South Twin

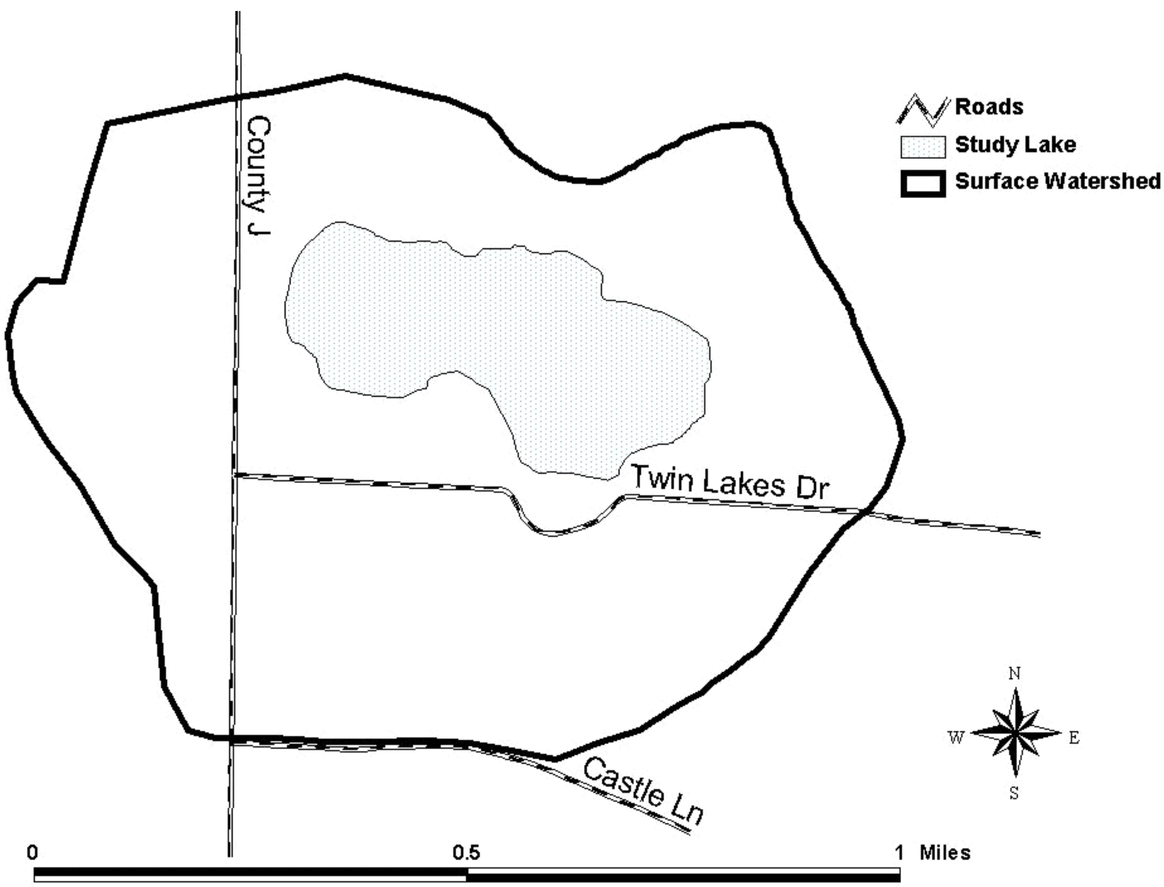
Introduction

South Twin Lake is located in the Town of Sharon, north of Polonia. It is a 52.7 acre, soft-water seepage lake with an estimated volume of 285 acre-feet. The length of shoreline is approximately 1.4 miles. It is a shallow lake with a maximum depth of 9 feet, and the bottom is comprised predominantly of sand and muck. The shoreline is fairly well vegetated and does not have any steep slopes. There are no inlets or outlets. Since there is no public access to South Twin Lake, historic information on the fishery and wildlife is limited.

Land Use and Watershed

The surface **watershed** for South Twin Lake is 382 acres (Figure 1). Land use in the surface **watershed** is largely dominated by non-irrigated agriculture (52%), followed by forest (21%) (Figure 2). Since 1948 there has been a small increase in the forested area and a small decrease in the non-irrigated agricultural areas, but overall land use has remained fairly consistent. Currently three percent of the **watershed** is residential with only one dwelling directly on the lakeshore (Figure 3).

Figure 1. South Twin Lake surface watershed boundary.



*Terms in bold, see glossary pp 18-23

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

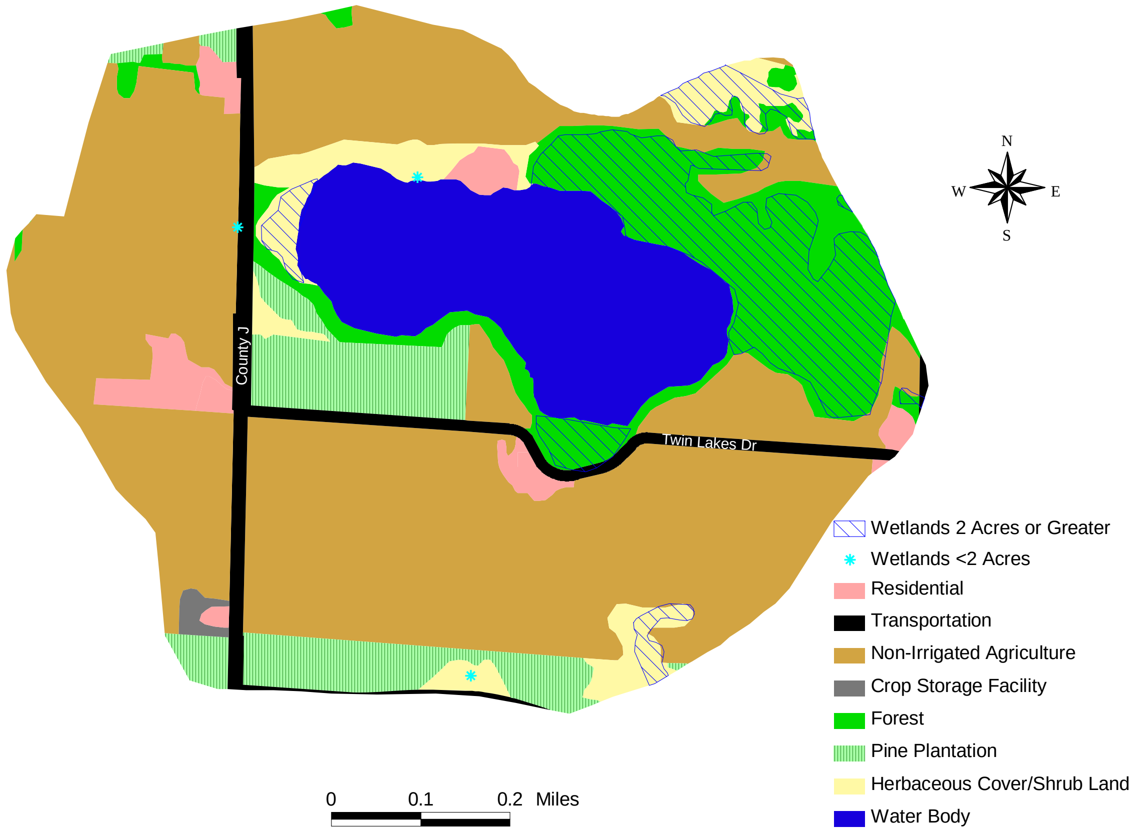
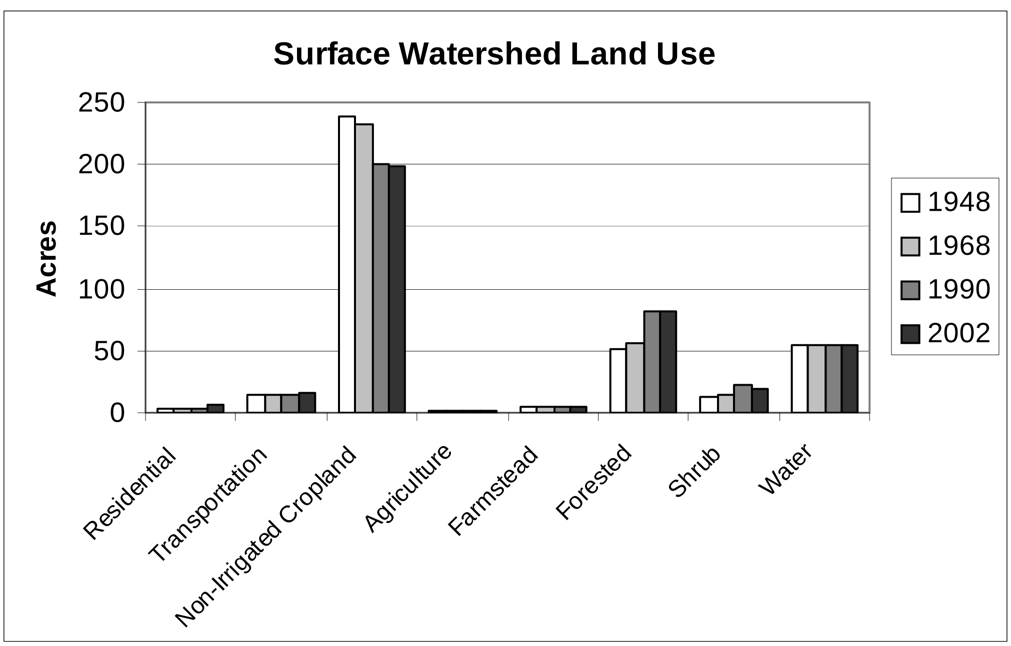


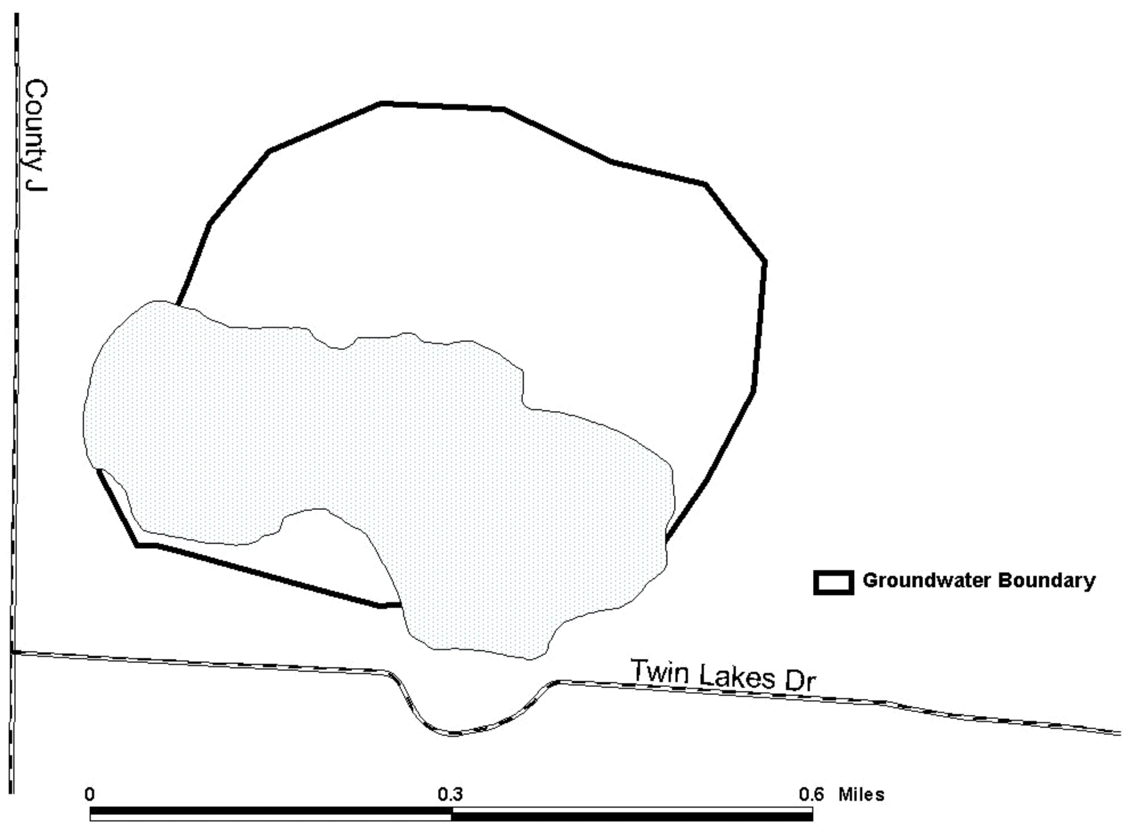
Figure 3. Land use in the South Twin Lake surface watershed 1948-2002.



*Terms in bold, see glossary pp 18-23

The **groundwater watershed** for South Twin Lake is 110 acres, mostly to the north of the lake (Figure 4). The dominant land uses are non-irrigated agriculture and forest. As with the surface **watershed,** there has been a modest decrease in non-irrigated agriculture since 1948. Forested land use increased by 1968 and dropped again slightly by 2002, while shrub/wetland cover increased by 1990 and then also declined slightly by 2002. The home on the north shore of the lake is the only residence in the **groundwater watershed**. It was built sometime between 1990 and 2000 (Figure 5 and Figure 6). A search of the records (2002 inventory) indicate that there are not any septic systems that are likely to be failing (due to age), or former landfill sites in either the surface or **groundwater watersheds**.

Figure 4. South Twin Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 18-23

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

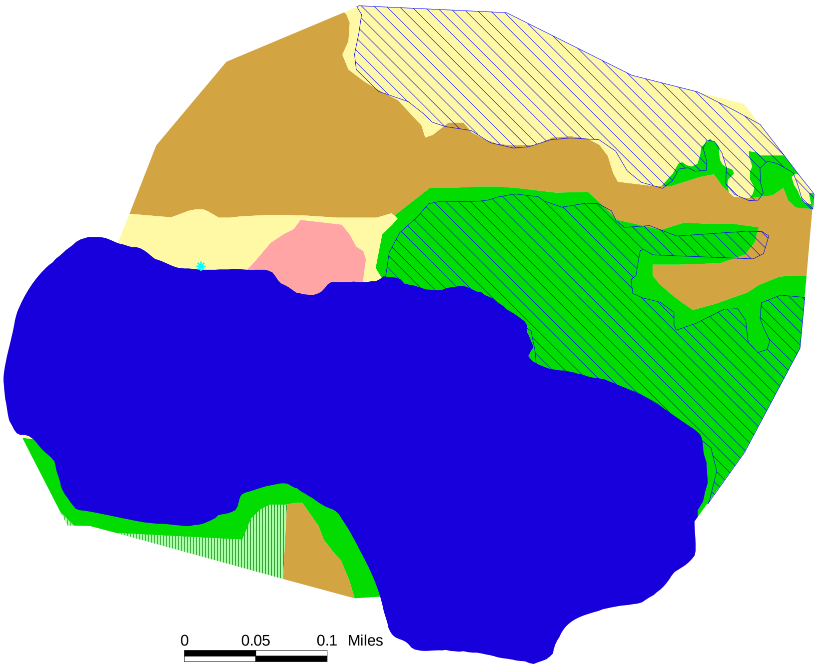
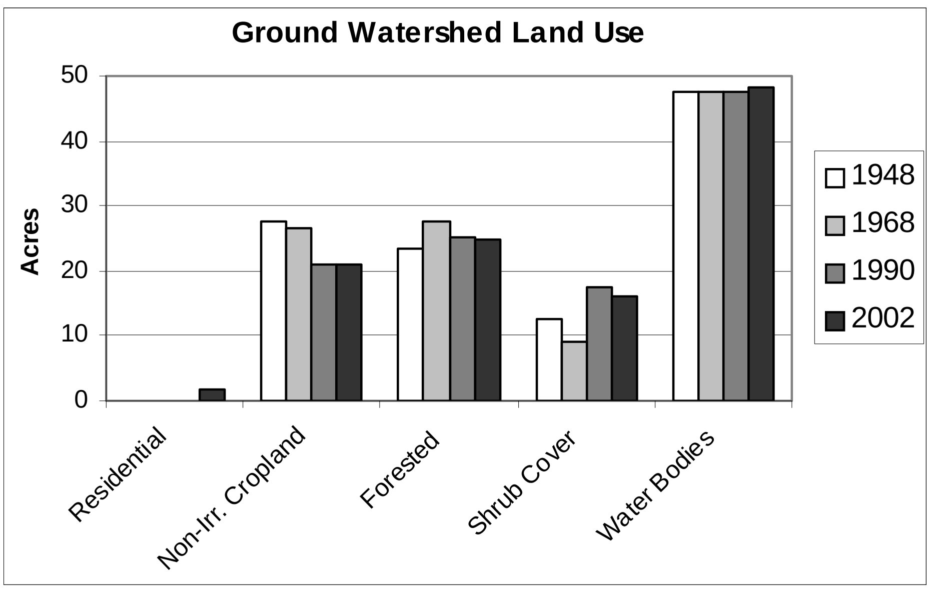


Figure 6. Land use in the South Twin Lake groundwater watershed 1948-2002.



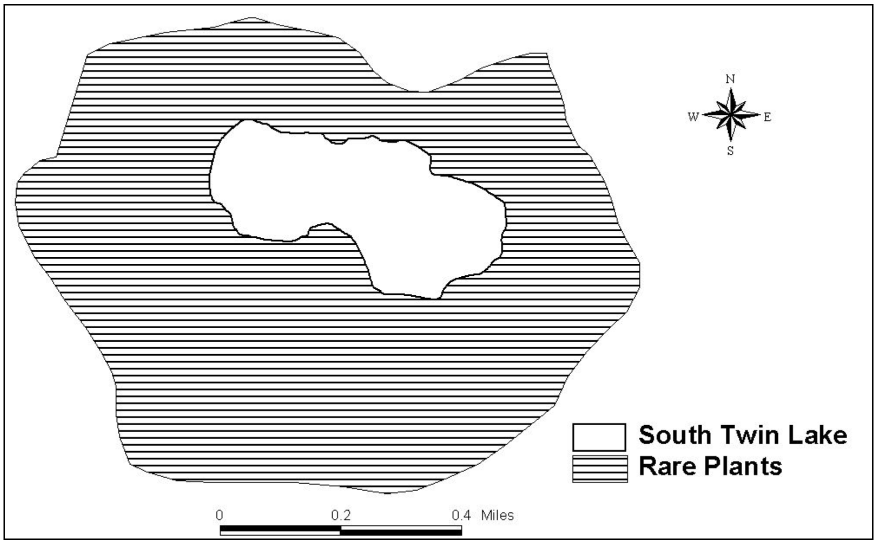
Sensitive Upland Areas

The survey of upland sensitive areas was conducted to identify areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. The area surrounding South Twin Lake was found to be unique, not only in its status as one of the

*Terms in bold, see glossary pp 18-23

few **soft water** lakes in the county, but in that it is rich in rare and high quality plant life (Figure 7). While not immediately in the **watershed** it is also worth noting that there is a Native American archeological area nearby, to the east of North Twin Lake.

Figure 7. Upland sensitive areas near South Twin 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*), 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.

*Terms in bold, see glossary pp 18-23

Table 1. Bird species identified near South Twin Lake.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Robin	2	insects	ground gleaner	cup	deciduous
Baltimore Oriole	2	insects	ground gleaner	oven	ground
Black-capped Chickadee	9	insects	foliage gleaner	cavity	deciduous
Blue Jay	3	omnivore	ground gleaner	cup	coniferous
Brown-headed Cowbird	1	insects	ground gleaner	parasite	deciduous
Chipping Sparrow	2	insects	ground gleaner	cup	coniferous
Green Heron	1	fish	stalk and strike	platform	deciduous
Mourning Dove	3	seeds	ground gleaner	saucer	deciduous
Northern Rough-winged Swallow	1	insects	aerial foliager	burrow	bank
Red-winged Blackbird	2	insects	ground gleaner	cup	reed
Song Sparrow	2	insects	ground gleaner	cup	ground
Total	**28**				

Shoreline Vegetation, Reptiles, Amphibians

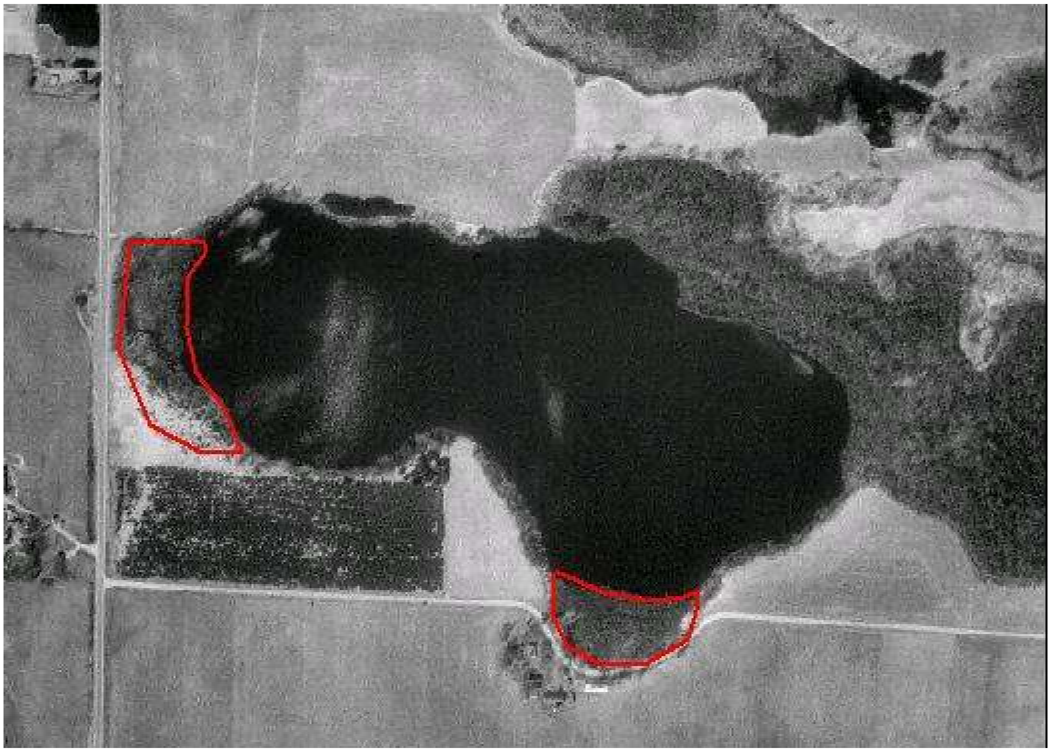
Amphibians (frogs and toads) were included in this survey because with their permeable skin and biphasic lifecycle (meaning that the young live in water while adults can survive on land) they are considered excellent indicators of overall ecosystem health. Furthermore, both turtles and amphibians utilize 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**.

Reptile surveys were not conducted near South Twin Lake. Five frog species were observed during the amphibian survey near South Twin Lake (spring peeper [*Pseudacris crucifer*], chorus frog [*Pseudacris triseriata*], American toad [*Bufo americanus*], gray treefrog [*Hyla versicolor*], and green frog [*Rana clamitans*]). The primary amphibian habitat is located on the south, west, and east sides of the lake (sensitive areas are 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 large sections of natural shoreline remain. However, there are also several small portions of altered shoreline.

*Terms in bold, see glossary pp 18-23

Figure 8. Regions of primary amphibian habitat around South Twin Lake.

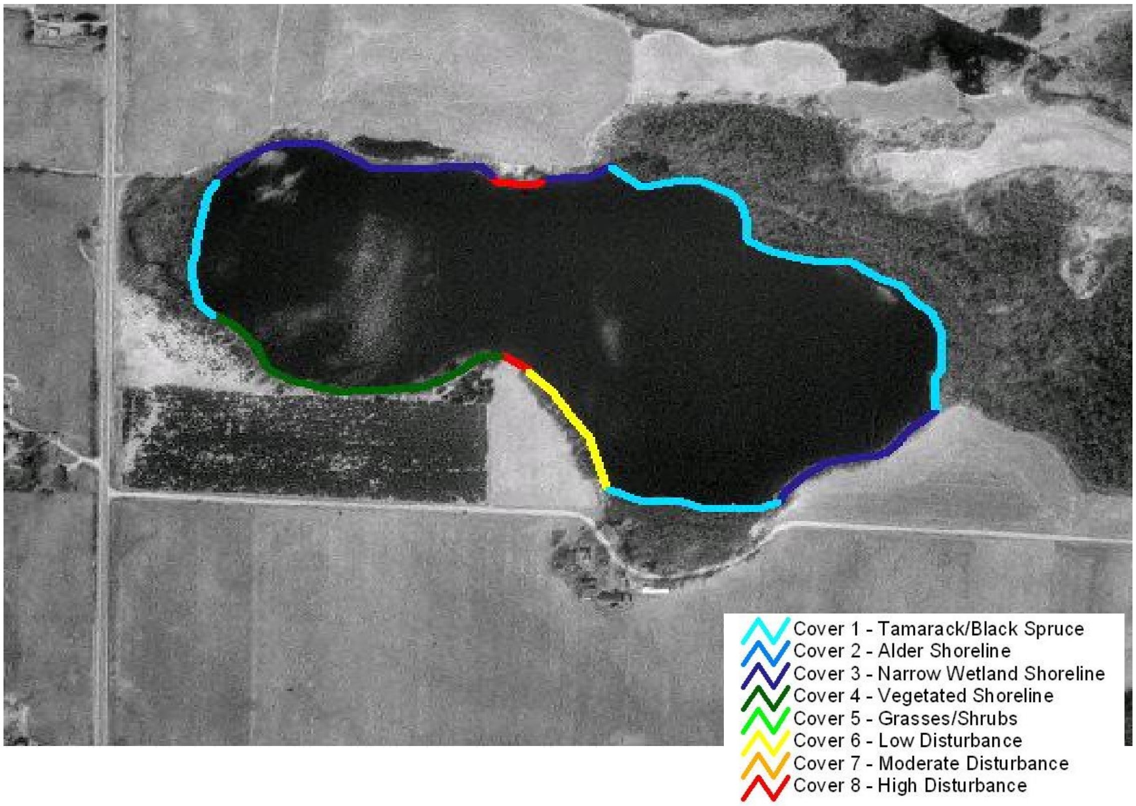


The shoreline of South Twin Lake is primarily composed of tamarack/black spruce wetland (44.2 %) and is represented by light blue in (Figure 9). Tamarack/black spruce wetlands are characterized as wetland shore zone with a sweet gale or leatherleaf understory and a black spruce or tamarack canopy. Twenty-eight percent of the shoreline is defined as narrow wetland shore which is represented by dark blue. Narrow wetlands are characterized as being wetland areas that extend less than 5 meters onto the shore and have an adjacent undeveloped upland area. Another 16.8 % of the shoreline is composed of vegetated 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.

Around South Twin Lake, 10 % of the shoreline is considered to be disturbed. Of that, 5.9 % is considered to be in the low disturbance developed category and 4.5 % is considered to be a highly disturbed developed state. An area that exhibits low vegetation disturbance is defined as a location where there is an unaltered shore zone except for pier access. 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.

*Terms in bold, see glossary pp 18-23

Figure 9. Shoreline vegetation around South Twin Lake.



Aquatic Plants

There are **60** species of **vascular plants**, plus several species of peatmoss, that have been found in South Twin Lake, on shore, or in the bog on the northeast shore. This is above average for Portage County lakes. The average **coefficient of conservatism (c-value)** of the 60 species of **vascular plants** is **6.8**, which is above average. The **floristic quality index**, adding 3 points for the three special concern species, is **55.7**, which is also above average for Portage County lakes.

South Twin Lake holds a rich and unusual aquatic flora. The c value of 6.8 ties Becker Lake for the highest rating in Portage County and the **floristic quality index** of 55.7 places it second highest of the 31 lakes for which this index has been calculated.

Many of the plants of South Twin Lake are characteristic of soft-water lakes of northernmost Wisconsin, and rarely occur as far south as Portage County. South Twin Lake is the only known location in Portage County for dwarf water-milfoil (*Myriophyllum tenellum*), threadleaf pondweed (*Potamogeton bicupulatus*), and naked bladderwort (*Utricularia cornuta*); and one of two known locations for twig-rush (*Cladium mariscoides*), slender fringe-rush (*Fimbristylis autumnalis*), stiff (spiny-spored) quillwort (*Isoetes echinospora*), Farwell's water-milfoil (*Myriophyllum farwellii*), Vasey's pondweed (*Potamogeton vaseyi*), limp bulrush (*Schoenoplectus subterminalis*), and violet bladderwort (*Utricularia resupinata*). Three of these species - Farwell's water-milfoil,

*Terms in bold, see glossary pp 18-23

Vasey's pondweed, and violet bladderwort - are rare throughout Wisconsin and thus are on the state list of Special Concern species.

Most of the submersed and emergent species have been found in shallow water throughout the lake, but are best represented near the east shore. Only during years of low water when parts of the shallow water zone are exposed do several normally submersed species, such as dwarf water-milfoil, limp bulrush, needle spikerush (*Eleocharis acicularis*), white buttons (*Eriocaulon aquaticum*), northern St. John's-wort (*Hypericum boreale*), brown-fruited rush (*Juncus pelocarpus*), and naked bladderwort flower and produce seed. This newly exposed lake bottom is vulnerable to invasion by weedy annuals which could easily displace these rare native plants. Therefore, native vegetation should be maintained on the shoreline and monitored for the appearance of alien species.

The small bog on the northeastern shore appears to be an intact high-quality bog, but has received little study prior to 2003. It needs to be surveyed for rare species.

Although most of the rare or notable species of this lake were still present in 2003, many of them appear to be declining in abundance. Unlike the observations made between 1968 and around 2000, filamentous **algae**, silt, and suspended material are becoming problems. Most of the rare or notable plants of South Twin Lake require clear **soft water** and low nutrient levels for their survival.

Current Water Quality Conditions

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.

South Twin is a very shallow lake with an east-west fetch so that it mixes routinely. As Figure 10 shows the temperature of the lake is fairly uniform from top to bottom. Because the lake does not stratify, oxygen distributes fairly uniformly throughout the lake; however, oxygen depletion problems at the bottom of the lake are seen in the late winter profiles in both 2003 and 2004 (Figure 11). Winter oxygen depletion is a common problem in shallow lakes with nutrient rich sediments. Most fish need a minimum of 5 **mg/L** of dissolved oxygen to thrive. The dissolved oxygen (DO) graph for South Twin Lake shows two years of data in which dissolved oxygen falls below this level at a depth of about 3 feet in both late winter and the middle of summer.

Figure 10. Profile of temperature in South Twin Lake 2002-2004.

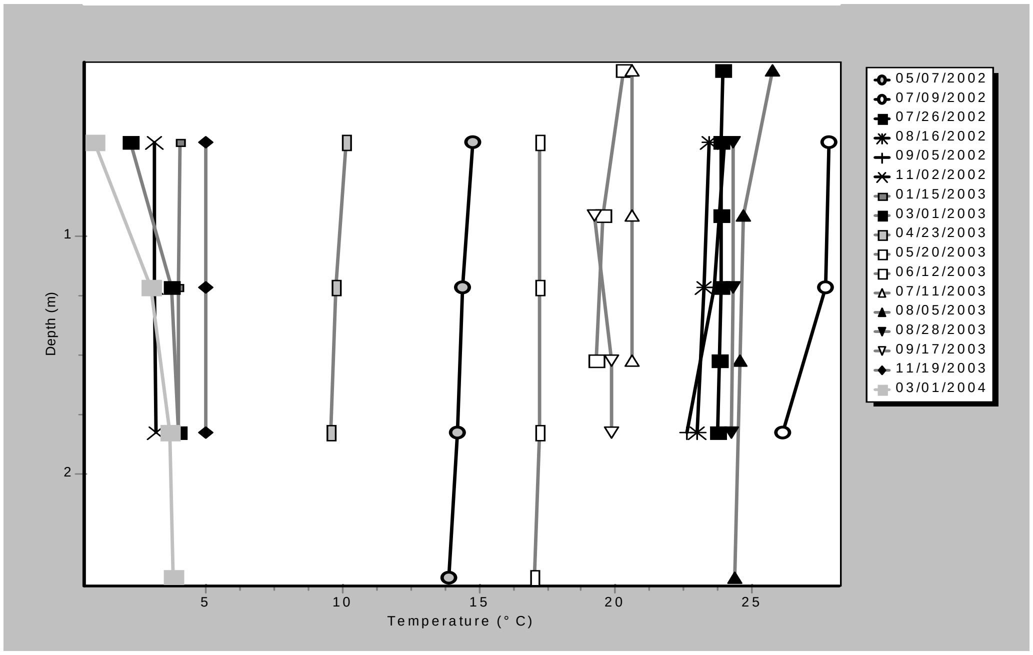
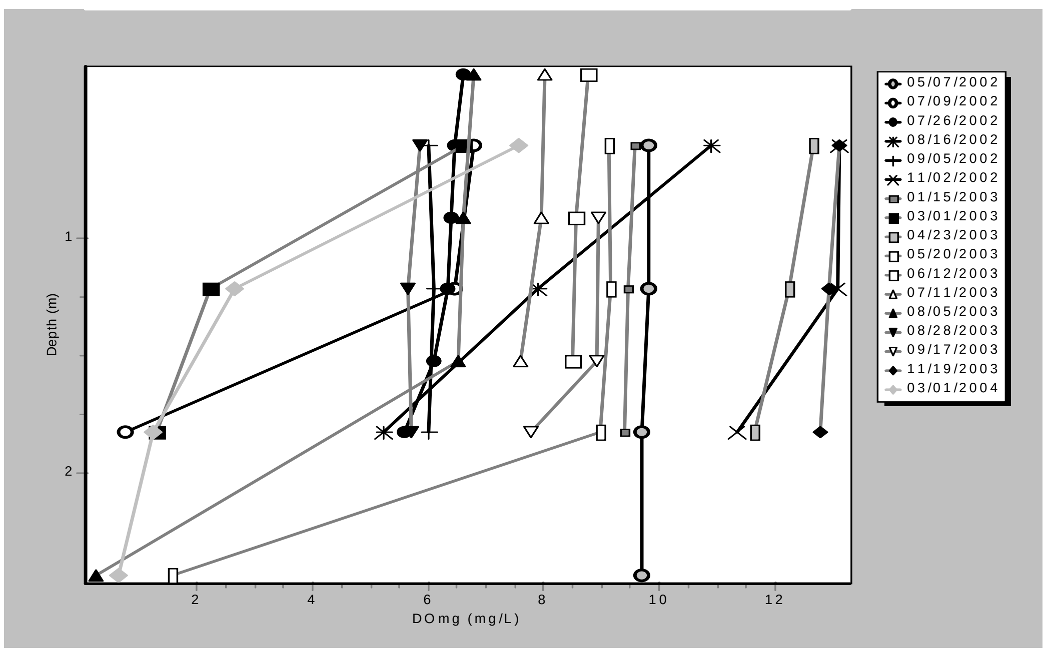


Figure 11. Profile of dissolved oxygen in South Twin Lake 2002-2004.

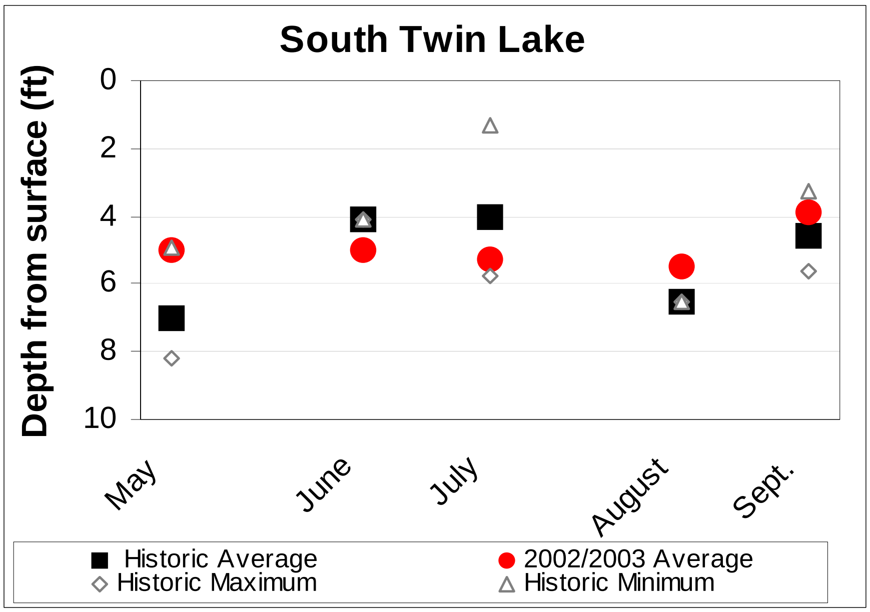


As an indicator of water quality, water **clarity** consists of dissolved materials in the water (**color**) and suspended materials in the water (**turbidity**). **Turbidity** consists of **suspended solids**, such as suspended sediments and **algae**. The **color** of the water in South Twin is in the low to medium range and is likely being naturally elevated by the

*Terms in bold, see glossary pp 18-23

tannins from the wetlands. The **turbidity** measured in South Twin Lake was also low despite the water being mixed by wind and motorcraft (Figure 12). Figure 12 shows the average monthly water **clarity** measurements from May through September 2002-2003. The readings range between 3.9 and 5.5 foot deep throughout the season which is notably worse than the 9 foot average for similar lakes in the county. This poor water **clarity** is primarily due to **algae**.

Figure 12. Monthly average water clarity measurements in South Twin Lake 2002-2003 and historic average, maximum and minimums.



Phosphorus and **nitrogen** are the primary nutrients of concern in our lakes as they drive aquatic plant and **algae** growth. In South Twin Lake **phosphorus** is the most important nutrient. Reactive **phosphorus** is easily available to plants because is dissolves in the water. South Twin Lake has a 2002-2003 spring average of 6.5 *u*g/L (Table 2) which is less than the 10 *u*g/L maximum **concentration** desired to limit summer **algae** blooms. Total **phosphorus** levels remain more stable than reactive **phosphorus** levels and include reactive **phosphorus** as well as the **phosphorus** suspended in plant and animal fragments in the lake water. The 2002-2003 average level of total **phosphorus** during spring and fall overturn was 30 *u*g/L, which is above the 25.5 *u*g/L average for other **seepage lakes** in the county. Total **phosphorus** levels above 30 *u*g/L categorize a lake as **eutrophic** giving it the nutrient level to support a large biomass of aquatic plants and **algae** and making it susceptible to oxygen depletion. Because South Twin is a shallow lake that is well mixed by the wind most of the year, the **phosphorus** in the sediment is continually re-suspended in the water column. Motorized boating activity can exacerbate this situation. In addition it is a soft-water lake without the mineral content, specifically calcium, to bind the **phosphorus**-forming **marl**. This combination of being well mixed and being low in calcium makes this lake particularly vulnerable to **phosphorus** loading

*Terms in bold, see glossary pp 18-23

from both natural and human sources, as the **phosphorus** remains dissolved in the water rather than bound in the sediment.

Nitrogen is the second most important nutrient after **phosphorus**. It is a major component of plants and animals, but is not found in the soil unless it is being deposited by animal or human waste, or fertilizers. The inorganic forms of **nitrogen** (NO_2+NO_3+NH_4) in South Twin Lake are less than 0.3 **mg/L** in the spring, so although plants and **algae** can use these forms of **nitrogen** it is unlikely that there is enough inorganic **nitrogen** to drive summer **algae** blooms (Table 2). Lakes may lose **nitrogen** to the atmosphere through denitrification if the oxygen in the lake becomes depleted.

Atrazine was found in low concentrations in the lake water (0.16 and 0.09 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 South Twin Lake.

Table 2. 2002-2003 water quality seasonal averages in South Twin Lake.

South Twin 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 (ug/L)*
Spring Averages	32.0	6.5	1.06	0.06	0.03	6.0	11.0	5.5	51	1.7	5.1
Summer Averages	29.1	7.0	1.04	0.03	0.01	5.5	9.5	4.3	43	1.8	9.9
Fall Averages	28.0	5.0	1.30	0.03	0.07	6.5	8.0	5.5	43	2.8	
Winter Averages	32.3	7.5	1.40	0.05	0.24						
2002-2004 Averages	29.4	5.4	1.15	0.04	0.03	16.5	8.5	5.1	45	2.1	8.7

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

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 (Table 3). **Sulfate** levels are also low in South Twin Lake. **Sulfate** is most often associated with specific mineral types in the **watershed** or with acid rain resulting from coal burning industries.

Table 3. 2002-2003 water chemistry averages in South Twin Lake and reference values.

South Twin	*Low*	*Medium*	*High*	**Reference Values**	*Low*	*Medium*	*High*
Sulfate	4.67			*Sulfate*	<10	10-20	>20
Chloride	0.56			*Chloride*	<3	3-10	>10
Potassium	1.22			*Potassium**	<2.16	2.16-4.30	>4.30
Sodium	0.40			*Sodium**	<2.28	2.28-5.09	>5.09

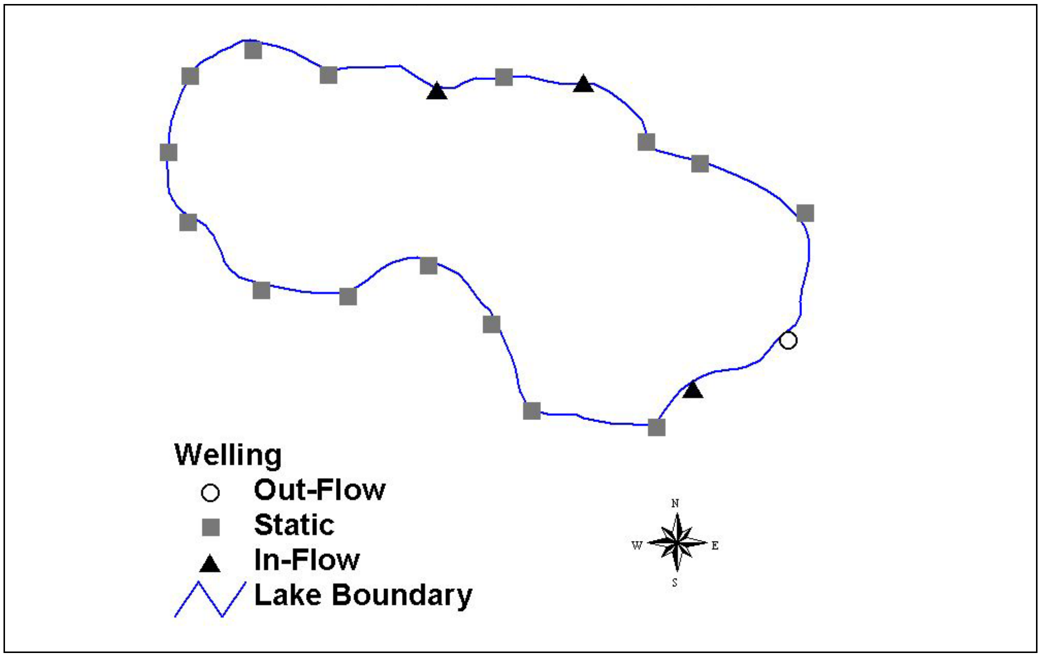
**Ranges of low, medium, high defined by taking the median values from the lake study and dividing into thirds.*

Installation of mini-piezometers in July 2003 show the inflow of **groundwater** along the north shore of the lake and outflow at the southeast end as expected based on the **groundwater** table contours. One point of local inflow was detected on the south shore

*Terms in bold, see glossary pp 18-23

(Figure 13). A chemical analysis of inflow from the north shore showed only trace amounts of **nitrate**, **ammonium**, reactive **phosphorus**, **chloride,** and **atrazine**. However, the detection of any **atrazine** in these samples indicates that there is **atrazine** in the **groundwater** and should be of concern.

Figure 13. Areas of groundwater inflow/no flow/outflow to South Twin Lake based on mini-piezometer measurements.



Algal Community

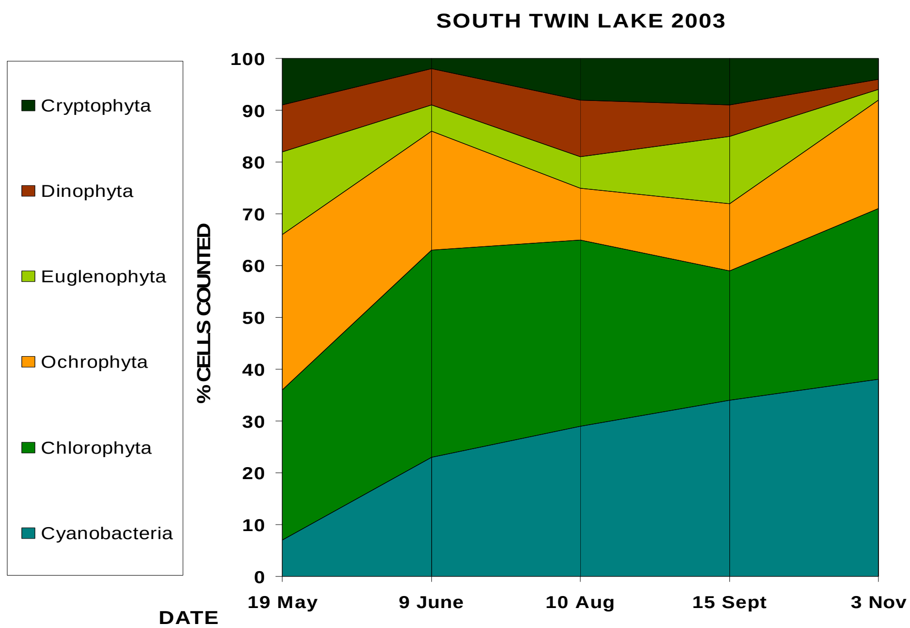
The algal community in South Twin Lake (Table 4) was dominated by green **algae** (Chlorophyta) and **blue-green algae** (Cyanobacteria); these groups accounted for 59% of all cells counted. In the 3750+ cells counted during this period there were 9 genera of Cyanobacteria, 12 genera of Chlorophyta, 12 genera of Ochrophyta (including 10 diatom genera), 4 genera of Euglenophyta, 2 general of Dinophyta, and 2 genera of Cryptophyta identified. The green **algae** represented between 25-40% (mean = 33%) of all cells counted and the **blue-green algae** represented between 7-38% (26%) of all cells counted (Table 4). The green **algae** were the dominant group in the May, June, and August sample periods while the **blue-green algae** were the most dominant group in September and November sample periods (Figure 14). The ochrophytes, mostly **diatoms**, were the co-dominant group during May and remained abundant in the June samples before slipping to minor status during August and September. The **diatoms** made a return to 21% of cells counted in November, probably due to lake mixing. The euglenoids, dinoflagellates, and cryptophytes combined averaged 21% of all cells counted and never did one of these phyla appear in numbers greater than 16% (Euglenophyta. May).

*Terms in bold, see glossary pp 18-23

Table 4. Algal phyla and mean seasonal composition in South Twin Lake from May to November 2003.

SOUTH TWIN LAKE						
PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	7	23	29	34	38	26
Chlorophyta	29	40	36	25	33	33
Ochrophyta	30	23	10	13	21	19
Euglenophyta	16	5	6	13	2	8
Dinophyta	9	7	11	6	2	7
Cryptophyta	9	2	8	9	4	6

Figure 14. Algal community composition by date in South Twin Lake from May to November 2003 (total phylum cells counted divided by total cells counted).



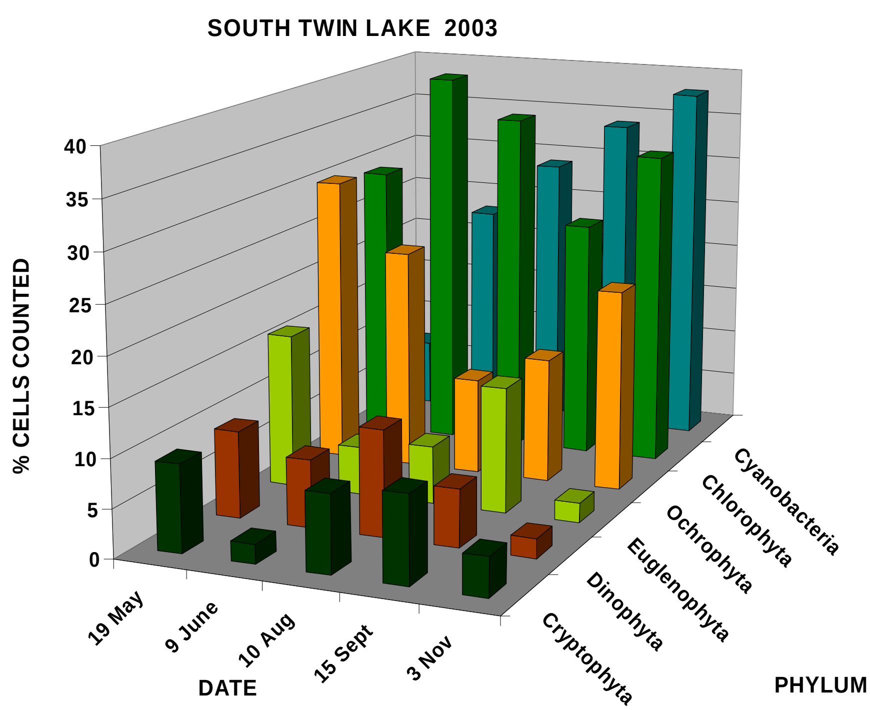
Green and **blue-green algae** (*Coelastrum*, *Anabaena*) were the dominant South Twin Lake taxa in four of five sample periods and occupied the top three abundance spots in 7 of 15 samples (Table 5). The filamentous diatom *Melosira* bloomed early in the season (May) and then dropped to a very minor component in the remaining sample periods (Figure 15). The colonial chlorophyte *Coelastrum* was common in May, then bloomed quickly to dominate in June and August before slipping back to a common (top 5) taxon during September and November. *Anabaena*, a filamentous cyanobacterium, was a minor but present component in May, becoming common in June and August, and then dominating in September and November. Cyanobacteria occupied 8 of 15 most abundant slots during the sampling period. The colonial diatom genus *Asterionella*, the colonial

*Terms in bold, see glossary pp 18-23

cyanobacterial genera *Coelosphaerium* and *Woronichinia*, and the dinoflagellate genus *Amphidium* were the other most common taxa during the sampling period. While they never figured as significant numerical dominants, there was a substantial filamentous green algal mat/cloud (genus *Mougeotia*) that formed periodically during the sampling period.

The algal community, when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for South Twin Lake, indicates a very **mesotrophic** lake. The 41 genera identified during the sample periods are all relatively common in the region and the muted dynamics of the algal community during the growing season (dominated by a few taxa of greens and blue-greens) are typical of a fairly **mesotrophic** lake like South Twin Lake. Also typical of very **mesotrophic** lakes is the common occurrence of facultative heterotrophic genera like the euglenophyte *Colacium*, *Euglena*, *Phacus*, and *Trachelomonas*; and dinoflagellates *Peridinium* and *Amphidinium*. These organisms are an indication of organic matter being present at times in the lake. Motile heterotrophs like these can use organic materials for food in place of or in supplement to **photosynthesis**. In many cases, an algal community such as that seen in this lake can be attributed to some source of organic enrichment such as heavy agricultural runoff, failing septic systems, or mixing of bottom sediments into the water column. Water **clarity** was poor most of the sampling period. The **clarity** dropped substantially during the mid-late growing season (August to November) when the green and **blue-green algae** dominated.

Figure 15. Algal community composition by phylum in South Twin Lake from May to November 2003.



*Terms in bold, see glossary pp 18-23

Table 5. Most common algal genera by date in South Twin Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Melosira*	*Asterionella*	*Coelastrum*
9 June	*Coelastrum*	*Asterionella*	*Anabaena*
10 August	*Coelastrum*	*Anabaena*	*Amphidinium*
15 September	*Anabaena*	*Coelosphaerium*	*Woronichinia*
3 November	*Anabaena*	*Coelosphaerium*	*Woronichinia*

*Terms in bold, see glossary pp 18-23

South Twin Lake Study Highlights

- The area surrounding South Twin Lake was found to be unique, not only in its status as one of the few **soft water** lakes in the county, but in that it is rich in rare and high quality plant life. While not immediately in the **watershed** it is also worth noting that there is a Native American archeological area nearby, to the east of North Twin Lake.
- Reptile surveys were not conducted near South Twin Lake. Five frog species were observed during the amphibian survey near South Twin Lake (spring peeper, chorus frog, American toad, gray treefrog, green frog). The primary amphibian habitat is located on the south, west, and east sides of the lake.
- The shoreline of South Twin Lake is primarily composed of tamarack/black spruce wetland (44.2 %) Twenty-eight percent of the shoreline is defined as narrow wetland shore and another 16.8 % of the shoreline is composed of vegetated shoreline. Ten percent of the shoreline is considered to be disturbed. Of that, 5.9 % is considered to be in the low disturbance developed category and 4.5% is considered to be in a highly disturbed developed state.
- This number of species in South Twin Lake, on shore, or in the bog on the northeast shore.is above average for Portage County lakes. The average **coefficient of conservatism (c-value)** and the **floristic quality index**, are also above average for Portage County lakes. South Twin Lake holds a rich and unusual aquatic flora. The **c-value** of 6.8 ties Becker Lake for the highest rating in Portage County and the **floristic quality index** of 55.7 places it second highest of the 31 lakes for which this index has been calculated.
- Many of the plants of South Twin Lake are characteristic of soft-water lakes of northernmost Wisconsin, and rarely occur as far south as Portage County. South Twin Lake is the only known location in Portage County for dwarf water-milfoil, threadleaf pondweed, and naked bladderwort; and one of two known locations for twig-rush, slender fringe-rush, stiff (spiny-spored) quillwort, Farwell's water-milfoil, Vasey's pondweed, limp bulrush, and violet bladderwort. Three of these species - Farwell's water-milfoil, Vasey's pondweed, and violet bladderwort are rare throughout Wisconsin and thus are on the state list of Special Concern species.
- Most of the submersed and emergent species have been found in shallow water throughout the lake, but are best represented near the east shore. Only during years of low water when parts of the shallow water zone are exposed do several normally submersed species, such as dwarf milfoil, limp bulrush, needle spikerush, white buttons, northern St. John's-wort, brown-fruited rush, and naked bladderwort flower and produce seed. This newly exposed lake bottom is vulnerable to invasion by weedy annuals which could easily displace these rare native plants. Therefore, native vegetation should be maintained on the shoreline and monitored for the appearance of alien species.
- The small bog on the northeastern shore appears to be an intact high-quality bog, but has received little study prior to 2003. It needs to be surveyed for rare species.

*Terms in bold, see glossary pp 18-23

- Although most of the rare or notable species of this lake were still present in 2003, many of them appear to be declining in abundance. Unlike the observations made between 1968 and around 2000, filamentous **algae**, silt, and suspended material are becoming problems. Most of the rare or notable plants of South Twin Lake require clear **soft water** and low nutrient levels for their survival.
- The algal community, when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for South Twin Lake, indicates a very **mesotrophic** lake. The 41 genera identified are all relatively common in the region and the muted dynamics of the algal community during the growing season (dominated by a few taxa of greens and blue-greens) are typical of a fairly **mesotrophic** lake like South Twin Lake. Also typical of very **mesotrophic** lakes is the common occurrence of facultative heterotrophic genera like the euglenophyte *Colacium*, *Euglena*, *Phacus*, and *Trachelomonas*; and dinoflagellates *Peridinium* and *Amphidinium*. These organisms are an indication of organic matter being present at times in the lake. Motile heterotrophs like these can use organic materials for food in place of or in supplement to **photosynthesis**. In many cases, an algal community such as that seen in this lake can be attributed to some source of organic enrichment such as heavy agricultural runoff, failing septic systems, or mixing of bottom sediments into the water column. Water **clarity** was poor most of the sampling period. The **clarity** dropped substantially during the mid-late growing season (August to November) when the green and **blue-green algae** dominated.

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.

*Terms in bold, see glossary pp 18-23

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."

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.

*Terms in bold, see glossary pp 18-23

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 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. 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 than180 mg/L $CaCO_3$.

*Terms in bold, see glossary pp 18-23

Impoundment:

Manmade lake or reservoir usually characterized by stream inflow and always by a stream outlet. Because of nutrient and soil loss from upstream land use practices, impoundments ordinarily have higher nutrient concentrations and faster sedimentation rates than natural lakes. Their retention times are relatively short.

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”

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.

*Terms in bold, see glossary pp 18-23

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.

Photosynthesis:

The process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

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.

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.

*Terms in bold, see glossary pp 18-23

Sodium:

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

Soft Water:

Water with less than 60 mg/L CaCO3 (see Hard water).

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 18-23