

## 4. Lake Features

### 4.1. Lake Map and Lake Statistics

Muskellunge Lake is approximately 272 acres in size, with a watershed of 550 acres and a contributing watershed of 2,602 acres (not including the lake acreage). The average depth of Muskellunge Lake is 2.8 meters (9.3 feet) with a maximum depth of 5.8 meters (19 feet) (Table 5). A lake contour map is shown in Figure 10. Muskellunge Lake is located in an area of Wisconsin that is dominated by forests and wetlands.

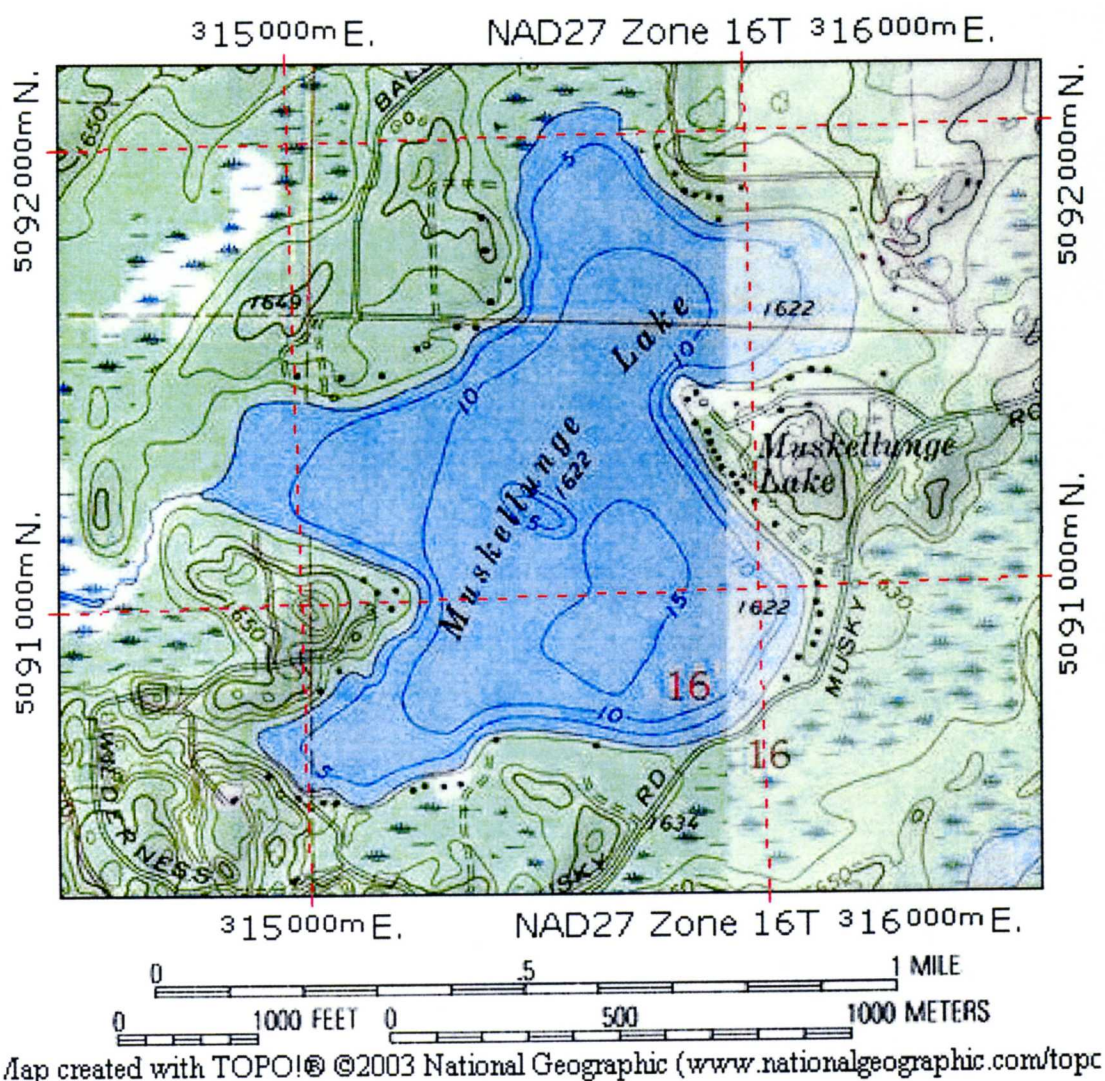


Figure 10. Muskellunge Lake, Vilas County, Wisconsin.

**Table 5. Muskellunge Lake Characteristics**

Area (Lake):	272 acres (110 ha)
Mean depth:	9.3 feet (2.8 m)
Maximum depth:	19 feet (5.8 m)
Volume:	2,530 acre-feet
Watershed area (including lake area):	2,874 acres (333 ha)
Watershed: Lake surface ratio	10:1
Public accesses (#):	1
Inlets:	1 or 2 intermittent streams (Intermittent means streams are sometimes dry and only flow when it rains or with snowmelt)



**Figure 11. Outlet area, May 2004.**

## 4.2. Dissolved Oxygen and Temperature

A number of dissolved oxygen and temperature profiles have been acquired over the years. Examples for 1998 - 2001 are shown on the next page. By examining the profiles, one can learn a great deal about the condition of a lake and the habitat that is available for aquatic life.

For example, the July 1999 profile shows that the lake was thermally stratified.

**Thermally stratified** means that the water column of the lake is segregated into different layers of water based on their temperature. Just as hot air rises because it is less dense than cold air, water near the surface that is warmed by the sun is less dense than the cooler water below it and it “floats” forming a layer called the *epilimnion*, or *mixed layer*. The water in the epilimnion is frequently mixed by the wind, so it is usually the same temperature and is saturated with oxygen.

Below this layer of warm, oxygenated surface water is a region called the *metalimnion*, or *thermocline* where water temperatures decrease precipitously with depth. Water in this layer is isolated from gas exchange with the atmosphere. The oxygen content of this layer usually declines with depth in a manner similar to the decrease in water temperature.

Below the thermocline is the layer of cold, dense water called the *hypolimnion*. This layer is completely cut off from exchange with the atmosphere and light levels are very low. So, once the lake stratifies in the summer, oxygen concentrations in the hypolimnion progressively decline due to the decomposition of plant and animal matter and respiration of benthic (bottom-dwelling) organisms.

Because Muskellunge Lake is relatively shallow, it appears the lake can mix over the summer. For example, in August of 1999, the lake was mostly mixed from top to bottom.

## Muskellunge Lake - dissolved oxygen and temperature profiles for 1998-2001

**4.28.98**

SD (ft): 4.5

TP (ppb): 59

Depth	Temp	DO
3	55	10.5
5	55	10.4
7	54	10.5
9	54	10.5
12	54	10.6
15	53	10.3
17	53	6.0

**6.16.98**

SD (ft): 5.5

TP (ppb): 30

Depth	Temp	DO
3	70	12.0
5	67	12.0
7	65	10.7
9	62	10.3
12	60	1.9
15	60	1.5

**7.22.98**

SD (ft): 3.8

TP (ppb): 81

Depth	Temp	DO
3	76	7.3
5	76	7.3
7	76	7.3
9	75	7.4
12	72	7.6
15	73	1.1

**8.24.98**

SD (ft): 3

TP (ppb): 57

Depth	Temp	DO
3	73	8.4
5	73	8.7
7	73	8.7
9	73	8.2
12	73	8.1
15	71	5.5
17	70	0.9

**5.26.99**

SD (ft): 4.8

TP (ppb): 36

Depth	Temp	DO
3	55	9.6
6	55	11.4
9	55	12.9
12	55	15.2
15	55	16.3

**6.29.99**

SD (ft): 3.3

TP (ppb): 43

Depth	Temp	DO
3	70	8.2
6	70	9.0
9	70	10.7
12	70	12.8
15	70	8.8

**7.27.99**

SD (ft): 2.5

TP (ppb): 51

Depth	Temp	DO
3	79	11.3
6	77.5	8.5
9	73	14.2
12	68	2.3
15	67	3.5

**8.14.99**

SD (ft): 2.0

TP (ppb): 71

Depth	Temp	DO
3	69	12.5
6	69	9.0
9	69	8.0
12	69	2.3
15	68	7.7

**10.19.99**

SD (ft): 5.6

TP (ppb): 41

Depth	Temp	DO
3	55	14.3
6	55	10.6
9	55	8.4
12	55	9.1
15	55	13.0

**5.16.00**

SD (ft): 10.3

TP (ppb): 21

Depth	Temp	DO
3	14.5	10.3
6	14.3	9.7
9	14.3	9.8
12	14.2	7.9
15	14	6.1

**6.13.00**

SD (ft): 6.0

TP (ppb): 28

Depth	Temp	DO
3	20.5	9.3
6	20.4	8.1
9	19.9	8.1
12	19.1	6.7
15	17	3.5

**7.24.00**

SD (ft): 3.5

TP (ppb): 41

Depth	Temp	DO
3	20.4	8.6
6	20.1	8.3
9	19.5	8.1
12	19.2	7.5
15	18.5	6.6

**8.23.00**

SD (ft): 3.8

TP (ppb): 54

Depth	Temp	DO
3	21.2	10.0
6	20.9	9.0
9	20.6	7.3
12	20.3	3.1

**5.14.01**

SD (ft): 5.3

TP (ppb): 37

Depth	Temp	DO
3	16.5	8.8
6	16.3	8.4
9	16	8.9
12	15.6	7.7
15	14.4	3.6
17	13.9	0.5

**6.18.01**

SD (ft): 4.5

TP (ppb): 46

Depth	Temp	DO
3	19.5	7.6
6	19.3	7.7
9	19.2	7.5
12	19	7.5
15	16.5	1.2

**7.23.01**

SD (ft): 4.0

TP (ppb): 49

Depth	Temp	DO
3	26.3	9.3
6	26.4	9.3
9	23.4	3.4
12	21.3	0.2
15	19.9	0.2
17	18.4	0.2

**8.20.01**

SD (ft): 2.5

TP (ppb): 75

Depth	Temp	DO
3	20.6	9.9
6	20.5	8.4
9	20.3	8.2
12	20.1	5.4
15	19.8	1.8
17	19.3	0.2

**10.16.01**

SD (ft): 3.8

TP (ppb): 63

Depth	Temp	DO
3	11.1	9.6
6	10.5	9.7
9	10.4	9.5
12	10.3	9.4
15	10.2	8.5
17	10.4	1.8

### 4.3. Lake Water Quality Summary

Summer water quality data were collected in 1991 - 2002, and 2004. Overall, the three water quality indicators (Secchi disc, total phosphorus, and chlorophyll a) indicate Muskellunge is moderately fertile.

Additional water quality evaluations are found in the next several sections.

**Table 6. Summary of summer water quality data collected through the Citizen Self-Help Monitoring Program.**

Date	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
<b>1991</b>			
7.30	3		
8.8	5		
8.15	4.5		
8.23	4		
9.1	3.75		
9.9	3		
9.16	2.75		
9.25	4		
<b>Jul - Sept Avg</b>	<b>3.6</b>		
<b>1992</b>			
5.4	5.5		
5.14	5.7		
5.30	6		
6.14	5.3		
6.29	4.7		
7.14	5.5	31	9
7.28	5.3		
8.13	3.5	38	15
8.15	4		
8.31	3.5		
9.14	4		
9.21	4	36	12
9.30	3.5		
<b>May - Sept Avg</b>	<b>4.7</b>	<b>35</b>	<b>12</b>

Date	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
<b>1993</b>			
5.12	6		
5.17	4	39	12
5.26	5		
6.9	4.5		
6.15	4	23	9
6.23	5.5		
7.7	4		
7.20	5	30	12
7.21	5		
8.4	4.25		
8.18	4		
8.23	3	39	14
9.1	4.5		
9.27	4.75		
<b>May - Sept Avg</b>	<b>4.6</b>	<b>33</b>	<b>12</b>
<b>1994</b>			
5.2	4.5		
5.16	4		
5.23	5.5	19	6
6.15	4		
6.29	3.5	39	20
7.1	3.75		
7.6	3.75		
7.11	3.5	44	21
7.21	3.75		
8.4	4		
8.18	3.25		
8.29	4	43	16
8.31	3.75		
9.14	4.25		
<b>May - Sept Avg</b>	<b>4.0</b>	<b>36</b>	<b>16</b>
<b>1995</b>			
5.18	3.5	46	14
6.20	6	21	6
6.28	9.5		
7.12	3	46	
7.16	15		
7.30	7.5		
8.7	3.5	50	
8.19	6.5		
<b>May - Aug Avg</b>	<b>6.2</b>	<b>41</b>	<b>10</b>

Date	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
<b>1996</b>			
5.29	2.5	58	37
6.25	3	43	14
7.29	2.75	52	22
8.21	4.75	30	18
<b>May - Sept Avg</b>	<b>3.3</b>	<b>46</b>	<b>23</b>
<b>1997</b>			
5.28	4.25	78	
6.22	4.75	74	8
7.28	3.75	51	23
8.25	3.5	63	29
<b>May - Aug Avg</b>	<b>4.1</b>	<b>67</b>	<b>20</b>
<b>1998</b>			
5.30	2.5		
6.15	3.5		
6.16	5.5	30	11
6.30	4		
7.8	4.5		
7.22	3.75	81	16
8.4	4		
8.18	3		
8.24	3	57	28
9.3	2.75		
9.30	3		
<b>Avg</b>	<b>3.4</b>	<b>56</b>	<b>18</b>
<b>1999</b>			
5.26	4.75	36	
6.29	3.25	43	23
7.27	2.5	51	35
8.14	2	71	91
<b>May - Aug Avg</b>	<b>3.1</b>	<b>50</b>	<b>50</b>
<b>2000</b>			
5.16	10.25	21	
6.13	6	28	8
6.26		27	
7.20		35	
7.24	3.5	41	11
8.18		57	
8.23	3.75	54	12
9.6	2.75		
9.25	4		
<b>May - Sept Avg</b>	<b>5.4</b>	<b>36</b>	<b>10</b>

Date	Secchi Disc (ft)	TP - top (ppb)	Chlorophyll a (ppb)
<b>2001</b>			
5.1		27	
5.14	5.25	34	
6.18	4.5	37	
6.19	3.75	46	9
7.2	4		
7.14	4		
7.20	3		
7.23	4	49	15
8.1	3.25		
8.15	3.5		
8.20	2.5	75	47
8.27		53	
9.4	4		
9.20	4.5		
<b>May - Sept Avg</b>	<b>4.1</b>	<b>46</b>	<b>24</b>
<b>2002</b>			
6.18		33	
<b>June Avg</b>	<b>--</b>	<b>33</b>	<b>--</b>
<b>2004</b>			
5.11	4	41	
6.13	5.5	41	9
7.19	4.5	19	43
<b>May - July Avg</b>	<b>4.7</b>	<b>34</b>	<b>26</b>



### 4.3.1. Secchi Disc Transparency

Water clarity is commonly measured with a Secchi disc. A typical seasonal pattern in lakes shows good clarity in May and June with a drop off in July and August. The low water clarity in late summer is usually due to algae growth. This pattern is not always found in Muskellunge. Water clarity summer averages from 1991 through 2004 are shown in Figure 12. The summer average for clarity in 2004 was less than 5 feet. Many lakes in the area have better clarity than Muskellunge.

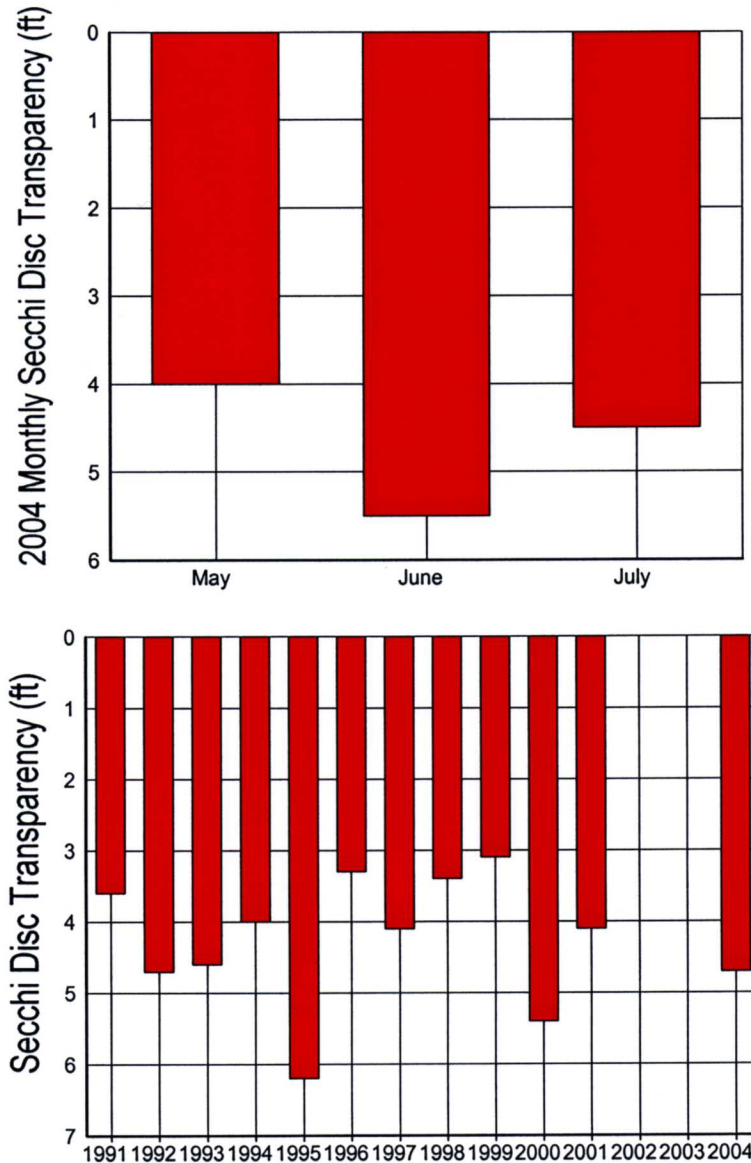


Figure 12. [top] Monthly Secchi disc readings in Muskellunge Lake in 2004. [bottom] Yearly Secchi disc readings for Muskellunge Lake.

### 4.3.2. Total Phosphorus

Phosphorus is the nutrient most often associated with stimulating nuisance algae growth. The more phosphorus in the lake, the more algae will be produced. Records of summertime lake phosphorus concentrations for Muskellunge Lake are shown in Figure 13. Phosphorus concentrations in Muskellunge Lake are moderate to high. When phosphorus concentrations get over 30 parts per billion (ppb) of phosphorus, that is high enough to produce algae growth that results in water clarity of 4 to 5 feet.

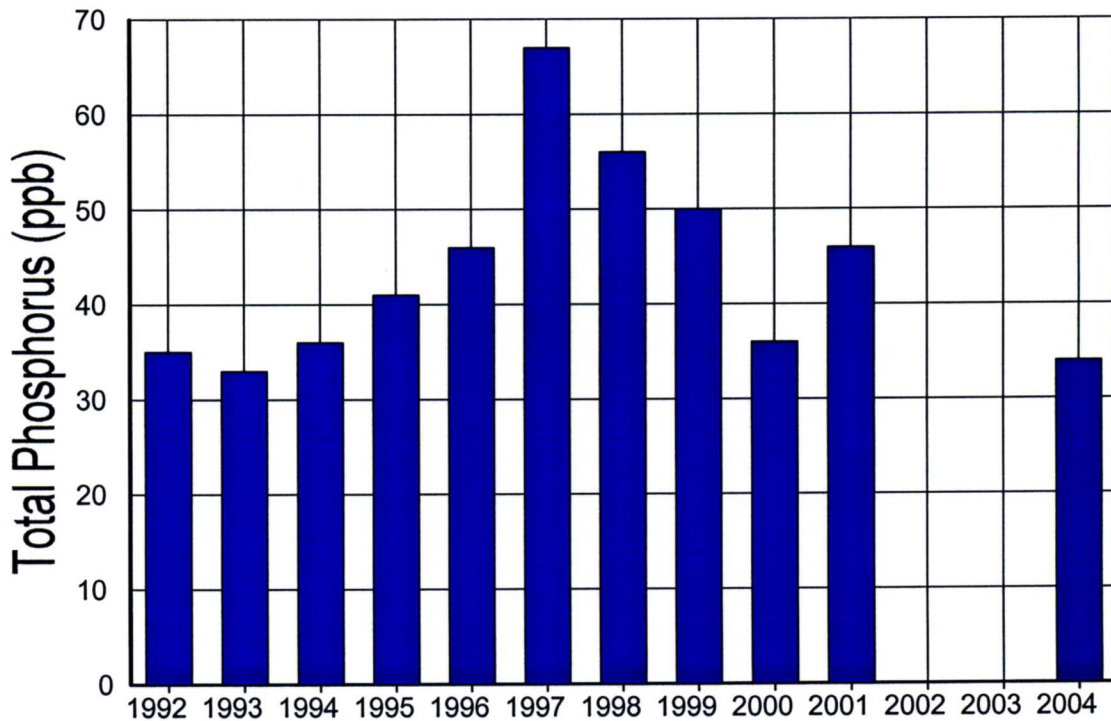


Figure 13. Yearly surface total phosphorus concentrations for Muskellunge Lake.

### 4.3.3. Chlorophyll a (a measure of algae)

Algae are small green plants, often consisting of single cells or grouped together in filaments (strings of cells). Because algae have chlorophyll, the amount of algae in the water can be characterized by measuring the chlorophyll content in lake water.

The amount of algae, as determined using chlorophyll measurements is directly influenced by the amount of phosphorus in the lake. Chlorophyll results from 1992 through 2004 are shown in Figure 14. Chlorophyll concentrations are moderate to high and this correlates with phosphorus concentrations which are also moderate to high.

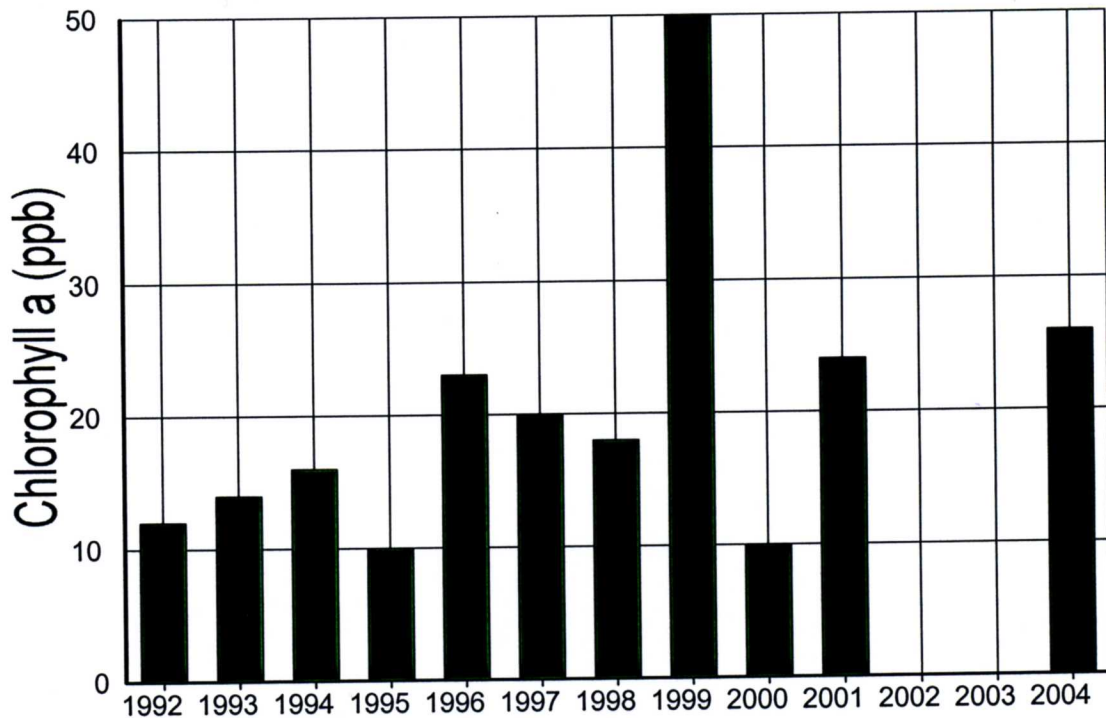
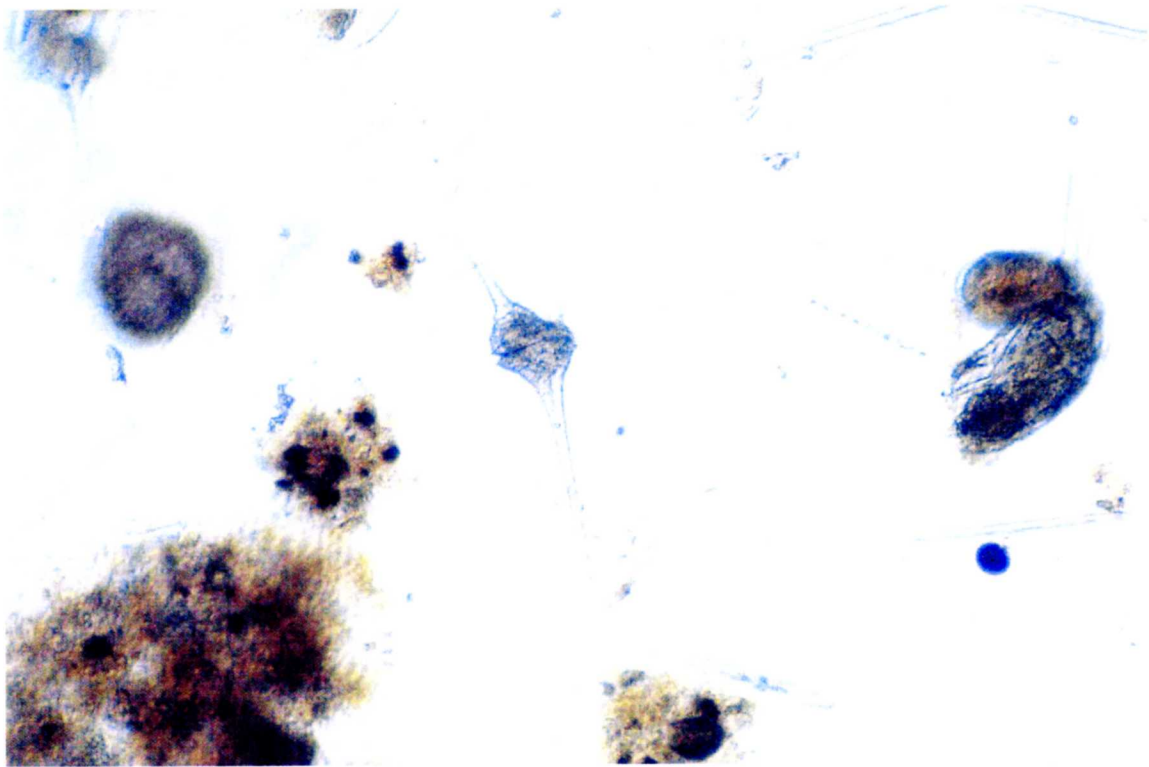


Figure 14. Yearly chlorophyll concentrations in Muskellunge Lake.

## 4.4. Algae

In mid to late summer, algae numbers increase and reduce transparency in Muskellunge Lake. The dominant late summer algal species in Muskellunge Lake in 2004 dinoflagellates and blue-green algae (Figure 15 shows a dinoflagellate). Both species had relatively high densities in August and are responsible for the low transparency in Muskellunge Lake.



**Figure 15. Dinoflagellate algae were present throughout the summer in Muskellunge Lake. A dinoflagellate is shown in the center of the picture.**

## 4.5. Zooplankton

Zooplankton are small crustaceans that can feed on algae. A variety of different zooplankton are commonly found in lakes. An example of zooplankton species from Muskellunge Lake is shown in Figure 16. The zooplankton community in Muskellunge Lake is typical for lakes in Northern Wisconsin. In the photo, the image is magnified 150 times.

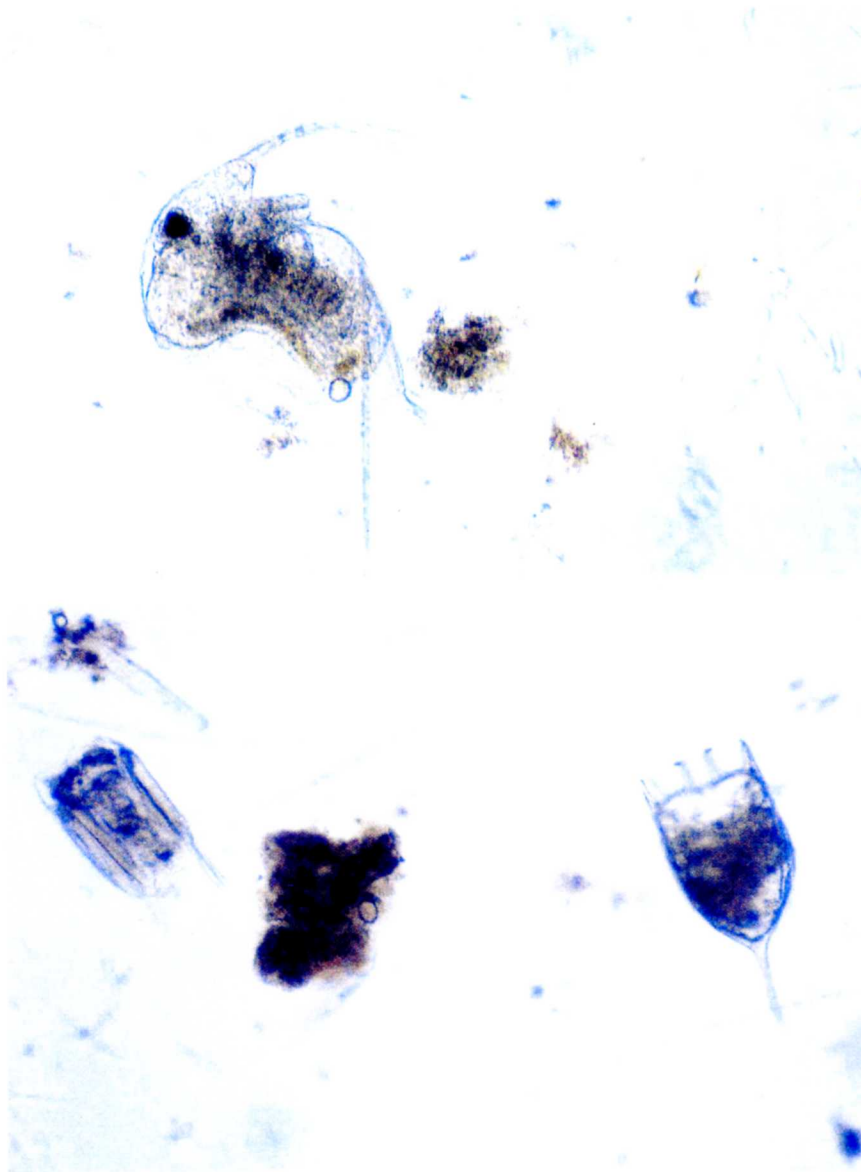


Figure 16. The animal in the upper left of the picture is a *Bosmina*, a cladoceran zooplankton that feeds on algae.

Zooplankton in Muskellunge Lake were sampled in May of 2004 and results are shown in Table 7. Chydorus was the dominant cladoceran but overall copepods and rotifers were the dominant zooplankton group. The number of large daphnids is somewhat low. This is a pattern found in many lakes, especially lakes with high panfish numbers.

**Table 7. Zooplankton counts for Muskellunge Lake (organisms/liter).**

<b>(Tow length was 7 feet)</b>	<b>5.25.04 (#/l)</b>
Big Daphnids	2
Little Daphnids	0
Ceriodaphnia	0
Bosmina	9
Chydorus	23
<b>Cladoceran</b>	<b>34</b>
Calonoids	3
Cyclopoids	31
Nauplii	28
<b>Copepods</b>	<b>62</b>
<b>Rotifers</b>	<b>222</b>
<b>Total Zooplankton</b>	<b>318</b>

## 4.6. Aquatic Plant Status

Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently Muskellunge Lake has a fair diversity of aquatic plants and no exotic plants were detected.

**Summary of Aquatic Plant Surveys for Muskellunge Lake in 2004:** Two aquatic plant surveys were conducted in Muskellunge Lake in 2004. An early summer survey on May 25 and a late summer survey on August 25. A summary is shown in Table 8.

**Table 8. Comparison of early and late summer surveys for Muskellunge Lake.**

	% Occur	
	May 25	August 25
Sedges ( <i>Carex sp</i> )	--	2
Arrowhead ( <i>Sagittaria sp</i> )	--	2
Bulrush ( <i>Scirpus sp</i> )	--	12
Floatingleaf burreed ( <i>Sparganium sp</i> )	2	--
Cattails ( <i>Typha sp</i> )	--	4
Wild rice ( <i>Zizania aquatica</i> )	--	2
Floatingleaf burreed ( <i>Sparganium sp</i> )	2	--
Spatterdock ( <i>Nuphar variegatum</i> )	6	12
White waterlily ( <i>Nymphaea sp</i> )	10	14
Cootail ( <i>Ceratophyllum demersum</i> )	74	80
Elodea ( <i>Elodea canadensis</i> )	24	48
Water marigold ( <i>Bidens Beckii</i> )	--	6
Northern watermilfoil ( <i>Myriophyllum sibiricum</i> )	2	28
Naiads ( <i>Najas flexilis</i> )	--	8
Stonewort ( <i>Nitella sp</i> )	--	2
Cabbage ( <i>Potamogeton amplifolius</i> )	26	30
Whitestem pondweed ( <i>P. praelongus</i> )	28	42
Claspingleaf pondweed ( <i>P. richardsonii</i> )	2	--
Fern pondweed ( <i>P. robbinsii</i> )	2	2
Stringy pondweed ( <i>P. sp</i> )	--	16
Flatstem pondweed ( <i>P. zosteriformis</i> )	8	42
Water celery ( <i>Vallisneria americana</i> )	--	36
Water stargrass ( <i>Zosterella dubia</i> )	16	6