake is primarily used by area residents for canoeing, boating, fishing, and aesthetic viewing purposes.

3.2 Goal

The BCWMC's goal for Sweeney Lake is a management classification of Level I, meaning its water quality should support all water-based recreational activities including swimming. Level I goals are (1) maximum total phosphorus concentration of 30 µg/L, (2) maximum chlorophyll *a* concentration of 10 µg/L, and (3) minimum Secchi disc transparency of 2.2 meters (about 7 feet) (Barr 2004).

3.3 State 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 the water and still allow it to meet designated uses, such as drinking water, 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 state water quality standards applicable to Sweeney Lake are (1) maximum total phosphorus concentration of 40 µg/L, (2) maximum chlorophyll *a* concentration of 14 µg/L, and (3) minimum Secchi disc transparency of 1.4 meters (Minn. R. Ch. 7050.0222 Subp. 3).

3.4 Watershed and Lake Management Plan/Sweeney Lake TMDL Study

In 1994, the BCWMC completed the *Sweeney Lake Watershed and Lake Management Plan* with several recommendations to consider that would improve the overall health of the lake. The recommendations in the Sweeney Lake Plan were split into two phases. The Phase I recommendations included:

- ***Monitoring the lake without the operation of the aeration system***. The monitoring results would then be used to determine if phosphorus was released from the sediments and mixed into the lake's surface waters by the aeration system and also whether Sweeney Lake was light limited. The aeration system was shut down and the lake monitored during 2007 and 2008.

- ***Implementation of general best management practices in the entire Bassett Creek watershed.***

- ***Maintenance of several existing ponding areas, including dredging and diversion of Breck Pond outflow through Spring Pond.*** Most of these ponding areas are tributary to the Interstate 394 and Trunk Highway 55 stormwater systems. The Sweeney Lake Plan recommends that four of these ponds – Duck, Glen 1, Glen 2, and Breck (Option 1 in Sweeney Lake Plan) – be dredged and/or excavated to provide additional storage for water quality treatment. Diverting Breck Pond outflow into Spring pond was also recommended.

- ***Alum treatment facility***. Construction of an alum treatment facility north of Highway 55, adjacent to the stormwater inlet south of the DNR protected wetland. The facility would treat stormwater and then discharge the treated stormwater into the DNR wetland.

- ***Excavate new wet detention pond adjacent to DNR protected wetland***. This pond was constructed as part of the Schaper Park project during 1998. The pond has effectively reduced the amount of sediment and other pollutants that enter the wetland and Sweeney Lake from this system.

Phase II recommendations included using the lake water quality monitoring results to define the benefit of the aeration system on the lake.

In 2004, Sweeney Lake was included as a new listing in the MPCA's impaired waters list. Sweeney Lake was listed for excess nutrients (total phosphorus). The BCWMC received funding from the MPCA to conduct a total maximum daily load (TMDL) study for Sweeney Lake. The TMDL study began in 2007 and will be completed by mid-2010. The TMDL study is taking into account the BMPs that were implemented as a result of the Sweeney Lake Plan and is taking into consideration the other (Phase I and Phase II) recommendations from the Sweeney Lake Plan. An implementation plan will be developed as part of the Sweeney lake TMDL study that identifies the BMPs needed to improve the water quality of Sweeney Lake.

3.5 Water Quality Data

Sweeney Lake was sampled thirteen times in both the northern basin and the southern basin during the 2008 growing season. Samples from both stations were averaged for each sampling date to allow comparisons to data collected in previous years. During the 2000 sampling period, samples were collected only from the southern basin, although samples were collected from both basins during 1996, 2005, and 2007. Water quality data (Appendix A) for Sweeney Lake include:

- Vertical profiles of temperature, dissolved oxygen concentration, specific conductivity, and pH
- 0-2 m composite samples analyzed for chlorophyll *a*, total phosphorus, soluble reactive phosphorus, and total nitrogen
- Total phosphorus above and below the thermocline and near bottom
- Secchi disc transparency

3.5.1 Temperature

Vertical profiles of temperature collected during 2008 show that the lake was stratified during late April through September and was mixed during fall turn-over in October (Appendix A). The 2008 data were similar to 2007 data (Appendix B) and confirm that the lake remains stratified throughout the growing season when the aeration system is turned off. In contrast, temperature data from 2005 indicate the lake remains mixed throughout the growing season when the aeration system is in operation (Appendix C).

3.5.2 Dissolved Oxygen

Vertical profiles of dissolved oxygen collected during 2008 show that lake stratification impacted the lake's oxygen concentrations. Waters above the lake's thermocline (warmer surface waters) were well oxygenated throughout the growing season. Waters below the lake's thermocline (cooler bottom waters) contained low oxygen concentrations. Dissolved oxygen concentrations were generally less than 5 mg/L at depths greater than 4 to 5 meters throughout the summer until the lake mixed during October. Dissolved oxygen concentrations near the bottom were near 0 from late April through September (Appendix A). Panfish and gamefish species within the lake require dissolved oxygen concentrations of 5 mg/L or greater. Therefore they would have been unable to live in the lake's deeper waters for most of the growing season. High total phosphorus concentrations near the sediment surface were also detected during this period indicating internal loading of phosphorus due to oxygen depletion. The cause of the oxygen depletion below the thermocline is due to microbial degradation of organic material from settled algal material and stormwater inputs.

2005 data indicate operation of the aeration system resulted in higher oxygen concentrations near the lake's bottom than occurred during 2008. Despite these higher concentrations during 2005, less than 5 mg/L oxygen was found at depths less than 4 to 6 meters during the summer and dissolved oxygen concentrations near the bottom were near 0 during July and August.

3.5.3 Total Phosphorus, Chlorophyll *a,* and Secchi Depth

Surface total phosphorus data are graphically summarized in Figure 2. The 2008 surface total phosphorus concentrations ranged from a high of 106 µg/L in late May to a low of 27 µg/L in early July and averaged 32 µg/L during the summer months (June through August). The 2008 average was lower than both the 2005 and 2007 summer averages (53 µg/L and 48 µg/L, respectively).

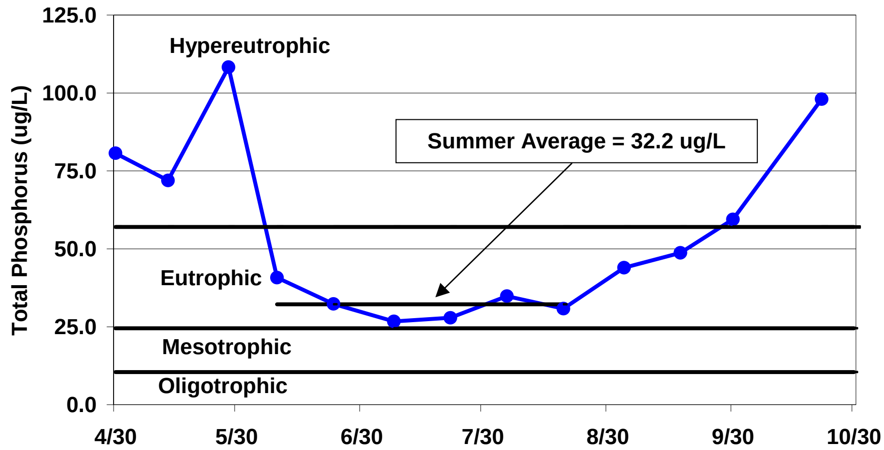

Figure 2 2008 Sweeney Lake Total Phosphorus Concentration

During June through September 2008, surface total phosphorus concentrations were generally an order of magnitude lower than concentrations near the bottom of the lake (Figure 3). When the lake's bottom waters become stagnant and lose oxygen, the sediment changes from a phosphorus storage unit to a massive phosphorus pumping system. The lake's sediment pumps phosphorus back into the lake. This cycle continues until oxygen is added to the water which breaks this cycle. The stagnant bottom waters of Sweeney Lake loaded phosphorus into the lake beginning in late-April and continued until the lake mixed during October. This resulted in much higher phosphorus concentrations near the bottom than at the surface. However, stratification (colder bottom temperatures) trapped the phosphorus below the thermocline during the summer. During the fall, this phosphorus pool was mixed and contributed to the lake's fertility.

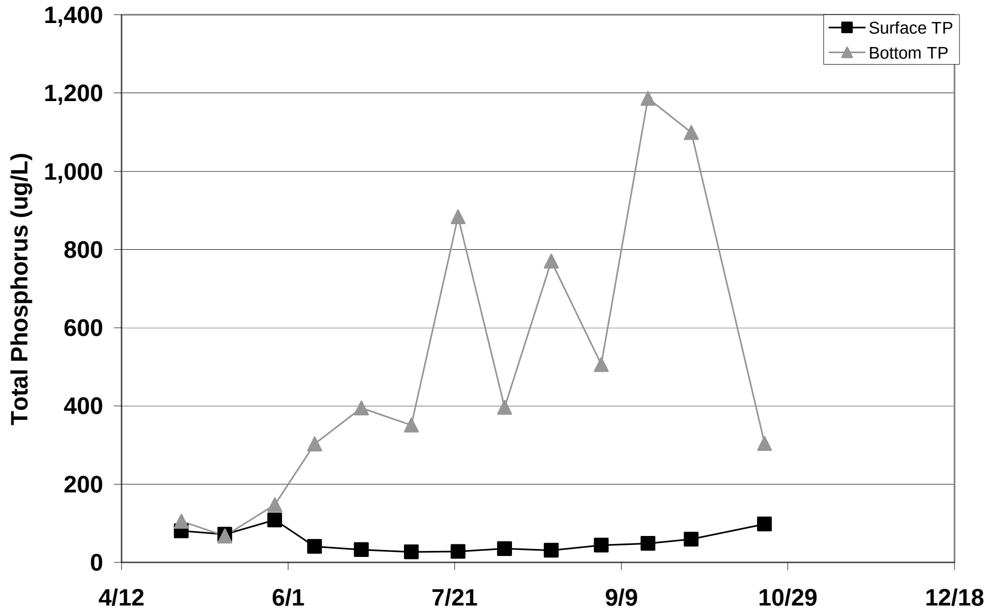

Figure 3 2008 Sweeney Lake Surface and Bottom Total Phosphorus Concentration

Operation of the aeration system during 2005 continuously mixed the lake, thus preventing a buildup of phosphorus in the lake's bottom waters. This mixing brought phosphorus from the lake's bottom waters to the surface during the summer. The lake's surface waters contained higher phosphorus concentrations during 2005 than 2008 and the lake's bottom waters contained lower phosphorus concentrations in 2005 than 2008 (Appendices A and C). Trapping phosphorus released by sediment in the bottom waters during 2008 improved the lake's summer water quality by reducing surface phosphorus concentrations.

Surface chlorophyll *a* data are graphically summarized in Figure 4. 2008 surface chlorophyll *a* concentrations ranged from a high of 58 µg/L in mid May to a low of 1.8 µg/L in early August. The average summer concentration was 5.8 µg/L. This was the lowest average concentration measured since monitoring began in 1972 and is much less than recent average summer concentrations in 2007 and 2005 (14.4 µg/L and 19.4 µg/L, respectively).

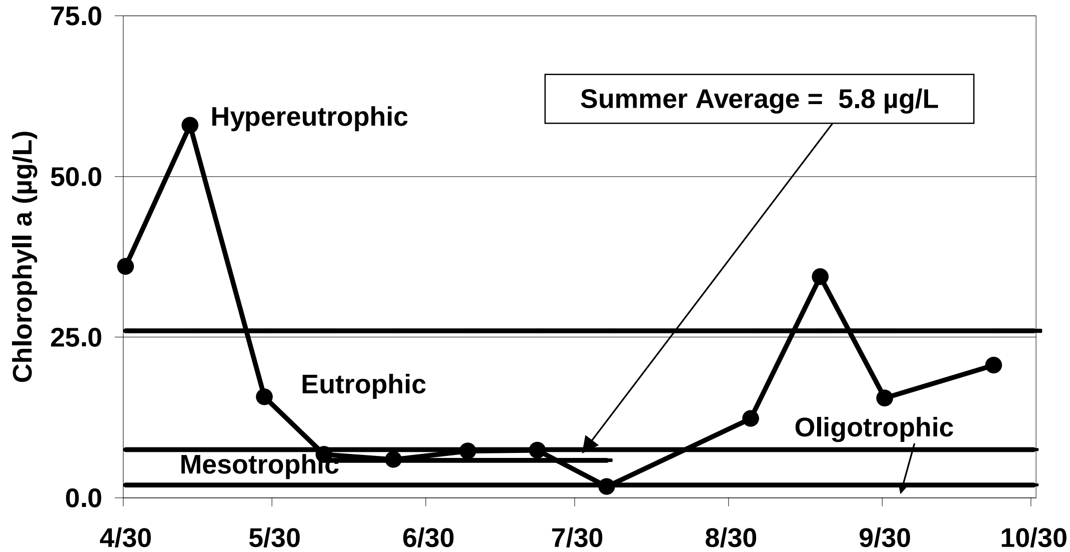

Figure 4 2008 Sweeney Lake Chlorophyll *a* Concentration

Secchi disc data are graphically summarized in Figure 5. 2008 Secchi disc transparency ranged from a low of 0.8 meters in mid May to a high of 4.0 meters in late June and averaged 2.7 meters during the summer months. This is the best average transparency (i.e. highest Secchi disc reading) recorded since 1972 and is much higher than summer averages from 2007 and 2005 (1.5 m and 1.8 m, respectively).

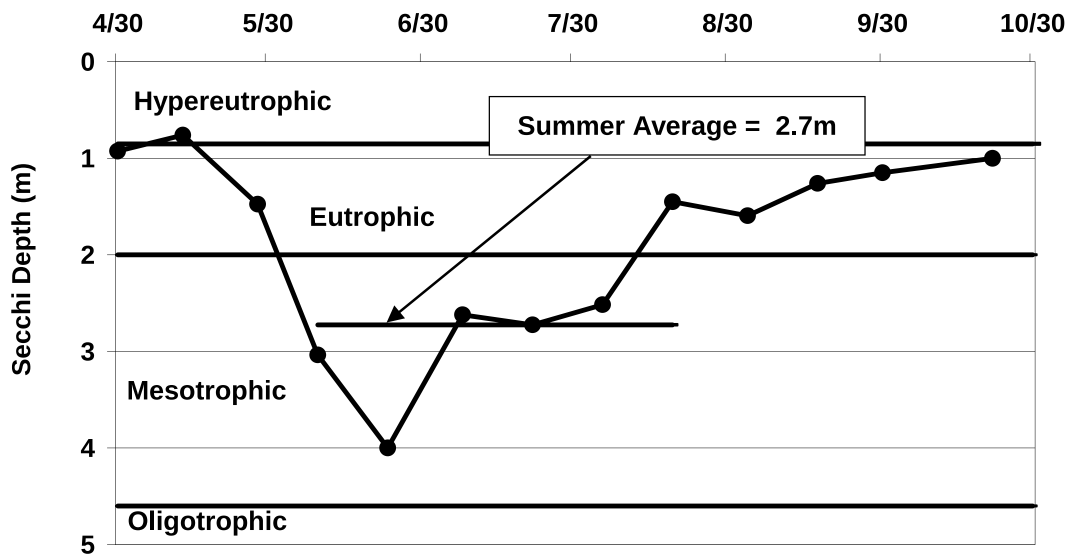

Figure 5 2008 Sweeney Lake Secchi Depth

Overall, all of the three indicators show that the water quality in Sweeney Lake has improved when compared to 2007 and 2005 because chlorophyll *a* and total phosphorus have decreased, while Secchi depth has increased, and water quality is the best since monitoring began in 1972. 2008 average summer phosphorous concentration is in the lower end of the eutrophic range, while 2008 average summer chlorophyll *a* and Secchi depth are within the mesotrophic range. The data indicate a moderate to rich level of available nutrients within the lake and relatively good water quality.

During 2008, Sweeney Lake's water quality met the state water quality standard. BCWMC's goals for chlorophyll and Secchi disc were met in 2008 and the phosphorus goal was nearly met. BCWMC's goal for phosphorus is a maximum of 30 µg/L and the summer average phosphorus concentration in Sweeney Lake was 32 µg/L, within 2 µg/L of goal attainment.

3.6 Historical Trends

Historical water quality trends are shown on Figure 6. Current data from all three measured parameters indicate better water quality than that determined during any previous year during the monitoring period. Decreasing concentrations of total phosphorus and chlorophyll *a* since 2000 indicate that water quality has been improving steadily since that time, and has surpassed the previous period of relatively good quality in the mid 1990's. Secchi depth appears to have more variation from one sampling year to the next, but on the whole has also decreased since 2000. Secchi disc transparency in 2008 was the highest (best) since monitoring began in 1972.

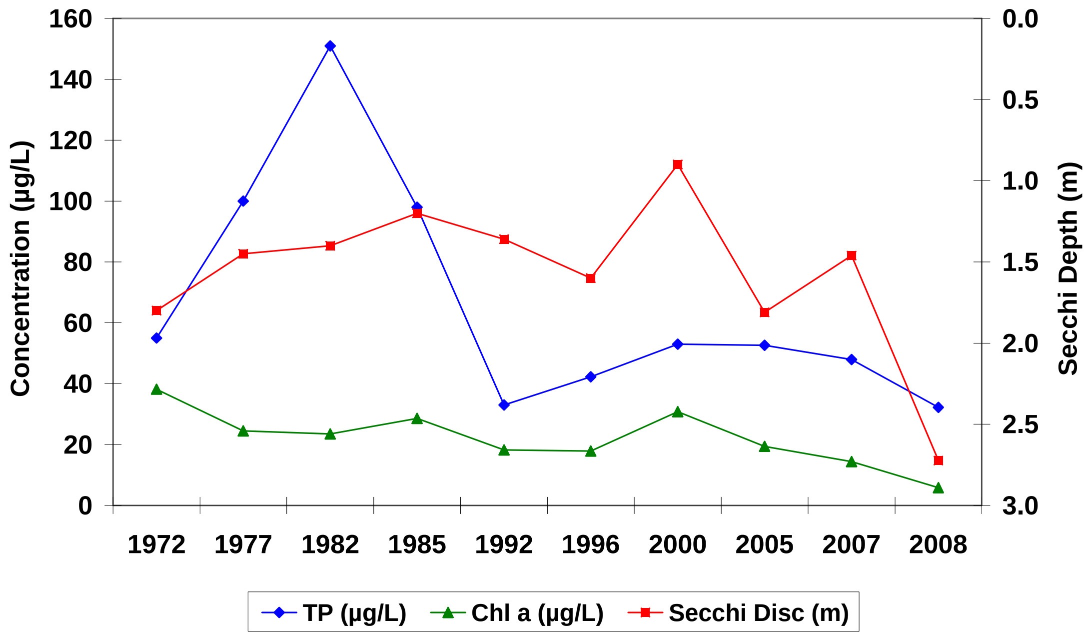

Figure 6 Historical Water Quality in Sweeney Lake.

3.7 Biota

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

3.7.1 Phytoplankton

Phytoplankton, also called algae, are single celled aquatic plants naturally present in lakes. They derive energy from sunlight (through photosynthesis) and from 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.

The lake's diverse algal community was comprised of five major algal groups (i.e., chlorophyta or green algae, cyanophyta or blue-green algae, bacillariophyta or diatoms, pyrrophyta or dinoflagellates, and cryptophyta or cryptomonads). Green algae and cryptomonds dominated the early summer community while blue green algae were predominant during the late summer. The number of phytoplankton increased throughout the growing season. The north basin generally observed higher numbers of phytoplankton than the south basin (Figures 7 and 8). A comparison of 2005 and 2008 data from the south basin indicates the highest number of phytoplankton in 2005 (28,979) was approximately double the highest number of phytoplankton observed in 2008 (14,991). A reduction in the number of phytoplankton observed during 2008 substantiates the water quality improvement indicated by reductions in phosphorus and chlorophyll *a* concentrations and increased Secchi disc transparency during 2008.

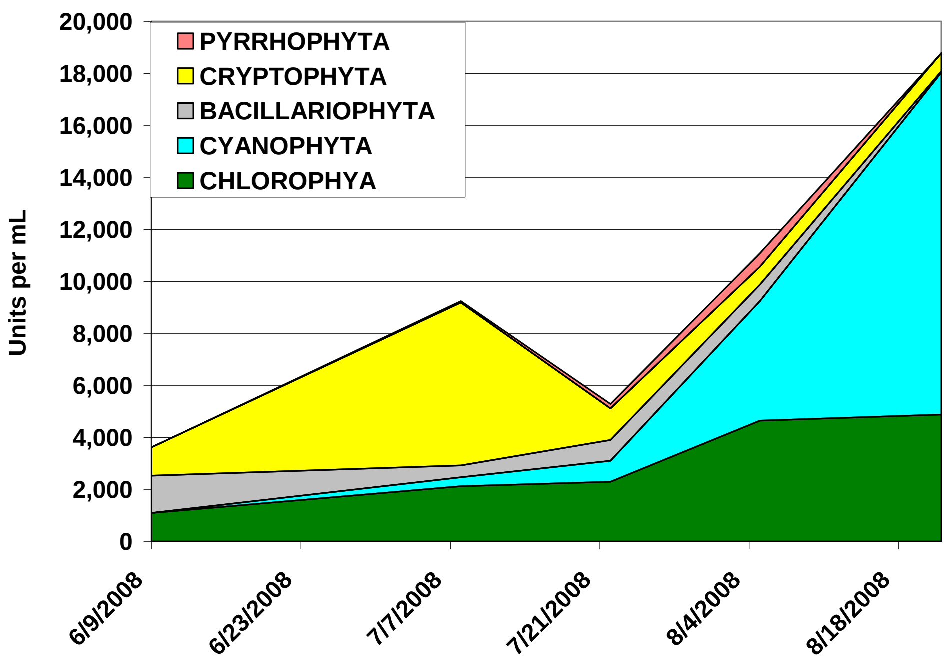

Figure 7 2008 Sweeney Lake (North Basin) Phytoplankton Data Summary by Division

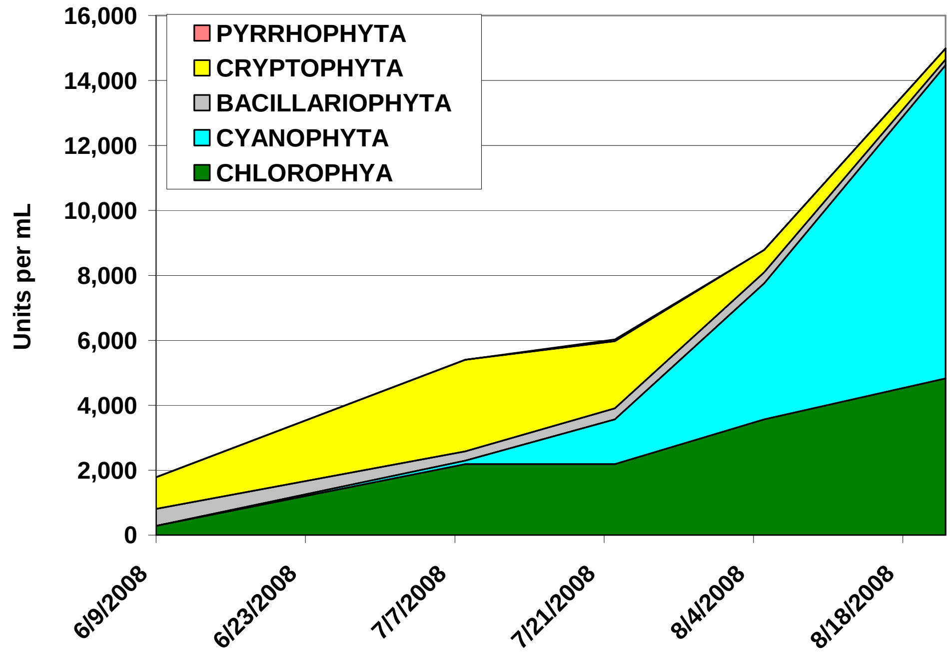

Figure 8 2008 Sweeney Lake (South Basin) Phytoplankton Data Summary by Division

3.7.2 Zooplankton

Zooplankton are microscopic animals that feed on particulate matter, including algae, and are, in turn eaten by fish. Healthy zooplankton communities are characterized by balanced densities (number per meter squared) of the three major groups of zooplankton: Cladocera, Copepods, and Rotifers. Fish predation, however, may alter community structure and reduce the numbers of larger bodied zooplankters (i.e., larger bodied Cladocera).

All three groups of zooplankton were well represented in Sweeney Lake during 2008 (see Figures 9 and 10). Large-bodied cladocerans were observed throughout the growing season at both the north and south sampling locations. Grazing by large-bodied cladocerans reduces the numbers of algae in the water and improves water transparency. The data indicate the lake has a healthy zooplankton community which supports the lake's fishery and exerts some control over the lake's algal community.

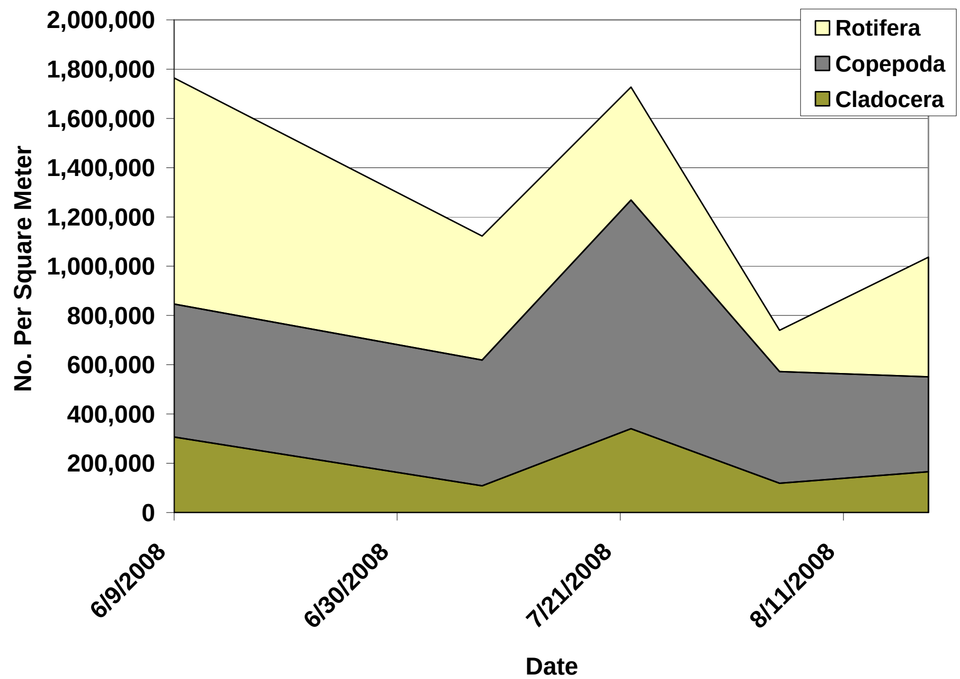

Figure 9 2008 Sweeney Lake (North Basin) Zooplankton Data Summary by Division

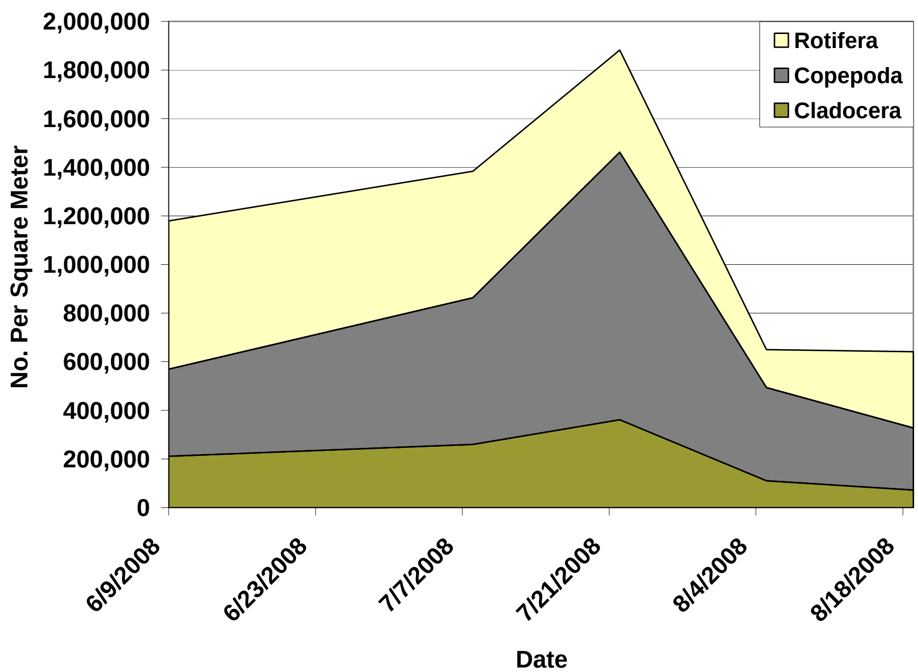

Figure 10 2008 Sweeney Lake (South Basin) Zooplankton Data Summary by Division

A comparison of 2005 and 2008 zooplankton indicates substantially higher numbers of zooplankton were observed in 2008 than 2005 (Figure 11). The highest number of zooplankton observed during 2008 in the South Basin (1,881,561 per square meter) was approximately double the highest number observed during 2005 (961,824 per square meter).

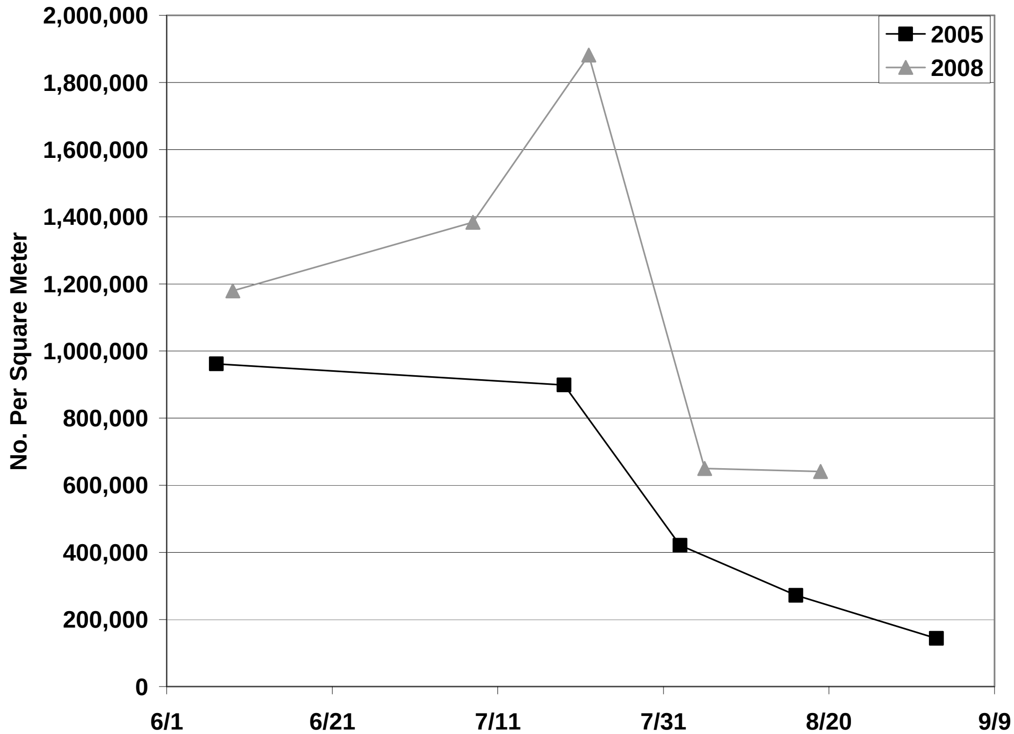

Figure 11 Comparison of 2005 and 2008 Zooplankton in Sweeney Lake (South Basin)

3.7.3 Macrophytes

Submerged vegetation was found throughout the lake's littoral (or shallow) zone in 2008. During June and August, a total of 17 species were found during each sample event (Figures 12 and 13). Submerged vegetation densities ranged from light to heavy.

Data from macrophyte surveys completed during June and August of 1996, 2000, 2005, and 2008 were compared. In all the surveys, a healthy, diverse plant community was found throughout the lake wherever the water depth was less than 6 to 13 feet. Improving water transparency has enabled plants to grow at increasing depths and to expand coverage within the lake. In 1996, plants grew to the 8 foot depth in early summer and to the 6 foot depth in late summer. In both 2000 and 2005, plants grew to the 10 foot depth. In 2008, plants grew to the 10 foot depth in June and to the 13 foot depth in August. A total of 12 to 18 individual species were observed during each plant survey, indicating the lake's plant community was stable and healthy. The density of individual species ranged from light to heavy.

The presence of two undesirable exotic (non-native) species, curlyleaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*), indicates regular assessment of the lake's plant community is warranted.

Curlyleaf pondweed was observed during the 1996, 2000, 2005, and 2008 June plant surveys. Coverage and densities were similar during the 4 surveys. Densities ranged from light to heavy. Although no change in plant coverage or density has been detected, the presence of curlyleaf pondweed in Sweeney Lake is of concern because it has the potential to degrade the lake's water quality. The plant begins growing in late August, grows throughout the winter at a slow rate, grows rapidly in the spring, and dies in early summer. Plant senescence then adds phosphorus to the lake, which may increase algal growth during the summer.

Purple loosestrife was first observed growing at the northeast end of the lake during August of 2005. During August 2008 it was observed growing in a single location along the northwest end of the lake during August. Although this plant is not currently causing a problem, the presence of purple loosestrife is of concern because this plant typically displaces native vegetation and becomes the sole emergent species. Purple loosestrife can be effectively managed through the use of leaf-eating beetles, which reduce plant growth and seed production by feeding on the leaves and new shoots. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife growth along Sweeney Lake's shoreline.

- No Macrophytes Found in Water > 9.0' to 10.0'
- Macrophyte Densities Estimated as Follows: 1 = light; 2 = moderate; 3 = heavy
- *Nymphaea tuberosa* (White waterlily) sporadic around entire lake perimeter

	Common Name	Scientific Name
Submerged Aquatic Plants:	Longleaf pondweed	*Potamogeton nodosus*
	Curlyleaf pondweed	*Potamogeton crispus*
	Floating leaf pondweed	*Potamogeton natans*
	Small pondweed	*Potamogeton pusillus*
	Flatstem pondweed	*Potamogeton zosteriformis*
	Sago pondweed	*Potamogeton pectinatus*
	Coontail	*Ceratophyllum demersum*
	Elodea	*Elodea canadensis*
	Muskgrass	*Chara sp.*
	Bushy pondweed and naiad	*Najas flexilis*
	Bushy pondweed and naiad	*Najas sp.*
	Water star grass	*Zosterella dubia*
Floating Leaf:	Spadderdock	*Nuphar variegata*
	Small yellow waterlily	*Nuphar microphyllum*
	White waterlily	*Nymphaea tuberosa*
Emergent:	Cattail	*Typha sp.*
	Bulrush	*Scirpus sp.*
No Aquatic Vegetation Found:		

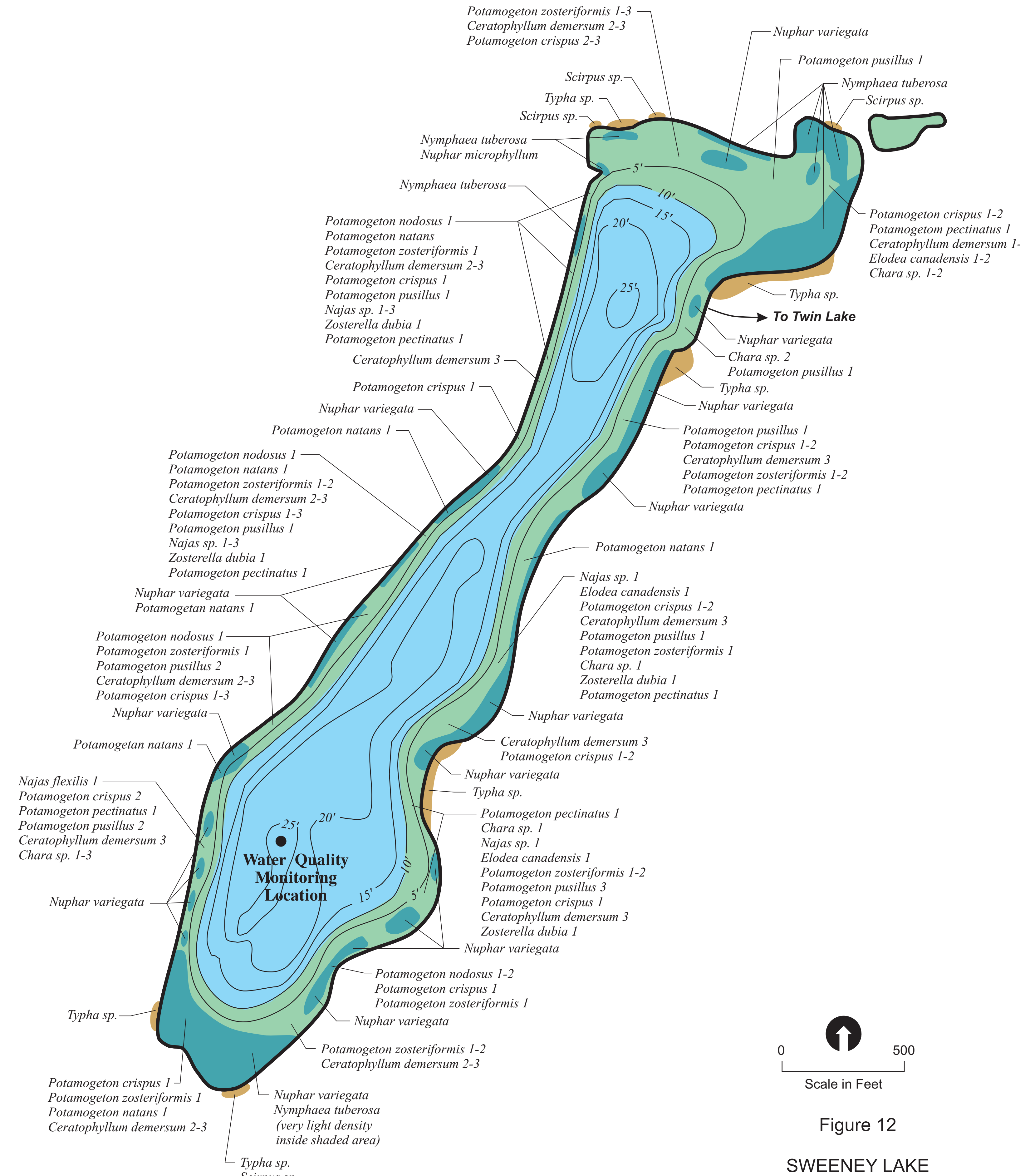

Figure 12

SWEENEY LAKE
MACROPHYTE SURVEY
JUNE 5, 2008

- No Macrophytes Found in Water > 12.0' to 13.0'
- Macrophyte Densities Estimated as Follows: 1 = light; 2 = moderate; 3 = heavy
- *Nymphaea tuberosa* (White waterlily) sporadic around entire lake perimeter

	Common Name	Scientific Name
Submerged Aquatic Plants:	Longleaf pondweed	*Potamogeton nodosus*
	Floating leaf pondweed	*Potamogeton natans*
	Small pondweed	*Potamogeton pusillus*
	Flatstem pondweed	*Potamogeton zosteriformis*
	Sago pondweed	*Potamogeton pectinatus*
	Coontail	*Ceratophyllum demersum*
	Elodea	*Elodea canadensis*
	Muskgrass	*Chara sp.*
	Bushy pondweed and naiad	*Najas flexilis*
	Bushy pondweed and naiad	*Najas sp.*
	Water star grass	*Zosterella dubia*
Floating Leaf:	Spadderdock	*Nuphar variegata*
	Small yellow waterlily	*Nuphar microphyllum*
	White waterlily	*Nymphaea tuberosa*
Emergent:	Cattail	*Typha sp.*
	Bulrush	*Scirpus sp.*
	Purple loosestrife	*Lythrum salicaria*
No Aquatic Vegetation Found:		

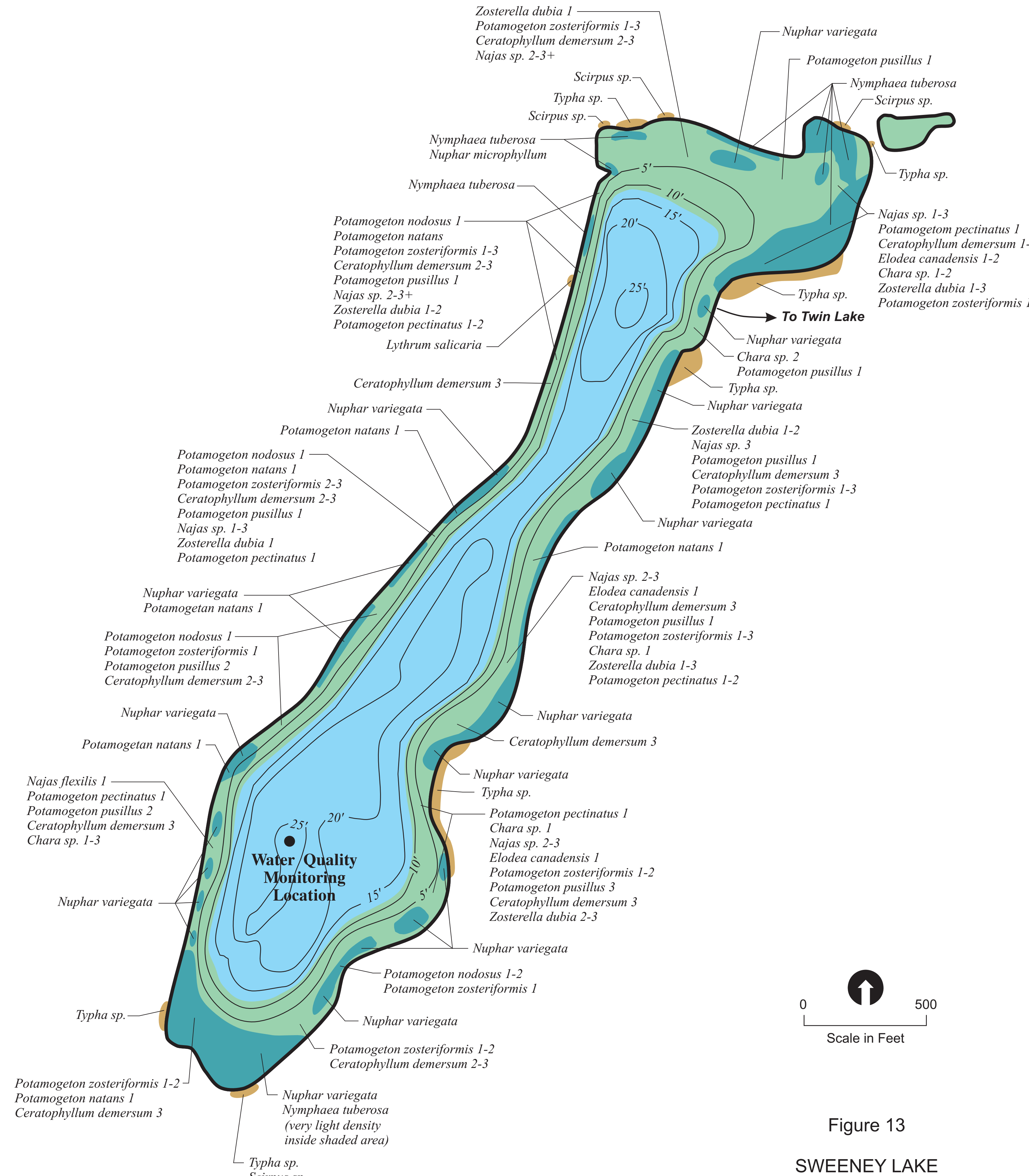

Figure 13

SWEENEY LAKE
MACROPHYTE SURVEY
AUGUST 12, 2008

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3.8 Conclusions

- Water quality status of Sweeney Lake was mesotrophic (moderate nutrients and good water quality) although the summer average phosphorus concentration was mildly eutrophic (nutrient rich and poor water quality) during the 2008 growing season.

- Vegetation (submerged and floating leaf) was found throughout the lake’s littoral (shallow) zone to depths of 10 feet during June and 13 feet during August.

- Because two undesirable non-native species, curlyleaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*), were observed during both 2005 and 2008, regular assessment of the lake’s plant community is warranted. Should curlyleaf pondweed expand in coverage or increase in density, management may be necessary. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife growth along Sweeney Lake’s shoreline.

- Sweeney Lake water quality has improved when compared to 2007 and 2005 because chlorophyll *a* and total phosphorus have decreased while Secchi depth has increased, and water quality is the best since monitoring began in 1972.

- Despite improvements, Sweeney Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L), although the 2008 average summer concentration (32 µg/L) was very close to the goal (within 2 µg/L). Chlorophyll *a* (average summer concentration not to exceed 10 µg/L) and Secchi disc transparency (average summer depth of at least 2.2 meters) goals were met in 2008.

- In 2008, Sweeney Lake water quality met the state standard.

- Phosphorus buildup in the lake’s bottom waters during 2008 resulted from internal loading. Because the aeration system was not in operation during 2008, lake mixing did not occur and the phosphorus pool was trapped in the lake’s bottom waters during the summer.

- A comparison of 2005 and 2008 water quality data indicate the lake's aeration system causes mixing of the phosphorus from the lake's bottom waters into the surface waters.

- Because phosphorus from internal loading mixes during the fall and spring mixing events, this phosphorus contributes to the lake's annual phosphorus load which affects the lake's water quality during the subsequent growing season. The TMDL study that is underway should evaluate options to minimize internal loading and its impact upon the lake's spring and summer water quality.

3.9 Recommendations

To further evaluate the changes in lake water quality observed during 2008, it is recommended that the lake be monitored without the operation of the aeration system during 2009. Samples would be collected prior to ice-out and throughout the growing season.

4.0 Twin Lake

4.1 Site Description

Twin Lake (Golden Valley, Hennepin County) has a water surface area of approximately 21 acres (8.5 hectares), a maximum depth of 54.5 feet (16.6 meters), and a mean depth of 25.7 feet (7.8 meters). The lake has a small watershed and during periods of high water it connects to Sweeney Lake via a meandering channel that runs through a wetland. The northern half of the lake is surrounded by the wooded Hidden Lakes residential development. The southern half of the lake is surrounded by Minneapolis Park and Recreation Board property and consists of wooded brush areas including a marsh at the southern end of the lake. The lake is used for all recreational activities, including swimming.

4.2 Goal

The BCWMC's goal for Twin Lake is a management classification of Level I, meaning its water quality should support all water-based recreational activities including swimming, scuba diving, and snorkeling. Level I goals are (1) maximum total phosphorus concentration of 30 µg/L, (2) maximum chlorophyll *a* concentration of 10 µg/L, and (3) minimum Secchi disc transparency of 2.2 meters (about 7 feet) (Barr 2004).

4.3 State 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 the water and still allow it to meet designated uses, such as drinking water, 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 state water quality standards applicable to Twin Lake are (1) maximum total phosphorus concentration of 40 µg/L, (2) maximum chlorophyll *a* concentration of 14 µg/L, and (3) minimum Secchi disc transparency of 1.4 meters (Minn. R. Ch. 7050.0222 Subp. 3).

4.4 Watershed and Lake Management Plan

The Twin Lake Watershed and Lake Management Plan was completed in June 2000 by the BCWMC. Because Twin Lake had previously met Level I water quality goals and watershed modeling indicated only modest improvements could be made with structural BMPs, emphasis for management was placed on using general watershed BMPs. One site-specific structural best management practice was recommended: the expansion of a pond in a low area on the south side of the railroad within the railroad right-of-way. The pond expansion would provide additional storage for water quality treatment. The BCMWC's 10-year capital improvement program (CIP) currently includes this pond expansion project.

4.5 Water Quality Data

Twin Lake was sampled at the deepest point six times during the 2008 growing season. Water quality data collected for Twin Lake are summarized in Appendix A, and include:

- Vertical profiles of temperature, dissolved oxygen concentration, specific conductivity, and pH
- 0-2 m composite samples analyzed for chlorophyll *a*, total phosphorus, soluble reactive phosphorus, and total nitrogen
- Total phosphorus at mid depth and near bottom
- Secchi disc transparency

3.5.1 Temperature

Vertical profiles of temperature collected during 2008 show that the lake was strongly stratified throughout the 2008 growing season (Appendix D).

3.5.2 Dissolved Oxygen

Vertical profiles of dissolved oxygen collected during 2008 show that lake stratification impacted the lake's oxygen concentrations. Waters above the lake's thermocline (warmer surface waters) were well oxygenated throughout the growing season. Waters below the lake's thermocline (cooler bottom waters) contained low oxygen concentrations. Dissolved oxygen concentrations were generally less than 1 mg/L at depths greater than 4 to 6 meters throughout the growing season (Appendix D). Panfish and gamefish species within the lake require dissolved oxygen concentrations of 5 mg/L or greater. Therefore they would have been unable to live in the lake's deeper waters for most of the growing season. High total phosphorus concentrations near the sediment surface were also detected during this period indicating internal loading of phosphorus due to oxygen depletion. The cause of the oxygen depletion below the thermocline is due to microbial degradation of organic material from settled algal material and stormwater inputs.

3.5.3 Total Phosphorus, Chlorophyll *a,* and Secchi Depth

Surface total phosphorus concentrations are graphically summarized in Figure 14. Twin Lake exhibited poor water quality in 2008 and its summer average total phosphorus concentration (0-2 m composite sample) was about 37 percent higher than Sweeney Lake for the same period. The 2008 Twin Lake surface total phosphorus concentration ranged from a high of 71.4 µg/L (early June) to a low of 27.9 µg/L (August) and averaged 43.7 µg/L during the summer.

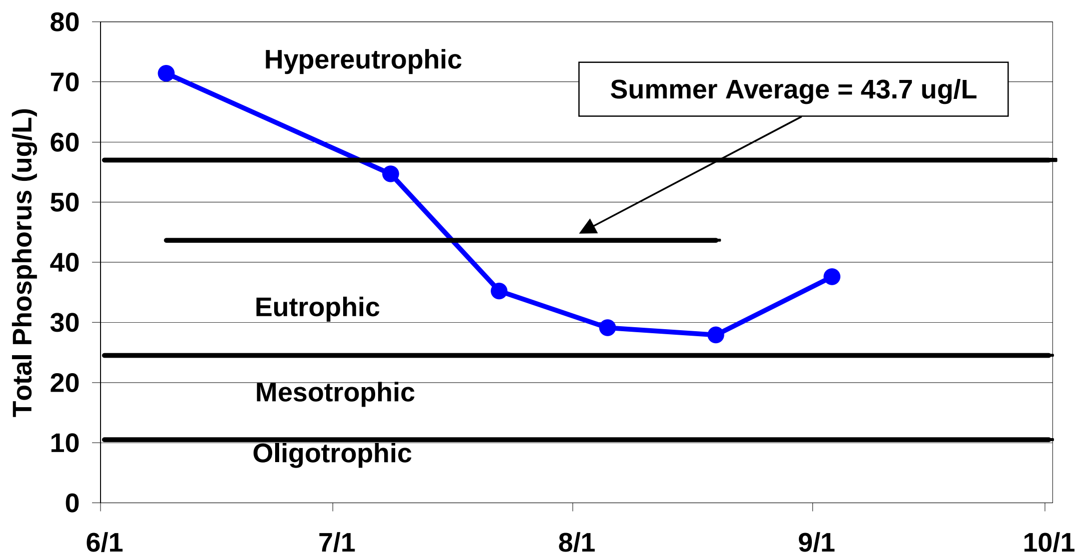

Figure 14 2008 Twin Lake Total Phosphorus Concentration

The lake's surface phosphorus concentration generally declined throughout the growing season. However, the lake's high phosphorus concentration during the early summer caused the lake's water quality to remain poor throughout the summer. The lake's phosphorus concentration in early June was within the hypereutrophic or extremely nutrient rich, extremely poor water quality category. Steady declines in phosphorus reduced the lake's concentration to the eutrophic or nutrient rich or poor water quality category by late summer. As shown in Figure 15, the early June phosphorus concentration during 2008 was substantially higher than early June phosphorus concentrations observed during 2000 and 2005.

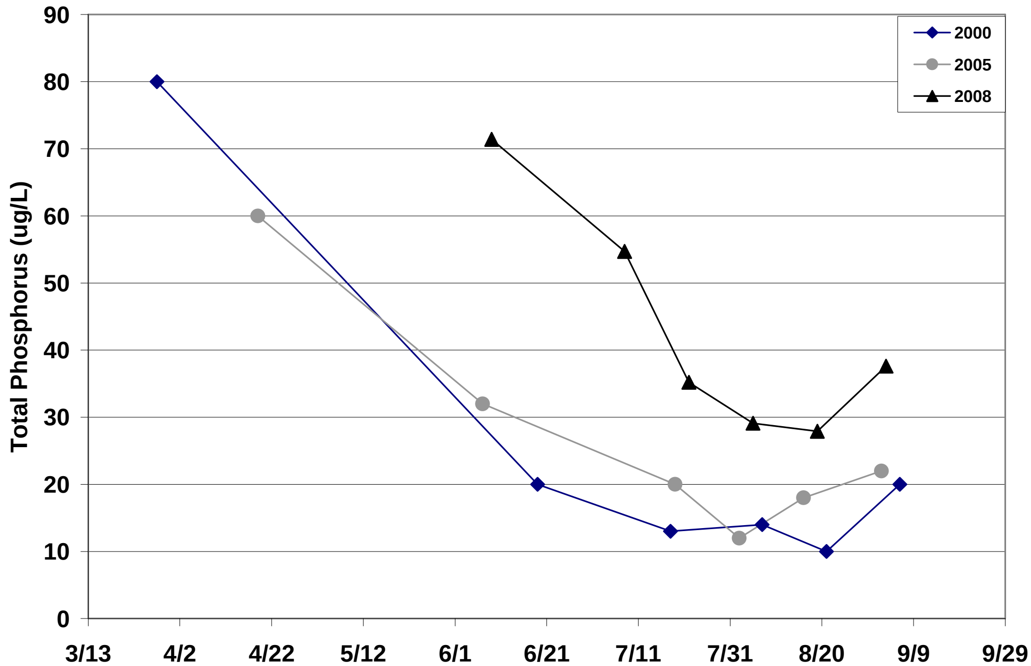

Figure 15 Comparison of 2000, 2005, and 2008 Twin Lake Surface Total Phosphorus Concentrations

The cause of the high phosphorus concentrations in 2008 is unknown and further study is recommended. Because internal loading occurred throughout the 2008 growing season (Figure 16), it is likely that internal loading also occurs during the winter period. Internal loading during the winter period may have resulted in elevated phosphorus concentrations following the spring mixing event. A late ice-out during 2008 may have further contributed to the lake's water quality degradation because the internal loading period was longer and higher phosphorus loads from winter internal loading likely occurred in 2008.

To determine the cause of the high phosphorus concentration in Twin Lake, additional monitoring is recommended to determine changes in the lake's phosphorus concentrations before and after ice-out. Specifically, it is recommended that samples be collected prior to ice-out and that samples be collected throughout the growing season. In addition, lake level monitoring of both Sweeney Lake and Twin Lake is recommended immediately after ice-out to rule out the possibility that Sweeney flows into Twin during periods of high water levels such as following spring snowmelt.

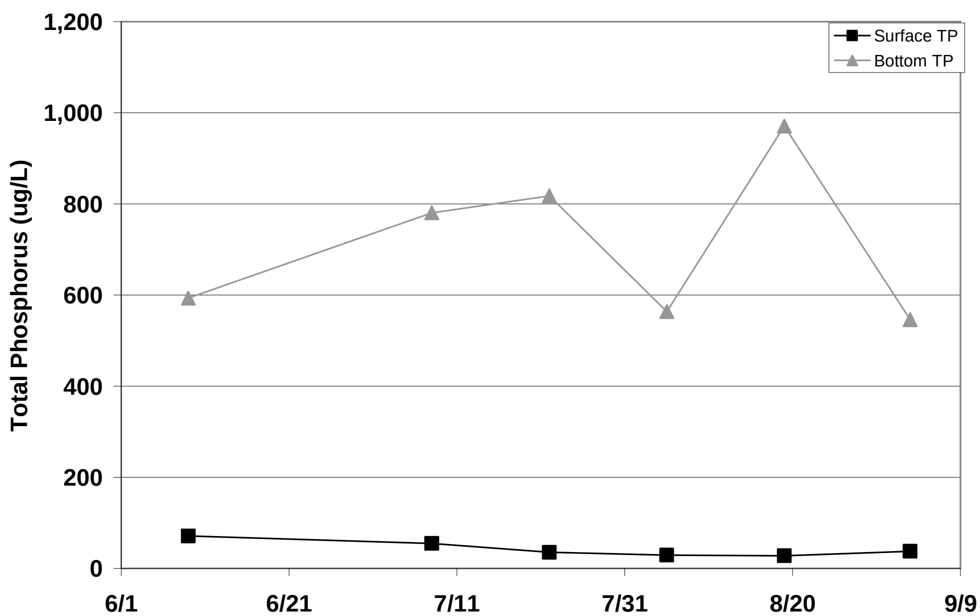

Figure 16 Twin Lake 2008 Surface and Bottom Total Phosphorus Concentration

In 2008, the Twin Lake summer average chlorophyll *a* concentration (6.7 µg/L) was higher than the Sweeney Lake summer average concentration (5.8 µg/L). Twin Lake concentrations ranged from a low of 1.8 µg/L in August to a high of 18.0 µg/L in September (Figure 17). The summer average chlorophyll *a* concentration (6.7 µg/L) is the highest concentration of chlorophyll *a* yet recorded in Twin Lake, compared to the second-highest peak of 5.7 µg/L in 1977, and substantially greater than the 3.6 µg/L recorded in 2005.

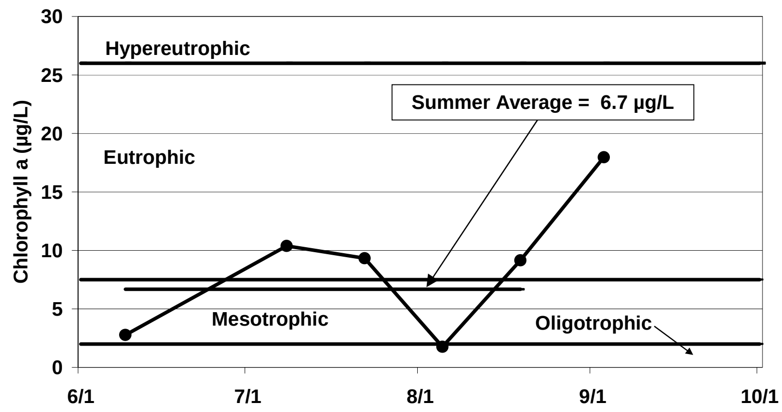

Figure 17 2008 Twin Lake Chlorophyll *a* Concentration

In 2008, Twin Lake Secchi disc transparency ranged from a high of 4.3 meters in early June to a low of 1.0 meters in August (Figure 18). The lake's average summer Secchi disc transparency was 2.0 meters, over one meter less than any other summer average since 1972 and 1.7 meters less than the 2005 summer average.

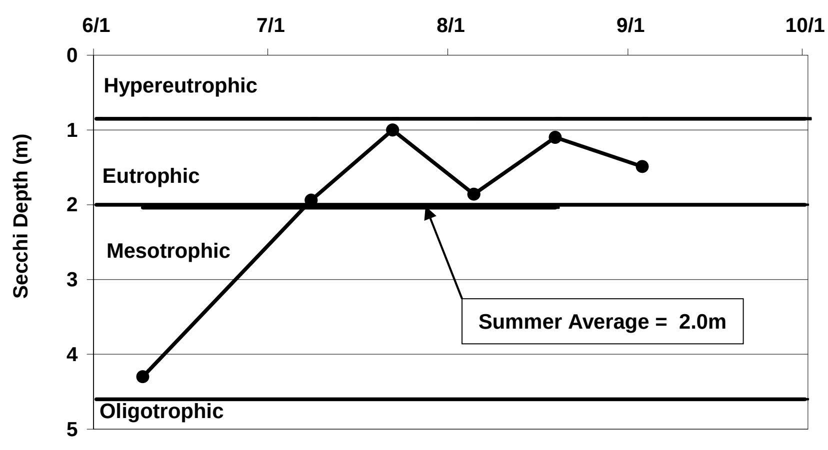

Figure 18 2008 Twin Lake Secchi Depth

The summer average of total phosphorus indicates that Twin Lake is in the eutrophic category, while the summer average chlorophyll *a* concentration and Secchi disc transparency are within the upper limits of the mesotrophic classification. With the exception of the June measurement, 2008 Secchi disc data points are in the eutrophic category.

In 2008, Twin Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L) or Secchi disc transparency (average summer depth of at least 2.2 meters). The lake's average summer total phosphorus concentration was 44 µg/L and Secchi disc transparency was 2.0 meters. The lake's average summer chlorophyll *a* concentration of 6.7 µg/L, however, met the BCWMC Level I water quality goal (average summer concentration not to exceed 10 µg/L).

In 2008, Twin Lake did not meet the state standard for water quality. The lake's average summer total phosphorus concentration (44 µg/L) exceeded the state maximum of 40 µg/L. However, the lake's average summer chlorophyll *a* (6.7 µg/L) and Secchi disc transparency (2.0 meters) met the state standard (chlorophyll *a* maximum of 14 µg/L and Secchi disc minimum of 1.4 meters).

4.6 Historical Trends

Historical data indicate an improvement in water quality between 1982 and 1992 after which it remained relatively constant from 1992 to 2005. However all three nutrient-related parameters indicate that water quality has decreased greatly between 2005 and 2008 and is at or near the poorest water quality observed since monitoring began (Figure 19).

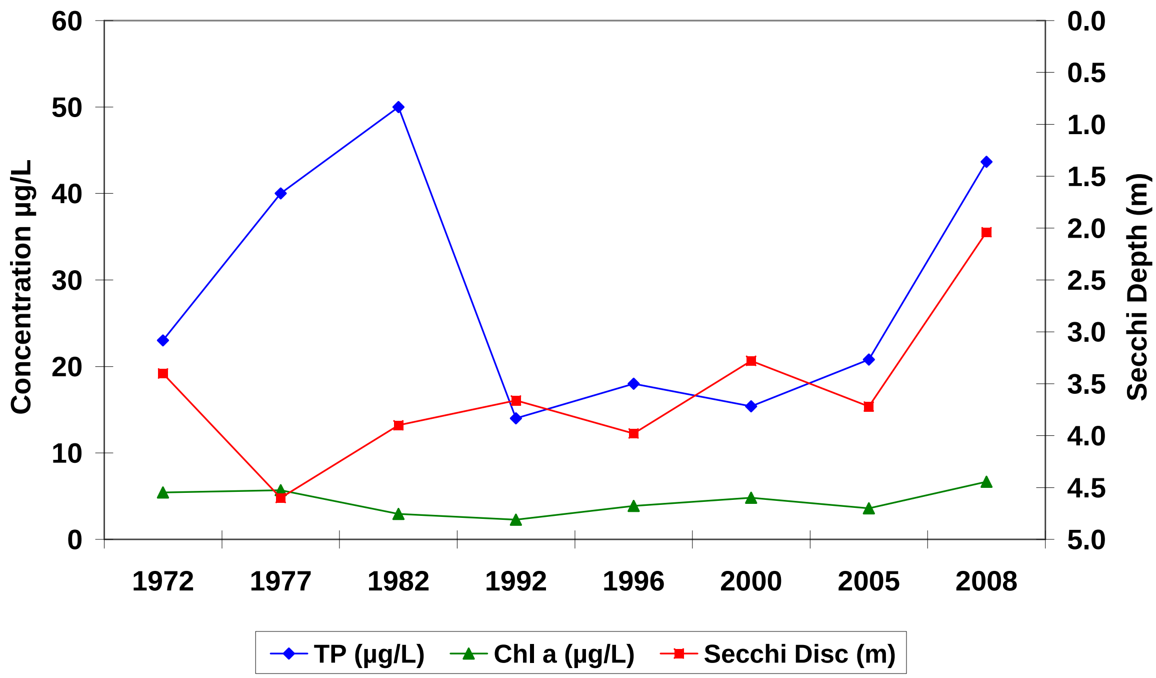

Figure 19 Historical Water Quality Data in Twin Lake

4.7 Biota

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

4.7.1 Phytoplankton

Phytoplankton, also called algae, are single celled aquatic plants naturally present in lakes. They derive energy from sunlight (through photosynthesis) and from 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.

The lake's diverse algal community was comprised of six major algal groups (i.e., chlorophyta or green algae, cyanophyta or blue-green algae, chrysophyta or golden-brown algae, bacillariophyta or diatoms, pyrrophyta or dinoflagellates, and cryptophyta or cryptomonads). Green algae, cryptomonds, and blue-green algae dominated the early summer community while blue green algae were predominant during the late summer. The number of phytoplankton tripled from early June through early July, tripled again from early to late July, and then remained relatively constant for the rest of the summer (Figure 20). 2008 noted substantially higher numbers of phytoplankton during the late summer as compared with 2000 and 2005 (Figure 21). The data substantiate the water quality degradation indicated by increases in phosphorus and chlorophyll *a* concentrations and reduced Secchi disc transparency.

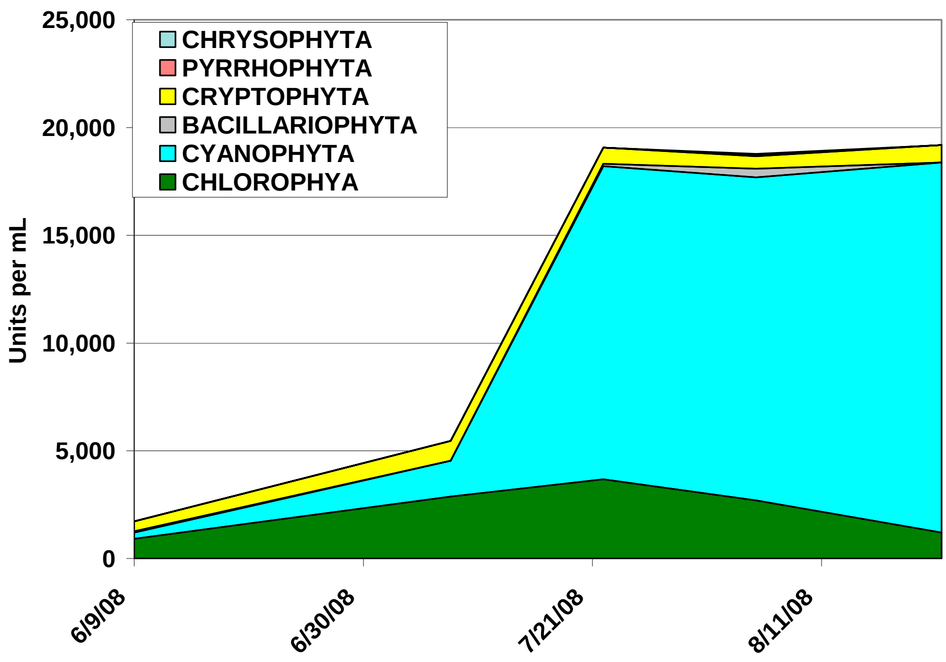

Figure 20 2008 Twin Lake Phytoplankton Data Summary by Division

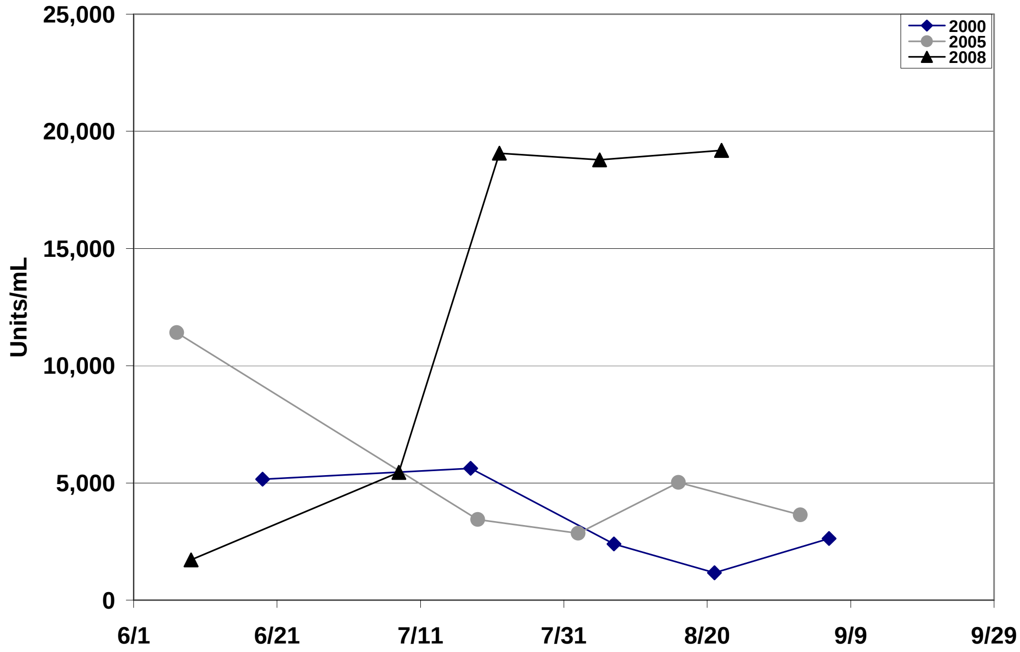

Figure 21 Comparison of 2000, 2005, and 2008 Twin Lake Phytoplankton

4.7.2 Zooplankton

Zooplankton are microscopic animals that feed on particulate matter, including algae, and are, in turn eaten by fish. Healthy zooplankton communities are characterized by balanced densities (number per meter squared) of the three major groups of zooplankton: Cladocera, Copepods, and Rotifers. Fish predation, however, may alter community structure and reduce the numbers of larger bodied zooplankters (i.e., larger bodied Cladocera).

All three groups of zooplankton were well represented in Twin Lake during 2008 (Figure 22). Large numbers of large-bodied zooplankton were observed during early June. Grazing by large-bodied cladocerans reduces the numbers of algae in the water and improves water transparency. The data indicate the lake has a healthy zooplankton community which supports the lake's fishery and exerted some control over the lake's algal community.

A substantial decline in large-bodied zooplankters occurred from early June to early July. The reduced control by zooplankton during this period corresponded with a tripling of the number of phytoplankton in the lake despite declining phosphorus concentrations.

Chlorophyll *a* concentrations also increased and Secchi disc transparency decreased during this period.

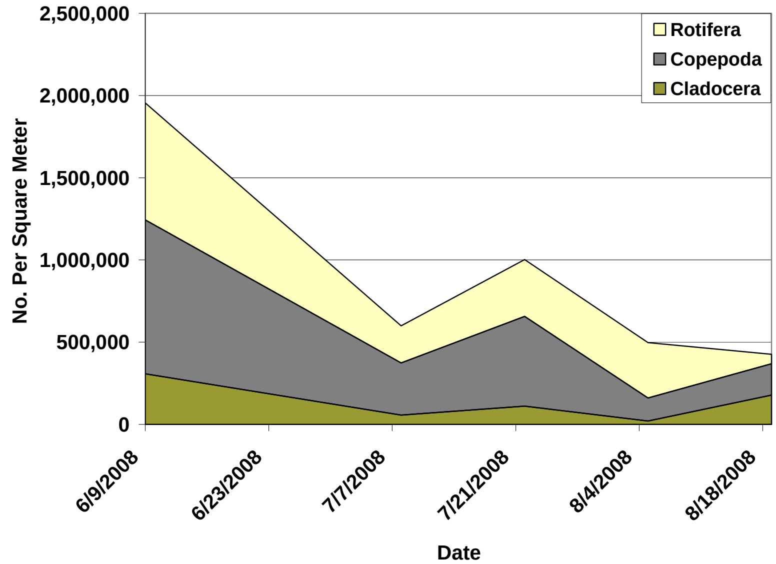

Figure 22 2008 Twin Lake Zooplankton Data Summary by Division

A comparison of 2000, 2005, and 2008 zooplankton indicates substantially higher numbers of zooplankton were observed during June of 2008 than were observed in June of 2000 and 2005 (Figure 23). Declines in zooplankton during June and July of 2008 resulted in similar numbers of zooplankton during August as were observed during August of 2000 and 2005.

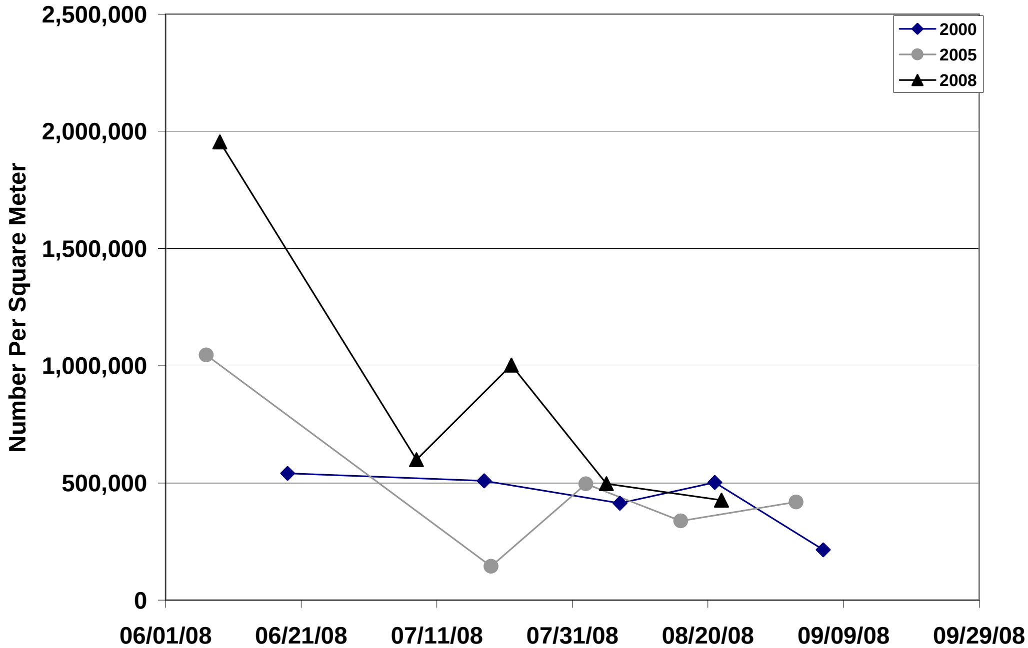

Figure 23 Comparison of 2000, 2005, and 2008 Twin Lake Zooplankton

4.7.3 Macrophytes

Submerged vegetation was found throughout the lake's littoral (or shallow) zone in 2008. A total of 21 species were found during June and 22 species during August (Figures 24 and 25). Submerged vegetation densities ranged from light to heavy.

Data from macrophyte surveys completed during June and August of 1996, 2000, 2005, and 2008 were compared. In all the surveys, a healthy, diverse plant community was found throughout the lake wherever the water depth was less than 10 to 16 feet. A larger number of plant species was observed in 2008 (21 to 22) than during 1996 through 2005 (15 to 19).

The presence of two undesirable exotic (non-native) species, curlyleaf pondweed (*Potamogeton crispus*) and purple loosestrife (*Lythrum salicaria*), indicates regular assessment of the lake's plant community is warranted.

Curlyleaf pondweed was observed in light density along the northeastern shore during June of 2000, was not observed during 2005, and was observed in light density at a single location along the southeastern shore during August of 2008.

Purple loosestrife was first observed growing along the south shoreline during 2000 and has been observed at this same location during 2005 and 2008. Although no increase in coverage has been observed, the presence of purple loosestrife is of concern because this plant typically displaces native vegetation and becomes the sole emergent species. Purple loosestrife can be effectively managed through the use of leaf-eating beetles, which reduce plant growth and seed production by feeding on the leaves and new shoots. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife growth along Twin Lake's south shoreline

- No Macrophytes Found in Water > 8' - 11' Rooted, 13' - 16' *Ceratophyllum demersum* (Coontail)
- Macrophyte Densities Estimated as Follows: 1 = light; 2 = moderate; 3 = heavy, 3+ extremely dense

	Common Name	Scientific Name
Submerged Aquatic Plants:	Longleaf pondweed	*Potamogeton nodosus*
	Floating leaf pondweed	*Potamogeton natans*
	Illinois pondweed	*Potamogeton illinoensis*
	Bladder wort	*Utricularia sp.*
	Narrowleaf pondweed	*Potamogeton sp. (narrowleaf)*
	Grassy pondweed	*Potamogeton gramineus*
	Flatstem pondweed	*Potamogeton zosteriformis*
	Large leaf pondweed	*Potamogeton amplifolius*
	Sago pondweed	*Potamogeton pectinatus*
	Northern milfoil	*Myriophyllum sibiricum*
	Coontail	*Ceratophyllum demersum*
	Elodea	*Elodea canadensis*
	Muskgrass	*Chara sp.*
	Bushy pondweed and naiad	*Najas sp.*
	Water star grass	*Zosterella dubia*
	Bladderwort	*Utricularia sp.*
Floating Leaf:	Spadderdock	*Nuphar variegata*
	White waterlily	*Nymphaea tuberosa*
Emergent:	Bulrush	*Scirpus sp.*
	Cattail	*Typha sp.*
	Purple loosestrife	*Lythrum salicaria*
No Aquatic Vegetation Found:		

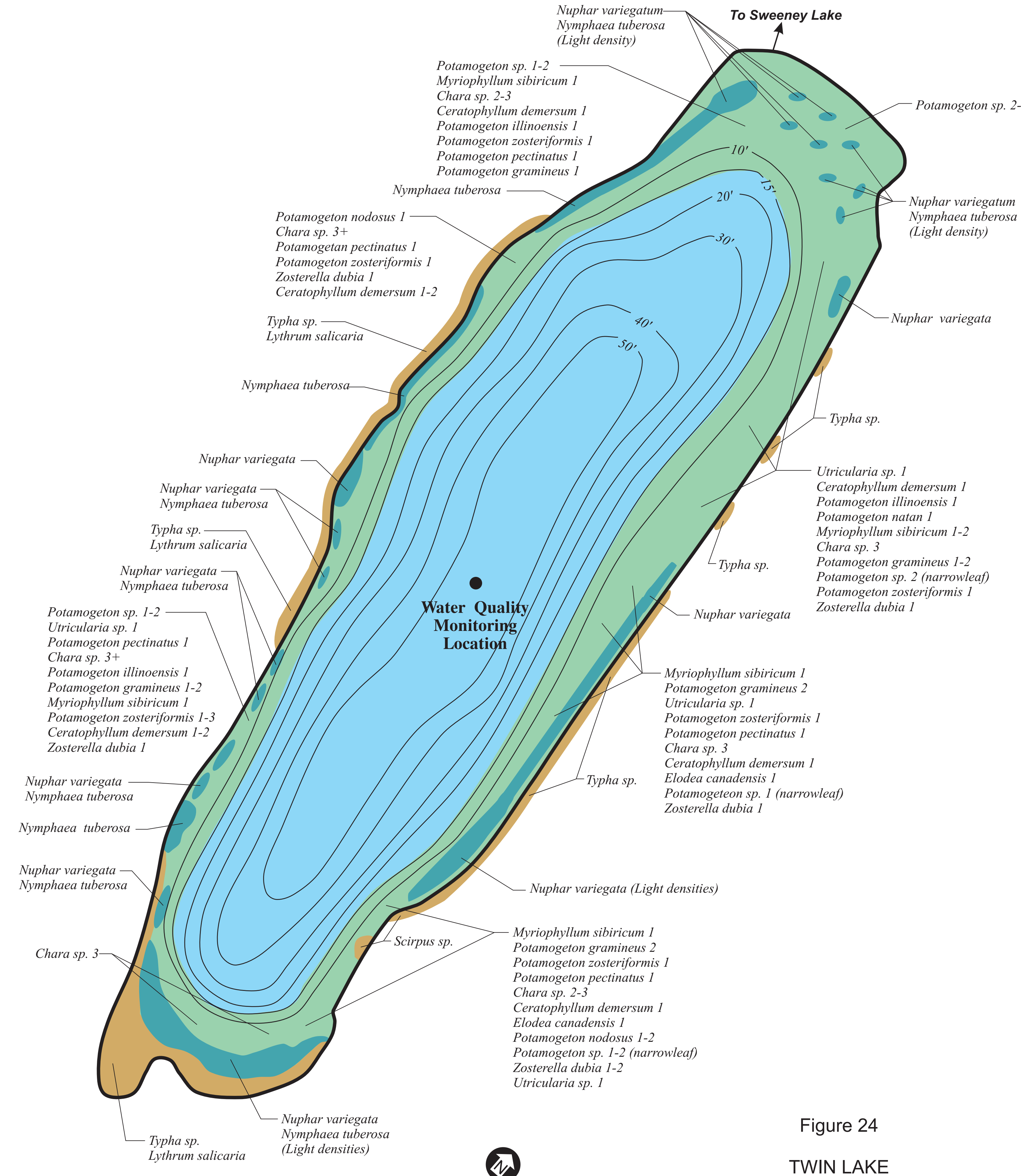

Figure 24

TWIN LAKE
MACROPHYTE SURVEY
JUNE 5, 2008

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- No Macrophytes Found in Water > 8' - 11' Rooted, 13' - 16' *Ceratophyllum demersum* (Coontail)
- Macrophyte Densities Estimated as Follows: 1 = light; 2 = moderate; 3 = heavy, 3+ extremely dense

	Common Name	Scientific Name
Submerged Aquatic Plants:	Curlyleaf pondweed	*Potamogeton crispus*
	Longleaf pondweed	*Potamogeton nodosus*
	Floating leaf pondweed	*Potamogeton natans*
	Illinois pondweed	*Potamogeton illinoensis*
	Bladder wort	*Utricularia sp.*
	Narrowleaf pondweed	*Potamogeton sp. (narrowleaf)*
	Grassy pondweed	*Potamogeton gramineus*
	Flatstem pondweed	*Potamogeton zosteriformis*
	Large leaf pondweed	*Potamogeton amplifolius*
	Sago pondweed	*Potamogeton pectinatus*
	Northern milfoil	*Myriophyllum sibiricum*
	Coontail	*Ceratophyllum demersum*
	Elodea	*Elodea canadensis*
	Muskgrass	*Chara sp.*
	Bushy pondweed and naiad	*Najas sp.*
	Water star grass	*Zosterella dubia*
	Bladderwort	*Utricularia sp.*
Floating Leaf:	Spadderdock	*Nuphar variegata*
	White waterlily	*Nymphaea tuberosa*
Emergent:	Bulrush	*Scirpus sp.*
	Cattail	*Typha sp.*
	Purple loosestrife	*Lythrum salicaria*
No Aquatic Vegetation Found:		

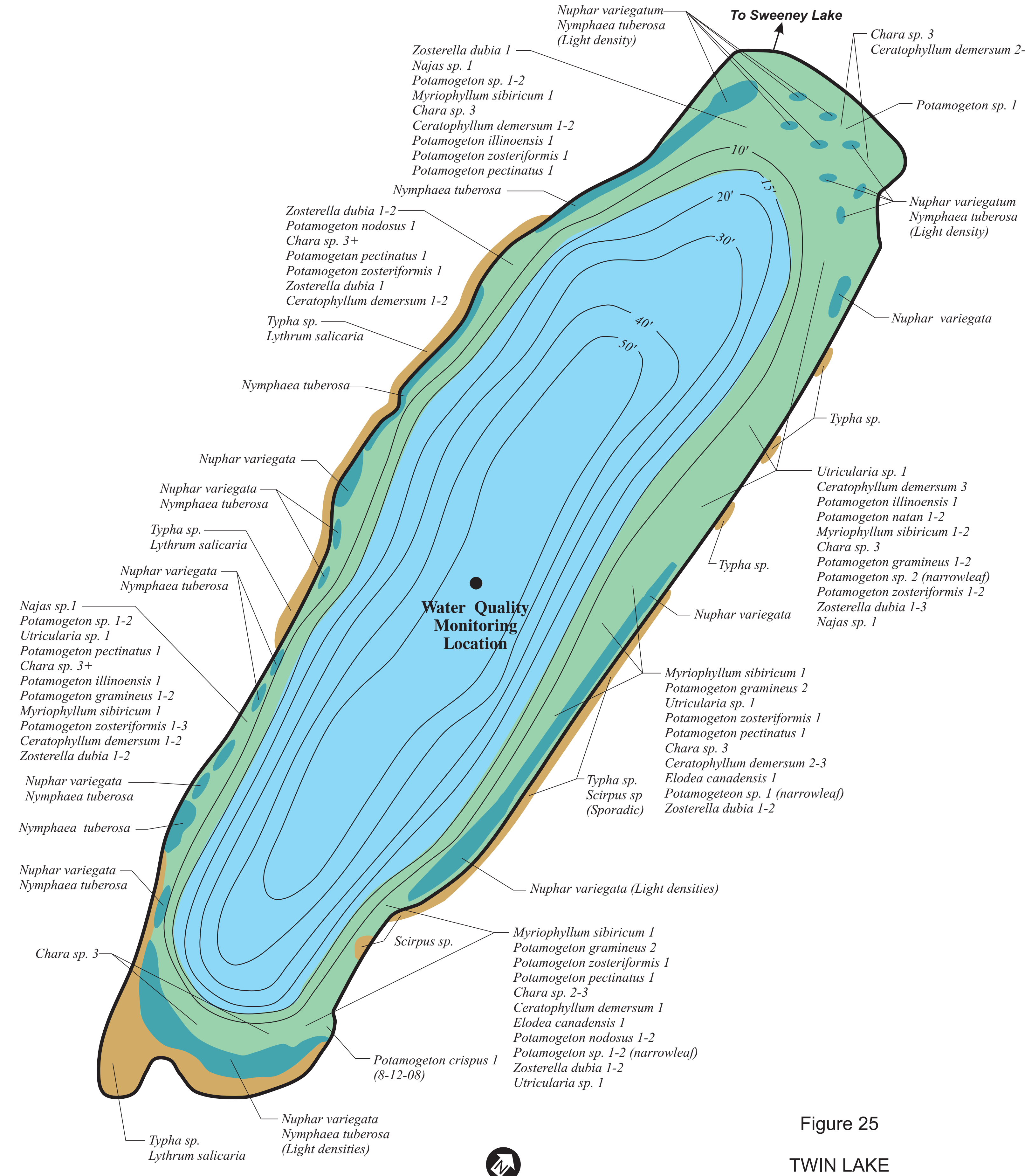

Figure 25

TWIN LAKE MACROPHYTE SURVEY AUGUST 12, 2008

P:\Mpls\23 MN\27\2327051\MovedFromMpls_P\LakeMacrophyteMaps\Twin\2008 Maps\Twin Lake August 2008.CDR RLG 01-28-09

4.8 Conclusions

- The summer average total phosphorus concentration indicates that Twin Lake is in the eutrophic category, while the summer average chlorophyll *a* concentration and Secchi disc transparency are within the upper limits of the mesotrophic classification. With the exception of the June measurement, 2008 Secchi disc data points are in the eutrophic category.

- In 2008, Twin Lake did not meet the BCWMC Level I water quality goal for total phosphorus (average summer concentration not to exceed 30 µg/L) or Secchi disc transparency (average summer depth of at least 2.2 meters). The lake's average summer total phosphorus concentration was 44 µg/L and Secchi disc transparency was 2.0 meters. The lake's average summer chlorophyll *a* concentration of 6.7 µg/L, however, met the BCWMC Level I water quality goal (average summer concentration not to exceed 10 µg/L).

- In 2008, Twin Lake did not meet the state standard for water quality. The lake's average summer total phosphorus concentration (44 µg/L) exceeded the state standard (maximum of 40 µg/L). However, the lake's average summer chlorophyll *a* (6.7 µg/L) and Secchi disc transparency (2.0 meters) both met the state standard (chlorophyll *a* maximum of 14 µg/L and Secchi disc minimum of 1.4 meters).

- Historical data indicate an improvement in water quality between 1982 and 1992 after which it remained relatively constant from 1992 to 2005. However all three nutrient-related parameters indicate that water quality has decreased greatly between 2005 and 2008 and is at or near the poorest water quality observed since monitoring began.

- 2008 noted substantially higher numbers of phytoplankton during the late summer as compared with 2000 and 2005.

- A substantial decline in large-bodied zooplankters occurred from early June to early July of 2008. The reduced control by zooplankton during this period corresponded with a tripling of the number of phytoplankton in the lake despite declining phosphorus concentrations.

- A comparison of 2000, 2005, and 2008 zooplankton indicates substantially higher numbers of zooplankton were observed during June of 2008 than were observed in

June of 2000 and 2005. Declines in zooplankton during June and July of 2008 resulted in similar numbers of zooplankton during August as were observed during August of 2000 and 2005.

- A larger number of plant species was observed in 2008 (21 to 22) than during 1996 through 2005 (15 to 19).

- Curlyleaf pondweed was observed in light density along the northeastern shore during June of 2000, was not observed during 2005, and was observed in light density at a single location along the southeastern shore during August of 2008. The August growth would be a new growth from turions (seeds) since the plant's growth cycle begins in late summer, continues through the winter, and concludes in late June each year.

- Purple loosestrife was first observed growing along the south shoreline during 2000 and has been observed at this same location during 2005 and 2008. Although no increase in coverage has been observed, the presence of purple loosestrife is of concern because this plant typically displaces native vegetation and becomes the sole emergent species. It is recommended that the BCWMC work with the Minnesota Department of Natural Resources (MDNR) to manage purple loosestrife growth along Twin Lake's south shoreline.

4.9 Recommendations

To determine the cause of the high phosphorus concentration in Twin Lake, additional monitoring is recommended to determine changes in the lake's phosphorus concentrations before and after ice-out. Specifically, it is recommended that samples be collected prior to ice-out and that samples be collected throughout the growing season. In addition, lake level monitoring of both Sweeney Lake and Twin Lake is recommended immediately after ice-out to rule out the possibility that Sweeney flows into Twin during periods of high water levels such as following spring snowmelt.

5.0 References

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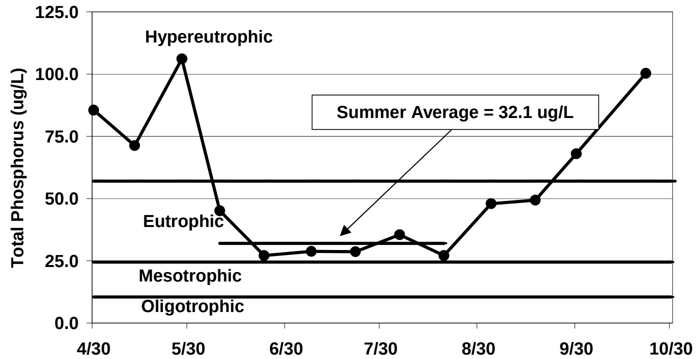
Osgood, R., A. 1989a. An evaluation of Lake and Stream Monitoring Programs in the Twin Cities Metropolitan Area. Metropolitan Council Publication No. 590-89-128.

Osgood, R., A. 1989b. 1989 Study of the Water Quality of 20 Metropolitan Area Lakes. Metropolitan Council Publication No. 590-89-130.

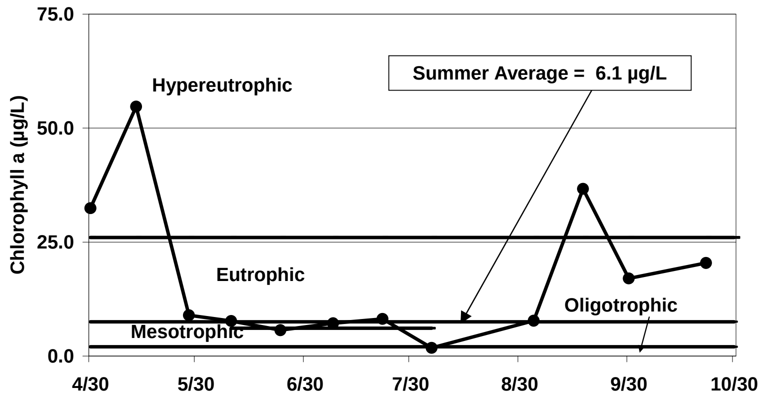
Appendix A

2008 Sweeney Lake Data

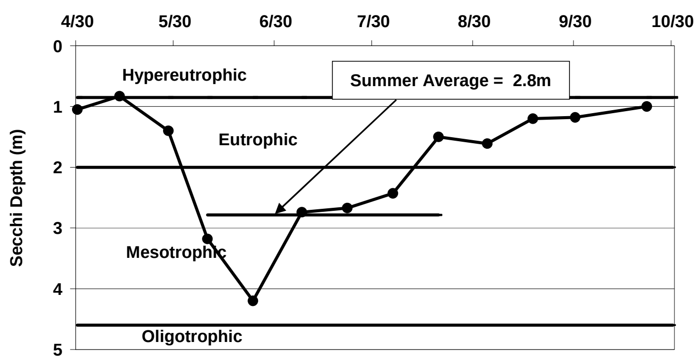
Sweeney Lake (North Basin)
2008 Total Phosphorus Concentration



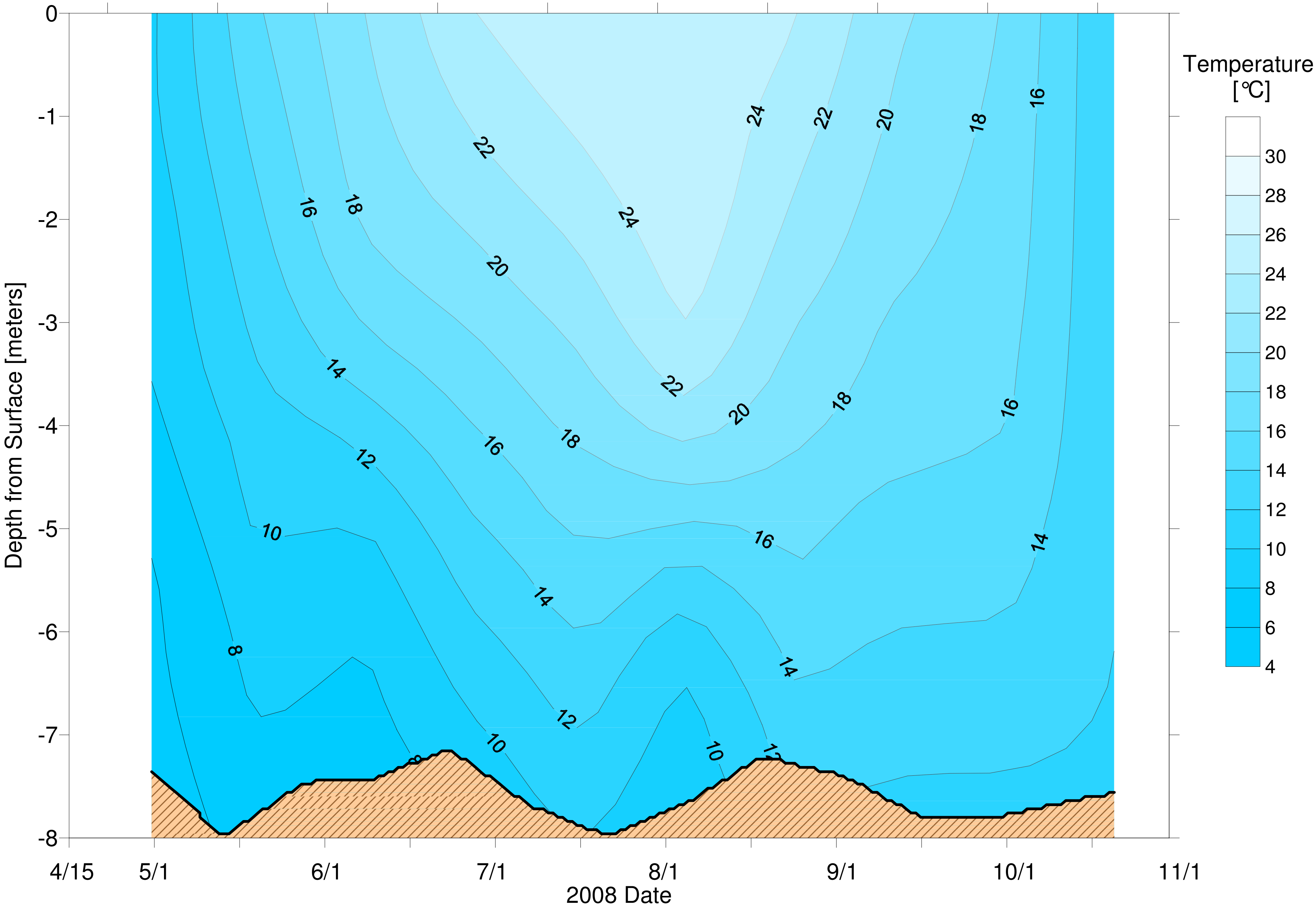
Sweeney Lake (North Basin)
2008 Chlorophyll *a* Concentration

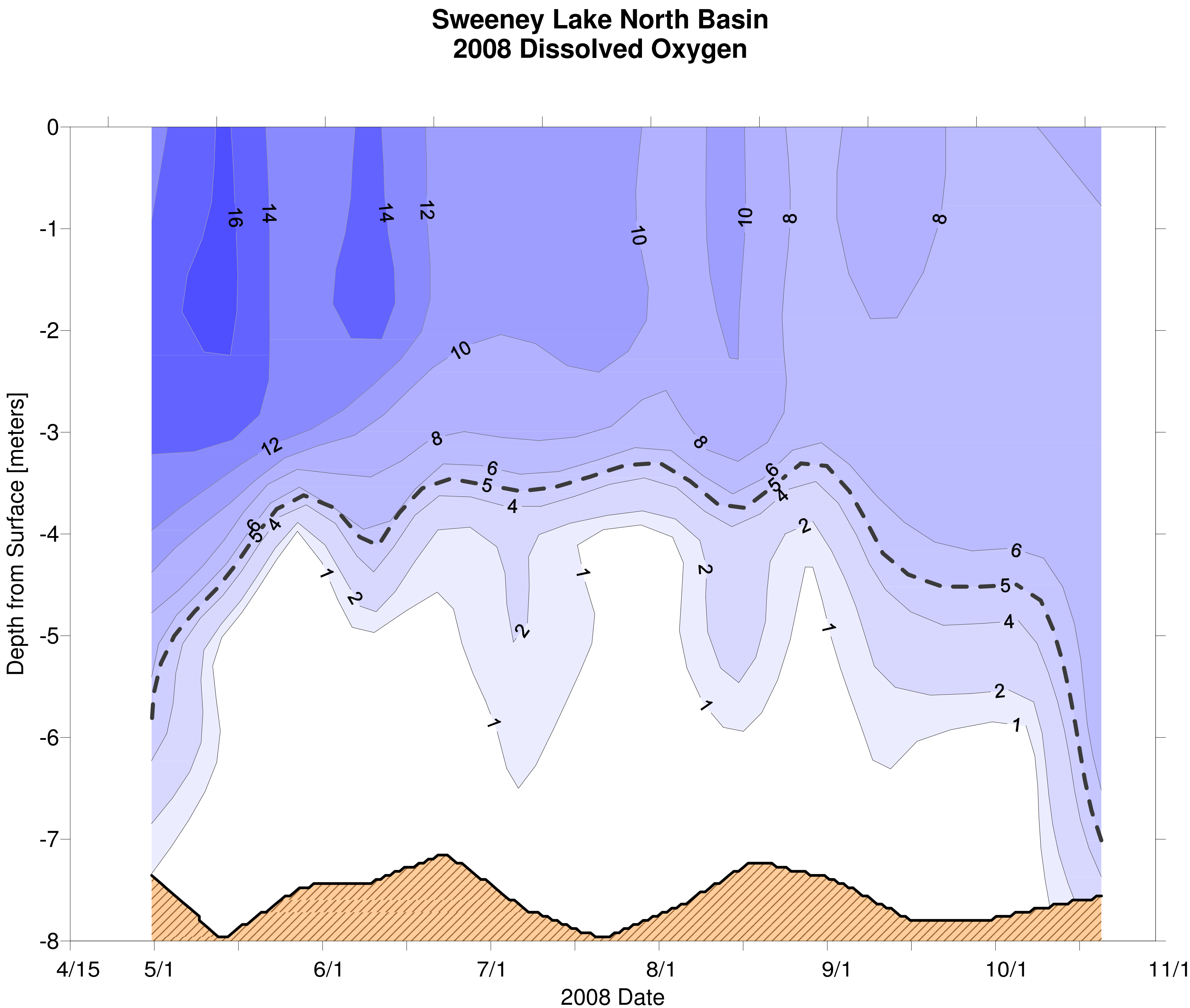


Sweeney Lake (North Basin)
2008 Secchi Depth

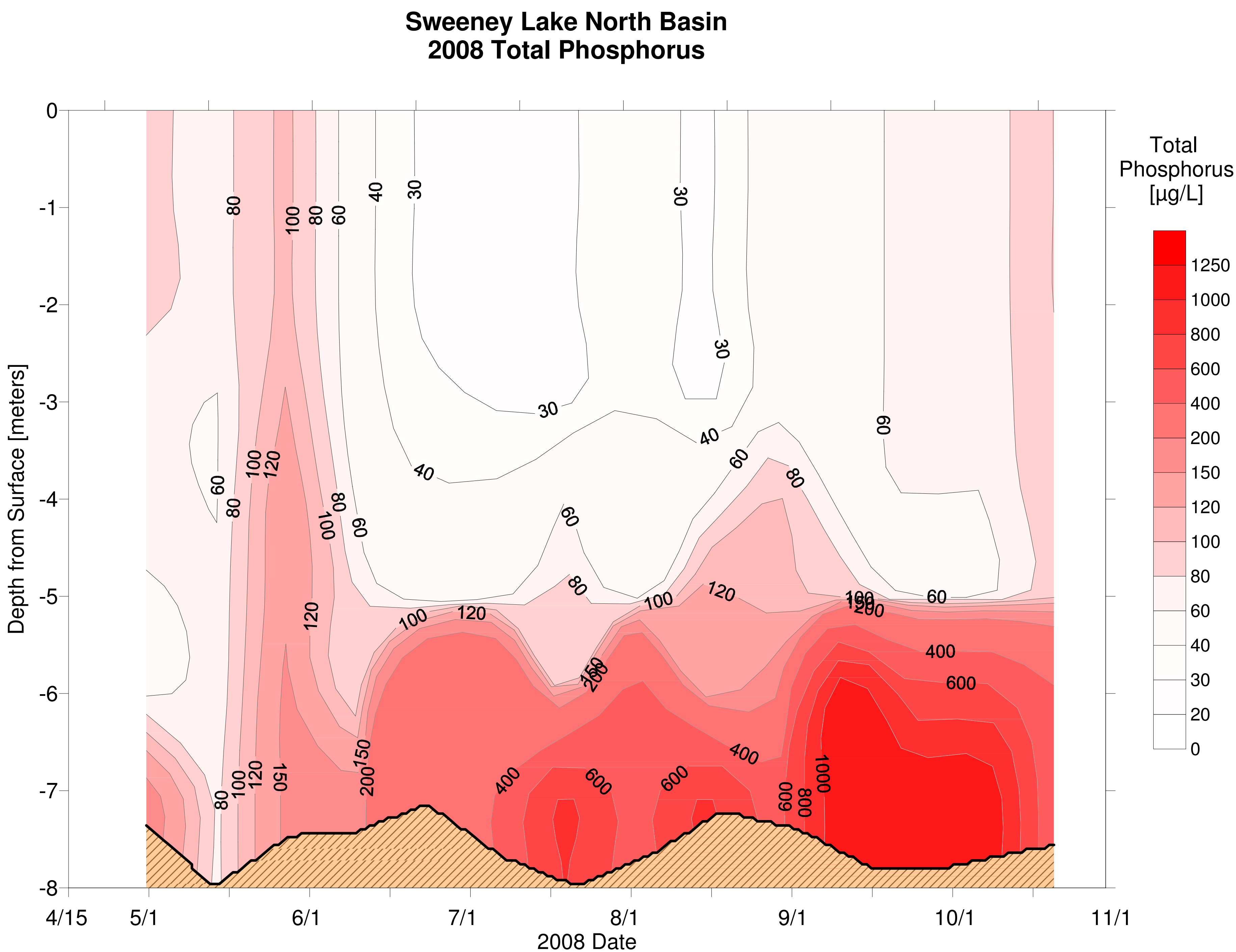


Sweeney Lake North Basin
2008 Temperature





Sweeney Lake North Basin
2008 Dissolved Oxygen
Depth from Surface [meters]
2008 Date
Dissolved Oxygen [µg/L]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
18
16
14
12
10
8
6
5
4
2
1
0


Sweeney Lake North Basin
2008 Total Phosphorus
Depth from Surface [meters]
2008 Date
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
Total
Phosphorus
[µg/L]
1250
1000
800
600
400
200
150
120
100
80
60
40
30
20
0

Sweeney Lake (North Basin) 2008

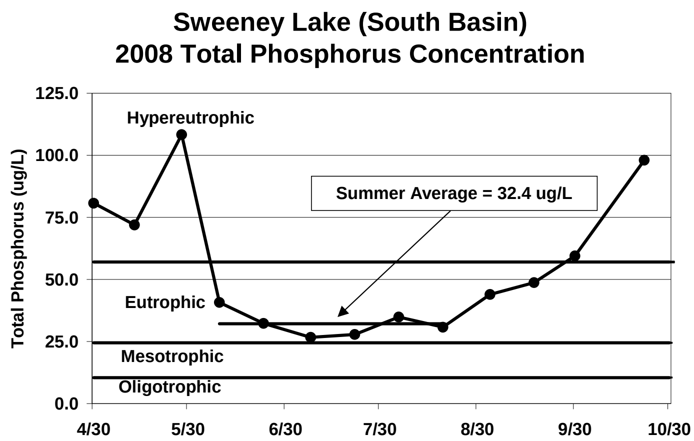
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
4/30/2008	7.38	0 - 2	1.05	32.4	.	.	.	.	85.5	0.5	1.43	.
		0	.	.	13.34	117.7	9.68	1243	.	.	.	8.47
		1	.	.	14.06	124.1	9.66	1242	.	.	.	8.48
		2	.	.	15.39	133	8.8	1254	.	.	.	8.42
		3	.	.	14.58	124.7	8.37	1268	.	.	.	8.38
		4	.	.	11.91	100.3	7.74	1304	67.9	0.4	.	8.3
		5	.	.	6.86	55.5	6.08	1470	57.1	0.3	.	8.13
		6	.	.	4.74	38	5.68	1501	.	.	.	8.1
		7	.	.	1.51	12	5.22	1536	164.3	0.3	.	8.04
		7.38	.	.	0.01	0.1	5.21	1514	.	.	.	8
5/13/2008	8	0 - 2	0.83	54.7	.	.	.	.	71.3	5.0	1.11	.
		0	.	.	16.37	164	15.33	1046	.	.	.	8.76
		1	.	.	16.67	166.9	15.3	1044	.	.	.	8.68
		2	.	.	16.61	165.8	15.14	1045	.	.	.	8.66
		3	.	.	14.72	142.9	13.87	1071	.	.	.	8.52
		4	.	.	8.38	72.7	8.96	1219	58.4	5.0	.	8.15
		5	.	.	0.89	7.3	6.8	1362	64.9	5.4	.	7.97
		6	.	.	0.78	6.3	6.26	1404	.	.	.	7.94
		7	.	.	0.01	0.1	5.95	1419	.	.	.	7.93
		8	.	.	0	0	5.91	1406	73.9	5.7	.	7.86
5/28/2008	7.48	0 - 2	1.4	8.9	.	.	.	.	106.1	5.0	.	.
		0	.	.	12.17	129.2	18.1	1058	.	.	.	8.48
		1	.	.	12.34	129.7	17.61	1048	.	.	.	8.54
		2	.	.	12.39	129.4	17.29	1048	.	.	.	8.55
		3	.	.	12.2	126	16.8	1047	122.9	4.4	.	8.53
		4	.	.	0.7	6.3	10.43	1174	143.7	5.2	.	8.04
		5	.	.	0.57	4.9	8.6	1267	.	.	.	7.96
		6	.	.	0.31	2.6	7.45	1320	.	.	.	7.93
		7	.	.	0.01	0.1	6.77	1348	156.6	9.6	.	7.91
		7.48	.	.	0.01	0.1	6.71	1329	.	.	.	7.88
6/9/2008	7.45	0 - 2	3.18	7.7	.	.	.	.	45.1	10.9	0.66	.
		0	.	.	14.5	159.9	19.99	1007	.	.	.	8.59
		1	.	.	14.84	163.2	19.87	1004	.	.	.	8.53
		2	.	.	14.95	163.9	19.71	1003	.	.	.	8.52
		3	.	.	9.66	101.4	17.56	1019	.	.	.	8.33
		4	.	.	5.9	56.1	12.9	1141	58.8	16.1	.	8.14
		5	.	.	0.9	7.8	8.59	1273	80.7	19.9	.	7.92
		6	.	.	0.28	2.4	7.59	1304	.	.	.	7.91
		7	.	.	0.01	0.1	7.12	1318	163.9	46.5	.	7.91
		7.45	.	.	0.01	0.1	7	1292	.	.	.	7.86
6/23/2008	7.16	0 - 2	4.2	5.7	.	.	.	.	27.1	6.0	0.58	.
		0	.	.	11.16	134.9	24.8	873	.	.	.	8.08
		1	.	.	11.2	133.5	24.07	869	.	.	.	8.1
		2	.	.	10.76	126.7	23.42	883	.	.	.	8.05
		3	.	.	8.07	89.5	20.31	917	33.8	3.2	.	7.88
		4	.	.	1.42	14.2	15.24	1049	41.8	6.8	.	7.61
		5	.	.	0.69	6.1	9.65	1215	.	.	.	7.59
		6	.	.	0.33	2.8	7.82	1254	.	.	.	7.59
		7	.	.	0.13	1.1	7.12	1293	397.9	178.0	.	7.41
		7.16	.	.	0.08	0.7	7.2	1297	.	.	.	7.41

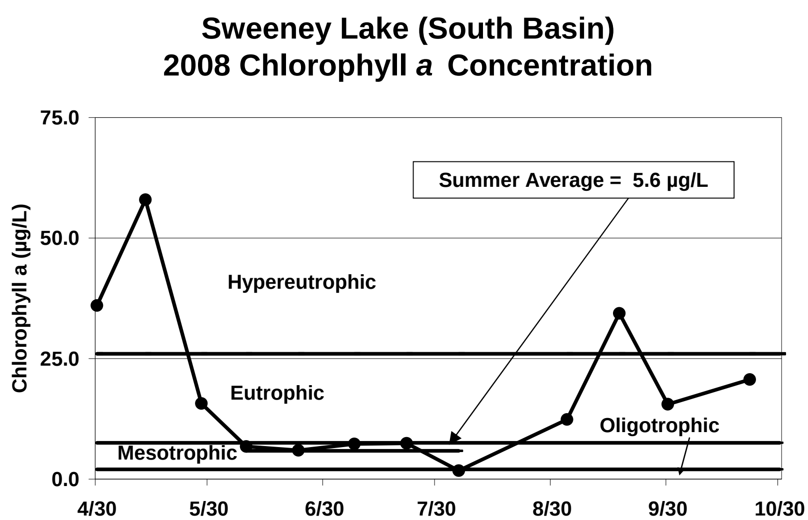
Sweeney Lake (North Basin) 2008

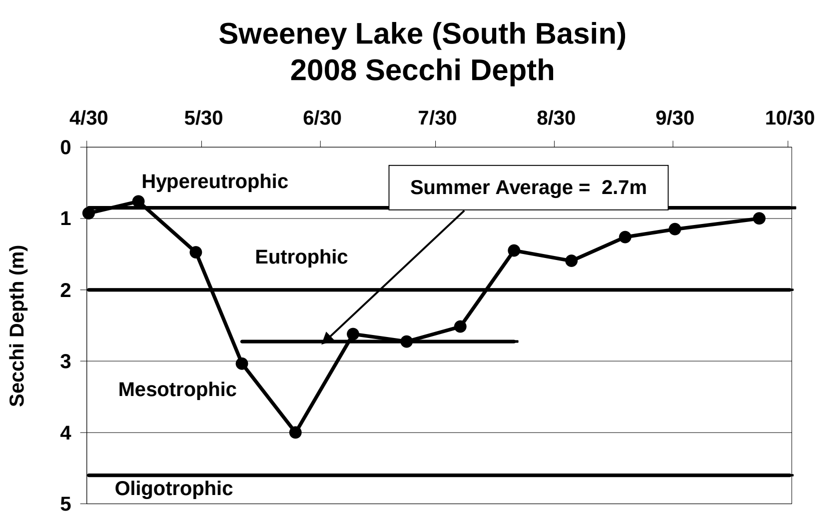
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
7/8/2008	7.71	0 - 2	2.74	7.2	.	.	.	.	28.8	5.8	0.49	.
		0	.	.	10.03	123.9	25.99	971	.	.	.	7.48
		1	.	.	10.3	126.8	25.82	972	.	.	.	7.75
		2	.	.	10.08	123.3	25.44	973	.	.	.	7.83
		3	.	.	8.44	99.7	23.57	1005	.	.	.	7.79
		4	.	.	2.49	26.7	18.7	1091	42.9	10.5	.	7.66
		5	.	.	2.1	19.7	12.25	1274	54.4	9.0	.	7.6
		6	.	.	1.22	10.6	9.07	1336	.	.	.	7.6
		7	.	.	0.78	6.6	8.1	1353	392.2	258.7	.	7.54
		7.71	.	.	0.46	3.9	7.76	1318	.	.	.	7.39
7/22/2008	8	0 - 2	2.67	8.1	.	.	.	.	28.7	4.6	0.57	.
		0	.	.	11.51	145.7	27.35	914	.	.	.	7.72
		1	.	.	11.09	137.7	26.28	924	.	.	.	7.78
		2	.	.	11.36	144	27.42	904	.	.	.	7.6
		3	.		8.17	98.7	24.77	948				7.77
		4	.	.	0.94	10.6	20.94	1024	58.6	3.1	.	7.65
		5	.	.	1.04	10.5	15.74	1164	88.3	8.3	.	7.64
		6	.	.	0.73	6.5	10.25	1296	.	.	.	7.61
		7	.	.	0.38	3.3	8.93	1322	.	.	.	7.53
		8	.	.	0.31	2.6	8.6	1293	806.5	756.8	.	7.45
8/5/2008	7.69	0 - 2	2.43	1.8	.	.	.	.	35.5	3.8	0.60	.
		0	.	.	9.39	115.8	25.86	1091	.	.	.	7.36
		1	.	.	9.4	115.9	25.85	1091	.	.	.	7.36
		2	.	.	9.48	116.6	25.7	1093	.	.	.	7.37
		3	.	.	6.91	82.7	24.26	1109	39.2	4.8	.	7.34
		4	.	.	0.78	8.8	21.6	1196	50.0	4.9	.	7.23
		5	.	.	0.42	4.2	15.18	1346	.	.	.	7.15
		6	.	.	0.42	4.2	10.77	1484	.	.	.	7.06
		7	.	.	0.53	4.6	9.05	1510	485.0	306.8	.	7.01
		7.69	.	.	0.53	4.6	8.6	1506	.	.	.	6.96
8/19/2008	7.23	0 - 2	1.5	.	.	.	.	.	27.1	4.0	0.64	.
		0	.	.	10.41	127.4	25.44	1079	.	.	.	7.35
		1	.	.	10.41	127.4	25.44	1079	.	.	.	7.35
		2	.	.	10.13	123.4	25.17	1079	.	.	.	7.35
		3	.	.	9.8	118.3	24.71	1085	.	.	.	7.37
		4	.	.	3.56	41	22.14	1153	57.2	4.4	.	7.35
		5	.	.	2.96	30.4	16.44	1336	130.3	4.1	.	7.26
		6	.	.	0.91	8.1	11.93	1461	.	.	.	7.19
		7	.	.	0.91	8.1	10.11	1485	803.0	572.2	.	7.14
		7.23	.	.	0.91	8.1	9.66	1505	.	.	.	7.11
9/3/2008	7.42	0 - 2	1.61	7.7	.	.	.	.	48.0	3.5	.	.
		0	.	.	6.87	79.9	22.7	1009	.	.	.	7.84
		1	.	.	7.14	82.9	22.67	1010	.	.	.	7.83
		2	.	.	6.76	78.3	22.47	1010	.	.	.	7.82
		3	.	.	6.47	74.3	22.1	1015	.	.	.	7.81
		4	.	.	1.24	14	21.03	1032	.	.	.	7.78
		5	.	.	0.37	4	19.06	1125	106.6	13.5	.	7.74
		6	.	.	0.01	0.1	13.14	1376	178.1	85.7	.	7.63
		7	.		0.01	0.1	10.4	1431	488.8	488.8		7.56
		7.42	.	.	0.01	0.1	10.12	1426	.	.	.	7.48

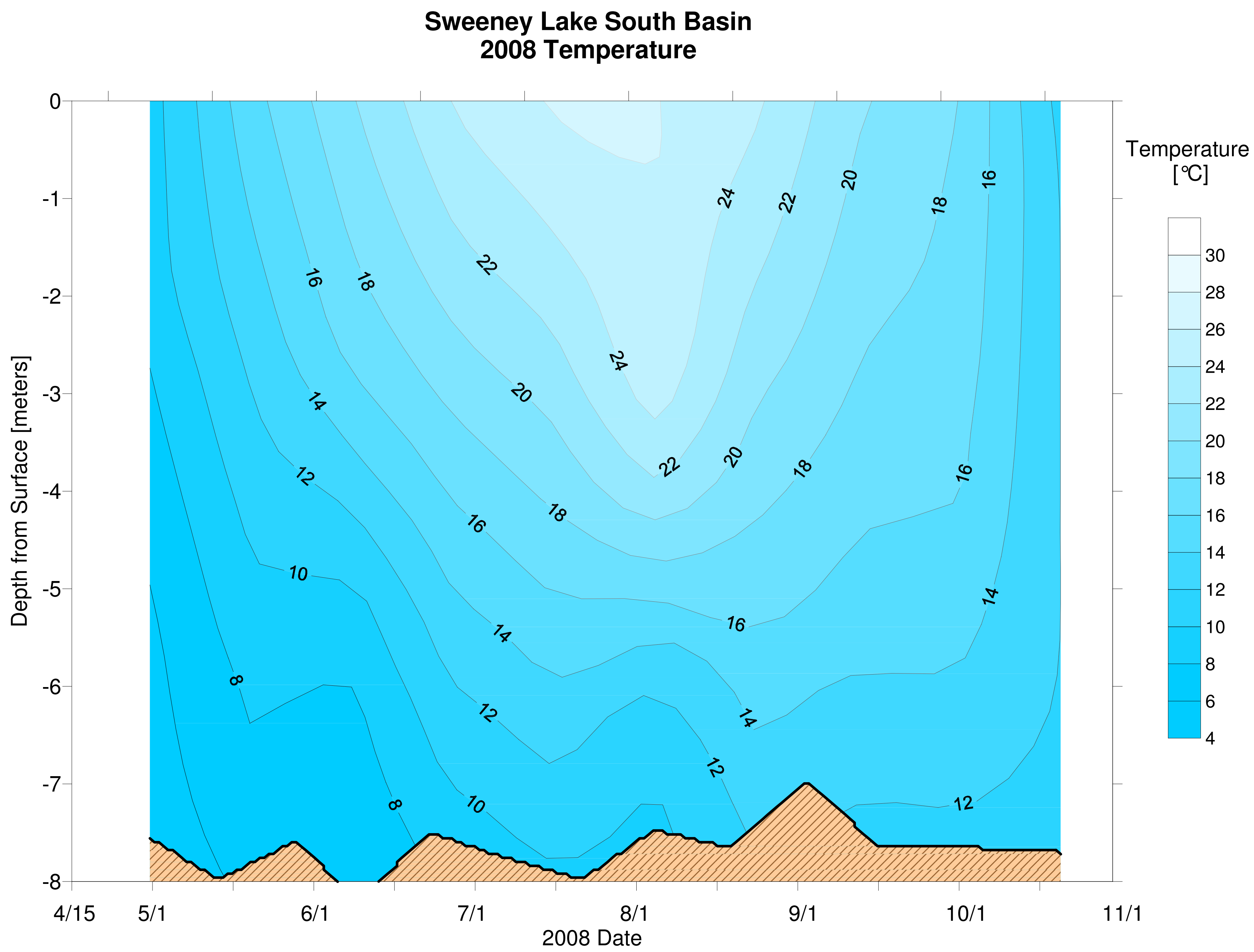
Sweeney Lake (North Basin) 2008

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
9/17/2008	7.82	0 - 2	1.2	36.7	.	.	.	.	49.4	2.1	0.77	.
		0	.	.	9.35	102.3	19.6	1059	.	.	.	7.22
		1	.	.	9.31	100.1	18.76	1058	.	.	.	7.25
		2	.	.	7.94	84.8	18.39	1059	.	.	.	7.24
		3	.	.	6.98	74.1	18.1	1060	.	.	.	7.24
		4	.	.	5.55	58.6	17.82	1066	49.8	3.3	.	7.24
		5	.	.	2.5	25.9	17.02	1132	95.6	9.0	.	7.22
		6	.	.	1.31	12.6	13.59	1431	.	.	.	7.15
		7	.	.	0.41	3.7	10.66	1483	1211.4	1131.9	.	7.11
		7.82	.	.	0.24	2.1	10.24	1500	.	.	.	7.06
9/30/2008	7.82	0 - 2	1.18	17.0	.	.	.	.	68.0	15.5	0.72	.
		0	.	.	7.8	82.8	18.1	1088	.	.	.	7.13
		1	.	.	7.61	80.8	18.1	1091	.	.	.	7.13
		2	.	.	6.75	71.4	17.91	1093	.	.	.	7.15
		3	.	.	6.63	69.9	17.77	1090	.	.	.	7.13
		4	.	.	6.41	67.6	17.71	1094	.	.	.	7.13
		5	.	.	3.76	39.3	17.25	1117	59.8	3.0	.	7.11
		6	.	.	0.75	7.3	14	1423	669.1	471.4	.	7
		7	.	.	0.21	1.9	11.28	1550	1177.1	760.6	.	7.02
		7.82	.	.	0.22	2	10.54	1557	.	.	.	7.04
10/22/2008	7.58	0 - 2	1	20.4	.	.	.	.	100.3	32.3	1.04	.
		0	.	.	9.39	87.6	12.06	1093	.	.	.	7.99
		1	.	.	7.6	70.9	12.1	1096	.	.	.	7.89
		2	.	.	7.35	68.6	12.12	1096	.	.	.	7.84
		3	.	.	7.2	67.3	12.13	1096	.	.	.	7.78
		4	.	.	7.19	67.1	12.13	1096	96.4	35.6	.	7.75
		5	.	.	7.11	66.3	12.1	1095	.	.	.	7.66
		6	.	.	7.03	65.5	12.03	1097	.	.	.	7.63
		7	.	.	5.03	46.7	11.88	1116	429.8	351.4	.	7.59
		7.58	.	.	2.25	20.7	11.45	1340	.	.	.	7.41

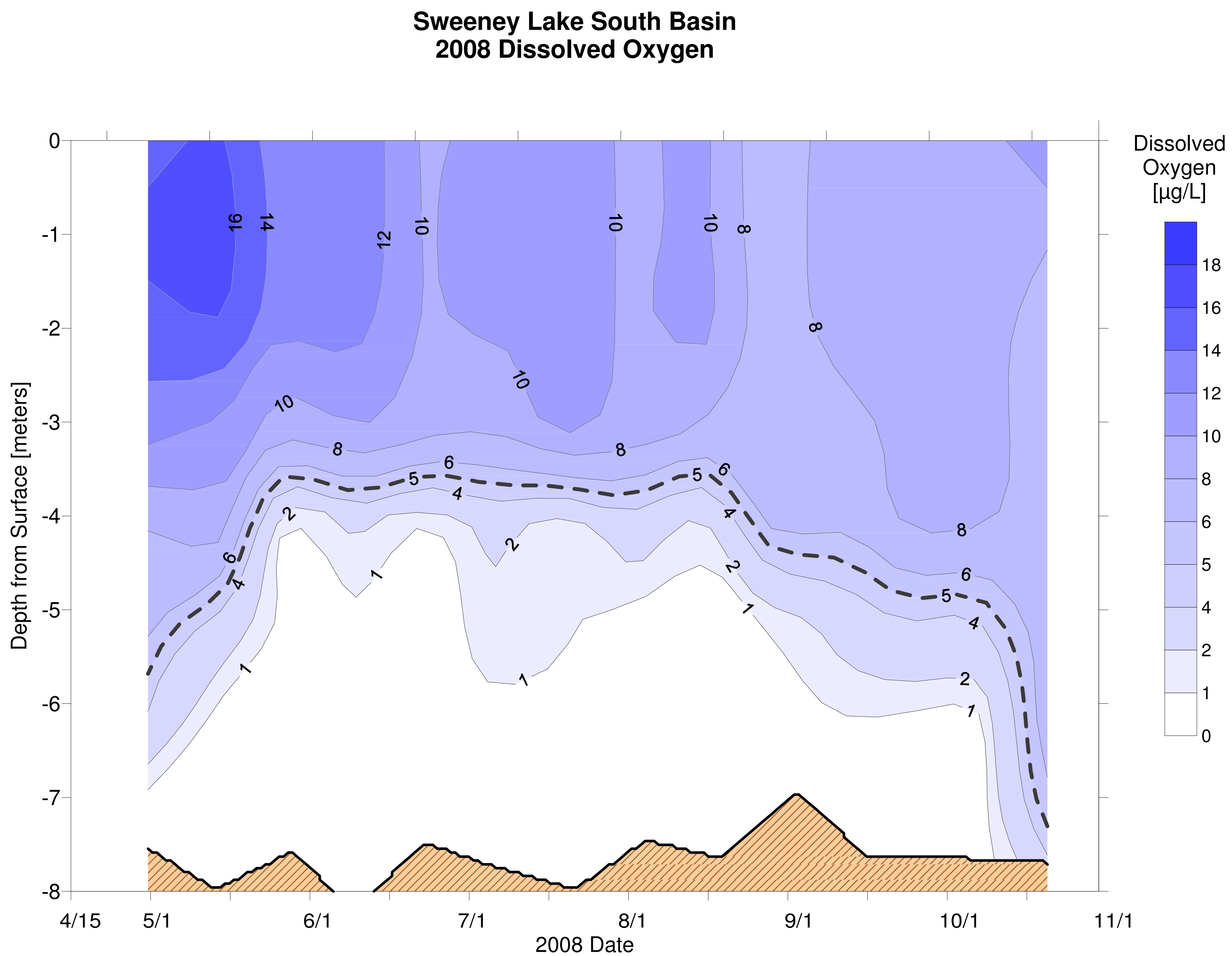

Sweeney Lake (South Basin)
2008 Total Phosphorus Concentration
Total Phosphorus (ug/L)
125.0
100.0
75.0
50.0
25.0
0.0
4/30
5/30
6/30
7/30
8/30
9/30
10/30
Hypereutrophic
Summer Average = 32.4 ug/L
Eutrophic
Mesotrophic
Oligotrophic


Sweeney Lake (South Basin)
2008 Chlorophyll a Concentration
Chlorophyll a (µg/L)
75.0
50.0
25.0
0.0
4/30
5/30
6/30
7/30
8/30
9/30
10/30
Summer Average = 5.6 µg/L
Hypereutrophic
Eutrophic
Oligotrophic
Mesotrophic

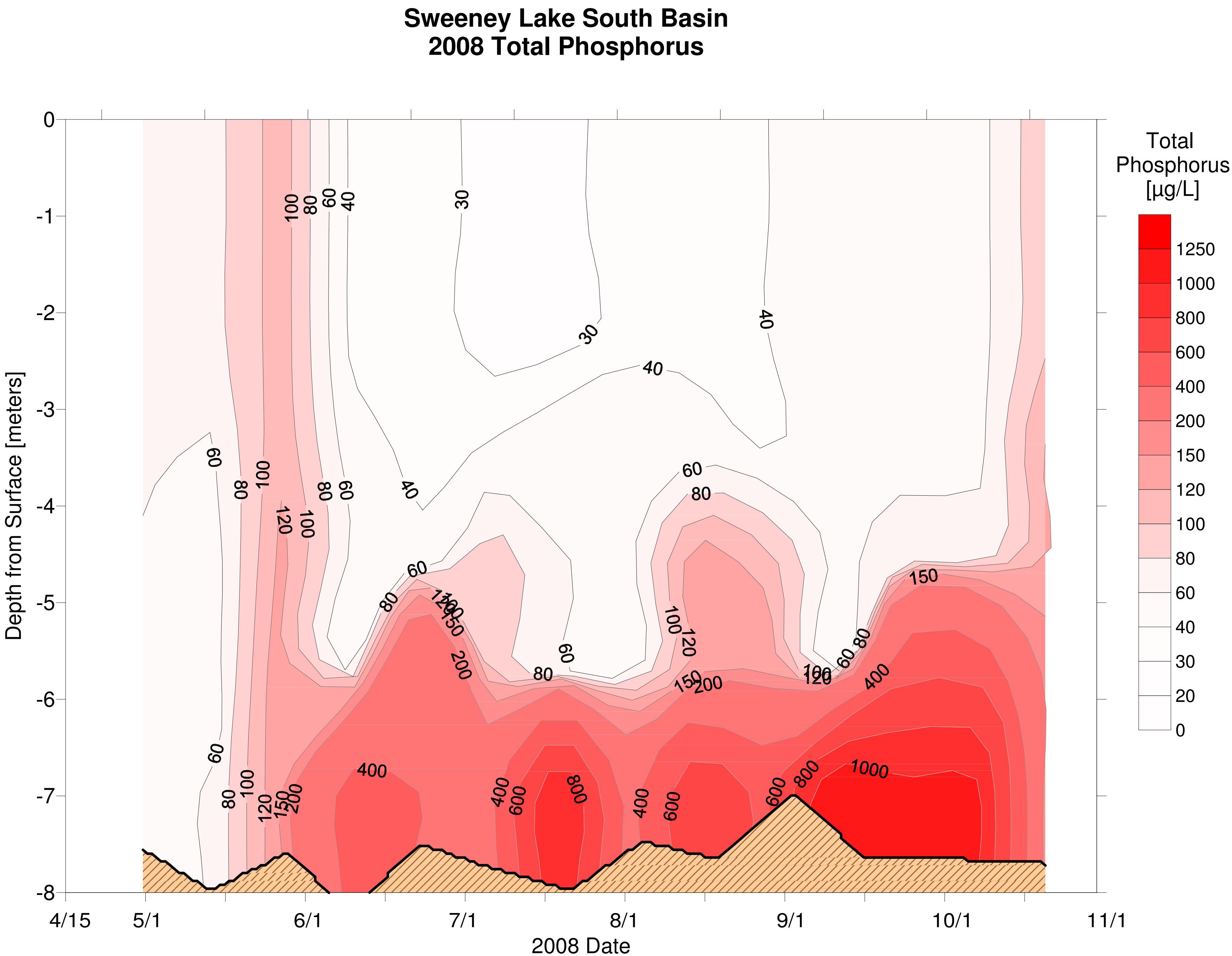

Sweeney Lake (South Basin)
2008 Secchi Depth
Secchi Depth (m)
4/30
5/30
6/30
7/30
8/30
9/30
10/30
0
1
2
3
4
5
Hypereutrophic
Summer Average = 2.7m
Eutrophic
Mesotrophic
Oligotrophic



Sweeney Lake South Basin
2008 Temperature
Depth from Surface [meters]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
2008 Date
Temperature
[℃]
30
28
26
24
22
20
18
16
14
12
10
8
6
4



Sweeney Lake South Basin
2008 Dissolved Oxygen
Depth from Surface [meters]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
2008 Date
Dissolved Oxygen [µg/L]
18
16
14
12
10
8
6
5
4
2
1
0


Sweeney Lake South Basin
2008 Total Phosphorus
Depth from Surface [meters]
2008 Date
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
Total Phosphorus [µg/L]
0
20
30
40
60
80
100
120
150
200
400
600
800
1000
1250

Sweeney Lake (South Basin) 2008

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
4/30/2008	7.57	0 - 2	0.8	39.6	.	.	.	.	75.9	0.0	1.44	.
		0	.	.	15.41	134.5	9.2	1239	.	.	.	8.7
		1	.	.	16.63	144.9	9.14	1244	.	.	.	8.66
		2	.	.	15.24	132.3	8.99	1244	.	.	.	8.61
		3	.	.	12.75	107.1	7.65	1316	.	.	.	8.37
		4	.	.	8.09	66.7	6.83	1426	63.4	0.1	.	8.19
		5	.	.	6.38	51.3	5.85	1472	57.6	1.4	.	8.09
		6	.	.	3.8	30.2	5.41	1519	.	.	.	8.04
		7	.	.	0.01	0.1	5.21	1567	46.7	1.9	.	8.02
		7.57	.	.	0.01	0.1	4.97	1685	.	.	.	7.9
5/13/2008	8	0 - 2	0.69	61.2	.	.	.	.	72.6	4.2	1.16	.
		0	.	.	16.44	162.5	14.72	1045	.	.	.	8.83
		1	.	.	17.16	169.7	14.7	1045	.	.	.	8.79
		2	.	.	15.78	153.7	14.02	1057	.	.	.	8.62
		3	.	.	11.49	106.2	11.7	1119	.	.	.	8.36
		4	.	.	9	78.4	9.16	1208	57.6	5.3	.	8.19
		5	.	.	3.53	29.3	7.12	1345	48.7	5.0	.	8
		6	.	.	0.56	4.5	6.02	1417	.	.	.	7.92
		7	.	.	0.01	0.1	5.6	1471	.	.	.	7.9
		8	.	.	0.01	0.1	5.48	1420	61.8	6.4	.	7.81
5/28/2008	7.61	0 - 2	1.55	22.5	.	.	.	.	110.5	4.4	.	.
		0	.	.	12.46	131.7	17.89	1052	.	.	.	8.48
		1	.	.	12.8	133.5	17.27	1049	.	.	.	8.49
		2	.	.	12.21	125.6	16.57	1052	.	.	.	8.44
		3	.	.	8.88	89.1	15.37	1074	114.6	3.7	.	8.26
		4	.	.	0.77	6.9	10.26	1173	126.5	3.8	.	7.94
		5	.	.	0.49	4.2	8.19	1280	.	.	.	7.86
		6	.	.	0.31	2.6	7.27	1329	.	.	.	7.82
		7	.	.	0.01	0.1	6.52	1386	138.5	4.6	.	7.82
		7.61	.	.	0.01	0.1	6.29	1405	.	.	.	7.8
6/9/2008	8.21	0 - 2	2.89	5.8	.	.	.	.	36.4	15.7	0.80	.
		0	.	.	13.65	151.3	20.24	997	.	.	.	8.54
		1	.	.	13.51	145.8	18.93	1012	.	.	.	8.5
		2	.	.	12.47	132.1	17.97	1014	.	.	.	8.43
		3	.	.	9.86	102.2	16.95	1029	.	.	.	8.3
		4	.	.	2.26	21.5	12.92	1128	49.0	29.8	.	8.05
		5	.	.	0.56	4.9	8.7	1268	56.1	24.8	.	7.89
		6	.	.	0.07	0.6	7.29	1314	.	.	.	7.84
		7	.	.	0.01	0.1	6.65	1367	.	.	.	7.83
		8	.	.	0.01	0.1	6.42	1390	442.4	70.8	.	7.79
		8.21	.	.	0.01	0.1	6.45	1387	.	.	.	7.8
6/23/2008	7.52	0 - 2	3.8	6.3	.	.	.	.	37.5	2.6	0.64	.
		0	.	.	9.67	117.7	25.23	875	.	.	.	7.81
		1	.	.	9.86	117.2	23.89	868	.	.	.	7.94
		2	.	.	9.75	114.6	23.28	866	.	.	.	7.98
		3	.	.	8.64	98.1	21.52	891	34.3	9.3	.	7.89
		4	.	.	0.96	9.5	14.8	1069	44.9	5.5	.	7.64
		5	.	.	0.61	5.6	10.88	1192	.	.	.	7.58
		6	.	.	0.51	4.4	8.55	1243	.	.	.	7.56
		7	.	.	0.4	3.4	7.82	1253	392.4	132.4	.	7.56
		7.52	.	.	0.17	1.4	7.58	1225	.	.	.	7.48

Sweeney Lake (South Basin) 2008

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
7/8/2008	7.79	0 - 2	2.5	7.4	.	.	.	.	24.6	7.0	0.50	.
		0	.	.	10.57	129.9	25.68	978	.	.	.	7.89
		1	.	.	10.64	130.3	25.52	987	.	.	.	7.93
		2	.	.	10.14	123.5	25.21	1013	.	.	.	7.92
		3	.	.	8.25	97.1	23.34	1019	.	.	.	7.83
		4	.	.	2.53	26.9	18.15	1094	41.7	10.5	.	7.68
		5	.	.	1.3	11.9	11.42	1287	95.6	13.5	.	7.57
		6	.	.	0.84	7.2	8.7	1337	.	.	.	7.54
		7	.	.	0.79	6.7	7.53	1390	310.0	163.6	.	7.51
		7.79	.	.	0.3	2.5	7.29	1401	.	.	.	7.37
7/22/2008	8	0 - 2	2.78	6.7	.	.	.	.	27.0	4.9	0.58	.
		0	.	.	11.26	144.1	27.93	935	.	.	.	7.73
		1	.	.	11.4	145.1	27.68	934	.	.	.	7.81
		2	.	.	11.39	144.3	27.39	936	.	.	.	7.85
		3	.	.	10.32	128	26.21	965	.	.	.	7.82
		4	.	.	1.37	15.6	21.54	1013	51.1	3.1	.	7.74
		5	.	.	1.15	11.7	15.94	1165	61.3	7.2	.	7.73
		6	.	.	0.69	6.2	10.24	1303	.	.	.	7.7
		7	.	.	0.4	3.4	8.35	1362	.	.	.	7.67
		8	.	.	0.22	1.9	8	1368	960.7	716.4	.	7.56
8/5/2008	7.49	0 - 2	2.6	1.8	.	.	.	.	34.2	4.6	0.55	.
		0	.	.	9.56	118.2	25.98	1093	.	.	.	7.36
		1	.	.	9.56	118.2	25.98	1093	.	.	.	7.36
		2	.	.	9.53	117.5	25.85	1087	.	.	.	7.37
		3	.	.	9.15	111.8	25.4	1063	.	.	.	7.37
		4	.	.	3.01	34.4	21.8	1180	59.0	4.0	.	7.29
		5	.	.	0.52	5.3	16.41	1314	53.7	4.6	.	7.12
		6	.	.	0.01	0.1	11.73	1453	.	.	.	7.06
		7	.	.	0.01	0.1	9.39	1511	308.2	191.4	.	7.01
		7.49	.	.	0.08	0.7	9.92	1491	.	.	.	6.96
8/19/2008	7.67	0 - 2	1.4	.	.	.	.	.	34.5	4.1	0.63	.
		0	.	.	10.58	130.5	25.9	1083	.	.	.	7.34
		1	.	.	10.58	130.5	25.9	1083	.	.	.	7.34
		2	.	.	10.51	127.5	25	1083	.	.	.	7.34
		3	.	.	7.75	92.3	23.94	1108	.	.	.	7.31
		4	.	.	1.53	17.7	22.49	1146	48.8	5.6	.	7.26
		5	.	.	0.23	2.3	17.09	1307	136.4	4.3	.	7.2
		6	.	.	0.06	0.5	11.44	1473	.	.	.	7.13
		7	.	.	0.06	0.5	9.37	1527	737.6	515.4	.	7.09
		7.67	.	.	0.01	0.1	9.53	1522	.	.	.	7.1
9/3/2008	7	0 - 2	1.58	17.0	.	.	.	.	39.9	3.6	.	.
		0	.	.	6.17	71.6	22.62	1012	.	.	.	7.98
		1	.	.	6.41	74.4	22.61	1012	.	.	.	7.81
		2	.	.	6.6	76.5	22.54	1013	.	.	.	7.75
		3	.	.	6.2	71.7	22.44	1014	.	.	.	7.74
		4	.	.	6.1	70.1	22.12	1019	.	.	.	7.72
		5	.	.	1.17	12.5	18.37	1167	107.6	11.0	.	7.66
		6	.	.	0.01	0.1	13.03	1384	146.8	70.4	.	7.53
		7	.	.	0.01	0.1	10.52	1448	523.5	523.5	.	7.45
			.									

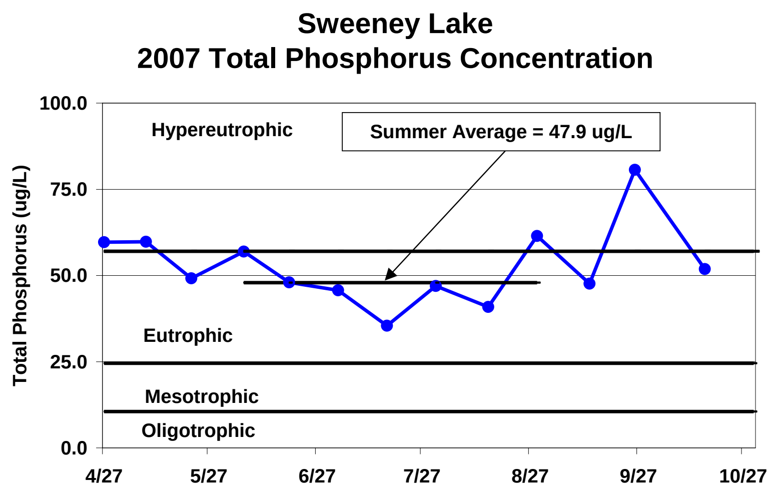
Sweeney Lake (South Basin) 2008

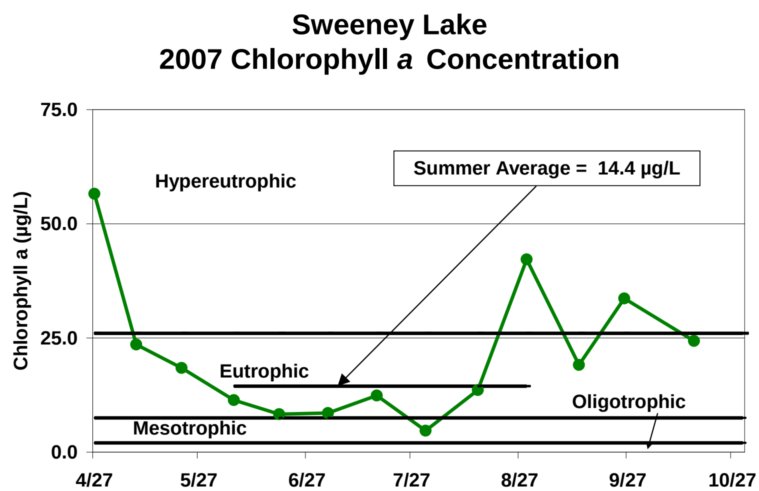
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
9/17/2008	7.65	0 - 2	1.32	32.1	.	.	.	.	48.0	1.6	0.77	.
		0	.	.	9.36	102.2	19.48	1059	.	.	.	7.27
		1	.	.	9.43	101.4	18.75	1057	.	.	.	7.27
		2	.	.	8.7	93.3	18.55	1058	.	.	.	7.26
		3	.	.	7.09	75.4	18.18	1060	.	.	.	7.24
		4	.	.	6.24	65.9	17.85	1061	46.6	5.7	.	7.24
		5	.	.	2.64	27.7	17.51	1084	53.1	5.0	.	7.22
		6	.	.	0.92	8.9	13.84	1429	.	.	.	7.1
		7	.	.	0.27	2.4	10.16	1526	1160.9	1136.8	.	7.03
		7.65	.	.	0.23	2	9.61	1551	.	.	.	6.96
9/30/2008	7.66	0 - 2	1.12	14.1	.	.	.	.	50.9	2.5	0.73	.
		0	.	.	8.78	93.7	18.3	1089	.	.	.	7.09
		1	.	.	8.68	92.7	18.36	1091	.	.	.	7.12
		2	.	.	8.7	92.7	18.29	1091	.	.	.	7.13
		3	.	.	8.71	92.5	18.13	1090	.	.	.	7.13
		4	.	.	8.04	85	17.86	1092	.	.	.	7.13
		5	.	.	3.95	40.9	16.87	1168	74.4	2.5	.	7.12
		6	.	.	0.8	7.9	14.36	1397	551.9	355.6	.	7.02
		7	.	.	0.28	2.5	10.95	1594	1020.9	776.5	.	6.95
		7.66	.	.	0.26	2.3	10.44	1616	.	.	.	6.89
10/22/2008	7.72	0 - 2	1	20.9	.	.	.	.	95.7	35.3	1.01	.
		0	.	.	11.83	108.6	11.4	1106	.	.	.	7.54
		1	.	.	8.11	75.4	11.96	1097	.	.	.	7.54
		2	.	.	7.29	67.8	11.99	1098	.	.	.	7.53
		3	.	.	7.14	66.4	11.99	1098	.	.	.	7.52
		4	.	.	7.04	65.5	11.99	1098	121.5	40.0	.	7.51
		5	.	.	7.01	65.3	11.99	1098	.	.	.	7.5
		6	.	.	6.94	64.5	11.99	1104	.	.	.	7.49
		7	.	.	5.4	49.8	11.48	1431	178.7	107.9	.	7.33
		7.72	.	.	2.06	18.7	10.98	1598	.	.	.	7.26

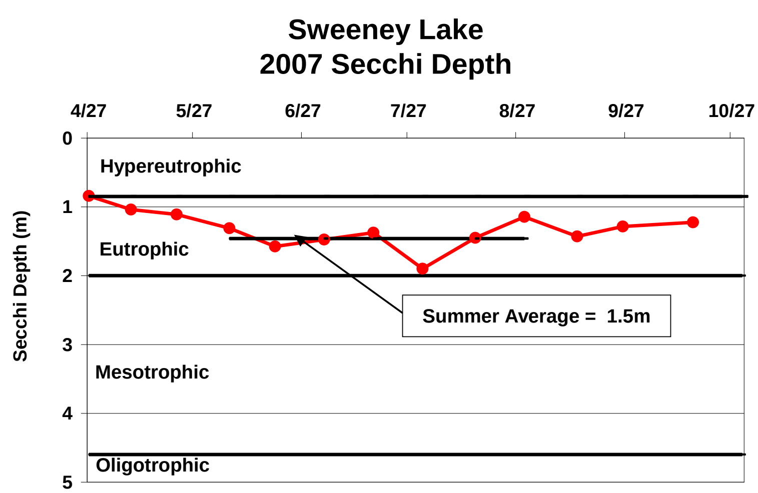
Appendix B

2007 Sweeney Lake Data

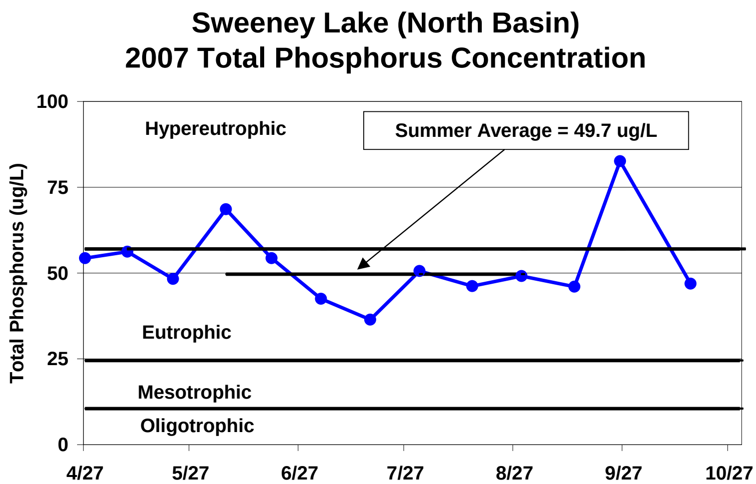
2007 Sweeney Lake Water Quality Data: Average of North and South Basins (surface = 0-2m depth)

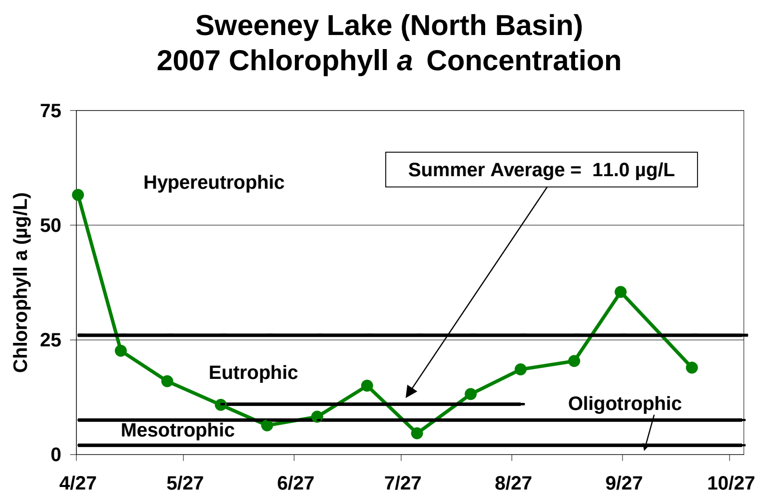


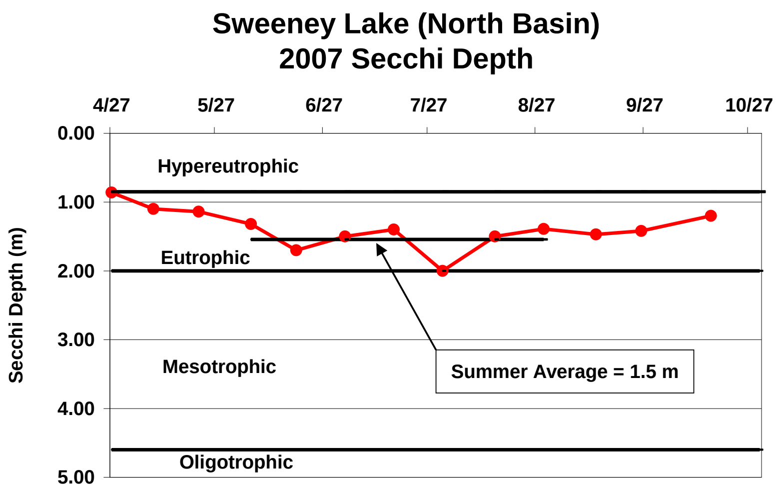




2007 Sweeney Lake Water Quality Data: North Basin only (surface = 0-2m depth)







Sweeney Lake (North Basin) 2007

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
4/27/2007	7.5	0	0.9	56.6	16.62	160.3	13.6	916	54.3	28.6	1.08	7.95
		1	.	.	16.48	158.6	13.51	916	.	.	.	7.93
		2	.	.	15.96	153.3	13.44	916	.	.	.	7.9
		3	.	.	13.57	128.8	12.89	924	.	.	.	7.77
		4	.	.	9.68	85.1	9.55	956	52	52	.	7.53
		5	.	.	7.41	60.6	6.61	975	51	22.28	.	7.45
		6	.	.	6.56	53.1	6.2	969	.	.	.	7.42
		7	.	.	4.37	35.2	5.96	977	34.3	9.4	.	7.39
		7.5	.	.	0.93	7.4	5.89	986	.	.	.	7.49
05/09/07	7.5	0	1.10	22.610628	11.74	124.1	17.92	921	56.2	3.24	1.025	8.18
		1	.	.	11.76	121	16.61	934	.	.	.	8.14
		2	.	.	10.65	106.9	15.44	941	.	.	.	7.99
		3	.	.	7.52	73.8	14.43	947	.	.	.	7.79
		4	.	.	4.65	42.6	11.34	961	56.3	2.9	.	7.59
		5	.	.	2.6	21.9	7.75	977	51.8	2.39	.	7.47
		6	.	.	1.42	11.6	6.64	988	.	.	.	7.43
		7	.	.	0.93	7.5	6.34	994	63.4	3.22	.	7.43
		7.5	.	.	0.59	4.8	6.33	995	.	.	.	7.52
05/22/07	7.1	0	1.14	15.963396	11.32	124.1	19.67	1109	48.3	0.87	0.813	8.15
		1	.	.	11.21	122.6	19.59	1110	.	.	.	8.19
		2	.	.	11.06	119.7	19.06	1110	.	.	.	8.18
		3	.	.	10.42	111.7	18.54	1112	.	.	.	8.14
		4	.	.	8.14	83.8	16.6	1135	53.4	0.71	.	7.95
		5	.	.	0.93	8.6	11.76	1149	71.9	2.27	.	7.5
		6	.	.	0.61	5.1	7.79	1175	.	.	.	7.46
		7	.	.	0.38	3.2	7.21	1146	62.1	1.32	.	7.44
		7.1	.	.	0.26	2.1	7.19	1145	.	.	.	7.46
06/06/07	7.5	0	1.32	10.80816	9.88	110.1	20.56	822	68.6	1.9	0.761	8.11
		1	.	.	9.97	111.3	20.65	821	.	.	.	8.09
		2	.	.	9.97	111.3	20.64	821	.	.	.	8.09
		3	.	.	9.71	107.7	20.29	825	52.3	4.09	.	8.05
		4	.	.	0.97	9.9	16.13	862	65.3	2.92	.	7.61
		5	.	.	1	9.3	12	886	.	.	.	7.58
		6	.	.	0.83	7.4	10.05	885	.	.	.	7.55
		7	.	.	0.64	5.5	8.88	900	223.5	4.29	.	7.55
		7.5	.	.	0.5	4.2	8.07	917	.	.	.	7.5
06/19/07	7.9	0	1.70	6.3499542	4.74	56.8	24.31	877	54.3	2	0.746	7.93
		1	.	.	5.19	62.1	24.28	877	.	.	.	8.01
		2	.	.	5.48	65.5	24.22	877	.	.	.	8.04
		3	.	.	4.2	49.8	23.73	881	.	.	.	7.98
		4	.	.	0	0	20.37	892	44	2.8	.	7.8
		5	.	.	0	0	16.27	919	82.8	8	.	7.77
		6	.	.	0	0	11.7	929	.	.	.	7.74
		7	.	.	0	0	9.67	958	300.5	8.2	.	7.74
		7.9	.	.	0	0	8.78	971	.	.	.	7.69
07/03/07	8	0	1.50	8.249766	9.67	117.6	25.14	1107	42.5	9.51	0.729	7.61
		1	.	.	10.07	121.9	24.85	1106	.	.	.	7.7
		2	.	.	9.89	119.5	24.75	1105	.	.	.	7.74
		3	.	.	7.54	90.4	24.36	1108	45	8.47	.	7.66
		4	.	.	0.91	10.5	21.95	1116	46.5	12.71	.	7.4
		5	.	.	0.85	9.5	21.06	1112	.	.	.	7.39
		6	.	.	0.85	7.9	11.95	1183	.	.	.	7.35
		7	.	.	0.94	8.3	9.29	1200	.	.	.	7.2
		8	.	.	0.75	6.6	9.26	1203	411.3	53.2	.	7.2

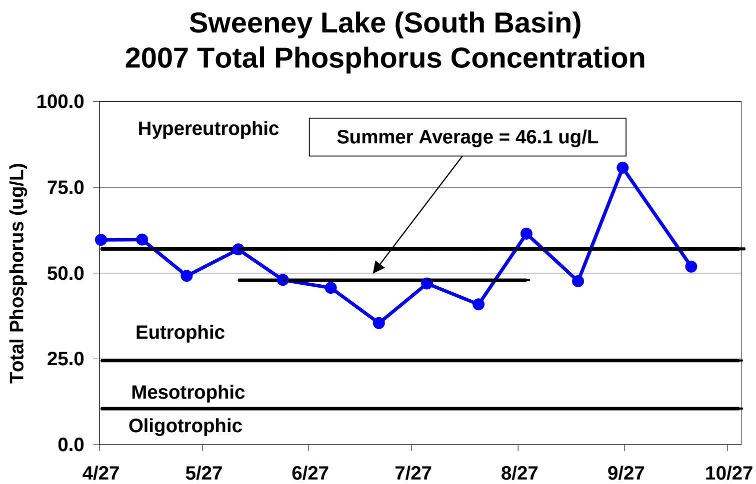
Sweeney Lake (North Basin) 2007

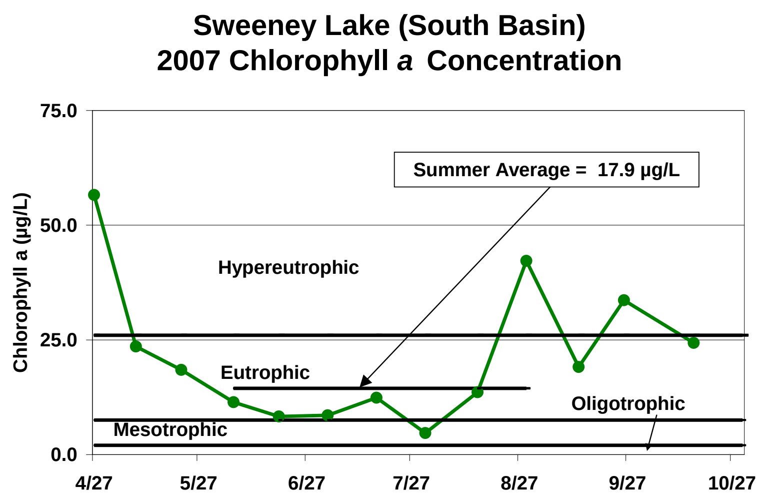
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
07/17/07	7.5	0	1.40	14.990448	9.38	115	25.58	1058	36.4	6.09	0.628	7.4
		1	.	.	9.74	119.4	25.55	1059	.	.	.	7.49
		2	.	.	9.17	110.7	24.69	1061	.	.	.	7.58
		3	.	.	7.57	90.4	24.13	1064	.	.	.	7.59
		4	.	.	2.64	30.9	23	1073	35.3	9.71	.	7.41
		5	.	.	0.91	9.4	16.97	1139	57.7	12.36	.	7.32
		6	.	.	0.65	6.1	12.59	1168	.	.	.	7.29
		7	.	.	0.61	5.7	12.03	1143	291.9	96.66	.	7.28
		7.5	.	.	0.38	3.4	10.21	1191	.	.	.	7.29
07/31/07	7.3	0	2.00	4.618032	8.52	109	27.95	921	50.6	6.2	0.52	7.44
		1	.	.	9.05	115.4	27.76	921	.	.	.	7.39
		2	.	.	9.18	116.8	27.64	921	.	.	.	7.43
		3	.	.	6.66	83	26.48	925	64.3	8.99	.	7.44
		4	.	.	0.72	8.7	24.22	927	57.5	5.56	.	7.24
		5	.	.	0.57	6.3	20.26	947	.	.	.	7.21
		6	.	.	0.52	5.4	16.7	972	.	.	.	7.16
		7	.	.	0.33	3.1	11.95	1007	528.4	133.35	.	7.13
		7.3	.	.	0.25	2.3	11.32	1018	.	.	.	7.11
08/15/07	7	0	1.50	13.177785					46.2	5.35	0.54	
		3	.	.					63.6	3.33	.	
		4	.	.					54.5	5.4	.	
		7	.	.					800.6	366.22	.	
08/29/07	7.4	0	1.39	18.5565	6.84	117.5	23.01	932.9	49.1	5.9	0.66	7.71
		1	.	.	6.92	117.5	22.46	930.6	.	.	.	7.75
		2	.	.	6.26	105.9	22.12	929.5	.	.	.	7.76
		3	.	.	4.53	76.6	21.87	939.4	46.1	7.86	.	7.73
		4	.	.	0.64	11	21.44	955	50.2	7.53	.	7.57
		5	.	.	0.62	10.3	19.71	980.1	.	.	.	7.51
		6	.	.	0.2	3.4	15.81	1178	.	.	.	7.38
		7	.	.	0.09	1.5	13.19	1228	846.1	403.07	.	7.34
		7.4	.	.	0.03	0.8	12.97	1234	.	.	.	7.3
09/13/07	7.5	0	1.47	20.383314	9.61	106.3	20.07	879	46	6.85	0.7	7.48
		1	.	.	9.6	106.1	20.11	879	.	.	.	7.44
		2	.	.	9.56	105.8	20.11	879	.	.	.	7.44
		3	.	.	9.55	105.5	20.11	879	.	.	.	7.46
		4	.	.	9.44	104.4	20.1	879	.	.	.	7.48
		5	.	.	9.35	103.1	20.03	882	48.6	3.38	.	7.51
		6	.	.	1.16	12.5	18.35	996	58.3	5.26	.	7.4
		7	.	.	0.58	5.8	14.64	1218	626.8	487.59	.	7.32
		7.5	.	.	0.36	3.5	14.32	1225	.	.	.	7.34
09/26/07	7.5	0	1.42	35.410608	6.4	68.5	18.56	731	82.6	9.96	0.813	7.98
		1	.	.	8.22	88	18.54	730	.	.	.	7.69
		2	.	.	3.1	33.2	18.51	731	.	.	.	7.59
		3	.	.	5.67	60.7	18.46	730	.	.	.	7.51
		4	.	.	5.4	57.7	18.39	730	71	12.33	.	7.44
		5	.	.	7.92	84	18.06	730	61.4	16.56	.	7.38
		6	.	.	1.12	11.8	17.75	730	.	.	.	7.34
		7	.	.	0	0	16.29	890	182.6	68.6	.	7.19
		7.5	.	.	0	0	15.81	927	.	.	.	7.11

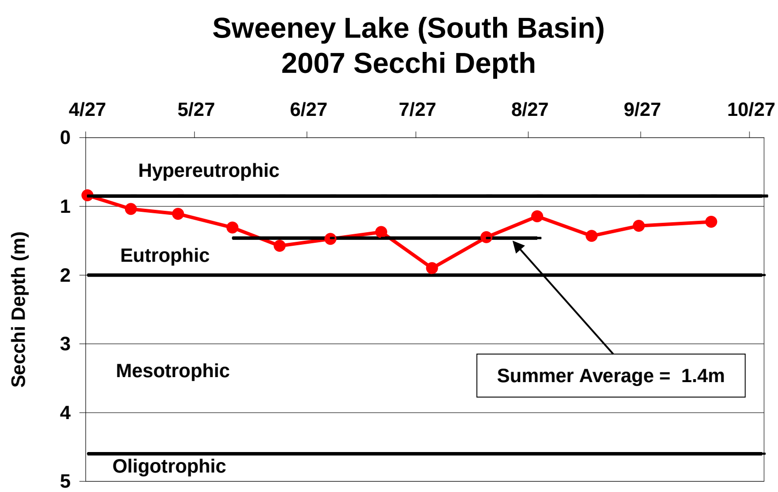
Sweeney Lake (North Basin) 2007

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25^{o}C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
10/16/07	7.4	0	1.20	18.916416	7.35	70.5	13.42	563	46.9	9.61	0.998	6.95
		1	.	.	6.52	62.5	13.42	563	.	.	.	6.92
		2	.	.	6.29	60.3	13.41	564	.	.	.	6.91
		3	.	.	5.98	57.4	13.39	564	45	8.48	.	6.9
		4	.	.	5.95	57.1	13.39	564	48	9.55	.	6.9
		5	.	.	5.92	56.8	13.39	564	.	.	.	6.9
		6	.	.	5.9	56.6	13.39	564	.	.	.	6.9
		7	.	.	5.84	56	13.39	564	56.7	11.02	.	6.91
		7.4	.	.	2.05	19.7	13.45	567	.	.	.	6.82

2007 Sweeney Lake Water Quality Data: South Basin only (surface = 0-2m depth)







Sweeney Lake (South Basin) 2007

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (μg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (μmhos/cm @25°C)	Total P (μg/L)	Ortho P (μg/L)	Total N (mg/L)	pH
04/27/07	7.5	0	0.82		17.3	169.9	14.43	920	65	4.77	1.074	7.98
		1	.	.	16.52	160.7	13.99	922	.	.	.	7.91
		2	.	.	15.18	147.4	13.89	925	.	.	.	7.85
		3	.	.	12.11	114.4	12.66	934	.	.	.	7.67
		4	.	.	7.87	67.2	8.32	953	44.8	6.22	.	7.48
		5	.	.	6.75	55.3	6.68	962	47	7.33	.	7.43
		6	.	.	6.02	48.3	5.87	969	.	.	.	7.42
		7	.	.	2.22	17.6	5.5	1013	43.1	14.9	.	7.4
		7.5	.	.	0.99	7.9	5.46	1044	.	.	.	7.45
05/09/07	7.6	0	0.98	24.49992	12.07	126.6	17.53	924	63.3	3.05	1.01	8.2
		1	.	.	12.38	128.5	17.02	925	.	.	.	8.22
		2	.	.	11.47	115.6	15.62	946	.	.	.	8.01
		3	.	.	7.69	75.4	14.38	952	.	.	.	7.76
		4	.	.	3.79	34.8	11.48	956	57.1	2.65	.	7.52
		5	.	.	2.5	21	7.65	976	52.9	1.91	.	7.43
		6	.	.	2.49	20.3	6.43	985	.	.	.	7.42
		7	.	.	2.21	17.9	6.09	1009	34.1	2.16	.	7.39
		7.6	.	.	0.6	4.9	6.08	1022	.	.	.	7.62
05/22/07	7.5	0	1.08	20.92	10.5	112.3	18.46	1116	50	0.8	0.836	8.15
		1	.	.	10.15	108.2	18.28	1117	.	.	.	8.14
		2	.	.	9.79	102.7	17.49	1119	.	.	.	8.07
		3	.	.	4.06	40.7	15.33	1124	.	.	.	7.67
		4	.	.	0.91	8.8	13.7	1132	55.7	1.41	.	7.5
		5	.	.	0.4	3.5	8.92	1167	78.7	0.56	.	7.41
		6	.	.	0.32	2.6	7.06	1175	.	.	.	7.39
		7	.	.	0.26	2.1	6.62	1209	48.5	0.57	.	7.41
		7.5	.	.	0.26	2.1	6.56	1212	.	.	.	7.43
06/06/07	7.6	0	1.30	11.986164	9.71	108	20.43	820	45.2	0.89	0.719	8.03
		1	.	.	9.89	110	20.44	820	.	.	.	8.07
		2	.	.	9.94	110.4	20.41	821	.	.	.	8.08
		3	.	.	4.84	51.9	18.61	844	59.9	3.37	.	7.74
		4	.	.	0.98	10.1	16.79	857	73.5	2.52	.	7.54
		5	.	.	0.87	8.2	12.52	879	.	.	.	7.52
		6	.	.	0.71	6.2	9	904	.	.	.	7.5
		7	.	.	0.64	5.5	8.43	909	278.4	3.82	.	7.5
		7.6	.	.	0.48	4	7.54	932	.	.	.	7.48
06/19/07	7.5	0	1.45	10.2246582	4.95	58.8	23.85	887	41.7	0.72	0.783	7.96
		1	.	.	5.34	63.4	23.8	887	.	.	.	7.99
		2	.	.	5.17	60.9	23.44	890	.	.	.	7.98
		3	.	.	2.71	31.6	22.8	894	.	.	.	7.81
		4	.	.	0.68	7.6	21.02	891	76.7	9.22	.	7.76
		5	.	.	0.17	1.9	19.55	890	72.5	8.7	.	7.74
		6	.	.	0	0	11.47	935	.	.	.	7.72
		7	.	.	0	0	8.83	967	412.9	8.7	.	7.7
		7.5	.	.	0	0	8.38	980	.	.	.	7.64

Sweeney Lake (South Basin) 2007

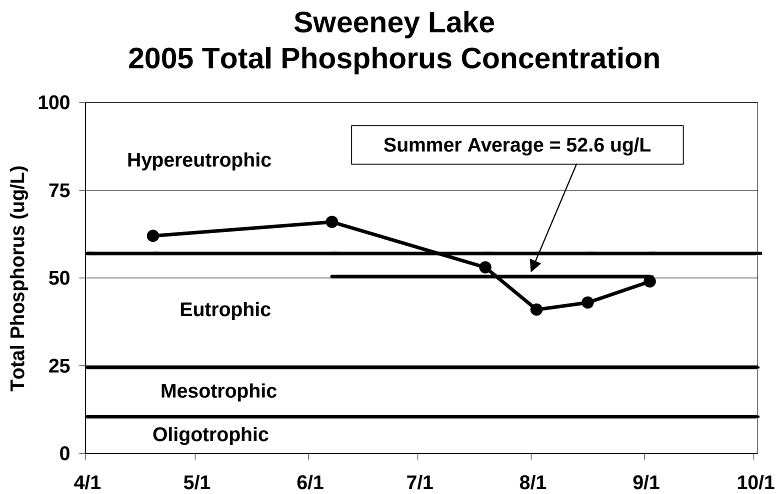
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
07/03/07	7.4	0	1.45	8.855322	10.43	126.3	24.85	1113	48.9	23.54	0.663	7.74
		1	.	.	10.8	130.4	24.7	1113	.	.	.	7.82
		2	.	.	9.58	114.8	24.32	1114	.	.	.	7.78
		3	.	.	7.89	93.9	23.94	1148	60.7	19	.	7.69
		4	.	.	0.99	11.4	21.97	1118	60.6	19.08	.	7.4
		5	.	.	1.56	15.9	16.09	1153	.	.	.	7.37
		6	.	.	0.97	8.8	10.89	1196	.	.	.	7.32
		7	.	.	0.94	8.5	10.65	1176	209.7	28.36	.	7.31
		7.4	.	.	0.98	8.6	9.32	1213	.	.	.	7.29
07/17/07	7.5	0	1.35	9.760185	9.34	114.8	25.69	1062	34.4	6.73	0.613	7.69
		1	.	.	9.74	119.1	25.42	1065	.	.	.	7.77
		2	.	.	9.47	114.8	24.94	1070	.	.	.	7.8
		3	.	.	7.01	83.6	24.03	1074	.	.	.	7.73
		4	.	.	2.38	27.8	22.91	1079	37.4	9.52	.	7.53
		5	.	.	0.93	10	19.1	1118	45.8	13.71	.	7.45
		6	.	.	0.94	9.2	14.29	1156	.	.	.	7.41
		7	.	.	0.73	6.7	11.48	1162	361.9	52.4	.	7.41
		7.5	.	.	0.58	5.2	10.49	1189	.	.	.	7.4
07/31/07	7.4	0	1.80	4.7289972	9.55	121	27.45	924	43.3	3.54	0.488	7.56
		1	.	.	10.05	127.2	27.35	921	.	.	.	7.65
		2	.	.	10.08	127.2	27.21	922	.	.	.	7.67
		3	.	.	5.73	71.1	26.24	934	55.7	6.62	.	7.56
		4	.	.	0.79	9.6	24.87	930	81.4	15.88	.	7.34
		5	.	.	0.5	5.5	19.97	952	.	.	.	7.31
		6	.	.	0.48	4.8	15.77	989	.	.	.	7.27
		7	.	.	0.37	3.5	12.17	1015	683.2	95.95	.	7.25
		7.4	.	.	0.28	2.6	11.65	1026	.	.	.	7.26
08/15/07	8	0	1.40	13.98379125					35.5	5.94	0.63	
		4	.	.					77.1	27.38	.	
		5	.	.					79.8	22.91	.	
		8	.	.					1208.7	122.01	.	
08/29/07	7.3	0	0.90	65.85403344	8.46	138.6	23.06	834	73.8	6.87	1.2	7.76
		1	.	.	8.81	140.8	22.82	791.6	.	.	.	7.84
		2	.	.	8.6	137.3	22.61	792.6	.	.	.	7.88
		3	.	.	6.3	97.3	21.79	755.9	55.9	7.31	.	7.86
		4	.	.	0.91	15.5	21.42	956.3	41.1	10.52	.	7.57
		5	.	.	0.81	13.5	20.72	957.6	.	.	.	7.55
		6	.	.	0.27	4.6	17.04	1149	.	.	.	7.44
		7	.	.	0.12	2.2	13.46	1236	984.1	156.77	.	7.4
		7.3	.	.	0.09	1.6	13.06	1245	.	.	.	7.38
09/13/07	7.3	0	1.39	17.783268	8.06	88.3	19.69	880	49.2	3.6	0.62	7.57
		1	.	.	8.06	88.3	19.69	880	.	.	.	7.57
		2	.	.	8.03	88	19.7	880	.	.	.	7.59
		3	.	.	7.98	87.4	19.7	880	.	.	.	7.59
		4	.	.	7.73	84.6	19.65	882	.	.	.	7.61
		5	.	.	7.55	82.5	19.56	885	46.8	3.91	.	7.61
		6	.	.	1.76	18.7	18.07	1046	95.2	19.19	.	7.44
		7	.	.	0.68	6.8	14.61	1225	723.7	426.45	.	7.36
		7.3	.	.	0.37	3.7	14.55	1225	.	.	.	7.36

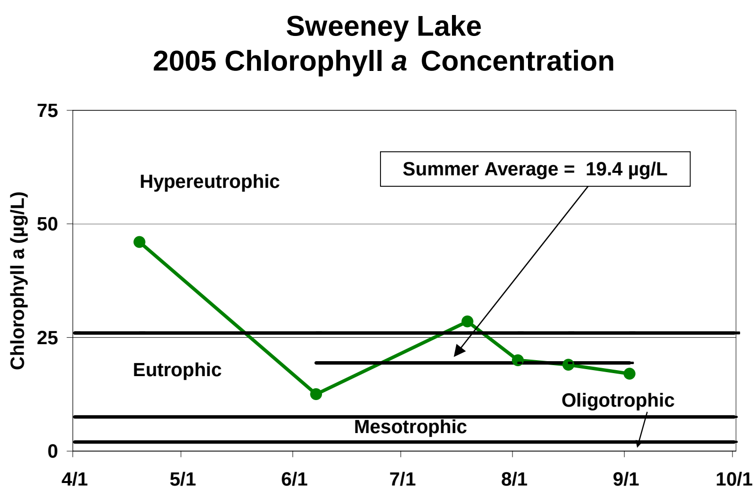
Sweeney Lake (South Basin) 2007

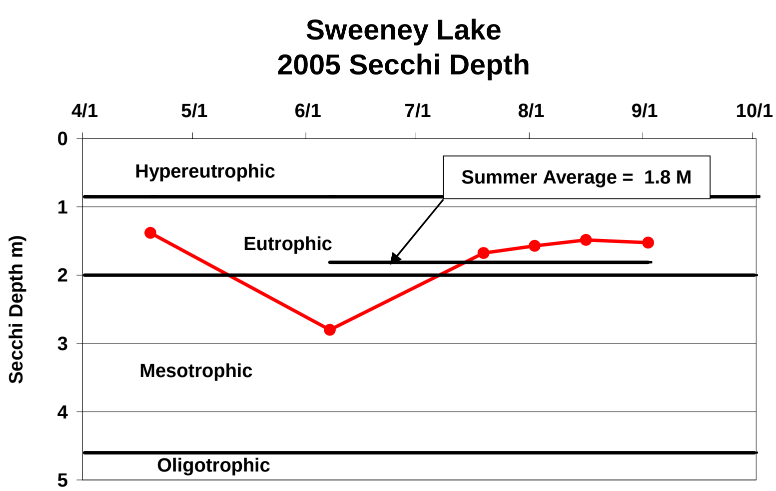
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
09/26/07	7.9	0	1.15	31.862712	6.17	66	18.52	713	78.7	15.19	0.827	7.36
		1	.	.	7.53	80.5	18.52	713	.	.	.	7.38
		2	.	.	6.69	71.5	18.5	720	.	.	.	7.38
		3	.	.	8.15	87	18.37	721	.	.	.	7.38
		4	.	.	4.96	52.5	18.17	722	74.7	20.75	.	7.38
		5	.	.	2.89	30.5	17.79	722	62.2	20.78	.	7.38
		6	.	.	4.71	49.2	17.45	725	.	.	.	7.36
		7	.	.	0	0	15.86	888		84.76	.	7.23
		7.9	.	.	0	0	15.21	976	.	.	.	7.15
10/16/07	7.8	0	1.25	29.767296	8.73	83.9	13.5	572	56.8	5.63	1.013	6.97
		1	.	.	7.98	76.7	13.5	572	.	.	.	6.97
		2	.	.	7.79	74.9	13.49	573	.	.	.	6.97
		3	.	.	7.51	72.1	13.48	573	52.6	6.62	.	6.98
		4	.	.	7.37	70.8	13.47	574	48	5.63	.	6.99
		5	.	.	7.3	70.1	13.47	576	.	.	.	6.99
		6	.	.	7.22	69.3	13.38	612	.	.	.	6.97
		7	.	.	7	66.4	12.92	675	50.6	6.62	.	6.96
		7.8	.	.	0.86	8.1	12.76	677	.	.	.	6.99

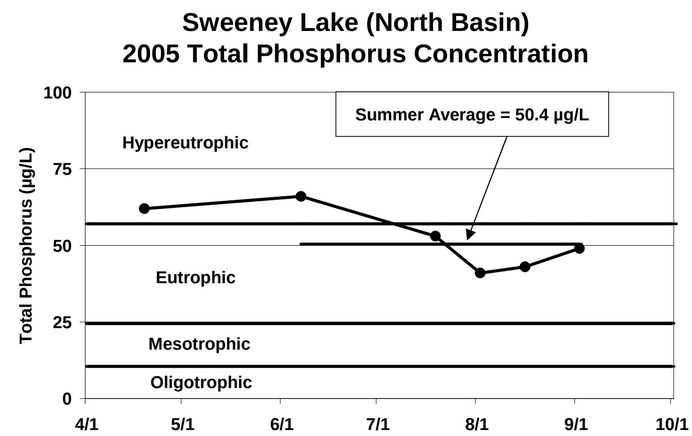
Appendix C

2005 Sweeney Lake Data

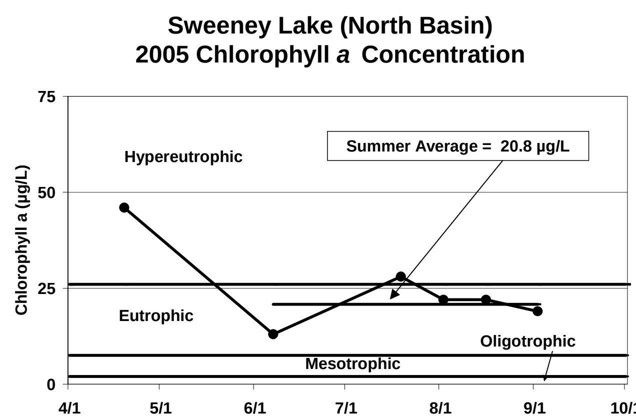

Sweeney Lake
2005 Total Phosphorus Concentration
Summer Average = 52.6 ug/L
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
Total Phosphorus (ug/L)
100
75
50
25
0
4/1
5/1
6/1
7/1
8/1
9/1
10/1


Sweeney Lake
2005 Chlorophyll *a* Concentration
Summer Average = 19.4 µg/L
Hypereutrophic
Eutrophic
Oligotrophic
Mesotrophic
Chlorophyll a (µg/L)
75
50
25
0
4/1
5/1
6/1
7/1
8/1
9/1
10/1

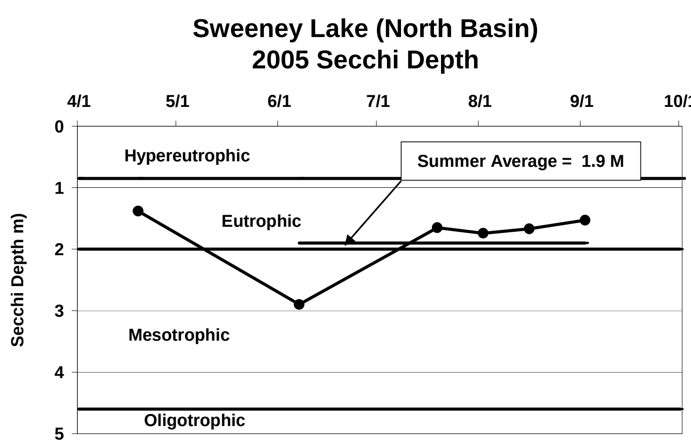

Sweeney Lake
2005 Secchi Depth
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Hypereutrophic
Summer Average = 1.8 M
Eutrophic
Mesotrophic
Oligotrophic
Secchi Depth m)
0
1
2
3
4
5



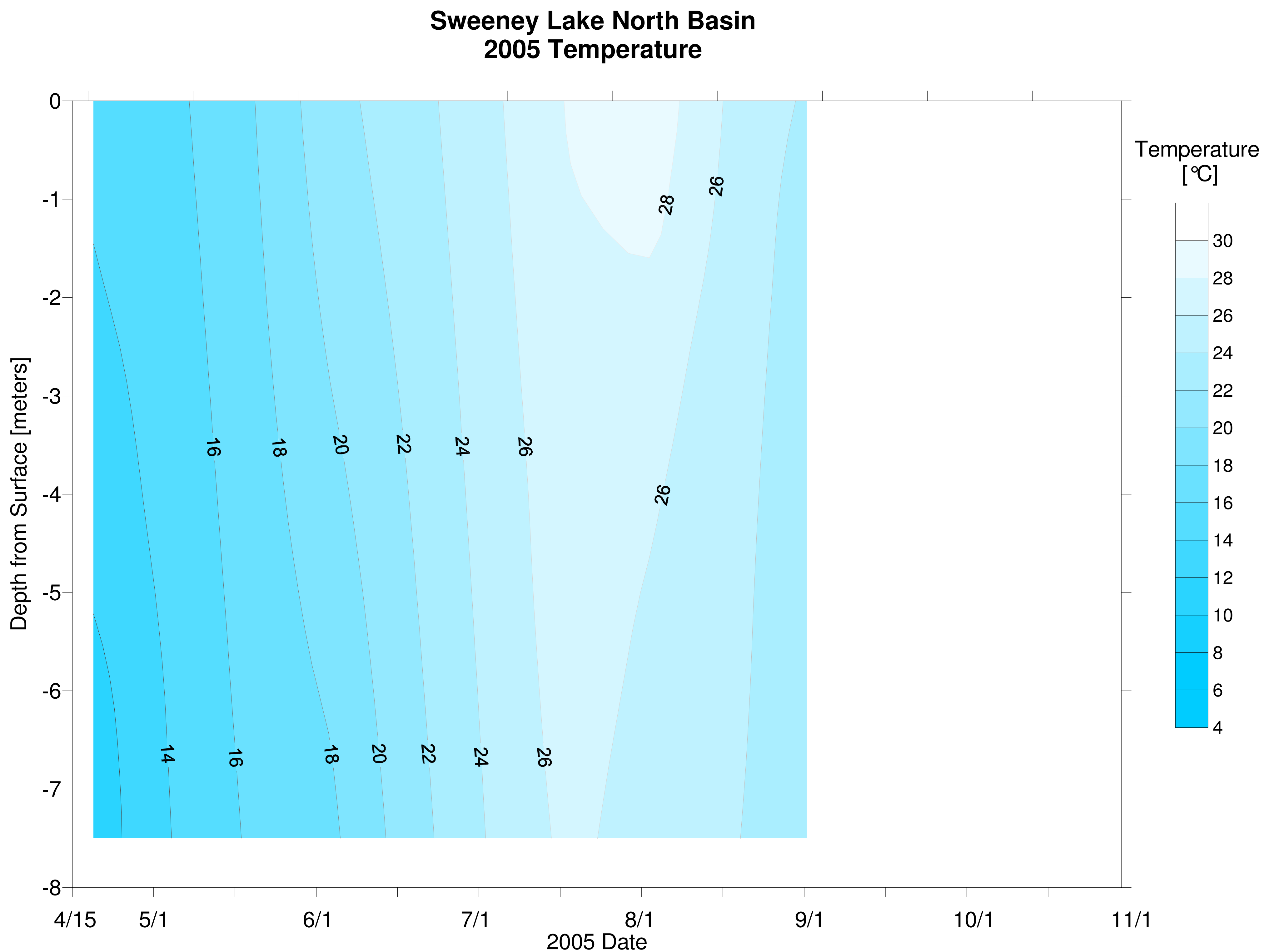
Sweeney Lake (North Basin)
2005 Total Phosphorus Concentration
Total Phosphorus (µg/L)
100
75
50
25
0
Summer Average = 50.4 µg/L
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
4/1
5/1
6/1
7/1
8/1
9/1
10/1



Sweeney Lake (North Basin)
2005 Chlorophyll *a* Concentration
Chlorophyll a (µg/L)
75
50
25
0
Summer Average = 20.8 µg/L
Hypereutrophic
Eutrophic
Oligotrophic
Mesotrophic
4/1
5/1
6/1
7/1
8/1
9/1
10/1

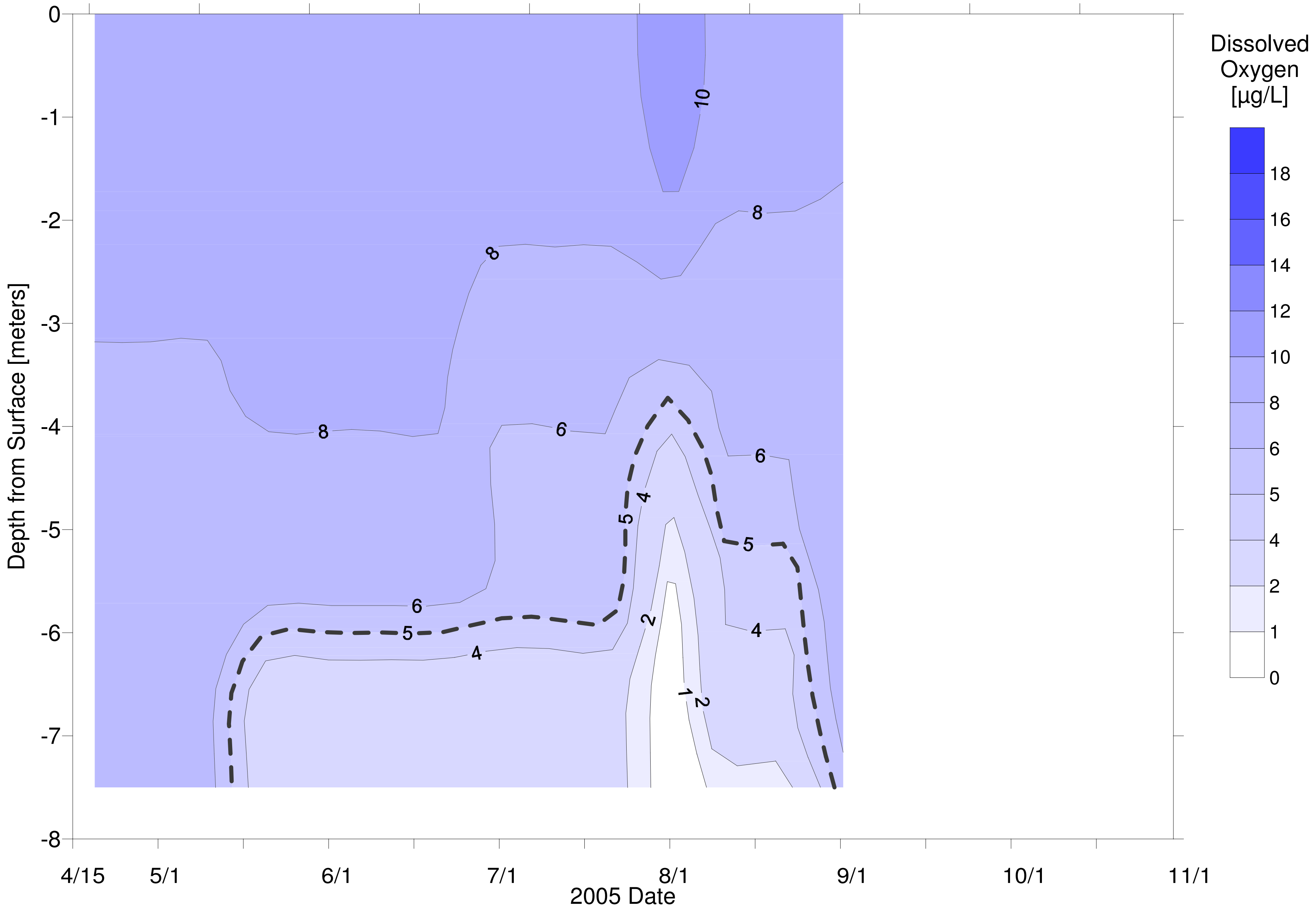


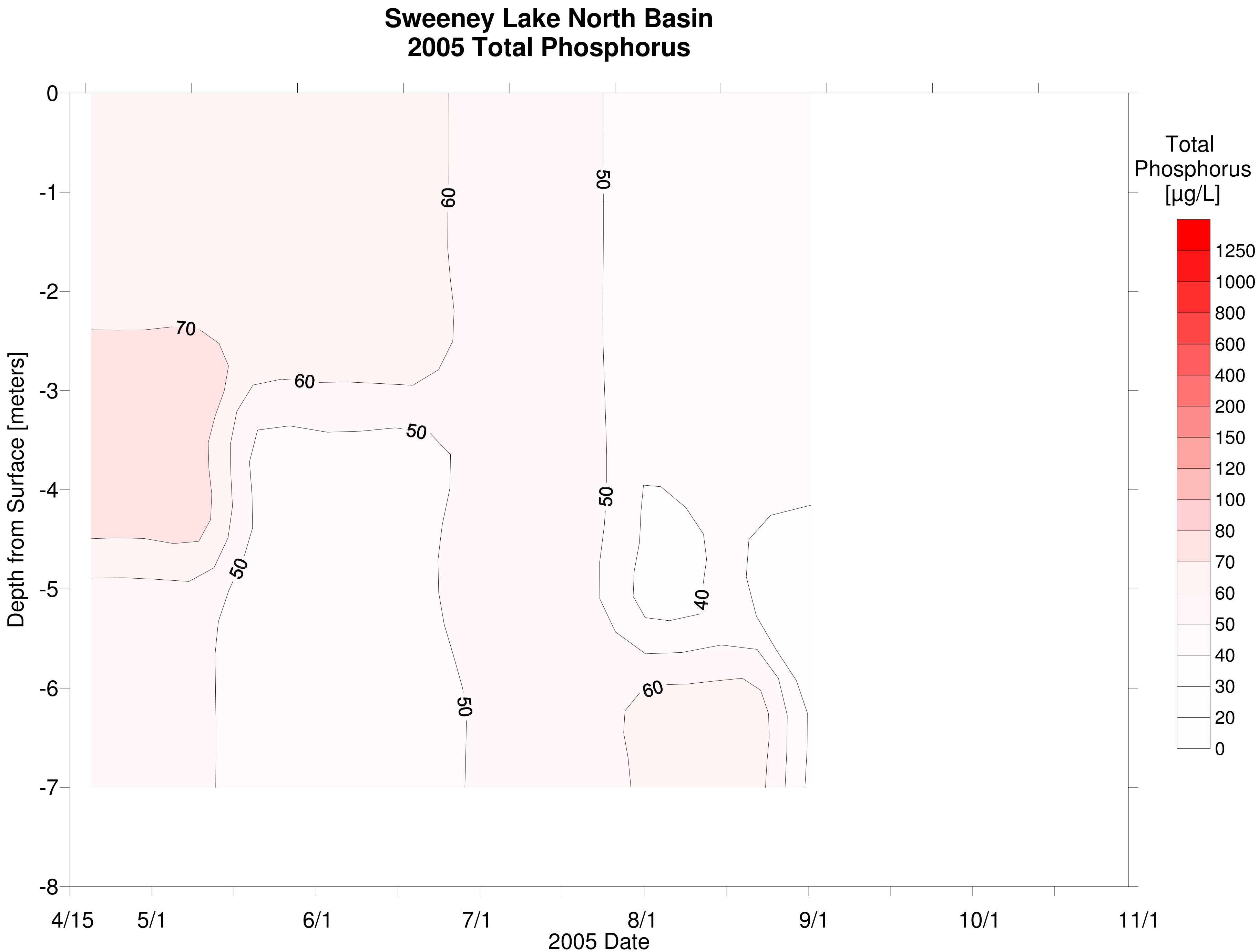
Sweeney Lake (North Basin)
2005 Secchi Depth
Secchi Depth m)
4/1
5/1
6/1
7/1
8/1
9/1
10/1
0
1
2
3
4
5
Hypereutrophic
Summer Average = 1.9 M
Eutrophic
Mesotrophic
Oligotrophic



Sweeney Lake North Basin
2005 Temperature
Depth from Surface [meters]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
2005 Date
Temperature
[℃]
30
28
26
24
22
20
18
16
14
12
10
8
6
4

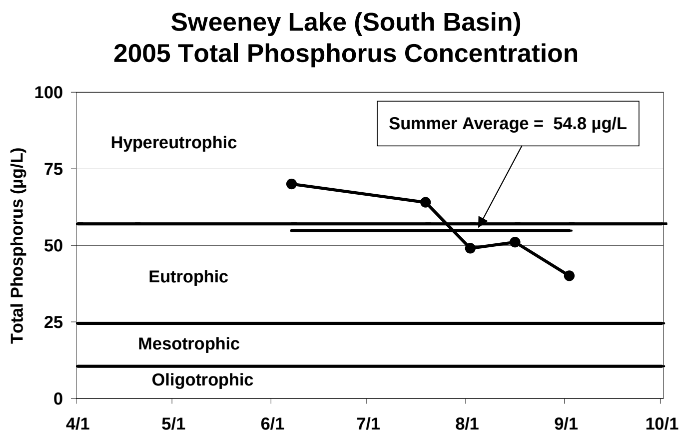
Sweeney Lake North Basin
2005 Dissolved Oxygen

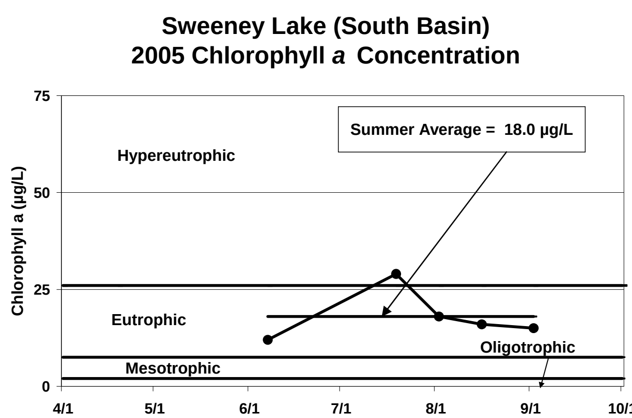


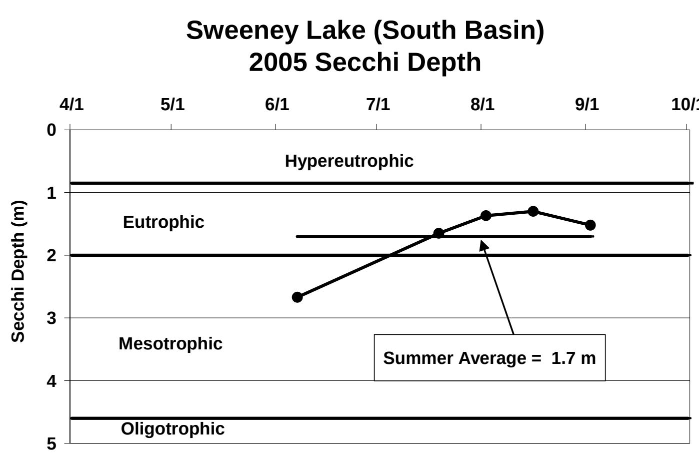

Sweeney Lake North Basin
2005 Total Phosphorus
Depth from Surface [meters]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
2005 Date
70
60
50
40
Total Phosphorus [µg/L]
1250
1000
800
600
400
200
150
120
100
80
70
60
50
40
30
20
0

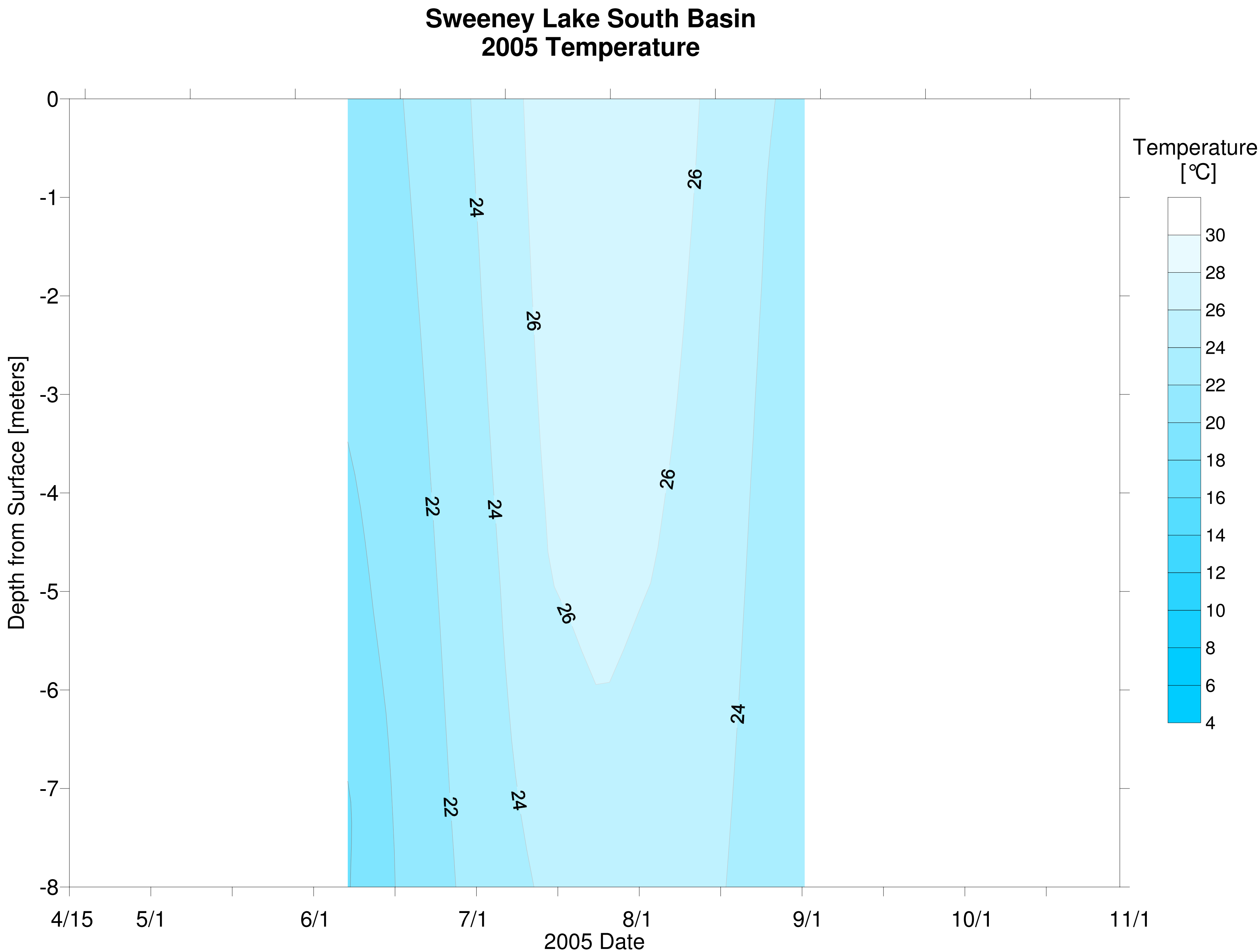
Sweeney Lake (North Basin)

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chl. a (ug/L)	D. O. (mg/L)	Temp (°C)	Sp. Cond. (µmho/cm @ 25°C)	Total P (mg/L)	Ortho P (mg/L)	Total Nitrogen (mg/L)	pH (S.U.)
4/19/05	7.5	0-2	1.4	46.0	--	--	--	0.062	0.003	1.25	--
		0.0			8.3	14.4	1177	--			6.6
		1.0			8.3	14.2	1177	--			6.6
		2.0			8.2	13.8	1178	--			6.5
		3.0			8.1	13.2	1177	0.073	0.003		6.5
		4.0			7.9	12.9	1181	--			6.5
		5.0			7.6	12.2	1198	--			6.4
		6.0			6.8	11.3	1221	--			6.4
		7.0			6.3	10.8	1227	0.051	0.16		6.3
6/7/05	7.5	0-2	2.9	13.0	--	--	--	0.066	0.004	0.93	--
		0.0			9.5	22.7	1041	--			7.3
		1.0			9.4	22.6	1042	--			7.3
		2.0			9.4	21.8	1042	--			7.3
		3.0			8.6	20.7	1044	--			7.2
		4.0			8.2	19.8	1046	0.048			7.1
		5.0			7.6	19.3	1047	--			7.1
		6.0			6.4	18.7	1050	--			7.1
		7.0			2.9	17.2	1050	0.047			6.6
7/19/05	7.5	0-2	1.7	28.0	--	--	--	0.053	0.003	0.67	--
		0.0			8.9	28.2	894	--			8.0
		1.0			8.1	27.9	894	--			8.0
		2.0			8.5	27.7	893	--			8.1
		3.0			7.3	27.4	893	--			8.0
		4.0			6.1	27.2	893	0.054	0.005		8.0
		5.0			5.8	27.2	893	--			8.0
		6.0			5.8	27.0	893	--			8.0
		7.0			2.6	26.7	899	0.051	0.010		7.7
8/2/05	7.5	0-2	1.7	22.0	--	--	--	0.041	0.004	0.67	--
		0.0			11.5	29.8	929	--			8.3
		1.0			11.8	29.2	929	--			8.3
		2.0			9.8	27.2	930	--			8.1
		3.0			7.4	26.8	929	--			7.9
		4.0			4.9	26.3	928	--			7.6
		5.0			2.3	25.9	930	0.039			7.4
		6.0			0.6	25.6	931	--			7.3
		7.0			0.2	25.2	939	0.063			7.1
8/16/05	8.0	0-2	1.67	22.0	--	--	--	0.043	0.003	0.58	--
		0.0			9.0	26.3	934	--			7.8
		1.0			8.5	25.7	934	--			7.8
		2.0			8.1	25.5	933	--			7.8
		3.0			7.1	24.9	930	--			7.7
		4.0			6.3	24.9	931	0.040			7.7
		5.0			5.8	24.8	931	--			7.7
		6.0			4.2	24.7	935	--			7.7
		7.0			3.6	24.7	935	0.065			7.6
		7.5			1.5	24.5	952	--			7.3
9/2/05	8.0	0-2	1.53	19.0	--	--	--	0.049	<0.003	0.59	--
		0.0			9.2	23.7	930	--			7.3
		1.0			8.3	23.2	925	--			7.3
		2.0			7.9	23.0	880	--			7.3
		3.0			7.7	23.0	880	--			7.4
		4.0			7.5	22.9	880	--			7.4
		5.0			7.4	22.8	880	0.037			7.4
		6.0			7.3	22.8	882	--			7.4
		7.0			6.7	22.7	882	--			7.4
		7.5			5.6	22.6	926	--			7.2


Sweeney Lake (South Basin)
2005 Total Phosphorus Concentration
Total Phosphorus (µg/L)
Summer Average = 54.8 µg/L
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
100
75
50
25
0
4/1
5/1
6/1
7/1
8/1
9/1
10/1

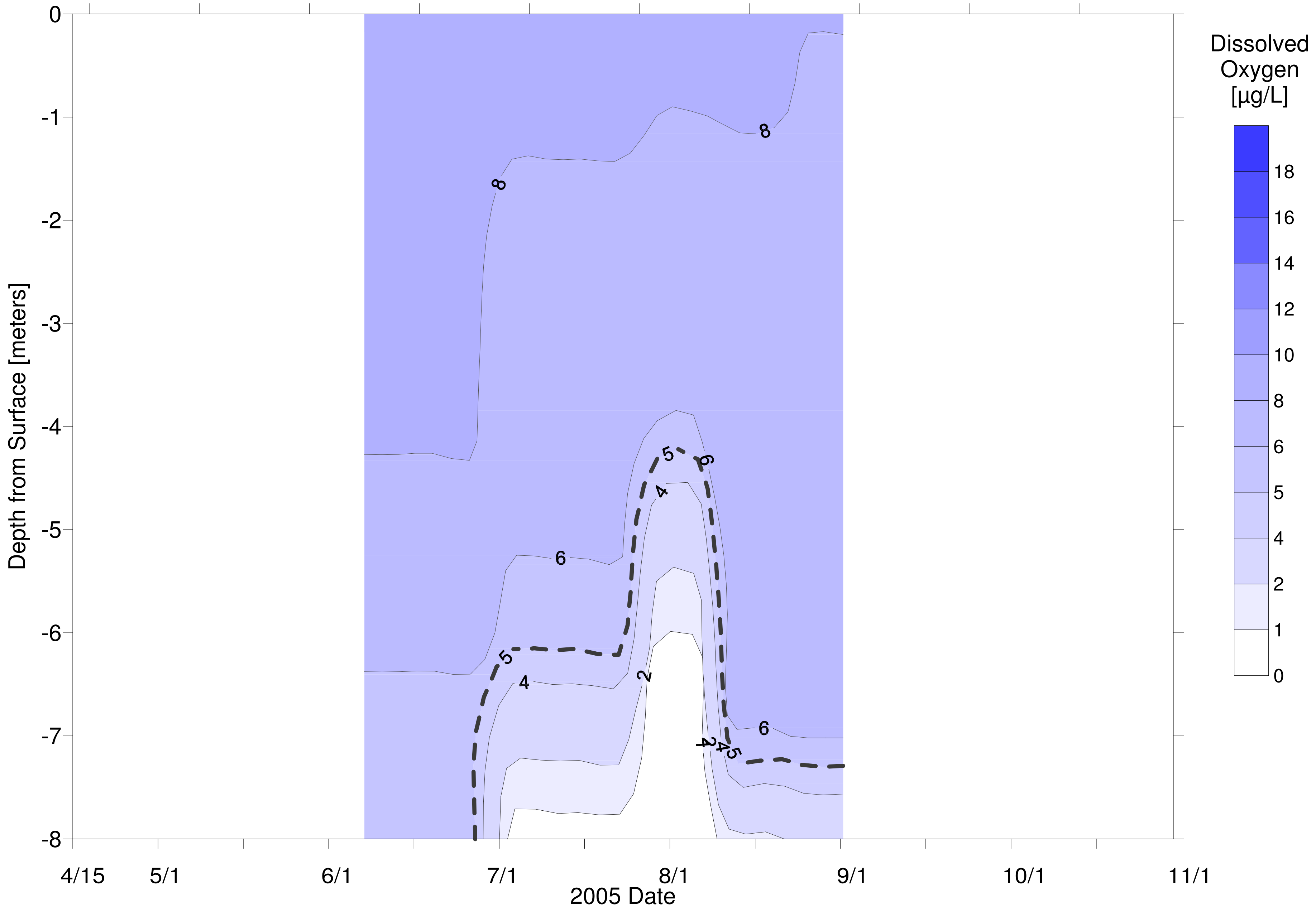

Sweeney Lake (South Basin)
2005 Chlorophyll a Concentration
Chlorophyll a (µg/L)
Summer Average = 18.0 µg/L
Hypereutrophic
Eutrophic
Oligotrophic
Mesotrophic
75
50
25
0
4/1
5/1
6/1
7/1
8/1
9/1
10/1

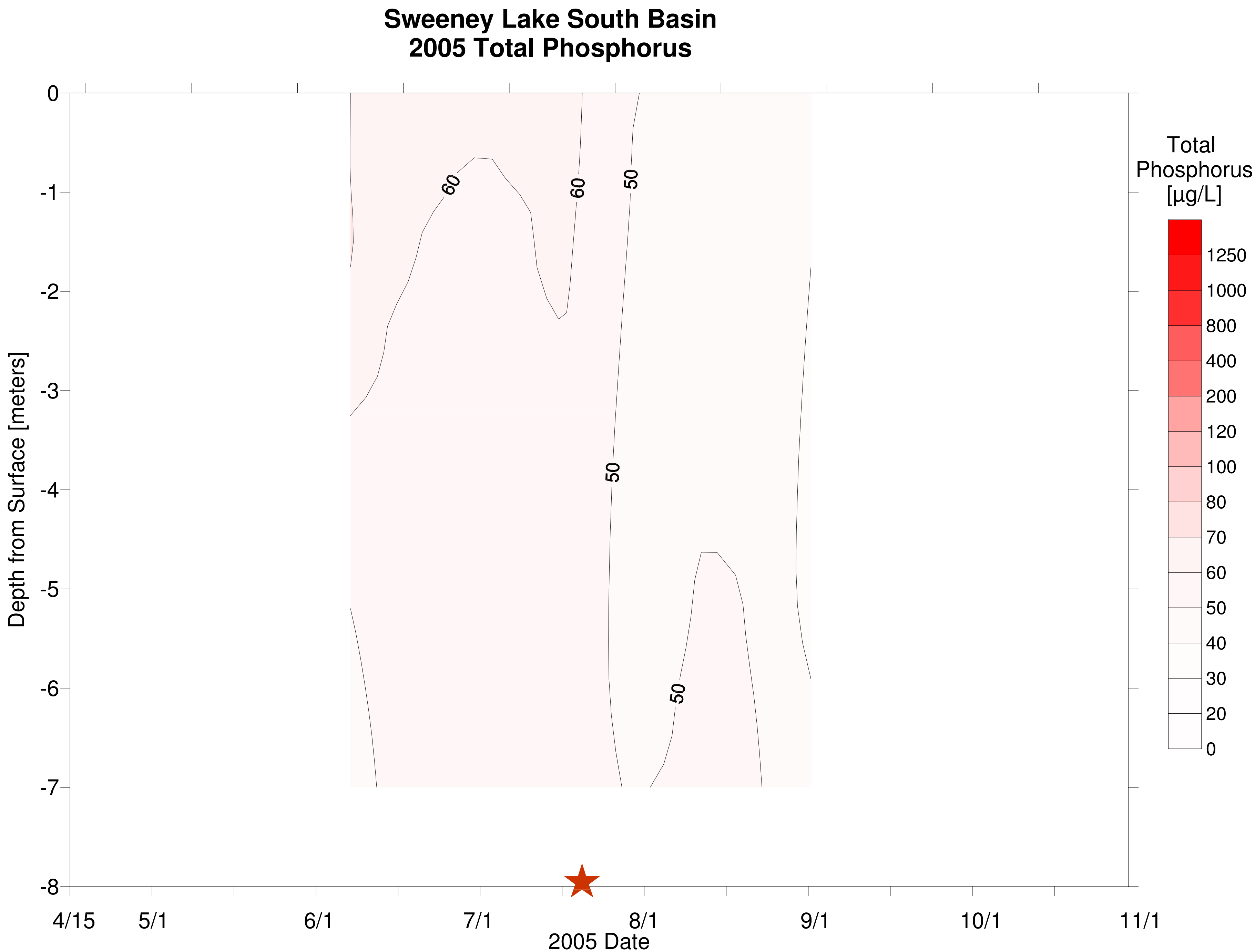

Sweeney Lake (South Basin)
2005 Secchi Depth
Secchi Depth (m)
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Hypereutrophic
Eutrophic
Mesotrophic
Oligotrophic
Summer Average = 1.7 m
0
1
2
3
4
5



Sweeney Lake South Basin
2005 Temperature
Depth from Surface [meters]
0
-1
-2
-3
-4
-5
-6
-7
-8
4/15
5/1
6/1
7/1
8/1
9/1
10/1
11/1
2005 Date
Temperature [℃]
30
28
26
24
22
20
18
16
14
12
10
8
6
4

Sweeney Lake South Basin
2005 Dissolved Oxygen





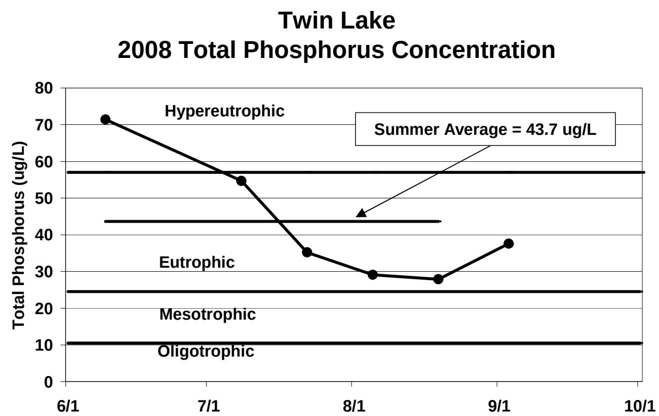
★ Note: TP concentration of 580ug/L noted at 8.0m depth, 7/19/2005

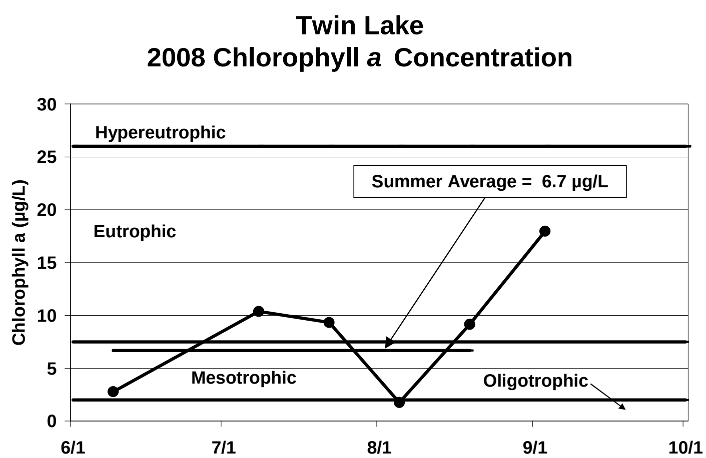
Sweeney Lake (South Basin)

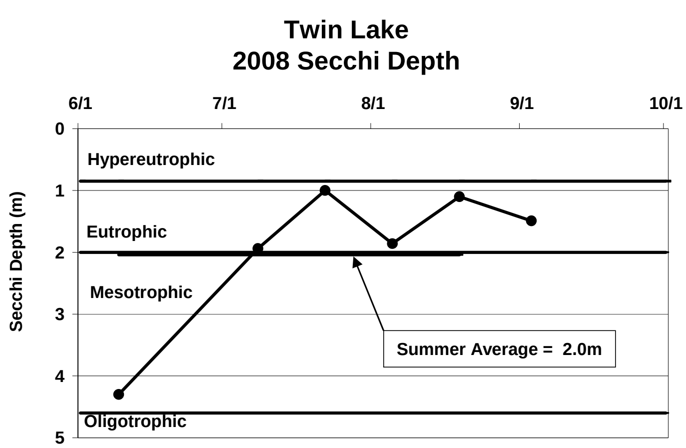
Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chl. a (ug/L)	D. O. (mg/L)	Temp (°C)	Sp. Cond. (µmho/cm @ 25°C)	Total P (mg/L)	Ortho P (mg/L)	Total Nitrogen (mg/L)	pH (S.U.)
6/7/05	7.5	0-2	2.7	12.0	--	--	--	0.070	0.004	0.98	--
		0.0			8.8	21.4	1046	--			7.0
		1.0			8.7	21.1	1046	--			7.0
		2.0			8.4	20.7	1046	--			6.9
		3.0			8.3	20.4	1046	--			6.9
		4.0			8.1	19.7	1047	0.054			6.9
		5.0			7.7	19.5	1047	--			6.9
		6.0			6.6	18.7	1052	--			6.8
		7.0			5.0	17.9	1054	0.044			6.8
7/19/05	8.5	0-2	1.7	29.0	--	--	--	0.064	0.008	0.93	--
		0.0			9.4	27.9	898	--			8.1
		1.0			8.4	27.7	899	--			8.0
		2.0			7.4	27.3	902	--			8.0
		3.0			6.6	27.2	902	--			7.9
		4.0			6.3	27.1	902	0.051	0.010		7.9
		5.0			6.2	27.0	902	--			7.9
		6.0			5.5	26.9	899	--			7.9
		7.0			2.5	26.2	924				7.8
		8.0			0.5	23.4	967	0.580	0.015		7.2
8/2/05	8.0	0-2	1.4	18.0	--	--	--	0.049	0.011	0.73	--
		0.0			8.9	28.2	935	--			7.9
		1.0			8.0	27.8	935	--			7.9
		2.0			7.5	27.1	933	--			7.8
		3.0			7.1	26.8	934	--			7.8
		4.0			5.9	26.4	928	--			7.7
		5.0			2.8	26.0	931	0.035			7.5
		6.0			1.1	25.7	932	--			7.4
		7.0			0.0	25.3	945	0.054			7.2
		7.5			0.0	25.2	946	--			7.1
8/16/05	8.0	0-2	1.3	16.0	--	--	--	0.051	<0.002	0.57	--
		0.0			8.6	25.6	940	--			7.8
		1.0			8.1	25.2	944	--			7.8
		2.0			7.6	25.0	939	--			7.8
		3.0			7.2	24.9	940	--			7.7
		4.0			7.2	24.9	940	0.040			7.7
		5.0			7.6	24.8	944	--			7.7
		6.0			6.9	24.8	944	--			7.7
		7.0			5.9	24.5	973	0.061			7.7
		7.5			1.7	24.3	992	--			7.3
9/2/05	8.0	0-2	1.52	15.0	--	--	--	0.040	<0.003	0.66	--
		0.0			8.0	23.4	884	--			7.5
		1.0			7.9	23.0	884	--			7.5
		2.0			7.8	22.9	884	--			7.5
		3.0			7.6	22.8	884	--			7.5
		4.0			7.4	22.8	884	--			7.5
		5.0			7.3	22.7	884	0.035			7.5
		6.0			7.0	22.6	887	--			7.6
		7.0			6.1	22.4	893	0.046			7.5
		7.5			2.4	22.2	1161	--			7.1

Appendix D

2008 Twin Lake Data


Twin Lake
2008 Total Phosphorus Concentration
Total Phosphorus (ug/L)
Hypereutrophic
Summer Average = 43.7 ug/L
Eutrophic
Mesotrophic
Oligotrophic
80
70
60
50
40
30
20
10
0
6/1
7/1
8/1
9/1
10/1


Twin Lake
2008 Chlorophyll *a* Concentration
Chlorophyll a (µg/L)
Hypereutrophic
Summer Average = 6.7 µg/L
Eutrophic
Mesotrophic
Oligotrophic
30
25
20
15
10
5
0
6/1
7/1
8/1
9/1
10/1


Twin Lake
2008 Secchi Depth
Secchi Depth (m)
6/1
7/1
8/1
9/1
10/1
Hypereutrophic
Eutrophic
Mesotrophic
Summer Average = 2.0m
Oligotrophic
0
1
2
3
4
5

Twin Lake 2008

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
6/9/2008	12.85	0 - 2	4.3	2.8	.	.	.	.	71.4	21.9	1.39	.
		0	.	.	15.3	169.6	20.33	500	.	.	.	8.72
		1	.	.	12.46	138.1	20.31	499	.	.	.	8.7
		2	.	.	11.62	125.1	18.86	498	.	.	.	8.61
		3	.	.	10.45	111.5	18.43	498	.	.	.	8.54
		4	.	.	8.13	83.3	16.49	503	55.0	24.2	.	8.44
		5	.	.	0.8	7.5	12.14	521	64.3	34.8	.	8.2
		6	.	.	0.06	0.5	9.61	550	.	.	.	8.09
		7		.	0.01	0.1	7.3	593	.	.	.	7.98
		8	.	.	0.01	0.1	6.91	601	.	.	.	7.94
		9	.	.	0.01	0.1	6.81	601	.	.	.	7.92
		10	.	.	0.01	0.1	6.32	611	.	.	.	7.88
		11	.	.	0.01	0.1	6.23	613	.	.	.	7.86
		12	.	.	0.01	0.1	6.14	617	593.5	458.9	.	7.85
		12.85	.	.	0.01	0.1	6.07	674	.	.	.	7.64
7/8/2008	13.29	0 - 2	1.94	10.4	.	.	.	.	54.7	5.5	0.79	.
		0	.	.	10.74	132.3	25.88	477	.	.	.	8.33
		1	.	.	8.57	105	25.6	482	.	.	.	8.46
		2	.	.	9.01	110.2	25.5	489	.	.	.	8.49
		3	.	.	6.52	79	24.97	497	.	.	.	8.39
		4	.	.	2.17	23.8	19.74	526	197.8	6.0	.	8.2
		5	.	.	0.94	9	13.48	555	240.2	5.7	.	8.08
		6	.	.	0.74	6.4	10.67	592	.	.	.	8.01
		7	.	.	0.74	6.4	8.8	625	.	.	.	7.94
		8		.	0.55	4.5	7.56	646	.	.	.	7.88
		9	.	.	0.55	4.5	6.96	655	.	.	.	7.77
		10	.	.	0.23	1.9	6.77	659	.	.	.	7.67
		11	.	.	0.12	0.9	6.72	660	.	.	.	7.61
		12	.	.	0.7	5.8	6.68	662	.	.	.	7.58
		13	.	.	1.18	9.6	6.62	678	780.4	652.2	.	7.47
		13.29	.	.	0.01	0.1	6.55	802	.	.	.	7.33
7/22/2008	13	0 - 2	1	9.3	.	.	.	.	35.2	0.2	0.81	.
		0	.	.	10.86	137.3	27.32	500	.	.	.	8.09
		1	.	.	10.97	138.3	27.17	501	.	.	.	8.24
		2	.	.	11.26	139.4	26.18	502	.	.	.	8.31
		3	.	.	8.49	102.6	24.82	512	43.8	0.4	.	8.29
		4	.	.	0.97	11.3	22.77	528	47.8	2.0	.	8.14
		5	.	.	0.58	6	17.34	560	.	.	.	8.06
		6	.	.	0.49	4.5	11.94	608	.	.	.	7.99
		7			0.38	3.3	9.17	648				7.95
		8	.	.	0.26	2.2	7.76	671	.	.	.	7.86
		9	.	.	0.21	1.7	7.43	676	.	.	.	7.77
		10	.	.	0.11	0.9	7.4	675			.	7.75
		11	.	.	0.12	1	7.34	676	.	.	.	7.74
		12	.	.	0.12	1	7.24	680	817.6	750.6	.	7.71
		13	.	.	0.14	1.2	7.14	798	.	.	.	7.59

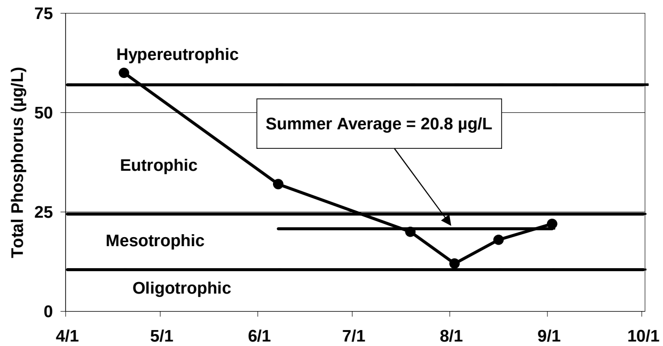
Twin Lake 2008

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chlorophyll-a (µg/L)	D.O. (mg/L)	D.O. % sat.	Temp (°C)	Sp. Cond. (µmhos/cm @25°C)	Total P (µg/L)	Ortho P (µg/L)	Total N (mg/L)	pH
8/5/2008	8.44	0 - 2	1.86	1.8	.	.	.	.	29.1	5.0	0.69	.
		0	.	.	8.11	99.4	25.64	516	.	.	.	7.61
		1	.	.	8.08	99	25.62	516	.	.	.	7.57
		2	.	.	8.11	99.3	25.59	517	.	.	.	7.55
		3	.	.	8.07	98.8	25.53	517	.	.	.	7.54
		4	.	.	7.46	90.8	25.2	517	29.7	5.5	.	7.54
		5	.	.	0.62	6.2	15.21	570	59.4	5.5	.	7.36
		6	.	.	0.13	1.2	11.57	608	.	.	.	7.27
		7	.	.	0.09	0.7	8.89	650	.	.	.	7.17
		8	.	.	0.09	0.7	7.71	666	563.9	492.8	.	7.13
		8.44	.	.	0.09	0.7	7.45	685	.	.	.	7.03
8/19/2008	13	0 - 2	1.1	9.2	.	.	.	.	27.9	3.9	0.71	.
		0	.	.	10.62	129.9	25.54	514	.	.	.	7.55
		1	.	.	10.62	129.9	25.54	514	.	.	.	7.55
		2	.	.	10.31	125	25.02	513	.	.	.	7.54
		3	.	.	9.75	117.2	24.56	515	.	.	.	7.56
		4	.	.	1.62	18.7	22.42	529	23.8	3.9	.	7.53
		5	.	.	0.71	7.3	16.31	570	90.4	3.5	.	7.44
		6	.	.	0.35	3.2	11.38	616	.	.	.	7.33
		7	.	.	0.45	3.8	8.65	655	.	.	.	7.24
		8	.	.	0.13	1.1	8.25	661	.	.	.	7.22
		9	.	.	0.27	2.3	7.53	670	.	.	.	7.19
		10	.	.	0.41	3.4	7.41	673	.	.	.	7.2
		11	.	.	0.22	1.9	7.33	675	.	.	.	7.21
		12	.	.	0.35	2.9	7.22	680	.	.	.	7.22
		13	.	.	0.42	3.5	7.32	713	971.0	748.1	.	7.11
9/3/2008	8.27	0 - 2	1.49	18.0	.	.	.	.	37.6	3.7	.	.
		0	.	.	7.96	91.7	22.28	482	.	.	.	7.91
		1	.	.	8.26	95	22.21	482	.	.	.	7.9
		2	.	.	7.98	91.7	22.17	482	.	.	.	7.91
		3	.	.	8.03	92.1	22.07	482	.	.	.	7.93
		4	.	.	7.56	86.5	21.97	483	.	.	.	7.95
		5	.	.	5.8	65.4	21.21	489	47.6	3.7	.	7.97
		6	.	.	0.38	3.6	12.27	596	84.0	4.6	.	7.89
		7	.	.	0.09	0.7	9.43	627	.	.	.	7.77
		8	.	.	0.09	0.7	7.85	667	546.1	404.0	.	7.65
		8.27	.	.	0.09	0.7	8.01	713	.	.	.	7.45

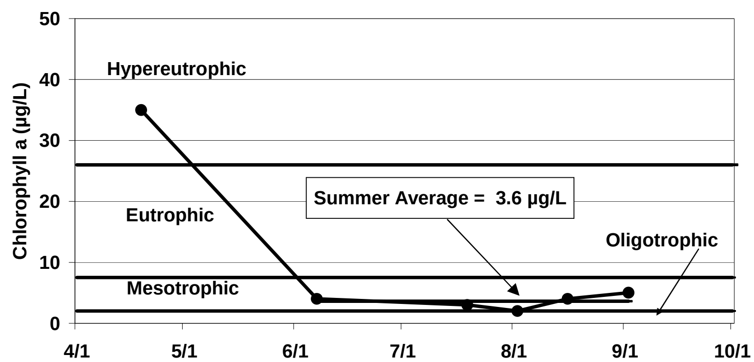
Appendix E

2005 Twin Lake Data

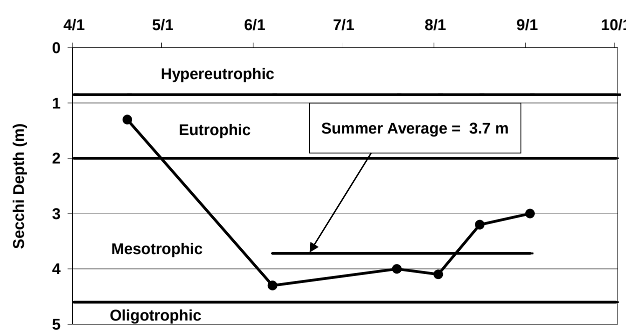
Twin Lake
2005 Total Phosphorus Concentration



Twin Lake
2005 Chlorophyll a Concentration



Twin Lake
2005 Secchi Depth



Twin Lake

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chl. a (ug/L)	D. O. (mg/L)	Temp (°C)	Sp. Cond. (µmho/cm @ 25°C)	Total P (mg/L)	Ortho P (mg/L)	Total Nitrogen (mg/L)	pH (S.U.)
4/19/05	16.0	0-2	1.3	35.0	--	--	--	0.060	0.005	1.3	--
		0.0			10.8	16.8	555	--			
		1.0			10.0	16.4	560	--			6.7
		2.0			8.5	13.1	590	--			6.6
		3.0			2.1	5.4	691	--			6.5
		4.0			0.8	4.0	704	0.100	0.005		6.5
		5.0			0.3	4.0	704	--			6.6
		6.0			0.0	3.5	714	--			6.5
		7.0			0.0	3.4	721	--			6.5
		8.0			0.0	3.3	723	--			6.5
		9.0			0.0	3.3	734	--			6.5
		10.0			0.0	3.3	734	--			6.5
		11.0			0.0	3.5	745	--			6.5
		12.0			0.0	3.7	753	--			6.5
		13.0			0.0	4.0	766	--			6.5
		14.0			0.0	4.1	773	--			6.5
		15.0			0.0	4.1	783	--			6.4
		16.0			0.0	4.3	789	0.732	0.623		6.4
6/7/05	16.0	0-2	4.3	4.0	--	--	--	0.032	0.003	0.75	--
		0.0			9.3	24.4	832	--			7.5
		1.0			9.2	24.2	808	--			7.5
		2.0			10.6	20.4	814	--			7.3
		3.0			8.4	14.3	829	--			6.7
		4.0			2.4	9.3	853	--			6.2
		5.0			0.7	5.6	859	0.056			6.1
		6.0			0.6	4.4	861	--			6.0
		7.0			0.3	3.8	864	--			6.0
		8.0			0.3	3.8	782	--			6.0
		9.0			0.2	3.7	791	--			5.9
		10.0			0.2	3.6	796	--			5.9
		11.0			0.2	3.7	805	--			5.9
		12.0			0.2	3.8	810	--			5.9
		13.0			0.2	3.9	824	--			5.8
		14.0			0.2	4.1	834	--			5.8
		15.0			0.1	4.1	837	--			5.8
		16.0			0.2	4.2	785	0.732			5.7

Twin Lake

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chl. a (ug/L)	D. O. (mg/L)	Temp (°C)	Sp. Cond. (µmho/cm @ 25°C)	Total P (mg/L)	Ortho P (mg/L)	Total Nitrogen (mg/L)	pH (S.U.)
7/19/05	16.0	0-2	4.0	3.0	--	--	--	0.020	<0.002	0.72	--
		0.0			8.2	27.7	611	--			8.3
		1.0			8.2	27.6	610	--			8.3
		2.0			8.3	27.1	607	--			8.3
		3.0			9.6	25.5	630	--			8.2
		4.0			12.3	17.0	672	--			7.8
		5.0			2.6	9.7	703	0.026	<0.002		7.0
		6.0			1.0	6.6	705	--			6.8
		7.0			0.8	4.4	722	--			6.7
		8.0			0.6	4.4	722	--			6.6
		9.0			0.6	4.3	722	--			6.6
		10.0			0.5	3.9	735	--			6.6
		11.0			0.5	3.8	745	--			6.5
		12.0			0.4	3.8	754	--			6.5
		13.0			0.4	3.9	771	--			6.4
		14.0			0.4	4.0	786	--			6.4
		15.0			0.3	4.2	796	--			6.4
		16.0			0.3	4.3	777	0.844	0.700		6.3
8/2/05	15.0	0-2	4.1	2.0	--	--	--	0.012	0.003	0.67	--
		0.0			8.3	28.8	682	--			7.9
		1.0			8.9	28.4	677	--			8.0
		2.0			9.1	27.0	676	--			8.0
		3.0			9.1	25.7	683	--			7.9
		4.0			9.7	21.4	729	--			7.6
		5.0			2.5	11.7	777	0.019			6.8
		6.0			0.0	7.7	779	--			6.6
		7.0			0.0	5.5	796	--			6.6
		8.0			0.0	4.7	796	--			6.5
		9.0			0.0	4.4	796	--			6.5
		10.0			0.0	4.2	800	--			6.4
		11.0			0.0	4.0	821	--			6.4
		12.0			0.0	4.0	830	--			6.4
		13.0			0.0	4.0	843	--			6.3
		14.0			0.0	4.1	857	--			6.3
		15.0			0.0	4.2	855	0.534			6.3

Twin Lake

Date	Max Depth (m)	Sample Depth (m)	Secchi Depth (m)	Chl. a (ug/L)	D. O. (mg/L)	Temp (°C)	Sp. Cond. (µmho/cm @ 25°C)	Total P (mg/L)	Ortho P (mg/L)	Total Nitrogen (mg/L)	pH (S.U.)
8/16/05	16.0	0-2	3.2	4.0	--	--	--	0.018	0.002	0.60	--
		0.0			10.1	25.3	672	--			8.0
		1.0			10.1	24.8	671	--			8.0
		2.0			9.2	24.4	672	--			8.0
		3.0			9.1	24.2	674	--			8.0
		4.0			9.6	21.4	716	--			7.9
		5.0			5.0	13.7	759	--			7.4
		6.0			0.9	9.3	768	0.023			7.3
		7.0			0.6	5.8	787	--			7.1
		8.0			0.4	4.6	791	--			7.1
		9.0			0.4	4.3	791	--			7.0
		10.0			0.3	4.2	791	--			7.0
		11.0			0.3	4.0	810	--			6.9
		12.0			0.3	3.9	822	--			6.8
		13.0			0.3	4.0	838	--			6.8
		14.0			0.3	4.1	856	--			6.8
		15.0			0.3	4.2	869	--			6.7
		16.0			0.5	4.2	842	0.881			6.6
9/2/05	16.5	0-2	3.0	<5.0	--	--	--	0.022	<0.003	0.56	--
		0.0			9.2	22.8	677	--			7.4
		1.0			9.1	22.6	676	--			7.5
		2.0			9.1	22.5	676	--			7.5
		3.0			7.9	22.2	684	--			7.6
		4.0			6.3	21.2	703	--			7.6
		5.0			2.3	15.7	754	--			7.2
		6.0			0.6	10.3	772	0.036			6.8
		7.0			0.5	7.0	778	--			6.7
		8.0			0.3	4.9	792	--			6.5
		9.0			0.3	4.3	796	--			6.5
		10.0			0.3	4.2	800	--			6.4
		11.0			0.3	4.0	816	--			6.3
		12.0			0.2	4.0	830	--			6.3
		13.0			0.2	4.0	842	--			6.3
		14.0			0.2	4.1	864	--			6.2
		15.0			0.2	4.2	875	--			6.2
		16.0			0.3	4.3	808	0.732			6.1
		16.5			0.3	4.3	801	--			6.1

Appendix F

1972-2008 Twin Cities Monthly and Yearly Precipitation Data

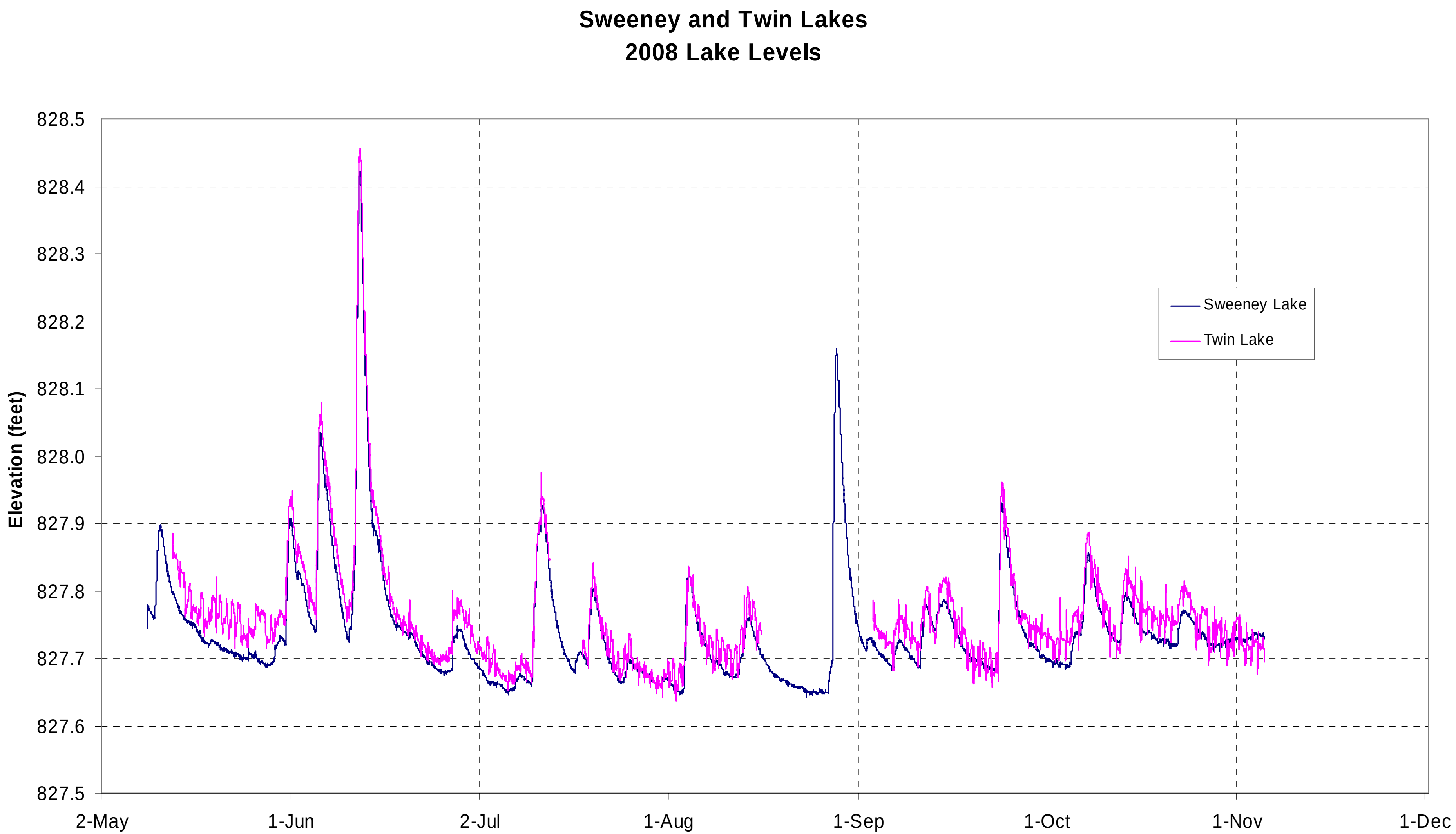
Twin Cities Monthly and Yearly Precipitation Totals (inches)
1891 - 2008 (abridged)
http://climate.umn.edu/text/historical/msppre.txt
Twin Cities International Airport (MSP)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Above 118yr Avg	Above 72-08 Avg	Jun-Aug total	Above Jun-Aug Avg
1972	0.84	0.49	1.25	1.69	2.18	3.31	5.12	2.48	1.96	1.77	1.11	1.57	23.77	-3.82	-5.78	10.91	-1.47
1973	0.92	0.84	1.12	2.32	2.48	1.06	2.9	3.05	2.08	1.29	1.97	1.1	21.13			7.01	
1974	0.17	1.06	1	2.42	2.08	5.21	1.14	2.75	0.58	1.69	0.66	0.35	19.11			9.10	
1975	2.82	0.79	1.67	5.4	3.81	7.99	0.58	4.92	1.31	0.27	4.8	0.79	35.15			13.49	
1976	0.87	0.59	2.83	0.8	1.13	3.86	2.45	1.39	1.42	0.49	0.16	0.51	16.5			7.70	
1977	0.65	0.93	2.66	1.84	2.86	3.57	3.72	9.31	4.43	2.34	1.42	1.15	34.88	7.29	5.33	16.60	4.22
1978	0.38	0.24	0.79	3.63	3.79	7.09	3.19	5.77	2.47	0.19	1.84	0.88	30.26			16.05	
1979	1.09	1.39	2.55	0.66	4.55	4.78	2.34	7.04	2.2	3.16	0.98	0.33	31.07			14.16	
1980	0.94	0.67	1.12	0.83	2.29	5.52	2.3	3.26	3.68	0.66	0.26	0.24	21.77			11.08	
1981	0.3	2.14	0.71	2.17	2.18	4.42	4.09	4.73	1.46	2.69	2.16	0.92	27.97			13.24	
1982	2.45	0.63	2.09	1.62	4.99	1.44	0.92	3.8	1.5	3.45	3.27	4.27	30.43	2.84	0.88	6.16	-6.22
1983	0.67	1.19	3.22	3.97	6.2	5.22	3.07	3.12	3.34	2.61	4.93	1.53	39.07			11.41	
1984	0.88	1.64	1.47	3.86	2.29	7.95	3.03	5.15	2.65	5.48	0.31	2.24	36.95			16.13	
1985	0.87	0.5	4.48	1.81	3.65	2.18	2.2	5.02	4.37	3.66	1.72	1.2	31.66	4.07	2.11	9.40	-2.98
1986	0.9	0.84	2.03	5.88	3.48	5.34	4.11	4.44	6.9	1.77	0.62	0.31	36.62			13.89	
1987	0.63	0.13	0.64	0.16	1.88	1.95	17.9	3.67	1.28	0.6	2.07	1.25	32.16			23.52	
1988	1.37	0.3	1.33	1.58	1.7	0.22	1.17	4.29	2.79	0.8	2.86	0.67	19.08			5.68	
1989	0.52	1.04	2.19	2.66	3.38	3.5	3.5	2.92	1.28	0.53	1.38	0.42	23.32			9.92	
1990	0.1	0.77	3.66	3.8	3.36	9.82	5.06	1.71	1.88	1.23	0.65	1.01	33.05			16.59	
1991	0.49	1.03	2.29	3.58	6.35	2.57	2.95	3.14	5.43	2.52	5.29	1.05	36.69			8.66	
1992	0.66	0.57	1.56	1.99	1.15	3.68	5.21	4.54	5.2	2.11	1.95	1.05	29.67	2.08	0.12	13.43	1.05
1993	1.25	0.39	1.25	1.99	4.02	6.28	5.58	6.5	2.04	0.79	1.57	0.55	32.21			18.36	
1994	1.17	0.78	0.32	3.77	2.21	3.09	4.12	2.9	4.74	4.65	1.39	0.53	29.67			10.11	
1995	0.36	0.25	2.11	1.9	2.43	3.38	2.72	4.59	2.21	3.68	0.88	1.15	25.66			10.69	
1996	1.87	0.24	1.39	0.76	2.37	4.76	2.09	1.43	1.3	3.01	5.08	1.75	26.05	-1.54	-3.50	8.28	-4.10
1997	1.71	0.3	1.18	1.01	1.7	3.7	12.6	6.01	3.19	2.03	0.69	0.31	34.43			22.31	
1998	1.64	0.8	4.56	1.56	4.4	6.52	2.63	5.99	1.32	2.19	1.32	0.46	33.39			15.14	
1999	2.67	0.4	1.86	3.43	6.56	3.68	4.55	2.64	2.73	0.92	0.77	0.33	30.54			10.87	
2000	0.9	1.08	1.12	1.12	4.56	4.56	6.1	3.19	2.15	1.09	3.38	1.23	30.48	2.89	0.93	13.85	1.47
2001	1.21	1.33	1.09	7	4.53	6.35	2.12	2.31	3.5	1.28	2.77	0.74	34.23			10.78	
2002	0.46	0.36	1.38	3.23	2.83	8.3	5.19	8.3	3.89	4.21	0.09	0.21	38.45			21.79	
2003	0.22	0.54	1.44	2.4	6.14	4.66	2.06	1.12	2.2	0.62	0.71	0.62	22.69			7.84	
2004	0.23	1.09	2.11	2.06	6.39	3.06	3.36	1.19	4.21	2.32	0.93	0.44	27.39			7.61	
2005	1.21	0.96	1.37	2.3	2.78	4.24	2.94	5.22	4.44	5.45	1.53	0.97	33.41	5.82	3.86	12.40	0.02
2006	0.71	0.32	2.01	5.97	1.66	2.81	1.29	6.9	2.44	0.41	0.92	2.13	27.57			11.00	
2007	0.31	1.37	3.64	1.11	1.99	2.05	3.29	9.32	6.04	3.63	0.09	1.48	34.32	6.73	4.77	14.66	2.28
2008	0.15	0.4	1.97	3.12	2.53	2.7	2.13	3.35	1.78	1.96	1.14	1.15	22.38	-5.21	-7.17	8.18	-4.20
118 Year Avg	0.85	0.83	1.63	2.24	3.4	4.17	3.58	3.51	2.92	2.07	1.45	0.93	27.59				
1972-2008 Avg	0.93	0.77	1.88	2.58	3.32	4.35	3.78	4.26	2.88	2.10	1.72	1.00	29.55		Jun-Aug Avg	12.38	
				2008 - avg	-0.79	-1.65	-1.65	-0.91									
				2005 - avg	-0.54	-0.11	-0.84	0.96									

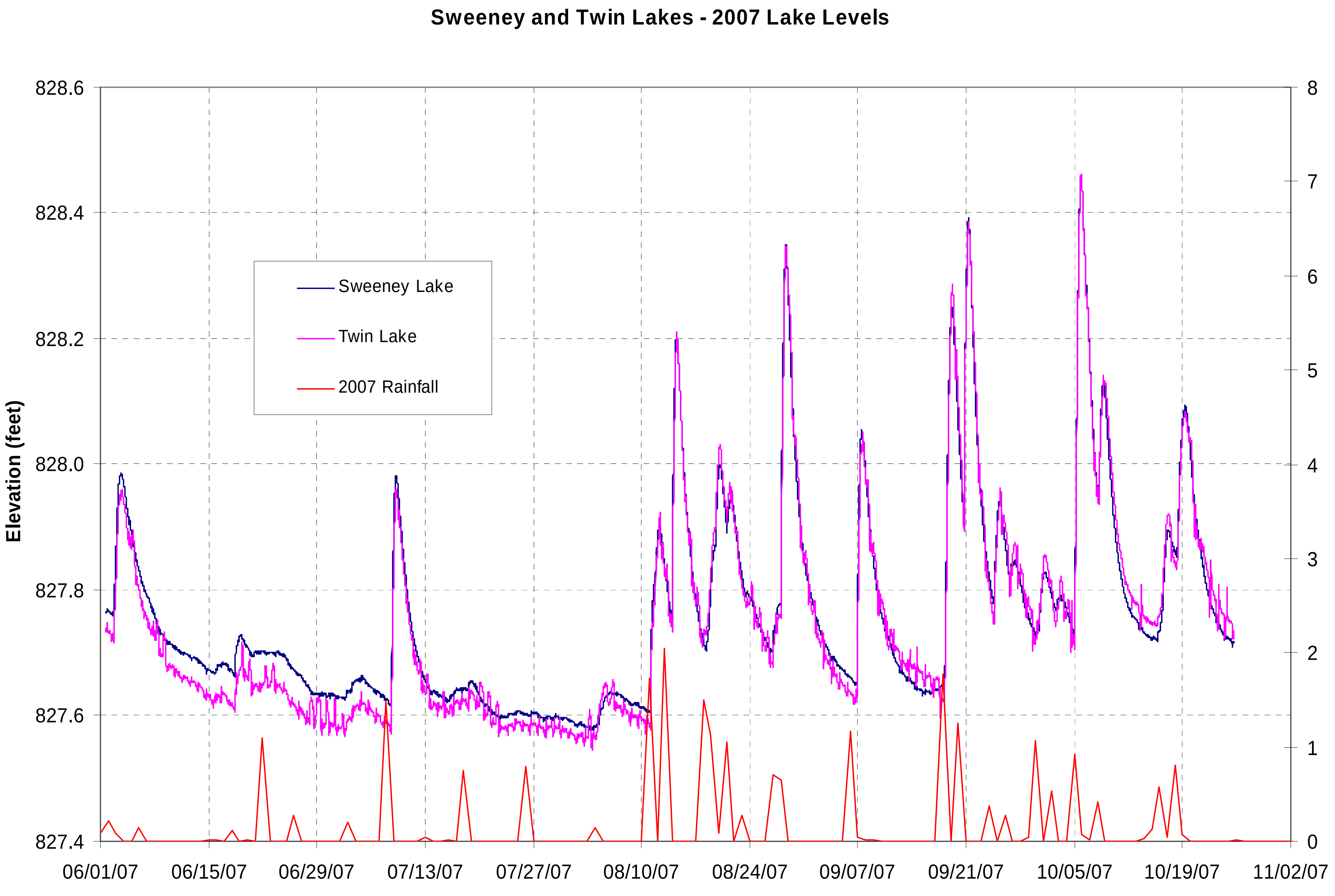
P:\Mpls\23 MN\27\2327051\WorkFiles\2008 Lake Monitoring_Twin_Sweeney\Monthly Precip data MSP.xls

Appendix G

Sweeney and Twin 2007-2008 Lake Level Data



Sweeney and Twin Lakes
2008 Lake Levels
Elevation (feet)
828.5
828.4
828.3
828.2
828.1
828.0
827.9
827.8
827.7
827.6
827.5
2-May
1-Jun
2-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Sweeney Lake
Twin Lake



Sweeney and Twin Lakes - 2007 Lake Levels
Elevation (feet)
828.6
828.4
828.2
828.0
827.8
827.6
827.4
8
7
6
5
4
3
2
1
0
Sweeney Lake
Twin Lake
2007 Rainfall
06/01/07
06/15/07
06/29/07
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