Lake Thomas

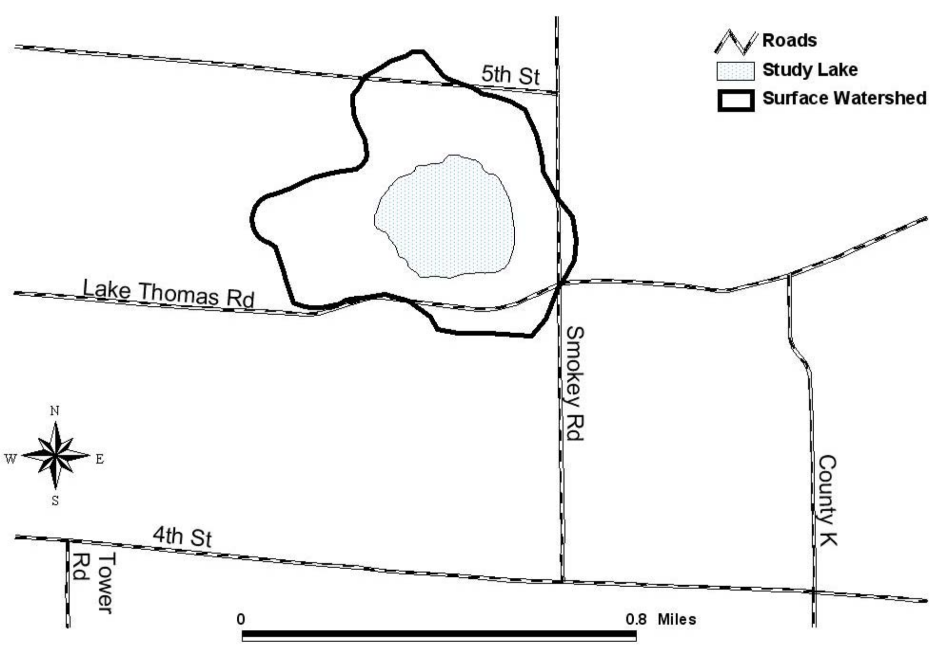
Introduction

Thomas Lake is a 32 acre hard-water seepage lake located three miles west of Amherst Junction in the Town of Stockton. The estimated volume of the lake is 540 acre-feet, with a shoreline length of 0.84 miles. The **littoral** zone has a sand bottom and is covered with dense aquatic vegetation to a depth of about fifteen feet. The lake's maximum depth is 28 feet, with an estimated **retention time** of 7.3 years. In the past the lake has been intensively managed for fish with chemical treatment and restocking projects. The sport fish population is presently dominated by bluegill, largemouth bass, and yellow perch. Light **erosion** along the bank occurred in the past from pasturing cattle adjacent to the water. Public access is present on the south side, including an unimproved boat launch area. Residential development has increased dramatically since 1968.

Land Use and Watershed

The surface **watershed** for Thomas Lake is 151 acres and is shown in Figure 1. Land use in the surface **watershed** in 2002 was dominated by forest (29%) and shrub/wetlands (16%), followed by non-irrigated agriculture (13%) (Figure 2). Since 1948 there appears to have been a significant conversion of non-irrigated cropland to forest land and residential development. From 1948 to 1968 there was a sharp decrease in shrub/wetland vegetation in the surface **watershed**, which appears to also correspond with the increase in forested area. Non-irrigated cropland continues to decrease as residential development continues to increase. Residential development currently makes up one-tenth of the land use (Figure 3).

Figure 1. Thomas Lake surface watershed boundary.



*Terms in bold, see glossary pp 21-25

Figure 2. Land use in the Lake Thomas surface watershed (2002).

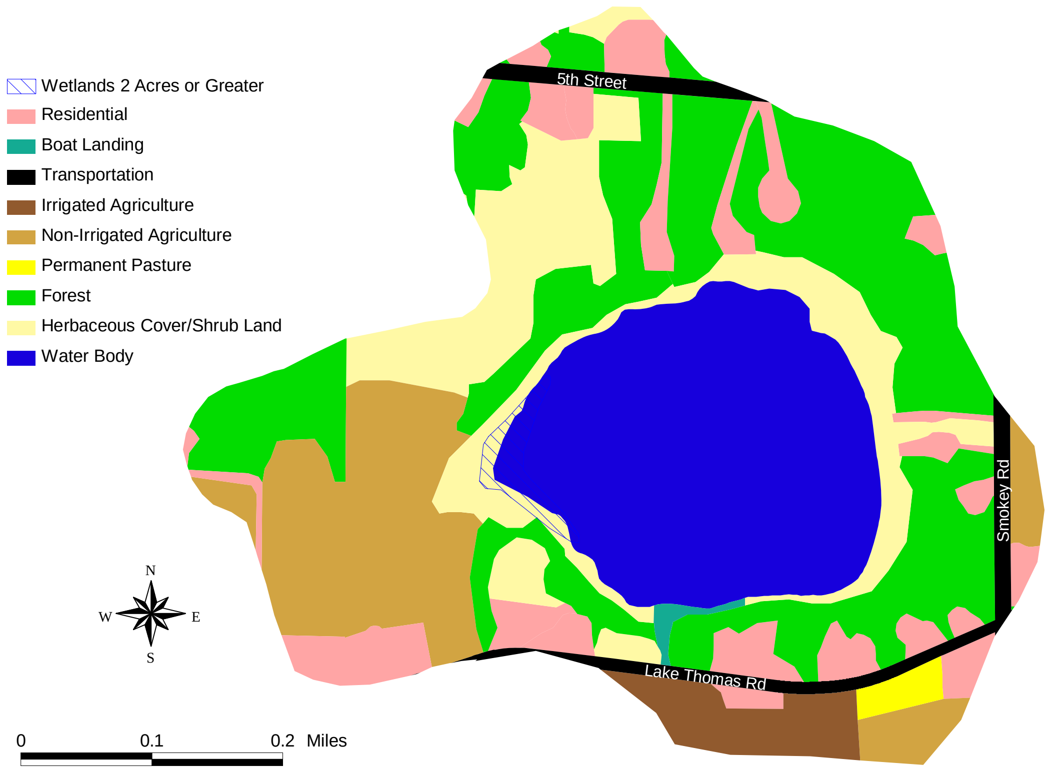
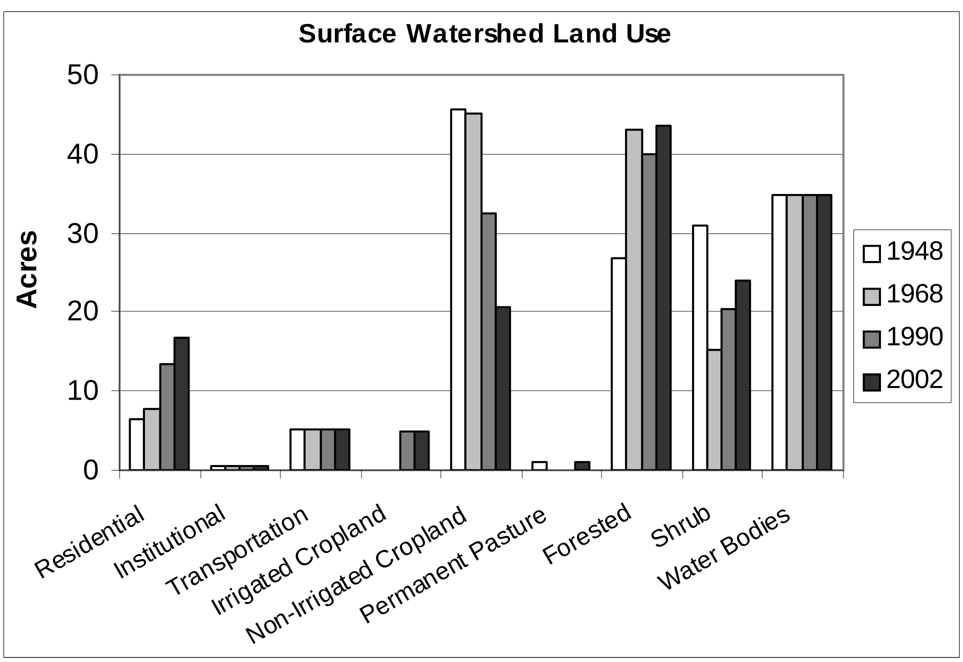


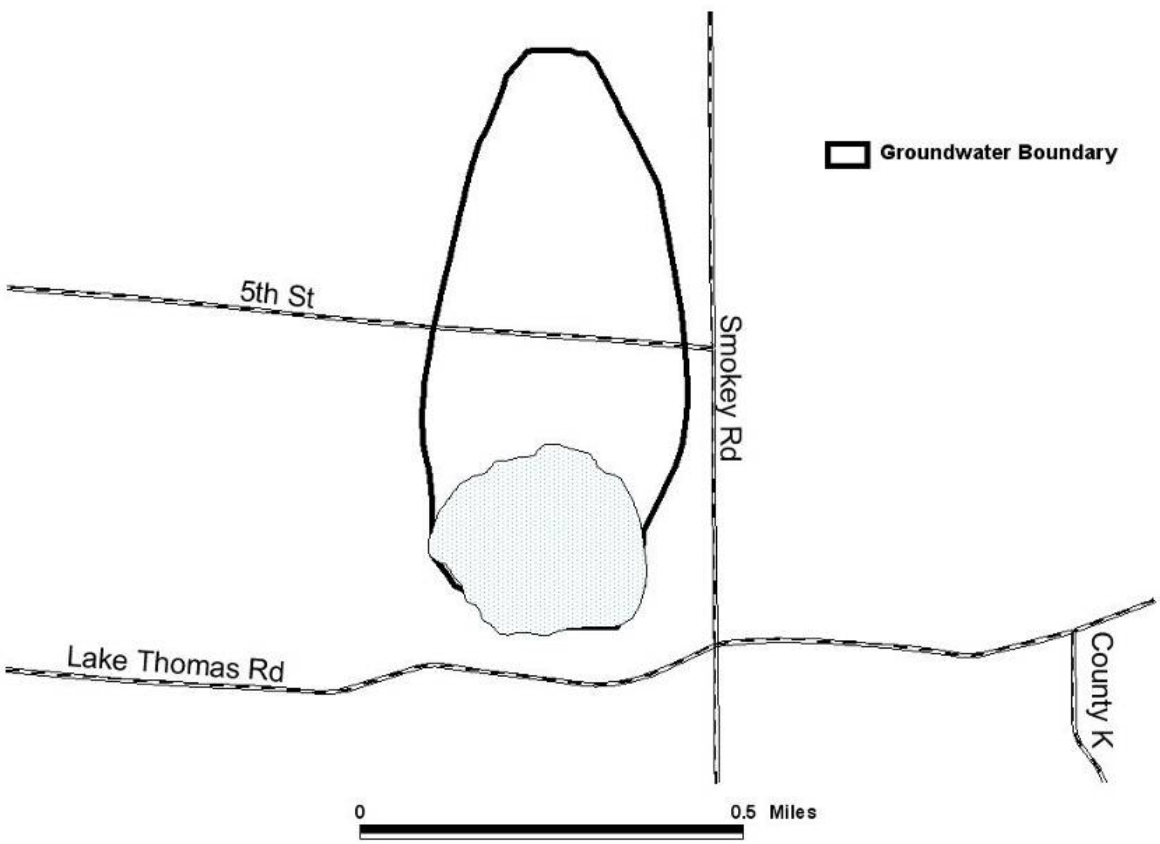
Figure 3. Land use in the Lake Thomas surface watershed 1948-2002.



*Terms in bold, see glossary pp 21-25

The **groundwater watershed** for Thomas Lake is approximately 128 acres (Figure 4). The land use in 2002 was largely shrub/wetland vegetation (32%) and forest (28%). Since 1948 the land use has seen large alterations. In 1948 non-irrigated cropland dominated the landscape, making up well over half of the land use. From 1968 to the present non-irrigated cropland decreased dramatically from 53 acres to 10 acres, while shrub/wetland cover and forested acres increased. Residential development in 2002 was still only a fraction of the land use within the **groundwater watershed** (5%), but pressure around the lakeshore is significant (Figure 5 and Figure 6). A records search in 2002 indicate that based on age there are no potentially failing septic systems or former landfill sites present in either the surface or **groundwater watersheds** of the lake.

Figure 4. Thomas Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 21-25

Figure 5. Land use in the Thomas Lake groundwater watershed (2002).

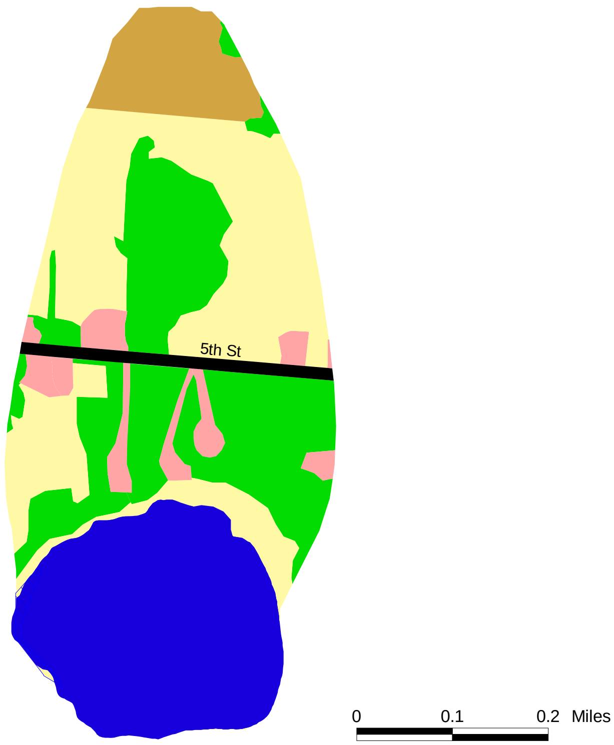
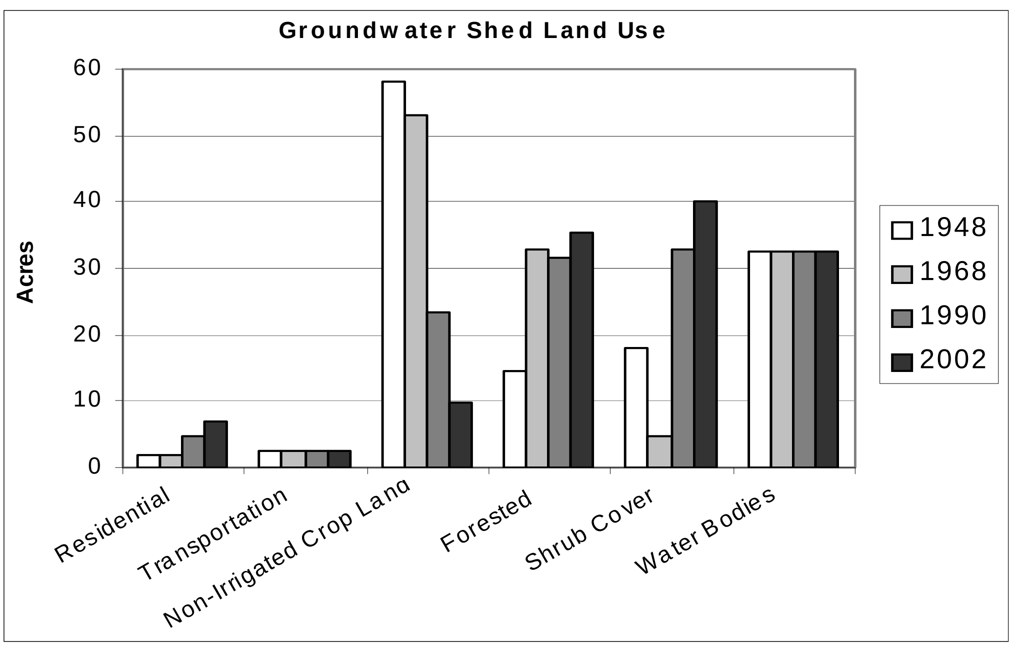


Figure 6. Land use in the Thomas Lake groundwater watershed 1948-2002.

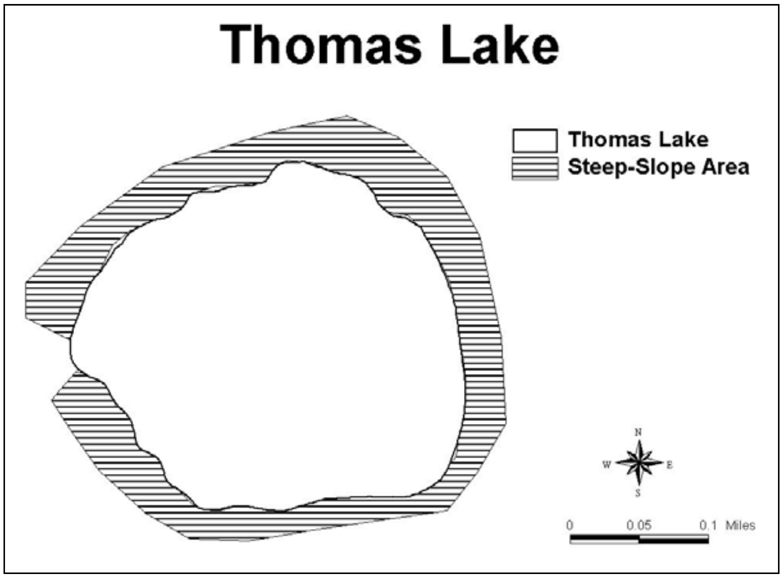


*Terms in bold, see glossary pp 21-25

Upland Sensitive Areas

The survey of upland sensitive areas was conducted to note areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. Thomas Lake is surrounded almost entirely by a steep slope with the exception of a cattle grazing pasture. Cattle have caused light **erosion** along a portion of the bank, and the remaining shoreline is susceptible to **erosion** from any activities that disturb the vegetative cover (Figure 7).

Figure 7. Upland sensitive areas near Thomas Lake.



Birds

Lakeshore development can negatively or positively affect habitat quality for birds depending on the ecological requirements of each species. Development can play a important role in providing resources unavailable to certain species in a more natural environment, yet eliminate other species' needs altogether, especially at the most extreme levels of development.

Of the 28 most common species, Eastern phoebe (*Sayornus phoebe*), American goldfinch (*Carduelis tristis*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), and downy woodpecker (*Picoides pubescens*) showed the greatest tendency to be found in developed areas. These species may be taking advantage of different resources available in the urban environment, such as birdfeeders (as in the case of the American goldfinch and downy woodpecker), open foraging areas (American robin and mourning dove), or nest sites (Eastern phoebe).

At undeveloped sites, least flycatcher (*Empidonax minimus*), great crested flycatcher (*Myiarchus crinitus*), red-eyed vireo (*Vireo olivaceus*), black-capped chickadee (*Poecile atricapillus*), blue jay (*Cyaanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), Eastern wood-pewee (*Contopus virens*), indigo bunting (*Passerina cyanea*),

*Terms in bold, see glossary pp 21-25

and common yellowthroat (*Geothylypis trichas*) were the most common. A majority of these species are insectivores and are likely to feed in more forested environments.

Table 1. Bird species identified near Thomas Lake.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Crow	2	omnivore	ground gleaner	cup	deciduous
American Goldfinch	5	seeds	foliage gleaner	cup	shrub
American Robin	1	insects	ground gleaner	cup	deciduous
Baltimore Oriole	1	insects	ground gleaner	oven	ground
Blue Jay	2	omnivore	ground gleaner	cup	coniferous
Catbird	3	insects	ground gleaner	cup	shrub
Downy Woodpecker	1	insects	bark gleaner	cavity	snag
Eastern Phoebe	2	insects	bark gleaner	cavity	snag
Eastern Wood-Pewee	1	insects	hawker	cup	deciduous
Great Crested Flycatcher	1	insects	hawker	cavity	deciduous
House Finch	1	seeds	ground gleaner	cup	deciduous
House Wren	2	insects	ground gleaner	cavity	deciduous
Red-eyed Vireo	1	insects	hover gleaner	cup	shrub
Red-winged Blackbird	5	insects	ground gleaner	cup	reed
Song Sparrow	6	insects	ground gleaner	cup	ground
Warbling Vireo	1	insects	foliage gleaner	cup	deciduous
White-breasted Nuthatch	2	insects	bark gleaner	cavity	deciduous
Total	**37**				

Shoreline Vegetation, Reptiles, and Amphibians

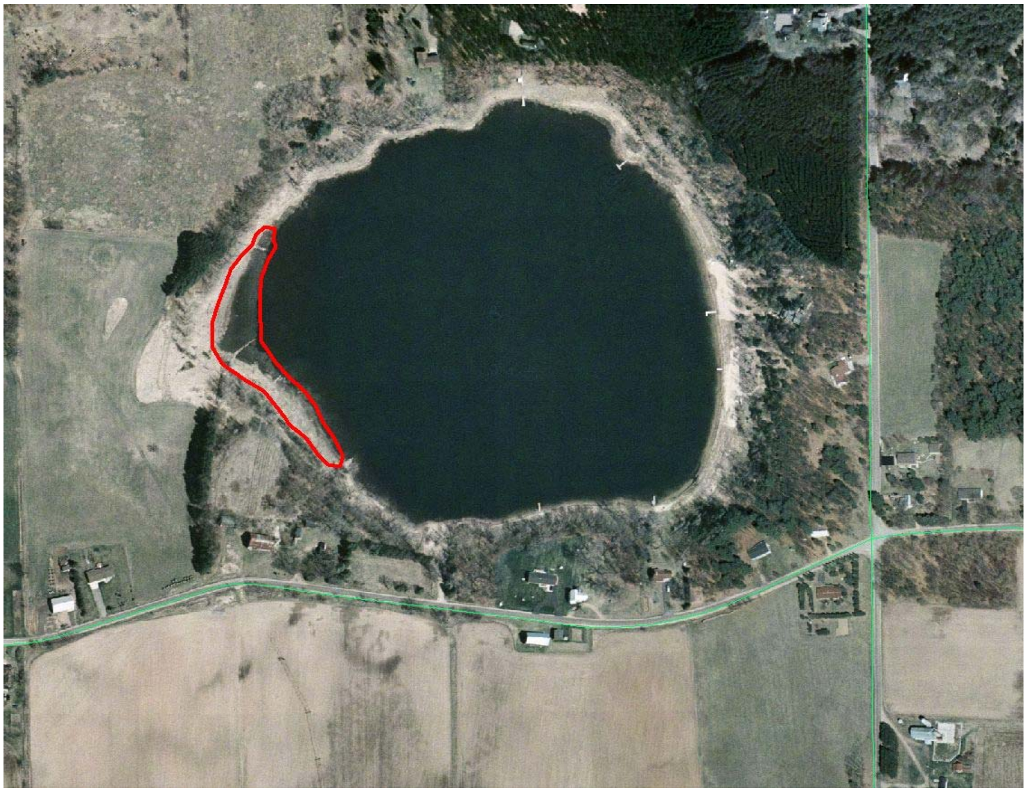
Amphibians (frogs and toads) were included in this survey because with their permeable skin and biphasic lifecycle (meaning that the young live in water while adults can survive on land) they are considered excellent indicators of overall ecosystem health. Furthermore, both turtles and amphibians utilize both aquatic and terrestrial habitats and especially the shoreline interface between these two habitats, and thus are of particular relevance.

Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these lakes also provide important habitat as many frog species migrate to lakes and other bodies of water in the spring or fall to breed and spend the summer months foraging in the uplands. Several species also use the surrounding uplands for overwintering. The turtle species found associated with lakes are predominantly aquatic, usually departing from the water only to deposit eggs in a nest. Nests are usually on south facing slopes above the shoreline where there is open vegetation and sandy soil. The newly hatched young then find their way to the water. Thus, both turtles and amphibian are intimately associated with lakes and the associated habitats of a **watershed**.

*Terms in bold, see glossary pp 21-25

During the survey of reptiles Thomas Lake was found to contain two turtle species (painted turtle [*Chrysemys picta*] and snapping turtle [*Chelydra serpentina*]). Five frog species were identified during the amphibian survey of Thomas Lake; spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), gray treefrog (*Hyla versicolor*), Cope's gray treefrog (*Hyla chrysoscelis*), and green frog (*Rana clamitans*). The primary amphibian habitat is located on the west side of the lake (sensitive area is identified in red in Figure 8). Some of the key features of this habitat include protected areas of marsh with large amounts of submergent, emergent and floating-leaf vegetation. The good news is that Thomas Lake contains large sections of undisturbed, natural shoreline. However, there are also small sections of altered shoreline.

Figure 8. **Regions of primary amphibian habitat around Thomas Lake.**



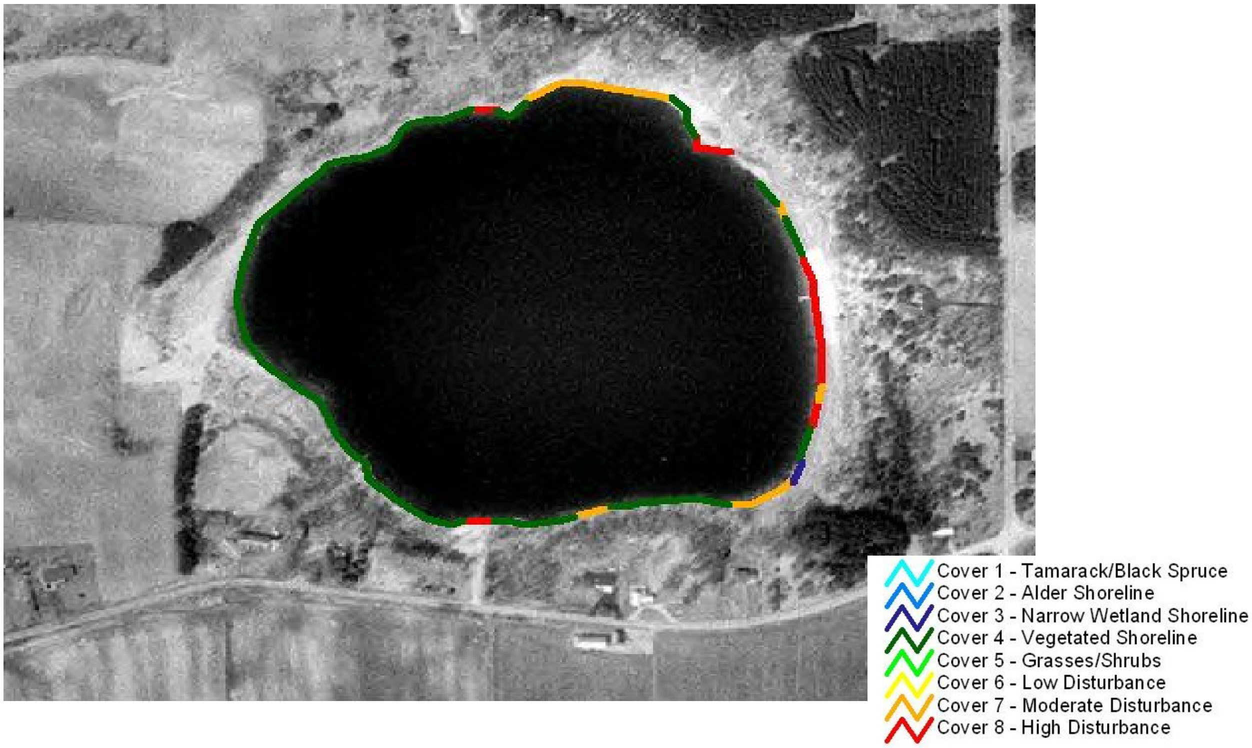
The vegetated shoreline around Thomas Lake comprises 68.6% of the shoreline. Vegetated shoreline is characterized as being upland areas with dense vegetation comprised of tall grasses or shrubs that lacks a rocky component. It is represented by dark green in Figure 9. Narrow wetland comprises 1.5% of the shoreline. Narrow wetlands are characterized as being wetland areas that extend less than 5 meters onto the shore and have an adjacent undeveloped upland area.

Around Thomas Lake, 33% of the shoreline is considered to be disturbed. Of that, 16.4% of the lake's shoreline vegetation is considered to be moderately disturbed developed areas. The other 16.4% of the shoreline's vegetation is considered to be a highly disturbed developed area. An area that has moderate vegetation disturbance is an area of

*Terms in bold, see glossary pp 21-25

shore that may contain a mowed lawn but has an intact overstory. An area that exhibits high vegetation disturbance is defined as a beach, **rip rap**, sea wall or where the shore is mowed to the water line.

Figure 9. **Shoreline vegetation around Thomas Lake.**



Aquatic Plants

There are **41** species of aquatic or wetland **vascular plants** that have been found in Thomas Lake or on the adjacent shore. This is slightly below average for Portage County lakes. The average **coefficient of conservatism (c value)** is **4.1**, which is below average. The **floristic quality index** is **26.3**, which is below average for Portage County lakes.

In 1985 Thomas Lake had fairly abundant submersed vegetation composed of common water-milfoil (*Myriophyllum sibiricum*), and several species of pondweeds. The aquatic vegetation of Thomas Lake has changed to a great extent in recent years from a lake of moderate diversity of submersed species to the present condition of dominance by Eurasian water-milfoil (*Myriophyllum spicatum*). The shore is also beginning to show the effects of spreading invasive alien species, especially reed canary-grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*).

Follow-up surveys of the Eurasian water-milfoil and some management attempts have been conducted by Golden Sands RC&D.

*Terms in bold, see glossary pp 21-25

The Fishery

Thomas Lake supports a warm water fishery and is routinely stocked with trout. The lake presently holds only seven species of fish compared to 14 from historical records dating back to the 1950s (Table 2). Three newly documented taxa were found, including the Iowa darter (*Etheostoma exile*), bluegill/pumpkinseed hybrids (*Lepomis gibbosus x macrochirus*) and yellow bullheads (*Ictalurus natalis*), although “bullheads” were previously commonly reported which could have been either black (*Ictalurus melas*) or yellow bullheads. The sport fish population is presently dominated by bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*). This lake has been subject to extensive management including removal of the entire native fish community. The lake was completely poisoned in 1957, reportedly an attempt to remove a stunted crappie (*Pomoxis* sp.) population. So much toxaphene (now a banned pesticide) was reported to have been used that the water was still toxic to fish placed in water from the lake four months after treatment. The lake was poisoned again in 1961 to kill all fish, probably to eliminate “bullheads” and “suckers” and restocked with bluegill, largemouth bass, smallmouth bass (*Micropterus dolomieu*) and rainbow trout (*Oncorhynchus mykiss*) in 1962. When the lake was sampled again in 1965, white suckers (*Catostomus commersoni*) and bullheads were once more reported along with the remainder of the stocked species, but the stocked smallmouth bass were essentially gone and none have been reported since. The futility of this heavy-handed approach to fisheries management was beginning to be recognized about this time and no further fish removal efforts were reported on this lake, although unwarranted stocking for some species has continued. This lake has been stocked historically with trout, but there is no evidence that they can survive more than a few months because of high summer temperatures and low dissolved oxygen below 14 feet. This lake is probably the least suited of all Portage County lakes that now receive an annual allotment of trout and there is no biological reason that it should continue other than public expectation that it has been stocked in the past.

A total of 17 species of fish have been reported from Thomas Lake since 1961. A greater percentage of species have been lost in Thomas Lake (59%) than in any other lake sampled, presumably an outcome of the fish removal efforts. Species lost or not documented in 2002 and 2003 include the trout species, northern pike (*Esox lucius*), walleye (*Sander vitreum*) smallmouth bass, green sunfish (*Lepomis cyanellus*), white sucker, banded killifish (*Fundulus diaphanus*) and common shiner (*Notropis cornutus*) (Table 2). There is very little habitat for the trout, walleye, and smallmouth bass and these stocked species would not be expected to be self-sustaining. The lake is bounded by high banks and has no inlets or outlets that could serve as natural corridors for movement of fish back into the lake. Because this lake appears to have been poisoned completely, probably before a complete survey had been conducted, the original community of fishes cannot be entirely known.

*Terms in bold, see glossary pp 21-25

Table 2. Species occurrence in Thomas Lake from the 2002/2003 study and WDNR records.

Note:"S" indicates WDNR stocking record.

Brook Trout	**S**; 1980
Brown Trout	1966. **S**; 1973
Rainbow Trout	1968, 1966, 1965, 1961. **S**; 2003-1998, 1996-1981, 1979-1972, 1962
Bluegill	2003, 2002, 1970, 1968, 1967, 1965, 1961. **S**; 1962
Bluegill/Pumpkinseed hybrid	2003, 2002
Pumpkinseed	2003, 2002, 1970, 1968, 1967, 1965, 1961
Green Sunfish	1961
Largemouth Bass	2003, 2002, 1970, 1968, 1967, 1966, 1965, 1961. **S**; 1962
Smallmouth Bass	1965. **S**; 1962
Yellow Perch	2002, 1967
Iowa Darter	2002
Northern Pike	1968
Yellow Bullhead	2003, 2002
Bullhead sp.	1965, 1961
White Sucker	1966, 1965
Sucker sp.	1961
Common Shiner	1961
Banded Killifish	1961

Bottom Substrate, Vegetative Structure, and Critical Habitat

Bottom **substrate** in **littoral** areas is mostly muck along the western shore with sand and detritus covered sand elsewhere (Figure 10). The sandy areas would probably be suitable for establishment of a population of blackchin shiners (*Notropis heterodon*), blacknose shiners (*Notropis heterolepis*), or bluntnose shiners should they be introduced. These species are present in several of the least impacted Portage County lakes. They may have been present in Thomas Lake prior to poisoning and may have been overlooked as often happened in early sport fish based management surveys. Unlike bluegills, they would provide a forage base that could be controlled by largemouth bass. Their introduction would also result in a more natural fish assemblage typical of a small glacial lake.

Most of the open water in Thomas Lake is dominated by Eurasian water-milfoil (Figure 11). In addition to aesthetic problems caused by this exotic plant, it provides such dense cover and protection from predators that it contributes to the problem of overpopulation by sunfish. The lake appears to be dominated by small bluegill. The western shore has an expanse of water lilies bordering beds of emergent vegetation along the shoreline. This appears to be an area where northern pike could spawn but they have only been occasionally found during surveys. With the extent of water-milfoil coverage in this lake, northern pike would probably not be able to forage effectively, and their fry would be

*Terms in bold, see glossary pp 21-25

heavily preyed upon by bluegill. Attention should be given to controlling this exotic plant and preventing its spread into other area lakes.

Figure 10. Littoral bottom map of Thomas Lake August 2004.

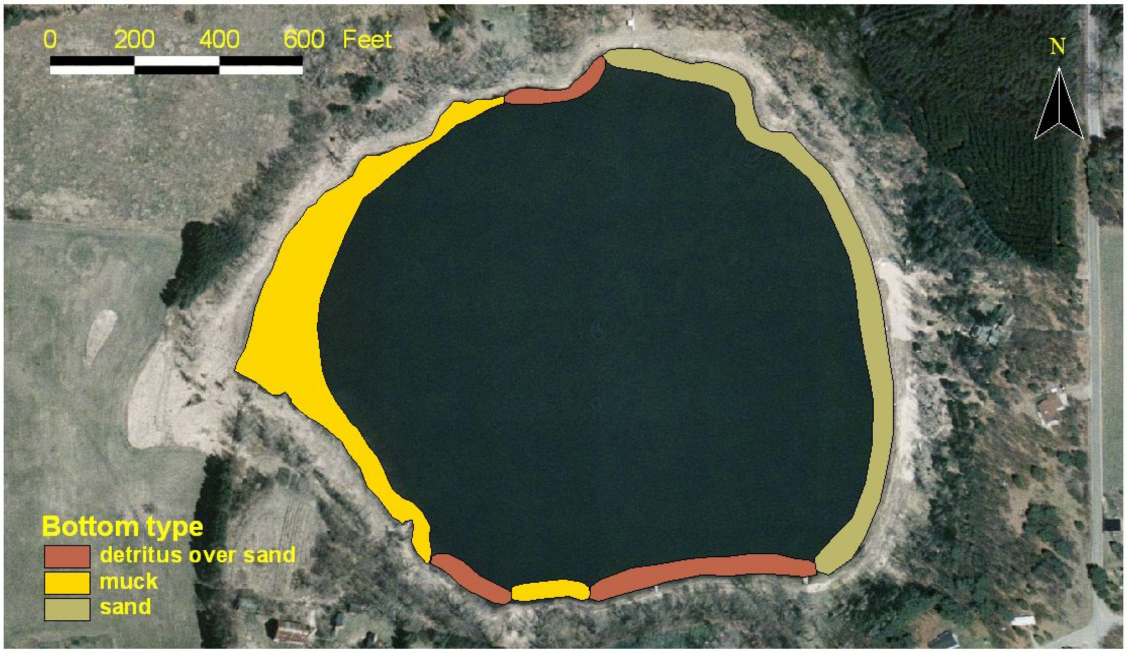
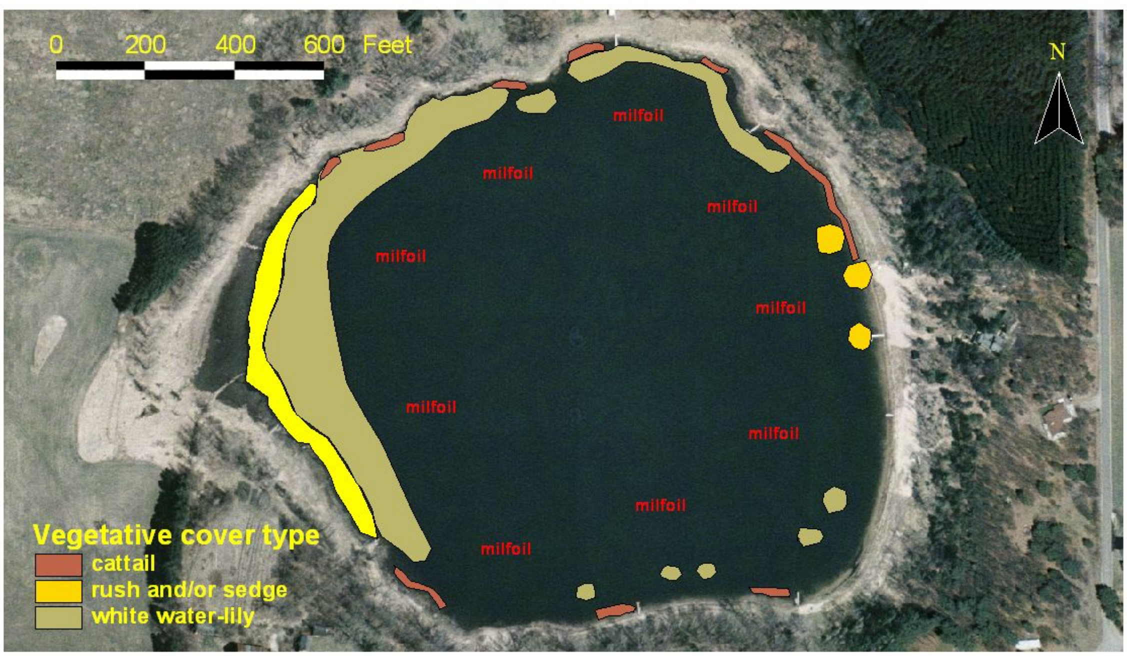


Figure 11. Vegetative cover map of Thomas Lake August 2004.



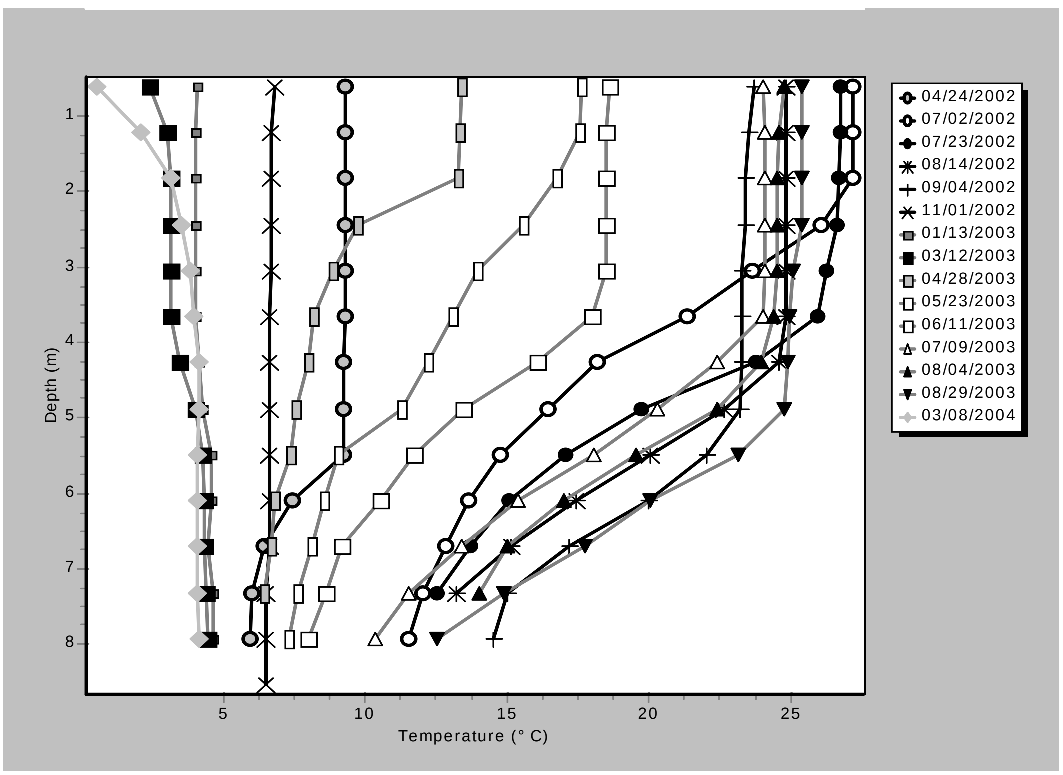
*Terms in bold, see glossary pp 21-25

Current Water Quality

Water quality in lakes is assessed by measuring different characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. Each of the constituents discussed play a complex role in water quality.

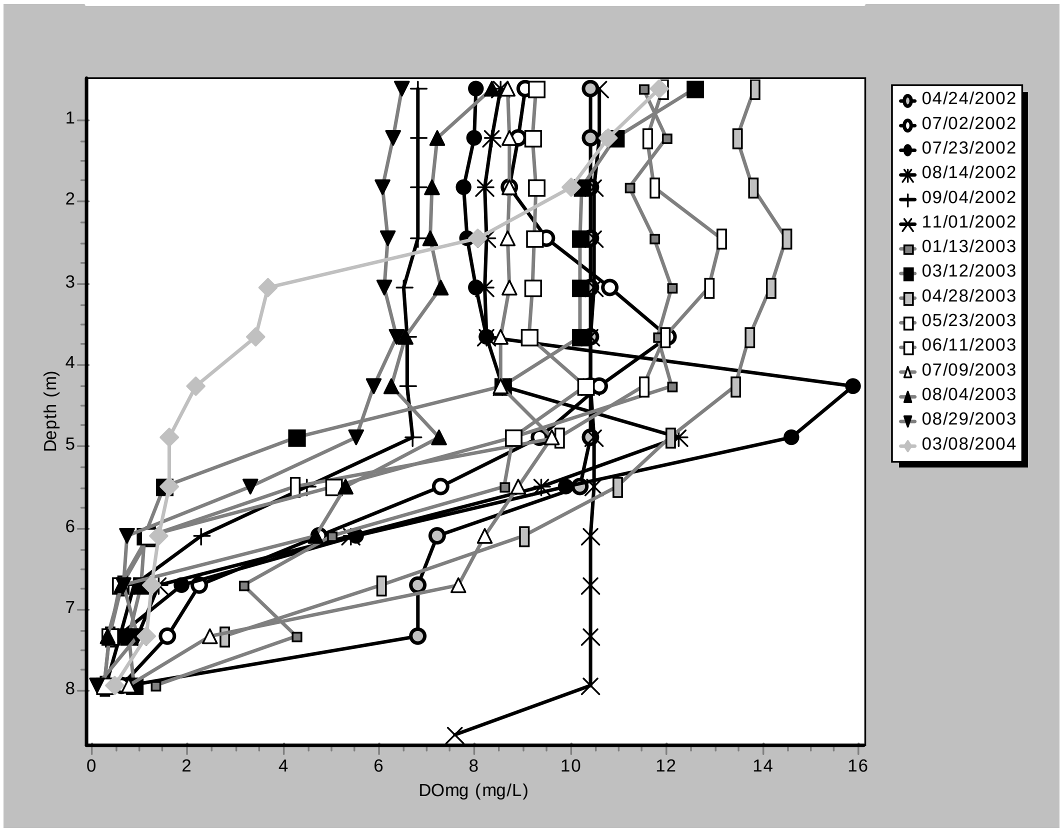
Based on temperature profiles, Thomas Lake shows periodic mixing and **stratification** common to many Wisconsin lakes (Figure 12). Oxygen concentrations were sufficient to support most aquatic biota for the upper 15 feet throughout most of the year, however only the upper 9 feet of water had well oxygenated water during the later part of the winter in 2004. Oxygen may become a problem in the future due to the large amount of decomposing aquatic vegetation.

Figure 12. Profile of temperature in Thomas Lake 2002-2004.



*Terms in bold, see glossary pp 21-25

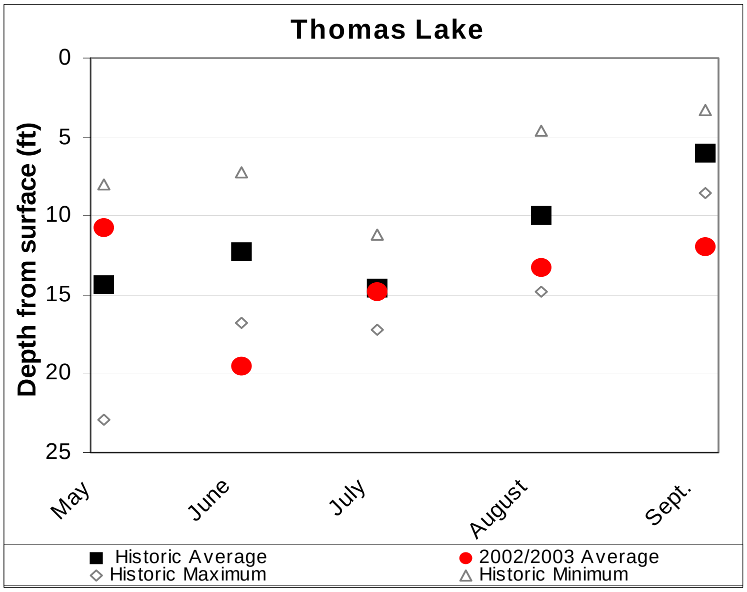
Figure 13. Profile of dissolved oxygen in Thomas Lake 2002-2004.



Water **clarity** measures the depth that light can penetrate water. This can be affected by water **color** and suspended materials in the water (**turbidity**). **Turbidity** is caused by **suspended solids**, which include suspended sediments and **algae** (**chlorophyll *a***). In Thomas Lake these measures are all fairly low (Figure 14) and therefore, the water **clarity** in Thomas Lake is considered good. The average **Secchi disc** depth reading for similar lakes in the county is nine feet; Thomas Lake appears to have better **clarity** than this. The water **clarity** of Thomas Lake during the 2002-03 growing seasons was similar or better than the historic growing season average, except during the month of May. The month of June shows the best water **clarity** and the month of May the poorest. These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

*Terms in bold, see glossary pp 21-25

Figure 14. Monthly average water clarity measurements in Thomas Lake 2002-2003 and historic maximum and minimums.



There are a number of chemicals that are used to evaluate the water quality in a lake. Nutrients (**phosphorus** and **nitrogen**) are most responsible for **algae** and aquatic plant growth, and in Thomas Lake, **phosphorus** is the nutrient that may limit the growth. Throughout the year total and reactive **phosphorus** concentrations are at a reasonable level, low enough to not stimulate excessive **algae**/aquatic plant growth, however the Eurasian water-milfoil plants in the lake are able to obtain additional **phosphorus** from the sediment. Every year when the plants die back the **phosphorus** that they have used returns again to the sediment for use by next year's plants. Much of the **nitrogen** in the water is in the particulate form that is not readily available for use by **algae**/aquatic plants. Concentrations of inorganic **nitrogen** in the spring are less than 0.3 **mg/L** which is the level that fuels excessive **algae** blooms throughout the summer. Thomas Lake is a moderately **hard water** lake with moderate **alkalinity**. This makes it a moderately productive lake that would have some capacity to buffer impacts from **phosphorus** but that capacity could be exceeded relatively easily compared to **marl**-producing **hard water** lakes.

Chloride levels, and to a lesser degree **sodium** and **potassium** levels, are commonly used as an indicator of how strongly a lake is being impacted by human activity. Samples taken in 2002-2004 are low for all three constituents indicating the lake is not suffering major impacts from septic systems, animal waste, potash fertilizer, or road salt. **Sulfate** levels are also low in Thomas Lake. **Sulfate** is most often associated with specific mineral types in the **watershed** or with acid rain resulting from coal burning industries. **Atrazine** was detected in Thomas Lake, although at low concentrations (0.14 and 0.11 μg/L); however, some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering Thomas Lake.

*Terms in bold, see glossary pp 21-25

Table 3. 2002-2003 water quality seasonal averages in Thomas Lake.

Thomas Lake	TP (ug/L)	RP (ug/L)	TN (mg/L)	NO2+NO3 (mg/L)	NH4 (mg/L)	Alkalinity (mg/L)	Total Hardness (mg/L)	Calcium Hardness (mg/L)	Color (CU)	Turbidity (NTU)	Chlorophyll a (ppm)
Spring Averages	23.0	27.5	0.90	0.12	0.07	100.0	105.0	62.0	11	2.2	2.1
Summer Averages	19.1	7.2	0.93	0.08	0.01	87.5	89.0	48.0	8	2.1	3.7
Fall Averages	23.5	7.0		0.53	0.10	95.5	97.5	56.5	12	2.0	
Winter Averages	14.5	2.3		0.08	0.17						
2002-2004 Averages	19.8	10.6	0.92	0.19	0.08	93.2	95.6	54.2	10	2.1	3.5

TP=total **phosphorus**; RP=reactive or soluble **phosphorus**; TN=total **nitrogen**; NO2+NO3=**nitrite** and **nitrate nitrogen**; NH4=**ammonia nitrogen**

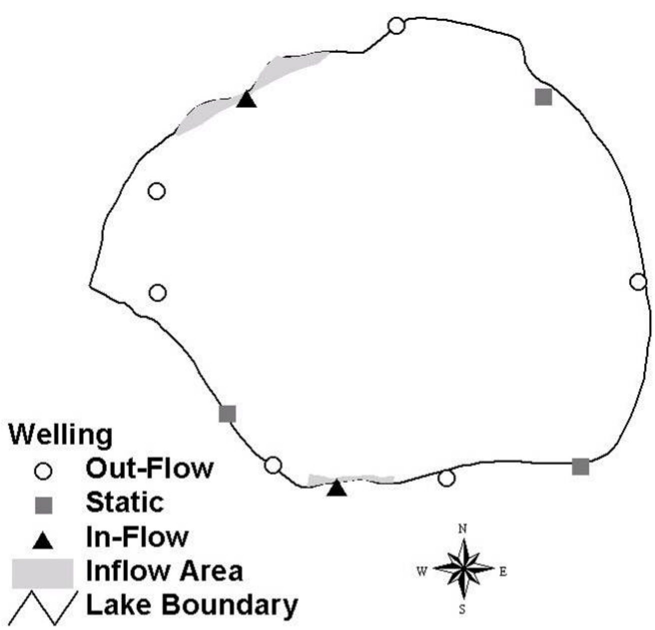
Table 4. 2002-2003 Thomas Lake average water chemistry and reference values.

Thomas Lake	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	2.15			Sulfate	<10	10-20	>20
Chloride	0.72			Chloride	<3	3-10	>10
Potassium	1.37			Potassium*	<2.16	2.16-4.30	>4.30
Sodium	1.42			Sodium*	<2.28	2.28-5.09	>5.09

**Ranges of low, medium, high defined by taking the median values from the lake study and dividing into thirds.*

Small wells (mini-piezometers) were placed in the sediment around Thomas Lake's perimeter to identify areas of **groundwater** inflow, no flow, and outflow. There were two primary areas of **groundwater** inflow located in Thomas Lake, on the northwest and southwest sides of the lake (Figure 15). The only **groundwater** sample analyzed for Thomas Lake was collected on the southwest end. It had elevated concentrations of **ammonium** and **phosphorus** and low concentrations of **nitrate** and **chloride** suggesting that the sources of **ammonium** and **phosphorus** may be from natural conditions.

Figure 15. Locations in Thomas Lake showing groundwater inflow/no flow/outflow from mini-piezometer measurements and winter observations.



*Terms in bold, see glossary pp 21-25

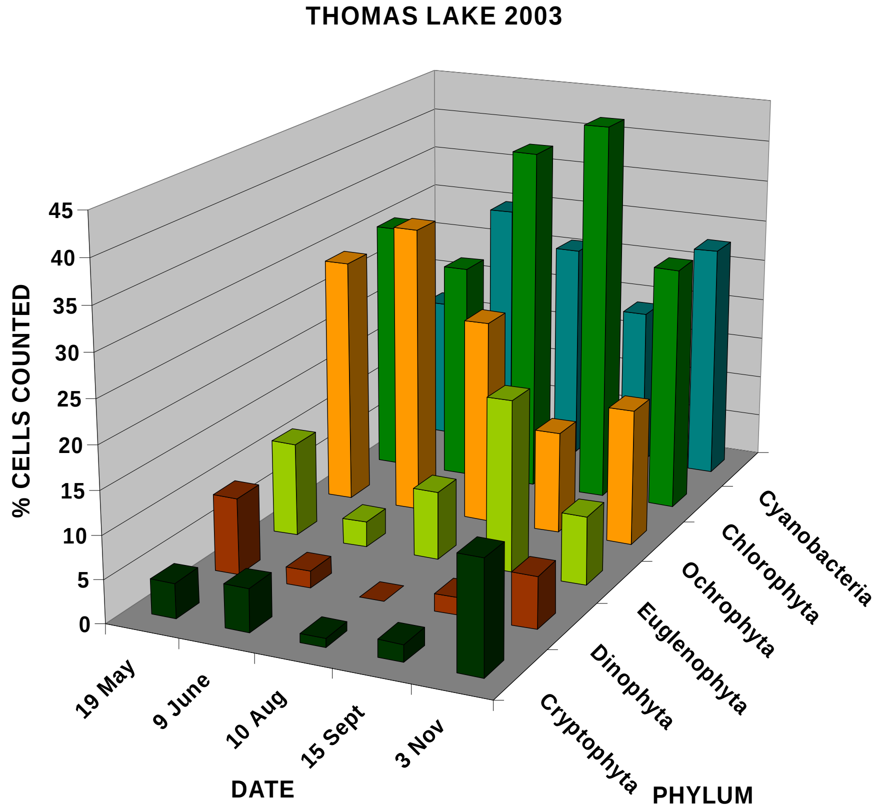
Algal Community
The algal community in Thomas Lake was not particularly diverse. The dominant groups were the green **algae** (Chlorophyta), **blue-green algae** (Cyanobacteria), and yellow-green **algae** and **diatoms** (Ochrophyta) (Table 5). The three dominant phyla represented 81% of all cells counted during the 2003 sampling season. In the 2500 cells counted during this period there were 5 genera of Cyanobacteria, 10 genera of Chlorophyta, 11 genera of Ochrophyta (including 7 diatom genera), 2 genera of Euglenophyta, 2 genera of Dinophyta, and 2 genera of Cryptophyta identified. The green **algae** (Chlorophyta) were consistently dominant, being most abundant in four of five sample periods, and represented an average of 34% of all cells counted. The Ochrophyta (mostly **diatoms**) co-dominated the early sample periods (May, June) before dropping to third or fourth sub-dominant the rest of the sampling season and leading to an overall seasonal average of 23% of all cells counted of the 2003 sampling period. The **blue-green algae** (Cyanobacteria) averaged 24% of all cells counted and had peak abundance in the June, August, and November sample periods. The other phyla (Euglenophyta, Dinophyta, and Cryptophyta) totaled about 19% of all cells counted, with no phylum ever represented by more that 13% of cells counted in a sample period (Figure 16).

Table 5. Algal phyla and mean seasonal composition in Thomas Lake from May to November 2003.

THOMAS LAKE PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	17	30	26	19	28	24
Chlorophyta	30	26	41	45	29	34
Ochrophyta	29	34	24	12	16	23
Euglenophyta	11	3	8	20	8	10
Dinophyta	9	2	0	2	6	4
Cryptophyta	4	5	1	2	13	5

*Terms in bold, see glossary pp 21-25

Figure 16. Algal community composition by date in Thomas Lake from May to November 2003 (total phylum cells counted divided by total cells counted).



Four of the five dominant taxa were green **algae** (Chlorophyta) (Figure 17). The small, non-motile genera *Ankistrodesmus* and *Selenastrum* were the dominant green **algae**, each being the most abundant in two sample periods. Greens also occupied two of the other top three abundance slots over the sampling period. *Snowella* and *Anabaena*, a small colonial and moderately-sized filament, respectively, were the most common cyanobacteria. These taxa were the second most abundant taxa in four of five sample periods. The unicellular diatom genus *Synedra* and the motile, unicellular euglenoid genus *Phacus* were both present twice in the top 15 abundance slots, with *Synedra* being the most abundant organism in the June sample. The cryptophyte genus *Cryptomonas* was also present once in the top 15 slots (Table 6).

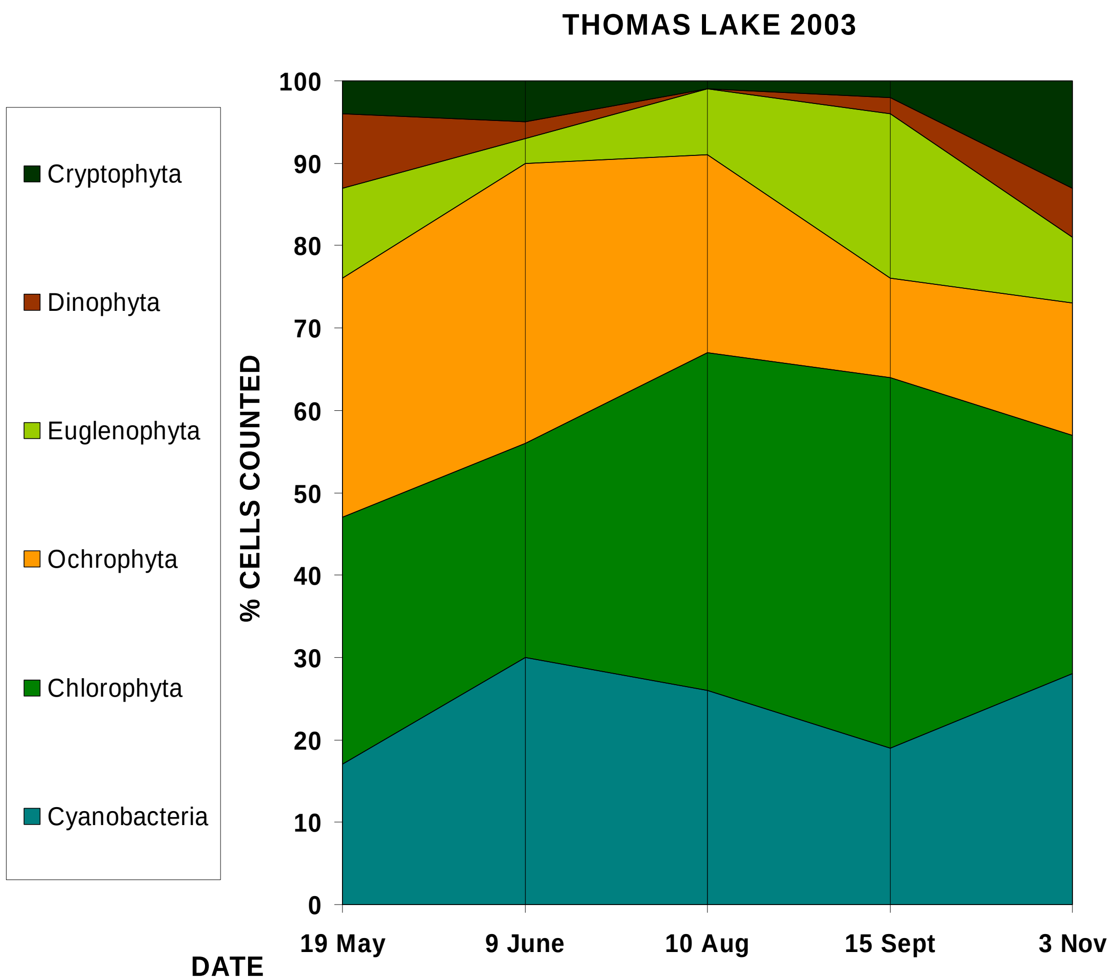
The algal community, when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Thomas Lake, presents a picture of a fairly **oligotrophic** lake. The 32 genera identified during the sample periods were relatively common and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The diversity of the lake algal community and the fairly typical seasonal succession of the algal community (**diatoms** early, greens in the middle, and cyanobacteria late) combined with the generally good water quality throughout the sampling period are all characteristics of **oligotrophic** bodies of water.

*Terms in bold, see glossary pp 21-25

Table 6. Most common algal genera by date in Thomas Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Ankistrodesmus*	*Snowella*	*Phacus 1*
9 June	*Synedra 2*	*Snowella*	*Scenedesmus*
10 August	*Selenastrum*	*Snowella*	*Synedra 2*
15 September	*Ankistrodesmus*	*Selenastrum*	*Phacus 1*
3 November	*Selenastrum*	*Anabaena*	*Cryptomonas*

Figure 17. Algal community composition by phylum in Thomas Lake from May to November 2003.



*Terms in bold, see glossary pp 21-25

Thomas Lake Study Highlights

- The survey of upland sensitive areas was conducted to note areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. Thomas Lake is surrounded almost entirely by a steep slope with the exception of a cattle grazing pasture. Cattle have caused light **erosion** along a portion of the bank and the remaining shoreline is susceptible to **erosion** from any activities that disturb the vegetative cover
- During the survey of reptiles Thomas Lake was found to contain two turtle species (painted turtle, snapping turtle). Five frog species were identified during the amphibian survey of Thomas Lake (spring peeper, American toad, gray treefrog, Cope's gray treefrog, green frog). The primary amphibian habitat is located on the west side of the lake. Some of the key features of this habitat include protected areas of marsh with large amounts of submergent, emergent and floating-leaf vegetation. The good news is that Thomas Lake contains large sections of undisturbed, natural shoreline. However, there are also small sections of altered shoreline.
- The number of aquatic or wetland **vascular plants** that have been found in Thomas Lake is slightly below average for Portage County lakes. The average **coefficient of conservatism** and the **floristic quality index** are also below average for Portage County lakes. In 1985 Thomas Lake had fairly abundant submersed vegetation composed of common water-milfoil, and several species of pondweeds. The aquatic vegetation of Thomas Lake has changed to a great extent in recent years from a lake of moderate diversity of submersed species to the present condition of dominance by Eurasian water-milfoil. The shore is also beginning to show the effects of spreading invasive alien species, especially reed canary-grass and purple loosestrife.
- Thomas Lake supports a warm water fishery and is routinely stocked with trout. The lake presently holds only seven species of fish compared to 14 from historical records dating back to the 1950s.. Three newly documented taxa were found, including the Iowa darter, bluegill/pumpkinseed hybrids and yellow bullheads, although "bullheads" were previously commonly reported which could have been either black or yellow bullheads. The sport fish population is presently dominated by bluegill, largemouth bass, and yellow perch.
- This lake has been subject to extensive management including removal of the entire native fish community. The lake was completely poisoned in 1957, reportedly an attempt to remove a stunted crappie population. The lake was poisoned again in 1961 to kill all fish, probably to eliminate "bullheads" and "suckers" and restocked with bluegill, largemouth bass, smallmouth bass and rainbow trout in 1962. When the lake was sampled again in 1965 white suckers and bullheads were once more reported along with the remainder of the stocked species, but the stocked smallmouth bass were essentially gone and none have been reported since. The futility of this heavy-handed approach to fisheries management was beginning to be recognized about this time and no further fish

*Terms in bold, see glossary pp 21-25

removal efforts were reported on this lake, although unwarranted stocking for some species has continued.

- This lake has been stocked historically with trout, but there is no evidence that they can survive more than a few months because of high summer temperatures and low dissolved oxygen below 14 feet. This lake is probably the least suited of all Portage County lakes that now receive an annual allotment of trout and there is no biological reason that it should continue other than public expectation that it has been stocked in the past.
- Species lost or not documented in 2002 and 2003 include the trout species, northern pike, walleye smallmouth bass, green sunfish, white sucker, banded killifish and common shiner. There is very little habitat for the trout, walleye, and smallmouth bass, and these stocked species would not be expected to be self-sustaining. The lake is bounded by high banks and has no inlets or outlets that could serve as natural corridors for movement of fish back into the lake.
- Bottom **substrate** in **littoral** areas is mostly muck along the western shore with sand and detritus covered sand elsewhere. The sandy areas would probably be suitable for establishment of a population of blackchin, blacknose or bluntnose shiners should they be introduced. Unlike bluegills, they would provide a forage base that could be controlled by largemouth bass. Their introduction would also result in a more natural fish assemblage typical of a small glacial lake.
- Most of the open water in Thomas Lake is dominated by Eurasian water-milfoil. In addition to aesthetic problems caused by this exotic plant, it provides such dense cover and protection from predators that it contributes to the problem of overpopulation by sunfish. The western shore has an expanse of water lilies bordering beds of emergent vegetation along the shoreline. This appears to be an area where northern pike could spawn but they have only been occasionally found during surveys. With the extent of water-milfoil coverage in this lake, northern pike would probably not be able to forage effectively and their fry would be heavily preyed upon by bluegill. Attention should be given to controlling this exotic plant and preventing its spread into other area lakes.
- **Atrazine** was detected in Thomas Lake, although at low concentrations (0.14 and 0.11 µg/L) however some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering Thomas Lake.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Thomas Lake presents a picture of a fairly **oligotrophic** lake. The 32 genera identified were relatively common and none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. The diversity of the lake algal community and the fairly typical seasonal succession of the algal community (**diatoms** early, greens in the middle, and cyanobacteria late) combined with the generally good water quality throughout the sampling period are all characteristics of **oligotrophic** bodies of water.

*Terms in bold, see glossary pp 21-25

Glossary

Algae:

One-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species occur. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

Alkalinity:

A measure of the amount of carbonates, bicarbonates, and hydroxide present in water. Low alkalinity is the main indicator of susceptibility to acid rain. Increasing alkalinity is often related to increased algae productivity. Expressed as milligrams per liter (mg/L) of calcium carbonate (CaCO3), or as microequivalents per liter (ueq/l). 20 ueq/l = 1 mg/L of $CaCO_3$.

Ammonia, Ammonium:

A form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is therefore an important nutrient. It converts rapidly to nitrate (NO_3) if oxygen is present. The conversion rate is related to water temperature. Ammonia is toxic to fish at relatively low concentrations in pH-neutral or alkaline water. Under acid conditions, non-toxic ammonium ions (NH_4^+) form, but at high pH values the toxic ammonium hydroxide (NH_4OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH_4OH. At a pH of 7 and a temperature of 68^o F (20^o C), the ratio of ammonium ions to ammonium hydroxide is 250:1; at pH 8, the ratio is 26:1.

Atrazine:

The nation's most widely used weedkiller for both grassy and broadleaf weeds.

Blue-Green Algae:

Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as they die. Many can fix nitrogen (N_2) from the air to provide their own nutrient.

Chloride (Cl-):

Chlorine in the chloride ion (Cl^-) form has very different properties from chlorine gas (Cl_2), which is used for disinfecting. The chloride ion (Cl^-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll *a*:

Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae and is therefore used as a common indicator of water quality.

Clarity:

see "Secchi disc."

*Terms in bold, see glossary pp 21-25

Coefficient of Conservatism (c-value):

Indicates on a scale of 0 to 10 the degree to which a species can tolerate disturbance to a native plant community; a species with a c value of 10 is found only in relatively undisturbed areas of native plant community, whereas a species with a c value of 0 never grows in undisturbed areas of native plant communities. Plants with low numbers tend to occur in a wide range of more-or-less disturbed plant communities. Alien species are also assigned a c value of 0. The c values are used in this report in calculating the Floristic Quality Index for each lake.

Color:

Measured in color units that relate to a standard. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. The average color value for Wisconsin lakes is 39 units, with the color of state lakes ranging from zero to 320 units. Color also affects light penetration and therefore the depth at which plants can grow.

Concentration Units:

Express the amount of a chemical dissolved in water. The most common ways chemical data is expressed is in milligrams per liter (mg/L) and micrograms per liter (ug/L). One milligram per liter is equal to one part per million (ppm). To convert micrograms per liter (ug/L) to milligrams per liter (mg/L), divide by 1000 (e.g. 30 ug/l = 0.03 mg/L). To convert milligrams per liter (mg/L) to micrograms per liter (ug/L), multiply by 1000 (e.g. 0.5 mg/L = 500 ug/L). Microequivalents per liter (ueq/L) is also sometimes used, especially for alkalinity; it is calculated by dividing the weight of the compound by 1000 and then dividing that number into the mg/L.

Diatoms:

A major group of eukaryotic algae, which are one of the most common types of phytoplankton. Diatom communities are a popular tool for monitoring environmental conditions, past and present, and are commonly used in studies of water quality; often the brown stuff attached to rock surfaces.

Drainage Lakes:

Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter retention times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

Erosion:

The lowering of the land surface by weathering, corrosion, and transportation, under the influence of gravity, wind, and running water.

Eutrophic:

Eutrophic lakes are high in nutrients and support a large biomass (all the plants and animals living in a lake). They are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion. Small, shallow, eutrophic lakes are especially vulnerable to winterkill which can reduce the number and variety of fish. Rough fish are commonly found in eutrophic lakes.

Eutrophication:

The process by which lakes and streams are enriched by nutrients, and the resulting increase in plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Floristic Quality Index (FQI):

The FQI is a standardized method for evaluating natural plant communities by multiplying the average coefficient of conservatism (c-value) for all species by the square root of the total number of species found at that lake; an additional point is added to the index for each state-listed special concern species, two points added for a threatened species, and three points added for an endangered species. A higher floristic quality index, such as FQI=60, indicates a higher floristic quality and biological integrity and a lower level of disturbance impacts. A lower floristic quality index, such as FQI=20, indicates a lower floristic quality and biological integrity and a higher level of disturbance impacts.

Groundwater:

Water found below the land surface in pore spaces between soil particles or in cracks in rock. It moves slowly from higher to lower areas on the landscape and may provide water to a lake.

Groundwater Drainage Lake:

Often referred to as a spring-fed lake, has large amounts of groundwater as its source, and a surface outlet. Areas of high groundwater inflow may be visible as springs or sand boils. Groundwater drainage lakes often have intermediate retention times with water quality dependent on groundwater quality.

Hardness, Hard Water:

The quantity of multivalent cations (cations with more than one +), primarily calcium (Ca++) and magnesium (Mg++) in the water expressed as milligrams per liter of $CaCO_3$. Amount of hardness relates to the presence of soluble minerals, especially limestone, in the lake watershed. Soft water has 60 mg/L $CaCO_3$ or less, moderately hard water has 61-120 mg/L $CaCO_3$, hard water has 121-180 mg/L $CaCO_3$, and very hard water has more than 180 mg/L $CaCO_3$.

Littoral:

The shallow water zone near the shoreline that is home to most aquatic plants.

Macrophytes:

see "Rooted aquatic plants."

Macrophytic Algae:

Algae that resemble true plants in that they appear to have stems and leaves, and are attached to the bottom.

Marl:

White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ($CaCO_3$) in hard water lakes. Marl may contain many snail and clam shells, which are also calcium carbonate. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

Mesotrophic:

Mesotrophic lakes lie between the oligotrophic and eutrophic trophic stages. In late summer, they lose oxygen at depth, limiting cold water fish and causing phosphorus release from sediments.

mg/L:

see “Concentration units”

*Terms in bold, see glossary pp 21-25

Nitrate (NO_3^-):

An inorganic form of nitrogen important for plant growth. Nitrogen is in this stable form when oxygen is present. Nitrate often contaminates groundwater when water originates from manure pits, fertilized fields, lawns or septic systems. High levels of nitrate-nitrogen (over 10 mg/L) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO_3-N) plus ammonium-nitrogen (NH_4-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

Nitrite (NO_2^-):

A form of nitrogen that rapidly converts to nitrate (NO_3^-) and is usually included in the NO_3^- analysis.

Nitrogen:

A chemical element that is an essential plant nutrient and may occur in the form of nitrate, nitrite, ammonium, or organic nitrogen in lakes.

Oligotrophic:

A trophic state in which lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations. However, oligotrophic lakes often develop a food chain capable of sustaining a very desirable fishery of large game fish.

Phosphorus:

Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Potassium:

A chemical element that is an essential plant nutrient and may enter lakes from runoff of agricultural fertilizers and animal wastes.

Retention Time: (Turnover Rate or Flushing Rate)

The average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time is important in determining the impact of nutrient inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the volume of water passing through the lake per year by the lake volume.

Rip Rap (Rip-Rap):

Hard rock, commonly granite or concrete rubble recycled from construction sites, used inland on lakes, rivers, coastlines, and other waterways to prevent bank erosion. Generally rip rap is not considered good management in lakes, due to its inability to provide adequate habitat, and is no longer commonly used.

Rooted Aquatic Plants: (Macrophytes)

Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

*Terms in bold, see glossary pp 21-25

Secchi Disc (Secchi Disk):

An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days.

Sedimentation:

Accumulated organic and inorganic matter on the lake bottom. Sediment includes decaying algae and weeds, marl, and soil and organic matter eroded from the lake's watershed.

Seepage Lakes:

Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a down gradient. Lakes with little groundwater inflow tend to be naturally acidic and most susceptible to the effects of acid rain. Seepage lakes often have long retention times, and lake levels fluctuate with local groundwater levels. Water quality is affected by groundwater quality and the use of land on the shoreline.

Sodium:

A chemical element that may enter lakes from runoff of road salt, fertilizers, and human and animal wastes.

Stratification, Stratified:

The layering of water due to differences in density. Water's greatest density occurs at 39^{o}F (4^{o}C). As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 ft. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline.

Sulfate (SO_4^{--}):

The most common form of sulfur in natural waters. The amounts relate primarily to soil minerals in the watershed. Sulfate (SO_4^{--}) can be reduced to sulfide (S^{--}) and hydrogen sulfide (H_2S) under low or zero oxygen conditions. Hydrogen sulfide smells like rotten eggs and harms fish. Sulfate input from acid rain is a major indicator of sulfur dioxide (SO_2) air pollution. Sulfate concentration is used as a chemical fingerprint to distinguish acid lakes acidified by acid rain from those acidified by organic acids from bogs.

Substrate:

The material found at the bottom of a lake, such as silt, mud, sand, clay, marl, gravel, etc.

Suspended Solids:

A measure of the particulate matter in a water sample, expressed in milligrams per liter. When measured on inflowing streams, it can be used to estimate the sedimentation rate of lakes or impoundments.

Turbidity:

The “cloudiness” or “murkiness” of water, caused by total suspended solids.

Vascular Plants:

Vascular plants are those plants that have tissues for conducting water, minerals, and food through the plant. Vascular plants include the ferns, clubmosses, flowering plants, and conifers.

Watershed:

The total land area that drains either surface water or groundwater toward a lake.

*Terms in bold, see glossary pp 21-25