Zvonimir Mihanovic: *At Rest*, **n.d.**

Lake Management Plan for Thunder Lake, Marinette County, Wisconsin

April 2006
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with contributions from Wisconsin Department of Natural Resources and the Thunder Lake Association

Funded in part by the Wisconsin Lake Management Planning Grants Program

Lake Management Plan for Thunder Lake, Marinette County Wisconsin

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Thunder Lake Report

MARIETTE COUNTY, WISCONSIN

Summary of the Lake Management Report 2006

Field Work: 2005 **Report: 2006**

Thunder Lake Management Report Completed

EURASIAN WATERMLFOIL IS STILL WIDESPREAD

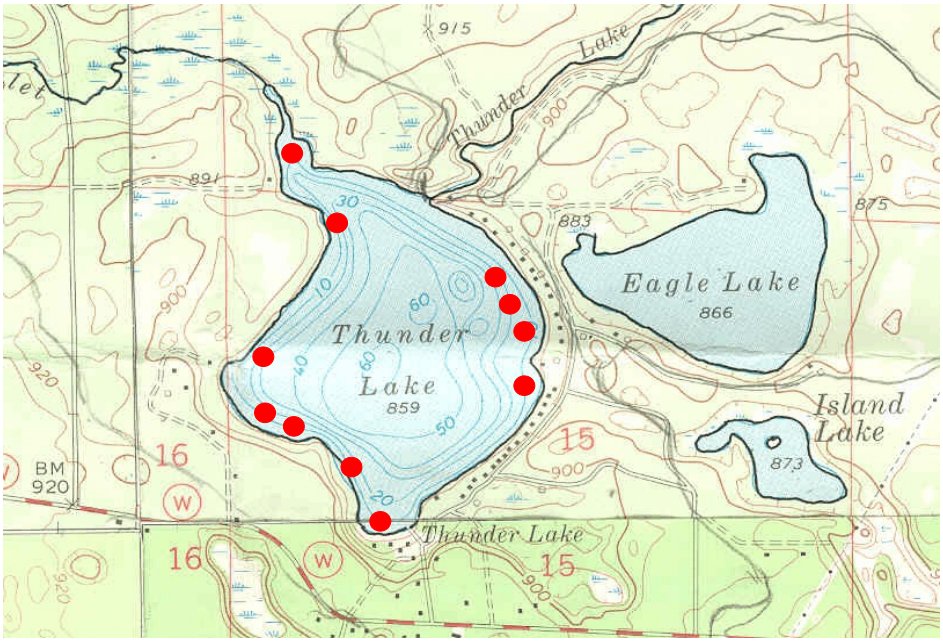
Water Quality Remains Good

A lake management report was completed in 2006. Highlights included an aquatic plant survey conducted on Thunder Lake on August 23, 2005 and a shoreline inventory which involved taking pictures of all the Thunder Lake shorelines which was also conducted on August 23, 2005.

The objectives of the surveys were to characterize existing conditions and use the information for future management planning efforts.

Results of the aquatic plant survey found the following.

- a total of twelve aquatic plant species were found.
- The most common plant in Thunder Lake is chara (which is actually a type of an algae).
- Eurasian watermilfoil was found in ten locations around Thunder Lake.
- Eurasian watermilfoil was not found to be surfacing or matting at the surface in Thunder Lake in 2005.
- When comparing the distribution of Eurasian watermilfoil in 2005 to a map produced in 1992, found milfoil has only slightly expanded it coverage in Thunder Lake in 13 years (since 1992).



Eurasian watermilfoil locations in Thunder Lake in 2005 are shown in red.

The other aquatic plant species found in Thunder Lake include the following: chara, nitella, elodea, cabbage, Illinois pondweed, and variable pondweed.

Chara, shown above on a rake, was the most common plant in Thunder Lake in 2005.

Several volunteers helped with the aquatic plant survey on August 23, 2005.

A List of Management Options for Eurasian Watermilfoil in Thunder Lake

Milfoil was estimated to cover a total of about 15 acres in Thunder Lake in 2005. In some years, up to 3 or 4 acres maybe surfacing in the lake. However in 2005 there was little Eurasian watermilfoil that reached the surface. Therefore in some years nuisance conditions might be worse compared to other years when there are non-nuisance conditions. The proposed plant strategy is to manage only the nuisance conditions and leave the non-nuisance growth conditions of milfoil alone.

Because milfoil has been in Thunder Lake at least 14 years its distribution is pretty well established. That is, it is not going to colonize and grow to nuisance conditions in new areas where it has not already grown to nuisance conditions.

The following is a list of potential options to consider for managing Eurasian watermilfoil.

1. **Herbicide control using a 2,4-D herbicide.**

The herbicide 2,4-D has been shown to be effective for controlling Eurasian watermilfoil on a seasonal basis. It typically does not produce long-term control. It should be applied in the early part of the summer when the plant is actively growing and before it gets encrusted with calcium carbonate (also called marl). When it becomes encrusted later in the summer the herbicide is sometimes not very effective because the marl acts as a coating and protects the plant.

The disadvantage of this option is if we are only going to treat nuisance areas we do not know where the nuisance areas are from year to year and by the time they present a nuisance often the milfoil is already encrusted with the marl and herbicides might not be very effective. The cost of herbicide applications typically range from $400 to $600 per acre.

2. Mechanical harvesting of Eurasian watermilfoil.

Mechanical harvesting has also been shown to be effective in controlling nuisance growth of Eurasian watermilfoil. A mechanical harvester is a machine that has a scissor-like cutting bar and captures about 90-98% of the plants that it cuts. The cutter bar typically can cut down to a water depth of about 5-6 feet or at least 60 inches below the surface.

There is little need to worry about the cut plants that are not picked growing in new areas since Eurasian watermilfoil has already been exposed to nearly all shoreline areas over the last 14 years. Therefore mechanical harvesting would not expand the distribution of Eurasian watermilfoil.

The downside is that because it only cuts down about 60 inches and because milfoil can grow up to 2 inches a day, there is the potential for a harvesting program to be effective for only about 30 days. For example, if milfoil is cut down 60 inches, it could grow back to the surface or near the surface within about a 30 day period, under ideal growing conditions. The cost of harvesting ranges from $400 to $700 per acre.

3. The use of the milfoil weevil to control Eurasian watermilfoil.

The milfoil weevil has been shown to control nuisance growth of Eurasian watermilfoil in some cases. In Thunder Lake there is a history of the use of the milfoil weevil going back into the 1990s. Recently in August of 2005 another batch of weevils were added to Thunder Lake.

The question is are they going to be able to control Eurasian watermilfoil and control nuisance conditions. It's possible. It appears the first batch of weevils put in the early 1990s may have had some effect but in 2004 there was little evidence of weevil control of nuisance Eurasian watermilfoil.

In 2005, with the addition of new weevils it may be best to wait through 2006 to see if they will have an effect. One of the downsides of relying on the weevils for milfoil control is that they are susceptible to being eaten by bluegill sunfish. The bluegills will eat the adult weevils right off the milfoil stem. Therefore if you have a moderate to high bluegill population in your lake weevil control of milfoil will be marginal. Fishery records help to determine if the bluegill population densities are too high.

Of the three control options, it appears that we should wait to see if the weevils will have an effect in 2006 before taking up a chemical or mechanical management option.

If weevils do not appear to be effective I would recommend the use of a mechanical harvester for 2007. If a mechanical harvester contractor is not easily found or hired than chemical control would be another option.

An additional question to address is how do you pay for either the use of herbicides or mechanical harvesting? Some lake associations use a 150 foot rule. Lakeside residents are responsible milfoil control from their shoreline out to 150 feet, and the lake association would then be responsible for milfoil control past 150 feet.

For Thunder Lake, the lake association would be responsible for areas at the landing and possibly in the inlet area. Lakeside residents could consider manual removal methods, harvesting or herbicide use for nuisance growth in their nearshore area.

Current Rules and Regulations for Aquatic Plant Management in Thunder Lake

Homeowners can clear an area not to exceed 30 feet wide from their shore out to open water without a permit using manual methods including raking or cutting the plants. All cut plants must be removed from the lake and shoreline.

Anything more than a 30 foot wide channel would require a permit from the Wisconsin DNR.

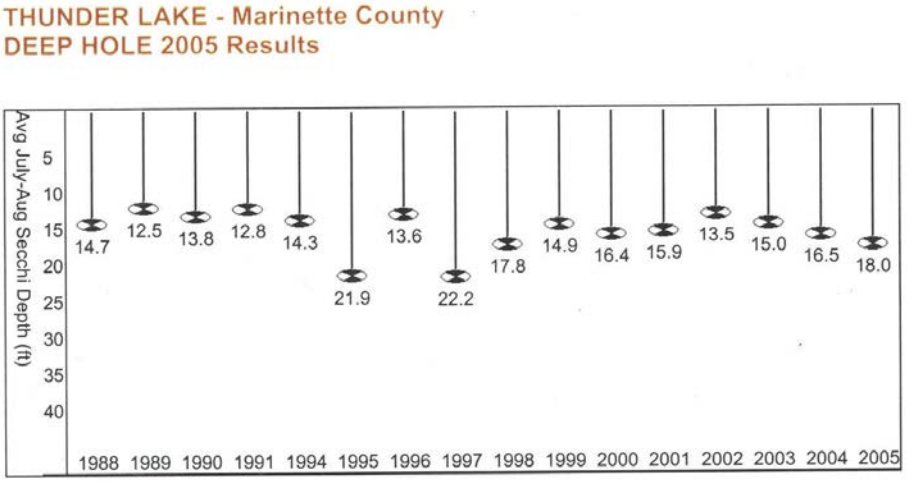
All other removal methods must be permitted by the Wisconsin DNR.

In addition to the 30 foot wide channel, manual removal of aquatic invasive species, like milfoil, from the shoreline area is allowed by lakeside residents. Removal must not damage or eliminate native species.

Water Clarity Has a Record of Excellent Conditions

Water clarity was excellent in Thunder Lake in 2005 and is slightly better compared to past readings going back to 1988.

Good water clarity indicates Thunder Lake has a low algae population which is typical for this part of the state. The reason for the low algae population is due to a low concentration of the fertilizing nutrient, phosphorus in the lake. As long as phosphorus levels are kept low, algae populations will remain low and Thunder Lake should maintain good, clear water.



(Based on WDNR information).

Most Shoreland Area Around Thunder Lake Is Rated "Natural"

Based on the shoreland inventory conducted in 2005, 76% of the parcels (59 out of 78) had natural shoreline buffers for at least 50% of their shoreline. Although this is good, there is room for improvement, and it is recommended that lake residents continue to receive information on the benefits of shoreline buffers and how to maintain them.

Thunder Lake Statistics

Thunder Lake

Lake size (acre):	135
Mean depth (feet):	31
Maximum depth (feet):	62
Volume (acre-feet):	4,185
Watershed area (acre): (not including the lake)	2,509
Watershed : Lake surface ratio	20
Clarity in 2005 (July-Aug)(feet):	18.0

Example of a Thunder Lake shoreland parcel that exhibits a good shoreline buffer and a natural upland area on the rest of the lot.

Other Lake Management Ideas

Management options for Eurasian watermilfoil were one of the primary objectives for this plan, but other components were addressed as well.

For water quality and the shoreland environment, the challenge will be to sustain the high quality conditions found in this study. Lake residents play a vital role. For example, if they maintain shoreline buffers and natural upland conditions, the natural setting is preserved and lake water quality is protected due to nutrient retention on the land.

Ongoing monitoring is recommended to continue to track any adverse changes to the lake.

This special newsletter was prepared by Blue Water Science, St. Paul, Minnesota and is part of a lake management program conducted on Thunder Lake. The program was funded by a grant from the Wisconsin DNR with volunteer assistance from the Thunder Lake Association.

1. INTRODUCTION AND PROJECT SETTING

Thunder Lake is located in Marinette County, Wisconsin (Figure 1). Thunder Lake characteristics are shown in Table 1.

The objectives of this study were to characterize existing lake conditions and to make recommendations to protect and improve the lake environment where feasible.

Table 1. Lake statistics (WDNR 1995).

	Thunder Lake
Size (acres)	135
Mean depth (ft)	31
Maximum depth (ft)	62
Watershed size (ac)	2,509
Lake : Watershed ratio	20 : 1

Figure 1. Thunder Lake is located in Marinette County, Wisconsin.

2. GLACIERS AND SOILS

Thunder Lake was formed approximately 16,000 years ago during the last glacial retreat of the Green Bay Lobe (Figure 2). The soils deposited by the Green Bay Lobe glacier were primarily sands and loamy-sands. Beneath these soils, at depths of about 50-350 feet, is Precambrian bedrock that is over one billion years old. The bedrock is referred to as the North American shield.

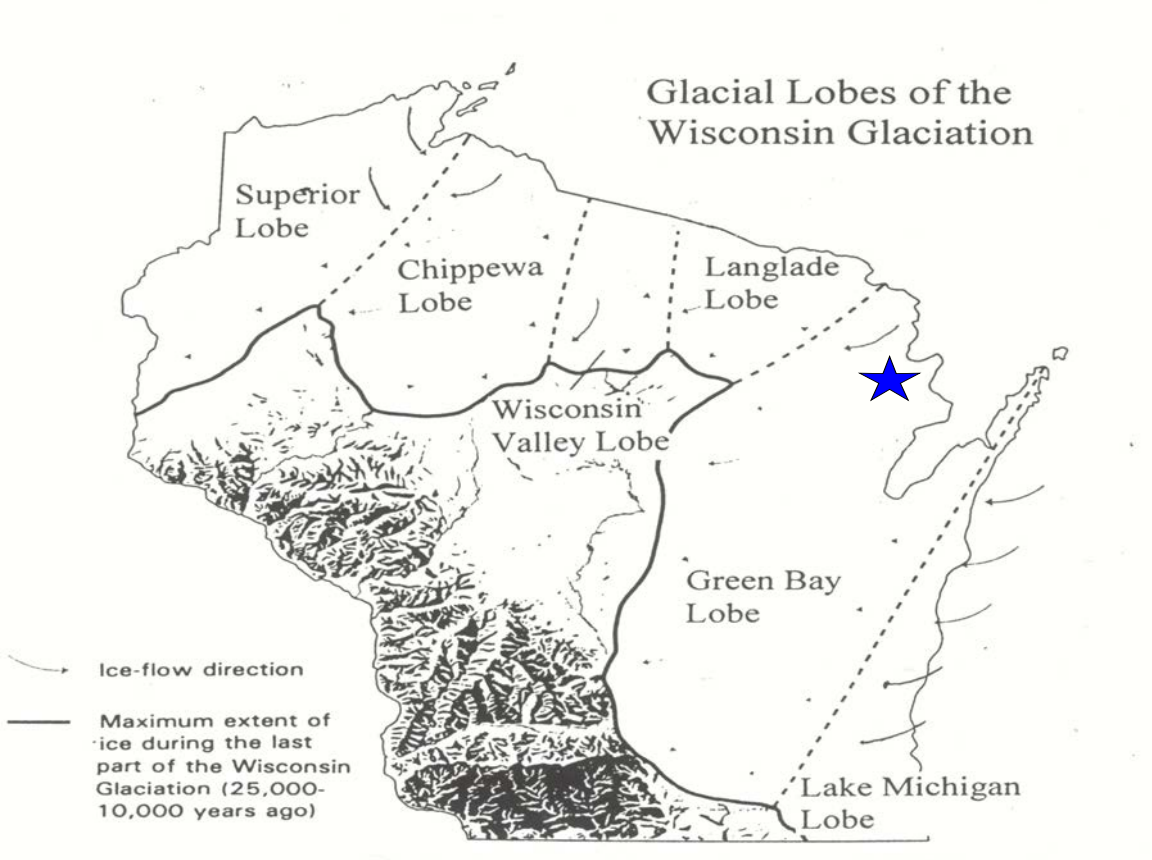


Figure 2. Glacial lobes of the Wisconsin glaciation. Thunder Lake is located in the Green Bay lobe.

Soil composition reflects the parent material that is present. Thunder Lake is located in an area dominated by forested silty soils and adjacent to forested loamy soils (Figure 3).

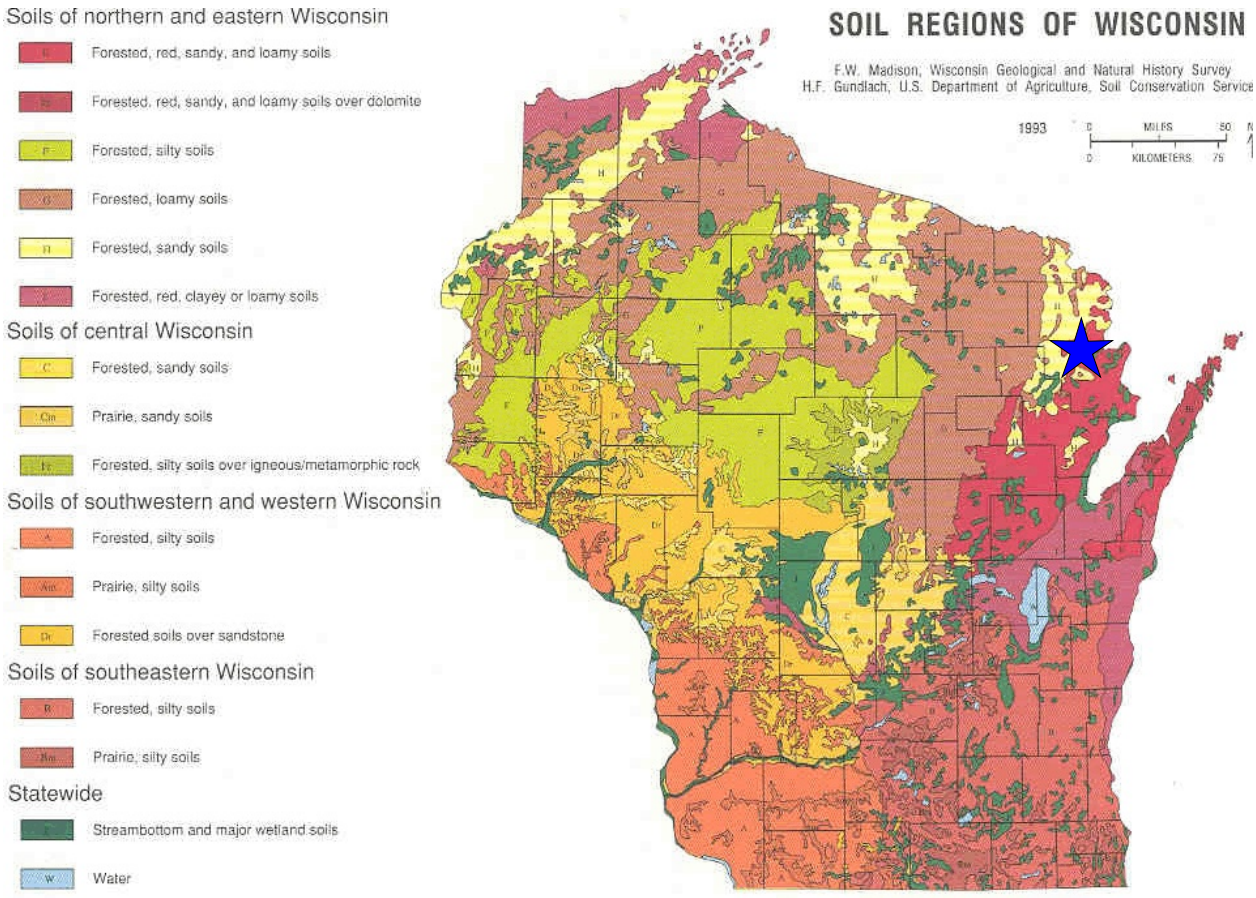


Figure 3. Thunder Lake is located within a soils group characterized as forested silty soils.

3. WATERSHED FEATURES

3.1. Drainage Area and Land Use of Thunder Lake

Drainage area to Thunder Lake is 2,509 acres (based on a USGS contour maps) and the delineation is shown in Figure 4. There are a number of lakes in the watershed and one major inflow, referred to as the Thunder Lake inlet.

Thunder Lake and its watershed are located within Marinette County and forested land (2,037 ac) is the dominant land use.

The watershed to lake ratio of Thunder Lake is 20 to one. Although that is a high watershed to lake ratio which sometimes can produce poor lake water conditions because of large nutrient loads, Thunder Lake has good water clarity. To preserve good water quality in years to come, conservation measures in the watershed and on the lakeshore of Thunder Lake should be considered.

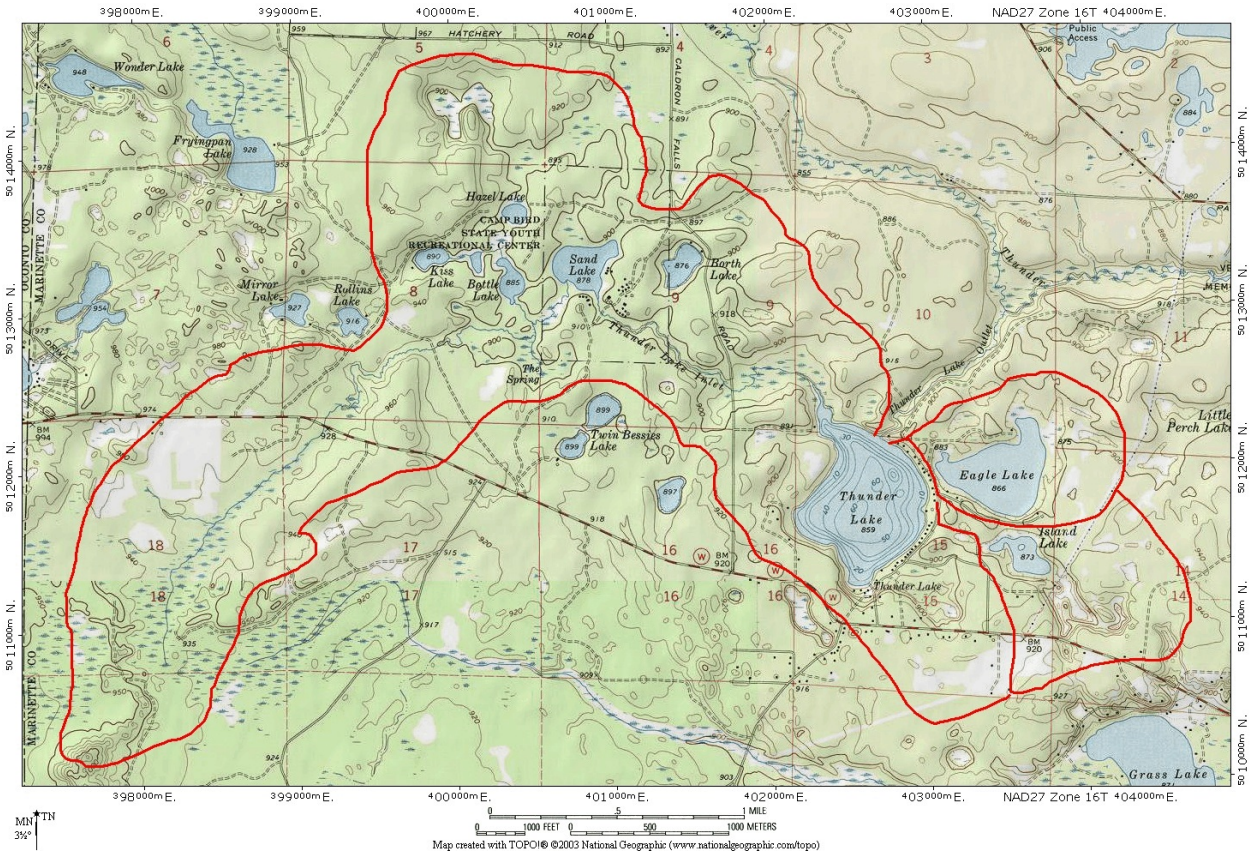


Figure 4. Watershed area for Thunder Lake (delineation was made by Blue Water Science, 2004).

3.2. Source of Water and Nutrients to Thunder Lake

Water: Source of water to Thunder Lake is from a combination of surface runoff, rainfall, and groundwater. The amount of water flowing into and out of Thunder Lake is estimated to be about 3.5 cubic feet per second. Flows were estimated based on runoff amounts listed for Marinette County in the Wisconsin Spreadsheet Lake Model (Table 2). Much of the flow is through groundwater springs in conjunction with the Thunder Lake inlet stream.

Table 2. Average annual water flow into Thunder Lake.

Drainage area (not including the lake) (acre)	2,509
Average yearly runoff for Marinette County (feet)(from WDNR WILMS Model)	1
Total water inflow (acre-feet)	2,509
Volume of Thunder Lake (acre-feet)	4,185

The estimated 2,509 acre-feet of water flowing into Thunder Lake in one year would be enough water to fill a swimming pool the size of a football field (which is about an acre in size) to a depth of 2,500 feet. It would also be enough drinking water to supply a town of 22,000 for a year (100 gallons per person per day).

Although this is a lot of water coming into Thunder Lake, the volume of Thunder Lake is 4,185 acre-feet. If Thunder Lake completely dried up, it would take 1.7 years to fill.

Watershed Nutrients: The primary source of phosphorus from the watershed of Thunder Lake is from forested areas. There are no known land uses such as row crops or agricultural lands contributing excess phosphorus to Thunder Lake. Phosphorus in rainfall and snowfall is also an important source of phosphorus to Thunder Lake. Additional information on watershed nutrients is presented in Section 5.3.

3.3. Shoreland Inventory

The shoreland area encompasses three components: the upland fringe, the shoreline, and shallow water area by the shore. A photographic inventory of the Thunder Lake shoreline was conducted in August of 2005 by lake resident volunteers and Blue Water Science. The objectives of the survey were to characterize existing shoreland conditions which will serve as a benchmark for future comparisons.

For analysis, each photograph was evaluated by Blue Water Science staff for shoreline and upland conditions. Our criteria for natural conditions were the presence of 50% native vegetation in the understory and at least 50% natural vegetation along the shoreline in a strip at least 15 feet deep. Although the shoreline recommendations for new development is a 35-foot deep buffer, a 15-foot deep buffer is about the minimum needed to achieve some degree of runoff water quality treatment. We evaluated shorelines and uplands at the 75% natural level as well. The objective of this approach was to get an approximate idea of existing natural conditions. It was not intended to be used for legal purposes.

A summary of the inventory results is shown in Table 3. Based on our subjective criteria about 76% of the parcels in the Thunder Lake shoreland area meet the natural ranking criteria for shorelines and upland areas. This is slightly below average for "northern Wisconsin lakes" where over 80% of the parcels meet the "natural" criteria.

In the next 10 years proactive volunteer native landscaping could improve the natural aspects of a number of parcels.

A comparison of Thunder Lake conditions to other lakes in Minnesota and Wisconsin is shown in Table 4 and in Figure 6.

Table 3. Summary of shoreline buffer and upland conditions in the shoreland area of Thunder Lake. Approximately 78 parcels were examined.

Thunder Lake	Natural Shoreline Condition		Natural Upland Condition		Undevel. Photo Parcels	Shoreline Structure Present		
	>50%	>75%	>50%	>75%		no structure	riprap	wall
TOTALS (no. of parcels = 78)	76% (59)	54% (42)	74% (58)	51% (40)	13% (10)	100% (78)	0% (0)	0% (0)

Figure 5. [top] This parcel would rate as having a shoreline with a buffer greater than 50% of the lot width and an understory with greater than 50% natural cover.
[bottom] This is an example of a parcel from another lake that would not qualify as having a natural shoreline buffer greater than 50% of the lot width. Also understory in the upland area would be rated as having less than 50% natural cover.

Table 4. Summary of shoreland inventories from Thunder Lake and 40 other lakes in Minnesota and Wisconsin.

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition		Natural Shoreline Condition		Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
					> 50% % (#)	>75% % (#)	> 50% % (#)	>75% % (#)		
NORTHWOODS LAKES										
Ballard chain Vilas Co, WI	LF	7.23.99	110	--	98 (108)	96 (106)	96 (106)	95 (105)	--	0
Pike Chain Price & Vilas Co, WI	LF	2001	722	380	92 (633)	87 (626)	95 (684)	91 (654)	--	5 (34)
Bear Oneida Co, WI	LF	6.8.99	115	6 (7)	93 (107)	78 (90)	84 (97)	77 (89)	1 (1)	8 (9)
Van Vliet Vilas Co, WI	LF	6.04	100	20 (20)	93 (93)	65 (65)	82 (82)	68 (68)	8 (8)	11 (11)
Muskellunge Vilas Co, WI	LF	8.7.04	129	8 (10)	81 (104)	62 (80)	88 (114)	76 (98)	2 (2)	18 (23)
Big Bear Lake Burnett Co, WI	LF	9.11.02	87	13 (11)	82 (71)	62 (54)	86 (75)	76 (66)	0	9 (8)
Nancy Lake Washburn Co, WI	LF	9.21.00	217	19 (41)	77 (167)	65 (141)	80 (174)	72 (156)		5 (11)
Plum Lake Vilas Co, WI	LF	7.26.01	225	13 (30)	75 (169)	58 (130)	81 (182)	708(158)	--	9(4)
Big Bearskin Oneida Co, WI	LF	8.10.99	130	--	73 (95)	63 (82)	80 (104)	67 (87)	--	0
Thunder Marinette Co, WI	LF	8.23.05	78	13 (10)	74 (58)	51 (40)	76 (59)	54 (42)	0	0
COUNTRY LAKES										
North Pipe Lake Polk Co, WI	CHF	8.03	80	45 (36)	100 (80)	96 (77)	94 (75)	91 (73)	0	1 (1)
Upper Turtle Lake Baron Co, WI	CHF	7.23-24.02	309	28 (85)	72 (224)	58 (178)	76 (234)	68 (209)	0	20 (63)
Lower Turtle Barron Co, WI	CHF	7.23.04	127	9 (12)	43 (54)	29 (37)	82 (104)	71 (90)	1 (1)	6 (8)
Pipe Lake Polk Co, WI	CHF	8.03	217	8 (17)	67 (144)	50 (108)	63 (137)	56 (121)	0	22 (48)
Little Pelican Otter Tail Co, MN	CHF	9.16.04	119	33% (39)	55% (65)	61% (51)	66% (79)	61% (73)	33 (39)	23 (27)
Comfort Chisago Co, MN	CHF	10.9-11.2.98	100	--	62 (62)	--	50 (50)	--	--	12 (12)
Lake Volney Le Sueur Co, MN	CHF	9.21.02	79	25 (20)	54 (43)	42 (33)	56 (44)	47 (37)	0	30 (24)
Rush Lake Chisago Co, MN	CHF	9.16.00	524	11 (58)	48 (253)	28 (147)	51 (267)	38 (201)	1 (3)	18 (92)
West Rush Lake, Chisago Co, MN	CHF	9.16.00	332	12 (40)	52 (171)	31 (103)	55 (184)	43 (142)	1 (2)	15 (50)
East Rush Lake, Chisago Co, MN	CHF	9.16.00	192	9 (18)	43 (82)	23 (44)	43 (83)	31 (59)	1 (1)	22 (42)
Fish Otter Tail Co, MN	CHF	9.16.04	95	21% (20)	38% (36)	36% (34)	43% (41)	36% (38)	48 (46)	7 (7)
Big Round Lake, Polk Co, WI	CHF	8.03	74	14 (10)	27 (20)	24 (18)	39 (29)	34 (25)	1 (1)	14 (10)
Bass Otter Tail Co, MN	CHF	9.16.04	22	0% (0)	6% (27)	3% (14)	41% (9)	41% (9)	68 (15)	2 (2)
Pelican Otter Tail Co, MN	CHF	9.16.04	881	14% (2)	21% (183)	14% (123)	21% (181)	16% (142)	2 (14)	80 (706)
Green Lake Kandiyohi Co, MN	CHF	9.19.01	721	1 (9)	20 (146)	12 (88)	19 (140)	14 (100)	0	62 (446)
Diamond Lake Kandiyohi Co, MN	CHF	8.13 & 14.02	344	2 (7)	13 (44)	11 (39)	16 (56)	12 (42)	1 (5)	49 (168)

Lake	Eco-region	Date of Survey	Total Number of Parcels (#)	Undevel. Parcels % (#)	Natural Upland Condition		Natural Shoreline Condition		Parcels with Erosion % (#)	Parcels with Shoreline Revetment % (#)
					> 50% % (#)	>75% % (#)	> 50% % (#)	>75% % (#)		
METROPOLITAN LAKES										
Ravine Lake Washington Co, MN	CHF	7.19.01	9	100 (9)	100 (9)	100 (9)	100 (9)	100 (9)	0	0
Pike Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	9	56 (5)	100 (9)	100 (9)	100(9)	100 (9)	0	0
Powers City of Woodbury, MN	CHF	1998	30	90 (27)	90 (27)	90 (27)	97 (29)	97 (29)	0	0
Lake Edward, City Maple Grove, MN	CHF	9.30 - 10.12.99	34	12 (4)	91 (31)	88 (30)	76 (26)	71 (24)	6 (2)	3 (1)
Rice Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	137	33 (45)	71 (97)	64 (87)	81 (111)	74 (102)	0	19 (25)
Lee Lake Dakota Co, MN	CHF	5.31.02	30	37 (11)	73 (22)	50 (15)	77 (23)	67 (20)	0 (0)	10 (3)
Fish Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	170	7 (12)	74 (126)	44 (75)	57 (97)	41 (70)	1 (1)	20 (34)
Alimagnet Lake Dakota Co, MN	CHF	8.6.03	108	37 (40)	54 (58)	47 (51)	69 (75)	61 (66)	0	16 (17)
Eagle Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	90	14 (13)	64 (58)	52 (47)	47 (42)	41 (37)	0	35 (32)
Cedar Island Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	93	5 (5)	62 (58)	35 (33)	55 (51)	39 (36)	0	22 (21)
Orchard Lake Dakota Co, MN	CHF	9.17.01	109	4 (4)	47 (51)	30 (33)	53 (58)	32 (35)	0	54 (59)
Lac Lavon Dakota County, MN	CHF	9.9.03	110	7 (8)	54 (59)	44 (48)	42 (46)	30 (33)	0	8 (9)
Upper Prior Scott Co, MN	CHF	9.30 - 10.12.99	366	10 (37)	51 (187)	36 (132)	35 (128)	31 (113)	4 (15)	46 (168)
Weaver Lake, City Maple Grove, MN	CHF	9.30 - 10.12.99	111	5 (5)	47 (52)	28 (31)	44 (49)	29 (32)	0	14 (16)
Lower Prior Scott Co, MN	CHF	9.24-30.99	691	10 (66)	36 (249)	24 (166)	22 (152)	17 (117)	5 (35)	54 (373)
Maple Grove Lake Summary, MN	CHF	9.30 - 10.12.99	644	14 (89)	67 (431)	48 (312)	60 (385)	48 (310)	1 (3)	20 (129)

* CHF = Central Hardwood Forest Ecoregion
** LF = Lake and Forests Ecoregion

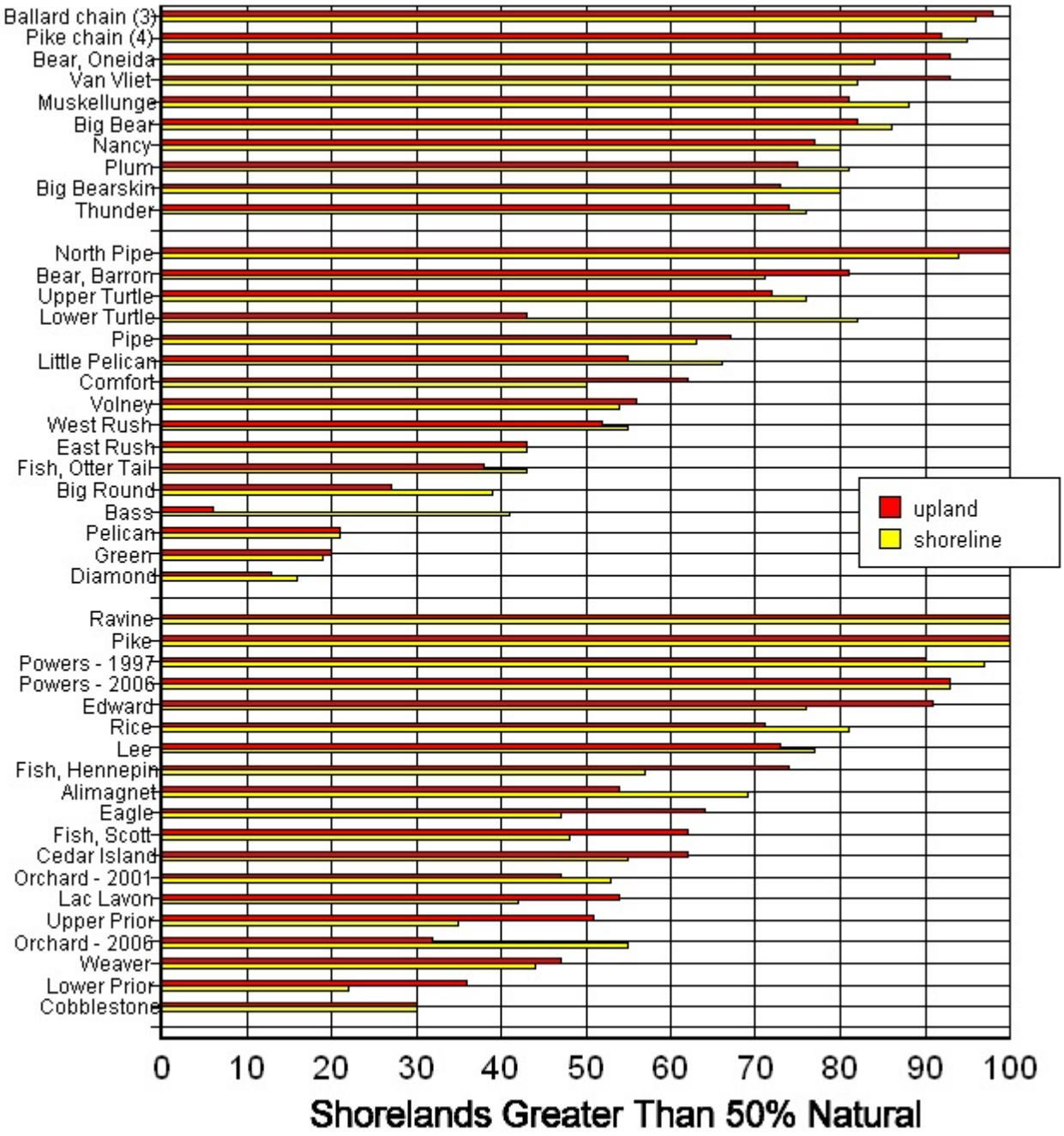


Figure 6. A summary of shoreland inventory results for lakes using an evaluation based on shoreland photographs. For each lake the percentage of shoreline and upland conditions with greater than 50% natural conditions is shown. The first tier of lakes are located in northern Wisconsin. The lower tier of lakes are in the Twin City Metropolitan area and are considered urban lakes. Although several lakes are "urban" lakes most of the shoreland is owned by the city and there is a high percentage of natural conditions. The middle tier of lakes are about an hour or two drive from the Twin Cities, and are not considered to be urban lakes, but are referred to as "country" lakes.

Thunder Lake is in the northern Wisconsin tier of lakes. It's natural shoreland conditions are slightly below average compared to other northern Wisconsin lakes.

3.4. On-site Wastewater Treatment Systems

Onsite systems appear to be in mostly good condition based on the surrounding soils in the area, and the setback of the cabins and homes. A conventional onsite system is shown in Figure 7. With proper maintenance (such as employing a proper pumping schedule) onsite systems are an excellent wastewater treatment option. The challenge is to maintain systems in good working condition.

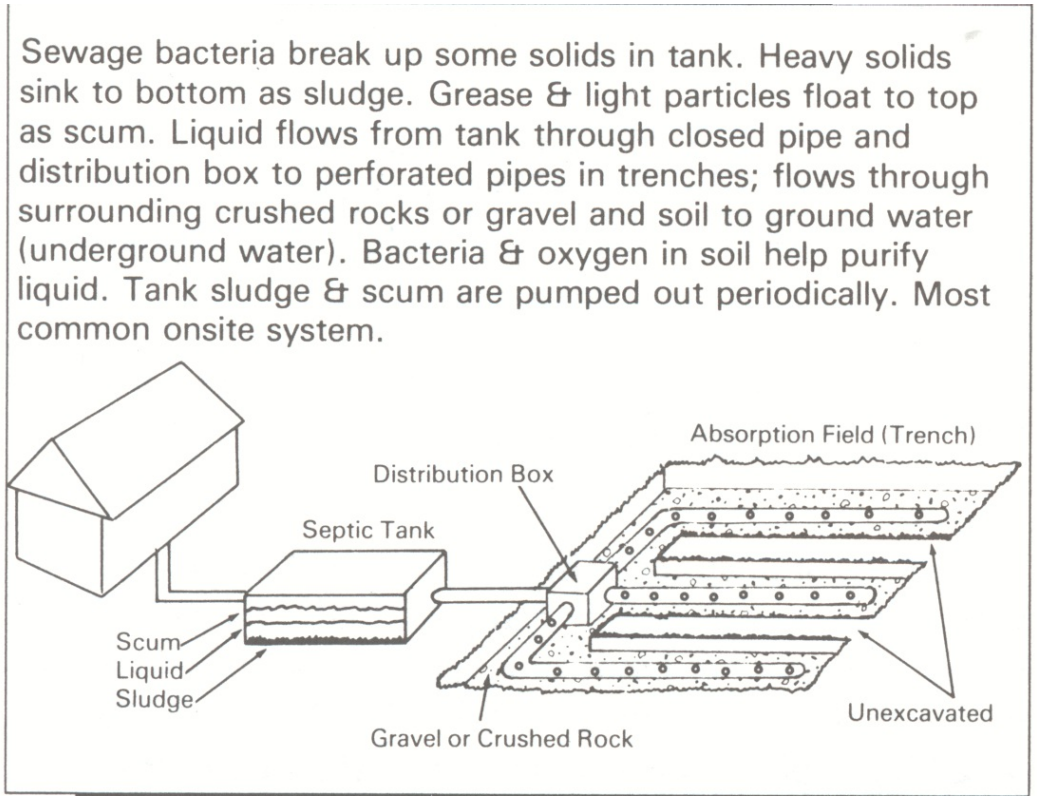


Figure 7. Typical onsite wastewater treatment system found in the Thunder Lake watershed.

4. LAKE FEATURES

4.1. Lake Map and Lake Statistics

Thunder Lake is 135 acres in size, with a watershed of 2,509 acres. The average depth of Thunder Lake is 9 meters (31 feet) with a maximum depth of 19 meters (62 feet) (Table 5). A lake contour map is shown in Figure 8. Thunder Lake is located in an area of Wisconsin that is dominated by forests and is in the Lakes and Forests Ecoregion.

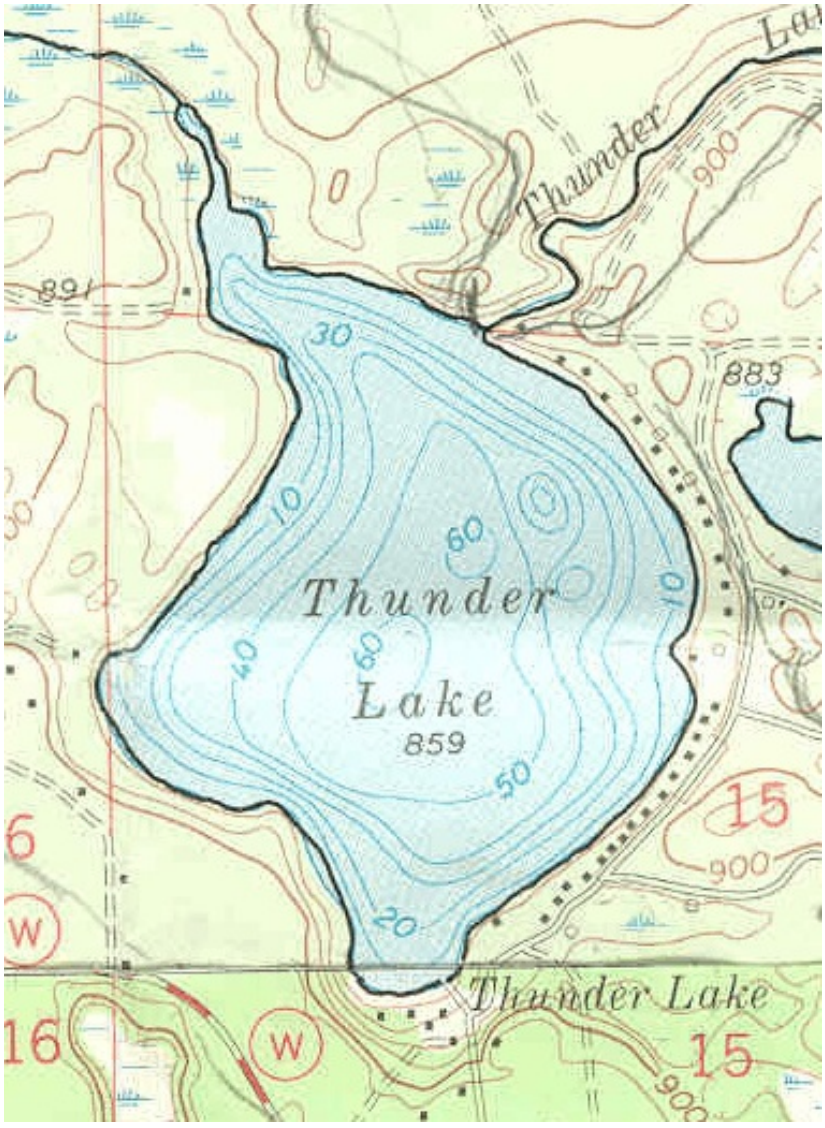


Figure 8. Thunder Lake, Marinette County, Wisconsin.

Table 5. Thunder Lake Characteristics

Area (Lake):	135 acres (55 ha)
Mean depth:	31 feet (9 m)
Maximum depth:	62 feet (19 m)
Volume:	4,185 acre-feet (495 Ha-M)
Watershed area (not including lake area):	2,509 acres (1,015 ha)
Watershed: Lake surface ratio	20 : 1
Public accesses (#):	1
Inlets:	1
Outlets:	1

Figure 9. Thunder Lake outlet area, August 23, 2005.

4.2. Dissolved Oxygen and Temperature

Dissolved oxygen and temperature profiles for Thunder Lake are shown in Figure 10.

A profile was obtained each month from May through August, 1992 in an earlier study (conducted by Blue Water Science and produced in 1994). 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 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 Thunder Lake is relatively shallow, it appears the lake can mix over the summer.

The July profile indicates that the epilimnion extended to a depth of about 15 feet. In the future, routine dissolved oxygen measurements will be collected as well.

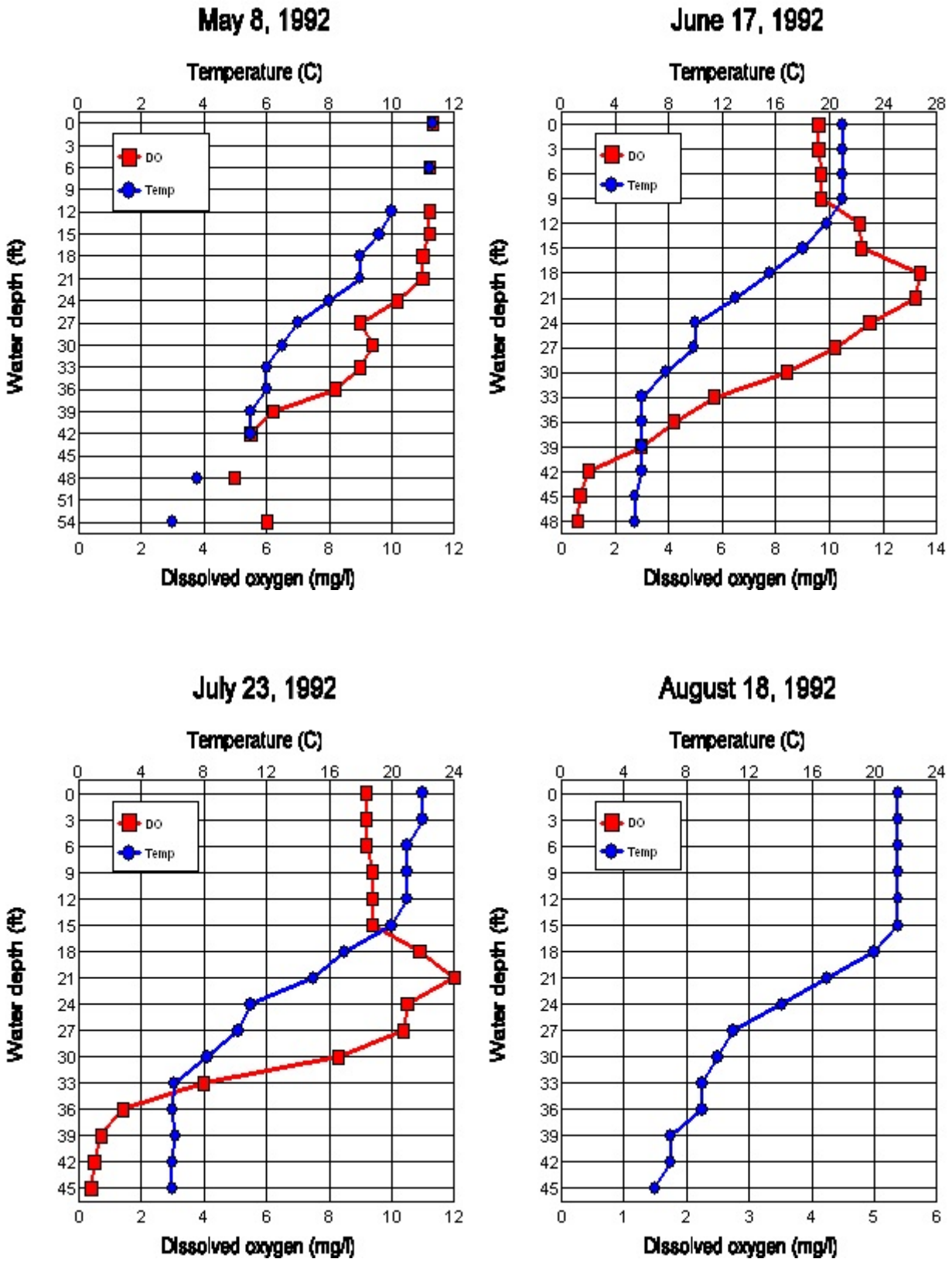


Figure 10. Thunder Lake dissolved oxygen and temperature profiles for the summer of 1992.

4.3. Lake Water Quality Summary

Summer water clarity data are available from 1988 through 2005 with the exception of a few years. The Secchi disc summer averages through the years indicate Thunder Lake has good water quality.

Table 7. Secchi disc transparency.

	Average (May - September)		
	number of readings	Average (May - Sept) (feet)	Average (July - August) (feet)
1988	8	15.1	14.7
1989	6	12.6	12.5
1990	4	14.4	13.8
1991	3	12.5	12.8
1994	9	17.5	14.3
1995	16	22.1	21.9
1996		13.6*	13.6*
1997	6	21.3	22.2
1998	12	17.7	17.8
1999	8	15.9	14.9
2000	16	18.5	16.4
2001	15	16.6	15.9
2002	11	13.8	13.5
2003	12	18.2	15.0
2004	18	18.4	16.5
2005	14	19.6	18.0

*July - August average

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 lower water clarity in late summer is usually due to algae growth. This pattern is also found in Thunder, although clarity is fairly stable from June through September (Figure 11).

Water clarity summer averages from 1988 through 2005 are shown in Figure 11. Clarity in 2005 was good with a 19.6 foot May - September average.

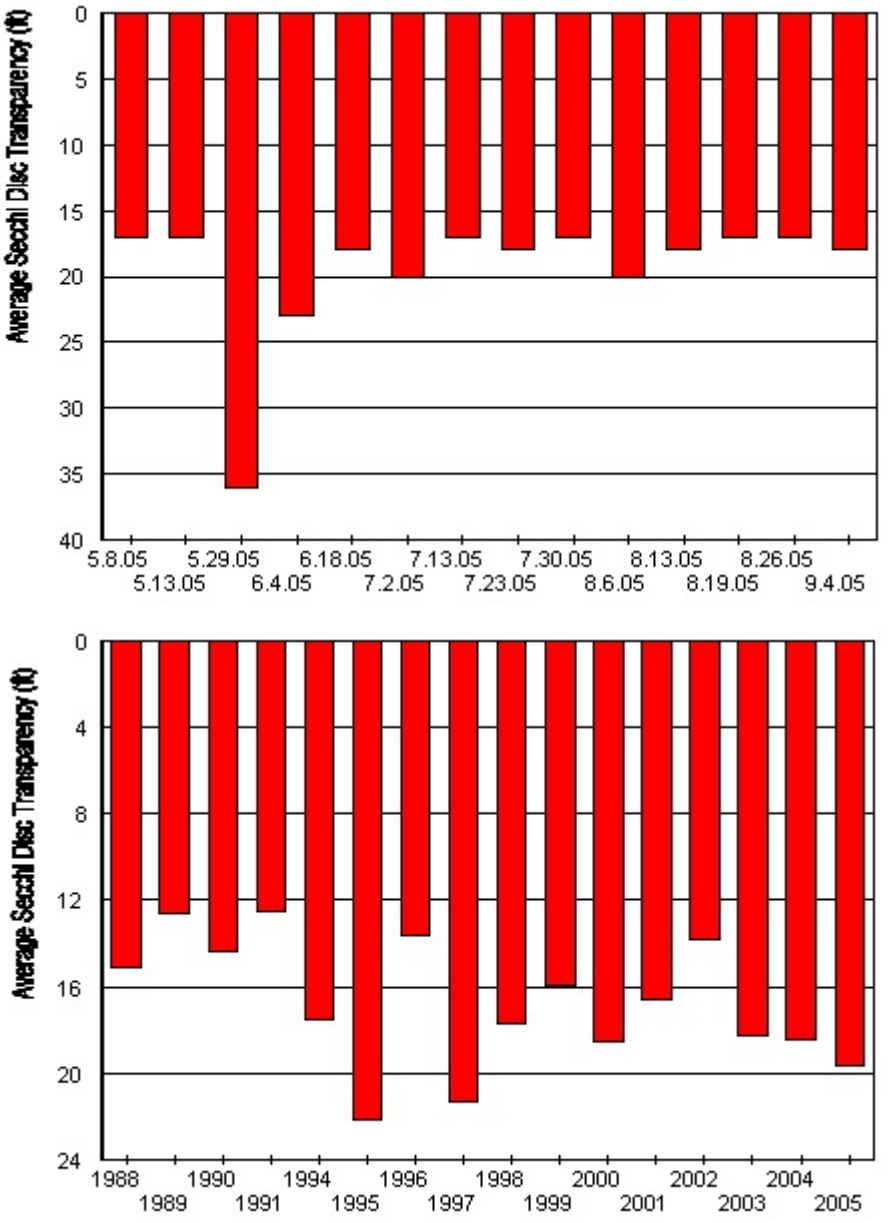


Figure 11. [top] Monthly Secchi disc readings in Thunder Lake in 2005. [bottom] Yearly Secchi disc readings for Thunder Lake.

4.3.2. Total Phosphorus

Phosphorus is the nutrient more often associated with stimulating nuisance algae growth. The last year with summer lake phosphorus concentrations was in 1992 and they are shown in Table 8 along with two nearby lakes, Eagle and Island. Phosphorus concentrations in Thunder Lake are low.

Table 8. Total phosphorus concentrations for the summer of 1992 (source: 1994 Thunder Lake Management Plan).

	Monthly (May - August) Total Phosphorus Concentrations (ppb)					
	Thunder Lake		Eagle Lake		Island Lake	
	top	bottom	top	bottom	top	bottom
5.8.92	20	20	20	20	20	
6.17.92	6	13	6	12	25	
7.23.92	6	53	9	11	16	
8.18.92	4	4	6/16	8	20	3180*
Average	9	22.5	10	12.75	20	3180

* sediments were stirred up on purpose to see if the sediments were phosphorus enriched.

4.3.3. Chlorophyll (a measure of algae)

Algae are small green plants, often consisting of single cells or grouped together in filaments (strings of cells). The amount of algae can be characterized by measuring the chlorophyll content in lake water. Chlorophyll results from 1992 are shown in Table 9. Chlorophyll concentrations are relatively low in all three lakes.

Table 9. Chlorophyll a concentrations for the summer of 1992 (source: 1994 Thunder Lake Management Plan).

	Monthly (May - August) Chlorophyll a Concentrations (ppb)		
	Thunder Lake	Eagle Lake	Island Lake
5.8.92	2	3	9
6.17.92	3	2	7
7.23.92	2.06	1.85	3.07
8.18.92	1.65	2.99	2.27
Average	2.2	2.46	5.3

4.4. Zooplankton

Zooplankton are microscopic crustaceans that can feed on algae. A variety of different zooplankton are commonly found in lakes. The zooplankton community in Thunder Lake is typical for lakes in Northern Wisconsin.

Zooplankton in Thunder Lake were sampled on one date in 2005 and results are shown in Table 10. The presence of big daphnids in late summer indicates there may be grazing pressure from zooplankton on the algae which may help keep algae population under control.

Table 10. Zooplankton counts for Thunder Lake (organisms/liter).

	Aug 23, 2005
Depth (ft)	20
Cladoceran	5
Big Daphnids	*3*
Little Daphnids	*1*
Ceriodaphnia	*0*
Bosmina	*1*
Chydorus	*0*
Copepods	5
Calonoids	*1*
Cyclopoids	*1*
Nauplii	*3*
Rotifers	2
Total	12

4.5. Aquatic Plant Status

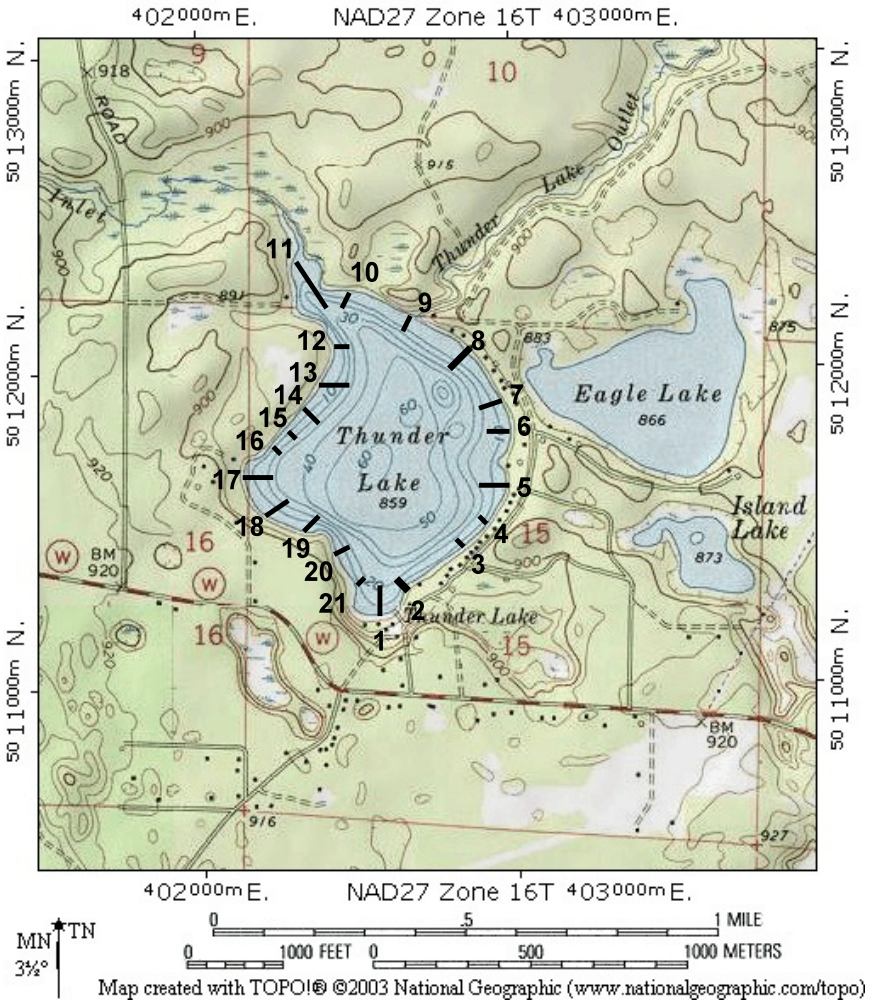
Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently Thunder Lake has a fair diversity of aquatic plants.

Aquatic plants were monitored in the summer of 2005. The dominant plant was chara, which was found at 46 of the 63 stations (76% occurrence). The next most common plant was Eurasian watermilfoil.

In August of 2005, aquatic plant distribution was estimated to be at 30 acres or about 22% of the lake bottom (Figure 12). Of that coverage, several acres of plants grew to nuisance conditions where Eurasian watermilfoil grew up to the lake surface.

Figure 12. Aquatic plant coverage on Thunder Lake on August, 2005.

Aquatic Plant Survey Methods: A line transect with a random stratified sampling component was used to survey aquatic plants in Thunder Lake in 2005. Twenty-one transects were established around Thunder Lake and three depths were sampled for each transect. The depth ranges were 0 - 5 feet, 6 - 10 feet, and 11 - 15 feet. A total of 63 sites were visited. At each site, 2 to 4 samples were collected with a rake. All plant species were identified and a density rating from 1 to 5 was used, where 5 represents the densest growth and 1 represented a trace of the plant in the rakehead.



Transect Locations

Transect Number	GPS Coordinates (NAD 27)	
	East	North
1	02 592	11 314
2	02 620	11 336
3	02 790	11 480
4	02 860	11 555
5	02 872	11 648
6	02 905	11 790
7	02 875	11 911
8	02 835	12 045
9	02 692	12 124
10	02 483	12 214
11	02 407	12 233
12	02 474	12 090
13	02 400	11 980
14	02 327	11 884
15	02 287	11 833
16	02 244	11 760
17	02 269	11 670
18	02 271	11 604
19	02 346	11 605
20	02 437	11 478

Figure 13. Location of transects for Thunder Lake.

A summary of aquatic plant statistics based on results from the aquatic plant survey is shown in Table 11.

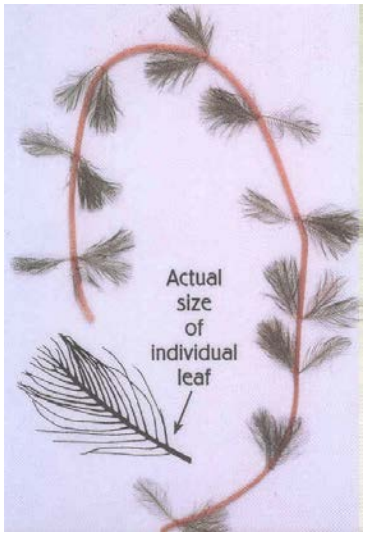
Table 11. Summer aquatic plant survey summary from August 23, 2005.

	All Stations
Number of submerged aquatic plant species found	12
Common plant species	Chara and Eurasian watermilfoil
Rarest plant	Coontail, naiads, and snailseed
Maximum depth of plant growth	15 feet
Acres of aquatic plant coverage	30
Acres of Eurasian watermilfoil	15
Acres of nuisance growth of Eurasian watermilfoil	4

Figure 14. Aquatic plant survey crew on Thunder Lake, August 23, 2005.

Table 12. Thunder Lake aquatic plant occurrences and densities for the August 23, 2005 survey based on 21 transects and 3 depths, for a total of 63 stations. Density ratings are 1-5 with 1 being low and 5 being most dense.

	Depth 0 - 5 feet (n=21)			Depth 6 - 10 feet (n=21)			Depth 11 - 15 feet (n=21)			All Stations (n=63)		
	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density	Occur	% Occur	Density
Bulrush (*Scirpus sp*)	1	5	2.0	--	--	--	--	--	--	1	2	2.0
White waterlily (*Nymphaea sp*)	1	5	3.0	--	--	--	--	--	--	1	2	3.0
Coontail (*Ceratophyllum demersum*)	1	5	0.5	--	--	--	--	--	--	1	2	0.5
Chara (*Chara sp*)	16	76	1.6	16	76	1.6	14	67	1.5	46	76	1.6
Elodea (*Elodea canadensis*)	1	5	0.5	2	10	0.8	2	10	0.8	5	8	0.7
Eurasian watermilfoil (*Myriophyllum spicatum*)	7	33	1.9	8	38	2.9	6	29	2.1	21	33	2.3
Naiad (*Najas flexilis*)	1	5	1.0	--	--	--	--	--	--	1	2	1.0
Nitella (*Nitella sp*)	--	--	--	1	5	1.0	4	19	0.8	5	8	0.8
Cabbage (*Potamogeton amplifolius*)	5	24	0.8	1	5	1.0	--	--	--	6	10	0.8
Variable pondweed (*P. gramineus*)	3	14	0.8	3	14	0.7	1	5	1.0	7	11	0.8
Illinois pondweed (*P. illinoensis*)	1	5	2.0	1	5	0.5	--	--	--	2	3	1.3
Whitestem pondweed (*P. praelongus*)	--	--	--	1	5	0.5	1	5	1.0	2	3	0.8
Snailseed (*P. Spirillus*)	--	--	--	1	5	1.0	--	--	--	1	2	1.0
Water celery (*Vallisneria americana*)	3	14	0.8	1	5	2.0	1	5	0.5	5	8	0.9



Eurasian watermilfoil

Figure 15. Eurasian watermilfoil (*Myriophyllum spicatum*), the only non-native plant observed in Thunder Lake was found in water depths to 15 feet.

Table 13. Individual transect data for Thunder Lake on August 23, 2005.

	T1			T2			T3			T4			T5			T6		
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
Bulrush				2														
White waterlily																		
Coontail																		
Chara	4				2	2	1	3	2	0.3	2	1				2	0.5	2
Elodea									1								0.5	
Eurasian watermilfoil	1	4	0.5	4									3	4		1	3.5	4
Naiad								1										
Nitella			1															
Cabbage	1			1	1											1		
Variable pondweed													1			1	0.5	1
Illinois pondweed																		
Whitestem pondweed																		
Snailseed								1										
Water celery																1		

	T7			T8			T9			T10			T11			T12		
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
Bulrush																		
White waterlily																		
Coontail																		
Chara	2	2	2		1		0.3	1	1	1	2	1	2.5				1	
Elodea														1	0.5			
Eurasian watermilfoil													0.5	3	0.5			
Naiad																		
Nitella					1							1			0.5			
Cabbage													0.5					
Variable pondweed		1																
Illinois pondweed																		
Whitestem pondweed																		
Snailseed																		
Water celery	1																	

Table 13. Concluded.

	T13			T14			T15			T16			T17			T18		
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
Bulrush																		
White waterlily										3								
Coontail																		
Chara	2	2	0.5	1.5	2	2	0.5	0.5	2	2.5	1		2	2	1	2	2	2
Elodea																		
Eurasian watermilfoil											2	2.5			3		0.5	
Naiad																		
Nitella																		
Cabbage																		
Variable pondweed											0.5							
Illinois pondweed																		
Whitestem pondweed						1												
Snailseed																		
Water celery																		

	T19			T20			T21		
	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15	0 - 5	6 - 10	11 - 15
Bulrush									
White waterlily									
Coontail							0.5		
Chara	1	2	1			1	0.5		
Elodea				0.5					
Eurasian watermilfoil				3	3.5		0.5	3	1.8
Naiad									
Nitella									0.5
Cabbage							0.5		
Variable pondweed							0.5		
Illinois pondweed				2	0.5				
Whitestem pondweed					0.5				
Snailseed									
Water celery							0.5	2	0.5

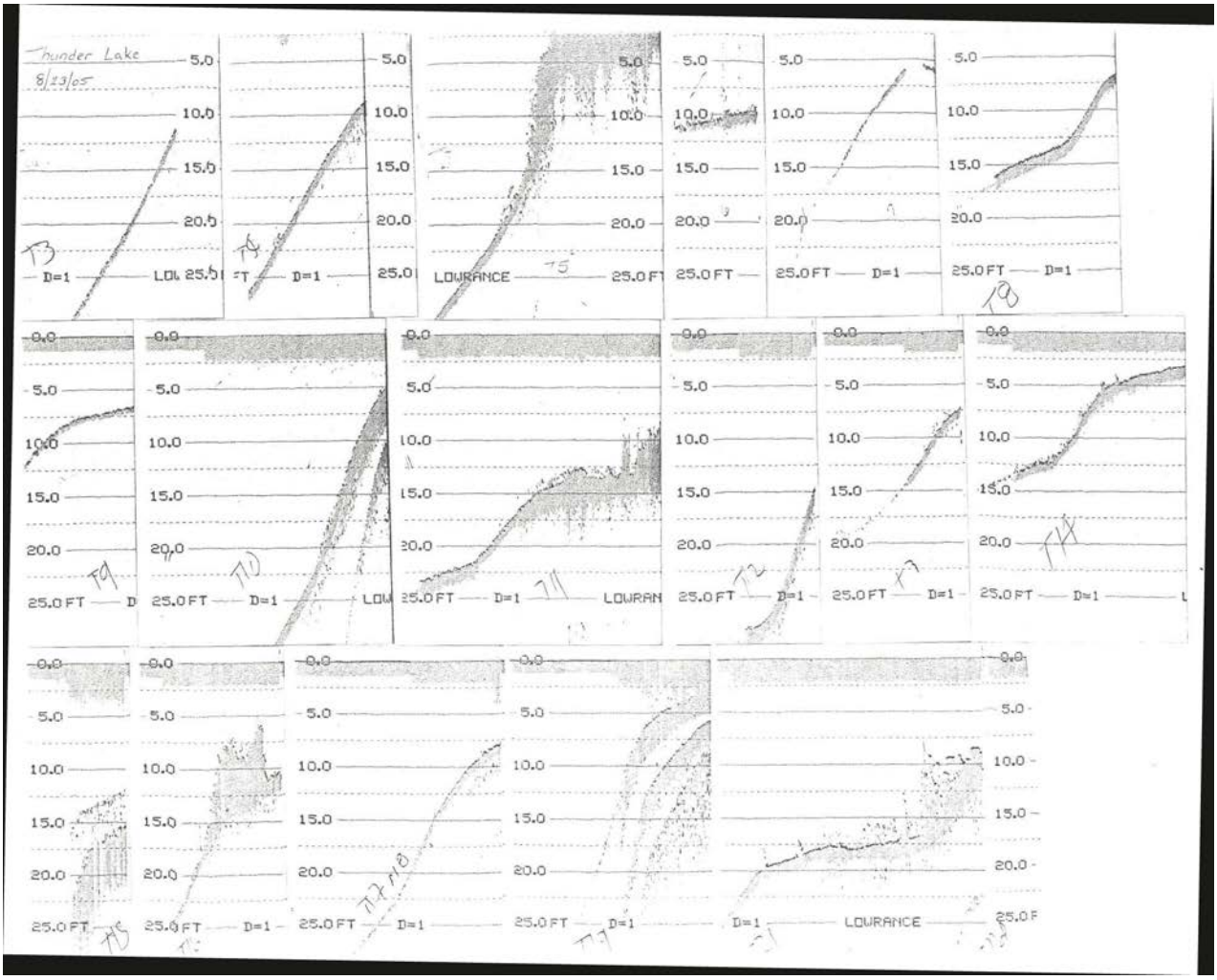


Figure 16. Sonar graphs show the aquatic plant canopy in Thunder Lake on August 23, 2005.

Figure 17. Examples of aquatic plant conditions in Thunder Lake in 2005. Photo on the left represents Eurasian watermilfoil at a density of a "4". On the right, is a photo of cabbage and bulrush beds.

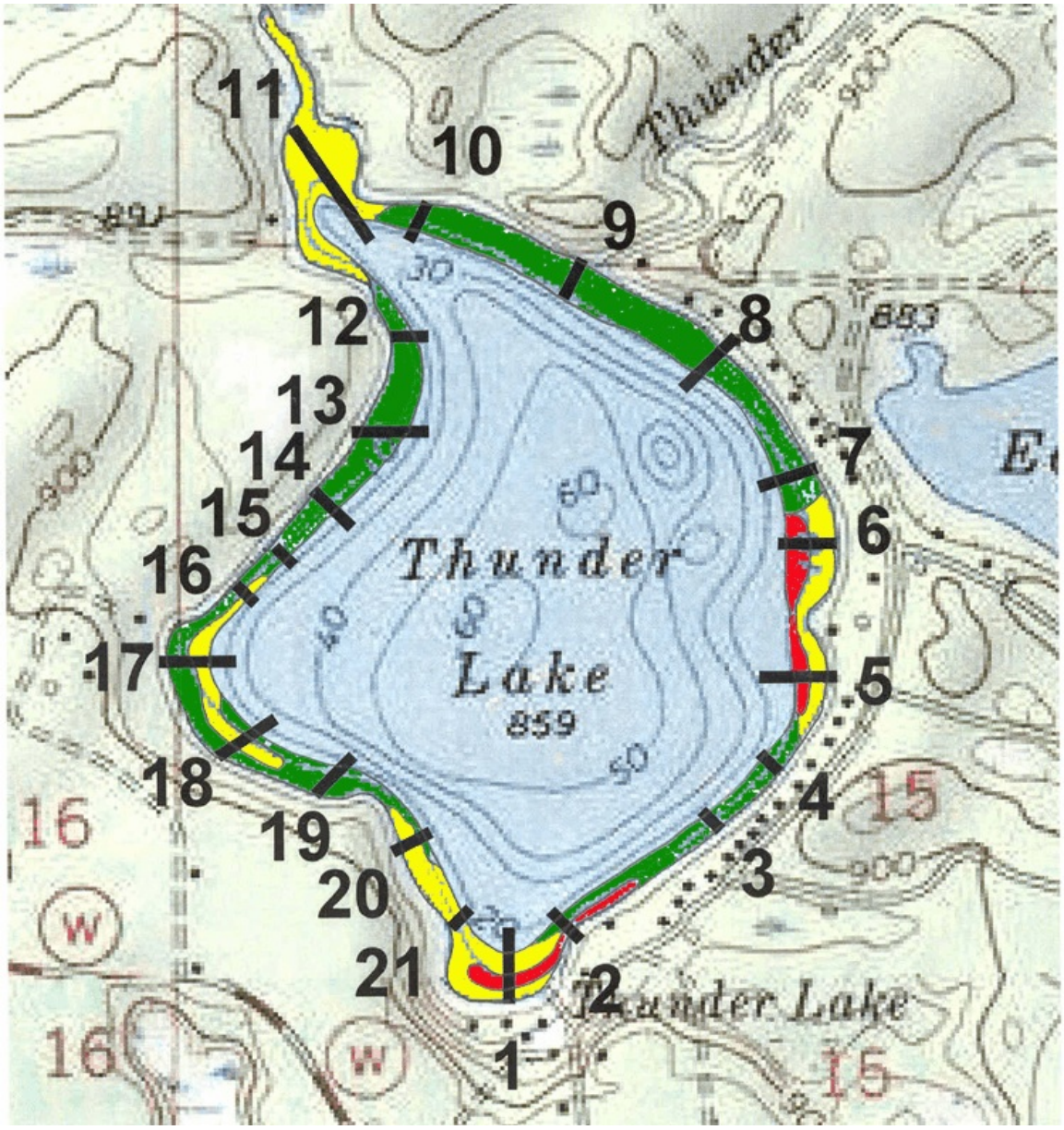
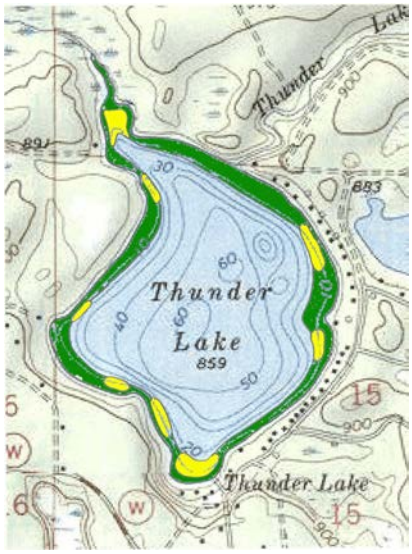
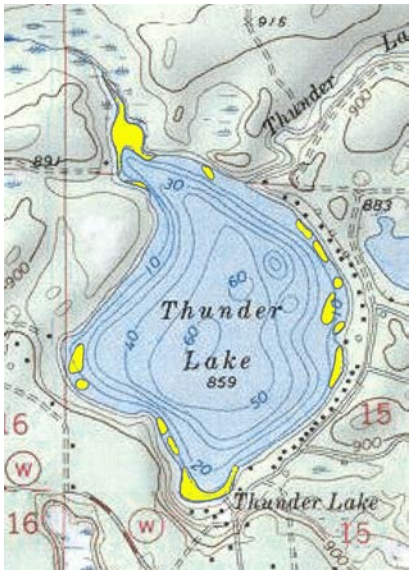


Figure 18. Aquatic plant coverage in Thunder Lake based on the August 23, 2005 survey. Green shading represents occurrence of native plant species only. Yellow shading represents the presence of Eurasian watermilfoil and red shading represents nuisance growth areas of Eurasian watermilfoil. Total plant coverage was estimated at 30 acres. Within the 30 acres, milfoil was present in 15 acres and nuisance growth within the 15 acres represented about 4 acres.

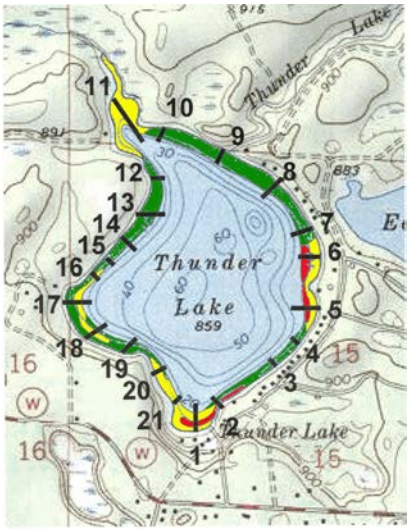
Status of Eurasian Watermilfoil in Thunder Lake from 1992 - 2005



1992 EWM occurrence is shown in yellow shading (from the 1994 Lake Management Plan. Plant survey was conducted by Blue Water Science).



2004 EWM occurrence is shown in yellow shading. EWM distribution has expanded slightly since 1992. EWM map was compiled by members of the Thunder Lake Association.



2005 EWM occurrence is shown in yellow and red shading. EWM distribution is similar to the distribution in 1992 and 2004. Red shading indicates areas of nuisance milfoil growth.

4.6. Fisheries

Because Thunder Lake is deep and has oxygen in the deep, cold water for much of the summer, the WDNR manages the lake for trout. Trout stocking records from 1972 through 2005 are shown in Table 14. Thunder Lake is a unique lake from the position that only a few lakes in Wisconsin have the right attributes (deep, cold, oxygenated water) to support trout.

Table 14. Stocking records for Thunder Lake. Yearling fish lengths ranged from 6 to 9 inches.

Year	Rainbow Trout	Brook Trout	Brown Trout
1972	5,500	1,000	
1973	5,000	1,000	
1974	5,000	1,000	
1975	5,020	1,000	
1976	5,000	1,000	
1977	5,000	1,000	
1978	5,000	1,000	
1979	5,000	1,000	
1980	5,000	1,000	
1981			6,000
1982	5,000	1,000	200
1983	5,000	1,000	
1984	5,000	1,000	
1985	5,000	1,000	
1986	5,000	1,000	
1987	18,000		
1988	5,000	1,000	
1989	6,000		
1990	10,000	2,000	
1991	5,000	1,000	
1992	5,000	1,000	
1993	5,000	1,000	
1994	5,000	1,000	
1995	5,000	1,000	
1996	2,000	768	
1997			
1998	4,120	824	
1999	5,000	1,000	
2000	5,000	1,000	
2001	5,000	1,000	
2002	5,000	2,000	
2003	5,000	1,000 (and 12,500 3 inch fingerlings)	200
2004	5,000	1,000	
2005	4,999	1,000	

5. LAKE AND WATERSHED ASSESSMENT

5.1. Thunder Lake Status

The status of Thunder Lake is mesotrophic meaning it has moderate fertility. Thunder has typical phosphorus concentrations compared to many of the surrounding lakes. One way to compare the status of Thunder Lake is to compare it to other lakes in a similar setting or ecoregion.

Ecoregions are geographic regions that have similar geology, soils, and land use. The continental United States has been divided into 84 ecoregions, and there are six ecoregions in Wisconsin. A map of Wisconsin ecoregions is shown in Figure 22. Thunder Lake is in the Northern Lakes and Forests ecoregion (Figure 22). Lakes in this area of the state have some of the best water quality values in the State. A range of ecoregion values for lakes in the ecoregion along with actual Thunder Lake data is shown in Table 15.

Table 15. Summer average quality characteristics for lakes in the Northern Lakes and Forest ecoregion (Minnesota Pollution Control Agency, 1988).

Parameter	Northern Lakes and Forests	Thunder		
		1992 (May-Sept Avg)	2004	2005 (May-Sept Avg)
Total phosphorus (ug/l) - top	14-27	9	10 (7.8.04)	--
Algae [as Chlorophyll (ug/l)]	<10	2.2	2.7 (7.8.04)	--
Chlorophyll - max (ug/l)	<15	3.0	2.7 (7.8.04)	--
Secchi disc (ft)	8-15	14.4	18.4 (May-Sept avg)	19.6

These comparisons indicate that the water quality conditions of Thunder Lake are either within range or better than predicted conditions compared to relatively unimpacted lakes within the Northern Lakes and Forests Ecoregion. The challenge will be to maintain water quality values within ecoregion ranges.

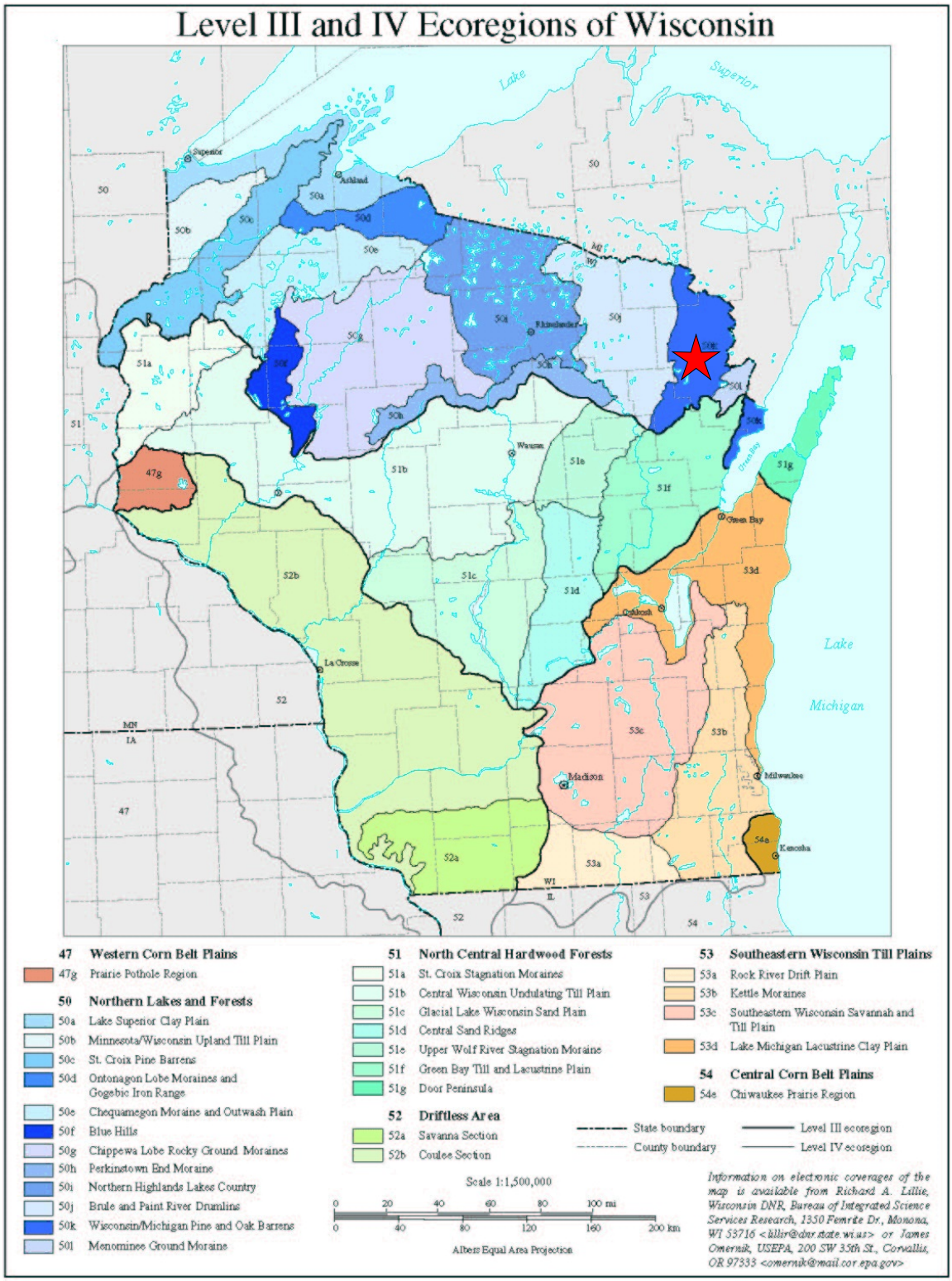


Figure 19. Ecoregion map for Wisconsin. Areas that are labeled with a "50" are within the Northern Lakes and Forest Ecoregion (blue and dark blue shading). Areas labeled with a "51" are in the Central Hardwood Forest Ecoregion. Thunder Lake, located in Marinette County, is located in the Northern Lakes and Forest Ecoregion.

5.2. Nutrient Inputs to Thunder Lake

Based on Northern Lakes and Forests Ecoregion ranges, Thunder Lake has phosphorus levels within range of lakes in this ecoregion. This is a desirable situation and nuisance algae blooms should be rare in Thunder. The reason for the good lake phosphorus concentration is due to the low amount of phosphorus coming into Thunder Lake. A summary of estimated phosphorus loads is shown in Figure 20. A total annual phosphorus load of 118 kilograms (260 pounds) of phosphorus is estimated based on a lake phosphorus concentration of 9 ppb. The watershed area that drains to Thunder Lake is dominated by forested acreage and nutrient inputs from the watershed are considered to be the biggest nutrient contributor, but not excessive.

For onsite system nutrient inputs, the WILMS model was used. Based on 15 permanent residences and 65 seasonal residences a phosphorus loading from septic systems is about 3 kg (6 pounds) per year.

The total estimated annual watershed phosphorus load to Thunder Lake is estimated at 118 kg.

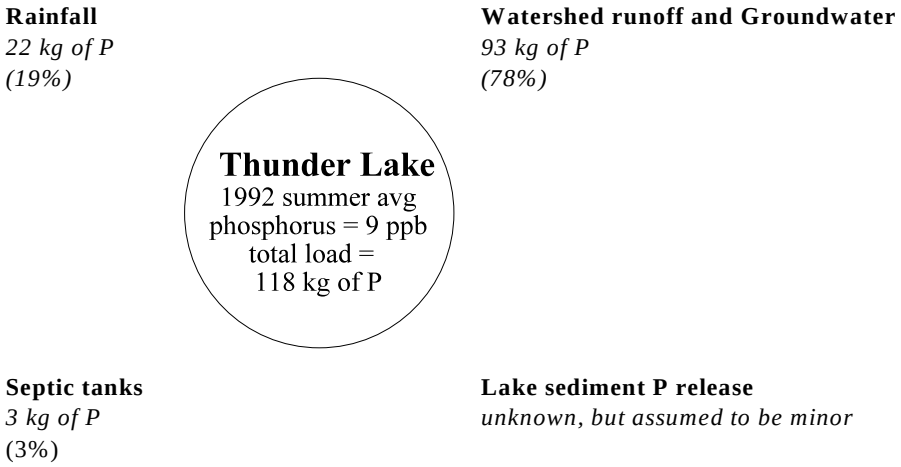


Figure 20. Sources of watershed phosphorus (P) that feed into Thunder Lake are shown above. It is estimated that approximately 126 pounds of phosphorus enter Thunder Lake on an annual basis.

5.3. Setting Water Quality Goals for Thunder Lake

Water quality in Thunder Lake appears to be about as good as would be predicted based on the ecoregion setting. Lake models were run to help determine feasible water quality goals for Thunder Lake. A lake model is a mathematical equation that uses phosphorus inputs along with lake and watershed characteristics to predict what a lake phosphorus concentration should be. Once a lake phosphorus concentration is determined, then seasonal water clarity and algae concentrations can be calculated as well.

Two lake models were run for the following conditions and then compared to existing observed conditions.

Model 1. Phosphorus loading under ecoregion pre-development conditions (run-off phosphorus concentration at 20 ppb)(Wisconsin LEAP Model).

Model 2. Phosphorus loading from relatively unimpacted lakes under current ecoregion conditions (runoff phosphorus concentration at 50 ppb)(Minnesota LEAP Model).

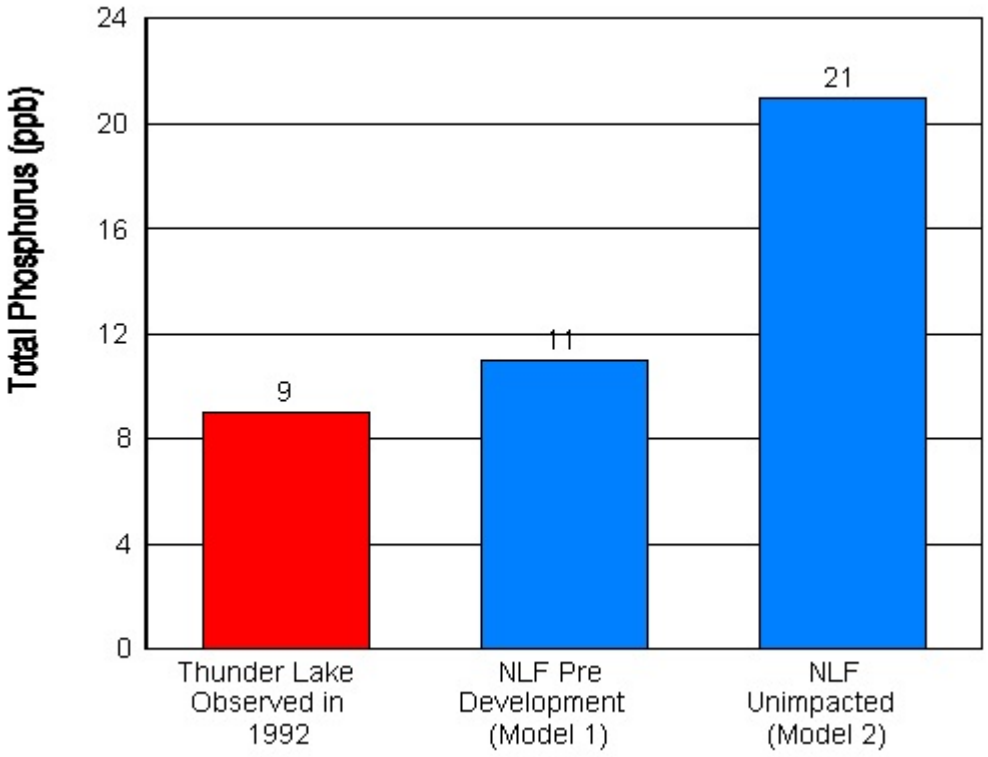


Figure 21. Comparison of total phosphorus conditions for Thunder Lake in 2004 (red bar) to predicted conditions for a lake the size of Thunder Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars).

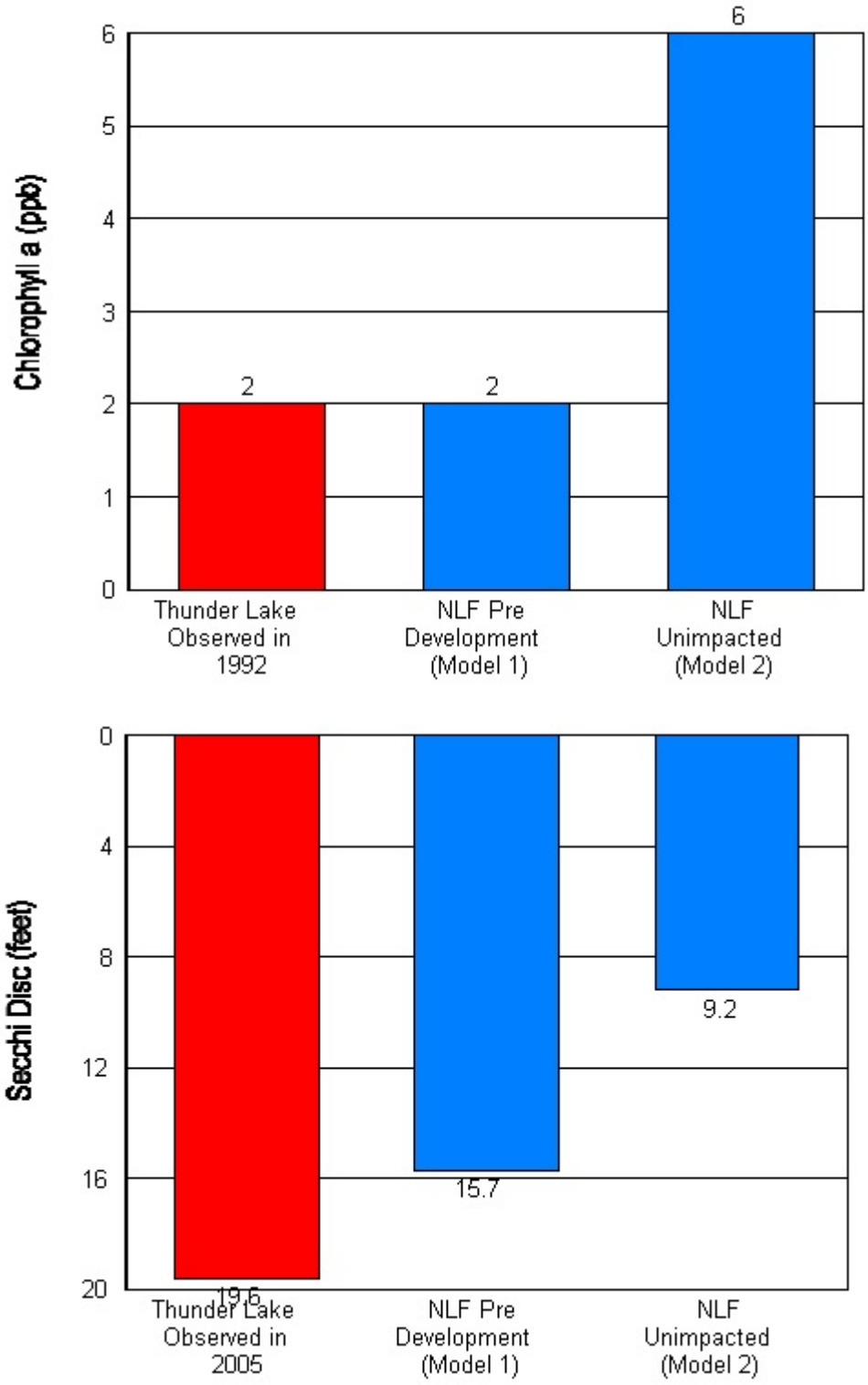


Figure 22. Comparison of chlorophyll a and water clarity conditions for Thunder Lake in 2004 (red bars) to predicted conditions for a lake the size of Thunder Lake situated in the Northern Lakes and Forest (NLF) ecoregion under two runoff conditions (blue bars).

Lake Goals: Based on lake modeling considerations it appears Thunder Lake has water quality conditions that are equivalent or even slightly better than predicted for a lake in this watershed setting.

The proposed water quality goal for lake phosphorus in Thunder Lake is 16 ppb which is the average of the pre-development and unimpacted conditions. Based on the last seasonal phosphorus data available from the summer of 1992, the average phosphorus concentration was 9 ppb. Thunder Lake is meeting the phosphorus goal.

The key to maintaining this lake phosphorus goal will be to maintain low nutrient inputs into Thunder Lake.

5.4. Significant Findings and Water Quality Strategy

- Water quality of Thunder is within range of lakes within the Lakes and Forests Ecoregion. Water quality parameters consisted of transparency readings, phosphorus, and chlorophyll.

- Lake water quality in Thunder is actually slightly better than would be expected based on watershed size and the ecoregion setting.

- Lake management efforts should be directed to protect the existing good water quality.

- Native aquatic plants are diverse but two species present some navigational problems. In the shallow southwest bay, fern pondweed is found close to the surface or floating. In a channel along the west side, broadleaf pondweed grows to the surface and can restrict some types of navigation.

- Managing the excessive growth of the aquatic plants could be considered. Harvesting or cutting methods are recommended for broadleaf pondweed. If a plant cutter is used then a plant collection effort is necessary.

6. LAKE MANAGEMENT PLAN FOR PROTECTING THE LAKE ENVIRONMENT

Project ideas for Thunder Lake are geared toward long-term protection of water quality.

A list of projects has six main categories:

1. Watershed projects.
2. On-site system maintenance.
3. Aquascaping projects.
4. Aquatic plant projects.
5. Ongoing education program.
6. Watershed and lake monitoring program.

Details for these projects areas are given in the next few pages.

Project 1. Watershed Projects

The main goal of the watershed projects program is to protect the natural character of the watershed which helps maintain good runoff water quality.

Currently, a majority of the watershed area is composed of wetlands and forests. Ongoing efforts will be needed and are recommended in order to protect and preserve this natural resource asset.

Project 2. On-site System Maintenance

The septic tank/soil absorption field has been one of the most popular forms of on-site wastewater treatment for years. When soil conditions are proper and the system is well maintained, this is a very good system for wastewater treatment. The on-site system is the dominant type of wastewater treatment found around Thunder Lake today.

However, problems can develop if the on-site system has not been designed properly or well-maintained. Around Thunder Lake there are probably some on-site systems that need maintenance or upgrades. At the same time, it is good practice to ensure that systems that are functioning adequately now will continue to do so in the future.

This project calls for an organized program to be developed that makes homeowners aware of all they can do to maintain their on-site systems.

A description of possible activities associated with the on-site maintenance program are described below:

- **Workshop**
  A workshop should be scheduled for Thunder Lake watershed residents to demonstrate the installation of a conforming septic system and the proper care and maintenance of a septic tank and septic system.

- **Septic Tank Pumping Campaign**
  Marinette County rules for septic tank maintenance associated with a permanent residences. Do they have to be pumped on a regular schedule? Rules should be sent out in a newsletter.

- **Ordinance Implementation**
  Work to maintain enforcement of the county ordinance, where septic systems must be "evaluated" at the time a property is transferred. The seller would obtain a septic system evaluation from Marinette County at the time of property transfer. The evaluation would determine if the septic system was "failing", "non-conforming", or "conforming". A "failing" septic system includes septic systems that discharge onto the ground surface, discharges into tiles and surface waters, and systems found to be contaminating a well. The county would require a "failing" system to be brought into compliance with the Marinette County ordinance within 90 days of property transfer.

Additional information on Marinette County septic system rules are found in the Appendix.

Project 3. Aquascaping Projects

Controls are in place at the county level to guide new shoreland development. A number of excellent reference publications are available to assist in promoting shoreland stewardship. For existing shoreland properties, it is important to either maintain or to improve the natural vegetative buffer.

The shoreland area is valuable for promoting a natural lake environment and a natural lake experience for lake users. The shoreland is defined as the upland area about 300 to 1,000 feet back from the shoreline, and out into the lake to about the end of your dock (Figure 22). A shoreland with native vegetation offers more wildlife and water quality benefits than a lawn that extends to the lake's edge. A summary of attributes and functions of native plants in the shoreland area is shown in Table 15.

Figure 22. Cross section of the lake shoreland habitat.

Table 15. Attributes and functions of native plants in the shoreland area (Source: Henderson and others, 1999. Lakescaping for Wildlife and Water Quality. MnDNR)).

Important functions of plants in and around lakes

Submergent and emergent plants

- Plants produce leaves and stems (carbohydrates) that fuel an immense food web.
- Aquatic plants produce oxygen through photosynthesis. The oxygen is released into lake water.
- Submerged and emergent plants provide underwater cover for fish, amphibians, birds, insects, and many other organisms.
- Underwater plants provide a surface for algae and bacteria to adhere to. These important microorganisms break down polluting nutrients and chemicals in lake water and are an important source of food for organisms higher in the food chain.
- Emergent plants break the energy of waves with their multitude of flexible stems, lessening the water's impact on bank and thus preventing erosion.
- Plants stabilize bottom sediments, which otherwise can be resuspended by currents and wave action. This reduces turbidity and nutrient cycling in the lake.

Shoreline and upland plants

- Shoreline and upland plants provide food and cover for a variety of birds, amphibians, insects, and mammals above the water.
- The extensive root systems of shoreline plants stabilize lake-bank soils against pounding waves.
- Plants growing on upland slopes that reach down to lake hold soil in place against the eroding forces of water running over the ground, and help to keep lake water clean.
- Upland plants absorb nutrients, like phosphorus and nitrogen, found in fertilizers and animal waste, which in excessive concentrations are lake pollutants.

Improving Upland Native Landscape Conditions: In the glacial lake states, three broad vegetative groups occur: pine forests with a variety of ground cover species including shrubs and sedges: hardwood forests with a variety of understory species, including ferns: and tallgrass prairie with a variety of grasses as well as bur oaks and willow trees. Residences around Thunder Lake are in the hardwood forest group.

Reestablishing native conditions in the shoreland area not only improves stormwater runoff quality, it also attracts a variety of wildlife and waterfowl to the shoreland area. Benefits multiply when other neighbors naturalize because the effects are cumulative and significant for water quality and wildlife habitat.

When installing native vegetation close to the shoreline residents are actually installing a buffer. A buffer is a strip of native vegetation wide-enough to produce water quality and wildlife improvements. Much of the natural vegetative buffer has been lost in shoreland areas with development where lawns have been extended right down to the shore.

Lawns are not necessarily bad for a lake. However they can be over fertilized and then runoff carries phosphorus to the lake. Also, lawns function as a low grade open prairie, with poor cover for wildlife and a food supply that is generally poor, except for geese

who may find it attractive. Replacing lawn areas with native landscaping projects reduces the need for fertilizer, reduces the time it takes to mow, increases the natural beauty of a shoreland area, and attracts wildlife.

Lawns do not make very good upland buffers. With runoff, short grass blades bend and do not serve as a very effective filter. Tall grass that remains upright with runoff is a better filter. Kentucky bluegrass (which actually is an exotic grass) is shallow-rooted and does not protect soil near shorelines as well as deep-rooted native prairie grasses, shrubs, or other perennials. Grass up to the shoreline offers poor cover, so predators visit other hiding areas more frequently reducing the prey food base and limiting predator populations in the long run. Also with short ground cover, ground temperatures increase in summer, evapotranspiration increases and results in drying conditions, reducing habitat for frogs and shoreline dependent animals.

Buffer Strip Considerations: A functional upland buffer should be at least 15 feet deep. With this you start getting water quality and wildlife habitat benefits. But a 35 foot deep buffer is recommended. In the past, before lakeshore development, buffers ringed the entire lake. For lakeshore residents it is recommended the length of the buffer extend for 75% of the shoreline, although 50% would produce buffer benefits.

A buffer strip can address two problem areas right away. Geese are shy about walking through tall grass because of the threat of predators. There will always be a few who charge right through but it is a deterrent for most of them. Also, muskrats shouldn't be a problem. They may burrow into the bank, but generally not more then 10 feet. With a buffer going back 15 to 25 feet, you won't be mowing over their dens. An occasional den shouldn't produce muskrat densities that limit desirable aquatic vegetation.

Several types of buffers can be installed or propagated that offer nutrient removal as well as wildlife benefits. Examples include:

Tall grass, sedge, flower buffer: Provides nesting cover for mallards, blue-winged teal and Canada geese. Provides above ground nesting habitat for sedge wrens, common yellow throat and others.

Shrub and brush buffer: Provides nesting habitat for lakeside songbirds such as yellow warblers, common yellowthroat, swamp sparrows, and flycatchers. It also provides significant cover during migration.

Forested buffers: Provides habitat for nesting warblers and yellow-throated vireo, Diamond herons, woodducks, hocked mergansers, and others. Upland birds such as red-winged blackbirds, orioles, and woodpeckers use the forest edge for nesting and feeding habitat.

Even standing dead trees, which are referred to as snags, have a critical role. When they are left standing they serve as perching sites for kingfishers and provide nesting sites for herons, egrets, eagles, and ospreys. In the midwest over 40 bird species and 25 mammal species use snags. To be useful, they should be at least 15 feet tall and 6-inches in diameter.

The initial step for lake residents to get started is to simply make a commitment to try something. Just what the final commitment is evolves as they go through a selection process. The next step in the process is to conduct a site inventory. On a map with lot boundaries, house and buildings, driveway, turf areas, trees, shrubs, and other features are drawn. If there is a chance, the property is checked during a rainstorm. Look for sources of runoff and even flag the routes. Find out where the water from the roof goes, and see if there are temporary ponding and infiltration areas. Are the paths down to the lake eroding? Then the next step is to consider a planting approach.

Native Landscaping for Buffers: Three Approaches: Native landscaping efforts can be put into three categories:

1. Naturalization
2. Accelerated Naturalization
3. Reconstruction

1. Naturalization: With this approach, the resident is going to allow an area to go natural. Whatever is present in the seedbank is what will grow. If they want to install a buffer along the shoreline, let a band of vegetation grow at least 15 feet deep from the shoreline back and preferably 35 feet or deeper. Just by not mowing will do the trick. Residents can check how it looks at the end of the summer. It will take up to three years for flowers and native grasses to grow up and be noticed. Residents can also select other spots on their property to "naturalize".

2. Accelerated Naturalization: After developing a plant list of species from the area, residents may want to mimic some features right away. They can lay out a planting scheme and plant right into existing vegetation. Several Minnesota and Wisconsin nurseries can supply native plant stock and seeds. The nurseries can also help select plants and offer planting tips. Wildflowers can be interspersed with wild grasses and sedges. Mulch around the new seedlings. With this approach lake residents can accelerate the naturalization process.

3. Reconstruction: To reestablish a native landscape with the resident's input and vision, another option is to reconstruct the site with all new plants. Again plant selection should be based on plants growing in the area. Site preparation is a key factor. Residents will want to eliminate invasive weeds and eliminate turf. This can be done with either herbicides or by laying down newsprint or other types of paper followed by 4 to 6 inches of hardwood mulch. Plantings are made through the mulch. This is the most expensive of the three native landscaping categories. Residents can do the reconstruction all at once, or phase it in over 3 to 5 years. This allows them to budget annually and continue evolving the plan as time goes by.

Also mixing and matching the level-of-effort categories allows planting flexibility. Maybe a homeowner employs naturalization along the sides of the lot and reconstruction for half of the shoreline and accelerated naturalization for the other half. Examples of the three approaches are shown in Figure 23.

A book that covers the shoreland improvements is “Lakescaping for Wildlife and Water Quality” by Carrol Henderson and others and is available from the Minnesota Department of Natural Resources for $21.

Shoreland erosion control effort using bio-logs on another lake in northern Wisconsin in 2004.

1. Naturalization: The easiest way to implement a natural shoreline setting is to select an area and leave it grow back naturally.

2. Accelerated Naturalization: To accelerate the naturalization, plant shrubs, wild flowers, or grasses into a shoreland area.

3. Restoration: This involves removing existing vegetation through the use of paper mats and/or mulching and planting a variety of native grasses, flowers, and shrubs into the shoreland area.

Figure 23. Examples of three shoreland management options.

Project 4. Aquatic Plant Projects

Currently, Thunder Lake has a variety of emergent and submergent aquatic plant growth. Aquatic plants are vital for helping sustain clear water conditions and contribute to fish habitat. Currently, there are no exotic plant species found in Thunder Lake. However, in a couple of areas, native aquatic plants can produce navigational hindrances in some summers.

The primary aquatic plant goal is to maintain and/or protect submerged aquatic plants in Thunder Lake. Two plant protection ideas are given below:

1. Maintain natural plant conditions in shallow, nearshore water to promote a diverse plant community. Ongoing aquatic plant monitoring and delineation will be important.

2. Conduct milfoil control demonstrations to evaluate the best way to control nuisance growth in Thunder Lake.

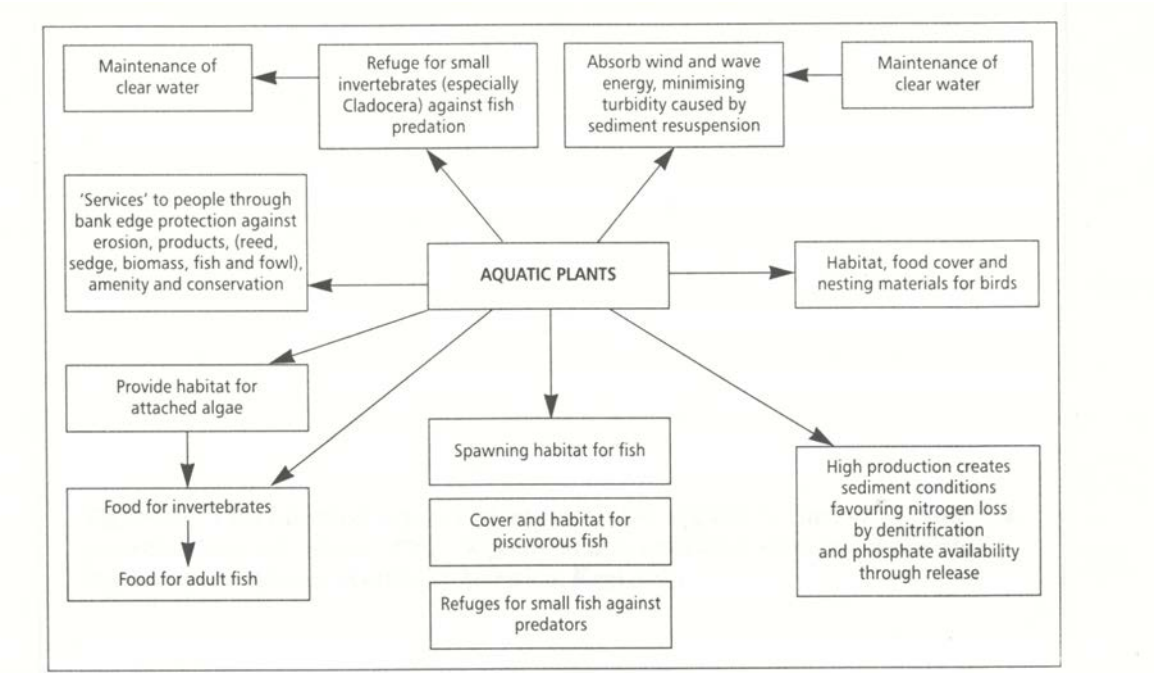


Figure 24. Aquatic plants are important. Links between aquatic plants and other organisms, including ourselves (source: Moss and others. 1996. A guide to the restoration of nutrient-enriched shallow lakes. Broads Authority Norwich, England).

Aquatic Plant Management Options: Based on the aquatic plant survey results from since 1992, Eurasian watermilfoil is the only plant that produces nuisance growth conditions in Thunder Lake.

A List of Management Options for Eurasian Watermilfoil in Thunder Lake: Milfoil was estimated to cover a total of about 15 acres in Thunder Lake in 2005. In some years, up to 3 or 4 acres maybe surfacing in the lake. However in 2005 there was little Eurasian watermilfoil that reached the surface. Therefore in some years nuisance conditions might be worse compared to other years when there are non-nuisance conditions. The proposed plant strategy is to manage only the nuisance conditions and leave the non-nuisance growth conditions of milfoil alone.

Because milfoil has been in Thunder Lake at least 14 years its distribution is pretty well established. That is, it is not going to colonize and grow to nuisance conditions in new areas where it has not already grown to nuisance conditions.

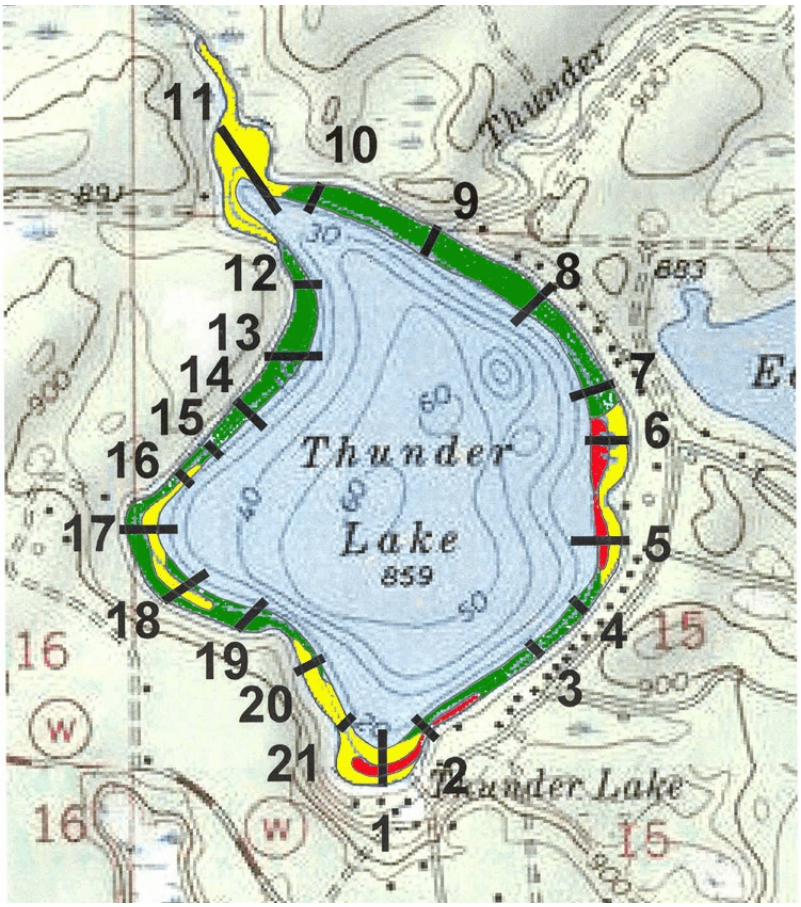


Figure 25. Areas where Eurasian watermilfoil have occasionally grown to nuisance conditions.

Eurasian Watermilfoil Growth Characteristics
(source: Steve McComas, Blue Water Science, unpublished)

Non-Nuisance Conditions

Plants rarely reach the surface.

Navigation and recreational activities generally are not hindered.

Stem density: 0 - 40 stems/m^2
Biomass: 0 - 51 g-dry wt/m^2

Light Nuisance Conditions

Broken surface canopy conditions. However, stems are usually unbranched.

Navigation and recreational activities may be hindered.

Lake users may opt for control.

Stem density: 35 - 100 stems/m^2
Biomass: 30 - 90 g-dry wt/m^2

Heavy Nuisance Conditions

Solid or near solid surface canopy conditions. Stems typically are branched near the surface.

Navigation and recreational activities are severely limited.

Control is necessary for navigation and/or recreation.

Stem density: 250\+ stems/m^2
Biomass: >285 g-dry wt/m^2

The following is a list of potential options to consider for managing Eurasian watermilfoil.

1. Herbicide control using a 2,4-D herbicide.
The herbicide 2,4-D has been shown to be effective for controlling Eurasian watermilfoil on a seasonal basis. It typically does not produce long-term control. It should be applied in the early part of the summer when the plant is actively growing and before it gets encrusted with calcium carbonate (also called marl). When it becomes encrusted later in the summer the herbicide is sometimes not very effective because the marl acts as a coating and protects the plant.

The disadvantage of this option is if we are only going to treat nuisance areas we do not know where the nuisance areas are from year to year and by the time they present a nuisance often the milfoil is already encrusted with the marl and herbicides might not be very effective. The cost of herbicide applications typically range from $400 to $600 per acre.

Mechanical harvesting of Eurasian watermilfoil.
Mechanical harvesting has also been shown to be effective in controlling nuisance growth of Eurasian watermilfoil. A mechanical harvester is a machine that has a scissor-like cutting bar and captures about 90-98% of the plants that it cuts. The cutter bar typically can cut down to a water depth of about 5-6 feet or at least 60 inches below the surface.

There is little need to worry about the cut plants that are not picked growing in new areas since Eurasian watermilfoil has already been exposed to nearly all shoreline areas over the last 14 years. Therefore mechanical harvesting would not expand the distribution of Eurasian watermilfoil.

The downside is that because it only cuts down about 60 inches and because milfoil can grow up to 2 inches a day, there is the potential for a harvesting program to be effective for only about 30 days. For example, if milfoil is cut down 60 inches, it could grow back to the surface or near the surface within about a 30 day period, under ideal growing conditions. The cost of harvesting ranges from $400 to $700 per acre.

2. The use of the milfoil weevil to control Eurasian watermilfoil.
The milfoil weevil has been shown to control nuisance growth of Eurasian watermilfoil in some cases. In Thunder Lake there is a history of the use of the milfoil weevil going back into the 1990s. Recently in August of 2005 another batch of weevils were added to Thunder Lake.

The question is are they going to be able to control Eurasian watermilfoil and control nuisance conditions. It's possible. It appears the first batch of weevils put in the early 1990s may have had some effect but in 2004 there was little evidence of weevil control of nuisance Eurasian watermilfoil.

In 2005, with the addition of new weevils it may be best to wait through 2006 to see if they will have an effect. One of the downsides of relying on the weevils for milfoil control is that they are susceptible to being eaten by bluegill sunfish. The bluegills will eat the adult weevils right off the milfoil stem. Therefore if you have a moderate to high bluegill population in your lake weevil control of milfoil will be marginal.

Of the three control options, it appears that we should wait to see if the weevils will have an effect in 2006 before taking up a chemical or mechanical management option. If weevils do not appear to be effective I would recommend the use of a mechanical harvester for 2007. If a

mechanical harvester contractor is not easily found or hired than chemical control would be another option.

An additional question to address is how do you pay for either the use of herbicides or mechanical harvesting? Some lake associations use a 150 foot rule. Lakeside residents are responsible milfoil control from their shoreline out to 150 feet, and the lake association would then be responsible for milfoil control past 150 feet.

For Thunder Lake, the lake association would be responsible for areas at the landing and possibly in the inlet area. Lakeside residents could consider manual removal methods, harvesting or herbicide use for nuisance growth in their nearshore area.

Figure 27. A mechanical harvester is recommended for controlling nuisance milfoil growth in open water.

Figure 28. Hockney-type weed cutter could be used to control milfoil in shallow nearshore areas, but cut plants have to be collected after they are cut.

Current Rules and Regulations for Aquatic Plant Management in Thunder Lake: Homeowners can clear an area not to exceed 30 feet wide from their shore out to open water without a permit using manual methods including raking or cutting the plants. All cut plants must be removed from the lake and shoreline.

Anything more than a 30 foot wide channel would require a permit from the Wisconsin DNR.

All other removal methods must be permitted by the Wisconsin DNR.

In addition to the 30 foot wide channel, manual removal of aquatic invasive species, like milfoil, from the shoreline area is allowed by lakeside residents. Removal must not damage or eliminate native species.

Figure 26. Chara is the dominant plant in Thunder Lake.

Project 5. Ongoing Education Program

Lake residents get an important amount of lake protection information from the lake newsletter. Each issue should offer tips on lake protection techniques. There is abundant material available. An example of an informational piece is shown below.

Reduce Waste *If not you, who?*

YOUR LAWN AND THE ENVIRONMENT

New phosphorus lawn fertilizer law aims to protect Minnesota lakes and rivers

Minnesota has recently passed a law that restricts the use of lawn fertilizers containing phosphorus, the primary nutrient that turns lakes green with algae.

New Phosphorus Law

Starting January 1, 2004, **fertilizers containing phosphorus cannot be used on lawns in the Twin Cities metro area** (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties). Greater Minnesota is restricted to lawn fertilizers with 3 percent or less phosphate content (with fertilizer, phosphorus is measured as *phosphate*). Look for the middle number on a bag of fertilizer. For the metro area, it should be zero (0) and in Greater Minnesota it should be three (3).

Keep fertilizer off paved surfaces: It's illegal to spread any fertilizer on hard surfaces such as streets, sidewalks, and driveways. Rain can wash the fertilizer into nearby storm drains or road ditches, eventually getting into a lake or river near you. If you accidentally spill or spread fertilizer on a hard surface, clean it up immediately.

Exemptions

Fertilizers containing phosphorus may be used on lawns if a soil test indicates that it is needed or if you are establishing a new lawn.

These restrictions do not apply to fertilizers used for agricultural crops, flower and vegetable gardening, or on golf courses by trained staff.

DO THE GREEN THING: FERTILIZE RESPONSIBLY Many garden centers and hardware stores now carry phosphorus-free lawn fertilizers.

Will phosphorus-free fertilizer keep my lawn healthy?

While phosphorus is necessary to grow healthy lawns, soils in many parts of Minnesota already have an adequate amount. In these instances, adding more phosphorus in fertilizer is not needed and will not benefit your lawn. Healthy lawns can be maintained with phosphorus-free fertilizers.

THE PROBLEM: TOO GREEN

GREEN AND MUCKY Excess algae and weed growth is a major problem in many Minnesota lakes and waterways.

MORE PHOSPHORUS, LESS FISH Too much algae lowers oxygen levels and darkens the water. This can have a devastating effect on fish populations.

What to look for

On any bag or box of fertilizer, there is a string of three numbers. The middle number indicates phosphorus content and should read "0" in the Twin Cities seven-county metropolitan area, and "3" or less in Greater Minnesota.

What can you do to protect water quality?

Fertilizers, leaves, grass clippings, eroded soil, and animal waste are all sources of phosphorus. When they are swept or washed into the nearest street or storm drain, they end up in your local lake or river. You can do your part to protect water quality by doing the following:

- Follow Minnesota's new phosphorus lawn fertilizer law.
- Keep leaves and lawn clippings out of your gutters, streets, and ditches.
- Clean lawn and garden equipment on the grass, not on hard surfaces. Never wash or blow soil or grass clippings into the street.
- Pick up pet waste promptly. Pet waste can contain harmful bacteria as well as nutrients. Never drop pet waste in the street or ditches.

- Control soil erosion around your house. When left bare, soil is easily washed away with rain, carrying phosphorus with it. Soil erosion can be prevented by keeping soil covered with vegetation or mulch.

Sweep it up Grass clippings and leaves left on streets and sidewalks are a major source of phosphorus.

Find out what you need: Test your soil

A soil test is a good idea, especially if you are concerned that your lawn may need phosphorus.

Instructions on soil testing are available through the University of Minnesota Extension Service's INFO-U by calling 612-624-2200 (metro) or 1-800-525-8636 and requesting message 468.

Soil testing information can also be obtained through the Internet by visiting **www.extension.umn.edu** and searching for "Lawn Soil Testing."

A list of laboratories certified for soil testing by the Minnesota Department of Agriculture can be found at **www.mda.state.mn.us/appd/soilabs.htm**.

Visit **www.reduce.org** for lots of ideas about reducing waste and toxic chemicals in your day-to-day life.

reduce.org

For more information on lawn care

- The **Yard & Garden Line** is the University of Minnesota Extension Service's one-stop telephone link to information about plants and insects in the home landscape. Call 612-624-4771, or (toll free) 1-888-624-4771 in Greater Minnesota.
- University of Minnesota **Extension Service's web site**: www.extension.umn.edu. From the home page click on "Garden" then on "Lawns."
- University of Minnesota Extension Service - **Sustainable Urban Landscape Information Series** (SULIS): www.sustland.umn.edu. From the home page, click on "Maintenance" then on "Lawn care."
- **Minnesota Department of Agriculture**: www.mda.state.mn.us. From the home page, click on "Water & Land," then on "Lawn Care & Water Quality."

To obtain additional copies of this fact sheet

contact Office of Environmental Assistance's **Education Clearinghouse** at 1-800-877-6300, 651-215-0232 or e-mail: clearinghouse@moea.state.mn.us.

Minnesota Department of Agriculture

Metro WaterShed Partners

University of Minnesota Extension Service

Minnesota Office of Environmental Assistance

Project 6. Watershed and Lake Monitoring Program

At this time, because of good lake water quality the stream inflow water quality is probably in good condition, although occasional monitoring is recommended. A lake monitoring program is outlined in Table 16. It is designed to be flexible to accommodate the volunteer work force and a fluctuating budget.

Table 16. Thunder Lake Water Quality Monitoring Program

Category	Level	Alternative	Labor Needed	Cost/Year
A. Dissolved oxygen and temperature profiles	1	Check dissolved oxygen in Thunder Lake once per month in January, February, and March depending on winter conditions.	Moderate	$1,500 - one time cost for meter
	2	Check dissolved oxygen in Thunder Lake every one to two weeks in December, January, February, and March, depending on winter conditions.	Moderate	meter cost
	3	Check dissolved oxygen and temperatures once per month from May - September.	Lights	meter cost
B. Water clarity	1	Secchi disc taken at spring and fall turnover.	Low	$0
	2	Secchi disc monitoring once per month May - October.	Low-moderate	$0
	3	Secchi disc monitoring twice per month, May - October.	Moderate	$0
C. Water chemistry	1	Spring and fall turnover samples are collected and sent to UW-Stevens Point. Selected parameters for analysis include: TP and chlorophyll.	Low	$200
	2	Sample for phosphorus and chlorophyll once per month from May - September (surface water only) with the Self-Help Monitoring Program.	Low-moderate	$300
	3	Sample for phosphorus and chlorophyll twice per month from May - October.	Moderate	$600
	4	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N once per month (May-October)	Moderate	$960
	5	Sample for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N twice per month (May-October).	Moderate	$1,920
D. Special samples or surveys	1	Special monitoring: suspended solids, BOD, chloride, turbidity, sampling bottom water, and other parameters as appropriate. Aquatic plant surveys, etc.	--	$100-$3,000

A recommended monitoring program consists of Level A3, B3, and C4 annually. An aquatic plant survey and Thunder Inlet stream sampling (Level D1) should be conducted every three years.

Appendix

Marinette County Private Sewage Systems Rules

Chapter 15 - Private Sewage Systems

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INTRODUCTION

GENERAL REQUIREMENTS

PERMITS AND APPLICATIONS

INSPECTIONS

SYSTEM MANAGEMENT AND MAINTENANCE

ADMINISTRATION AND ENFORCEMENT

APPENDIX A

15.36 MAINTENANCE AND MANAGEMENT

(1) All private sewage systems shall be managed and maintained in accordance with Comm 83 and 84, Wisconsin Administrative Code, and this chapter.

(2) The property owner shall report to the County each inspection, maintenance or servicing event, in accordance with Comm 83, Wisconsin Administrative Code, and this chapter.

(3) The property owner shall submit a copy of an appropriate maintenance agreement and/or servicing contract to the County prior to sanitary permit issuance.

(4) The property owner shall submit a new or revised maintenance agreement and/or servicing contract to the County whenever there is a change to such document(s).

(5) The property owner shall submit a new maintenance agreement and/or servicing contract to the County prior to expiration of any existing maintenance agreement and/or servicing contract.

15.37 SEPTIC TANK MAINTENANCE PROGRAM

(1) All Private Onsite Wastewater Treatment Systems shall be visually inspected and pumped every three years after installation, unless upon inspection the tank is found to have less than 1/3 of the volume occupied by sludge and scum. More frequent maintenance intervals may be required as part of a management plan for the Private Onsite Wastewater Treatment System.

(2) Pumping of a septic tank shall be done by a certified septage servicing operator in accordance with NR 113, Wisconsin Administrative Code.

(3) Visual inspection of a private sewage system shall be performed by a master plumber, master plumber restricted service, certified POWTS inspector, certified septage service operator under Ch. NR 114, or by an authorized County or State employee to determine the condition of the tank and whether wastewater or effluent from the POWTS is ponding on the ground surface.

(4) The owner of such septic tank shall furnish the County with a copy of the inspection report verifying the condition of the tank, whether wastewater or effluent from the POWTS is ponding on the ground surface and the date of pumping within 10 days of the date of inspection and pumping. Reports shall include all information required in Comm 83.55, Wisconsin Administrative Code, and be signed by the person(s) inspecting and pumping the private sewage system. Other maintenance or management reports required by Comm 83 or 84, Wisconsin Administrative Code, should be included with this report.

15.38 HOLDING TANK AGREEMENTS

(1) Holding Tank Agreements. Prior to the issuance of a sanitary permit for a holding tank, the property owner shall sign an agreement with the municipality in which the tank will be located stating that the owner agrees to have the tank pumped and, if the owner does not, the municipality will have the tank pumped at the owner's expense. Any property owner who signed a previous holding tank agreement that required quarterly pumping reports has the option of signing a new holding tank agreement to allow for semi-annual reporting of pumping. The holding tank agreement must be recorded in the Register of Deeds office prior to sanitary permit issuance. Such agreement shall be binding upon the owner, the heirs of the owner and assignees of the owner.

(2) Holding Tank Servicing Agreement. Prior to the issuance of a sanitary permit for a holding tank, a holding tank servicing agreement signed by the property owner and a licensed pumper must be submitted to the County and municipality where the tank is located. The licensed pumper agrees to pump the holding tank as needed and submit semi-annual reports to the municipality and County. In the event the owner decides to change licensed pumpers, a new service contract must be filed with the municipality and the County within ten business days from the date of change.

(3) Pumping Report Forms. Pumping reports shall be submitted to the County on forms approved by the County on a semi-annual basis. The County shall submit to the Department of Commerce an annual report summarizing the semi-annual service reports.

ADMINISTRATION AND ENFORCEMENT

15.39 ADMINISTRATION

The Zoning Administrator shall be responsible for the administration of this chapter. The Zoning Administrator may delegate his responsibilities to personnel employed by the Zoning Department and in the case of issuing abatement orders, to the Marinette County Health Department.

15.40 POWERS AND DUTIES

In the administration of this chapter, the Zoning Administrator shall have the following powers and duties:

(1) Delegate duties to and supervise clerical staff and other employees to assure full and complete compliance with this chapter and related Wisconsin Statutes and the Administrative Code.

(2) Advise applicants concerning the provisions of this chapter and assist them in preparing permit applications.

(3) Review and approve plans for private sewage systems for one and two family residences or as approved through agent status by the State.

(4) Issue sanitary permits and inspect properties for compliance with this chapter and related Wisconsin Statutes and the Administrative Code.

(5) Keep records of all sanitary permits issued, inspections made, work approved, and other official actions.

(6) Report violations of this chapter to the Corporation Counsel or issue citations for violations of this chapter.

(7) Have access to any premises for the purpose of performing official duties between 7 a.m. and 7 p.m. or at other times set by mutual agreement between the property owner or his agent and the Zoning Administrator or upon issuance of a special inspection warrant in accordance with §66.122, Wisconsin Statutes. Application for a sanitary permit is considered, for the purposes of this chapter, as the owner's consent to enter the premises.

(8) Upon reasonable cause or question as to proper compliance, revoke or suspend any sanitary permit and issue cease and desist orders requiring the cessation of any construction, alteration or use of a building which is in violation of the provisions of this chapter, until compliance with this chapter or applicable Wisconsin Statutes and the Administrative Code is obtained.

(9) Issue and enforce orders to plumbers, pumpers, property owners, their agents or contractors or the responsible party, to assure proper compliance with all provisions of this chapter or delegate this authority to the Marinette County Health Department.

(10) Apply for and distribute grants obtained through the Wisconsin Fund Grant Program.

(11) Withhold a permit(s) or approval(s) pursuant to this chapter where the applicant, owner or licensed contractor is in violation of this or any chapter administered by Marinette County and for any parcel(s) of land which have an outstanding violation until the violation(s) has been corrected. A request for waiver of these provisions may be made, to approve a permit on the merits of the application, to the Corporation Counsel and the Zoning Committee.

(12) Perform other duties regarding private sewage systems as considered appropriate by the County or the State.