Lewis Lake

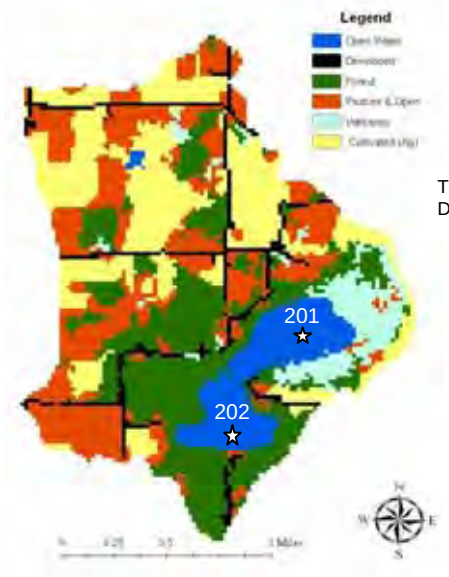
Kanabec County

2010CLMP+ Data Summary

CLMP+ Volunteers: Mary Shimshock & Mark Scheidhauer
Minnesota Lake ID: 33-0032
Area: 71 hectares (175 acres)
Watershed Area: 723 hectares (1786 acres)
Ecoregion: Northern Central Hardwood Forest (NCHF)
Trophic Status: Mesotrophic
Maximum Depth: 14.6 meters (48 feet)
Mean Depth: 5 meters (16.5 feet)
Mixing Status: Thermally Stratified

Figure 2. Air photo of Lewis Lake

Figure 1. Lewis Lake watershed land use



The National Land Cover Database 2006

Table 1. Land use composition

Land use	Lewis Lake land use percentage	NCHF typical land use percentage
Developed	6	2 – 9
Cultivated (Ag)	26	22 – 50
Pasture & Open	26	11 – 25
Forest	27	6 – 25
Water & Wetland	16	14 – 30
Feedlots (#)	3	

Table 2. Lewis Lake 2009-2010 as compared to typical range for Northern Central Hardwood Forest (NCHF) ecoregion reference lakes

Parameter	Lewis Lake 201, 2009	Lewis Lake 202, 2009	Lewis Lake 201, 2010	Lewis Lake 202, 2010	NCHF
Number of reference lakes	1	1	1	1	43
Total Phosphorus (µg/L)	27	29	29	33	23 – 50
Chlorophyll mean (µg/L)	9.3	15.8	13.9	16.9	5 – 22
Secchi Disk (feet) (meters)	7.9 2.4	6.9 2.1	7.9 2.4	6.9 2.1	4.9 – 10.5 (1.5 – 3.2)
Total Kjeldahl Nitrogen (mg/L)	0.86	–	1.0	–	0.6 – 1.2
Alkalinity (mg/L)	123	–	125	–	75 – 150
Color (Pt-Co U)	11	–	18	–	10 – 20
Chloride (mg/L)	9.48	–	9.45	–	4 – 10
Total Suspended Solids (mg/L)	3.8	–	3.5	–	2 – 6
Total Suspended Inorganic Solids (mg/L)	1.5	–	0.3	–	1 – 2
TN:TP ratio	32:1	–	34:1	–	25:1 – 35:1

ug/L = micrograms per liter
mg/L = milligrams per liter
Pt-Co-U = Platinum Cobalt Units

Numbers shown are summer mean values (June – September)

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Figure 3. Lewis Lake 2009 temperature profiles (Site 201)

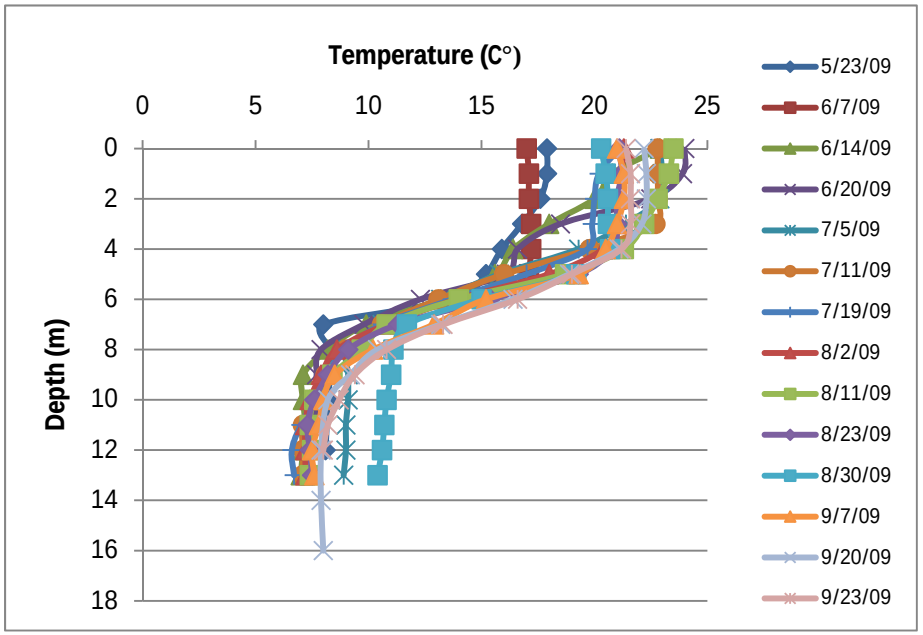

Figure 4. Lewis Lake 2010 temperature profiles (Site 201)

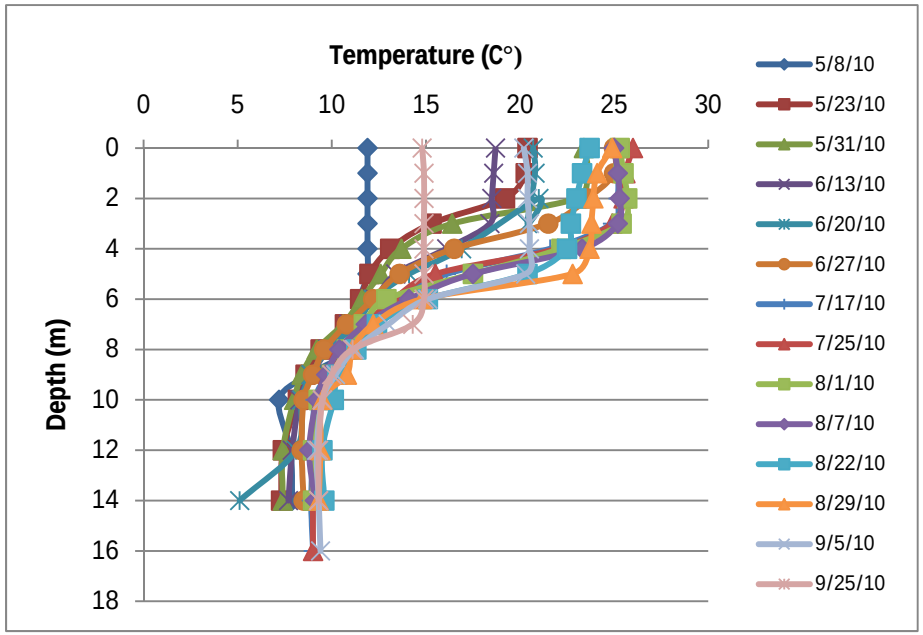

Figure 5. Lewis Lake 2009 temperature profiles (Site 202)

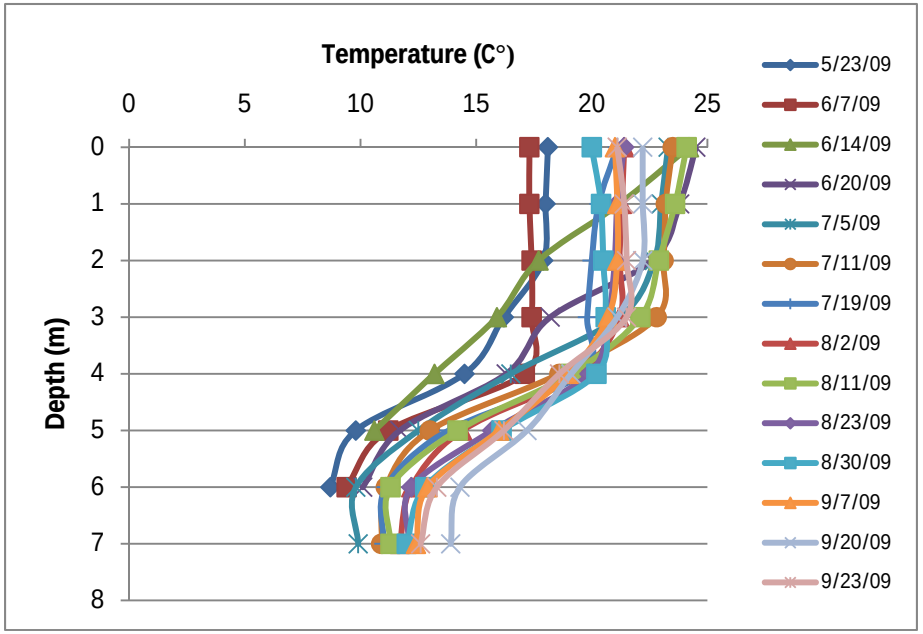

Figure 6. Lewis Lake 2010 temperature profiles (Site 202)

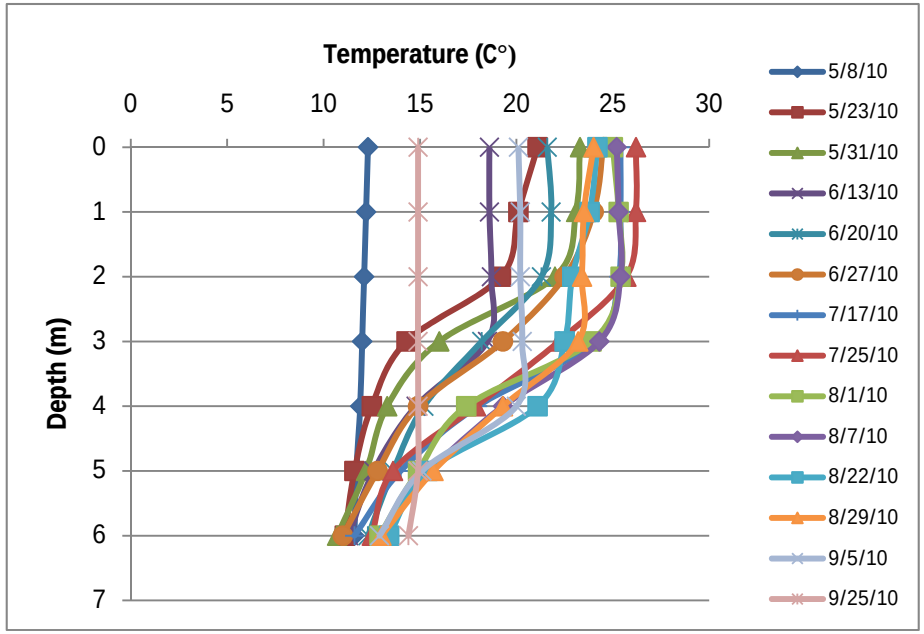

Figure 7. Lewis Lake 2009 dissolved oxygen (DO) profiles (Site 201)

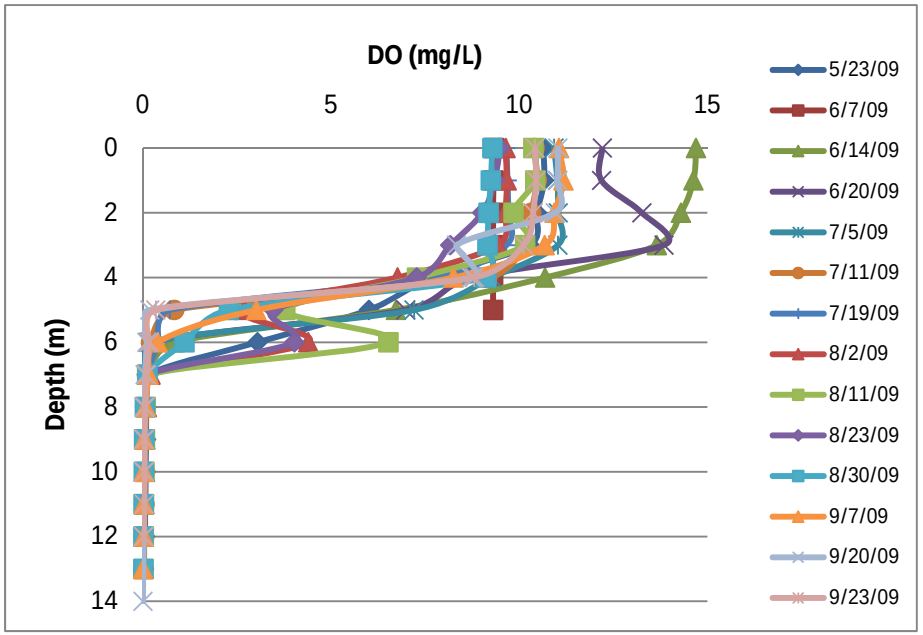

Figure 8. Lewis Lake 2010 dissolved oxygen (DO) profiles (Site 201)

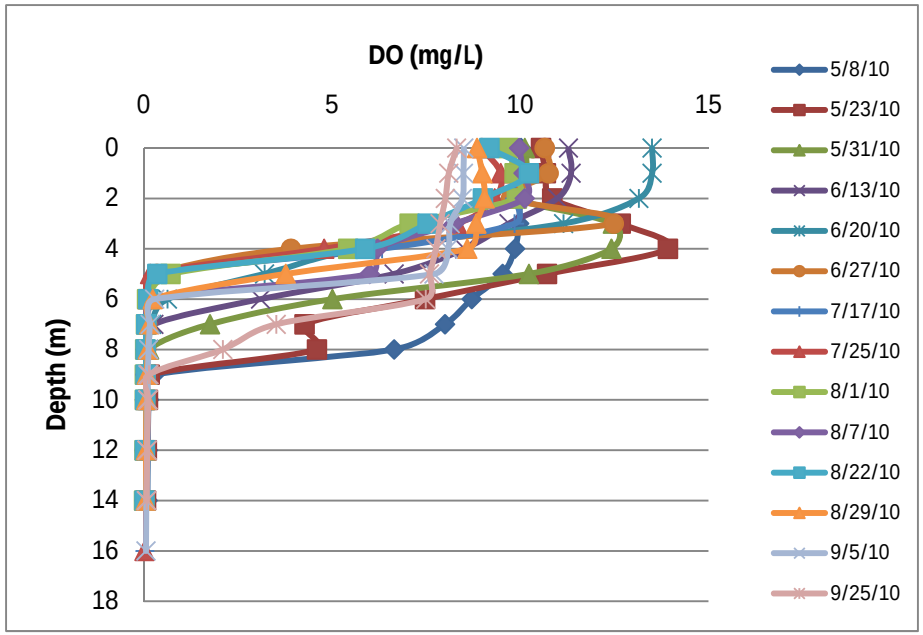

Figure 9. Lewis Lake 2009 dissolved oxygen (DO) profiles (Site 202)

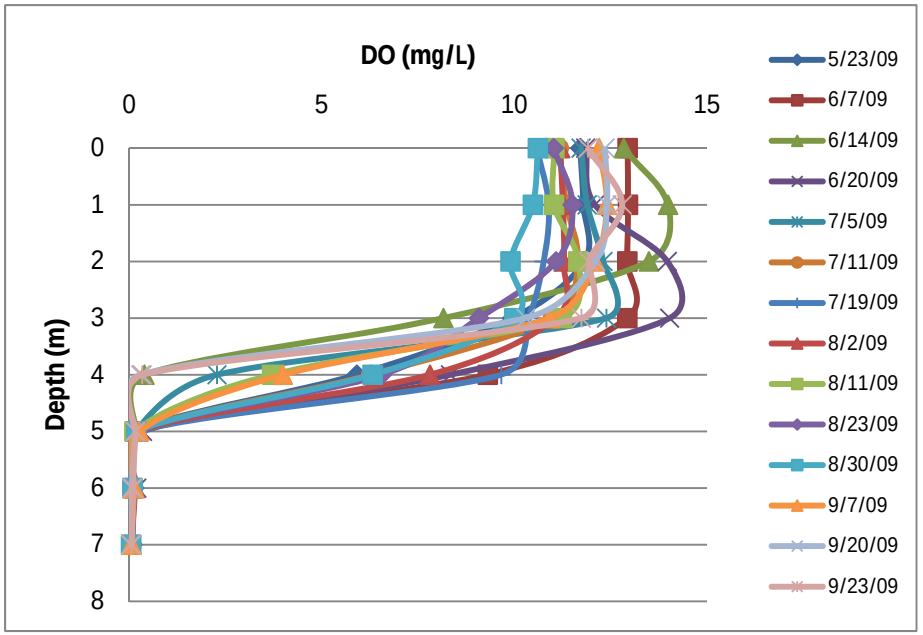

Figure 10. Lewis Lake 2010 dissolved oxygen (DO) profiles (Site 202)

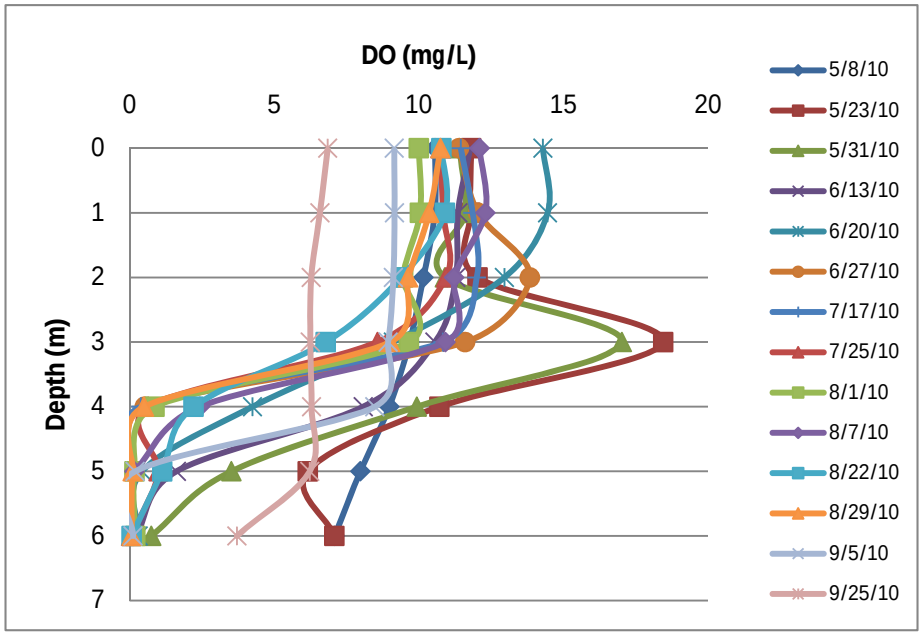

Figure 11. Lewis Lake 2009 total phosphorus (TP), chlorophyll-a (Chl-*a*), and Secchi

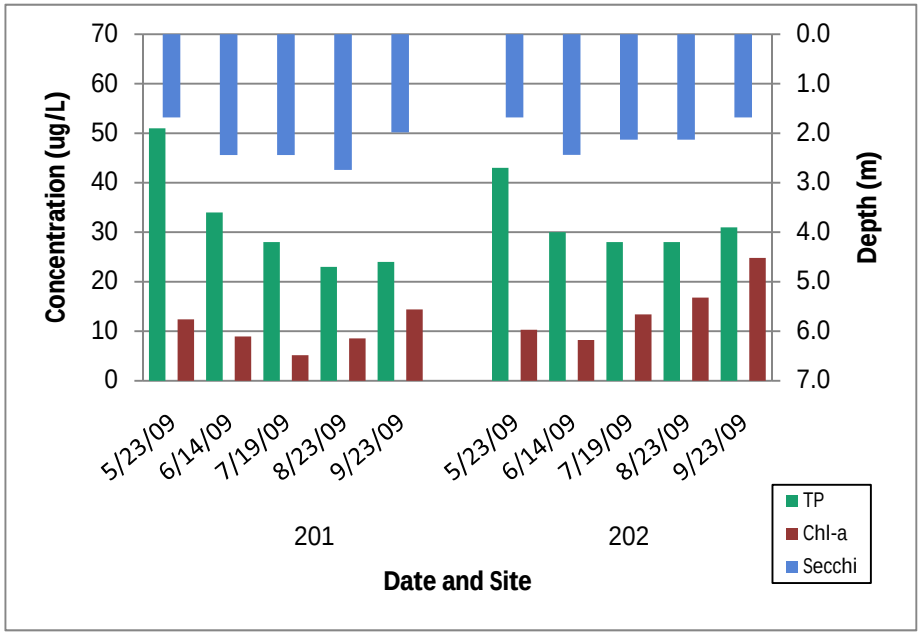

Figure 12. Lewis Lake 2010 total phosphorus (TP), chlorophyll-a (Chl-*a*), and Secchi

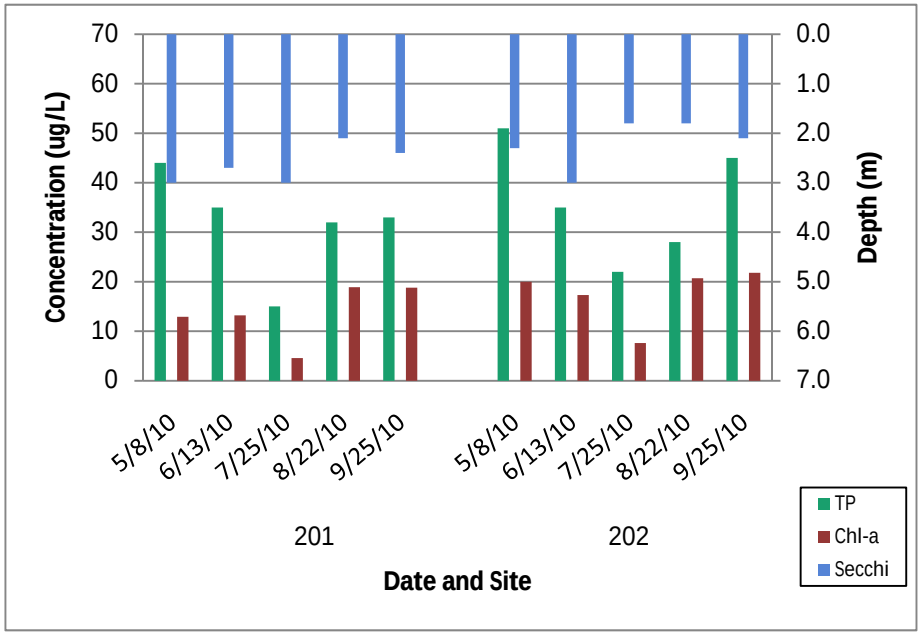

Figure 13. Lewis Lake 2009 total phosphorus (TP) depth samples

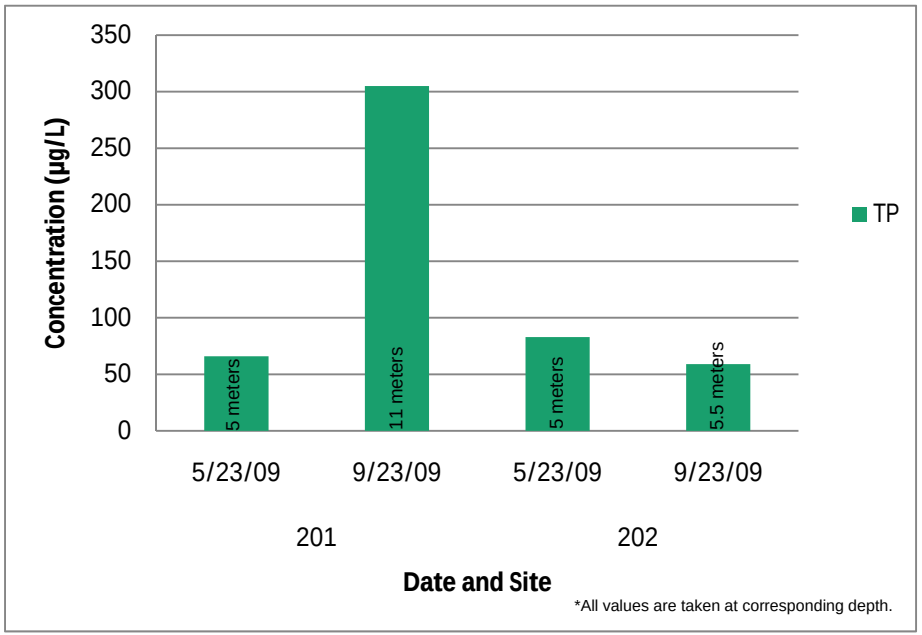

Figure 14. Lewis Lake 2010 total phosphorus (TP) depth samples

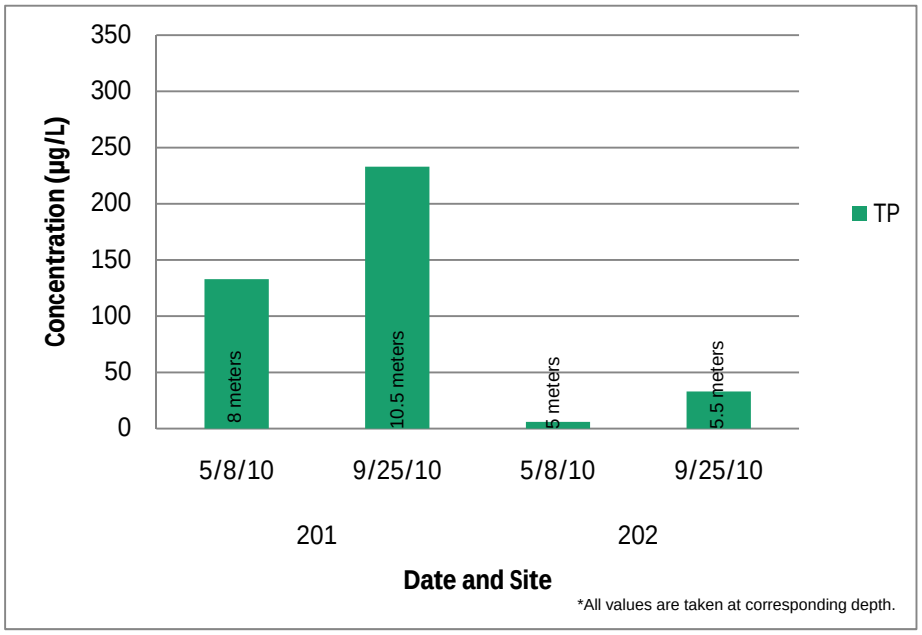

Figure 15. Lewis Lake 2009 summer Secchi readings

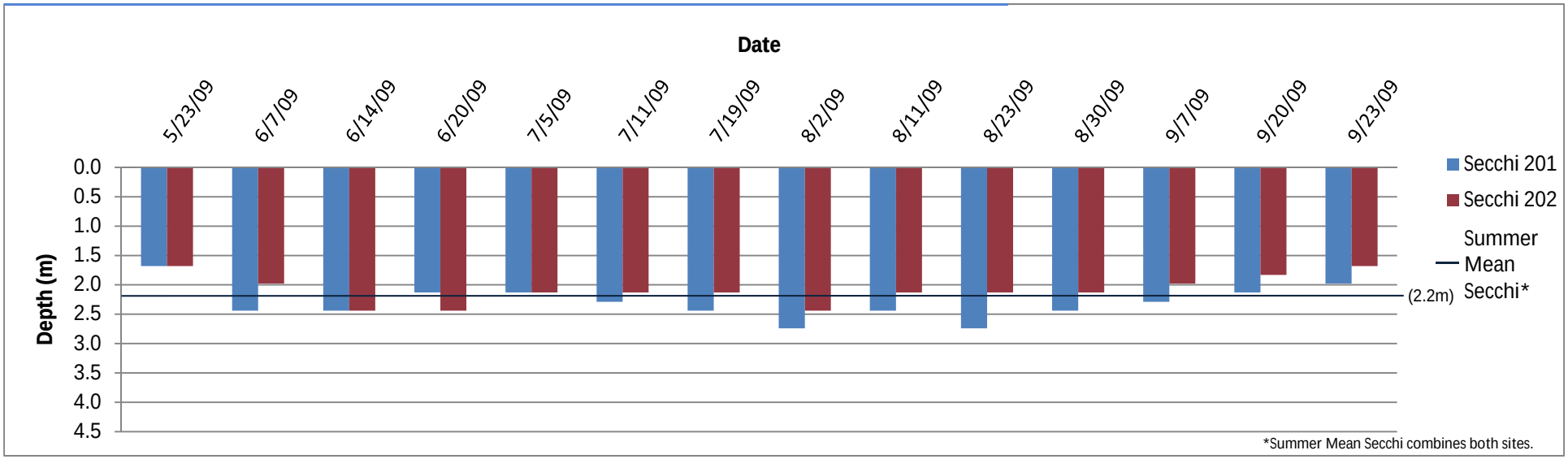

Figure 16. Lewis Lake 2010 summer Secchi readings

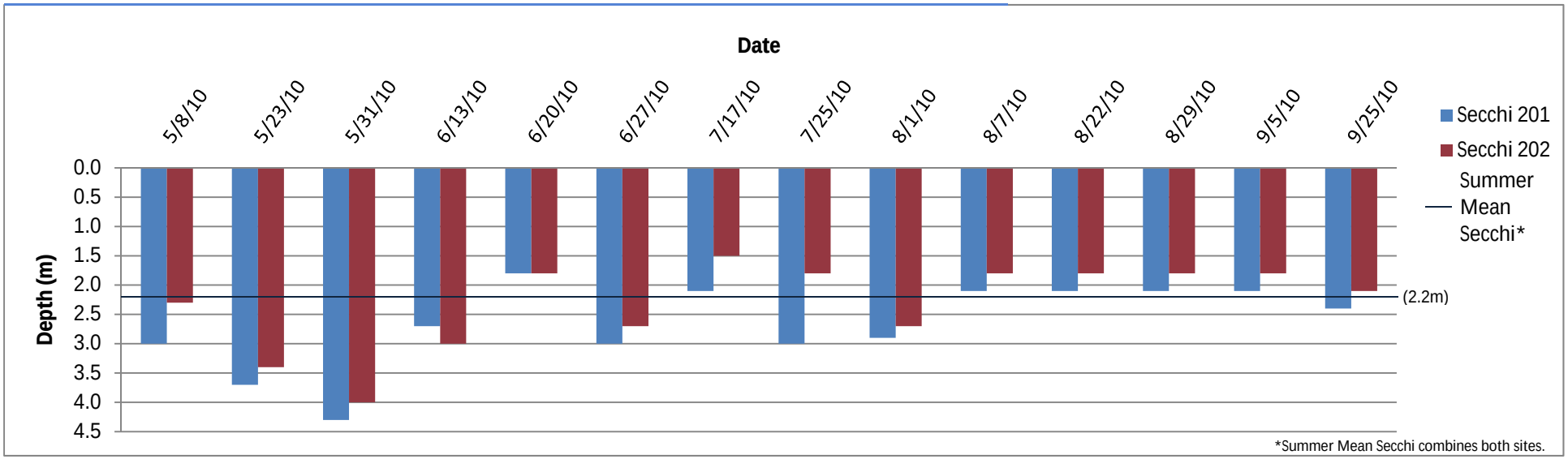

Table 3. Lake eutrophication standards by ecoregion and lake type (summer mean values)

Ecoregion	TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
NCHF – Aquatic Rec. Use (Class 2B)	<40	<14	>1.4
Lewis Lake (Site 201) 2009 summer mean values	27	9.3	2.4
Lewis Lake (Site 202) 2009 summer mean values	29	15.8	2.1
Lewis Lake (Site 201) 2010 summer mean values	29	13.9	2.4
Lewis Lake (Site 202) 2010 summer mean values	33	16.9	2.1
Lewis Lake 2 year summer mean values	29	13.9	2.2

Watershed and water quality summary

Lewis Lake is located in Kanabec County, approximately one mile east of Milaca. The lake has a maximum depth of 14.6 meters (48 feet) and a mean depth of five meters (16.5 feet). Lewis Lake is located in the North Central Hardwood Forest (NCHF) ecoregion. Lewis Lake watershed is in the typical NCHF land use percentage range except for the "Pasture & Open" and "Forest" categories, which are just above the Ecosystem range. The lake is heavily forested around its perimeter which creates a natural buffer (Figure 1, 2 and Table 1).

Mary Shimshock and Mark Scheidhauer monitored Secchi depth, temperature, and dissolved oxygen (DO) profiles weekly and collected chemistry samples monthly from May through September 2009 and 2010, as part of the Advanced Citizen Lake Monitoring Program (CLMP+).

All chemical parameters were averaged from June to September (referred to as "summer mean" values in the figures above) and compared to minimally impacted lakes in the NCHF ecoregion (Table 2). All measured water quality parameters for Lewis Lake (Site 201 and 202) fall within the typical range for NCHF lakes except total suspended inorganic solids which was below the range in 2010. Total phosphorus (TP) and chl-*a* were in the expected range in every month of sampling with two exceptions: the September 2009 sample from Site 202, in which chl-*a* measured above the typical range, and the July 2010 samples from both sites, in which TP measured below the typical range. Secchi stayed within the typical NCHF ecoregion range throughout the summer.

The temperature profiles for Site 201 indicate the lake was stratified (had formed layers of differing temperatures) in May and remained so throughout the 2009 and 2010 sampling periods (Figures 3 and 4). The thermocline (the area of greatest temperature change) formed at about 5-6 meters (m) in the deeper north basin (Site 201). In the shallower south basin (Site 202), the thermocline formed between 3-5 m on most dates (Figure 5 and 6). As is typical in stratified lakes, DO remains elevated in the warm well-mixed waters of the epilimnion (surface layer of water), but declines rapidly in the lower, cooler waters of the hypolimnion (bottom layer of water) (Figures 7, 8, 9, and 10). In Lewis Lake, hypolimnetic DO was 2 mg/L or lower throughout the summer, too low to sustain game fish, which require a DO minimum of 5 mg/L. When hypolimnetic oxygen drops to 0 mg/L, phosphorus bound in the sediment is released, which can result in algal blooms during fall turnover. On several sample dates, there was a distinct increase in DO in the metalimnion (middle layer of water) (Figure 7, 8, 9, and 10). This is referred to as a "metalimnetic maximum" and is the result of cooler water that holds more oxygen and algae that are actively photosynthesizing at this depth. This phenomenon is frequently observed in oligotrophic to mesotrophic lakes with moderate to high transparency, and blue-green algae such as *Oscillatoria* are often major contributors[1] An algae sample collected in July 2009 confirmed the presence of *Oscillatoria* in Lewis Lake.

[1] Wetzel, Robert G. 1983. Limnology Second Edition. Orlando, Florida. Saunders College Publishing.

Figures 11 and 12 show a relationship between the rise and fall of TP, chl-*a*, and Secchi. Generally, we expect TP and chl-*a* to rise and fall together, while Secchi will do the opposite (high TP results in algal growth—chl-*a*—which results in decreased Secchi values). Due to the clumping nature of *Oscillatoria* in Lewis Lake (which allows greater light penetration through the water column than other algae), the Secchi value can be high even though the TP and chl-*a* are high compared to the expected summer range.

Figures 13 and 14 show the results of TP samples collected near the bottom of the lake. In a stratified lake, we expect these deep TP values be similar to surface TP values in the spring after mixing, and to increase throughout the season due to the release of stored phosphorus from the sediments in anoxic conditions. Due to high winds in May of both years, the May TP samples from site 201 weren't collected in the hypolimnion. The May sample at Site 202 in 2010 is suspect. Considering the fully mixed conditions (temperature and DO) and the previous year's data, it would be expected that the surface and deep TP values should be similar. Both September samples from Site 201 were taken from the hypolimnion (11 meters in 2009 and 10.5 meters in 2010), resulting in such high TP values.

The Secchi values (Figure 15 and 16) have a summer average greater than the NCHF – Aquatic Rec. Use (Class 2B) (Table 3) and are within the range of the NCHF ecoregion reference lakes (Table 2). Site 201 has a consistently higher Secchi value than site 202 due to its greater depth. .

Lewis Lake was included in a Lake Assessment Report in 1997[2]. One of the observations made by the report's authors is that Lewis Lake retains most of the phosphorus that enters it, and is therefore sensitive to even small increases in TP. Therefore, the authors recommend that steps be taken to minimize external loading of phosphorus to the lake. It is worth noting that the summer mean TP value reported in the 1997 report was 23 µg/L. The summer mean TP value for Site 201 in 2009 and 2010 was 28 ug/L, indicating an increase in TP since 1997. The 1997 report data also show a metalimnetic maximum similar to the one observed in 2009 and 2010, indicating that this is not a new phenomenon, but rather, has occurred historically.

Lewis Lake will be assessed for aquatic recreation use in the spring of 2019. Based on current data averaging results from both sites, the lake would be considered fully supporting (Table 3).During the 2019 assessment, the most recent 10 years of data for the entire lake will be used to assess the lake. Once the assessment is made, Lewis Lake will be included in a watershed-wide plan to protect lakes that are currently meeting water quality standards, and to restore lakes that are not.

[2] Minnesota Pollution Control Agency. 1997. Lake Assessment Program: Lewis Lake. MPCA. St. Paul, MN.