Ebert Lake

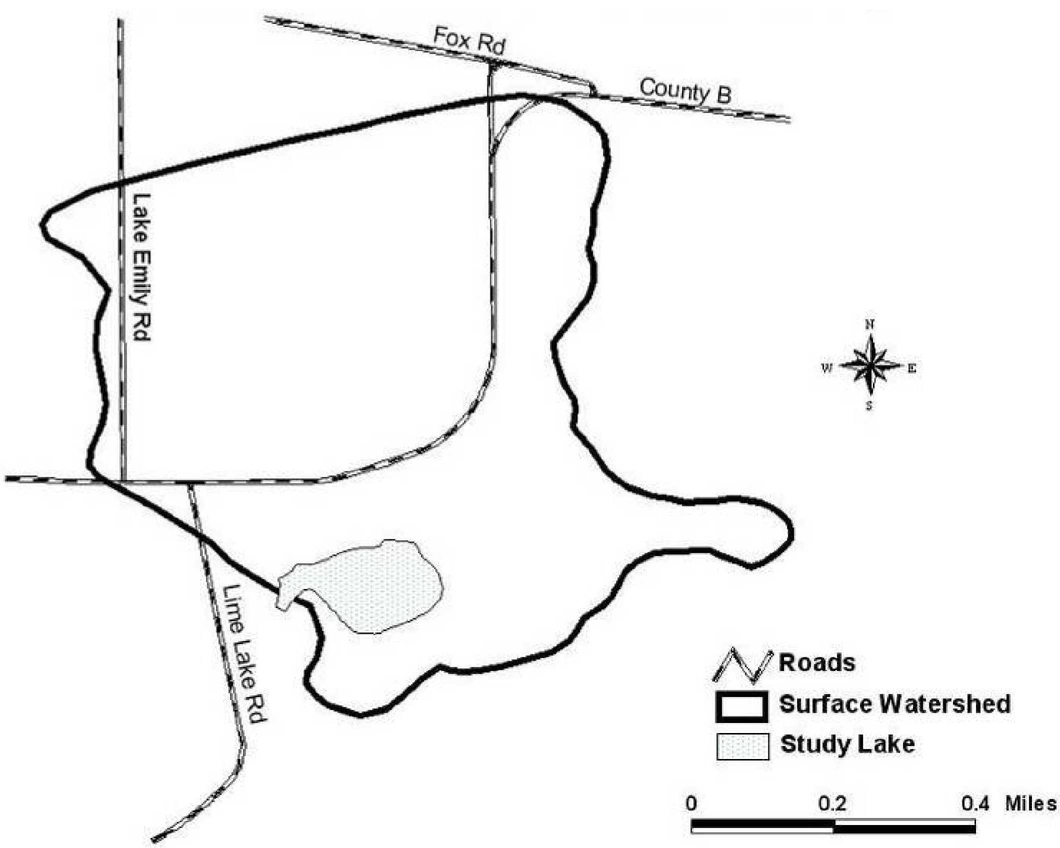
Introduction

Ebert is an 11.6 acre **groundwater drainage lake** located in the Township of Amherst, one and a half miles west of the Village of Amherst. The maximum depth of this lake is 35 feet with a bottom consisting of sand, rubble and **marl**. **Retention** time is approximately 0.4 years. The 0.9 mile shoreline has remained mostly undeveloped with only a few homes set back from the water. It is surrounded by a mixed conifer and hardwood forest. Wildlife is abundant in the area. Largemouth bass, panfish, and trout are common fish species in Ebert Lake. The lake is spring fed and has one outlet that feeds into Bear Creek. This outlet stream is navigable and allows public access to the lake.

Land Use and Watershed

The surface **watershed** of Ebert Lake is 318 acres (Figure 1). Land use in this area is largely non-irrigated agriculture (42%) and forest (33%). These two land uses have dominated the surface **watershed** since 1948. By 2002 the agricultural acres decreased slightly with a corresponding increase in forested acres. Residential areas increased slightly by 2002 but remain a small fraction of the land use in the surface **watershed** (Figure 2 and Figure 3).

Figure 1. Ebert Lake surface watershed boundary.



*Terms in bold, see glossary pp 16-21

Figure 2. Land use in the Ebert Lake surface watershed 2002.

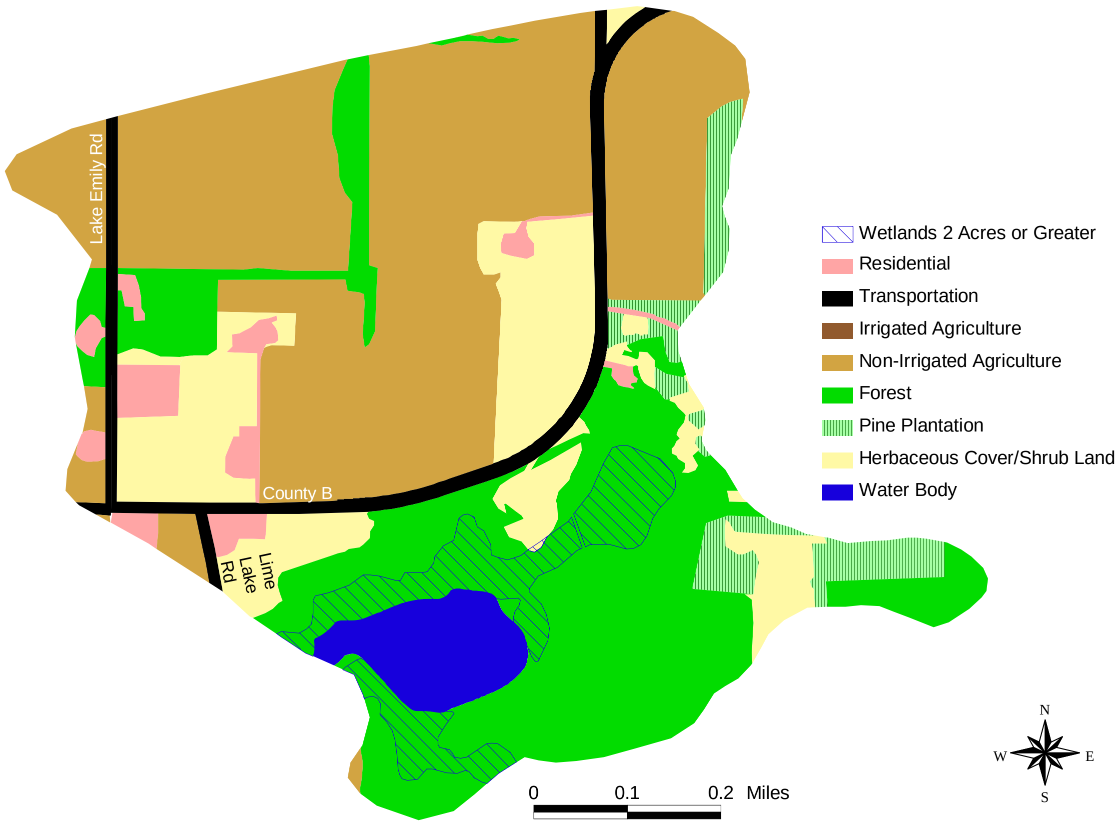
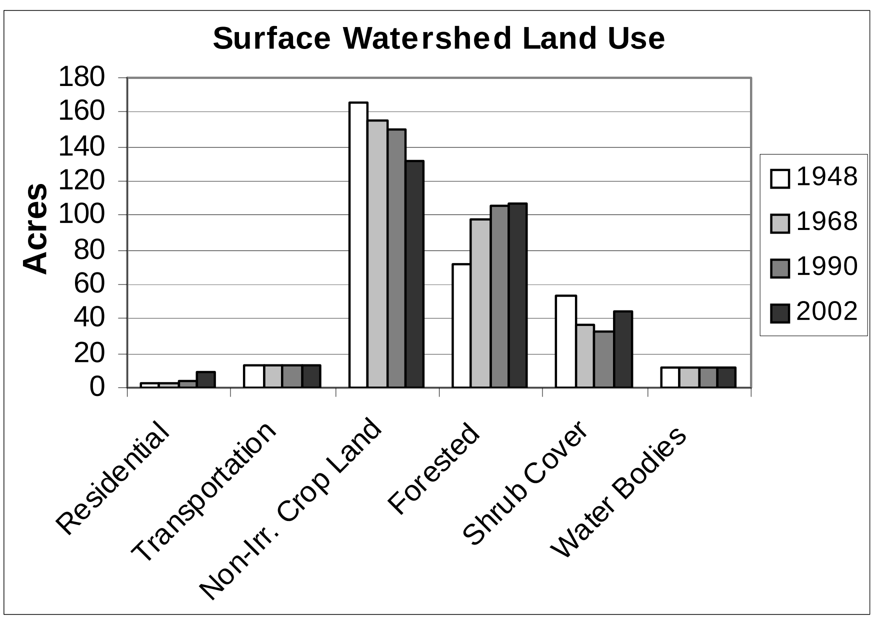


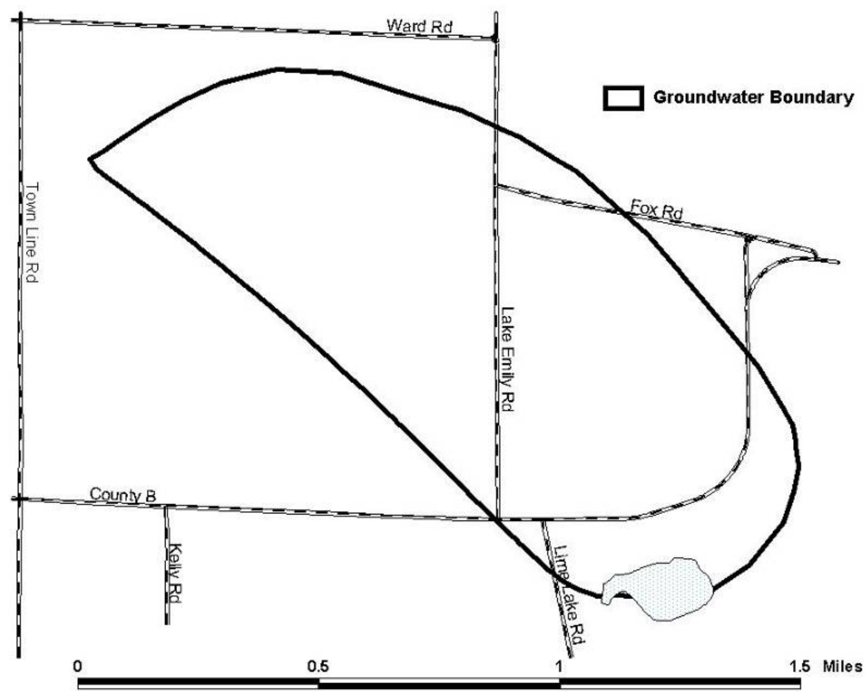
Figure 3. Land use in the Ebert Lake surface watershed 1948-2002.



*Terms in bold, see glossary pp 16-21

The **groundwater watershed** of Ebert Lake is 534 acres (Figure 4). Agriculture dominated the land use in 2002 with both non-irrigated (43%) and irrigated cropland (21%). Since 1948 non-irrigated cropland has declined significantly while forested areas have increased slightly. Irrigated cropland did not appear in the **groundwater watershed** until sometime after 1968 but has remained steady and prevalent within the **watershed** since that time. Residential use is minimal but has been increasing since 1990 (Figure 5 and Figure 6). Records indicate that based on age there is one potentially failing septic system within both the surface **watershed** and **groundwater watershed**, on the north shore of the lake. There are no former landfill sites recorded in either the surface or the **groundwater watershed**.

Figure 4. Ebert Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 16-21

Figure 5. Land use in the Ebert Lake groundwater watershed 2002.

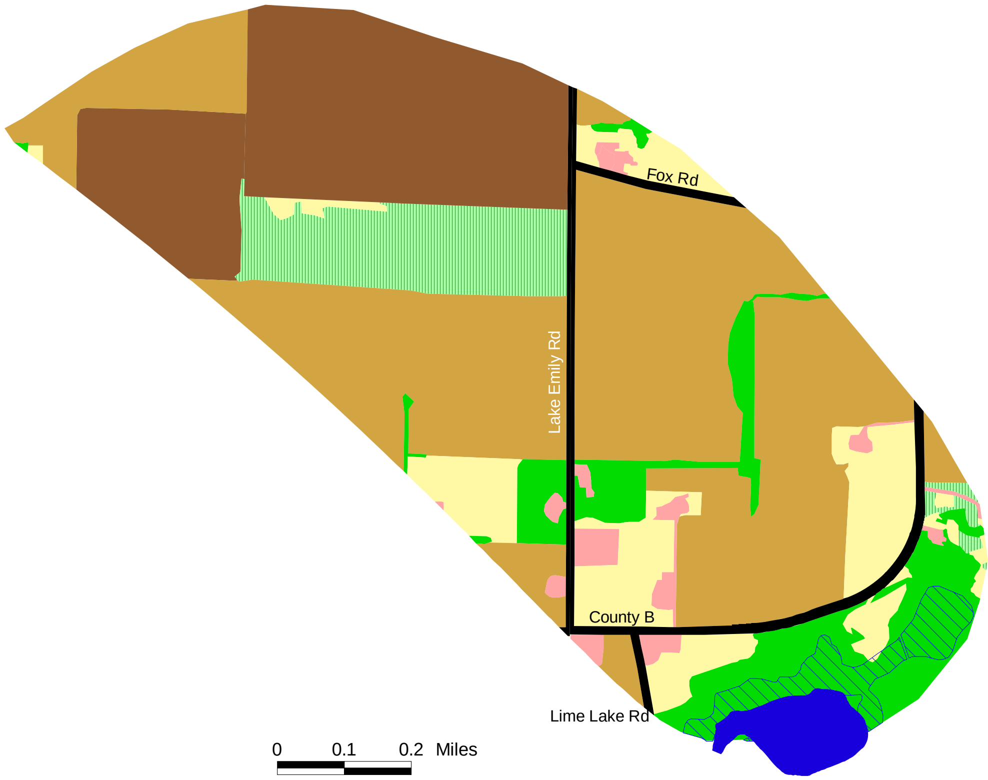
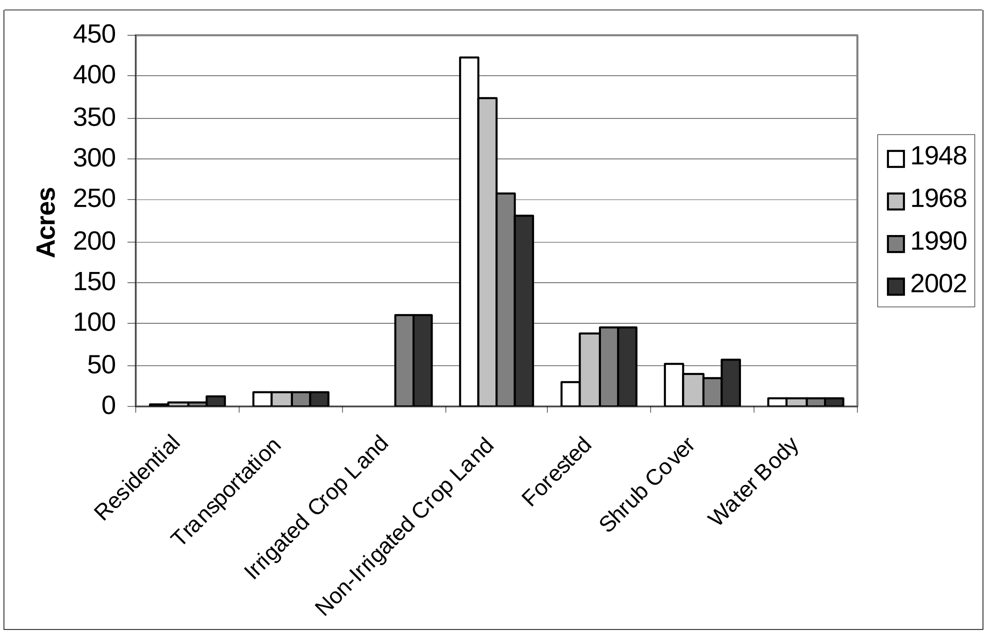


Figure 6. Land use in the Ebert Lake groundwater watershed 1948-2002.

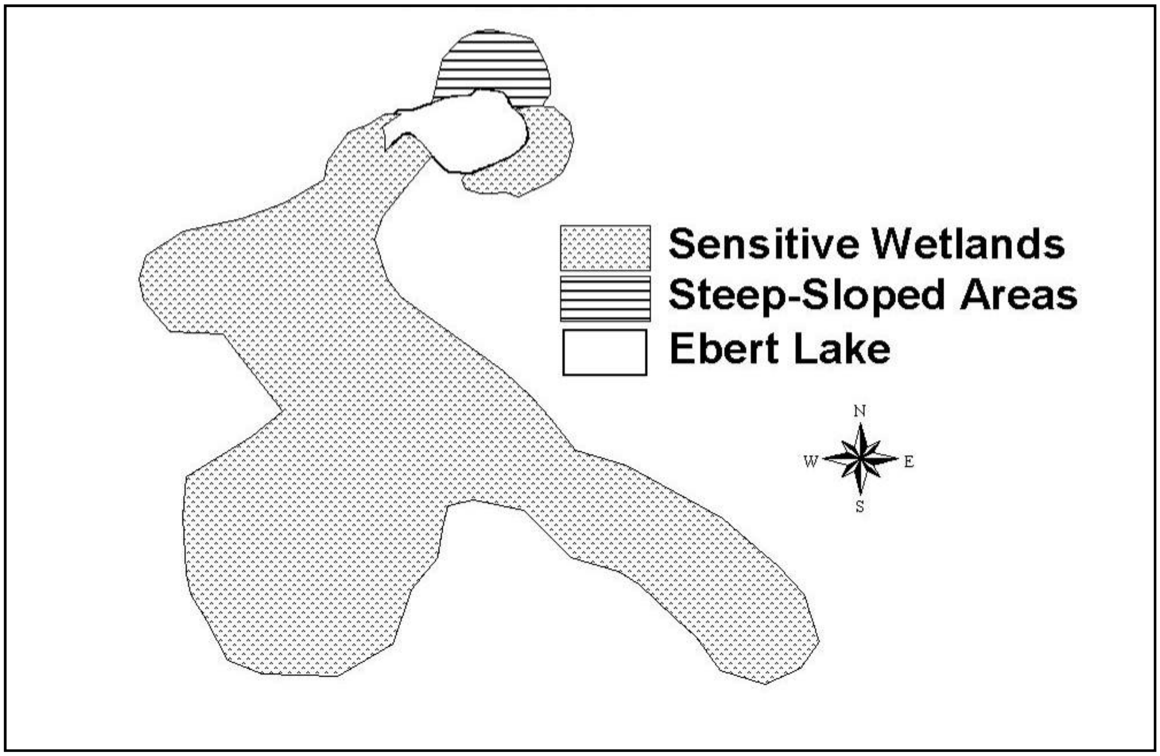


*Terms in bold, see glossary pp 16-21

Upland Sensitive Areas

The survey of upland sensitive areas was conducted to identify areas immediately around the lakeshore that are particularly valuable, or sensitive to disruption. Ebert Lake is a small lake that is adjacent to a large wetland extending from the southwestern shore and adjacent to the outlet channel south and southeast as it becomes part of Bear Creek. There is also a smaller wetland area on the eastern shore. The north shore of the lake has steep slopes making it susceptible to **erosion** (Figure 5).

Figure 7. Upland sensitive areas near Ebert 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 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.

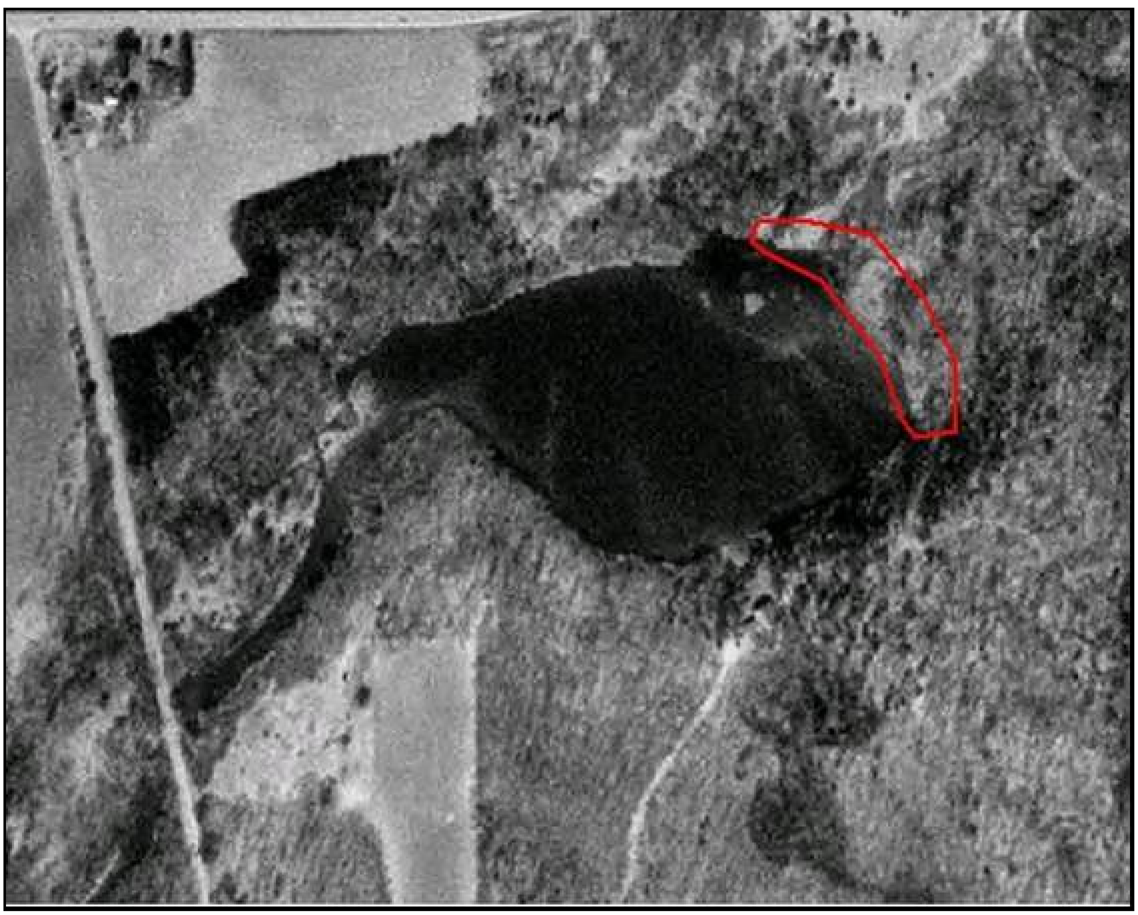
Large sections of continuous natural shoreline on lakes are ideal habitats for many frog species. Natural areas with large amounts of submergent, emergent, and floating-leaf vegetation provide protection and a place for attachment of eggs during the breeding season. The upland areas surrounding these 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

*Terms in bold, see glossary pp 16-21

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**.

The primary amphibian habitat can be found around the majority of the lake (Figure 8). Some of the key features of this habitat include the unaltered shoreline and areas with large amounts of submergent, emergent, and floating-leaf vegetation as well as downed trees. Three frog species were identified near Ebert Lake; spring peeper (*Pseudacris crucifer*), American toad (*Bufo americanus*), and green frog (*Rana clamitans*). During the survey of reptiles Ebert Lake was found to contain 2 species of turtles (painted turtle [*Chrysemys picta*] and snapping turtle [*Chelydra serpentina*]). The good news is that there is a lot of ideal amphibian and reptile habitat present; there is minimal residential development and excellent shoreline protection. Because of this there really are no major threats to amphibian and reptile habitat at this time.

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

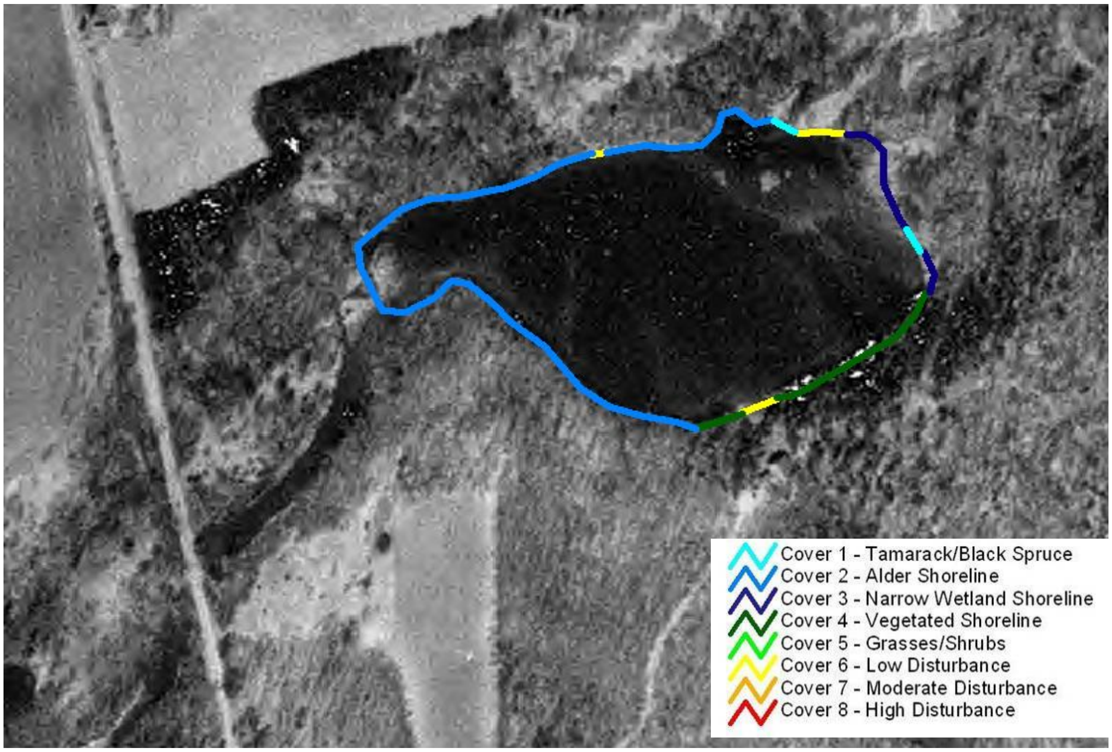


*Terms in bold, see glossary pp 16-21

The shoreline of Ebert Lake is composed 65.2% of alder shoreline, which is represented by sky blue in Figure 9. Vegetated shoreline comprises 14.4% of the shoreline. Vegetated shoreline is characterized by upland areas with dense vegetation comprised of tall grasses or shrubs that lack a rocky component. It is represented by dark green in Figure 9. Twelve percent of the shoreline is classified as narrow wetland shore. Narrow wetlands are characterized by wetland areas that extend less than 5 meters onto the shore and have an adjacent undeveloped upland area. Lastly, 2.3% of the shore is tamarack (*Larix laricina*)/black spruce (*Picea mariana*) wetland and is represented by light blue. Tamarack/black spruce wetlands are characterized by wetland shoreland with a sweet gale (*Myrica gale*) or leather-leaf (*Chamaedaphne calyculata*) understory and a black spruce or tamarack canopy.

On Ebert Lake, 6.1% of the lake's shoreline vegetation is considered to be a low disturbance developed area. An area that exhibits low vegetation disturbance is defined as a location where there is an unaltered shore zone except for pier access.

Figure 9. Shoreline vegetation around Ebert Lake.



Aquatic Plants

There are **57** species of aquatic **macrophytes** (56 **vascular plants** plus 1 species of **macrophytic algae**), and **fen** plants have been found in or around Ebert Lake. This is above average for Portage County lakes. The average **coefficient of conservatism (c-value)** of the 56 species of **vascular plants** is **5.8** which is above average as well. The **floristic quality index** is **43.4** which is also above average for Portage County lakes.

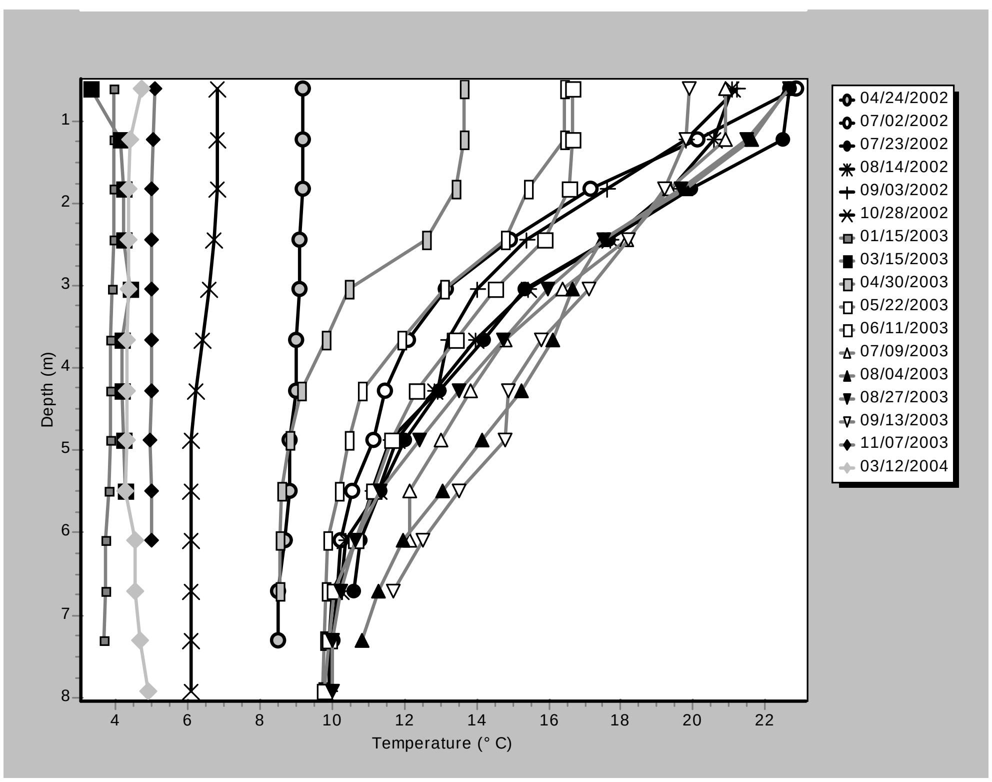
*Terms in bold, see glossary pp 16-21

Ebert Lake is a very small lake with only a few species of submersed aquatic **macrophytes**, of which only stonewort (*Chara* spp.), common water-milfoil (*Myriophyllum sibiricum*), and small pondweed (*Potamogeton pusillus*) are abundant. The shore surrounding the lake is almost entirely undeveloped, and the vegetation consists of native species. No aggressive alien invaders have been seen here. The wetland, which nearly surrounds the lake, comprises a **fen** (a rich **fen** according to one classification of peatland communities). This **fen** extends downstream to Bear Creek and along Bear Creek on both sides of Lime Lake Road. It constitutes probably the largest and best example of a **fen** in Portage County. The Ebert Lake **fen** is the only known location in Portage County for the **fen** orchid (*Liparis loeselii*) and for the native shrubby cinquefoil (*Pentaphylloides floribunda*)(the cultivated plants of shrubby cinquefoil are European), and one of two known sites for stiff cowbane (*Oxypolis rigidior*), grass-of-parnassus (*Parnassia glauca*), and sage-leaf willow (*Salix candida*). All of these species are typical **fen** plants and are relatively rare throughout Wisconsin. Without fire or efforts to suppress shrub growth, this **fen** complex will probably become a shrub community over the next 10-20 years.

Current Water Quality Conditions

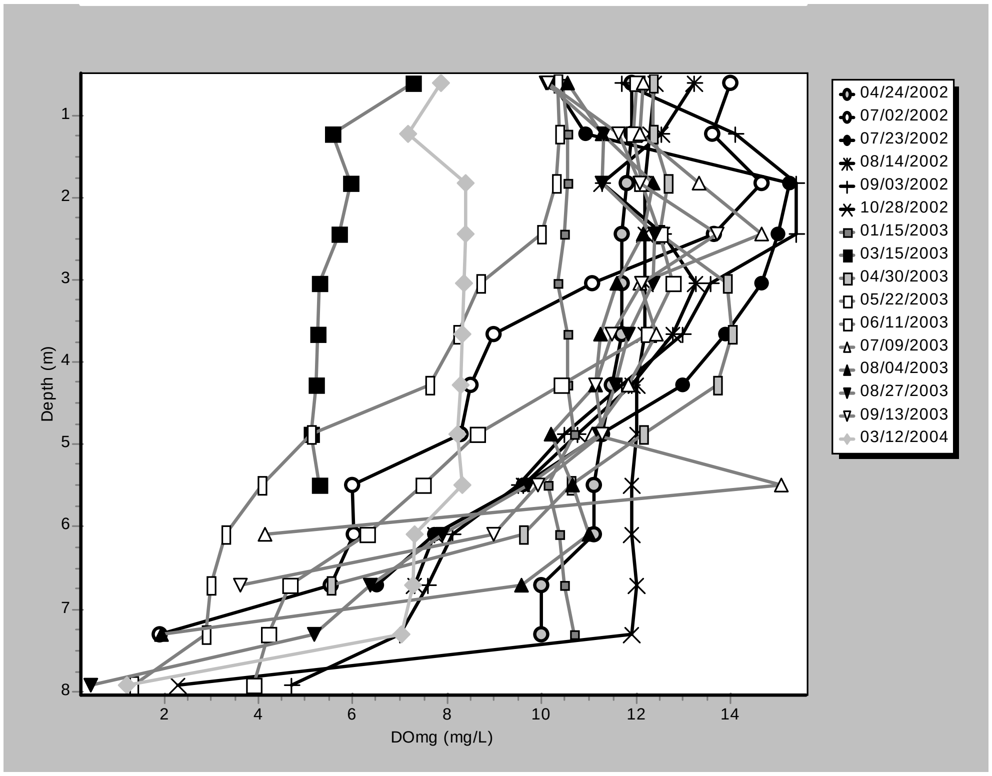
Water quality in lakes is assessed by measuring different characteristics including temperature, dissolved oxygen, water **clarity**, **chlorophyll *a***, water chemistry, and the algal community. The temperature in Ebert Lake indicates that it is mixed from top to bottom in the spring and fall and is **stratified** during the winter and summer, which is typical for many lakes in Wisconsin (Figure 10). Generally there is sufficient dissolved oxygen in the upper 16 feet of water to support most local species of fish (Figure 11).

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



*Terms in bold, see glossary pp 16-21

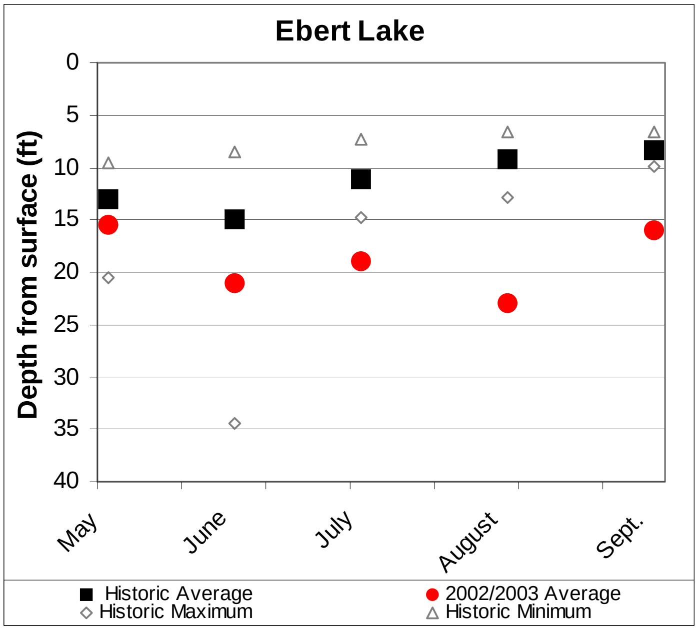
Figure 11. Profile of dissolved oxygen in Ebert Lake 2002-2004.



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 in the water (**turbidity**). **Turbidity** consists of **suspended solids**, such as suspended sediments and **algae** (**chlorophyll *a***). **Color**, **turbidity**, and **chlorophyll *a*** measures were all low, and the water **clarity** in Ebert Lake is considered good. The average **Secchi disc** depth reading for similar lakes in the county is 11 feet; Ebert Lake appears to have better **clarity** than this. The water **clarity** of Ebert Lake during the 2002-03 growing seasons was better than the historic growing season average. The month of August shows the best water **clarity** and the month of May the poorest. These fluctuations throughout the summer are normal as **algae** populations and **sedimentation** increase and decrease (Figure 12).

*Terms in bold, see glossary pp 16-21

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



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). **Phosphorus** concentrations in Ebert Lake are low throughout the year resulting in minimal amounts of **algae**. **Phosphorus** concentrations were much higher in the 1970s and early 80s. **Nitrogen** in the lake is predominantly **nitrate** and is likely entering the lake from the **groundwater**. It is in sufficient concentrations to result in **algae** blooms but is not having this result due to the low **phosphorus** concentrations.

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. **Potassium** concentrations were low, but **sodium** and **chloride** were slightly elevated. Although these constituents are not detrimental to the aquatic ecosystem, they indicate that sources of contaminants (road salt, fertilizer, animal waste, and/or septic system effluent) are entering the lake from either surface runoff or via **groundwater**. **Atrazine** was found in low concentrations in the lake water; 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 Ebert Lake.

*Terms in bold, see glossary pp 16-21

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

Ebert 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	17.7	5.5	3.9	3.5	0.04	190	221	116.5	11	1.1	0.7
Summer Averages	16.8	5.7	3.1	2.9	0.03	187	201	99.7	6	2.1	3.0
Fall Averages	19.5	5.0	2.8	2.4	0.09	193	213	114.0	8	1.3	
Winter Averages	9.5	8.5	4.7	4.1	0.06						
2002-2004 Averages	16.4	6.1	3.6	3.2	0.05	190	212	110.1	8	1.5	2.5

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

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

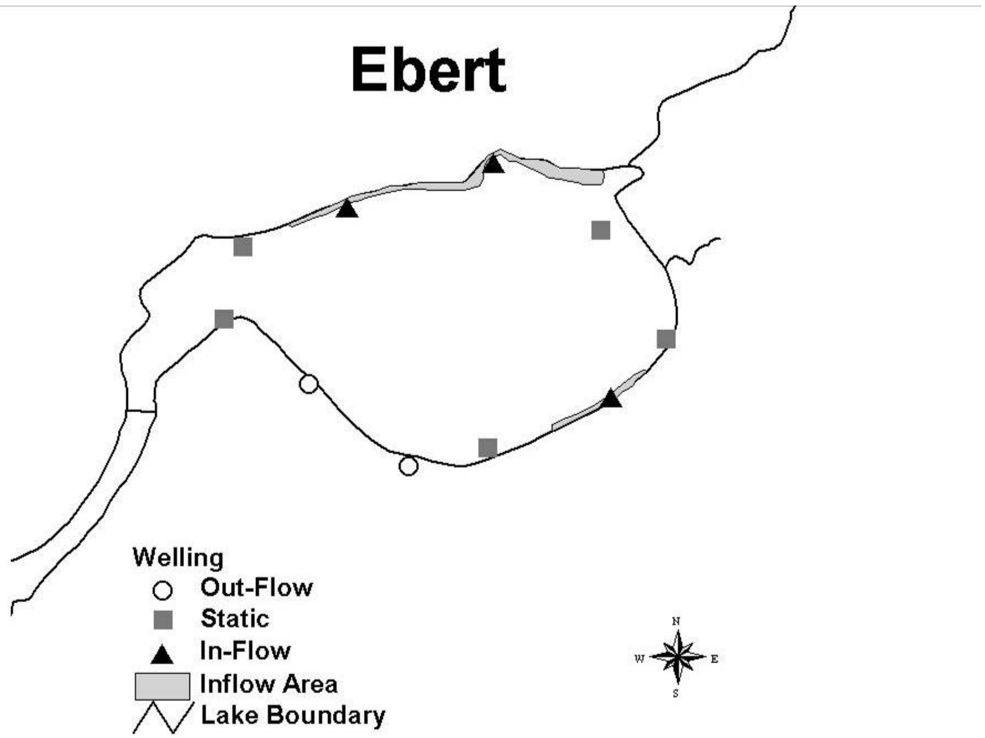
Ebert Lake	*Low*	*Medium*	*High*	**Reference Values**	*Low*	*Medium*	*High*
Sulfate	8.78			*Sulfate*	<10	10-20	>20
Chloride		6.86		*Chloride*	<3	3-10	>10
Potassium	1.30			*Potassium**	<2.16	2.16-4.30	>4.30
Sodium		3.42		*Sodium**	<2.28	2.28-5.09	>5.09

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

Small wells were placed in the lakebed around Ebert Lake to determine locations of **groundwater** inflow/no flow/outflow. Three of the ten sites sampled showed **groundwater** inflow with most of the **groundwater** inflow on the north side of the lake (Figure 13). Water chemistry was run on samples from two sites (one on the north, one on the south). **Nitrate** concentrations were slightly elevated (around 3 **mg/L**) in both samples, and **chloride** was elevated in the south sample. **Ammonium**, reactive **phosphorus**, and **atrazine** concentrations were low in both samples. Water was leaving the lake to **groundwater** in the southwest part of the lake.

*Terms in bold, see glossary pp 16-21

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



Algal Community

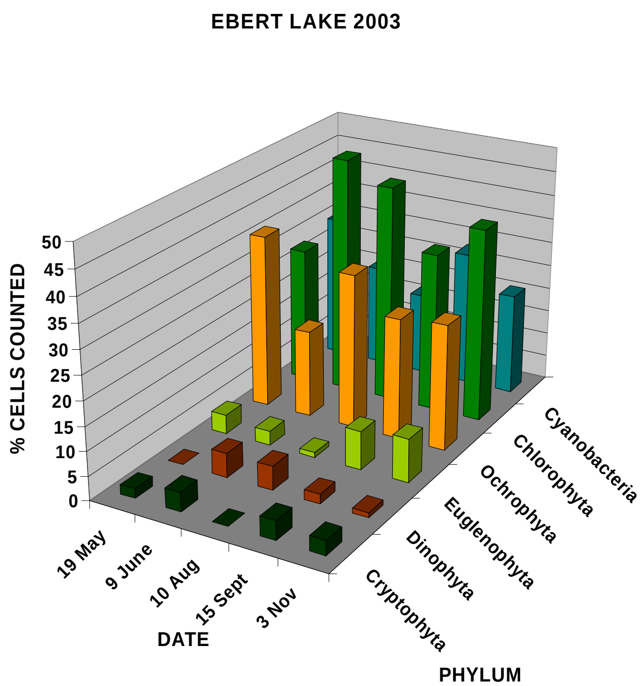
The algal community in Ebert Lake was not very complex. The dominant groups were the green **algae** (Chlorophyta, 39% of all cells counted), the **diatoms** (Ochrophyta, 27% of all cells counted), and the **blue-green algae** (Cyanobacteria, 27% of all cells counted) (Table 3). These three phyla represented 89% of all cells counted during the 2003 sampling season. In the 2,938 cells counted during this period, there were 3 genera of Cyanobacteria, 8 genera of Chlorophyta, 6 genera of Ochrophyta (including 6 **diatom** genera), 2 genera of Euglenophyta, 2 genera of Dinophyta, and 1 genus of Cryptophyta identified. There was very little cycling, just a few peaks and valleys, as the three dominant phyla never accounted for less than 86% of all cells counted regardless of sample period. The **diatoms** dominated the May sample with the blue-greens and greens of nearly equal abundance. The greens then dominated for the remaining four sample periods in 2003. In all but one of these subsequent periods (June) the **diatoms** were the second most abundant group with the blue-greens as the third most abundant group of organisms. The other three algal phyla (Dinophyta, Euglenophyta, Cryptophyta) represented only 11% of all cells counted, and no single group ever accounted for more than 9% of cells counted in any period (Figure 14).

*Terms in bold, see glossary pp 16-21

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

EBERT LAKE PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					**MEAN**
	19 May	9 June	10 Aug	15 Sept	3 Nov	
Cyanobacteria	30	21	17	28	21	23
Chlorophyta	28	49	45	33	40	39
Ochrophyta	36	18	32	25	26	27
Euglenophyta	4	3	1	8	9	5
Dinophyta	0	5	5	2	1	3
Cryptophyta	2	4	0	4	3	3

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



As with the phylum representations, the green **algae** dominate the genus level analyses (Figure 1). Chlorophytes were the dominant taxa in four of the five sample periods of 2003 and overall occupied 6 of 15 top spots. The small, nonmotile, unicellular genus *Ankistrodesmus* was twice the most abundant organism (September, November); earlier season samples were dominated by the small, nonmotile, colonial genus *Coelastrum* (June) and the small, nonmotile, unicellular genus *Selenastrum* (August). *Asterionella*, a ring-forming colonial **diatom**, was the dominant

*Terms in bold, see glossary pp 16-21

genus in May and then faded to a third most abundant subdominant in June, August, and November. Several potentially unpleasant blue-green algal genera were also in the most abundant category. The diffuse, small-celled, colonial genus *Microcystis* and the unbranched, nonheterocystous filament *Oscillatoria* were never the most abundant taxa but were second most abundant in four of the five sample periods (May, June, September, November) (Table 4).

The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Ebert Lake presents a picture of a reasonably stable **oligotrophic** lake. The 22 genera identified during the sample periods were relatively common and with the exception of the cyanobacterium *Microcystis*, none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. For a lake with good water **clarity** and **oligotrophic** chemical signals it is somewhat surprising that only 22 genera were found. The consistent presence of a fairly substantial load of cyanobacteria should be the cause of some concern despite the current lake status.

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

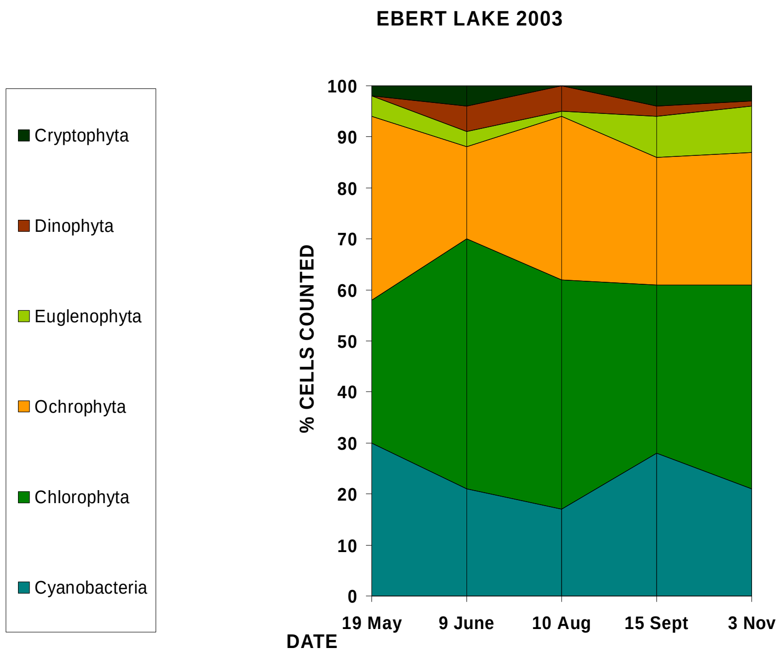


Table 4. Most common algal genera by date in Ebert Lake from May to November 2003.

DATE	TOP THREE TAXA (MOST ABUNDANT, LEFT TO RIGHT)		
19 May	*Asterionella*	*Microcystis*	*Anabaena*
9 June	*Coelastrum*	*Microcystis*	*Asterionella*
10 August	*Selenastrum*	*Ankistrodesmus*	*Asterionella*
15 September	*Ankistrodesmus*	*Microcystis*	*Coelastrum*
3 November	*Ankistrodesmus*	*Oscillatoria*	*Asterionella*

*Terms in bold, see glossary pp 16-21

Ebert Lake Study Highlights

- Ebert Lake is adjacent to a large wetland extending from the southwestern shore and adjacent to the outlet channel south and southeast as it becomes part of Bear Creek. There is also a smaller wetland area on the eastern shore. The north shore of the lake has steep slopes making it susceptible to **erosion**.
- There is a lot of ideal amphibian and reptile habitat present; there is minimal residential development and excellent shoreline protection. Because of this there really are no major threats to amphibian and reptile habitat at this time.
- Approximately 6.1% of the lake's shoreline vegetation is considered to be a low disturbance developed area.
- The number of species of aquatic **macrophytes**, the average **coefficient of conservatism (c-value)**, and **floristic quality index** are above average for Portage County lakes. The shore surrounding the lake is almost entirely undeveloped and the vegetation consists of native species. No aggressive alien invaders have been seen here. The wetland, which nearly surrounds the lake, comprises a **fen** (a rich **fen** according to one classification of peatland communities). This **fen** extends downstream to Bear Creek and along Bear Creek on both sides of Lime Lake Road. It constitutes probably the largest and best example of a **fen** in Portage County. The Ebert Lake **fen** is the only known location in Portage County for the **fen** orchid and for the native shrubby cinquefoil, and one of two known sites for stiff cowbane, grass-of-parnassus, and sage-leaf willow. All of these species are typical **fen** plants and are relatively rare throughout Wisconsin. Without fire or efforts to suppress shrub growth, this **fen** complex will probably become a shrub community over the next 10-20 years.
- The algal community when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Ebert Lake presents a picture of a reasonably stable **oligotrophic** lake. The 22 genera identified were relatively common and with the exception of the cyanobacterium *Microcystis*, none of those that reached numerical dominance in the sample counts are associated with toxins or health issues. For a lake with good water **clarity** and **oligotrophic** chemical signals, it is somewhat surprising that only 22 genera were found. The consistent presence of a fairly substantial load of cyanobacteria should be the cause of some concern despite the current lake status.

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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 provide the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

Alkalinity:

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

Ammonia, Ammonium:

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

Atrazine:

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

Blue-Green Algae:

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

Chloride (Cl-):

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

Chlorophyll *a*:

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

Clarity:

see "Secchi disc."

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 retention 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.

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++) 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.

*Terms in bold, see glossary pp 16-21

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.

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.

*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 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.

*Terms in bold, see glossary pp 16-21

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