

# Pickerel Lake

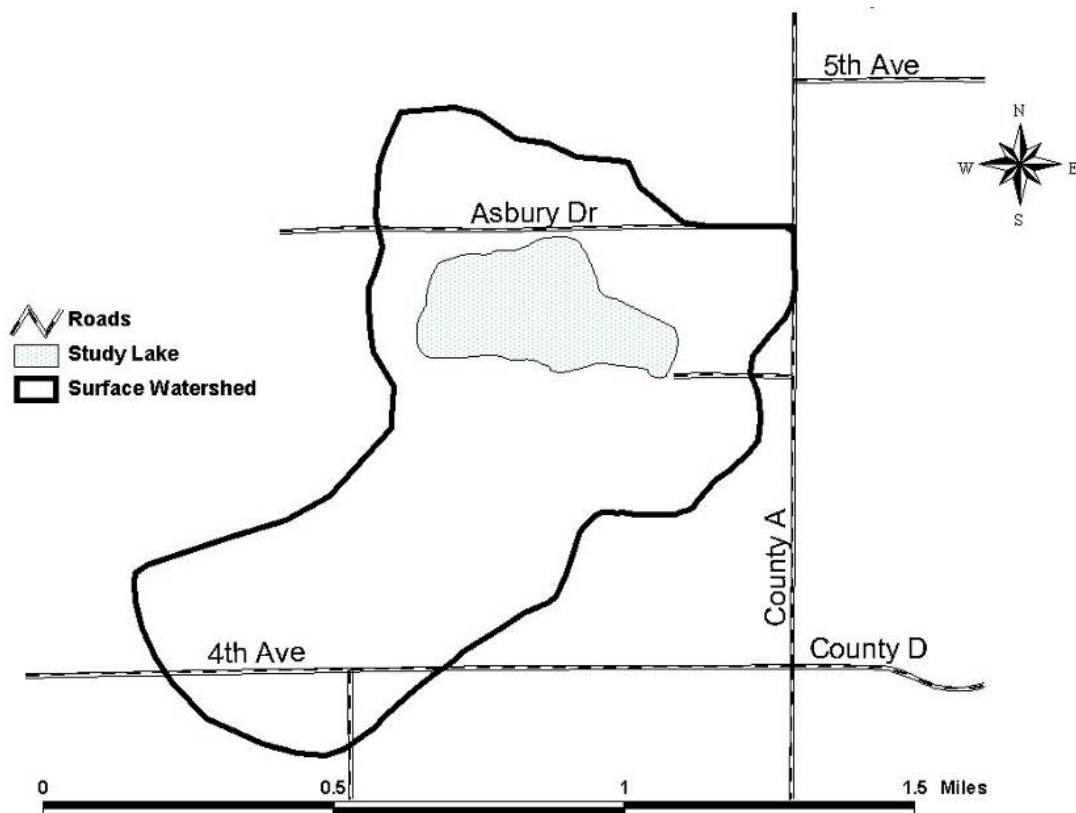
## Introduction

Pickerel Lake is a clear 40 acre, hard-water **marl** seepage lake located in the Town of Belmont, just west of Blaine. It is a relatively shallow lake with a maximum depth of 16 feet and a sandy bottom. The estimated lake volume is 406 acre-feet and the estimated **retention time** is 0.7 years. Historically, the lake experiences significant fluctuations in water level and can become quite low following periods of drought. Poplar and hardwood forest surround the 1.3 mile shoreline. Much of the shoreline is public land that is owned by the state (WDNR). The only developed beach belongs to the camp that owns the balance of the shoreline. The east end of Pickerel Lake offers a boat launch that is open to the public. The fishery at one time was predominantly bass and panfish; however, severe winterkills, low water levels, and oxygen depletion from intense summer **algae** blooms have impacted the fishery.

## Land Use and Watershed

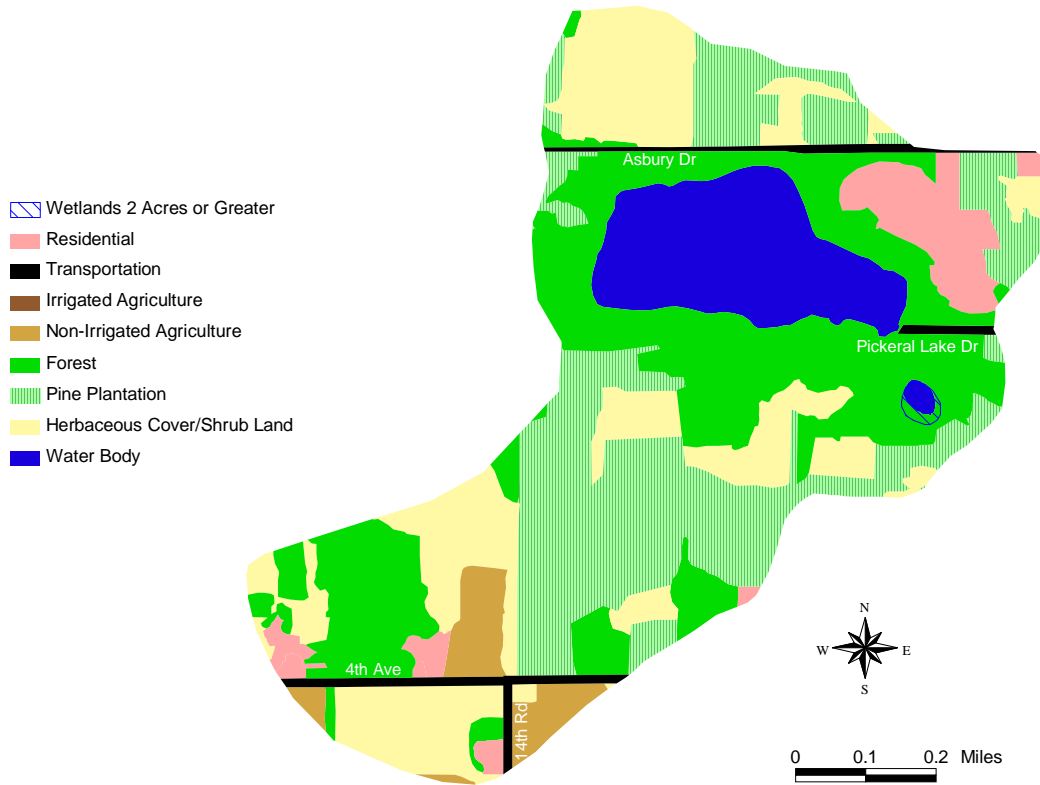
The Pickerel Lake surface **watershed** is approximately 395 acres (Figure 1). The dominant land use in the **watershed** is forest (55%), (Figure 2). Since 1948 there has been a gradual decrease in non-irrigated agricultural area and shrub land. The number of forested acres has steadily increased since 1948, and residential use doubled sometime between 1968 and 1990 (Figure 3).

Figure 1. Pickerel Lake surface watershed boundary.

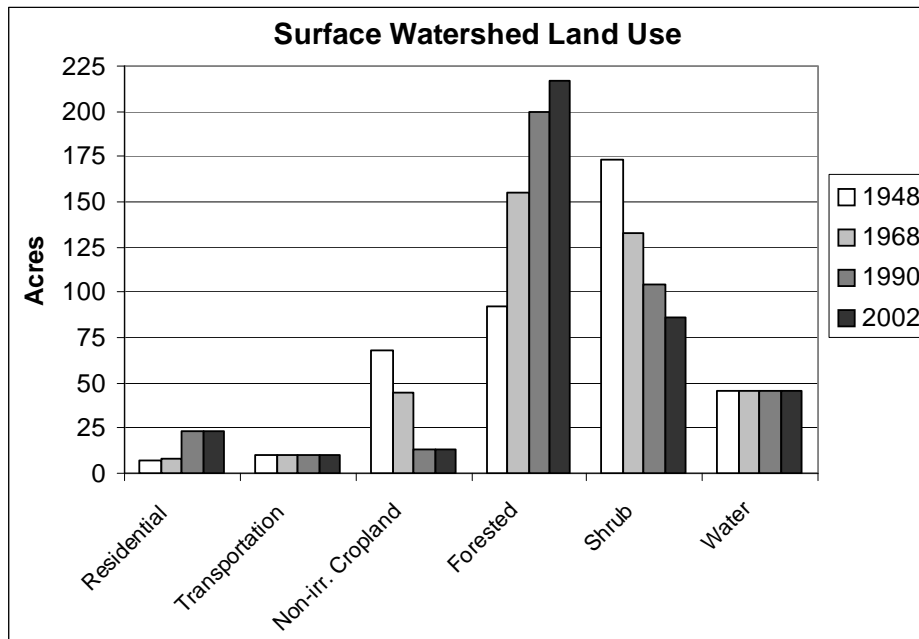


\*Terms in bold, see glossary pp 16-21

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



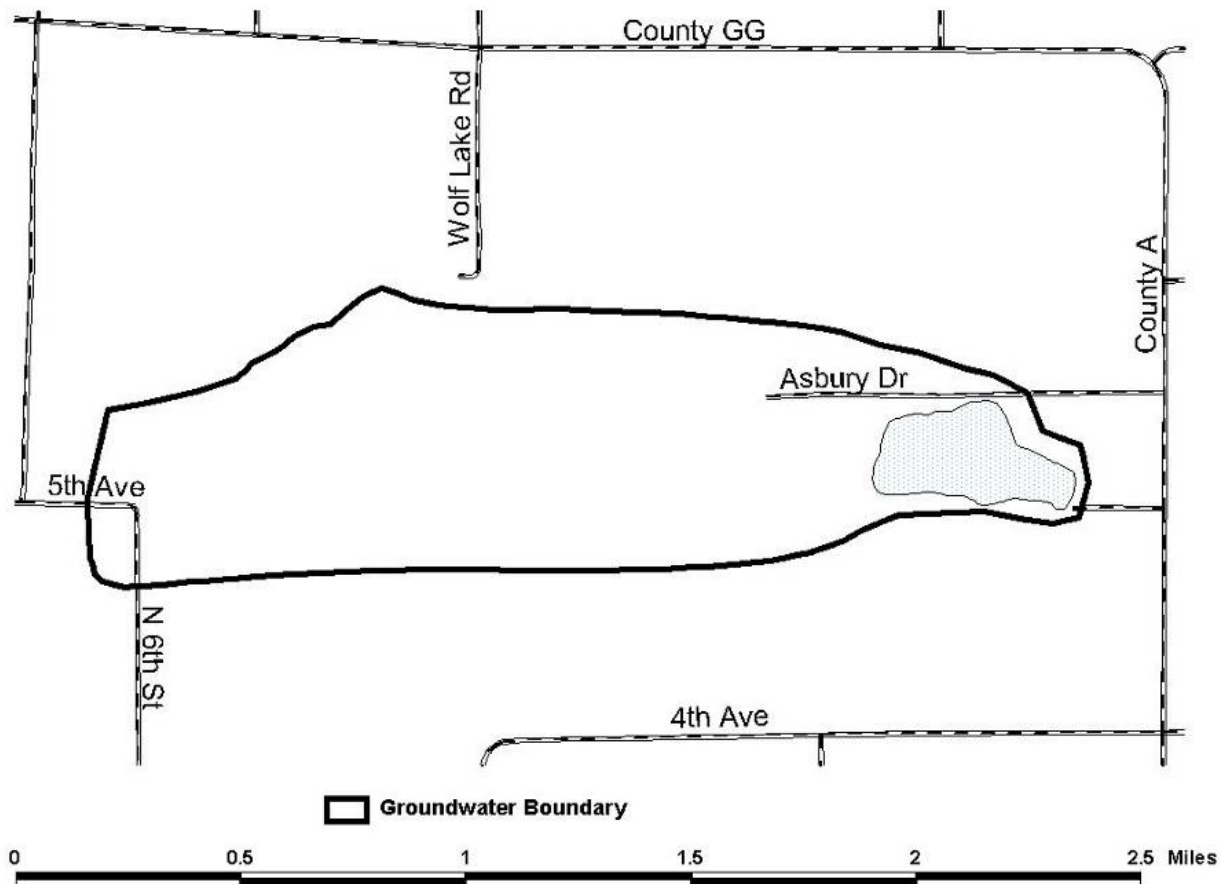
**Figure 3. Land use in the Pickerel Lake surface watershed 1948-2002.**



\*Terms in bold, see glossary pp 16-21

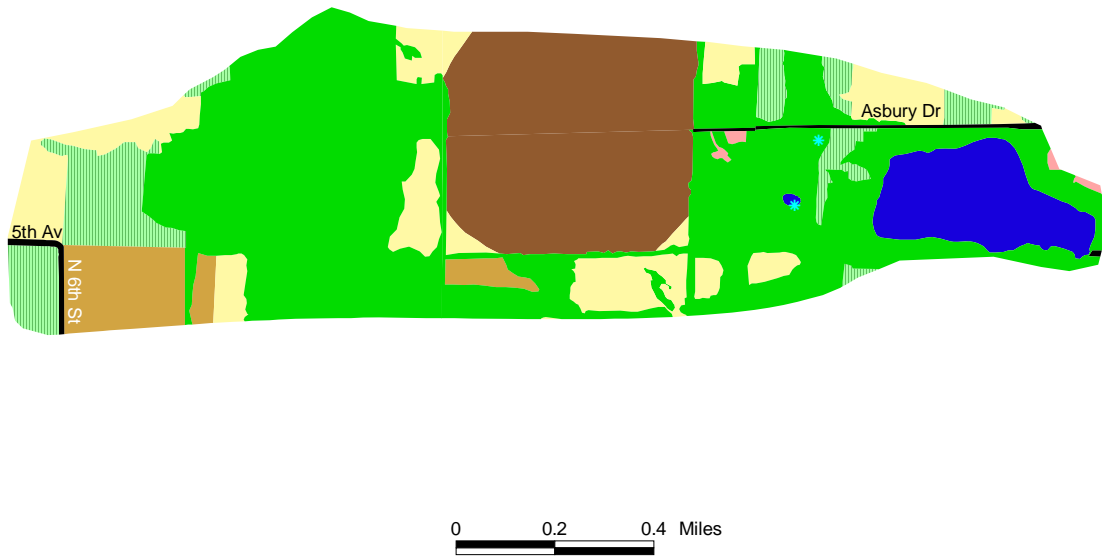
The **groundwater watershed** for Pickerel Lake is 672 acres extending westward from the lake (Figure 4). The dominant land use in this area is forest, which currently comprises over half of the acreage (Figure 5). Sometime after 1968 irrigated agriculture became one of the dominant land uses; however, currently there is only one large irrigated field in the **groundwater watershed**. Non-irrigated agriculture decreased markedly after 1968 and is currently approximately 35 acres. The residential land use is minimal in the **groundwater watershed** and has remained stable since 1948 (Figure 6). An inventory of the County records in 2002 indicate that based on age, there are no potentially failing septic systems or former landfill sites in either the surface or **groundwater watersheds** of Pickerel Lake.

Figure 4. Pickerel Lake groundwater watershed boundary.

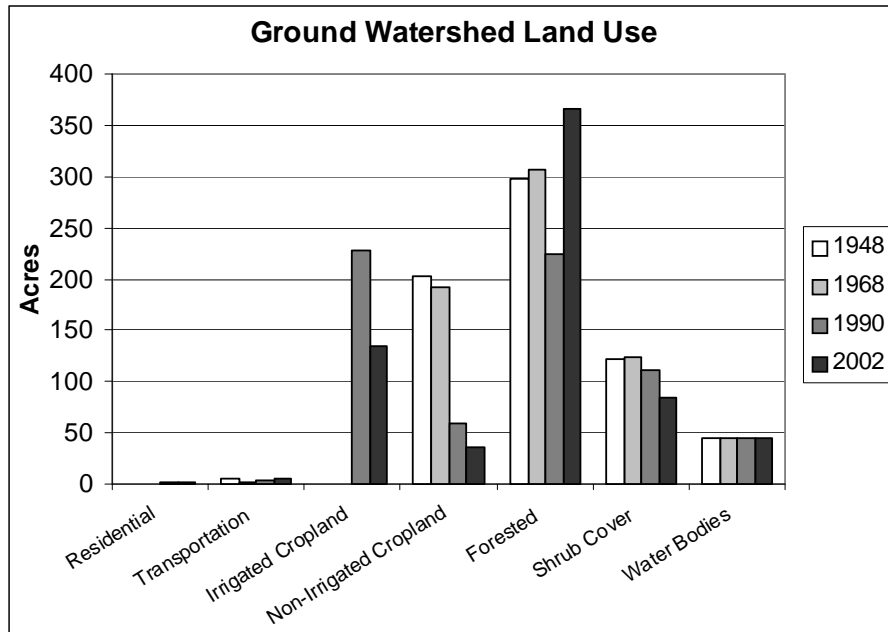


\*Terms in bold, see glossary pp 16-21

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



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



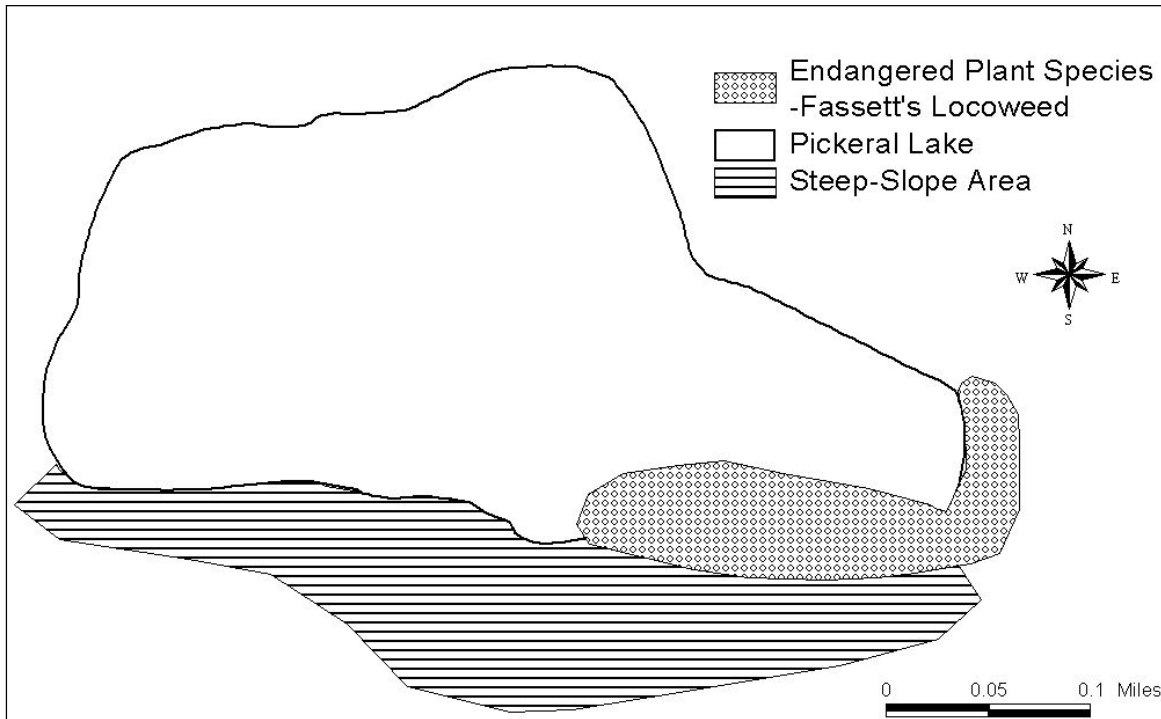
**Upland Sensitive Areas**

The survey of upland sensitive areas was conducted to highlight areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. Fassett’s locoweed (*Oxytropis chartacea*), an endangered plant species, is found along the southeast shoreline of Pickerel Lake.

\*Terms in bold, see glossary pp 16-21

In addition, the south side of the lake has steep slopes that may be sensitive to **erosion** if they are not kept well vegetated (Figure 7).

**Figure 7. Upland sensitive areas near Pickerel Lake.**



### **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 the 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

*Pickerel Lake from Portage County Lake Study Final Report June 2007*

During the reptile survey Pickerel Lake was found to contain two species of turtles: painted turtle (*Chrysemys picta*) and snapping turtle (*Chelydra serpentina*). Three species were identified during the frog survey near Pickerel Lake: spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), and gray treefrog (*Hyla versicolor*). The primary amphibian habitat is located on several small sections of shoreline, along with a pond to the southeast of the lake (sensitive area is identified in red in Figure 8). The key feature of this habitat is undisturbed natural shoreline. The good news is that there is currently a minimal level of shoreline development. Despite this fact, there are few areas that contain large amounts of submergent, emergent, and floating-leaf vegetation.

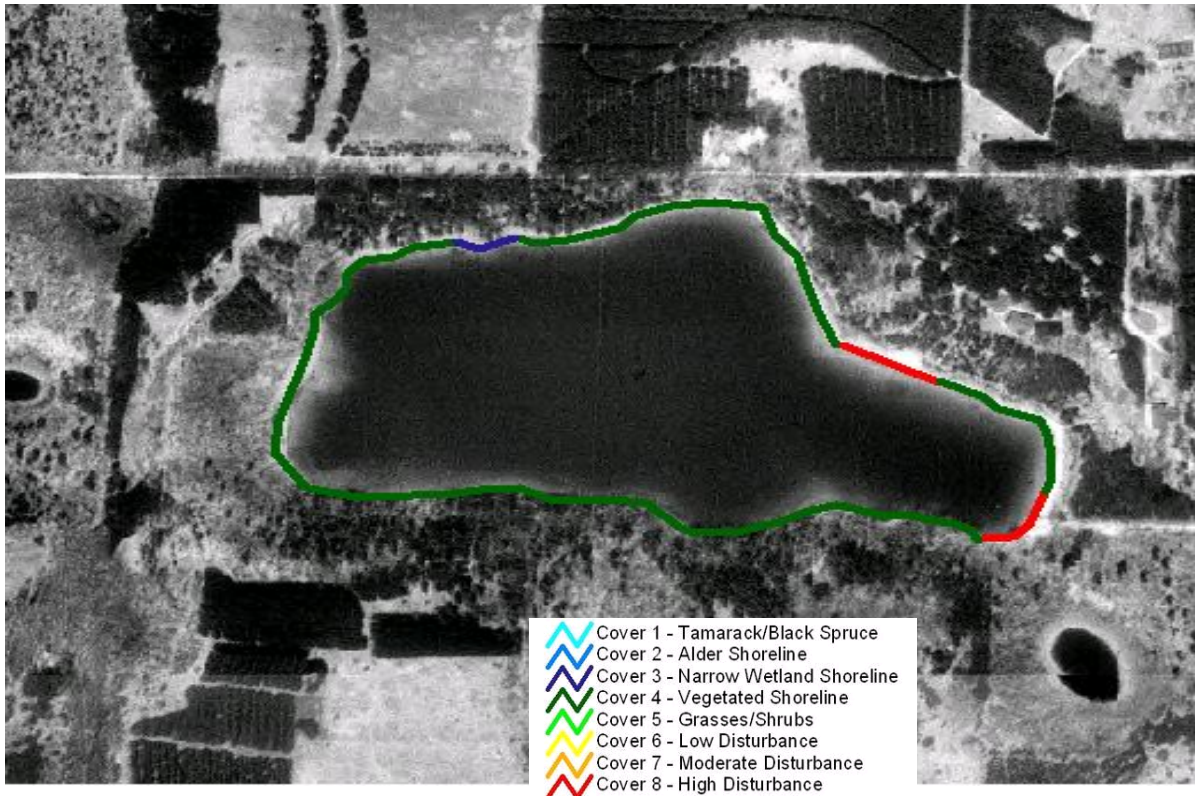
**Figure 8. Regions of primary amphibian habitat near Pickerel Lake.**



Approximately 86.6% of the Pickerel Lake shoreline is 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 in dark green in Figure 9. About 32% of that shoreline is defined as narrow wetland shore which is represented in 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. About 10% of the lake's shoreline vegetation is considered to be in a highly disturbed developed state. 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 16-21

Figure 9. Shoreline vegetation around Pickerel Lake.



### Aquatic Plants

There are 42 species of aquatic **macrophytes** (41 species of **vascular plants** plus one species of macrophytic **algae**) that occur in Pickerel Lake or on the west areas of the shore. This is slightly below average for Portage County lakes. The average **coefficient of conservatism (c-value)** is 4.7, which is average. The **floristic quality index** (including the addition of 3 points for an endangered species) is 33.0, which is slightly above average for Portage County lakes.

Pickerel Lake is surrounded by an essentially undeveloped shore. Most of the shore was purchased by the Wisconsin Department of Natural Resources to protect Fassett's locoweed (*Oxytropis chartacea*), an endangered species (treated as a subspecies or variety of the arctic yellow locoweed by some authors) which has been found on only a few lake shores, all in Wisconsin. Probably an important factor in the survival of Fassett's locoweed is the fluctuation in lake levels. The seed of the locoweed lies dormant underwater during years of high water level in the lake, when live plants of the locoweed are almost absent. The high water also serves to drown out invading upland species, reversing plant succession. In years of lower water levels in the lakes, the locoweed seed germinates and the plant becomes fairly common for a few years until plant succession of more vigorous upland species start to crowd out the locoweed. The return of high water renews the cycle.

\*Terms in bold, see glossary pp 16-21

*Pickerel Lake from Portage County Lake Study Final Report June 2007*

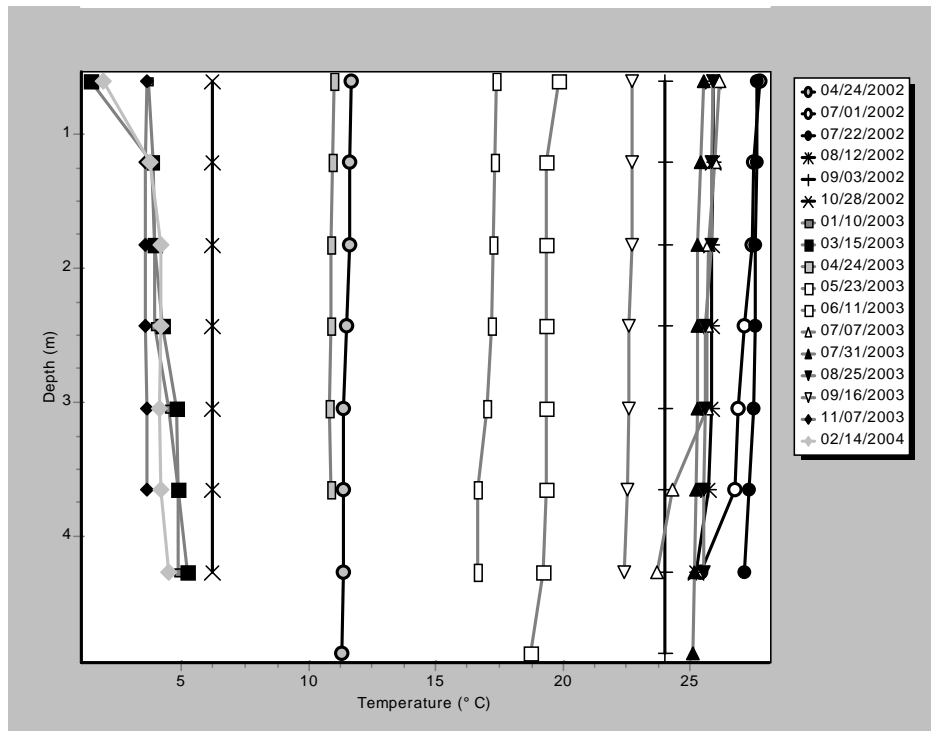
As of 2003 the lake level at Pickerel Lake was exceptionally low and has been low for the last few years. Many non-aquatic and aggressive alien plants are taking hold of the upper beach area. A return to high water would probably eliminate most of these invaders, except for the increased disturbance from ATVs and foot traffic which may be threatening the seed bank of locoweed, and carrying in aliens such as sweet clover (*Melilotus* spp.) and spotted knapweed (*Centurea biebersteinii*). If these and similar aliens become established, the Fassett's locoweed population could eventually be extirpated by competition from these alien species.

### Current Water Quality Conditions

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

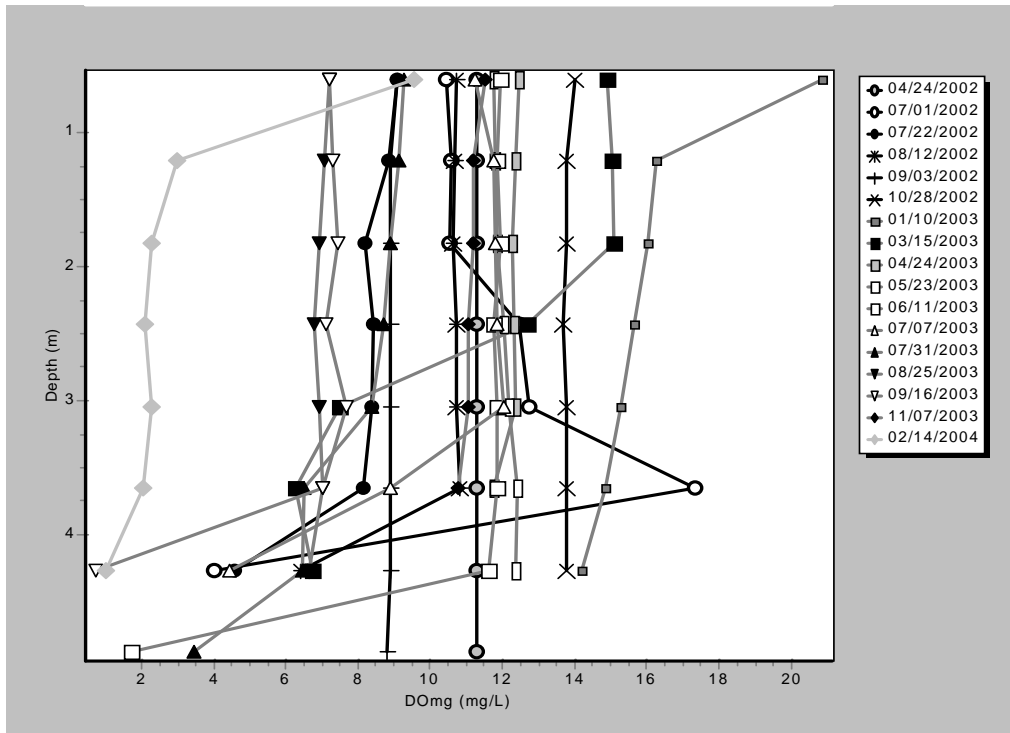
Based on temperature, water in Pickerel Lake stays mixed top to bottom throughout the year (Figure 10). However, some variability in dissolved oxygen occurs with depth. For the most part the upper 12 feet of water retains sufficient oxygen to support many aquatic species, but in February 2004 dissolved oxygen concentrations fell well below the 5 mg/L needed to support many of the fish, and only the upper 3 feet had higher concentrations (Figure 11). This oxygen depletion during winter ice cover could result in fish kills. Dissolved oxygen concentrations should be monitored throughout winter. Something as simple as plowing snow off of the ice during years of heavy snow may allow the aquatic plants to produce enough oxygen to enhance concentrations in the water below the ice.

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



\*Terms in bold, see glossary pp 16-21

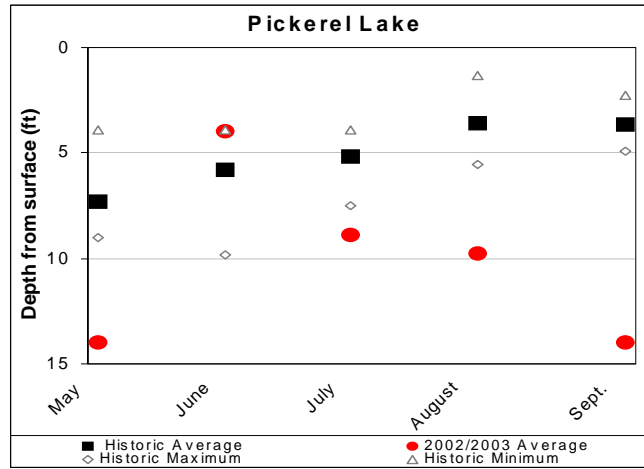
**Figure 11. Profile of dissolved oxygen in Pickerel Lake 2002-2004.**



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 water **color** and suspended materials found in the water (**turbidity**). **Turbidity** consists of **suspended solids**, which include suspended sediments and **algae (chlorophyll *a*)**. Samples collected from Pickerel Lake show that **color**, **turbidity**, and **chlorophyll *a*** were all low (Figure 12). During the 2002-03 sampling period **turbidity** ranged from 0.6 to 3.3 NTUs, **chlorophyll *a*** ranged from <0.1 to 7.21 **mg/L**, and water **clarity** ranged from 4 to 15 feet (Table 1). Water clarity was strongly correlated to **chlorophyll *a*** (algae). The 2002-03 water clarity in Pickerel Lake is considered good. The average **Secchi disc** depth reading for similar lakes in the county is about 9 feet; Pickerel Lake appears to have similar water clarity. When compared to the historical growing season average, the clarity of Pickerel Lake in 2002-03 was much better. The months of May and September show the best water clarity and the month of June the poorest (Figure 12). These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease.

\*Terms in bold, see glossary pp 16-21

**Figure 12. Monthly average water clarity measurements in Pickerel Lake 2002-2003 and historic average, minimum and maximum**



Nutrients (**phosphorus** and **nitrogen**) are important measures of water quality in lakes because they are used for growth by **algae** and aquatic plants (similar to houseplants and crops). On average, **phosphorus** concentrations were low throughout the year; however, when oxygen concentrations were low at the bottom of the lake there were extremely high concentrations of **phosphorus** in the bottom water. If this water mixes periodically in the summer, pulses of **phosphorus** become available for **algae** blooms as the inorganic **nitrogen** ( $\text{NO}_2 + \text{NO}_3\text{-N} + \text{NH}_4$ ) concentrations are great enough to promote summer **algae** blooms. Throughout the rest of the year **nitrogen** concentrations are relatively low. This is a moderately hard lake, with about half of the **hardness** attributed to calcium.

**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. **Chloride** concentrations are elevated and may be due in part to road salt from nearby Cty Hwy A (Table 2). **Chloride** is also entering the lake via **groundwater**. Concentrations of **sodium** and **potassium** were low. **Atrazine** was found in low concentrations in the lake water (0.13 and 0.12  $\mu\text{g/L}$ ); however, some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of **atrazine** indicates that other agrichemicals may also be entering Pickerel Lake.

**Table 1. 2002-2003 water quality seasonal averages in Pickerel Lake.**

<b>Pickerel Lake</b>	<b>TP</b> ( $\mu\text{g/L}$ )	<b>RP</b> ( $\mu\text{g/L}$ )	<b>TN</b> ( $\text{mg/L}$ )	<b>NO<sub>2</sub>+NO<sub>3</sub></b> ( $\text{mg/L}$ )	<b>NH<sub>4</sub></b> ( $\text{mg/L}$ )	<b>Alkalinity</b> ( $\text{mg/L}$ )	<b>Total Hardness</b> ( $\text{mg/L}$ )	<b>Calcium Hardness</b> ( $\text{mg/L}$ )	<b>Color</b> (CU)	<b>Turbidity</b> (NTU)	<b>Chlorophyll a</b> (ppm)
Spring Averages	20.0	8.0	0.99	0.53	0.09	89.0	117.5	50.5	10	0.6	0.01
Summer Averages	19.5	10.2	0.76	0.16	0.04	89.0	102.5	31.3	10	2.0	3.8
Fall Averages	18.5	6.5	0.99	0.24	0.12	97.5	109.5	42.5	11	1.2	
Winter Averages	17.0	6.5		0.21	0.31						
2002-2004 Averages	19.2	8.1	1.07	0.27	0.13	95.5	109.8	41.4	11	1.3	3.3

TP=total phosphorus; RP=reactive or soluble phosphorus; TN=total nitrogen; NO<sub>2</sub>+NO<sub>3</sub>=nitrite and nitrate nitrogen; NH<sub>4</sub>=ammonia nitrogen

\*Terms in bold, see glossary pp 16-21

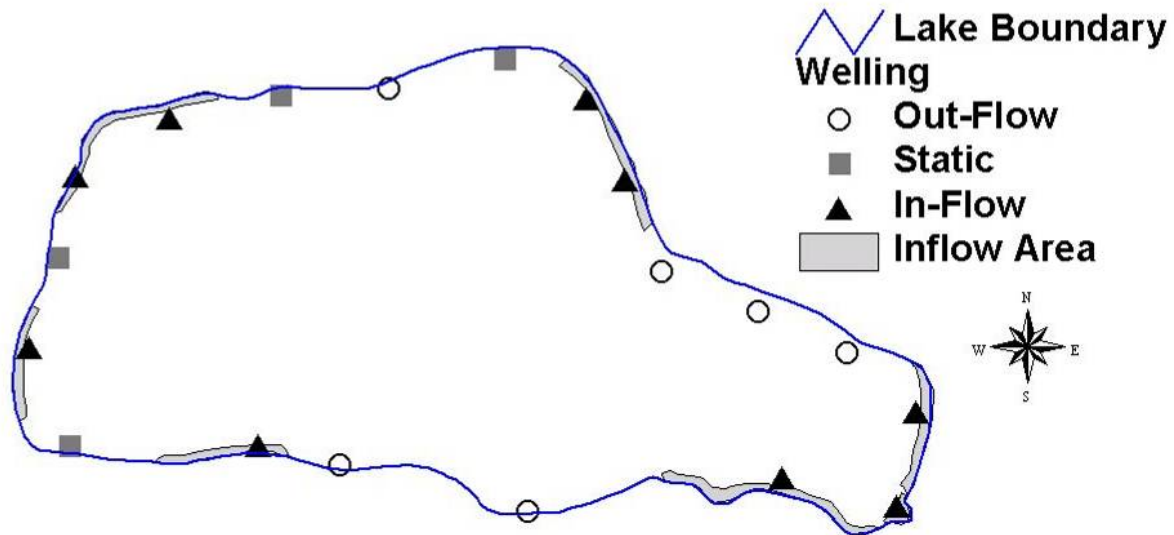
**Table 2. 2002-2003 Pickerel Lake average water chemistry and reference values.**

<b>Pickerel Lake</b>	<i>Low</i>	<i>Medium</i>	<i>High</i>	<b>Reference Values</b>	<i>Low</i>	<i>Medium</i>	<i>High</i>
<i>Sulfate</i>	7.20			<i>Sulfate</i>	<10	10-20	>20
<i>Chloride</i>		7.33		<i>Chloride</i>	<3	3-10	>10
<i>Potassium</i>	0.23			<i>Potassium*</i>	<2.16	2.16-4.30	>4.30
<i>Sodium</i>	1.92			<i>Sodium*</i>	<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.*

Mini-piezometer wells were installed in the lakebed in July 2003 to identify areas of **groundwater** inflow and outflow. Based on the information collected from the wells and during observations of open water in early spring, **groundwater** is entering in various locations around the lake (Figure 13). Three samples were collected for water analysis from the mini-piezometers located in inflow area on the west and south sides. All wells had elevated **chloride** (4 – 9 mg/L) and the south well on the west side had **nitrate** concentrations of 6 mg/L. The other two wells had low concentrations of **nitrate**. Triazine (**atrazine**) was measured in the south well at very low concentrations. All wells had low concentrations of reactive **phosphorus** (<4 mg/L).

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



### **Algal Community**

The algal community in Pickerel Lake was very diverse and dominated by green **algae** (Chlorophyta), **blue-green algae** (Cyanobacteria), yellow-green **algae** and **diatoms** (Ochrophyta), and to a lesser extent the cryptophytes (Cryptophyta) (Table 3). The greens and blue-greens accounted for 58% of all cells counted, and the four dominant phyla represented 91% of all cells counted during the 2003 sampling period. In the 2313 cells counted during this period

\*Terms in bold, see glossary pp 16-21

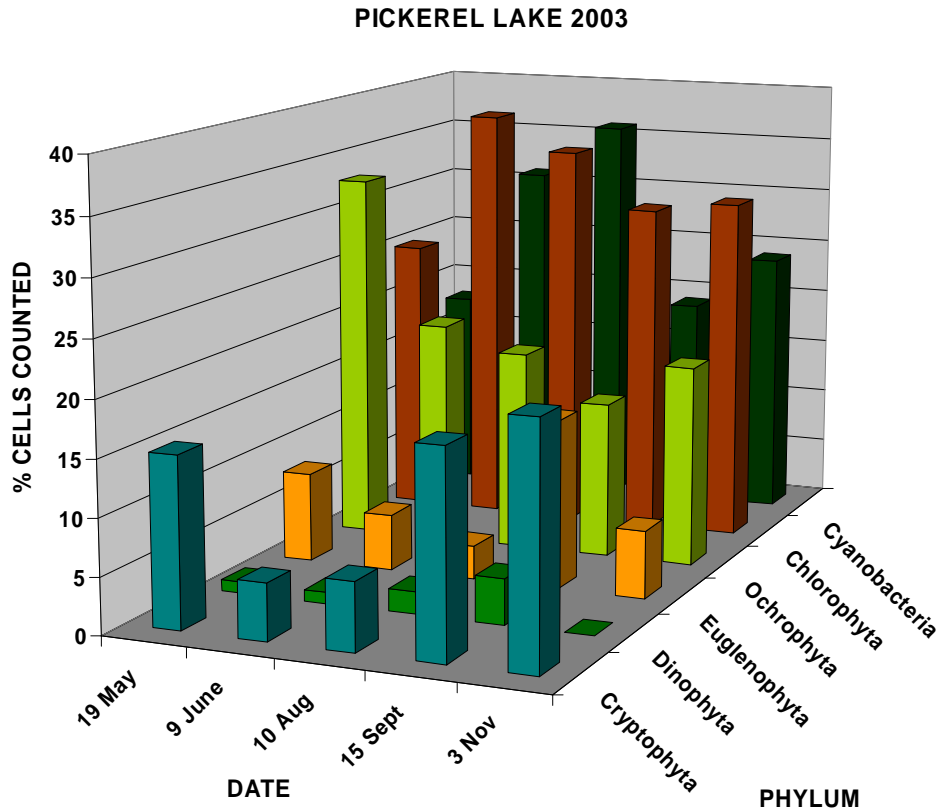
there were 7 genera of Cyanobacteria, 11 genera of Chlorophyta, 11 genera of Ochrophyta (including 9 **diatom** genera), 3 genera of Euglenophyta, 3 genera of Dinophyta, and 1 genus of Cryptophyta identified. The green **algae** represented between 25-38% of all cells counted. The green **algae** showed little change in abundance over the sampling period indicating a relatively stable lake system. Green **algae** were the dominant group in three of the five sampling periods and a close, second most abundant in the other two periods. The Cyanobacteria represented between 18-36% of all cells counted. This group generally increased in abundance over the sampling period but final sampling period abundances were depressed by the late season bloom of cryptophytes. The blue-greens were the dominant group once, second most dominant in three periods, and third most abundant in the other sampling period. The Ochrophyta represented between 14-33% (Table 3). This group was the dominant in the first sampling period and then declined in abundance in subsequent sampling periods. Ochrophytes were third most common in the second and third sampling periods (June-August) and fell to fourth most abundant in the late season samples (September-November). The Cryptophyta (cryptophytes) were most abundant in the late season samples where they rose to third most abundant, a situation rarely seen in the other lakes in this study. The other two phyla (Dinophyta and Euglenophyta) averaged 9% of all cells counted (Figure 14).

**Table 3. Algal phyla and mean seasonal composition in Pickerel Lake from May to November 2003.**

PICKEREL LAKE						
PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					MEAN
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	18	31	36	19	24	26
Chlorophyta	25	38	35	30	31	32
Ochrophyta	33	20	18	14	18	21
Euglenophyta	8	5	3	15	6	7
Dinophyta	1	1	2	4	0	2
Cryptophyta	15	5	6	18	21	13

\*Terms in bold, see glossary pp 16-21

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



Results of individual taxa tracking confirm the very diverse and mixed nature of the algal community in Pickerel Lake (Figure 15). The dominant taxon was different in each sampling period. Two green algae (*Scenedesmus*, *Ankistrodesmus*), a diatom (*Synedra*), a blue-green (*Coelosphaerium*), and a cryptophyte (*Chroomonas*) headed the column over the 2003 sampling periods (Table 4). Green and blue-green algae each filled 5 of the top 15 abundance slots over the sampling period. Cryptophytes held 3 of the 15 spots with the ochrophytes filling the other 2 abundance levels.

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Pickerel Lake present somewhat of a conflicting picture. Using the chemical indicators the lake would be considered **mesotrophic** or slightly **eutrophic**. However the rotating and seasonal algal dominance (indicative of successive algal blooms perhaps) and the heavy presence of **blue-green algae** (indicators of **eutrophication**); coupled with observations of dense algal communities and blooms throughout the sampling period indicate the likelihood of a much more **eutrophic** lake than the chemical signals show. The 36 genera identified during the sample periods were relatively common, and several of the most common cyanobacterial dominants have been associated with the production of potentially harmful toxins.

\*Terms in bold, see glossary pp 16-21

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

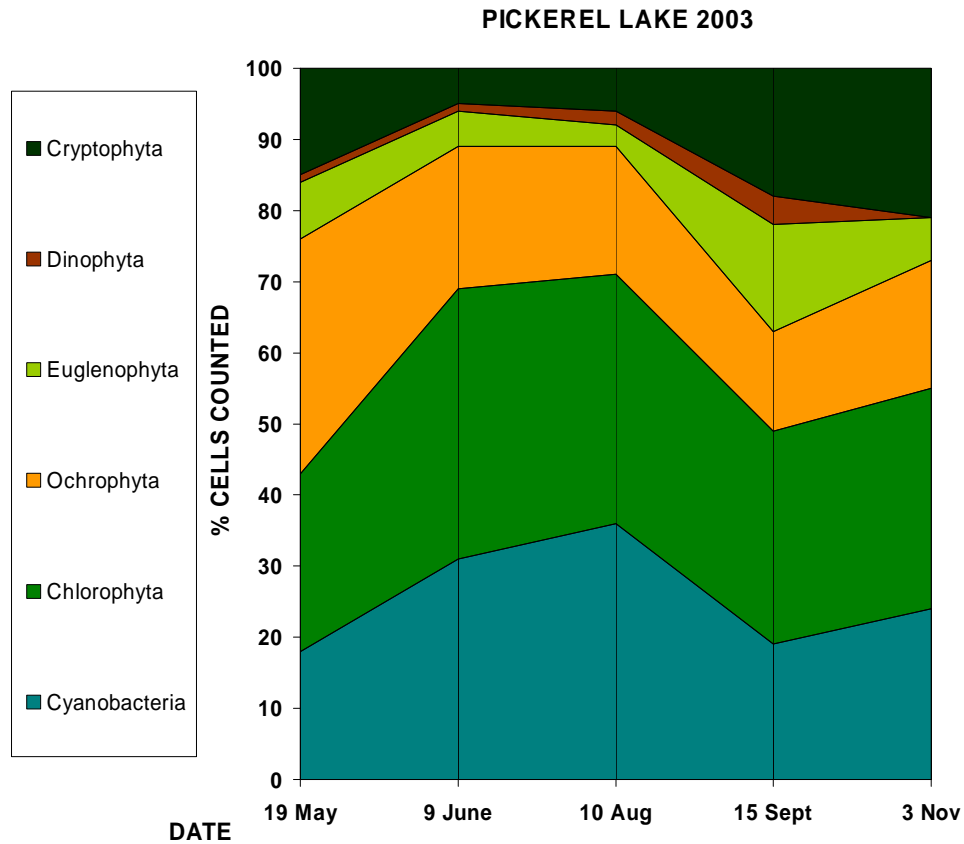


Table 4. Most common algal genera by date in Pickerel Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	<i>Synedra 2</i>	<i>Chroomonas</i>	<i>Scenedesmus</i>
9 June	<i>Scenedesmus</i>	<i>Coelosphaerium</i>	<i>Synedra 2</i>
10 August	<i>Coelosphaerium</i>	<i>Ankistrodesmus</i>	<i>Microcystis</i>
15 September	<i>Ankistrodesmus</i>	<i>Chroomonas</i>	<i>Coelosphaerium</i>
3 November	<i>Chroomonas</i>	<i>Ankistrodesmus</i>	<i>Coelosphaerium</i>

\*Terms in bold, see glossary pp 16-21

## Pickerel Lake Study Highlights

- Pickerel Lake is surrounded by an essentially undeveloped shore. Most of the shore was purchased by the Wisconsin Department of Natural Resources to protect Fassett's locoweed, an endangered species (treated as a subspecies or variety of the arctic yellow locoweed by some authors) which has been found on only a few lake shores, all in Wisconsin. Probably an important factor in the survival of Fassett's locoweed is the fluctuation in lake levels. The seed of the locoweed lies dormant underwater during years of high water level in the lake, when live plants of the locoweed are almost absent. As of 2003 the lake level at Pickerel Lake was exceptionally low and has been low for the last few years. Many non-aquatic and aggressive alien plants are taking hold of the upper beach area. A return to high water would probably eliminate most of these invaders, except for the increased disturbance from ATVs and foot traffic which may be threatening the seed bank of locoweed, and carrying in aliens such as sweet clover and spotted knapweed. If these and similar aliens become established, the Fassett's locoweed population could eventually be extirpated by competition from these alien species.
- The south side of the lake has steep slopes that may be sensitive to **erosion** if they are not kept well vegetated.
- During the reptile survey Pickerel Lake was found to contain two species of turtles (painted turtle, snapping turtle). Three species were identified during the frog survey near Pickerel Lake (spring peeper, American toad, gray treefrog). The primary amphibian habitat is located on several small sections of shoreline, along with a pond to the southeast of the lake. The key feature of this habitat is undisturbed natural shoreline.
- In February 2004 dissolved oxygen concentrations fell well below the **5 mg/L** needed to support many of the fish, and only the upper 3 feet had higher concentrations. This oxygen depletion during winter ice cover could result in fish kills. Dissolved oxygen concentrations should be monitored throughout winter. Something as simple as plowing snow off of the ice during years of heavy snow may allow the aquatic plants to produce enough oxygen to enhance concentrations in the water below the ice.
- Lake water quality was generally good; however, elevated **nitrate**, **chloride**, and **atrazine** were measured in groundwater.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Pickerel Lake present somewhat of a conflicting picture. Using the chemical indicators the lake would be considered **mesotrophic** or slightly **eutrophic**. However the rotating and seasonal algal dominance (indicative of successive algal blooms perhaps) and the heavy presence of **blue-green algae** (indicators of **eutrophication**); coupled with observations of dense algal communities and blooms throughout the sampling period indicate the likelihood of a much more **eutrophic** lake than the chemical signals show. The 36 genera identified were relatively common and several of the most common cyanobacterial dominants are have been associated with the production of potentially harmful toxins.

\*Terms in bold, see glossary pp 16-21

## 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 (CaCO<sub>3</sub>), or as microequivalents per liter (ueq/l). 20 ueq/l = 1 mg/L of CaCO<sub>3</sub>.

### 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<sub>3</sub>) 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<sub>4</sub><sup>+</sup>) form, but at high pH values the toxic ammonium hydroxide (NH<sub>4</sub>OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH<sub>4</sub>OH. At a pH of 7 and a temperature of 68° F (20° 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<sub>2</sub>) from the air to provide their own nutrient.

### Chloride (Cl<sup>-</sup>):

Chlorine in the chloride ion (Cl<sup>-</sup>) form has very different properties from chlorine gas (Cl<sub>2</sub>), which is used for disinfecting. The chloride ion (Cl<sup>-</sup>) 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 16-21

**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 Basin:**

The total land area that drains toward the lake.

**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 residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

**Endocrine:**

An integrated system of small organs that involve the release of extracellular signaling molecules known as hormones. The endocrine system is instrumental in regulating metabolism, growth, development and puberty, tissue function, and also plays a part in determining mood.

**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.

\*Terms in bold, see glossary pp 16-21

**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.

**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<sup>++</sup>) and magnesium (Mg<sup>++</sup>) in the water expressed as milligrams per liter of CaCO<sub>3</sub>. 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<sub>3</sub>, hard water has 121-180 mg/L CaCO<sub>3</sub>, and very hard water has more than 180 mg/L CaCO<sub>3</sub>.

**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.

\*Terms in bold, see glossary pp 16-21

**Marl:**

White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate ( $\text{CaCO}_3$ ) 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 ( $\text{NO}_3^-$ ):**

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 ( $\text{NO}_3\text{-N}$ ) plus ammonium-nitrogen ( $\text{NH}_4\text{-N}$ ) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

**Nitrite ( $\text{NO}_2^-$ ):**

A form of nitrogen that rapidly converts to nitrate ( $\text{NO}_3^-$ ) and is usually included in the  $\text{NO}_3^-$  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 ( $\text{CO}_2$ ) 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.

\*Terms in bold, see glossary pp 16-21

**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 residence 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.

**Soft Water:**

Water with less than 60 mg/L CaCO<sub>3</sub> (see Hard water).

**Stratification, Stratified:**

The layering of water due to differences in density. Water's greatest density occurs at 39°F (4°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<sub>4</sub><sup>-</sup>):**

The most common form of sulfur in natural waters. The amounts relate primarily to soil minerals in the watershed. Sulfate (SO<sub>4</sub><sup>-</sup>) can be reduced to sulfide (S<sup>-</sup>) and hydrogen sulfide (H<sub>2</sub>S) 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<sub>2</sub>) 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.

**Turbidity**

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

\*Terms in bold, see glossary pp 16-21

**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.

**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