Sunset Lake

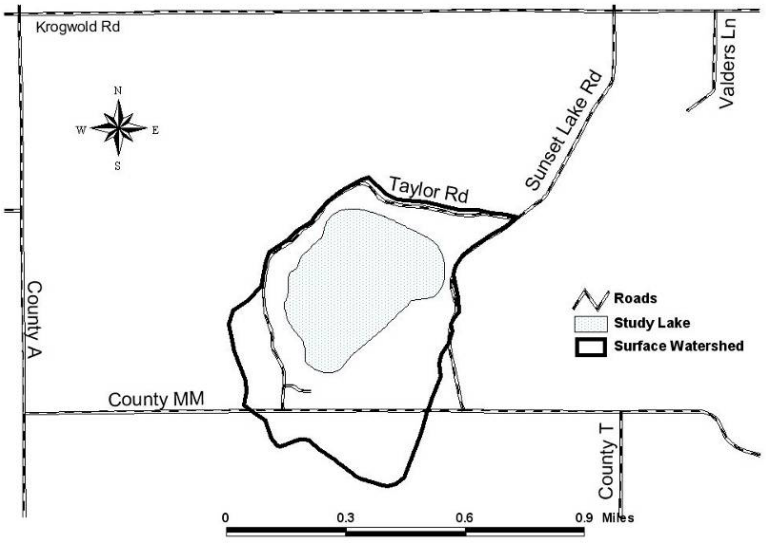
Introduction

Sunset Lake is a 61.2 acre, **hard water seepage lake** located in the Town of New Hope, five miles northeast of Nelsonville. With a maximum depth of 55 feet, it is one of the deepest lakes in the County. The estimated **retention time** is 20.8 years. The near-shore **littoral** areas of the lake have large stretches of sand and gravel. Smaller stretches of rubble and silt are also present. The lake is a well-known recreation spot and the shoreline has been developed over the years. A County park is present on the east side with picnic tables, grills, toilets, a beach, playground, and boat ramp as part of the facilities. A large parking area is also present. The Central Wisconsin Environmental Station, a camp run by the University of Wisconsin-Stevens Point, occupies much of the southeast side of the lake. Residences occupy the remainder of the shoreline. Many of these are well hidden from view and do not detract from the aesthetic value of the lake. The majority of the shoreline is still forested with steep slopes lining the lake. This lake has seen some intense fishery management in the past, including chemical treatments to remove the entire fish population in order to restock "more desirable" species. Currently, largemouth bass, panfish, and trout are present. Sunset Lake serves as an excellent feeding and loafing area for waterfowl, particularly diver ducks during migration.

Land Use and Watershed

Sunset Lake's surface **watershed** is approximately 318 acres (Figure 1). As of 2002 the land use in this small **watershed** was predominantly forested (50%), followed by non-irrigated agriculture (28%) (Figure 2). Since 1948 the surface **watershed** has seen an increase in the amount of forested area and a significant decrease in herbaceous vegetation. Other land uses have remained relatively constant (Figure 3).

Figure 1. Sunset Lake surface watershed boundary.



*Terms in bold, see glossary pp 16-21

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

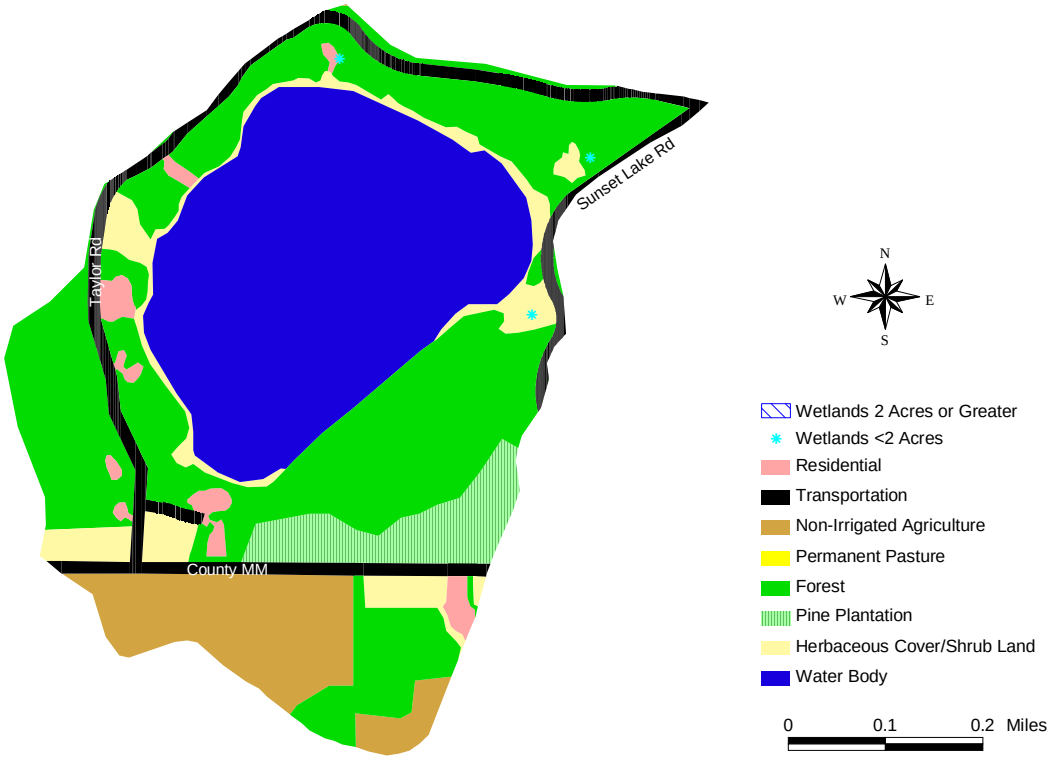
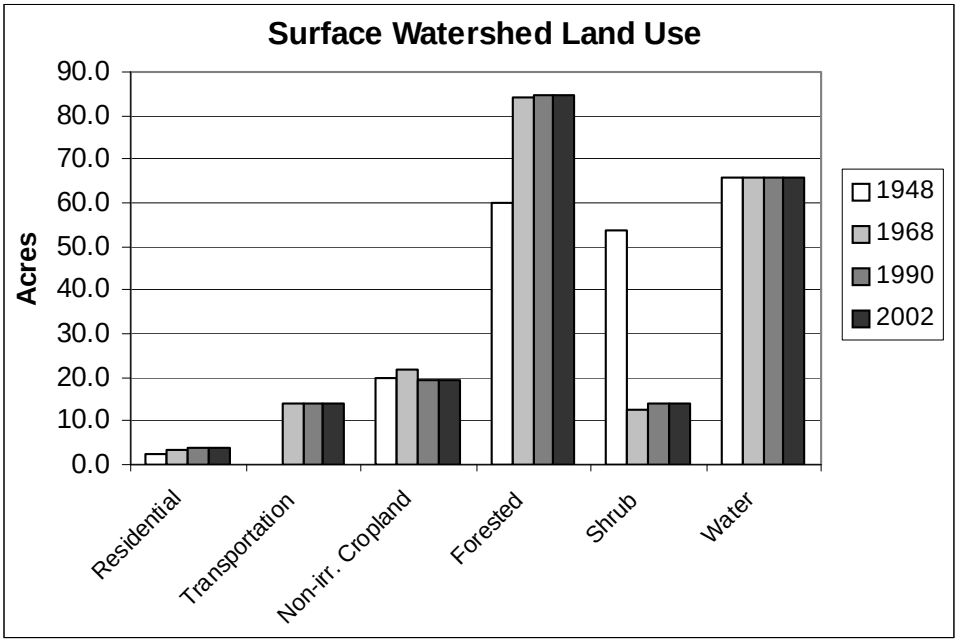


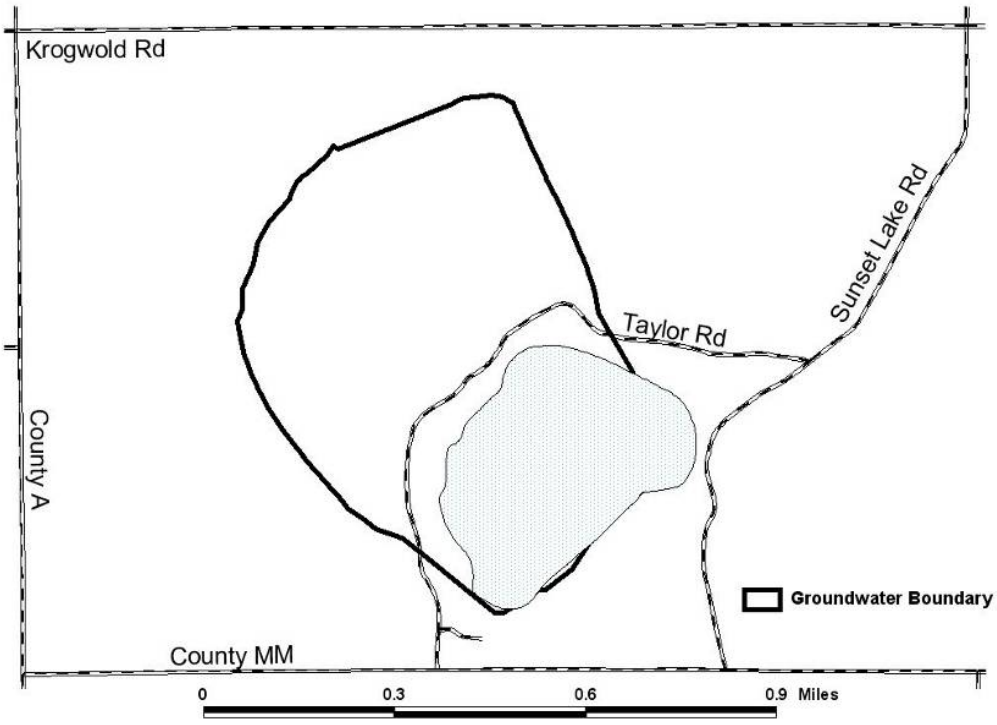
Figure 3. Land use in the Sunset Lake surface watershed 1948-2002.



*Terms in bold, see glossary pp 16-21

The **groundwater watershed** of Sunset Lake is approximately 222 acres and extends northwest of the lake (Figure 4). In this area non-irrigated cropland dominates the landscape (33%), followed by forested areas (24%). Land use in the **groundwater watershed** has not altered significantly since 1948 (Figure 5 and Figure 6). According to the most current records based on age there are no potentially failing septic systems or former landfill sites present in either the surface or **groundwater watersheds**.

Figure 4. Sunset Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 16-21

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

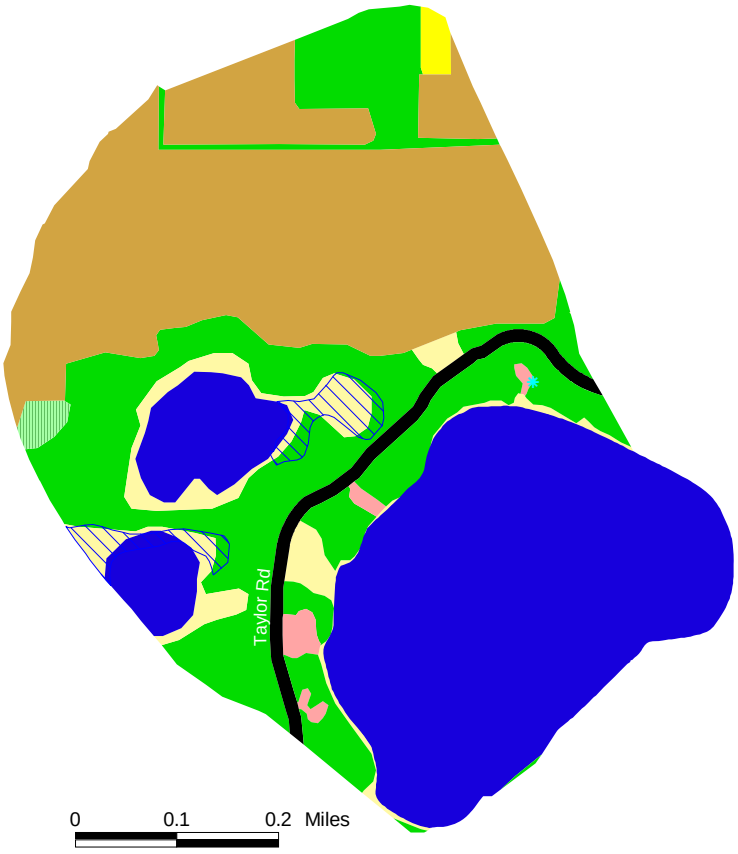
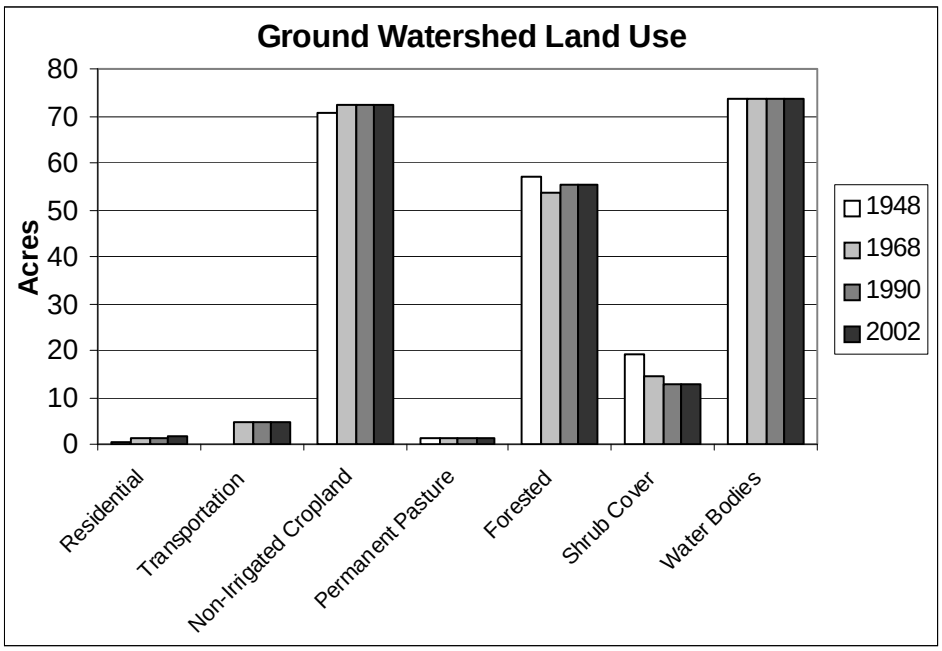


Figure 6. Land use in the Sunset Lake groundwater watershed 1948-2002.

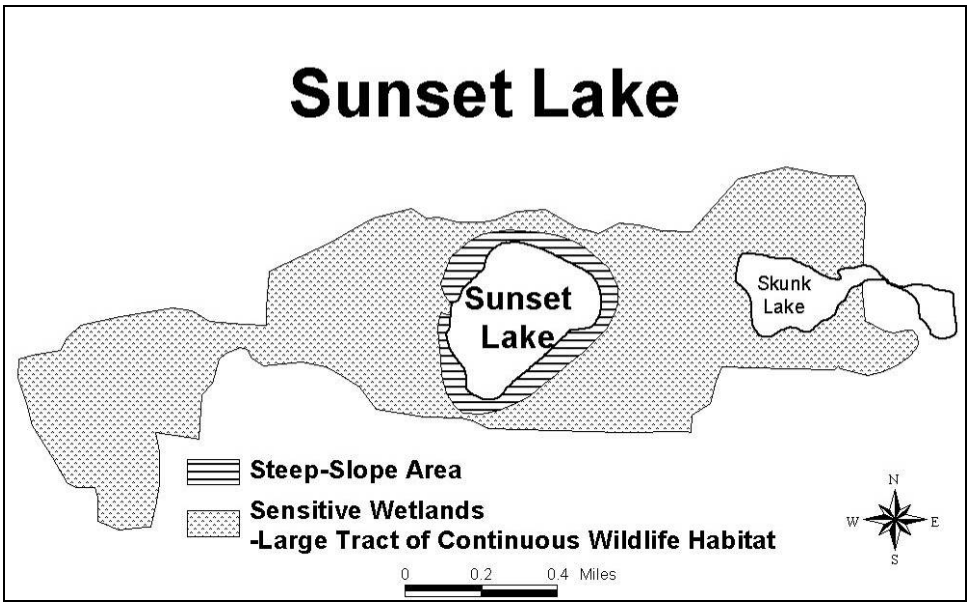


*Terms in bold, see glossary pp 16-21

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. Sunset Lake sits in the middle of a large tract of contiguous wetland that runs east-west and includes most of Skunk Lake. Sunset Lake is also ringed with steep slopes which are prone to **erosion** (Figure 7).

Figure 7. Upland sensitive areas near Sunset 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 16-21

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 Sunset Lake.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	3	seeds	foliage gleaner	cup	shrub
American Robin	3	insects	ground gleaner	cup	deciduous
Baltimore Oriole	2	insects	ground gleaner	oven	ground
Black-and-white Warbler	1	insects	bark gleaner	cup	ground
Black-capped Chickadee	2	insects	foliage gleaner	cavity	deciduous
Blue Jay	1	omnivore	ground gleaner	cup	coniferous
Brown-headed Cowbird	1	insects	ground gleaner	parasite	deciduous
Chipping Sparrow	1	insects	ground gleaner	cup	coniferous
Cooper's Hawk	1	birds	aerial foliager	platform	deciduous
Downy Woodpecker	1	insects	bark gleaner	cavity	snag
Eastern Phoebe	1	insects	bark gleaner	cavity	snag
House Finch	1	seeds	ground gleaner	cup	deciduous
House Wren	2	insects	ground gleaner	cavity	deciduous
Mourning Dove	1	seeds	ground gleaner	saucer	deciduous
Red-eyed Vireo	1	insects	hover gleaner	cup	shrub
Rose-breased Grosbeak	1	insects	foliage gleaner	cup	deciduous
Ruby-throated Hummingbird	1	nectar	hover gleaner	cup	deciduous
White-breasted Nuthatch	2	insects	bark gleaner	cavity	deciduous
Total	**26**				

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 16-21

During the reptile survey Sunset Lake was found to house one turtle species (painted turtle [*Chrysemys picta*]). Six frog species were observed during the survey of Sunset Lake (wood frog [*Rana sylvatica*], spring peeper [*Pseudacris crucifer*], chorus frog [*Pseudacris triseriata*], American toad [*Bufo americanus*], gray treefrog [*Hyla versicolor*], and Cope's gray treefrog [*Hyla chrysoscelis*]), along with two salamander species (blue-spotted salamander [*Ambystoma laterale*] and northern redback salamander [*Plethodon cinereus*]). The primary amphibian habitat is located on the east and southeast sides of the lake (sensitive areas are identified in red and yellow in Figure 8). Some of the key features of this habitat include undisturbed natural shoreline with large amounts of submergent, emergent, and floating-leaf vegetation for frogs; moist wooded areas for salamanders.

The good news is that several species of frogs are present and some large, undisturbed areas of natural shoreline still exist. There is also a small wetland near the boat landing that provides excellent frog habitat, and a large wooded area at CWES which provides ideal habitat for salamanders. The bad news is that sections of highly altered shoreline are present around the lake.

Figure 8. Regions of primary amphibian habitat around Sunset Lake.

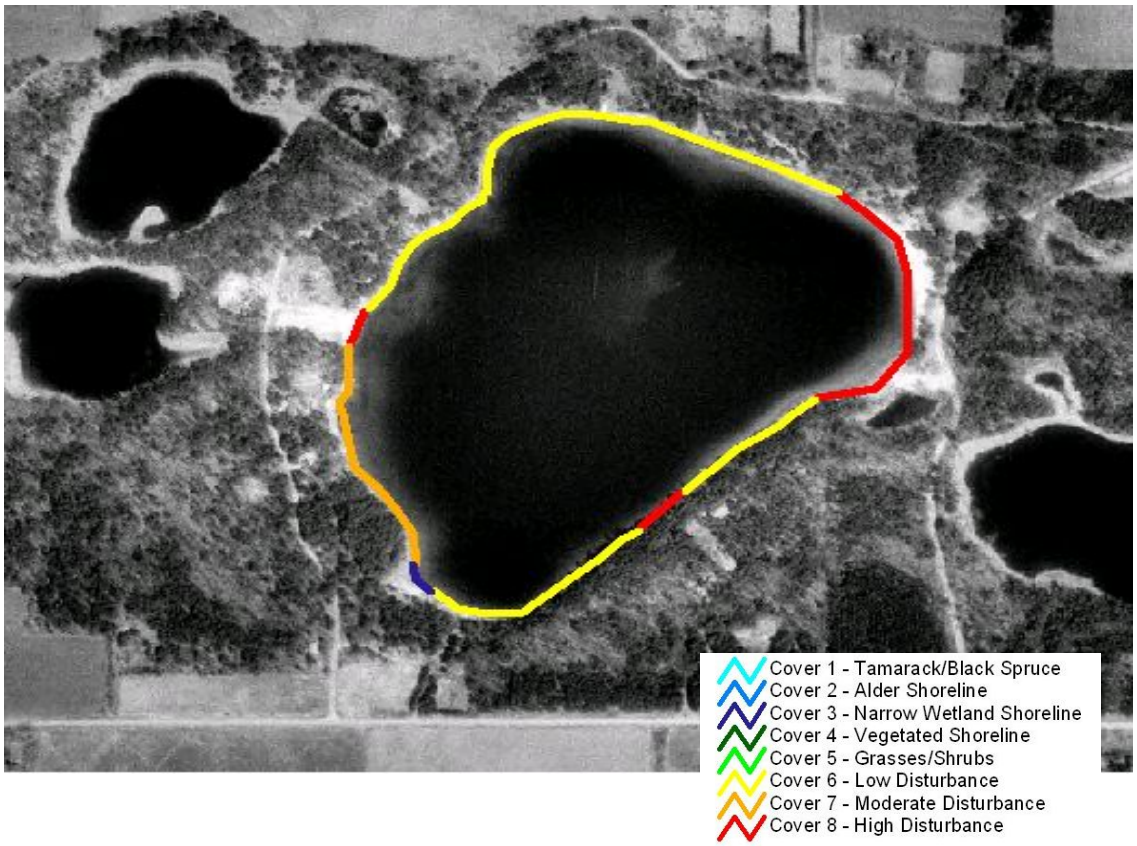
Ninety-eight percent of the shoreline is considered to be disturbed. Of that, 58% of the lake's shoreline vegetation is considered to be low disturbance developed. Moderately disturbed developed areas comprise 15.7% of the disturbed shoreline and 24.1% is

*Terms in bold, see glossary pp 16-21

considered high disturbance. 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 has moderate vegetation disturbance is an area of shore that may contain a mowed lawn but has an intact overstory vegetation. 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.

The shoreline of Sunset Lake consists 2.2% of narrow wetland shore which is represented by dark blue in Figure 9. Narrow wetlands are characterized as being wetland areas that extend less than 5 meters onto the shore and have an adjacent undeveloped upland area.

Figure 9. Shoreline vegetation around Sunset Lake.



Aquatic Plants

There are **69** species of aquatic and wetland **macrophytes** (**68** species of **vascular plants** plus one or more species of **macrophytic** submersed mosses) that have been found in Sunset Lake or on the adjacent wetlands and shore. This is above average for Portage County lakes. The average **coefficient of conservatism (c value)** is **5.3**, which is above average. The **floristic quality index** is **43.6**, which is also above average for Portage County lakes.

Sunset Lake supports a relatively large flora of aquatic and wetland plants. Most of the species are native, and, except for relatively few patches of reed canary-grass (*Phalaris*

*Terms in bold, see glossary pp 16-21

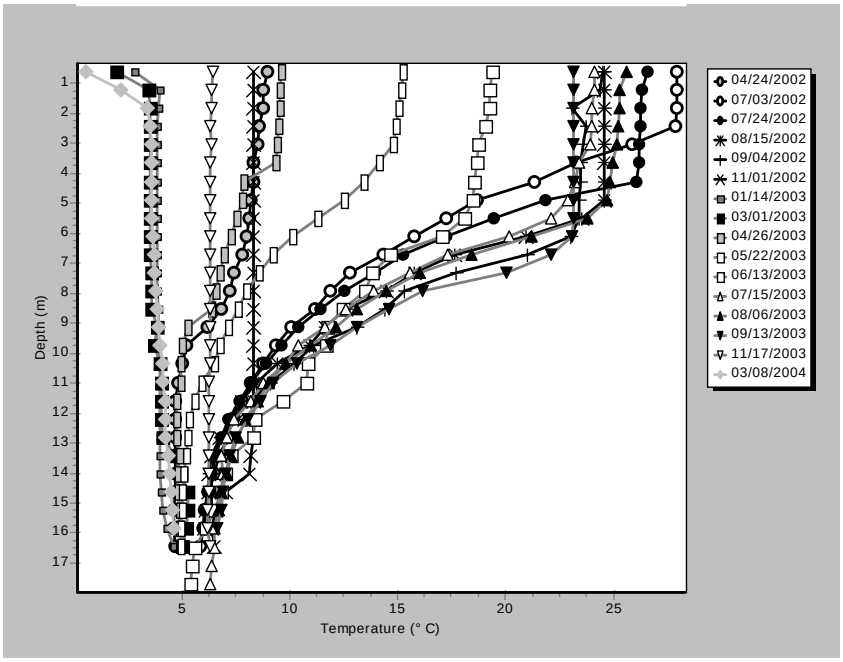
arundinacea), free of invasive species. The north shore is undeveloped and has a good representation of **fen** species.

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.

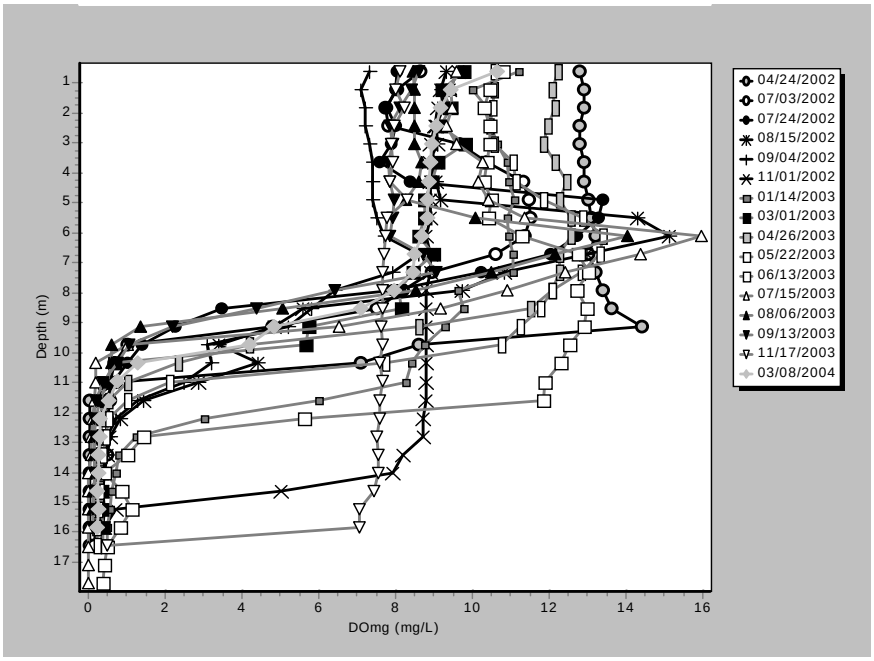
During 2002/03 Sunset Lake exhibited the mixing and **stratification** cycle typical to many Wisconsin lakes (Figure 10). This seasonal mixing helps to replenish oxygen throughout the lake (Figure 11). Because of the shape and depth of the lake and the surrounding steep banks, the lake may not fully mix in seasons without strong winds. There are sufficient dissolved oxygen concentrations to support most aquatic species down to about 18 feet.

Figure 10. Profile of temperature in Sunset Lake 2002-2004.



*Terms in bold, see glossary pp 16-21

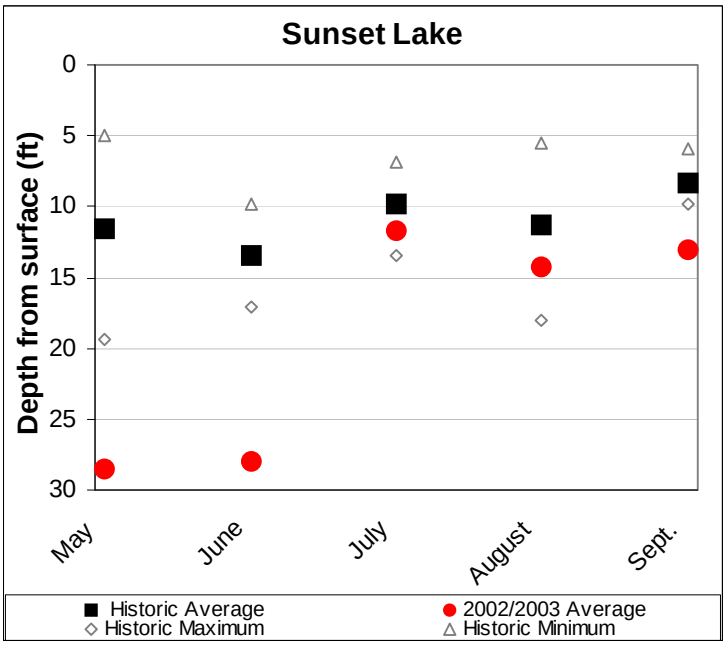
Figure 11. Profile of dissolved oxygen in Sunset Lake 2002-2004.



Water **clarity** is a measure of how deep light can penetrate. It is an aesthetic measure and is related to how deep **rooted aquatic plants** can grow. Water **clarity** is affected by **turbidity** and water **color**. **Turbidity** is caused by **suspended solids**, which include suspended sediments and **algae** (**chlorophyll *a***). All of these measures were low in Sunset Lake (Table 2). Water **clarity** in Sunset Lake was variable throughout the course of the 2002-03 study. During some points **clarity** can be considered good, at other times excellent. The average **Secchi disc** readings for similar **seepage lakes** in the region was around 9 to 10 feet; on average Sunset Lake's **clarity** was better than this. The water **clarity** was best in May, around 28.5 feet, and worst in July, about 12 feet. These large fluctuations can mostly be attributed to **algae** populations and **sedimentation** increase and decrease (Figure 12).

*Terms in bold, see glossary pp 16-21

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



In terms of **algae** and aquatic plant growth, nutrients (**phosphorus** and **nitrogen**) are of primary concern in our lakes. Throughout the year the **phosphorus** and **nitrogen** concentrations are minimal and currently not a concern, however changes in land use practices including increased **erosion**, removal of filtering vegetation or increased runoff due to additional impervious surfaces could increase these concentrations. Sunset Lake is considered moderately hard with about half of the **hardness** from calcium. Indicators of septic system, animal waste, and road salt contaminants including **chloride**, **potassium**, and **sodium** are all low. **Atrazine** concentrations are also low (0.18 and 0.15 µg/L), but show that pesticides are reaching the lake and are of potential concern to its aquatic inhabitants (Table 3).

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

Sunset 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	18.3	1.8	0.62	0.06	0.11	121.8	122.0	64.5	3	0.3	2.8
Summer Averages	17.0	4.2	0.74	0.03	0.07	112.5	109.5	52.3	3	1.4	3.7
Fall Averages	13.0	7.0	1.09	0.01	0.21	116.0	110.0	61.5	9	2.0	
Winter Averages	14.7	4.7	0.88	0.03	0.28						
2002-2004 Averages	16.4	4.4	0.84	0.03	0.17	116.8	113.8	59.4	5	1.2	3.6

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

*Terms in bold, see glossary pp 16-21

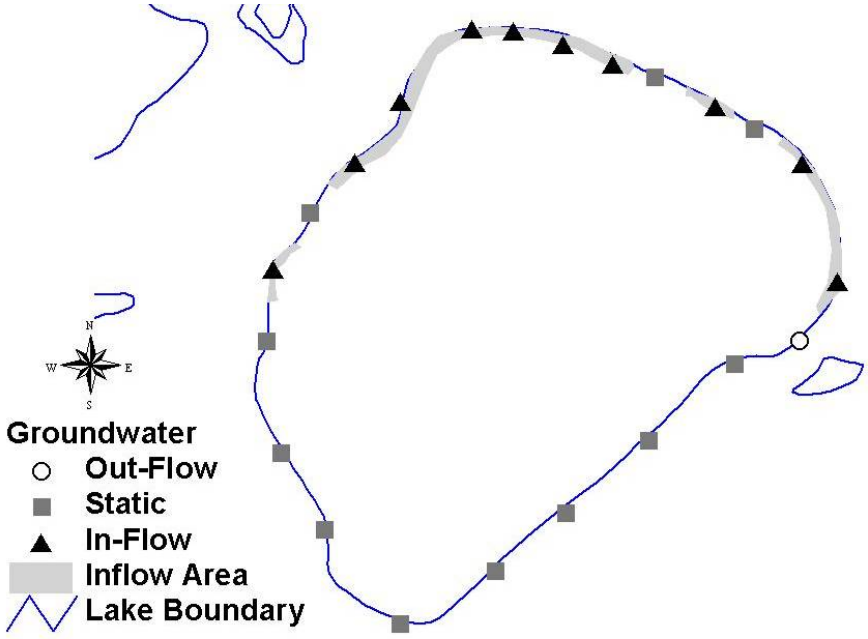
Table 3. 2002-2003 Sunset Lake average water chemistry and reference values.

Sunset Lake	*Low*	*Medium*	*High*	Reference Values	*Low*	*Medium*	*High*
Sulfate	1.73			*Sulfate*	<10	10-20	>20
Chloride	0.95			*Chloride*	<3	3-10	>10
Potassium	0.90			*Potassium**	<2.16	2.16-4.30	>4.30
Sodium	1.40			*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.*

Groundwater entering Sunset Lake was determined using mini-piezometer wells that were placed into the lakebed. Temperature and conductivity were measured when possible and one water sample was collected from the north side for lab analysis. In addition, volunteers made observations of open water in the late winter. The majority of the **groundwater** entering Sunset Lake is from the north and east sides of the lake (Figure 13). The results of the lab analysis showed low concentrations of **nitrate** and **chloride**. **Atrazine** was not detected; however, **atrazine** has been measured in samples obtained from monitoring wells located on the north shore.

Figure 13. Locations in Sunset Lake showing groundwater inflow/no flow/outflow from mini-piezometer measurements and winter observations.



Algal Community

The algal community in Sunset Lake was not particularly diverse. The dominant groups were the green **algae** (Chlorophyta), **blue-green algae** (Cyanobacteria), euglenoids (Euglenophyta), and yellow-green **algae** and **diatoms** (Ochrophyta) (Table 4). These four algal phyla were most represented by the Chlorophyta and Ochrophyta that combined for 49% of all cells counted. The blue-green and euglenoids **algae** were subdominants accounting for 33% of all cells counted. The four dominant phyla represented 82% of all

*Terms in bold, see glossary pp 16-21

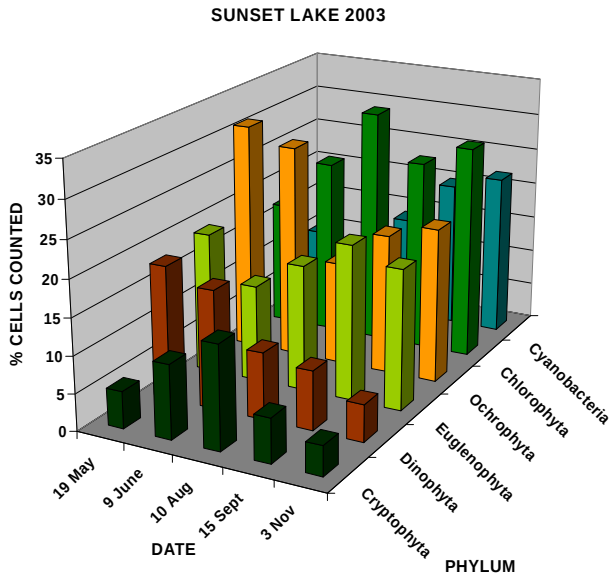
cells counted during the 2003 sampling season. In the 3804 cells counted during this period there were 6 genera of Cyanobacteria, 9 genera of Chlorophyta, 9 genera of Ochrophyta (including 8 diatom genera), 3 genera of Euglenophyta, 3 genera of Dinophyta, and 1 genus of Cryptophyta identified. The Ochrophyta (mostly **diatoms**) dominated the early sample periods (May, June) before dropping to third or fourth sub-dominant the rest of the sampling season. The green **algae** (Chlorophyta) were insignificant in the May sample but rose quickly to the dominant phylum in the remaining sample periods, especially August, September, and November sampling periods. The **blue-green algae** (Cyanobacteria) followed a similar trajectory as the green **algae** but a bit slower and never reached quite the dominance levels of the green **algae**. Euglenoids (Euglenophyta) were a steady contributor of about 15-20 of all cells counted across all sampling periods. The other phyla (Dinophyta, Cryptophyta) totaled about 18% of all cells counted with no phylum ever represented by more that 18% of cells counted in a sample period (Figure 14).

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

SUNSET LAKE

PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					MEAN
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	10	8	14	20	22	15
Chlorophyta	17	24	32	26	29	26
Ochrophyta	31	29	14	19	21	23
Euglenophyta	19	13	17	21	19	18
Dinophyta	18	16	9	8	5	11
Cryptophyta	5	10	14	6	4	8

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

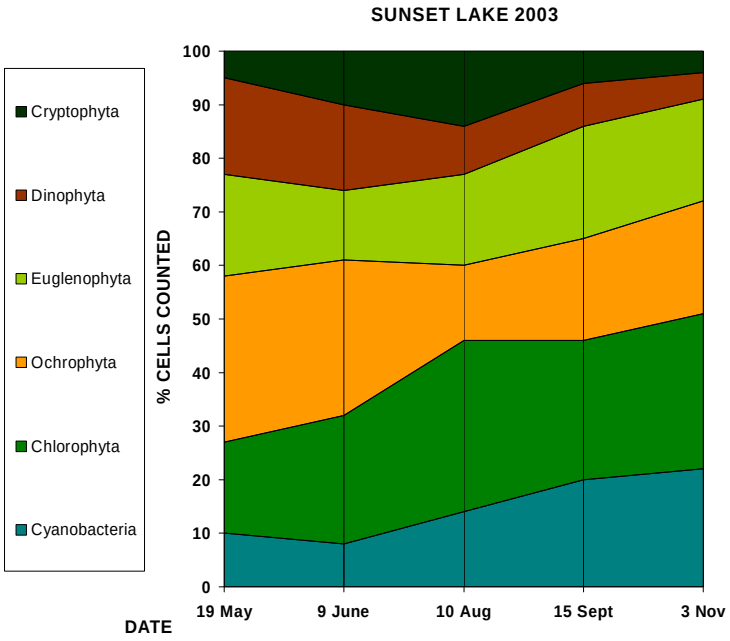


*Terms in bold, see glossary pp 16-21

The diatom taxon *Asterionella*, a beautiful, ring-forming, colonial organism, was the dominant taxon during the early sampling season (May, June) before dropping out of the top spots for the rest of the sampling periods (Figure 15). The green **algae** *Planktosphaeria* and *Ankistrodesmus* were dominant in the three remaining sample periods. No other green **algae** made the top 15 abundance slots during the 2003 sampling period. The euglenoids genus *Phacus* was a subdominant in four of the five samples. The blue-green alga *Coelosphaerium* was twice a subdominant during the late season samples (September, November) while the dinoflagellate genus *Amphidinium* was twice a subdominant, but only during the early season samples (May, June). *Chroomonas*, a cryptophyte genus, was twice a subdominant during midseason (June, August) (Table 5).

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Sunset Lake presents a picture of a fairly **oligotrophic** lake. The 31 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.

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



*Terms in bold, see glossary pp 16-21

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

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Asterionella*	*Amphidinium*	*Phacus 2*
9 June	*Asterionella*	*Chroomonas*	*Amphidinium*
10 August	*Planktosphaeria*	*Chroomonas*	*Phacus 2*
15 September	*Planktosphaeria*	*Coelosphaerium*	*Phacus 2*
3 November	*Ankistrodesmus*	*Phacus 2*	*Coelosphaerium*

*Terms in bold, see glossary pp 16-21

Sunset Lake Study Highlights

- Sunset Lake sits in the middle of a large tract of contiguous wetland that runs east-west and includes most of Skunk Lake. Sunset Lake is also ringed with steep slopes which are prone to **erosion**.
- Sunset Lake was found to house one turtle species (painted turtle). Six frog species were observed during the survey of Sunset Lake (wood frog, spring peeper, chorus frog, American toad, gray treefrog, and Cope's gray treefrog), along with two salamander species (blue-spotted salamander and northern redback salamander). The primary amphibian habitat is located on the east and southeast sides of the lake. Some of the key features of this habitat include undisturbed natural shoreline with large amounts of submergent, emergent, and floating-leaf vegetation for frogs, and moist wooded areas for salamanders.
- Ninety-eight percent of the shoreline is considered to be disturbed. Of that, 58% of the lake's shoreline vegetation is considered to be low disturbance developed. Moderately disturbed developed areas comprise 15.7% of the disturbed shoreline and 24.1% is considered high disturbance.
- The number of species of aquatic and wetland **macrophytes** that have been found in Sunset Lake or on the adjacent wetlands and shore is above average for Portage County lakes. The average **coefficient of conservatism** and the **floristic quality index** are also above average for Portage County lakes.
- Sunset Lake supports a relatively large flora of aquatic and wetland plants. Most of the species are native, and, except for relatively few patches of reed canary-grass, free of invasive species. The north shore is undeveloped and has a good representation of **fen** species.
- **Atrazine** concentrations are low, but show that pesticides are reaching the lake and are of potential concern to its aquatic inhabitants.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Sunset Lake presents a picture of a fairly **oligotrophic** lake. The 31 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.

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.

*Terms in bold, see glossary pp 16-21

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."

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.

*Terms in bold, see glossary pp 16-21

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).

Fen:

A fen is a type of wetland fed by surface and/or groundwater. Fens are characterized by their water chemistry, which is neutral or alkaline, unlike bogs, which are generally acid.

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.

*Terms in bold, see glossary pp 16-21

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. 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 than180 mg/L $CaCO_3$.

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.

*Terms in bold, see glossary pp 16-21

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.

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.

*Terms in bold, see glossary pp 16-21

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 16-21