Minnesota Pollution Control Agency

Prepared in cooperation with the Minnesota Department of Natural Resources

Madison Lake

Blue Earth County

Sentinel Lakes

Minnesota Lake ID: 07-0044
Area: 1,344 Acres
Watershed Area: 5,547 acres
Ecoregion: Western Corn Belt Plains (WCBP)

Trophic State: Eutrophic
Maximum Depth: 59 feet
Mean Depth: 11 feet
Mixing Status: Intermittent

Figure 1. Madison Lake watershed land use

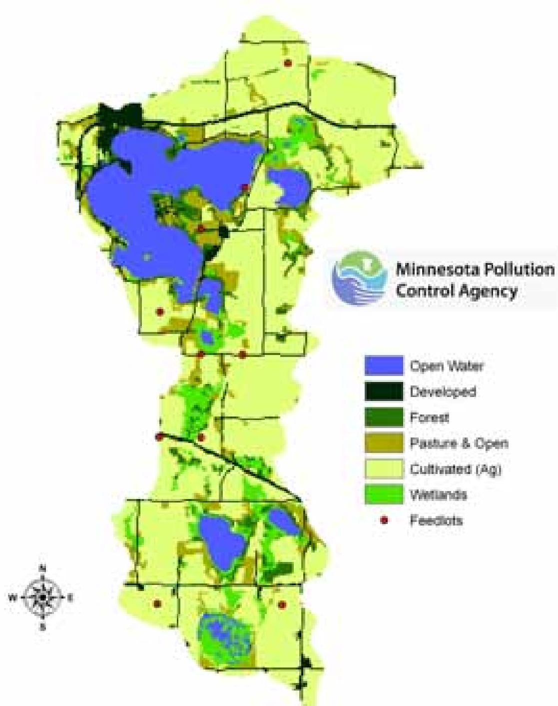

Figure 2. Madison Lake 3D depth contour

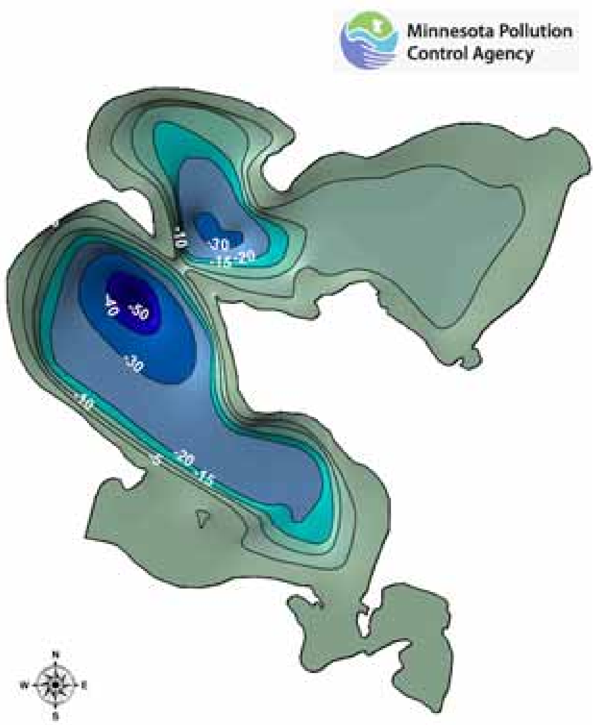

Table 1. Land use composition

Land use	Madison Lake land use percentage	WCBP typical land use percentage
Developed	9	0 – 16
Cultivated (Ag)	48	42 – 75
Pasture & Open	10	0 – 7
Forest	2	0 – 15
Water/ Wetland	31	3-26
Feedlots (#)	10	

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Table 2. Madison Lake summer-mean as compared to typical range for WCBP ecoregion reference lakes MPCA data based on 1985-86 and 2008 sample collections

Parameter	Madison 2006	Madison 2008	WCBP
Number of reference lakes			16
Total Phosphorus (µg/L)	81 ± 11	75	65 – 150
Chlorophyll mean (µg/L)	47 ± 5	27	30 – 80
Secchi Disk (meters)	0.7 ± .06	1.1	1.6 – 3.3
Total Kjeldahl Nitrogen (mg/L)	1.8 ± 0.1	1.3	1.3 – 2.7
Alkalinity (mg/L)	144 ± 2	140	125 – 165
Color (Pt-Co U)	18 ± 2	20	15 – 25
pH (SU)	8.7 ± 0.1	8.0	8.2 – 9.0
Chloride (mg/L)	20.6 ± 0.2	22	13- – 22
Total Suspended Solids (mg/L)	10.0 ± 1	7.6	7 – 18
Total Suspended Inorganic Solids (mg/L)	2.1 ± .04	2.8	3 – 9
Conductivity (umhos/cm)	267.5 ± 67	358	300 – 650
TN:TP ratio	22.5:1	16.3:1	17:1 – 27:1

µg/L = micrograms per liter
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter
Pt-Co-U = Platinum Cobalt Units
SU = Standard Units

Figure 3. Madison Lake 2006 and 2008 temperature and dissolved oxygen (DO) profiles

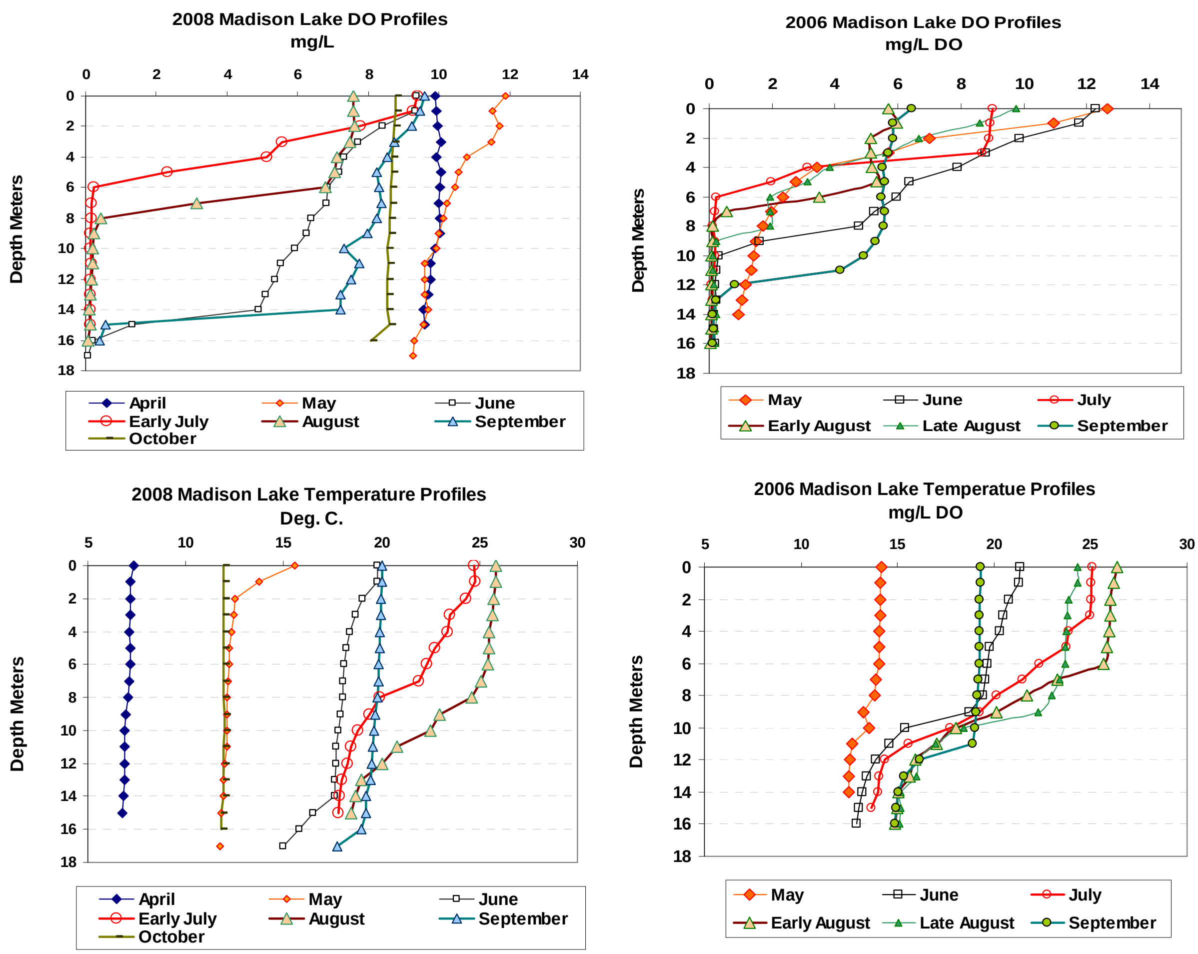
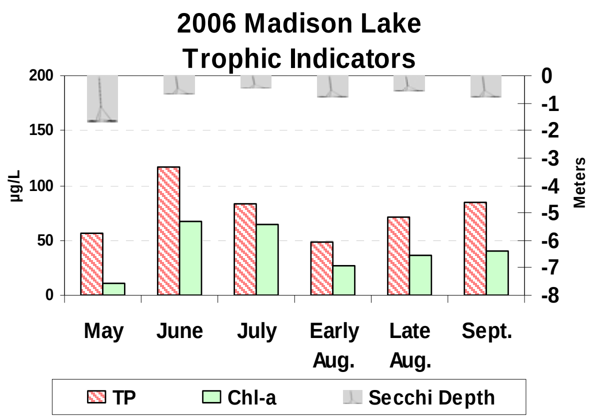


Figure 4. Madison Lake 2006 and 2008 trophic indicators



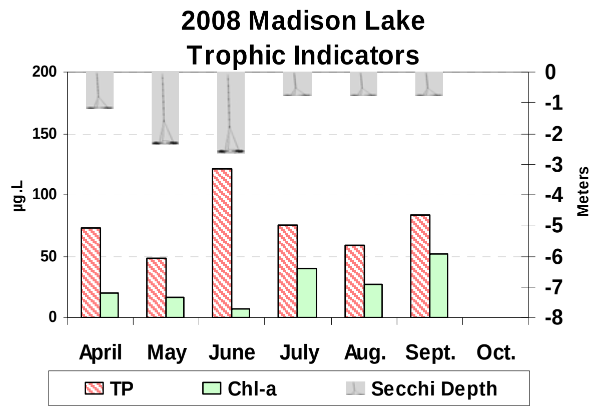
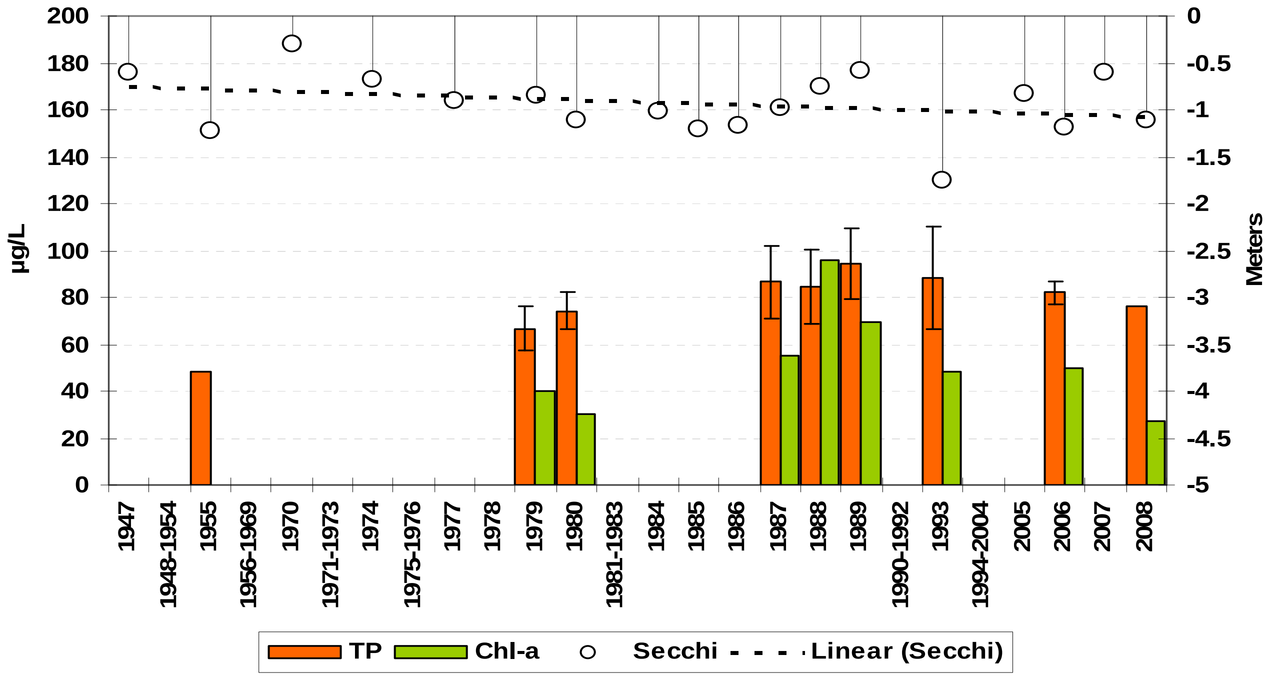


Figure 5. Madison Lake long-term trophic indicators summer mean



Water quality, fishery and watershed management issues

Madison Lake is located east of the Mankato area in south central Minnesota. Madison is one of the more popular lakes in southern Minnesota, known for its walleye population. The lake has a long water quality monitoring history going back to 1947. The lake has small watershed-to-lake area ratio at 4:1. In addition to the 2008 monitoring, Madison Lake was included in a 2006 algal toxin study and a comparison is provided in Table 2.

Temperature profiles from 2008 revealed a temporary thermocline in July and August at about 6-8 meters (Figure 3). This temperature stratification resulted in anoxic conditions in the hypolimnion during these months. Profiles from 2006 revealed temperature stratification from June through September. DO concentrations declined rapidly with depth and the thermocline was anoxic for most of the summer. Fall mixing was underway in September 2006. This comparison for 2006 and 2008 indicates that stratification patterns may vary from year to year in Madison Lake, likely as a function of wind intensity, direction and related factors.

Seasonal patterns in water quality vary as well from year-to-year in Madison. Monitoring from 2008 revealed increasing Secchi and decreasing chlorophyll-a (Chl-a) from April to June, but increased thereafter (Figure 4). Maximum total phosphorus (TP) was observed in June corresponding to the onset of stratification. TP declined in July and August when the lake was stratified but increased in September when fall mixing was underway. Monitoring data from 2006 exhibited a similar patterns and range of concentrations. In general, the summer-mean TP, Chl-a and Secchi values for Madison were within the typical range for WCBP

lakes (Table 2); however, its summer-mean values do exceed the eutrophication standards for deep WCBP lakes: 65 µg/L, 22 µg/L and 0.9m respectively and it is likely Madison will be assessed as nutrient-impaired on the 2010 303(d) assessment.

Long-term TP and Chl-a data indicate these measures vary from year to year and peak measures correspond to the drought period of 1987-1989 (Figure. 5). Summer-mean Secchi data dating to 1947 show a slightly positive trend.

Fishery and aquatic plant survey summary

Table 3. Focal species captured during recent surveys and their size and abundance compared with other lakes in its lake class

Species	Stocked	Abundance	Size	Trend	Notes
Walleye*	Y	Average	Large	Stable	
Northern Pike	N	Average	Large	Stable	
Black Crappie*	N	High	Large	Increasing	
White Crappie	N	Average	Average	Decreasing	
Largemouth bass	N	Low	Small	Stable	
Bluegill*	N	Average	Average	Increasing	
Gizzard Shad	N	Variable	Variable	Decreasing	Discovered in 1970
Yellow perch	N	Average	Small	Increasing	

Table 4. Aquatic plant summary

Percent cover of aquatic plants ≤ 15ft deep	25%
Number of common species (i.e., ≥ 10% cover)	0
Lake depth at which most vegetation disappeared	3.8ft
Infested with non-native plants	Curly-leaf pondweed (lightly)

Narrative

Madison Lake is productive both from a nutrient and fishery standpoint and sustains heavy angling pressure. High nutrient productivity generally favors pelagic-oriented species such as walleye and crappie, while reducing aquatic plant growth, and plant-oriented species such as northern pike, largemouth bass, yellow perch, and bluegill. Northern pike are generally large in Madison Lake, but recruitment appears to have declined over time, presumably due to habitat alterations. Madison is the only inland Minnesota lake harboring a population of gizzard shad. Gizzard shad are oily fish that can provide a high-fat food source for large predators; however, these prolific species quickly outgrow the gape-size of predators and can further exacerbate internal nutrient loading through their omnivorous feeding habits. Reducing external nutrient loads to favor greater aquatic plant growth should benefit a wide range of native species and potentially limit habitat suitability for gizzard shad.

Physical habitat and plant assessments at 10 random sites on Madison Lake in 2008 by MPCA staff suggest that curly-leaf pondweed infestation may be quite high on the lake early in the summer. A June assessment indicated the northeast bay (Figure 1 and picture) was nearly impassable because of curly-leaf dominance. As with other lakes, the growth and senescence of curly-leaf may influence the seasonal cycling (Fig. 4) and relationships of the trophic status variables. Future work on Madison can address this in more detail.