Lake Mohawk
2010 Lake Summary

Lake Mohawk 1988

Prepared
for
Lake Mohawk Property Owners Association
Board & Committee Members

Jeff Gray M.S.
Aquatic Biologist

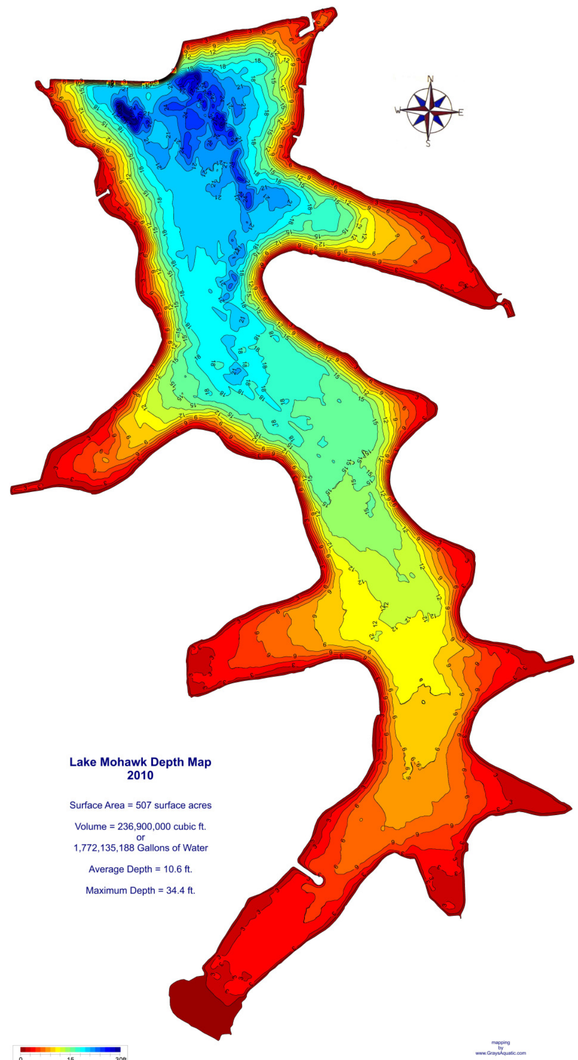
January 10, 2011

The following report is a summary of my 2010 limnological (lake) observations and lake management program at Lake Mohawk, Malvern, Ohio. The purpose of this report is to provide a continuum of information that supplements my 2009 report dated October 27, 2009. (Copy available – Downloadable from www.Lake-Mohawk.us)

Abstract Summary

Based on bathymetric map data collected on June 16, 2010 (Figure 1.), Lake Mohawk is a 507 acre lake with an average depth of 10.6 feet. Most of the larger bays which include bays 3, 6, 7, 8, 9/10, 11, & 12, have average depths of 3 to 5 feet. Areas that are shaded in red to yellow provide ideal growing conditions for nuisance aquatic plants such as Curlyleaf pondweed and Watermilfoil. I believe that it is important to mention that the original design of Lake Mohawk in 1963 was NOT that of a "deep water" lake. Lake Mohawk was designed to provide maximum waterfront property or property that would overlook various sections of the lake in an economical manner.

Lake Mohawk experienced significant increases in both Curlyleaf pondweed and Watermilfoil in 2010. The aquatic plant Naiad (Najas minor), which appears in July/August, remained similar to that of the density observed in 2009. Blue Green algae was suppressed using low doses of copper sulfate beginning on July 8, 2010 when 600 pounds of copper sulfate was applied to the lake. Chara/Nitella, which is an advanced form of algae that looks like a plant, became abundant through out the lake. As you may remember, Chara/Nitella is desirable from a management perspective as it provides good fish habitat while crowding out exotic (undesirable) species of plants.



The most important issue regarding lake management at Lake Mohawk in my opinion is the control of blue-green algae. All management practices should evolve around the control of these nuisance species of algae. Blue-green algae are associated with adverse human health issues in addition to the indirect impacts on recreational and property values. Fortunately, I believe that the main source of "fuel" (phosphorus) for blue-green algae comes from within the lake itself (autochthonous) rather than from outside sources (allochthonous) such as agricultural runoff, etc.. This means is that the "fuel" is limiting or limited and can be controlled, manipulated, and/or removed. Provided that the watershed inputs remain the same, I do not believe that Lake Mohawk is in any danger of becoming a "Grand Lake St. Mary" where huge farming operations add significant amounts of phosphorus to the nutrient pool. Caution must be applied in the control of these algae, as copper based algaecides can become a larger problem than the algae itself, as copper accumulates in the lake sediments over time where it becomes toxic to aquatic plants and organisms.

Aquatic Plant Succession at Lake Mohawk

In regard to nuisance aquatic plant growth, **Curlyleaf pondweed (CLP) (*Potamogeton crispus*)** was present in almost all areas that were less than the 9 foot depth contour. (Red-Orange). The first weed concern was reported on April 20, 2010. Scott Noble also reported significant growth of CLP in an April 21, 2010 e-mail. As various areas of the CLP matured, those areas were treated with a combination of Reward, Aquathol K, and Komeen. CLP as you may know is the first nuisance plant to occur in the year. While CLP does senesce (die) naturally by late June, the predominant recreational uses of Lake Mohawk, which include skiing and boating require that this plant be controlled to non-nuisance levels by mid May.

Watermilfoil (WM)(*Myriophyllum spicatum*) increased significantly from 2009. From a management perspective, WM is perhaps the most challenging and important plant to control. WM spreads easily, has high growth rates, and crowds out desirable species of plants important to fisheries. Watermilfoil was observed in early to mid-May mixed with CLP. Dense growths of WM were observed throughout all of Bay 11. Early growths of WM were observed fragmenting (a means of vegetative reproduction) as early as April 20th. I believe that the first "plant concern" reported to Scott Noble was a "floating island" of fragmented Watermilfoil. Many fragments of WM that were observed in the marina and "north shoreline" (lots 1, 2, 3, etc.) had their origin in the southern 1/3 of the lake where south to south-west winds would transport the fragments via wind and wave action. Watermilfoil was observed in most all Red-Red/Orange zones similar to that of the CLP by the end of summer.

Naiad (*Najas minor*) is the third major species of plant to occur in Lake Mohawk. Naiad appears in July and will remain through September/October. This is an annual plant that reproduces by seeds. Naiad often occurs in environments that have fluctuating water levels. (such as draw downs at Lake Mohawk). The growth habit of Naiad, which is typically low growing, makes this one of the desirable plants to have at Lake Mohawk. This plant does however reach nuisance conditions in the very shallowest sections of the bays. Bay 12 is perhaps one of the most common locations that this plant requires some level of control. The benefits of this plant comes from the fact that it crowds out less desirable species such as Watermilfoil in addition to stabilizing the sediments from phosphorus release (which "feeds" blue green algae blooms).

Algae – Macroscopic (larger) and Microscopic (smaller)

Chara/Nitella are advanced forms of algae that actually look like plants. They are beneficial to Lake Mohawk in that they provide good cover for a healthy fishery, crowd out Watermilfoil, and stabilize the sediments. The growth of these beneficial macrophytic algae increased significantly from 2009. In order to maintain this type of beneficial growth, it is important not to overdose with copper based algaecides.

Blue-Green Algae growth was suppressed throughout the season starting on July 8th, when 600 pounds of copper sulfate was applied to mainly the bays and northern 1/3 of the lake. The second treatment for blue-green algae occurred on July 27th when 750 pounds of copper sulfate was applied to a similar area. The third blue-green algae treatment occurred on August 4th when 1500 pounds was applied to the entire lake surface. On August 24th, an additional 1500 pounds was applied to the entire lake surface. The treatment approach was based on suppressing the blue green algae while attempting to promote the "green" species of phytoplankton. In other words, encouraging competition from beneficial phytoplankton. This is possible by the fact that many beneficial green algae are more tolerant to low doses of copper while many potentially toxic blue-green forms are not. In addition, maintaining some level of beneficial phytoplankton also promotes a healthy fishery while limiting sun to nuisance aquatic plants. Note: The amount of elemental copper added to the Lake Mohawk sediments during 2010 was 0.00257 milligrams per square foot.

Oxygen/Temperature (The Blue-Green Algae Connection)

Understanding the importance of oxygen in "iron controlled" lakes such as Lake Mohawk is vital to understanding how internal (sedimentary) sources of phosphorus "fuel" blue-green algae blooms. **Table 1**. Shows how oxygen values decrease significantly below 15 feet in the summer. In "iron controlled" lakes, iron (Fe) in the PRESENCE of OXYGEN combines with SEDIMENTARY PHOSPHORUS to form FERRIC PHOSPHATE, an insoluble form of phosphorus that is NOT available to blue-green algae. In the ABSENCE of OXYGEN, sedimentary phosphorus is REALEASED from the sediments as the iron changes to the SOLUBLE FERROUS form. This released phosphorus is available to "feed or fuel" blue-green algae blooms. What this means at Lake Mohawk is that all lake sediments which are at 15 feet or greater are contributing to blue green algae blooms in the summer. (Note: shallow bay sediments disturbed by wind, wave, and boat action also contribute phosphorus)

The 2009 sedimentary analysis revealed that it was the deeper sediments that contained the most phosphorus. It should be noted that when iron (Fe) becomes limited, the "Ferric Phosphate" reaction no longer takes place, even in the presence of oxygen. For that reason, alum can be utilized to "tie up" sedimentary phosphorus. The reaction between alum and phosphorus is not oxygen dependent

Note: Fall turnover on 9/8/10 when the lake becomes "isothermal" (same temperature). As the lake becomes the same temperature from top to bottom, it easily mixes from wind and wave action, allowing the depths below 15 feet to become oxygenated thereby naturally reducing the available phosphorus from the chemical reaction stated above.

Oxygen (mg/l) Temperature (F) Profile - Lake Mohawk 2010

5/19/10		6/4/10		6/25/10		7/7/10		7/14/10		7/30/10		8/19/10		**9/8/10**	
O2	T	O2	T	O2	T	O2	T	O2	T	O2	T	O2	T	O2	T
9.4	65.3	8.7	78.8	8.7	80.4	9.3	84.7	8.3	84.0	8.1	84.0	9.4	84.4	7.1	73.6
9.3	64.9	8.7	78.3	8.7	80.1	9.5	84.2	8.4	82.4	8	83.2	9.5	84.2	7.1	73.8
9.4	63.7	8.8	77.7	8	79.9	9.4	83.5	8	81.7	7.9	82.7	9.7	82.9	6.9	73.8
9.4	63.3	8.8	77.4	8.7	79.7	8.5	81.9	8.1	81.3	7.7	82.1	8.9	82.2	6.7	73.4
9.4	63.3	9.7	75.0	8.7	79.5	7.3	80.1	5.5	80.6	7.2	81.9	6.1	81.7	6.6	73.4
8.7	62.6	8.1	64.4	7.5	77.7	4.7	77.5	0.1	77.9	7.3	81.6	2.6	80.8	6.3	73.4
					Summer Thermocline										
5.4	61.0	0.6	60.6	2.2	70.3	0.3	72.9	0.1	72.7	0.7	74.4	0.2	75.7	6	73.4
3.6	59.5	0.2	59.5	0.2	64.9	0	65.7	0	66.6	0	67.8	0	69.4	4	72.9
0.8	59.5	0.1	59.1	0	61.2	0	61.5	0	62.2	0	63.8	0	65.1	0.2	68.7
0	55.8			0	59.0	0	60.6	0	61.2	0	62.6	0	63.9	0	66.2

Table 2.

Secchi Disc Visibility (ft.) Lake Mohawk 2010

N 40 40.542' W 81 11.526'

4/21/10	5/19/10	6/4/10	6/25/10	7/7/10	7/14/10	7/30/10	8/19/10	9/8/10
5.6	12.9	14.1	10.9	4.5	5.7	5.4	5.2	5.7

Note: Secchi Disc visibility provides a rough estimate of the phytoplankton (microscopic algae and "animals" zooplankton) density in Lake Mohawk. Note how the lack of vegetation through both natural senescence and chemical control in May leads to decreased visibility. Phosphorus becomes more available as it is not bound up in plant tissues. Sedimentary phosphorus release from the deep water sediments also starts to "feed" the microscopic algae. Blue-green algae often dominate due to their superior adaptive abilities over more desirable and less harmful species.

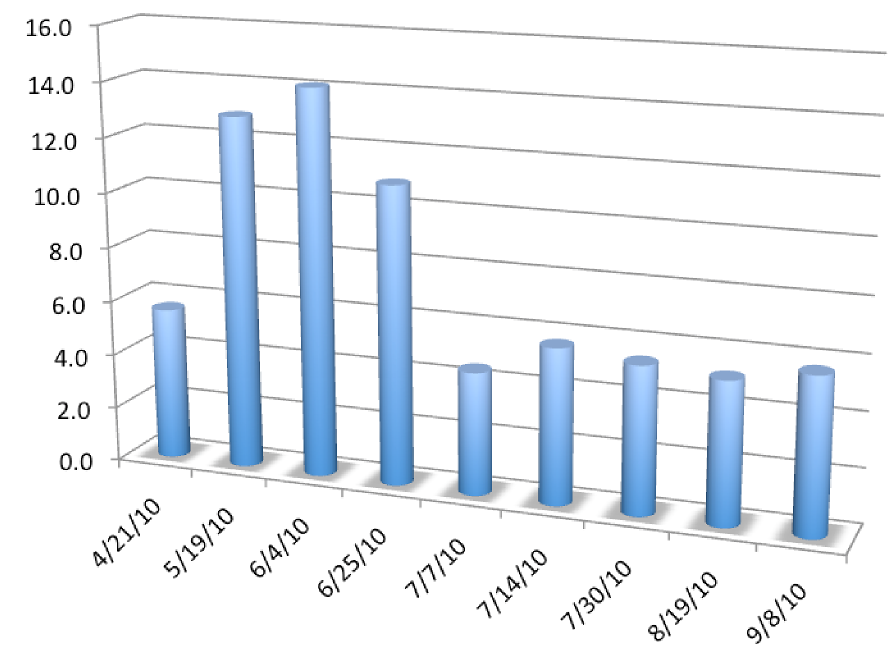


Table 3. Note: Rain Data collected and recorded by Eric Howland onsite at Lake Mohawk
Note: Numbers from 1-36 in columns represent inches from top of dam overflow. i.e. March 29th, water level was 1” below overflow

2010 Rainfall & Lake Level

	JAN		FEB		MAR		APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	0.04		0	32	0.31		0	0	0	0	0	0	0	0	0
2	0		0.04		0		0	0.28	0.55	0	0	0	0.2	0	0
3	0		0		0		0	0.08	0.55	0	0	0.08	0.24	0	0
4	0	36	0.04		0		0	0	0.16	0	0.59	0	0.2	0	0
5	0		0		0		0	0	0.75	0	0.04	0	0.16	0	0
6	0		0		0		0.08	0.12	0.2	0	0.04	0	0.2	0.04	0
7	0		0		0		0	0	0	0	0	0.12	0	0	0
8	0		0		0	24	0.24	0.35	0	0	0	.04	0	0	0
9	0		0		0		0	0	1.5	0.24	0	0	0	0	0
10	0		0		0		0	0	0	0	0	0	0	0	0
11	0		0		0		0	0.75	0	0	0	0.3	0	0	0.12
12	0		0		0		0	0.08	0	0.2	0	0	0	0	0.83
13	0		0		0.55		0.04	0	0.2	0	0	0	0	0	0
14	0.04		0		0.08	13	0	0	0	0	0.28	0	0	0.08	0
15	0.31		0		0.04	13	0	0	0.04	0	0.16	0	0	0	0
16	0		0		0		0.28	0	0	0	0	0.44	0	0.51	0
17	0.28		0		0		0	0.55	0	0	0	0	0.2	0.04	0
18	0	33	0.16		0	11.5	0	0.12	0	0.04	0	0.04	0	0	0
19	0		0		0		0	0	0	0	0	0	0	0	0
20	0.08		0		0		0	0	0	0.16	0	0	0	0	0
21	0		0		0		0	0	0	0.12	0.55	0	0	0	0
22	1.02		0.16		1.14	9.5	0	0	0.39	0	0	0	0	0	0
23	0.28		0		0	6	0	0	0.47	0	0	0	0	0.16	0
24	0		0.04		0		0.08	0	0	1.26	0	0	0	0	0
25	0	28	0		0.16		0.51	0	0	0.43	0.08	0	0	2.24	0
26	0		0		0	4	0.16	0	0	0	0	0	0.94	0.28	0
27	0		0		0		0	0	0	0	0	0	0	0	0
28	0		0		0.43		0	0.04	0.71	0.35	0	0.59	0	0	0
29	0				0.04	1	0	0	0	0	0	0	0	0	0
30	0				0		0	0	0	0	0	0	0	1.18	0.16
31	0				0			0		0	0		0		0
Total	**2.05**		**0.44**		**2.75**		**1.39**	**2.37**	**5.52**	**2.8**	**1.74**	**1.61**	**2.14**	**4.53**	**1.11**
CAK Airport	**2.2**		**3.6**		**3**		**2.11**	**3.24**	**10.26**	**4.34**	**2.44**	**3.41**	**2.98**	**5.93**	**0.77**

Table 4.

Summary of Services Provided to Lake Mohawk in 2010

E-Mail Correspondence – Approx. 130-150

3/11/10 –	Background Soil Copper Tests
3/24/10 –	Attend Board Meeting
4/5/10 –	Monday Night Fish Group Meeting
4/6/10-	Survey Lake with Scott
4/10/10-	Lake Committee Meeting
4/21/10-	Meeting w/ Bill Sheckler
4/27/10-	Treatment – 22 surface acres of CLP
4/28/10-	Attend Board Meeting
5/4/10-	Treatment – 30 surface acres of CLP
5/5/10-	Treatment – 27.5 surface acres (Mix of CLP and Milfoil)
5/6/10-	Treatment – 25 surface acres (CLP/Milfoil)
5/19/10-	Treatment – 37.5 surface acres (CLP/Milfoil)
5/26/10 -	Treatment (100 lbs of copper sulfate) Filamentous algae
6/4/10-	Lot 1308 – H191-Cutrine Granules – Lots 9/10 Reward/Aquathol/Komeen
6/8/10-	Oxygen/Temp recordings – Treatment 7.5 surface acres – Milfoil
6/12/10-	Lake Committee Meeting
6/17/10-	Mapping / Bay 6 Treatment – 2.5 surface acres Milfoil
6/23/10-	Meeting – Board
6/25/10-	Treatment – 7.5 surface acres
6/26/10-	Web Updates
7/7/10-	Treatment – North Shoreline (lots 1,2,3, etc.)
7/8/10-	Treatment – Blue Green Algae (600 lbs. copper sulfate)
7/14/10-	Treatment – 8.5 surface acres (Milfoil)
7/21/10-	Treatment – 2.5 surface acres (Milfoil)
7/27/10-	Treatment – Blue Green Algae (750 lbs copper sulfate)
7/28/10-	Meeting – Board
7/31/10-	Web Updates
8/4/10-	Treatment – Blue Green Algae (1500 lbs copper sulfate)
8/5/10-	Treatment – 10 surface acres Naiads
8/19/10-	Treatment- 15 surface acres Naiads
8/24/10-	Treatment- Blue Green Algae (1500 lbs. copper sulfate)
8/25/10-	Meeting-Board
9/8/10-	Basic Monitoring – Oxygen Temp
9/19/10-	Oktoberfest

Total Chemicals –
195 Gallons Reward / 205 Gallons Aquathol K / 209 Gallons Komeen / 1.1 Gallons H191
Plus Adjuvants (Cygnet Plus / Polyan)

Copper sulfate – 4530 lbs.

Summary

The two most significant nuisance aquatic plants of 2010 were curlyleaf pondweed and watermilfoil. Although treatment for CLP was applied much earlier in 2010 than in 2009, it is unknown how much CLP will return in 2011. Theoretically, treating CLP early stops the seed production of the plant, which should result in fewer plants the following season. In reality, it is unknown what to expect in terms of CLP plant density for 2011. Considering that there were many deep-water locations where CLP existed but were not treated (due to cost limitations), I believe that CLP seeds still exist in numbers that will present some level of nuisance conditions. How many and where these deep-water plants spread their seeds is unknown.

In regard to watermilfoil, I believe that this plant will be at 2010 levels or greater. Contact herbicides that were used to control this plant did not control the root system. When treating with contact herbicides, this plant may require 2-3 treatments per season depending on location. Harvesting this plant is neither feasible nor desirable due to fragmentation concerns. Considering all factors at Lake Mohawk, I believe that this plant should be controlled with a systemic herbicide such as fluridone that kills the root system. Aquatic 2,4D may also be used but at a later than desirable date with a two week control period. It should be noted that a Spring Sonar application will NOT control summer growths of Naiad. It will also not control blue-green algae or any other type of algae.

Blue-green algae should be controlled with minimal dose applications of an algaecide such as copper sulfate until more permanent solutions are implemented. Other non-copper based algaecides are not economically feasible in a lake the size of Lake Mohawk. Sediment removal (soft upper layers only) via a light suction dredge and phosphorus inactivation in deep water locations (greater than 12 feet) should continue to be investigated. Much of the phosphorus that contributes to the summer blue-green algae blooms is coming from deep water sediments that become anaerobic in the summer months. Depending on the amount of iron in the sediments, a deep-water aeration system may also reduce phosphorus release.

Aquatic plant harvesting trials for 2011 should be focused on nuisance levels of Naiad in July/August if fluridone is used as a Spring treatment.

Lake Mohawk is a high quality lake that serves a wide variety of people with recreational uses that include fishing, boating, skiing, swimming, etc.. The main issue facing Lake Mohawk in my opinion is the ecologically sensitive control of blue-green algae. Due to the fact that much of the phosphorus responsible for blue-green algae blooms is from internal sources, management solutions are available and feasible. The selective management of desirable aquatic plants is a “win-win” situation for both fishing and skiing groups. Integrating control methods of both “Mother Nature” and man provide the most sensible solutions to mixed user lake environments such as Lake Mohawk. Based on input from these two varied groups, the 2010 lake season was relatively successful in terms of lake management with the exception of late season watermilfoil growth in Bay 9/10.