2010 Lake Water Quality Study

Medicine Lake

Prepared by
Bassett Creek Watershed Management Commission

March 2011

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Executive Summary

Since 1970, the Bassett Creek Watershed Management Commission (BCWMC) has monitored water quality in ten major lakes within the Bassett Creek watershed. This long-term monitoring program was developed to detect changes or trends in lake water quality over time that will help determine the effects of changing land use patterns within the watershed as well as the effectiveness of BCWMC's efforts to maintain and improve water quality. The BCWMC adopted its current watershed management plan in 2004. This 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, and it 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 2010 in Medicine Lake. The lake was monitored for both chemical and biological water quality parameters, the latter including phytoplankton, zooplankton, and macrophytes (aquatic plants). Monitoring results are summarized and include a description of the results along with graphical representations of the data.

Three indicators that are commonly used to measure water quality include the amount of total phosphorus (the main nutrient required for algal growth), chlorophyll *a* (a measurement of algae or small plants), and Secchi depth (transparency of the water). In 2010, the overall water quality status of Medicine Lake was determined from these three indicators. Trend analyses were performed on the three indicators to determine whether significant changes in water quality have occurred during the past 20 years.

The conclusions and recommendations from 2010 water quality monitoring are as follows:

- A trend analysis of data collected during the past 21 years (i.e., 1990 through 2010) indicates changes in total phosphorus and chlorophyll *a* were not significant. The analysis indicates Secchi disc water transparency has significantly improved at the rate of about 0.034 meters per year or about 1 foot every 10 years. The trend analysis results indicate management efforts to prevent water quality degradation during periods of rapid development in the Medicine Lake watershed have been successful.

- The overall water quality status of Medicine Lake in 2010 was eutrophic (nutrient rich) and poor quality. Chlorophyll *a* and Secchi disc summer averages were eutrophic while the summer average phosphorus concentration was hypereutrophic (nutrient rich and poor water quality).

- In 2010, total phosphorus, chlorophyll *a*, and Secchi disc transparency summer averages did not meet water quality goals for Medicine Lake or State water quality standards.

- Three undesirable non-native plant species, Curlyleaf pondweed, purple loosestrife, and Eurasian watermilfoil, were observed during 2010.

- In 2010, the quality of the Medicine Lake plant community was average and the lake's plant species were tolerant of moderate disturbance.

- Historical water quality data from the Main Basin of Medicine Lake for the period 1966 through 2010 compared with State water quality standards indicates summer averages met State water quality standards during 2 of the 33 years of data collection.

Recommendations include:

- Continue implementation of management strategies in the Medicine Lake TMDL and BCWMC Watershed Management Plan (2004), including two Plymouth Creek projects (i.e., current project on lower Plymouth Creek and forthcoming upper Plymouth Creek project).

- Assess Medicine Lake water quality following implementation of the Medicine Lake water quality improvement projects that have recently been completed or are underway and determine whether sufficient water quality improvement has occurred to attain water quality goals and State water quality standards as outlined in the Medicine Lake TMDL Implementation Plan. Document and track activities and projects in the Medicine Lake watershed that reduce phosphorus to the 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) and internal loading are the predominant causes 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.

This report presents the results of the water quality monitoring in 2010 of Medicine Lake (location shown on Figure 1). The lake was 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.

The water quality conditions were classified as to trophic state, based on the TP concentration, chlorophyll *a* concentration, and Secchi disc transparency (Table 1).

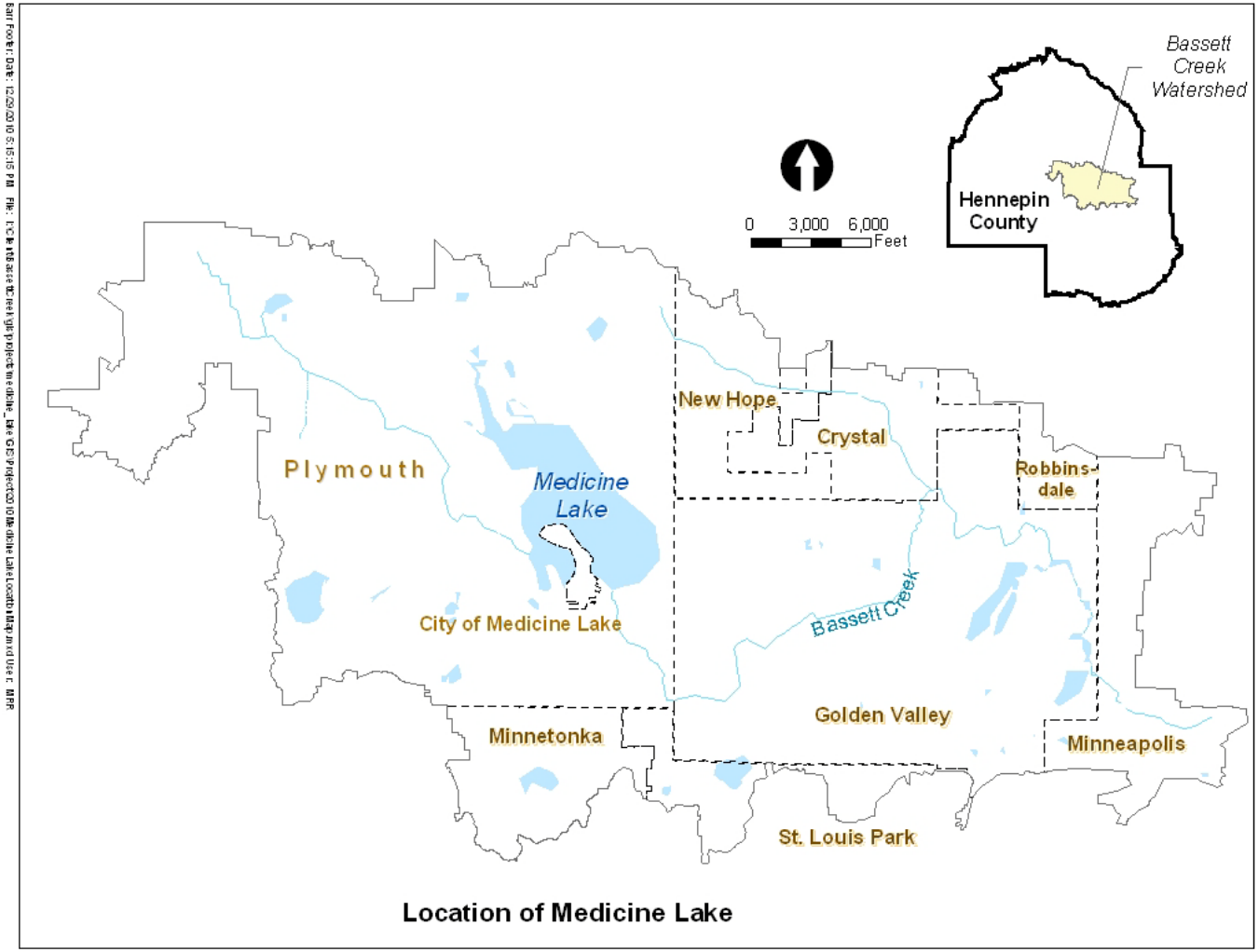


Figure 1 Location of Medicine Lake

Table 1 Trophic State Classifications for Total Phosphorus, Chlorophyll *a*, and Secchi Disc Transparency

Trophic State	Total Phosphorus (TP)	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 plants) 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.

The annual lake water quality monitoring program established by the BCWMC in 1991 generally followed the Metropolitan Council (Osgood 1989) recommendations 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 2 Lakes Monitored by BCWMC (Years with sampling data are in parentheses)

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, 2007[1], 2008[1], 2009[1])
Medicine (1977, 1982, 1983, 1984, 1988, 1994[1], 1999[1], 2006[1], 2010[1])	Twin (1977, 1982, 1992, 1996, 2000, 2005, 2008[1], 2009[1])
Northwood (1972, 1977, 1982, 1992, 1996, 2000, 2005, 2009[1])	Westwood[2] (1977, 1982, 1993, 1997, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007[1])

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

[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 parentheses:

- Cortlawn, East Ring, and West Ring Ponds (1993)
- Grimes Pond (1996)
- North Rice and South Rice Ponds (1994, 1998, and 2009)

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

2.0 Methods

2.1 Water Quality Sampling

Samples were collected from the deepest location in each of the two lake basins, the Main Basin and the Southwest Basin. The lake was sampled bi-weekly from the spring through the fall. Table 3 lists the thirteen sampling dates. 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

Sample Collection Dates
April 19, 2010
May 4, 2010
May 17, 2010
June 1, 2010*
June 15, 2010*
June 29, 2010*
July 13, 2010*
July 27, 2010*
August 10, 2010*
August 24, 2010*
September 8, 2010
September 28, 2010
October 12, 2010

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.

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
pH	Surface to bottom profile at one meter intervals	
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 sample	X
Total Nitrogen (or Nitrogen Species Needed to Determine Total Nitrogen)	0-2 meter composite sample	X
Chlorophyll *a*	0-2 meter composite sample	X

2.2 Ecosystem Data

2010 phytoplankton and zooplankton data were collected from the Main Basin and Southwest Basin of Medicine Lake monthly during April through September. Phytoplankton and zooplankton samples were collected by Three Rivers and analyzed by BCWMC staff. Macrophyte (aquatic plants) data were collected by BCWMC staff.

- **Phytoplankton—**Samples were surface water samples (composite 0-2 meter sample) and sample analysis included identification and enumeration of species.
- **Zooplankton—**Samples were bottom to surface tows and sample analysis included identification and enumeration of species.
- **Macrophytes—**Macrophyte (aquatic plant) surveys were completed during June and August.

3.0 Medicine Lake

3.1 Site Description

Medicine Lake, the second largest lake in Hennepin County, is located in the cities of Plymouth and Medicine Lake, northwest of the Highway 169 and Highway 55 interchange (Figure 1). The lake has an approximate water surface of 886 acres and a maximum depth of 49 feet (Bassett Creek Watershed Management Commission, 2007). The lake's littoral area (<15 feet in depth) comprises approximately 33 percent of the entire surface acreage (LimnoTech, 2010). Medicine Lake has a large fetch (3-km) that is oriented from the northwest to the southeast. The lake typically stratifies during the summer (Vlach et al., 2007). However, prolonged winds from the north and/or south often initiate complete or partial turnover events (in addition to the spring and fall turnover) that potentially exacerbate the internal loading of phosphorus (USEPA, 2000).

The fully developed Medicine Lake watershed consists of 11,613 acres and includes the Plymouth Creek and Ridgedale watersheds. Both watersheds discharge into Medicine Lake in the southwestern most bay (Bassett Creek Watershed Management Commission, 2007). Stormwater from approximately 90 percent of the Medicine Lake watershed currently drains through some form of wet detention before it enters Medicine Lake (LimnoTech, 2010). Medicine Lake serves as the headwaters for Bassett Creek, which eventually drains into the Mississippi River in downtown Minneapolis.

Medicine Lake is considered the most important recreational water body in the Bassett Creek watershed. Regional and local parks and trails are located on or near the lake. These amenities provide access to the lake and contribute to the intense uses of the lake during both summer and winter months. Fishing, boating, swimming, water-skiing, and aesthetic viewing are some of the major recreational uses made of the lake.

3.2 Goal

The BCWMC's goal for Medicine Lake is a management classification of Level I, meaning its water quality should support all water-based recreational activities including swimming. The water quality goals for Medicine Lake are (1) average summer total phosphorus concentration not to exceed 38 µg/L, (2) average summer chlorophyll *a* concentration not to exceed 10 µg/L, and (3) average summer Secchi disc transparency at least 2.2 meters (about 7

feet) (*BCWMC Watershed Management Plan* 2004). In 2010, summer averages for total phosphorus, chlorophyll *a*, and Secchi disc transparency did not meet water quality goals for Medicine Lake (Figures 2 and 3).

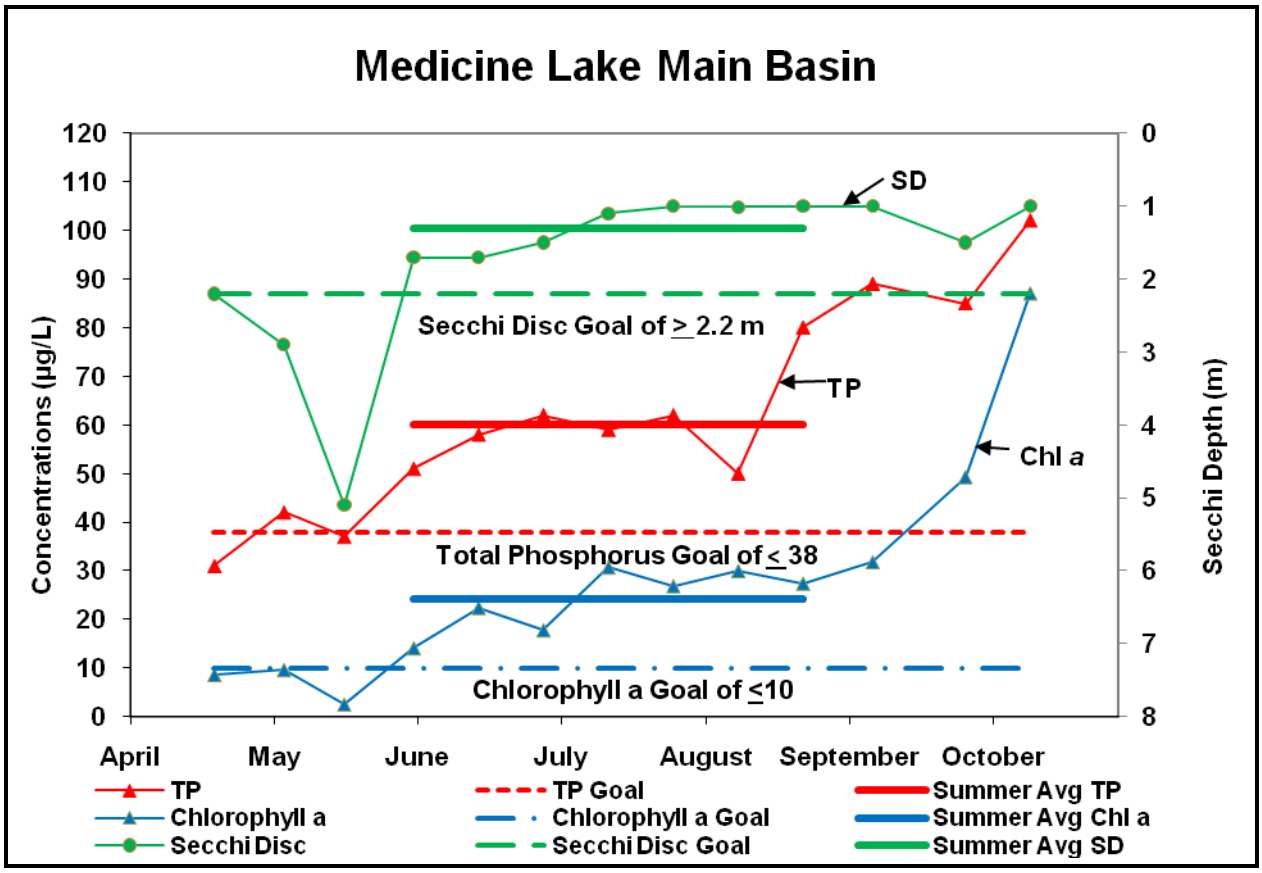


Figure 2 2010 Medicine Lake Main Basin Water Quality Compared with Water Quality Goals

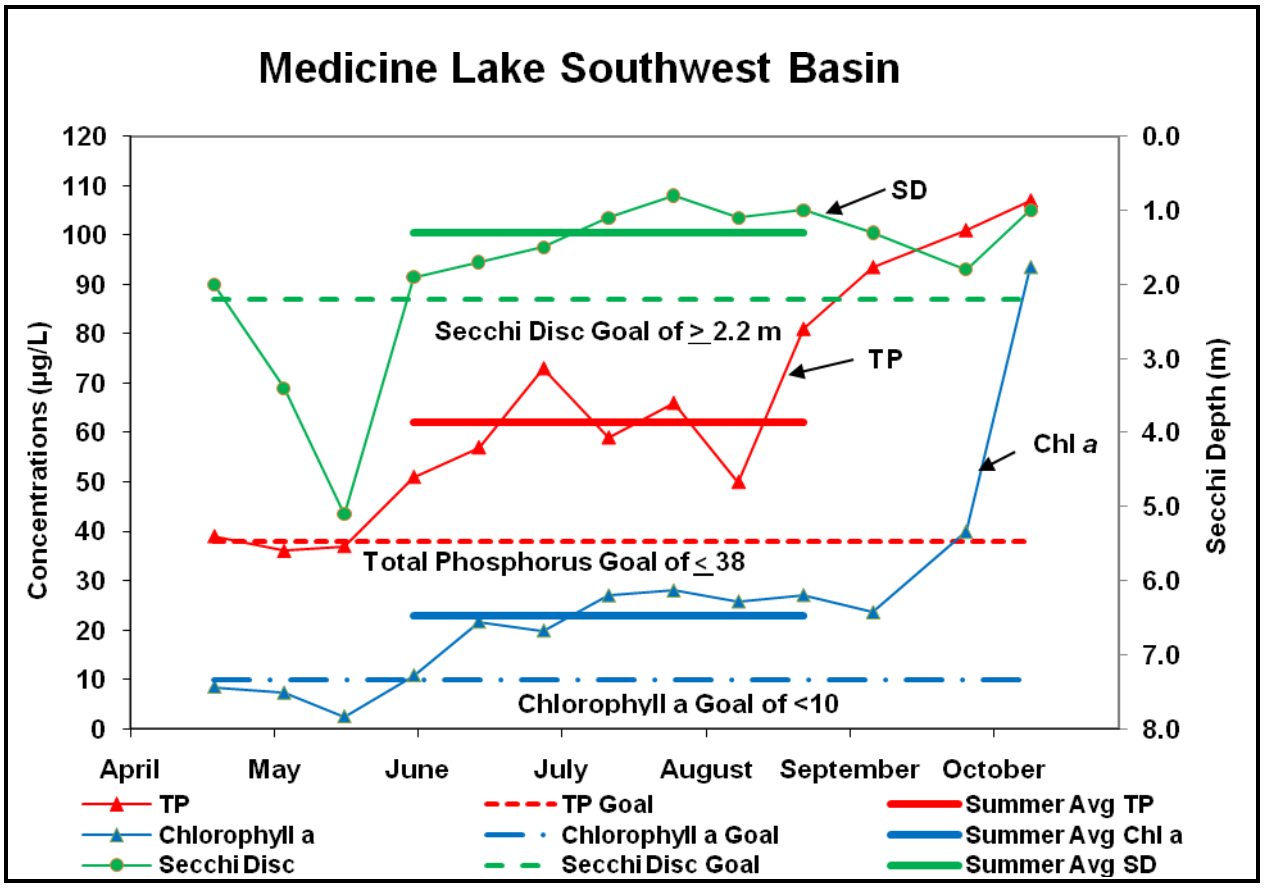


Figure 3 2010 Medicine Lake Southwest Basin Water Quality Compared with Water Quality Goals

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 Medicine 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).

In 2010, summer averages for total phosphorus, chlorophyll *a*, and Secchi disc transparency failed to meet state water quality standards (Figures 4 and 5).

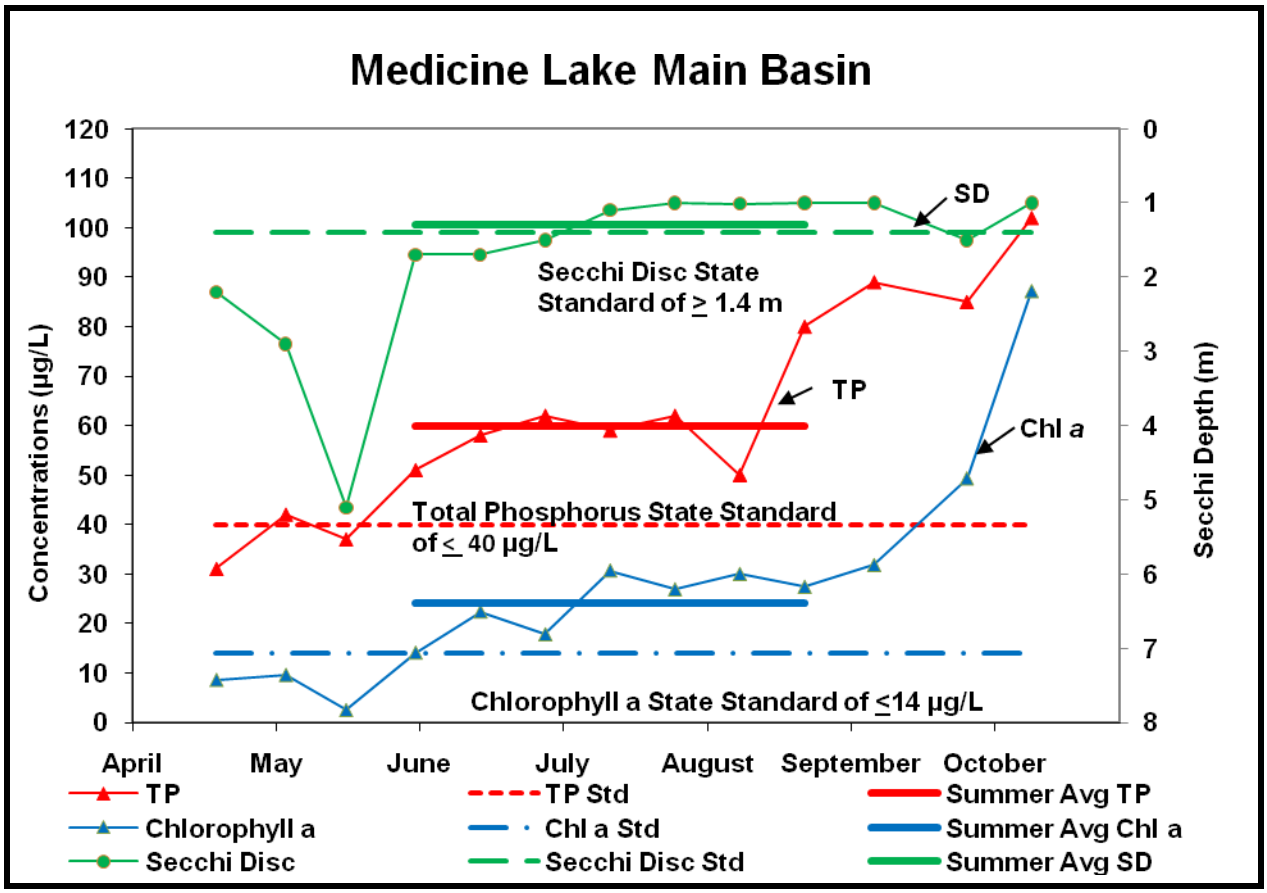


Figure 4 **2010 Medicine Lake Main Basin Water Quality Compared with State Water Quality Standards**

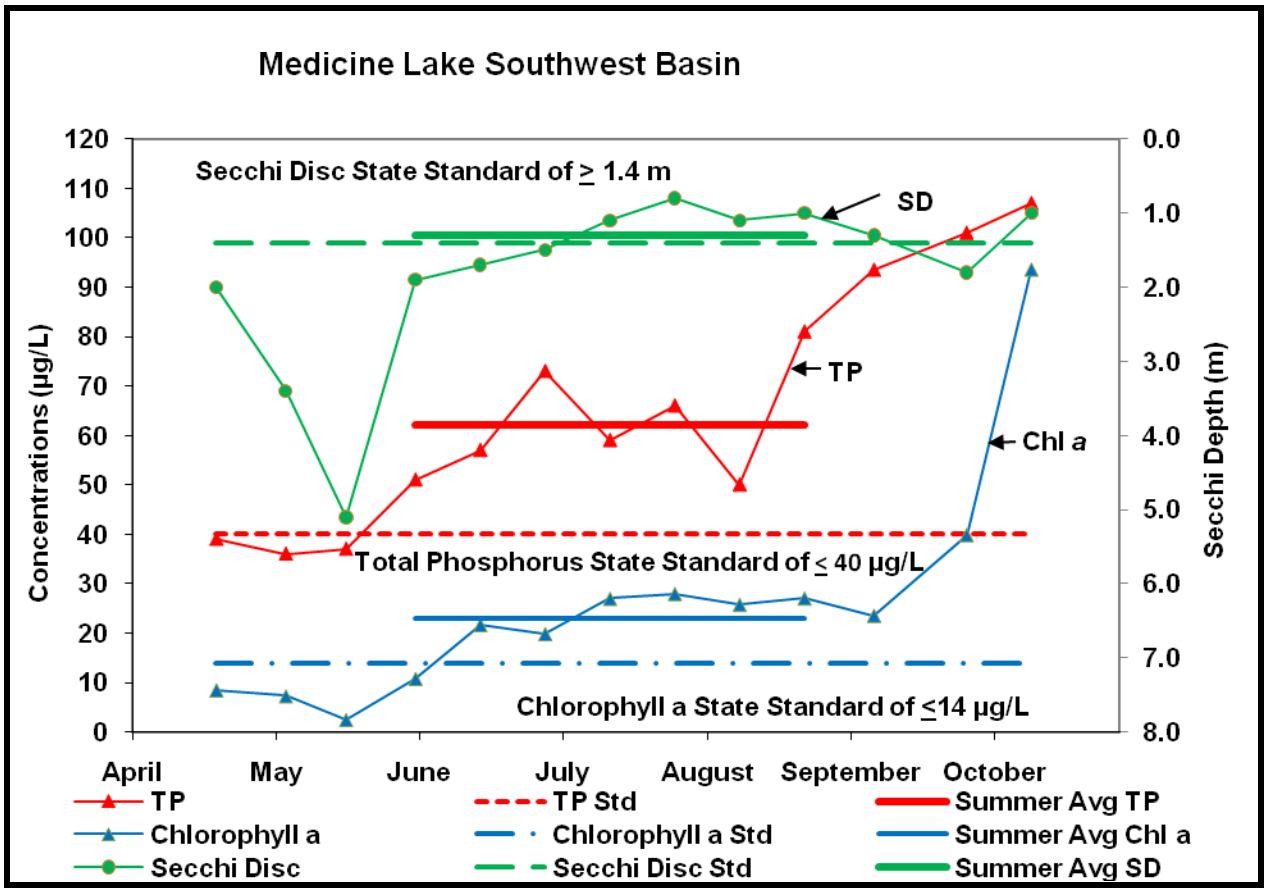


Figure 5 2010 Medicine Lake Southwest Basin Water Quality Compared with State Water Quality Standards

3.4 BCWMC Watershed Management Plan, Medicine Lake Watershed and Lake Management Plan, and Medicine Lake TMDL Study

The BCWMC, the City of Plymouth, Three Rivers Park District, and the City of Medicine Lake have been partners in working to improve the water quality of Medicine Lake for many years. The Commission completed the *Medicine Lake Watershed and Lake Management Plan* (2000) with specific recommendations to improve the overall health of the lake. The *BCWMC Watershed Management Plan* (2004) incorporated the recommendations of the *Medicine Lake Watershed and Lake Management Plan* (2000). The City of Plymouth adopted a *Medicine Lake Watershed Implementation and Management Plan* in 2001. A number of projects were completed by the City of Plymouth or jointly by BCWMC and the City of Plymouth to improve the lake's water quality. Projects completed prior to 2006 are detailed in the *2006 Lake Water Quality Study: Medicine Lake* (BCWMC 2007). Recent

projects include construction of stormwater ponds in West Medicine Lake Park in the City of Plymouth (i.e., ponds BC98 and BC107, construction completed in 2010). In addition, continued management of Curlyleaf pondweed has occurred. A total of 62 acres of Curlyleaf pondweed were treated with herbicide in 2009 and 29 acres in 2010 (Association of Medicine Lake Area Citizens, 2010). The City of Plymouth with BCWMC funding is currently completing a water quality improvement project on lower Plymouth Creek and intends to complete an additional Plymouth Creek restoration project in the near future.

In 2004, Medicine Lake was included as a new listing on the MPCA's impaired waters list. Medicine Lake was listed for excess nutrients (total phosphorus). The Clean Water Act and Environmental Protection Agency (EPA) regulations require states to develop total maximum daily loads (TMDLs) for water bodies that are not meeting water quality standards. A TMDL study completed for Medicine Lake in 2010 was approved by the Environmental Protection Agency (EPA) on February 8, 2011. An implementation plan was developed as a part of the *Medicine Lake Excess Nutrients Total Maximum Daily Load (TMDL)* (LimnoTech, 2011). The implementation strategy for the Medicine Lake TMDL includes:

- Continued maintenance of existing stormwater ponds and assessment and implementation of retrofits for improved performance;
- Continued Curlyleaf pondweed control to maintain densities equal to or less than that experienced in 2006 (TRPD, 2008);
- Continued educational efforts that promote stewardship;
- Continued streambank stabilization efforts;
- Continued shoreline restoration efforts;
- Assessment and implementation of BMPs that reduce runoff; and
- Continued monitoring, assessment, and adaptive management.

The study concluded that a combination of these efforts can be expected to achieve the 28% reduction in watershed TP loads required to meet the TMDL and maintain or reduce existing internal loads (LimnoTech, 2010).

3.5 Water Quality Data

Medicine Lake was sampled 13 times in both the main basin and the southwest basin during 2010. Water quality data (Appendices A and B) for Medicine 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
- Phytoplankton
- Zooplankton

In addition, aquatic plant data were collected from Medicine Lake during June and August.

3.5.1 Temperature and Dissolved Oxygen

Temperature and dissolved oxygen (DO) measurements indicate that Medicine Lake is stratified throughout much of the summer season. Medicine Lake mixes when the ice melts in the spring. Following spring mixing, the water column has the same temperature from surface to bottom. As air temperatures warm, Medicine Lake changes from being completely mixed to stratified with an upper layer of warm, well-mixed (epilimnion) and cold temperatures in a bottom layer (hypolimnion). Separating these two layers is a layer of varying depth that has a sharp temperature gradient (thermocline). Because of the density differences between the lighter warmer water and the heavier cold water, Medicine Lake water became resistant to mixing and stratified. Temperature (Figures 6 and 7) and DO (Figures 8 and 9) measurements indicate the thermocline was located at a depth of approximately 6 to 8 meters from the lake surface and the hypolimnion was stable at depths below 10 meters. DO measurements also show the hypolimnetic layer (greater than 10 meters depth) was nearly depleted of oxygen from mid-May through mid-September in the main basin and from mid-April through mid-October in the southwest basin. The anoxic zone reached to approximately 9 meters from the bottom as more oxygen was depleted during the summer months.

Medicine Lake has a relatively large fetch (3-km) that is oriented from the northwest to the southeast. Although the lake typically stratifies during the summer, prolonged winds from

the north and/or south often initiate complete or partial turnover events (in addition to the spring and fall turnover). In 2010, three mixing events occurred in the Main Basin, one during the period July 13 through July 27, one during the period August 24 through September 8, and one during the period September 8 through September 26. Mixing of surface and bottom waters during these events warmed the waters near the lake bottom. No mixing events occurred in the Southwest Basin. Hence, higher water temperatures were observed near the lake bottom in the Main Basin than in the Southwest Basin. For a more detailed discussion of Medicine Lake mixing events, see Section 3.5.3 of this report

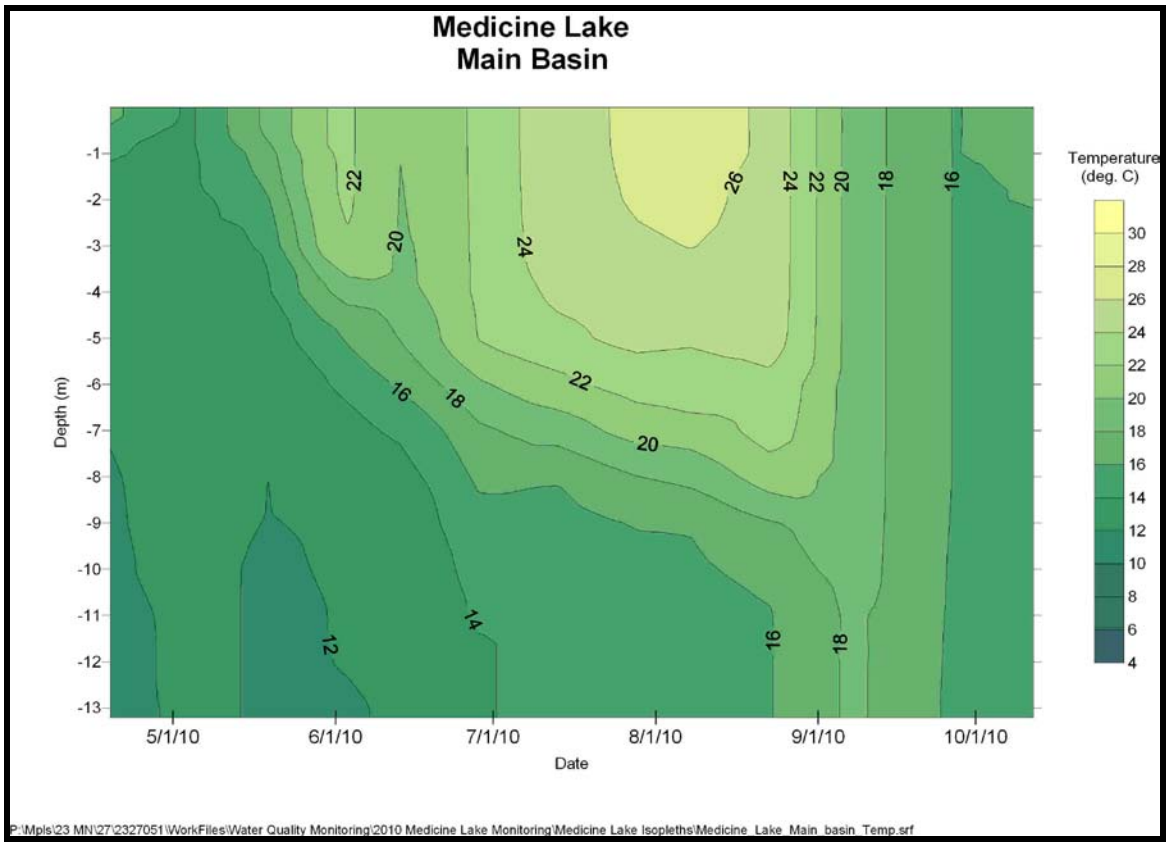


Figure 6 2010 Medicine Lake Main Basin Temperature Isopleth

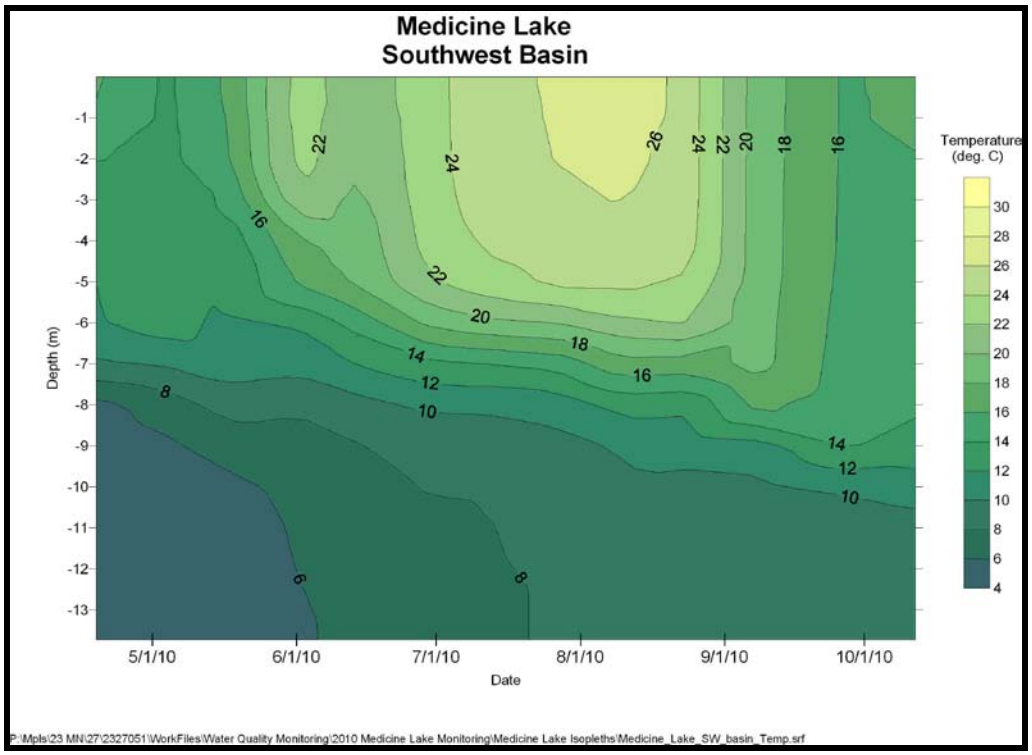


Figure 7 2010 Medicine Lake Southwest Basin Temperature Isopleth

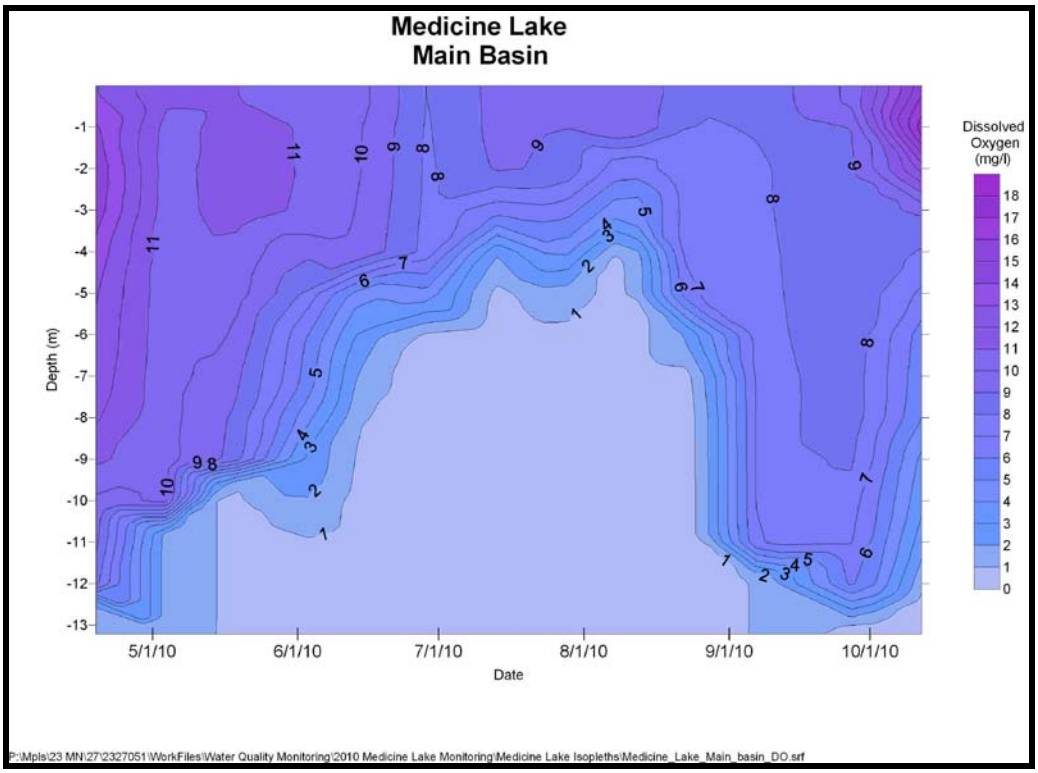


Figure 8 2010 Medicine Lake Main Basin Dissolved Oxygen

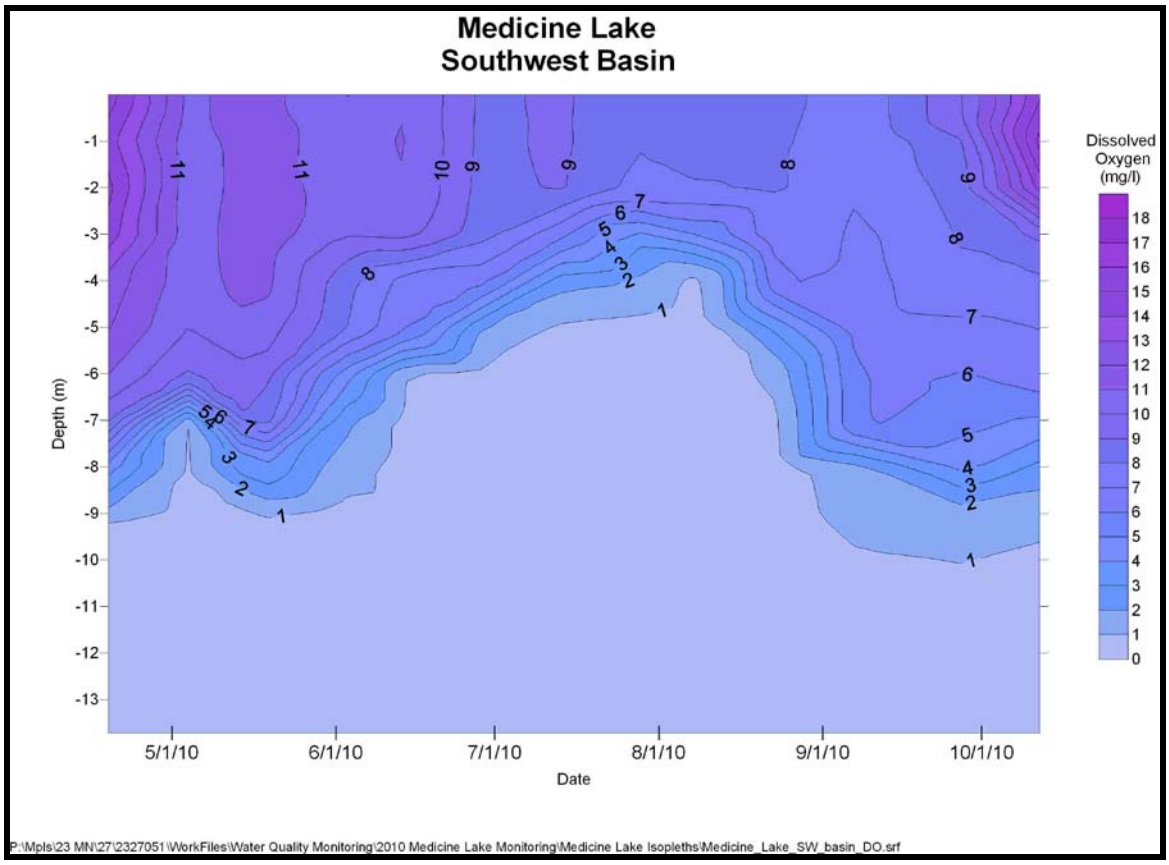


Figure 9 2010 Medicine Lake Southwest Basin Dissolved Oxygen Isopleth

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

Surface total phosphorus concentrations in Medicine Lake increased throughout the growing season. The lowest concentrations were observed in both basins during spring (i.e., 31 and 36 µg/L in the Main and Southwest Basins, respectively) and the highest concentrations were observed in fall after the lake had mixed (i.e., 102 and 107 µg/L in Main and Southwest Basins, respectively). The average summer surface total phosphorus concentration was 60 µg/L in the Main Basin and 62 µg/L in the Southwest Basin (Figures 10 and 11). Both averages failed to meet the State water quality standard (maximum of 40 µg/L) as well as the water quality goal (maximum of 38 µg/L). The data indicate the lake's water quality was impaired during 2010.

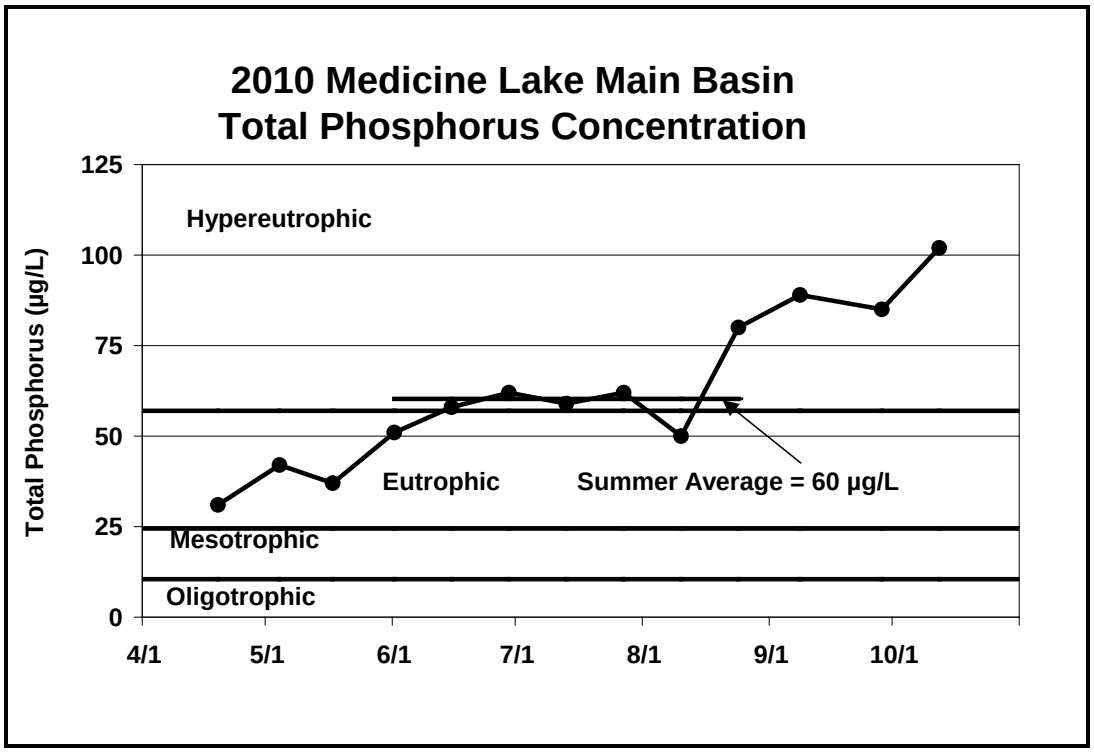


Figure 10 2010 Medicine Lake Main Basin Total Phosphorus

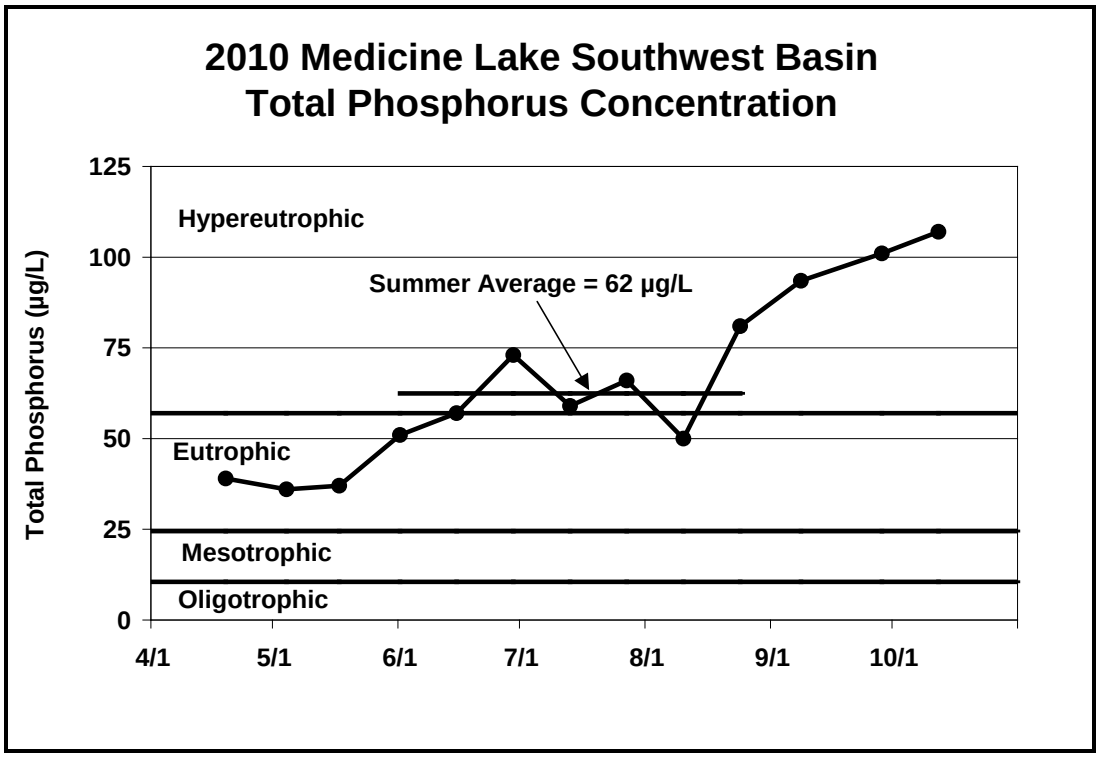


Figure 11 2010 Medicine Lake Southwest Bay Total Phosphorus

Surface chlorophyll a concentrations in Medicine Lake increased throughout the growing season, following a similar pattern as total phosphorus concentrations. The lowest concentrations were observed in both basins during spring (i.e., 2.5 µg/L) and the highest concentrations were observed in fall after the lake had mixed (i.e., 87.1 and 93.6 µg/L in the Main and Southwest Basins, respectively). The average summer surface chlorophyll *a* concentration was 24.2 µg/L in the Main Basin and 22.9 µg/L in the Southwest Basin (Figures 12 and 13). Both averages failed to meet the State water quality standard (maximum of 14 µg/L) as well as the BCWMC goal (maximum of 10 µg/L). The data indicate the lake's water quality was impaired during 2010.

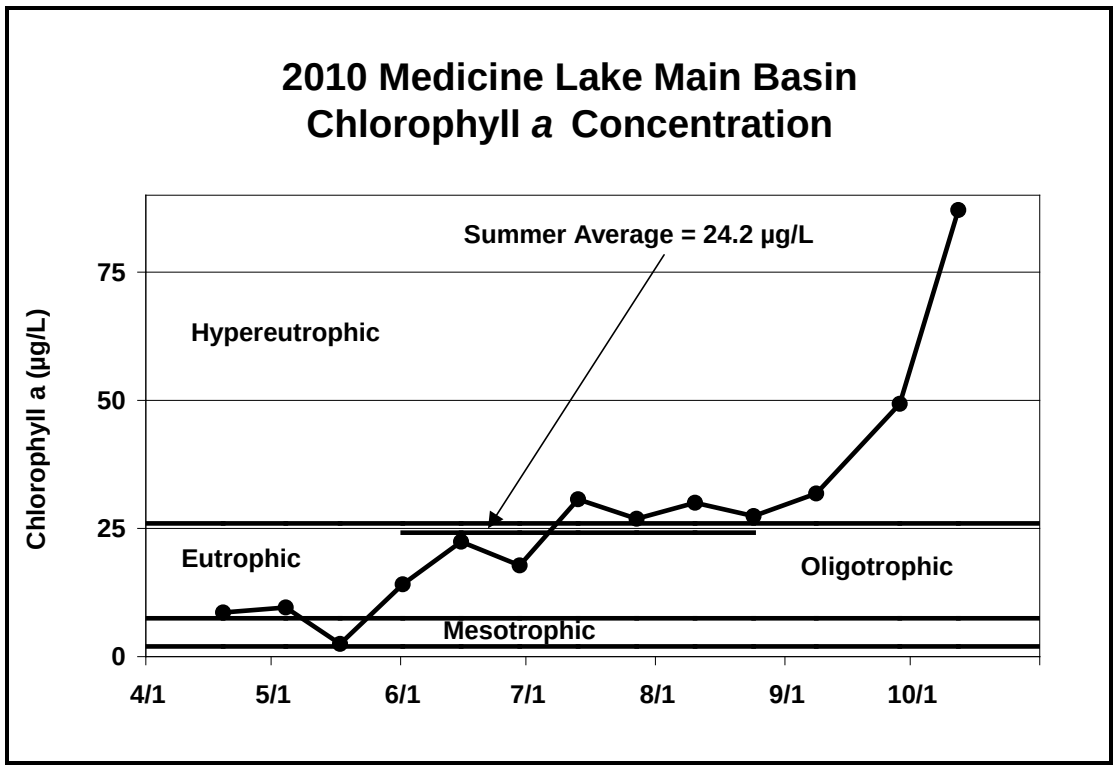


Figure 12 2010 Medicine Lake Main Basin Chlorophyll a Concentration

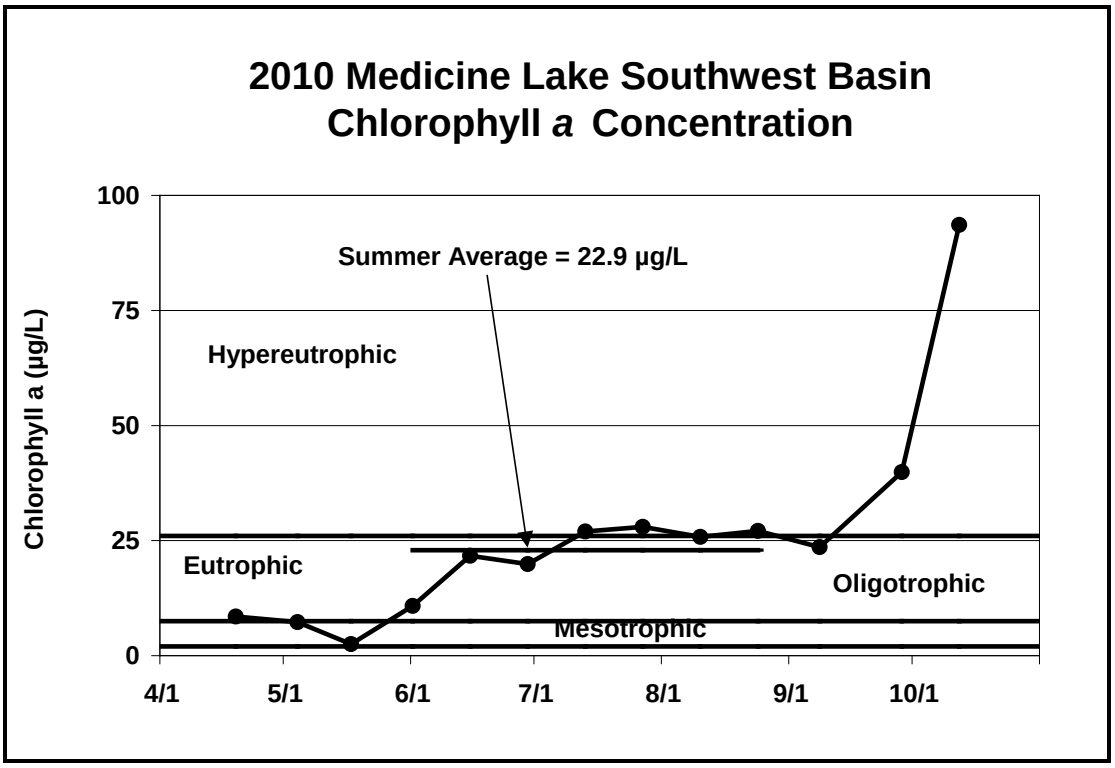


Figure 13 2010 Medicine Lake Southwest Basin Chlorophyll a Concentration

Secchi disc transparency in Medicine Lake declined throughout the growing season. The highest transparency was observed in both basins during spring (i.e., 5.1 meters) and the lowest transparency was observed in fall after the lake had mixed (i.e., 1.0 meter). The average summer Secchi disc transparency was 1.3 meters in both basins (Figures 14 and 15). This average failed to meet the State water quality standard (at least 1.4 meters) as well as the BCWMC goal (at least 2.2 meters). The data indicate the lake's water quality was impaired during 2010.

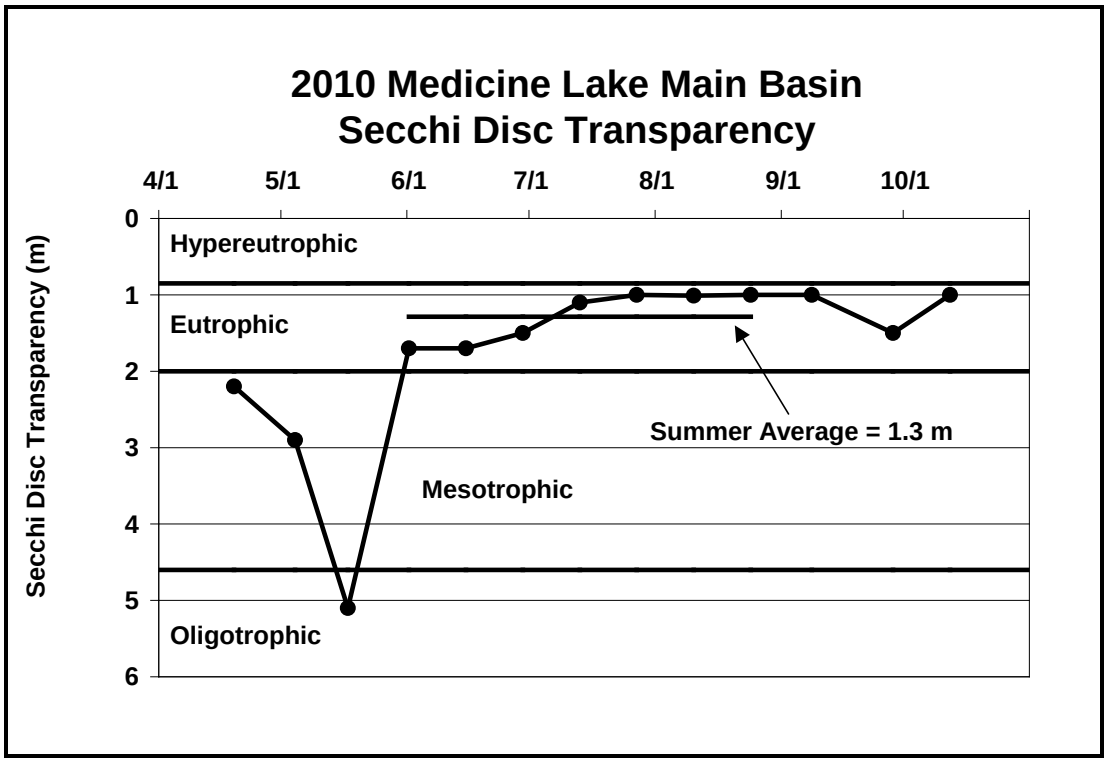


Figure 14 2010 Medicine Lake Main Basin Secchi Disc Transparency

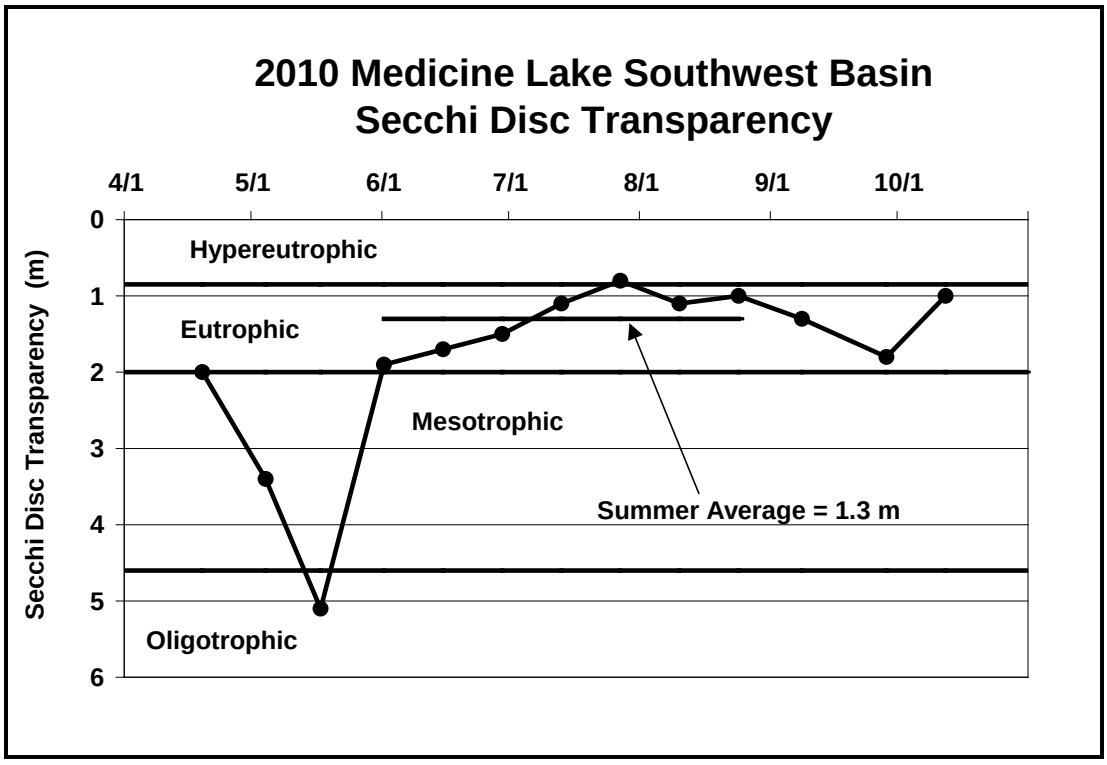


Figure 15 2010 Medicine Lake Southwest Basin Secchi Disc Transparency

3.5.3 Hypolimnetic Phosphorus

Substantial increases in phosphorus concentration during the summer months are evident in the bottom waters of both the Main and Southwest Basins of Medicine Lake (Figures 16 and 17). The increases are due to sediment release of phosphorus initiated by anoxic conditions (i.e., oxygen concentrations less than 2 mg/L) in the bottom waters during periods in which the lake was stratified (Figures 8 and 9). The phosphorus released by bottom sediments builds up in the bottom waters until the lake mixes in spring or fall or during the summer when wind-initiated mixing events occur. Phosphorus released from the sediment diffuses throughout the water column whenever the lake mixes. Previous studies, (e.g., EPA 2000) indicate that Medicine Lake experiences wind events that completely mix the water column in July, August, and September in addition to spring and fall. As shown in Figure 16, summer mixing events occurred in the Main Basin during July 13 through 27 as well as August 24 through September 26. Following each mixing event, the concentration of phosphorus in the bottom waters was reduced (Figure 16) and surface phosphorus concentrations increased (Figure 10). Although summer mixing events occurred in the Main Basin (Figure 16), no mixing events occurred in the Southwest Basin between spring and fall overturn (Figure 17. Hence, the phosphorus concentration in the bottom waters of the Southwest Basin had an opportunity to buildup throughout the summer (Figure 17).

In 2010, summer mixing events in Medicine Lake, pictured above, brought phosphorus from the lake bottom to the surface where it fueled algal growth.

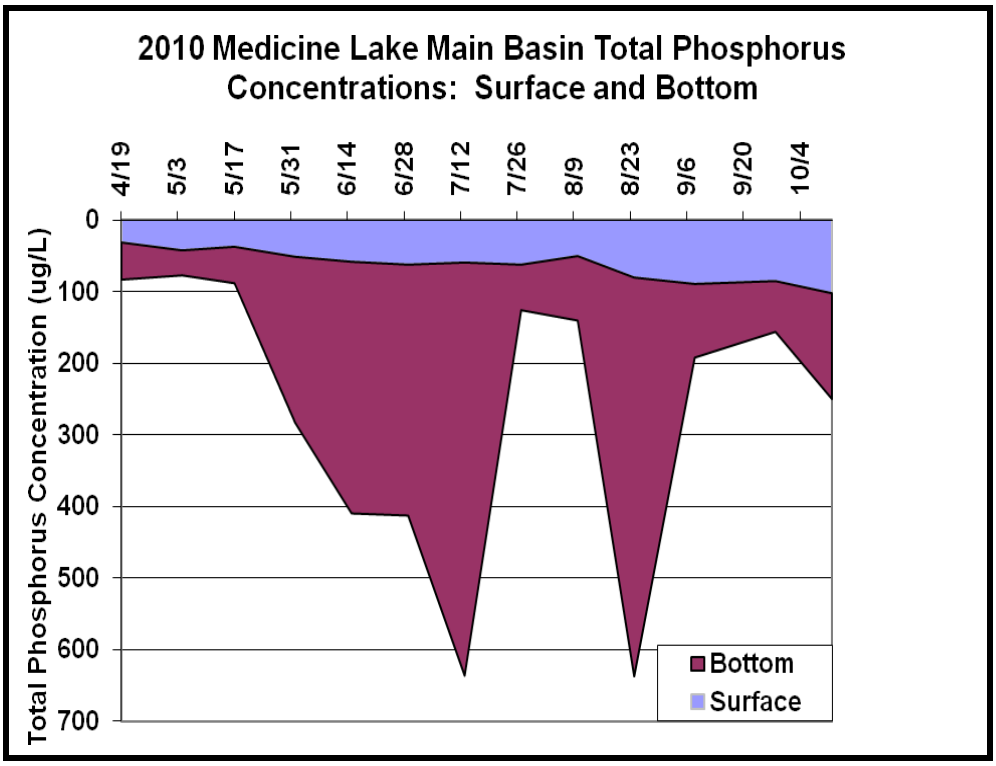


Figure 16 2010 Medicine Lake Main Basin Total Phosphorus Concentrations: Surface and Bottom

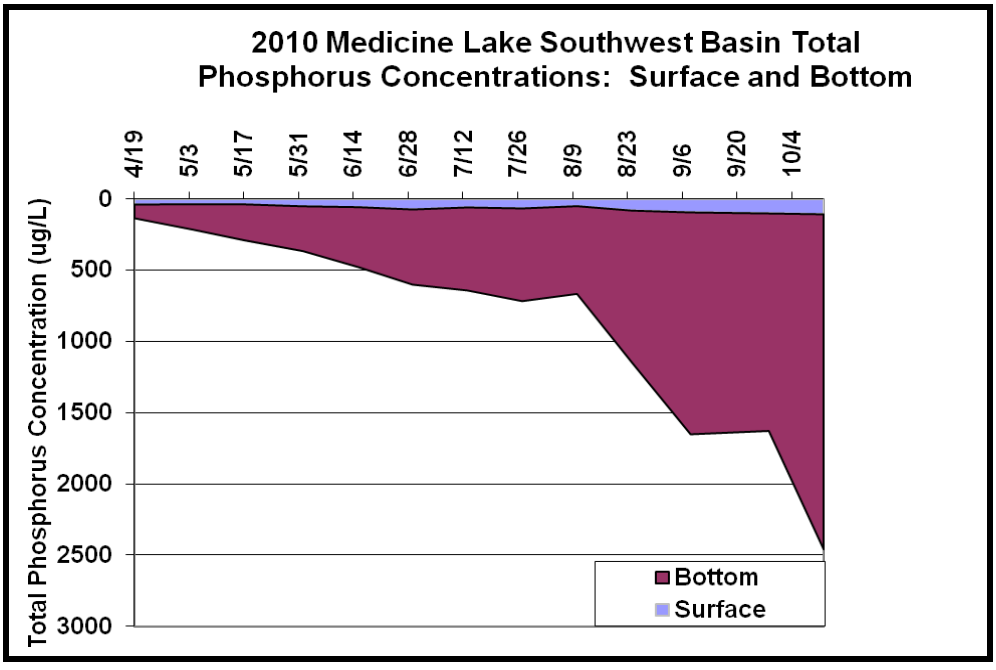


Figure 17 2010 Medicine Lake Southwest Basin Total Phosphorus Concentrations: Surface and Bottom

3.6 Historical Trends

A trend analysis of data collected during the past 20 years (i.e., 1990 through 2010) from the Main Basin of Medicine Lake was completed using WQ Stat, a trend analysis software program. The results indicate changes in total phosphorus and chlorophyll *a* were not significant (Figures 18 and 19). Phosphorus and chlorophyll concentrations have consistently fluctuated both upward and downward over the past 20 years. The analyses results indicate the fluctuations have not shown a trend. Hence, the trend lines for total phosphorus and chlorophyll *a* are nearly flat. About half of the concentrations are above the trend line and half of the concentrations are below the trend line (Figures 18 and 19). The slope of the trend lines (Sens slope) indicate both total phosphorus and chlorophyll have decreased slightly over time, but not enough to be a significant change. Total phosphorus has declined about 0.097 µg/L per year or about 1 µg/L every 10 years. Chlorophyll *a* has declined about 0.135 µg/L per year or about 1 µg/L every 7 years.

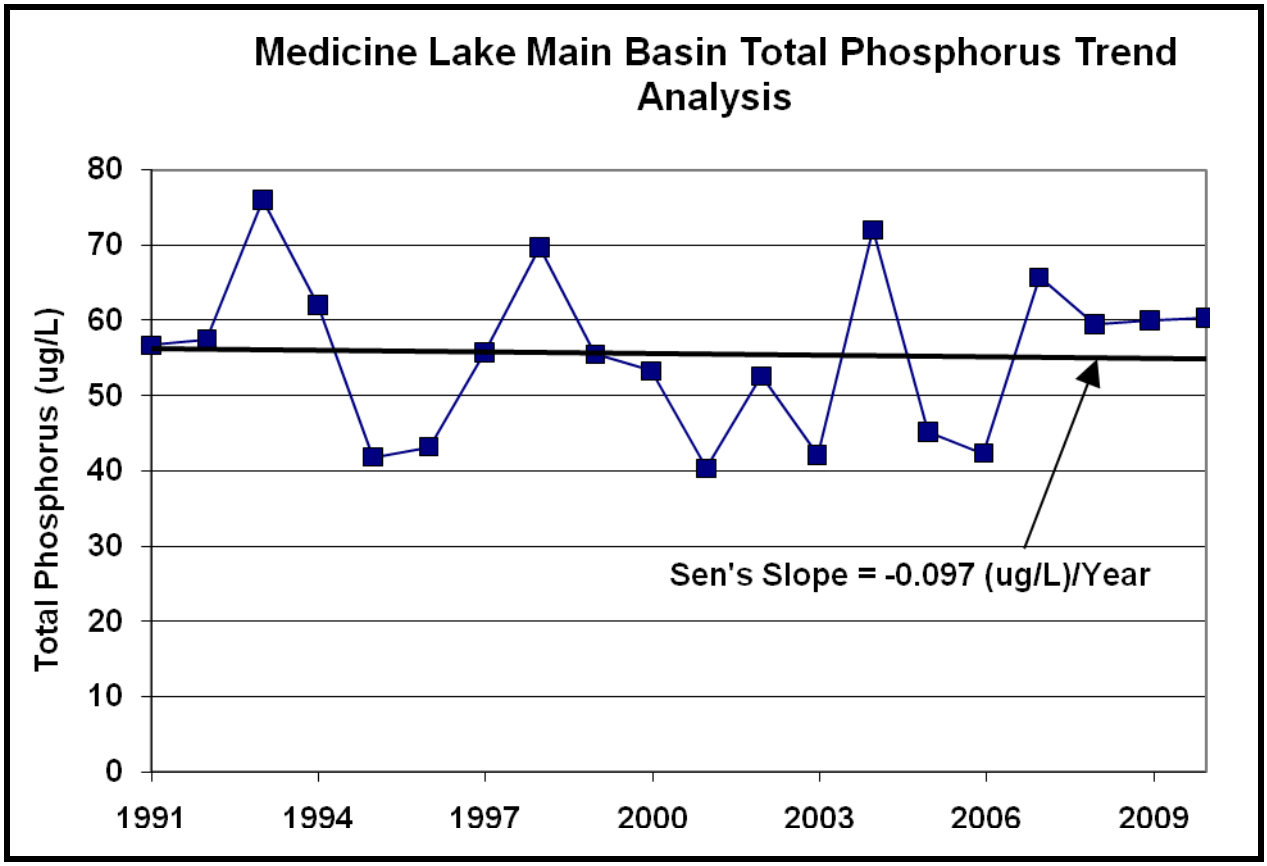


Figure 18 Medicine Lake Main Basin Total Phosphorus Trend Analysis: 1991-2010

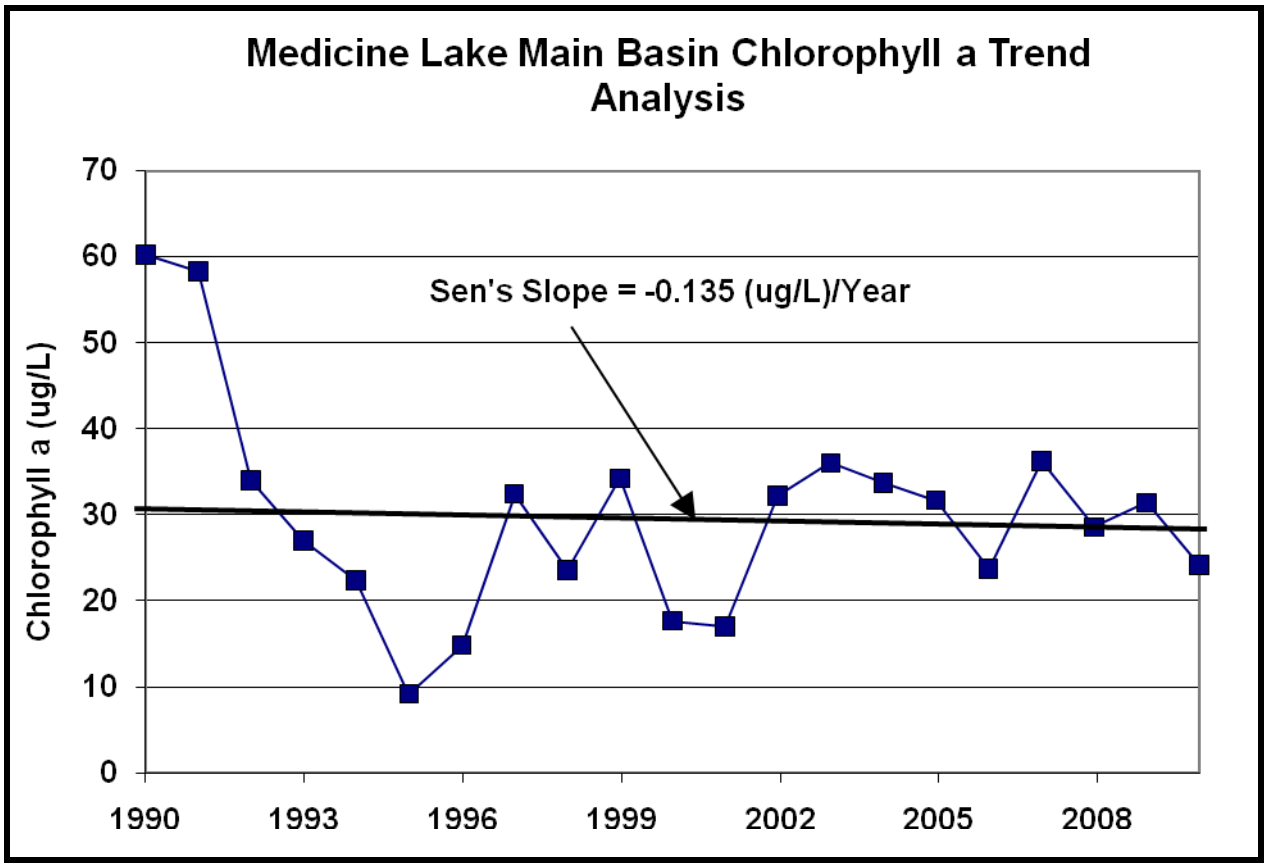


Figure 19 Medicine Lake Main Basin Chlorophyll a Trend Analysis: 1990-2010

The trend analyses indicate Secchi disc water transparency has significantly improved (Figure 20). The analysis indicates the rate of improvement has been about 0.034 meters per year or about 1 foot every 10 years.

The trend analysis results indicate that management efforts to prevent water quality degradation during periods of rapid development in the Medicine Lake watershed have been successful. Installation of Best Management Practices (BMPs) during periods of development within the lake's watershed have prevented significant increases in phosphorus and chlorophyll *a* concentrations and have improved water transparency.

3.7 Historical Attainment of Goals and State Standards

Historical water quality data from the Main Basin of Medicine Lake for the period 1966 through 2010 are compared with lake water quality goals in Figure 21. The summer averages indicate the lake's water quality generally has not met goals during the period of record. Chlorophyll *a* met the goal during 1995 and Secchi disc transparency met the goal during

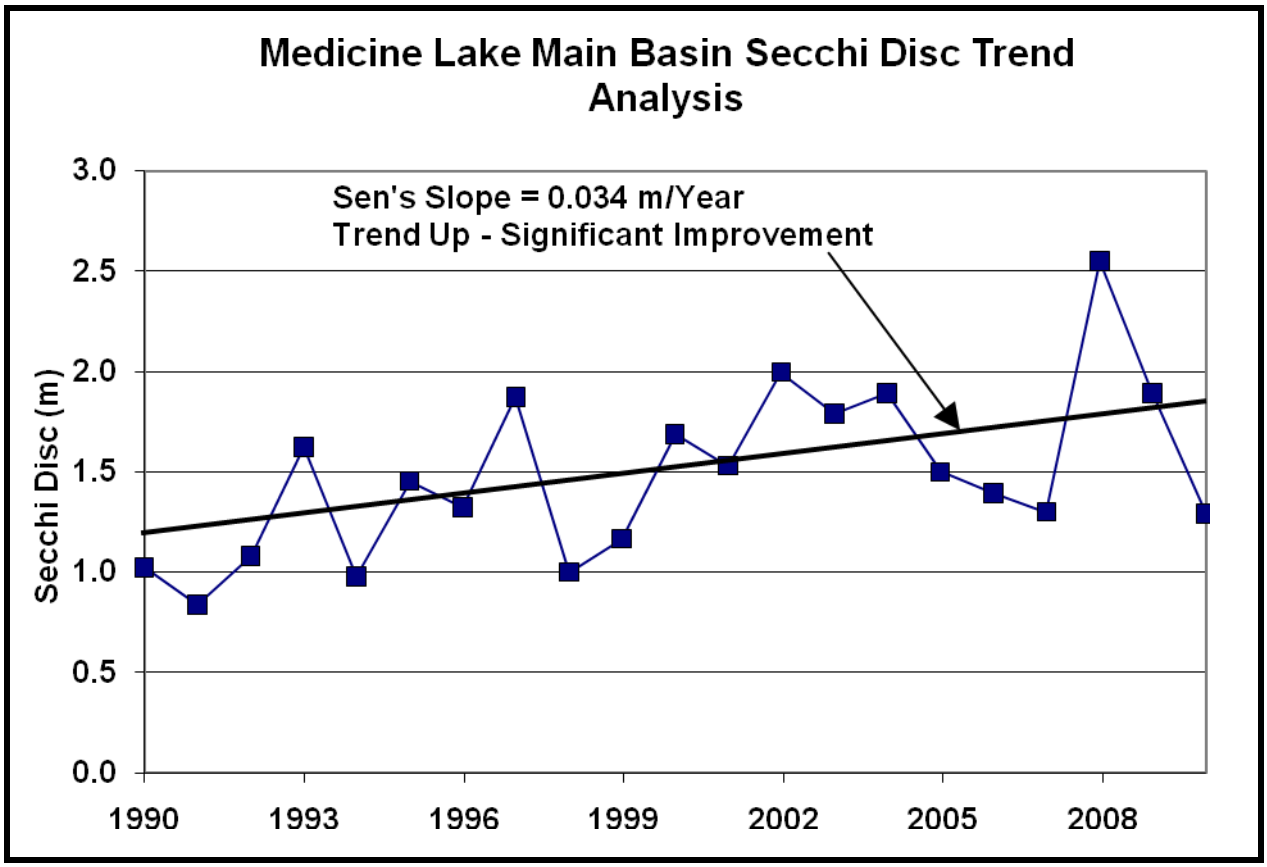


Figure 20 Medicine Lake Main Basin Secchi Disc Trend Analysis: 1990-2010

1977 and 2008. All other chlorophyll *a* and Secchi disc values and all total phosphorus concentrations observed during the period of record failed to meet water quality goals.

Historical water quality data from the Main Basin of Medicine Lake for the period 1966 through 2010 are compared with State water quality standards in Figure 22. The summer averages indicate the lake's water quality generally has not met State water quality standards during the period of record. Secchi disc summer averages met the criteria for the State standard during 15 of the 33 years (45 percent) in which data were collected. However, the State Standard specifies that in addition to Secchi disc, either chlorophyll *a* or total phosphorus summer average concentrations must meet the standard criteria for a lake to meet the State standard. Since none of the 33 total phosphorus summer averages and only two of the chlorophyll summer averages met State standard criteria, Medicine Lake has only met the state standard on two occasions (1977 and 1995). The data indicate the state standard has not been met during the past 15 years.

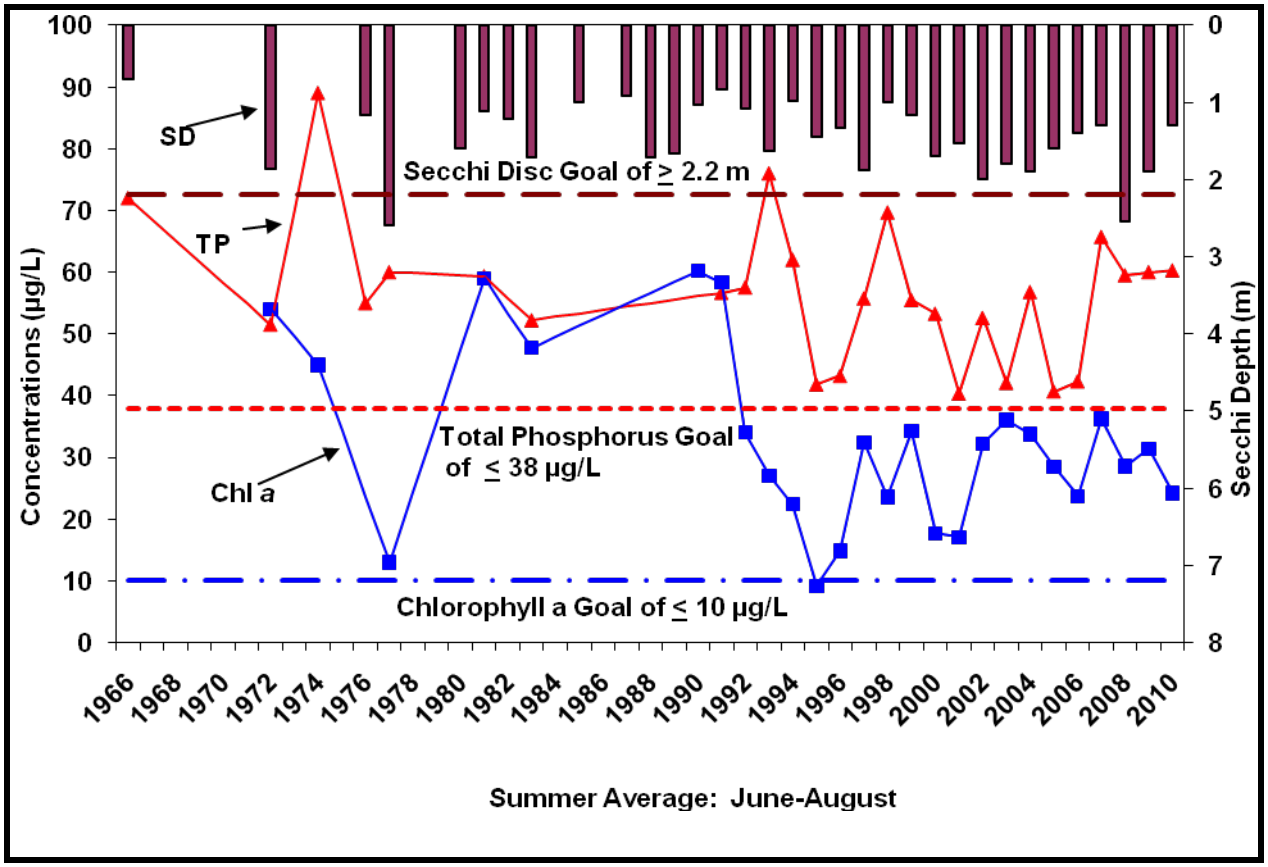


Figure 21 **1966-2010 Medicine Lake Main Basin Historical Water Quality Data Compared With Lake Water Quality Goals**

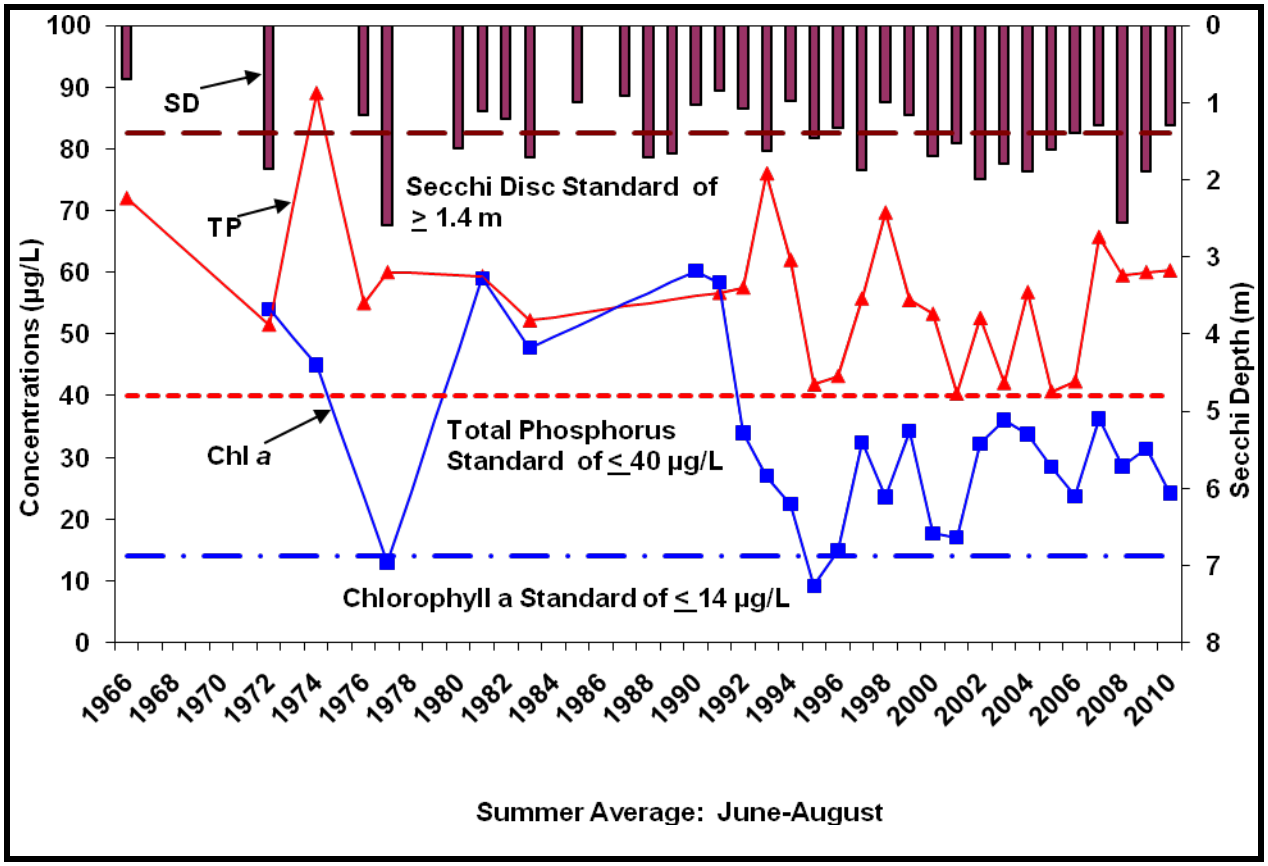


Figure 22 1966-2010 Medicine Lake Water Quality Compared with State Standards

3.8 Biota

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

3.8.1 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.

In 2010, phytoplankton densities followed a similar pattern as chlorophyll *a* concentrations. Both noted declining values from early spring to summer and then increasing values during the summer. Total phytoplankton population density declined from more than 20,000 per milliliter in April to less than 2,000 per milliliter in May in the Main Basin and from more than 5,000 per milliliter in April to less than 2,000 per milliliter in May in the Southwest Basin (Figures 23 and 24). Both basins observed a consistent increase in density throughout the summer. During June through August, the number of phytoplankton increased nearly five-fold in the Main Basin and more than six fold in the Southwest Basin of Medicine Lake (Figures 23 and 24). In the Main Basin, population density peaked at nearly 50,000 per milliliter while the Southwest Basin population density peaked at more than 60,000 per milliliter. Density declined about an order of magnitude between late August and late September (Figures 23 and 24).

Green algae dominated the spring community while blue green algae were predominant during the summer (Figures 23 and 24). Blue-green algae can produce natural toxins that can be harmful to the health of pets and humans in sufficiently high concentrations. The World Health Organization (WHO) has published guidelines for safe recreational water environments, including safe levels of blue-green algae. The guidelines indicate blue-green algae at densities of at least 20,000 cells per milliliter but less than 100,000 cells per milliliter pose a low risk of adverse health effects. Within this range, the levels of toxins produced by the algae are not expected to cause illness, but there is a possibility that lake users may

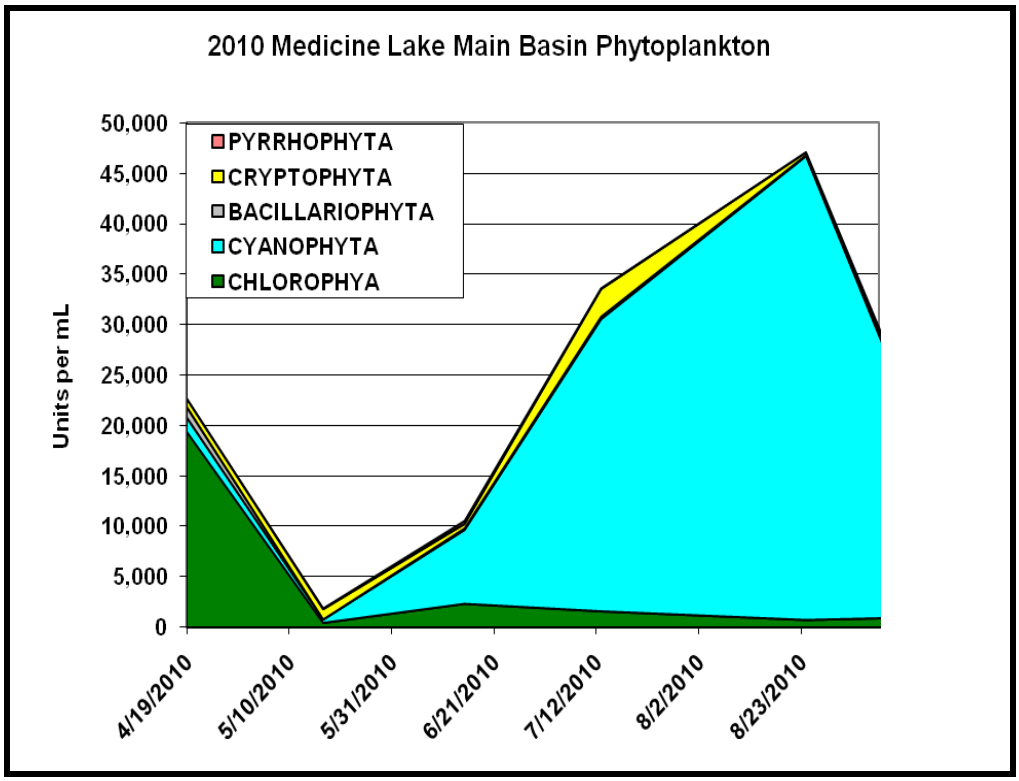


Figure 23 2010 Medicine Lake Main Basin Phytoplankton Data Summary by Division

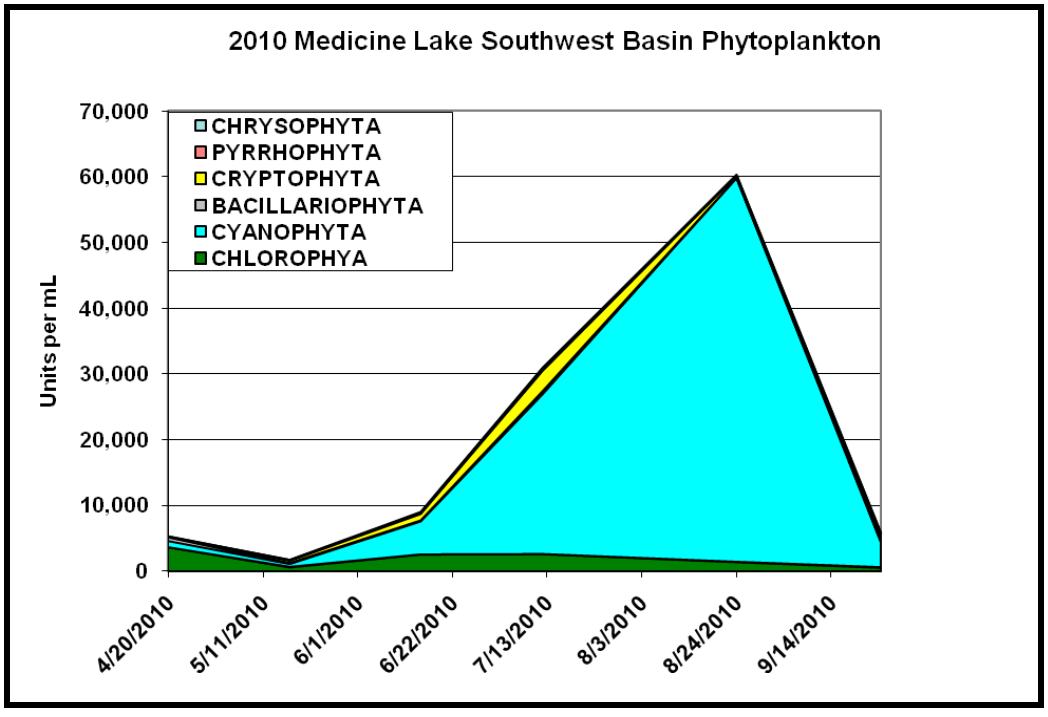


Figure 24 2010 Medicine Lake Southwest Basin Phytoplankton Data Summary by Division

experience skin irritations or allergenic effects such as watery eyes. The WHO guidelines indicate blue-green algae at densities of at least 100,000 cells per milliliter pose a moderate risk of adverse health effects. The moderate level is considered a threshold of concern because it indicates sufficient algal toxins may be present to cause adverse health effects, including long-term illness (WHO, 2003).

As shown in Figure 25, blue-green algae levels in Medicine Lake during 2010 were at or below the low risk threshold and were never within the moderate risk threshold of adverse health effects. The data indicate the highest levels of blue-green algae ranged from 46,026 cells per milliliter in the Main Basin to 58,525 cells per milliliter in the Southwest Basin (Figure 25). Hence, blue-green algae levels were roughly halfway to the moderate risk threshold of adverse health effects.

The dominant blue-green algae species in Medicine Lake during 2010 was *Cylindrospermopsis raciborski* (Figure 26), known for its ability to produce toxins. The toxin produced by this algal species, cylindrospermopsin, is a general cytotoxin that can cause liver or kidney failure by blocking protein synthesis if sufficient quantities are ingested by pets or lake users. At the peak of the lake's blue-green algae bloom in late August, about two thirds of the blue-green algae were *Cylindrospermopsi raciborski*. However, the numbers of *Cylindrospermopsi raciborski* in Medicine Lake during 2010 were below the moderate risk threshold of adverse health effects and, hence, would not be expected to pose a risk of illness to lake users.

The phytoplankton data affirm the importance of future management efforts to improve the water quality of Medicine Lake and prevent increases in algal species that produce toxins. The data also suggest monitoring for algal toxins and phytoplankton is necessary to identify changes in numbers of blue-green algae and to determine the levels of toxins added to the lake by blue-green algae. The data will help to identify measures to prevent increases in algal toxins and thereby prevent harmful health effects to lake users and animals such as family pets.

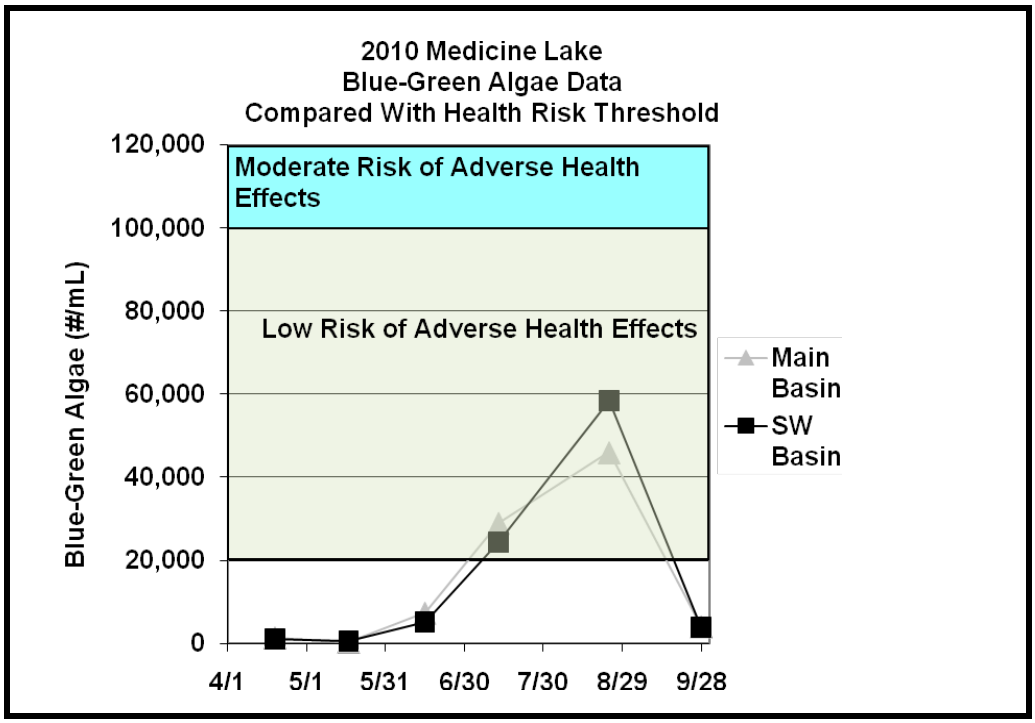


Figure 25 2010 Medicine Lake Blue-Green Algae Data Compared with Health Risk Threshold

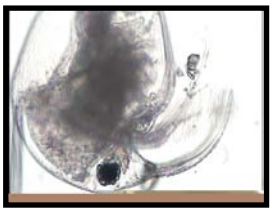
Figure 26 Cylindrospermopsis raciborski (Medicine Lake Main Basin, August 24, 2010)

3.8.2 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

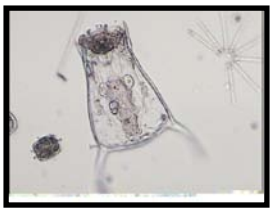
All three groups of zooplankton (Cladocera, Copepod, and Rotifer) were represented in Medicine Lake during 2010 (see Figures 27 and 28 and pictures below). The data indicate the lake has a healthy zooplankton community which supports the lake's fishery.

Daphnia galeata, **Cladocera group**



Bosmina longristris, **Cladocera group**

Cyclops sp. **Copepod group**



Keratella quadrata **Rotifer group**

In the Main Basin, total zooplankton population density peaked at slightly more than 6 million per square meter in late September. The second highest density was observed in spring when population density was nearly 5 million per square meter. Population density declined between spring and summer and then fluctuated between approximately 1.5 and 2 million per square meter during the summer (Figure 27).

In the Southwest Basin, zooplankton density declined from a density of about 1.5 million per square meter in April to about 350,000 per square meter in May. Densities then increased throughout the summer, reaching a maximum density of around 2.3 million per square meter in late August (Figure 28).

The dominant taxa in both basins during 2010 were Copepoda and Rotifers. The large-bodied Cladocera were much less abundant and only accounted for between 1 and 28 percent of all zooplankton collected (Figures 27 and 28). The lower levels of Cladocera and the decline of the total population of zooplankton between spring and summer indicate that fish are present in large numbers and exert pressure on zooplankton through grazing. Indeed, in 2004 a DNR fish population survey showed that yellow perch, black crappies, and particularly bluegills, are found in large numbers in Medicine Lake. The data indicate Medicine Lake zooplankton are a valuable food source for the lake's fishery.

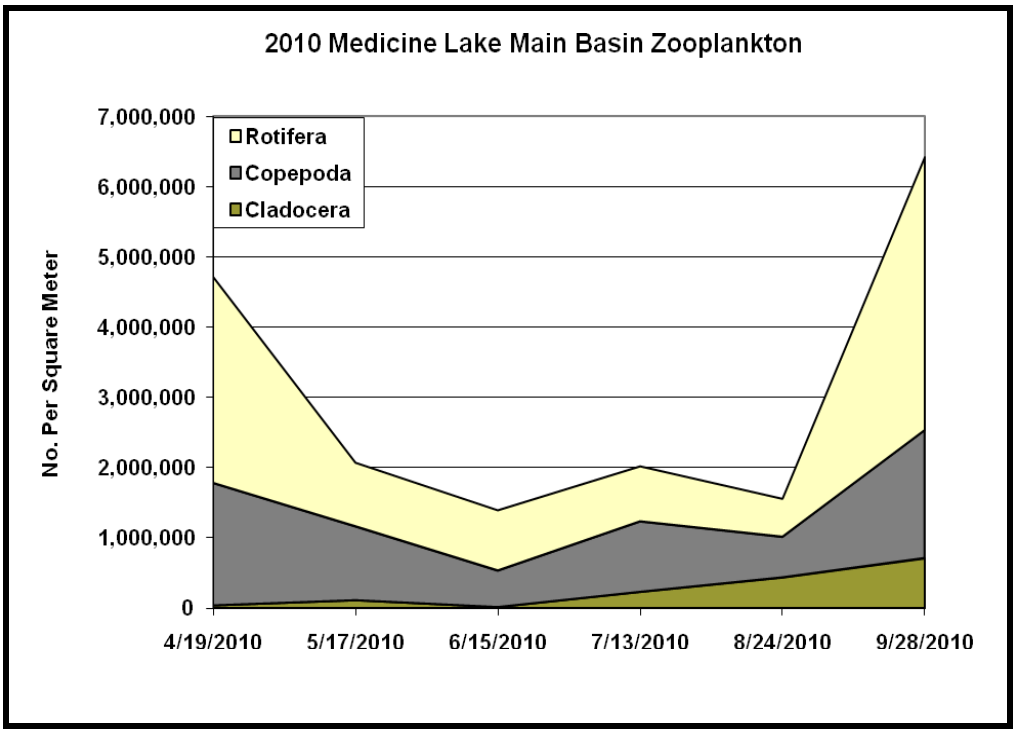


Figure 27 2010 Medicine Lake Main Basin Zooplankton Data Summary by Division

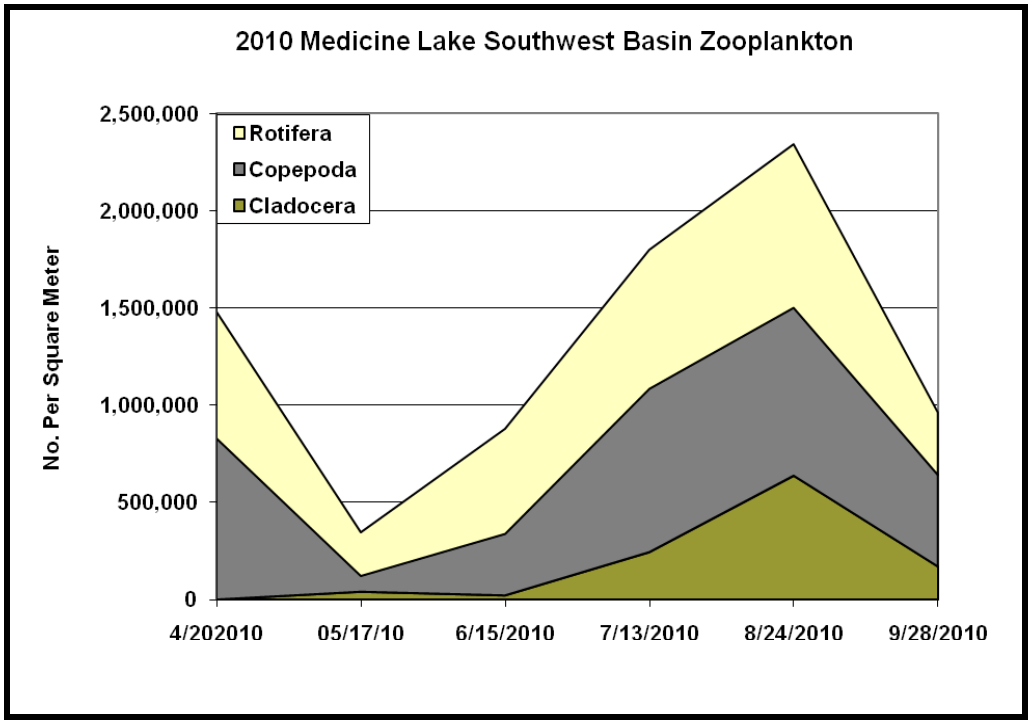


Figure 28 2010 Medicine Lake Southwest Basin Zooplankton Data Summary by Division

3.8.3 Macrophytes (Aquatic Plants)

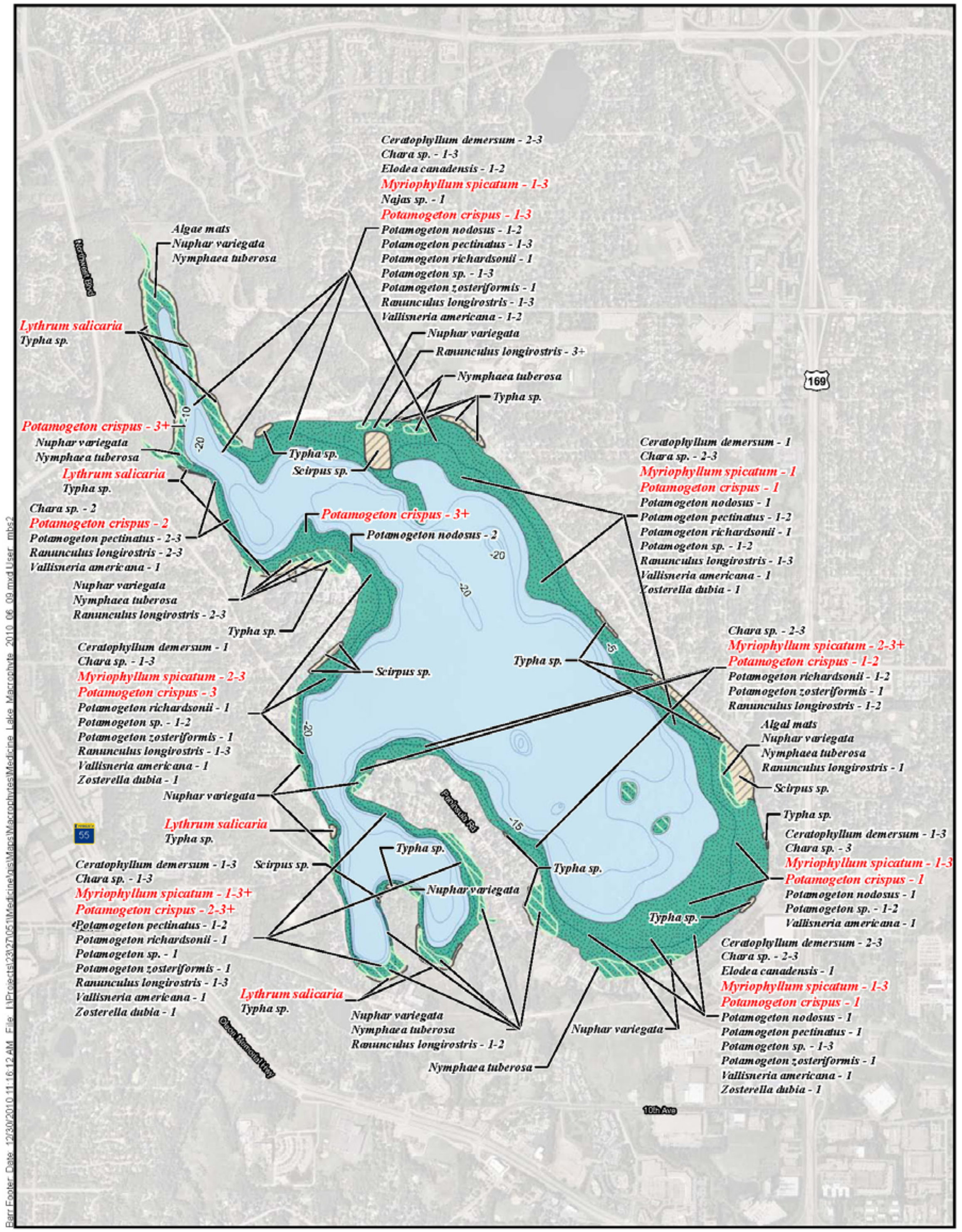
Submerged vegetation was found throughout the lake's littoral (or shallow) zone in 2010. A total of 20 species were found in June and 21 species were found in August (Figures 29 and 30). Submerged vegetation densities ranged from light to heavy.

The presence of three undesirable non-native species, Curlyleaf pondweed (*Potamogeton crispus*), Eurasian watermilfoil (*Myriophyllum spicatum*) and purple loosestrife (*Lythrum salicaria*), indicates regular assessment of the lake's plant community is warranted.

The quality of the Medicine Lake plant community was measured by the Floristic Quality Index (FQI) which considers the quality of the individual species found in the lake and the number of species. To compute FQI, each individual plant species in a lake is assigned a number depicting its quality, termed a Coefficient of Conservatism or C value, which indicates how tolerant a species is to degraded conditions, including water quality degradation. C values are on a scale of 0 to 10, with increasing values indicating increasing intolerance toward degraded conditions. An average of the C values of the individual species within a plant community indicates the average tolerance of the plant community to degraded conditions. Increases in the average C value of a plant community indicate a change toward species less tolerant of degraded conditions and a higher quality plant community.

In 2010, the Medicine Lake mean C value was 5.3 in June and 5.4 in August. The mean C was approximately midway in the 0 to 10 range and indicates, on average, plants in Medicine Lake are tolerant of moderate disturbance.

FQI considers the number of native species present within the lake in addition to changes in species tolerance to degraded conditions (C values). In 2010, the number of native species increased from 17 in June to 19 in August (Figures 29 and 30). FQI changed accordingly. FQI was 21 in June and 23 in August. In 2010, the average FQI was 22. Although Minnesota has not kept a record of FQI values, Wisconsin records indicate FQI values have ranged from 3 (representing degraded conditions) to 49 (representing diverse native plant communities). The median FQI for Wisconsin lakes is 22. The summer FQI values in Medicine Lake were similar to the median FQI for Wisconsin Lakes, indicating the plants are of average quality and tolerant to moderate disturbance.



Submerged Aquatic Plants

Common Name	Scientific Name
bushy pondweed and naiads	*Najas sp.*
narrowleaf pondweed	*Potamogeton sp. (narrowleaf)*
sago pondweed	*Potamogeton pectinatus*
Richard's pondweed	*Potamogeton richardsonii*
coontail	*Ceratophyllum demersum*
curlyleaf pondweed	***Potamogeton crispus***
Eurasian watermilfoil	***Myriophyllum spicatum***
flatstem pondweed	*Potamogeton zosteriformis*
muskgrass	*Chara sp.*
floatingleaf pondweed	*Potamogeton natans*
white water crowfoot	*Ranunculus longirostris*
water stargrass	*Zosterella dubia*
Longleaf pondweed	*Potamogeton nodosus*
water celery	*Vallisneria americana*
Canada waterweed	*Elodea canadensis*

Floating Leaf Plants

Common Name	Scientific Name
white waterlily	*Nymphaea tuberosa*
yellow waterlily	*Nymphaea variegata*

Emergent Plants

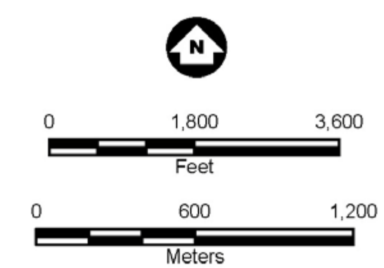
Common Name	Scientific Name
cattail	*Typha sp.*
purple loosestrife	***Lythrum salicaria***
bulrush	*Scirpus sp.*

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

FIELD NOTES:
- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy
- Main growth from 0-8', 11-13' approx. max growing depth
- Ceratophyllum demersum sporadic at depths > 11-13'

Legend

- Emergent Plants
- Floating Leaf Plants
- Submerged Aquatic Plants
- No Aquatic Vegetation



Imagery Source: Aerials Express, 2009

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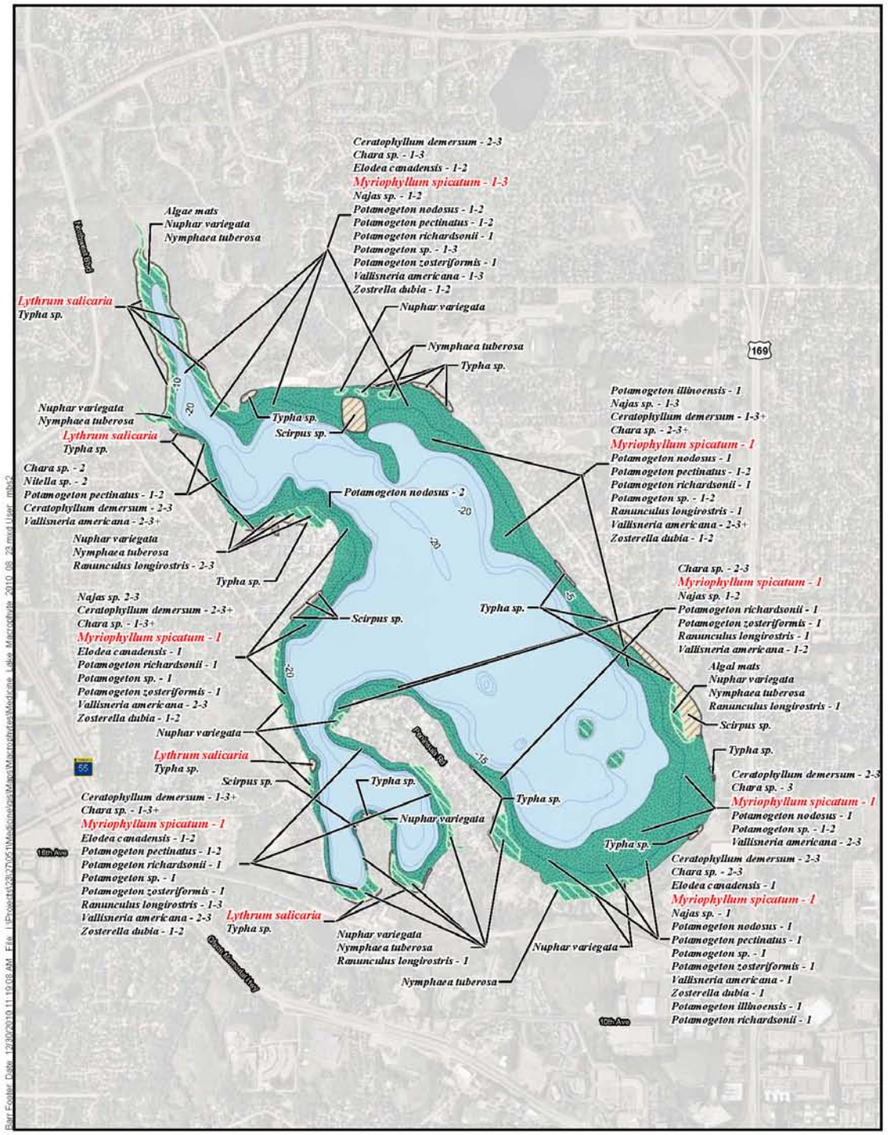
MEDICINE LAKE MACROPHYTE SURVEY RESULTS
June 9, 2010
Bassett Creek Watershed Management Commission

Figure 29 Medicine Lake Macrophyte Survey Results: June 9, 2010



Submerged Aquatic Plants

Common Name	Scientific Name
bushy pondweed and naiads	*Najas sp.*
Illinois pondweed	*Potamogeton illinoensis*
narrowleaf pondweed	*Potamogeton sp. (narrowleaf)*
sago pondweed	*Potamogeton pectinatus*
Richard's pondweed	*Potamogeton richardsonii*
coontail	*Ceratophyllum demersum*
Eurasian watermilfoil	***Myriophyllum spicatum***
flatstem pondweed	*Potamogeton zosteriformis*
muskgrass	*Chara sp.*
floatingleaf pondweed	*Potamogeton natans*
white water crowfoot	*Ranunculus longirostris*
water stargrass	*Zosterella dubia*
Longleaf pondweed	*Potamogeton nodosus*
water celery	*Vallisneria americana*
stonewort	*Nitella sp.*
Canada waterweed	*Elodea canadensis*

Floating Leaf Plants

Common Name	Scientific Name
white waterlily	*Nymphaea tuberosa*
yellow waterlily	*Nymphaea variegata*

Emergent Plants

Common Name	Scientific Name
cattail	*Typha sp.*
purple loosestrife	***Lythrum salicaria***
bulrush	*Scirpus sp.*

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

FIELD NOTES:
- Macrophyte densities estimated as follows: 1=light; 2=moderate; 3=heavy
- Main growth from 0-8', 11-13' approx. max growing depth
- Ceratophyllum demersum sporadic at depths > 11-13'

Legend

- Emergent Plants
- Floating Leaf Plants
- Submerged Aquatic Plants
- No Aquatic Vegetation

N

0 1,800 3,600
Feet

0 600 1,200
Meters

Imagery Source: Aerials Express, 2009

BARR

MEDICINE LAKE MACROPHYTE SURVEY RESULTS
August 23, 2010
Bassett Creek Watershed Management Commission

Figure 30 Medicine Lake Macrophyte Survey Results: August 23, 2010

3.9 Conclusions and Recommendations

Conclusions include:

- A trend analysis of data collected during the past 20 years (i.e., 1990 through 2010) indicates changes in total phosphorus and chlorophyll *a* were not significant. The analysis indicates Secchi disc water transparency has significantly improved at the rate of about 0.034 meters per year or about 1 foot every 10 years. The trend analysis results indicate that management efforts to prevent water quality degradation during periods of rapid development in the Medicine Lake watershed have been successful.

- The overall water quality status of Medicine Lake in 2010 was eutrophic (nutrient rich) and poor quality. Chlorophyll *a* and Secchi disc summer averages were eutrophic while the summer average phosphorus concentration was hypereutrophic (nutrient rich, poor water quality).

- In 2010, total phosphorus, chlorophyll *a*, and Secchi disc transparency summer averages did not attain water quality goals for Medicine Lake or State water quality standards.

- Three undesirable non-native plant species, Curlyleaf pondweed, purple loosestrife, and Eurasian watermilfoil, were observed during 2010.

- In 2010, the quality of the Medicine Lake plant community was average and the lake's plant species were tolerant of moderate disturbance.

- Historical water quality data from the Main Basin of Medicine Lake for the period 1966 through 2010 compared with State water quality standards indicates summer averages met State water quality standards during 2 of the 33 years of data collection.

Recommendations include:

- Continue implementation of management strategies in the Medicine Lake TMDL and BCWMC Watershed Management Plan (2004), including two Plymouth Creek projects (i.e., current project on lower Plymouth Creek and forthcoming upper Plymouth Creek project).

- Assess Medicine Lake water quality following implementation of the Medicine Lake water quality improvement projects that have recently been completed or are underway and determine whether sufficient water quality improvement has occurred to attain goals and State water quality standards as outlined in the Medicine Lake TMDL Implementation Plan. Document and track activities and projects in the Medicine Lake watershed that reduce phosphorus loads to the lake.

4.0 References

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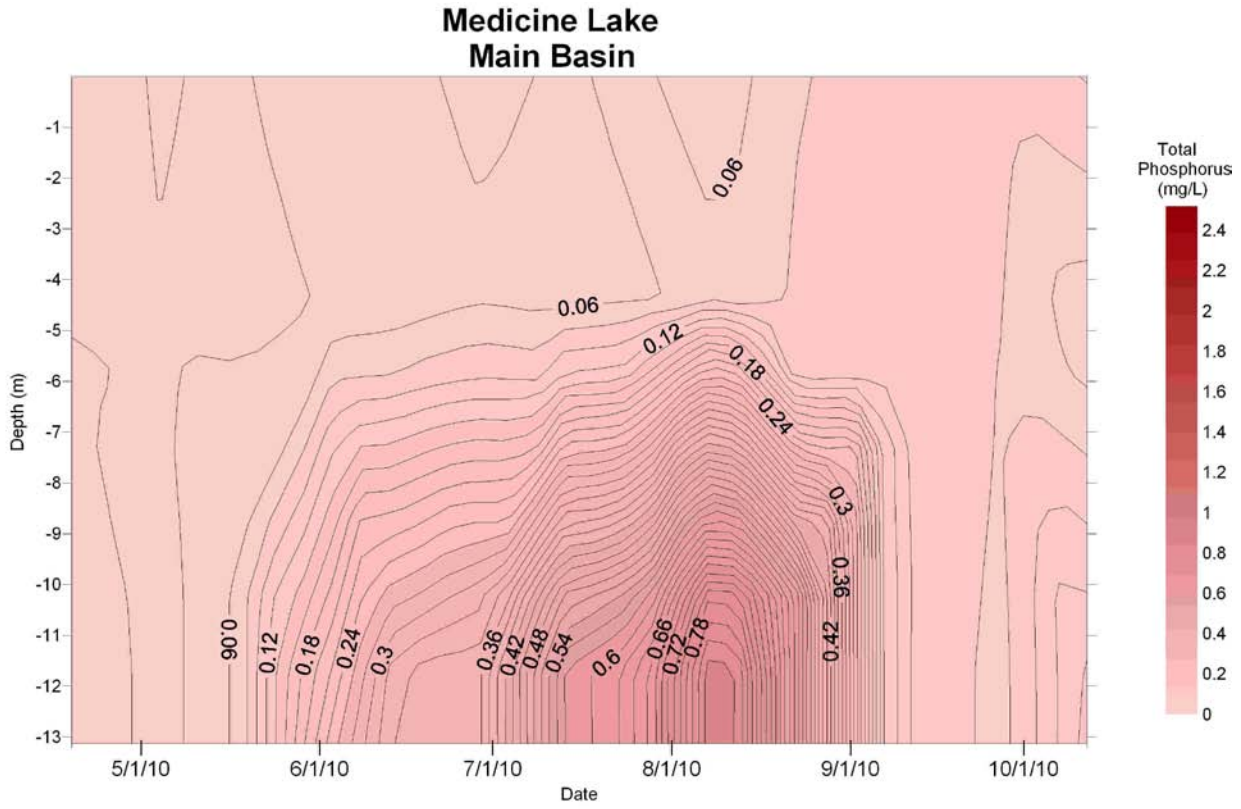
Appendix A

2010 Medicine Lake Main Basin Data



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Medicine Lake Main Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
4/19/2010	2.2	0-2	8.6				0.031	<0.006	0.865		
		0.0		16.5	13.06	726				8.55	
		1.0		14.0	14.24	723				8.47	<2
		2.0		13.3	14.77	722				8.45	
		3.0		12.5	14.50	723				8.44	
		4.0		12.4	13.55	724				8.45	
		5.0		12.3	13.06	724				8.44	
		6.0		12.3	12.81	724	0.042	<0.006		8.44	
		7.0		12.1	12.56	725				8.44	
		8.0		11.7	12.12	728				8.44	
		9.0		11.6	11.19	729				8.43	
		10.0		11.3	9.67	735				8.40	
		11.0		10.7	9.21	738				8.40	
		12.0		10.5	8.23	744	0.052	<0.006		8.37	
		12.5		10.1	1.73	794				7.99	
5/4/2010	2.9	0-2	9.6				0.042	0.027	0.771		
		0.0		13.6	11.20	741				8.71	
		1.0		13.6	10.58	741				8.62	
		2.0		13.6	10.47	741				8.61	
		3.0		13.6	10.41	741				8.60	
		4.0		13.5	10.38	741				8.60	
		5.0		13.5	10.35	741	0.039	0.007		8.60	
		6.0		13.5	10.33	741				8.60	
		7.0		13.5	10.28	741				8.59	
		8.0		13.5	10.25	741				8.59	
		9.0		13.5	10.26	741				8.59	
		10.0		13.5	10.17	742	0.035	0.008		8.58	
		10.8		13.1	1.5	772				7.95	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
5/17/2010	5.1	0-2	<5.0				0.037	<0.006	0.832		
		0.0		17.8	11.12	713				7.37	
		1.0		16.2	11.36	715				7.43	
		2.0		14.6	11.56	711				7.46	
		3.0		13.4	11.50	712				7.49	
		4.0		12.9	11.04	713				7.50	
		5.0		12.4	10.76	714	0.038	0.007		7.52	
		6.0		12.1	10.29	715				7.53	
		7.0		12.0	9.62	716				7.54	
		8.0		11.9	9.27	716				7.57	
		9.0		11.9	9.06	717	0.051	0.008		7.57	
		9.7		11.7	0.88	743				7.40	
6/1/2010	1.7	0-2	14.1				0.051	0.007	0.891		
		0.0		22.8	10.36	683				7.70	
		1.0		22.8	11.01	684				7.93	
		2.0		22.8	11.02	683				7.95	
		3.0		22.0	10.9	681				7.97	
		4.0		18.6	9.04	693				7.96	
		5.0		15.8	8.20	684	0.040	0.011		7.94	
		6.0		14.1	6.61	689				7.86	
		7.0		13.3	6.25	689				7.81	
		8.0		12.7	4.82	692				7.78	
		9.0		12.3	3.16	696				7.74	
		10.0		12.2	2.09	697				7.72	
		11.0		12.0	0.90	699				7.68	
		12.0		12.0	0.57	701				7.66	
		13.0		11.8	0.35	735	0.232	0.098		7.50	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
6/15/2010	1.7	0-2	22.4				0.058	0.015	0.931		3.9
		0.0		19.7	10.34	727				7.61	
		1.0		19.6	10.07	729				7.60	
		2.0		19.6	10.04	729				7.61	
		3.0		19.5	9.86	730				7.62	
		4.0		19.4	9.69	729				7.62	
		5.0		18.3	3.95	738	0.044	0.013		7.56	
		6.0		16.5	2.50	751				7.54	
		7.0		14.4	1.52	754				7.55	
		8.0		13.3	0.83	760				7.53	
		9.0		13.0	0.68	765				7.51	
		10.0		12.7	0.46	767				7.48	
		11.0		12.6	0.40	771				7.46	
		12.0		12.5	0.36	776	0.352	0.161		7.42	
		12.9		12.3	0.41	857				7.33	
6/29/2010	1.5	0-2	17.8				0.062	<0.006	1.007		
		0.0		22.6	7.89	698				7.93	
		1.0		22.6	7.81	698				8.06	
		2.0		22.6	7.75	699				8.10	
		3.0		22.6	7.70	699				8.12	
		4.0		22.5	7.59	700				8.12	
		5.0		22.2	4.55	702	0.057	<0.006		7.83	
		6.0		19.7	0.56	723				7.37	
		7.0		17.7	0.32	737				7.27	
		8.0		16.5	0.30	743				7.23	
		9.0		15.4	0.28	748				7.18	
		10.0		14.7	0.27	752				7.14	
		11.0		14.3	0.26	754	0.351	0.164		7.09	
		11.6		13.9	0.25	776				6.68	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
7/13/2010	1.1	0-2	30.7				0.059	<0.006			
		0.0		25.4	9.33	682				8.54	
		1.0		25.4	9.33	681				8.55	
		2.0		25.3	9.12	682				8.52	
		3.0		25.0	6.19	687				8.12	
		4.0		24.4	1.98	696				7.61	
		5.0		23.4	0.58	704	0.050	0.006		7.44	
		6.0		21.3	0.22	713				7.33	
		7.0		18.6	0.22	735				7.22	
		8.0		16.1	0.30	747				7.08	
		9.0		15.0	0.14	754				6.96	
		10.0		14.7	0.25	757				6.90	
		11.0		14.3	0.24	792	0.578	0.344		6.70	
7/27/2010	1.0	0-2	26.9				0.062	<0.006	1.311		
		0.0		26.2	9.25	696				8.47	
		1.0		26.2	8.93	697				8.46	
		2.0		26.1	8.84	698				8.40	
		3.0		25.8	6.64	699				8.13	
		4.0		25.1	4.46	703				7.70	
		5.0		24.5	1.83	705	0.059	0.010		7.46	
		6.0		22.6	0.78	723				7.37	
		7.0		20.6	0.51	740				7.25	
		8.0		17.8	0.44	757				7.09	
		9.0		16.0	0.44	768				6.98	
		10.0		15.4	0.40	773				6.85	
		11.0		14.9	0.37	793	0.637	0.448		6.58	
		11.3		14.7	0.35	807				6.48	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
8/10/2010	1.01	0-2	30.0				0.05	0.012	1.13		5.2
		0.0		27.4	10.09	705				8.40	
		1.0		27.4	10.13	706				8.61	
		2.0		26.4	6.12	712				8.33	
		3.0		26.1	3.83	714				8.00	
		4.0		25.4	0.35	715				7.49	
		5.0		24.2	0.29	723	0.063	0.011		7.44	
		6.0		23.7	0.30	726				7.40	
		7.0		21.0	0.30	749				7.37	
		8.0		18.6	0.32	764				7.28	
		9.0		16.1	0.33	786				7.13	
		10.0		15.7	0.31	789				7.04	
		11.0		14.9	0.28	822	0.902	0.571		6.78	
		11.1		14.7	0.27	879				6.64	
8/24/2010	1.0	0-2	27.4				0.080	0.008	1.323		
		0.0		25.2	8.18	662				8.05	
		1.0		25.2	7.84	663				8.11	
		2.0		25.2	7.97	663				8.12	
		3.0		25.2	7.71	663				8.10	
		4.0		25.2	7.87	663				8.08	
		5.0		25.0	7.14	665				7.94	
		6.0		23.4	2.27	670	0.087	0.017		7.55	
		7.0		22.9	0.57	676				7.36	
		8.0		21.2	0.29	718				7.26	
		9.0		17.8	0.26	759				6.98	
		10.0		17.0	0.23	764	0.558	0.429		6.88	
		10.9		16.0	0.23	792				6.62	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
9/8/2010	1.0	0-2	31.8				0.089	0.016	1.280		
		0.0		19.0	8.33	677				7.59	
		1.0		19.0	8.08	677				7.65	
		2.0		18.9	7.87	677				7.65	
		3.0		18.9	7.87	677				7.66	
		4.0		18.9	7.82	677				7.66	
		5.0		18.9	7.79	677				7.66	
		6.0		18.9	7.74	677	0.095	0.012		7.66	
		7.0		18.9	7.65	678				7.65	
		8.0		18.9	7.63	677				7.65	
		9.0		18.9	7.63	678				7.65	
		10.0		18.8	7.62	678				7.65	
		11.0		18.4	7.37	679	0.103	0.015		7.63	
		12.0		18.5	1.18	704				7.05	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl *a* (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
9/28/2010	1.5	0-2	49.3				0.085	0.013	1.319		
		0.0		15.7	10.35	664				6.35	
		1.0		15.8	9.02	663				6.72	
		2.0		15.8	8.87	663				6.86	
		3.0		15.8	8.82	663				6.98	
		4.0		15.8	8.75	663				7.11	
		5.0		15.8	8.70	663				7.19	
		6.0		15.8	8.62	663	0.078	0.013		7.24	
		7.0		15.8	8.51	663				7.33	
		8.0		15.8	8.53	663				7.37	
		9.0		15.7	8.15	665				7.39	
		10.0		15.6	7.42	666				7.38	
		11.0		15.6	7.03	666				7.37	
		12.0		15.5	6.48	666	0.071	0.021		7.26	
		13.0		15.4	0.97	734				6.54	
		13.2		15.4	0.91	735				6.51	

Medicine Lake Main Basin Water Quality Data for 2010 (Continued)

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (µg/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)	BOD (mg/L)
10/12/2010	1.0	0-2	87.1				0.102	0.006	1.354		
		0.0		17.4	15.61	657				7.62	
		1.0		17.4	17.70	656				8.24	
		2.0		16.1	13.17	674				8.33	
		3.0		15.2	9.04	676				8.12	
		4.0		15.0	7.80	677				8.03	
		5.0		14.9	6.79	677	0.044	0.010		7.92	
		6.0		14.8	5.51	679				7.80	
		7.0		14.8	5.32	679				7.75	
		8.0		14.8	5.00	680				7.70	
		9.0		14.8	3.69	684				7.63	
		10.0		14.7	3.25	687				7.59	
		11.0		14.7	2.41	690				7.56	
		12.0		14.7	1.24	698	0.148	0.072		7.48	
		12.4		14.6	0.79	703				7.32	

Phytoplankton Analyses
Medicine Lake - Main Basin

Sample Depth: 0-2 m

Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
CHLOROPHYTA (GREEN ALGAE)	*Ankistrodesmus falcatus*	0	0	0	0	0	57
	Chlamydomonas globosa	19,413	402	2,240	976	755	1,034
	Closterium sp.	0	0	0	57	0	0
	Elakatothrix sp.	0	0	0	57	0	0
	Oocystis parva	0	0	115	57	0	57
	Pandorina morum	0	0	0	0	0	0
	Rhizoclonium hieroglyphicum	0	0	0	459	0	0
	Schroederia Judayi	0	0	0	0	0	0
	Selenastrum sp.	0	0	0	0	0	0
	Sphaerocystis Schroeteri	0	57	0	0	0	0
	CHLOROPHYTA TOTAL	**19,413**	**459**	**2,355**	**1,608**	**755**	**1,149**
CHRYSOPHYTA (YELLOW-BROWN ALGAE)	*Dinobryon sociale*	0	0	0	0	0	0
	CHRYSOPHYTA TOTAL	**0**	**0**	**0**	**0**	**0**	**0**

Phytoplankton Analyses
Medicine Lake - Main Basin

Sample Depth: 0-2 m

Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
CYANOPHYTA (BLUE-GREEN ALGAE)	*Anabaena affinis*	0	0	0	2,929	283	0
	Anabaena flos-aquae	0	0	57	1,666	94	0
	Anabaena spiroides v. crassa	0	0	0	0	0	0
	Aphanizomenon flos-aquae	1,149	345	2,757	12,176	6,979	3,618
	Coelosphaerium Naegelianum	0	0	172	172	0	0
	Cylindrospermopsis raciborski	0	0	0	2,642	31,973	115
	Lyngbya limnetica	0	0	0	0	0	0
	Lyngbya sp.	0	0	0	0	0	0
	Microcystis aeruginosa	0	0	0	115	94	0
	Microcystis incerta	0	0	1,149	287	0	230
	Oscillatoria Agardhii	287	0	2,412	4,135	4,621	0
	Oscillatoria limnetica	0	0	0	4,652	1,981	57
	Phormidium mucicola	0	0	804	172	0	57
	Unidentified Blue Green	0	0	0	57	0	0
	CYANOPHYTA TOTAL	**1,436**	**345**	**7,352**	**29,005**	**46,026**	**4,078**

Phytoplankton Analyses
Medicine Lake - Main Basin
Sample Depth: 0-2 m
Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
BACILLARIOPHYTA (DIATOMS)	*Cocconeis placentula*	0	0	0	0	0	0
	Fragilaria crotonensis	0	0	0	172	0	0
	Melosira granulata	0	0	0	0	0	115
	Navicula sp.	0	0	0	0	0	0
	Nitzschia sp.	0	0	0	0	0	0
	Stephanodiscus Hantzschii	689	0	0	0	0	0
	Stephanodiscus sp.	115	0	57	0	0	459
	Synedra ulna	230	0	57	0	0	0
	BACILLARIOPHYTA TOTAL	**1,034**	**0**	**115**	**172**	**0**	**574**
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	804	1,034	459	2,757	283	172
	CRYPTOPHYTA TOTAL	**804**	**1,034**	**459**	**2,757**	**283**	**172**
EUGLENOPHYTA (EUGLENOIDS)	**EUGLENOPHYTA TOTAL**	**0**	**0**	**0**	**0**	**0**	**0**

Phytoplankton Analyses
Medicine Lake - Main Basin
Sample Depth: 0-2 m
Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
PYRRHOPHYTA (DINOFLAGELLATES)	*Ceratium hirundinella*	0	57	287	57	0	574
	PYRRHOPHYTA TOTAL	**0**	**57**	**287**	**57**	**0**	**574**
	TOTALS	**22,687**	**1,895**	**10,568**	**33,600**	**47,063**	**6,548**

Zooplankton Analyses
Medicine Lake Main Basin
Vertical Tow (m)
Sedgewick Rafter Analysis Method

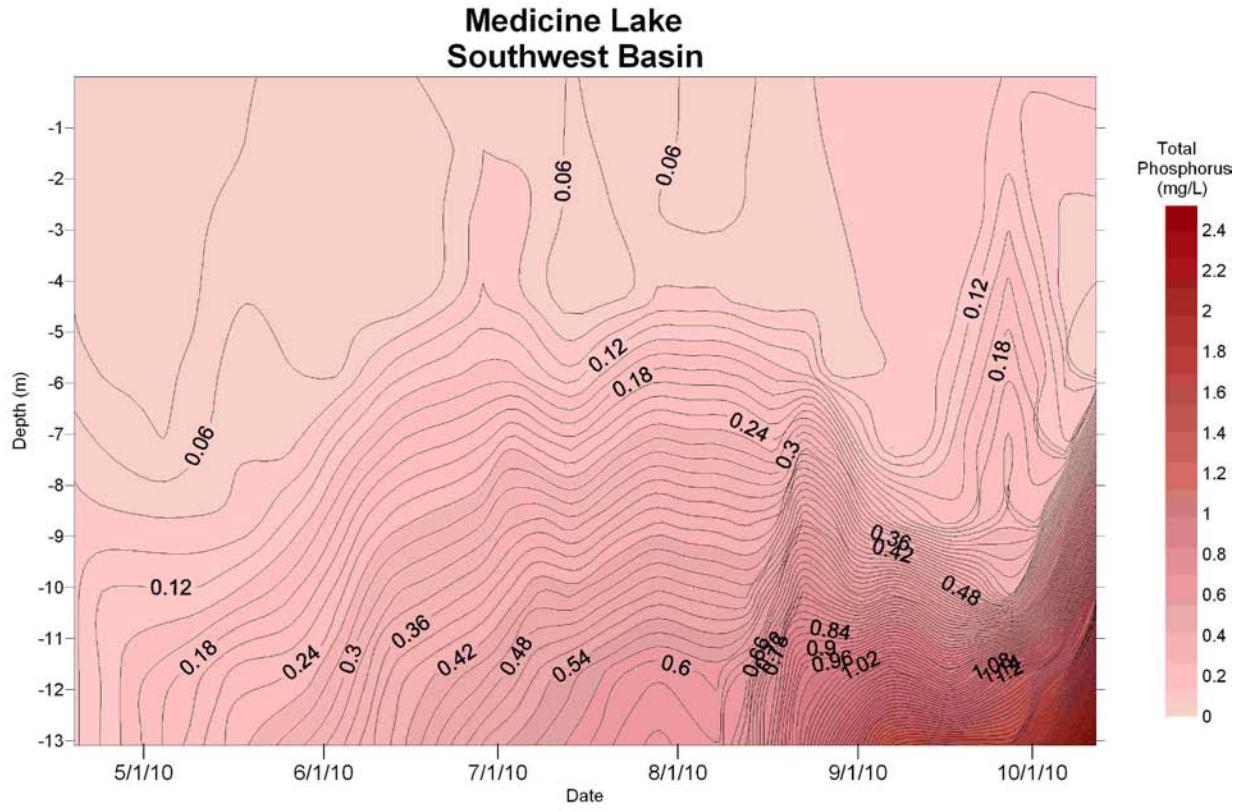
DIVISION	TAXON	04/19/10 #/m2	05/17/10 #/m2	6/15/2010 #/m2	7/13/2010 #/m2	8/24/2010 #/m2	9/28/2010 #/m2
CLADOCERA	*Bosmina longirostris*	0	99,648	0	29,001	77,013	82,760
	Ceriodaphnia sp.	0	0	0	7,250	41,469	10,345
	Chydorus sphaericus	0	4,333	14,766	21,751	5,924	0
	Daphnia galeata mendotae	38,904	4,333	0	94,255	41,469	268,971
	Daphnia retrocurva	0	0	0	50,753	148,102	289,661
	Diaphanosoma leuchtenbergianum	0	0	0	29,001	124,406	62,070
	Immature Cladocera	0	4,333	0	0	0	0
	CLADOCERA TOTAL	**38,904**	**112,646**	**14,766**	**232,012**	**438,382**	**713,808**
COPEPODA	*Cyclops sp.*	369,592	398,594	221,490	116,006	59,241	103,450
	Diaptomus sp.	29,178	394,261	88,596	217,511	189,571	362,077
	Nauplii	1,342,204	255,620	206,724	667,034	325,825	1,355,201
	COPEPODA TOTAL	**1,740,974**	**1,048,475**	**516,810**	**1,000,552**	**574,636**	**1,820,728**

Zooplankton Analyses
Medicine Lake Main Basin
Vertical Tow (m)
Sedgewick Rafter Analysis Method

DIVISION	TAXON	04/19/10 #/m2	05/17/10 #/m2	6/15/2010 #/m2	7/13/2010 #/m2	8/24/2010 #/m2	9/28/2010 #/m2
ROTIFERA	*Asplanchna priodonta*	87,535	38,993	0	0	5,924	0
	Brachionus sp.	19,452	0	0	0	0	0
	Filinia longiseta	1,264,395	0	0	0	0	0
	Keratella cochlearis	223,701	272,950	723,534	311,766	456,155	3,444,901
	Keratella quadrata	1,264,395	545,900	118,128	7,250	0	10,345
	Kellicottia bostoniensis.	29,178	34,660	0	36,252	23,696	31,035
	Lecane sp.	0	0	0	398,771	41,469	351,732
	Polyarthra vulgaris	48,631	12,998	14,766	21,751	5,924	51,725
	Trichocerca cylindrica	0	0	0	7,250	5,924	0
	ROTIFERA TOTAL	**2,937,286**	**905,501**	**856,428**	**783,040**	**539,092**	**3,889,738**
	TOTALS	**4,717,165**	**2,066,622**	**1,388,005**	**2,015,604**	**1,552,111**	**6,424,274**

Appendix B

2010 Medicine Lake Southwest Basin Data



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Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
4/19/2010	2.0	0-2	8.5				0.039	<0.006	0.810	
		0.0		16.3	15.54	724				8.43
		1.0		15.7	14.41	735				8.52
		2.0		14.1	15.30	737				8.60
		3.0		12.7	14.56	735				8.62
		4.0		12.3	12.59	735				8.60
		5.0		12.0	12.07	735	0.038	0.007		8.59
		6.0		11.8	11.02	750				8.56
		7.0		9.7	9.17	755				8.54
		8.0		5.5	4.49	866				8.47
		9.0		4.9	1.66	897	0.096	<0.006		8.38
		9.3		5.0	0.64	904				8.25
5/4/2010	3.4	0-2	7.3				0.036	<0.006	0.760	
		0.0		13.7	10.69	752				8.24
		1.0		13.6	10.37	752				8.23
		2.0		13.6	10.36	751				8.24
		3.0		13.4	10.43	751				8.27
		4.0		13.4	10.39	751				8.28
		5.0		13.3	10.02	752				8.29
		6.0		12.8	8.81	755				8.30
		7.0		10.1	0.95	785				8.23
		8.0		6.8	0.88	860	0.035	0.009		8.24
		9.0		5.6	0.74	900				8.21
		10.0		5.4	0.75	908				8.19
		11.0		5.0	0.55	921				8.18
		12.0		4.8	0.52	941	0.179	0.102		8.09
		12.1		4.8	0.54	941				8.07

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
5/17/2010	5.1	0-2	<5.0				0.037	<0.006		
		0.0		16.1	11.67	723				7.63
		1.0		15.6	11.61	722				7.60
		2.0		15.4	11.58	717				7.58
		3.0		14.1	11.75	721				7.58
		4.0		12.6	11.58	718				7.57
		5.0		12.1	10.72	737				7.57
		6.0		11.5	9.88	732				7.58
		7.0		10.9	9.13	736				7.58
		8.0		8.8	4.13	812				7.53
		9.0		6.7	0.99	860	0.091	0.023		7.48
		10.0		5.4	0.56	884				7.46
		11.0		5.2	0.43	894				7.45
		12.0		5.1	0.30	900	0.252	0.185		7.39
		12.1		5.2	0.26	899				7.36

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
6/1/2010	1.9	0-2	10.82				0.051	0.041	1.018	
		0.0		23.0	9.79	690				7.57
		1.0		23.1	10.46	690				7.70
		2.0		23.0	10.62	689				7.82
		3.0		21.2	10.11	689				7.93
		4.0		17.6	8.65	687				7.96
		5.0		16.1	8.37	681				7.95
		6.0		12.0	4.71	712	0.058	0.008		7.93
		7.0		10.5	2.39	723				7.86
		8.0		8.3	1.53	783				7.77
		9.0		6.9	0.68	822				7.69
		10.0		6.5	0.41	833				7.65
		11.0		6.1	0.32	840				7.61
		12.0		6.0	0.24	843				7.58
		13.0		5.8	0.19	853	0.314	0.237		7.49
		13.3		5.7	0.13	879				7.40

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
6/15/2010	1.7	0-2	21.7				0.057	0.011	1.122	
		0.0		20.7	11.02	727				7.56
		1.0		20.3	11.14	727				7.55
		2.0		20.0	11.00	727				7.55
		3.0		19.4	10.33	728				7.56
		4.0		18.9	6.46	730	0.037	0.014		7.51
		5.0		18.3	5.89	715				7.51
		6.0		14.8	0.62	761				7.45
		7.0		12.1	0.55	781				7.46
		8.0		9.3	0.55	841				7.44
		9.0		8.0	0.53	881				7.39
		10.0		7.3	0.49	898				7.36
		11.0		7.0	0.48	906				7.35
		12.0		6.8	0.45	912	0.419	0.345		7.32
		13.0		6.7	0.44	917				7.30
		13.3		6.6	0.49	918				7.24

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
6/29/2010	1.5	0-2	19.9				0.073	<0.006	1.069	
		0.0		23.2	8.73	668				8.31
		1.0		23.2	8.66	668				8.32
		2.0		23.1	8.56	668				8.28
		3.0		23.0	8.33	669				8.19
		4.0		22.6	6.19	645				7.78
		5.0		21.6	1.77	660	0.111	0.036		7.42
		6.0		18.3	0.70	730				7.32
		7.0		13.3	0.33	773				7.18
		8.0		10.2	0.29	821				7.09
		9.0		8.7	0.26	853				6.99
		10.0		8.1	0.25	867				6.95
		11.0		7.7	0.25	875				6.92
		12.0		7.6	0.23	877				6.90
		13.0		7.5	0.22	878	0.527	0.411		6.89
		13.7		7.2	0.21	917				6.48

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
7/13/2010	1.1	0-2	27.0				0.059	0.008	1.383	
		0.0		25.6	9.22	687				8.44
		1.0		25.5	9.25	687				8.45
		2.0		25.5	9.15	686				8.42
		3.0		25.1	6.15	691				7.97
		4.0		24.4	2.34	694				7.64
		5.0		23.3	0.82	700	0.045	0.006		7.46
		6.0		19.4	0.35	724				7.31
		7.0		13.6	0.36	783				7.21
		8.0		10.3	0.33	827				7.01
		9.0		8.9	0.32	852				6.83
		10.0		8.1	0.31	866				6.76
		11.0		8.0	0.29	871				6.73
		12.0		7.8	0.27	875	0.582	0.533		6.71
		12.8		7.7	0.39	895				6.45

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
7/27/2010	0.8	0-2	28.0				0.066	0.010	1.283	
		0.0		26.2	8.17	698				8.37
		1.0		26.1	8.04	698				8.33
		2.0		26.0	7.69	698				8.29
		3.0		25.4	3.57	702				7.60
		4.0		25.0	1.88	705	0.062	0.010		7.44
		5.0		24.2	0.63	709				7.32
		6.0		19.8	0.56	746				7.22
		7.0		14.5	0.52	801				7.07
		8.0		10.7	0.47	848				6.91
		9.0		9.4	0.43	868				6.80
		10.0		8.7	0.36	878				6.68
		11.0		8.5	0.34	880				6.67
		12.0		8.3	0.30	892	0.650	0.610		6.47

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
8/10/2010	1.1	0-2	25.8				0.050	0.016	1.206	
		0.0		28.0	8.95	711				8.47
		1.0		27.6	9.02	707				8.42
		2.0		26.7	7.91	710				8.26
		3.0		26.1	5.09	713				8.07
		4.0		25.4	0.53	715	0.060	0.013		7.66
		5.0		24.4	0.32	722				7.52
		6.0		21.4	0.34	742				7.42
		7.0		17.3	0.39	781				7.38
		8.0		12.6	0.41	835				7.28
		9.0		10.2	0.41	868				7.18
		10.0		9.6	0.39	877				7.07
		11.0		8.5	0.35	898				6.95
		12.0		8.3	0.32	901	0.615	0.573		6.87
		13.0		8.0	0.29	914				6.67

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
8/24/2010	1.0	0-2	27.1				0.081	0.012	1.320	
		0.0		25.1	8.39	655				8.01
		1.0		25.1	8.16	656				8.08
		2.0		25.1	8.16	656				8.09
		3.0		25.1	7.94	658				8.05
		4.0		24.9	7.11	665				7.85
		5.0		23.6	3.35	650	0.071	0.012		7.50
		6.0		22.1	1.38	664				7.33
		7.0		16.8	0.82	780				7.19
		8.0		12.4	0.66	824				7.03
		9.0		10.8	0.48	842				6.90
		10.0		9.3	0.44	859				6.80
		11.0		8.9	0.36	866				6.72
		12.0		8.9	0.29	867	1.064	0.902		6.68
		12.6		8.8	0.25	885				6.54

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
9/8/2010	1.3	0-2	23.60173				0.0935	0.02008	1.249	
		0.0		19.1	7.23	665				7.64
		1.0		19.1	7.14	665				7.63
		2.0		19.0	7.03	665				7.63
		3.0		19.0	6.75	665				7.60
		4.0		19.0	6.62	665				7.58
		5.0		18.9	6.52	665				7.58
		6.0		18.8	6.19	666				7.55
		7.0		18.7	6.20	666				7.55
		8.0		16.4	1.63	758	0.0797	0.0227		7.12
		9.0		10.9	1.54	876				7.02
		10.0		9.6	0.87	882				6.89
		11.0		9.2	0.69	889				6.81
		12.0		9.0	0.57	894				6.75
		13.0		8.9	0.50	897	1.5558	1.26528		6.71
		13.5		8.8	0.39	906				6.57

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
9/28/2010	1.8	0-2	39.9				0.101	0.025	1.251	
		0.0		15.6	10.03	600				7.21
		1.0		15.6	8.86	600				7.26
		2.0		15.5	8.45	600				7.30
		3.0		15.5	8.13	601				7.31
		4.0		15.5	7.85	601				7.32
		5.0		15.3	6.70	596				7.30
		6.0		15.1	5.90	594				7.27
		7.0		14.8	5.28	578				7.25
		8.0		14.6	4.23	563				7.21
		9.0		14.1	1.58	615				7.10
		10.0		10.2	0.99	890	0.290	0.218		6.91
		11.0		9.0	0.80	909				6.83
		12.0		8.9	0.71	910	1.525	1.503		6.77
		12.7		8.7	0.68	914				6.70

Medicine Lake Southwest Basin Water Quality Data for 2010

Date	Secchi Disc (M)	Sample Depth (M)	Chl a (ug/L)	Temp. (C)	D.O. (mg/L)	Specific Cond. (umho/cm @ 25 C)	Total P (mg/L)	Soluble Reactive P mg/L)	Total N (mg/L)	pH (Std. Units)
10/12/2010	1.0	0-2	93.6				0.107	0.008	1.406	
		0.0		17.3	14.92	643				8.17
		1.0		17.0	16.37	648				8.38
		2.0		15.7	14.35	661				8.29
		3.0		15.1	9.22	665				8.12
		4.0		15.0	7.74	664				8.06
		5.0		14.8	6.97	658				8.00
		6.0		14.7	6.64	660	0.036	0.011		7.94
		7.0		14.5	4.78	660				7.87
		8.0		14.2	2.60	661				7.75
		9.0		13.4	1.21	687				7.65
		10.0		10.7	0.84	916				7.42
		11.0		9.3	0.65	939				7.25
		12.0		8.8	0.59	950				7.13
		13.0		8.7	0.54	959	2.349	1.762		6.96
		13.5		8.6	0.53	973				6.80

Phytoplankton Analyses
Medicine Lake - Southwest Basin
Sample Depth: 0-2 m
Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
CHLOROPHYTA (GREEN ALGAE)	*Ankistrodesmus Brauni*	0	57	0	0	0	0
	Chlamydomonas globosa	3,561	57	2,068	1,723	414	345
	Closterium sp.	0	0	57	172	207	0
	Elakatothrix sp.	0	0	0	0	0	0
	Oocystis parva	0	57	172	57	0	115
	Pandorina morum	0	0	0	0	0	0
	Rhizoclonium hieroglyphicum	0	0	0	459	725	57
	Schroederia Judayi	0	0	57	115	0	0
	Selenastrum sp.	0	0	0	0	0	0
	Sphaerocystis Schroeteri	0	402	115	0	0	0
	CHLOROPHYTA TOTAL	**3,561**	**574**	**2,470**	**2,527**	**1,347**	**517**
CHRYSOPHYTA (YELLOW-BROWN ALGAE)	*Dinobryon sociale*	0	0	0	0	0	0
	CHRYSOPHYTA TOTAL	**0**	**0**	**0**	**0**	**0**	**0**

Phytoplankton Analyses
Medicine Lake - Southwest Basin
Sample Depth: 0-2 m
Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
CYANOPHYTA (BLUE-GREEN ALGAE)	*Anabaena affinis*	0	0	57	3,102	207	0
	Anabaena flos-aquae	0	0	115	2,125	0	0
	Anabaena spiroides v. crassa	0	0	0	0	0	0
	Aphanizomenon flos-aquae	919	402	1,838	4,595	4,247	2,068
	Coelosphaerium Naegelianum	0	0	0	172	104	0
	Cylindrospermum raciborski	0	0	0	1,838	35,633	287
	Lyngbya limnetica	0	0	0	0	0	0
	Lyngbya sp.	0	0	0	0	0	0
	Merismopedia tenuissima	0	0	57	0	0	0
	Microcystis aeruginosa	0	0	0	115	207	0
	Microcystis incerta	57	57	862	172	0	115
	Oscillatoria Agardhii	57	0	1,666	5,686	16,263	1,378
	Oscillatoria limnetica	0	0	0	6,490	1,865	0
	Phormidium mucicola	0	57	517	115	0	0
	CYANOPHYTA TOTAL	**1,034**	**517**	**5,112**	**24,410**	**58,525**	**3,848**

Phytoplankton Analyses
Medicine Lake - Southwest Basin
Sample Depth: 0-2 m
Standard Inverted Microscope Analysis Method

DIVISION	TAXON	4/19/2010 units/mL	5/17/2010 units/mL	6/15/2010 units/mL	7/13/2010 units/mL	8/24/2010 units/mL	9/28/2010 units/mL
BACILLARIOPHYTA (DIATOMS)	*Asterionella formosa*	57	0	0	0	0	0
	Cocconeis placentula	0	0	57	0	0	0
	Cymbella sp.						0
	Fragilaria crotonensis	0	0	0	402	0	0
	Melosira granulata	0	0	0	0	0	287
	Navicula sp.	0	0	0	0	0	0
	Nitzschia sp.	115	0	0	0	0	0
	Stephanodiscus Hantzschii	172	0	0	0	0	115
	Stephanodiscus sp.	0	57	0	0	0	345
	Synedra ulna	172	0	0	0	0	0
	Unidentified Diatom	57	0	0	0	0	0
	BACILLARIOPHYTA TOTAL	**574**	**57**	**57**	**402**	**0**	**747**
CRYPTOPHYTA (CRYPTOMONADS)	*Cryptomonas erosa*	57	459	1,091	3,159	311	287
	CRYPTOPHYTA TOTAL	57	459	1,091	3,159	311	287
EUGLENOPHYTA (EUGLENOIDS)	*Phacus sp.*						
	EUGLENOPHYTA TOTAL	**0**	**0**	**0**	**0**	**0**	**0**
PYRRHOPHYTA (DINOFLAGELLATES)	*Ceratium hirundinella*	0	57	230	0	104	459
	Peridinium cinctum	0	0	0	402	0	0
	PYRRHOPHYTA TOTAL	**0**	**57**	**230**	**402**	**104**	**459**
	TOTALS	**5,227**	**1,666**	**8,960**	**30,900**	**60,286**	**5,858**

Zooplankton Analyses
Medicine Lake Southwest Basin
Vertical Tow (m)
Sedgewick Rafter Analysis Method

DIVISION	TAXON	4/202010 #/m2	05/17/10 #/m2	6/15/2010 #/m2	7/13/2010 #/m2	8/24/2010 #/m2	9/28/2010 #/m2
CLADOCERA	*Bosmina longirostris*	0	25,376	10,610	94,432	94,432	17,861
	Ceriodaphnia sp.	0	0	0	0	0	80,373
	Chydorus sphaericus	0	0	0	7,869	55,085	0
	Daphnia galeata mendotae	0	14,501	10,610	55,085	62,954	35,721
	Daphnia retrocurva	0	0	0	62,954	275,426	26,791
	Diaphanosoma leuchtenbergianum	0	0	0	23,608	149,517	8,930
	CLADOCERA TOTAL	**0**	**39,877**	**21,221**	**243,949**	**637,414**	**169,676**
COPEPODA	*Cyclops sp.*	224,585	21,751	42,441	149,517	133,778	98,234
	Diaptomus sp.	11,229	18,126	42,441	165,255	141,648	80,373
	Nauplii	595,150	43,502	233,427	527,244	590,198	294,701
	COPEPODA TOTAL	**830,964**	**83,379**	**318,309**	**842,016**	**865,624**	**473,308**

Zooplankton Analyses
Medicine Lake Southwest Basin
Vertical Tow (m)
Sedgewick Rafter Analysis Method

DIVISION	TAXON	4/202010 #/m2	05/17/10 #/m2	6/15/2010 #/m2	7/13/2010 #/m2	8/24/2010 #/m2	9/28/2010 #/m2
ROTIFERA	*Asplanchna priodonta*	0	7,250	0	0	7,869	0
	Filinia longiseta	89,834	3,625	0	0	0	0
	Keratella cochlearis	44,917	97,880	456,243	456,420	661,022	0
	Keratella quadrata	494,087	105,130	42,441	0	0	0
	Kellicottia bostoniensis.	11,229	10,876	10,610	31,477	78,693	107,164
	Lecane sp.	0	0	0	188,863	39,347	151,816
	Polyarthra vulgaris	11,229	0	31,831	39,347	39,347	35,721
	Trichocerca cylindrica	0	0	0	0	7,869	17,861
	Trichocerca multicrinis	0	0	0	0	7,869	8,930
	Un identified Rotifer	0	0	74,272	0	0	0
	ROTIFERA TOTAL	**651,296**	**224,762**	**541,126**	**716,107**	**842,016**	**321,492**
	TOTALS	**1,482,260**	**348,018**	**880,655**	**1,802,072**	**2,345,054**	**964,477**