

Jacqueline Lake

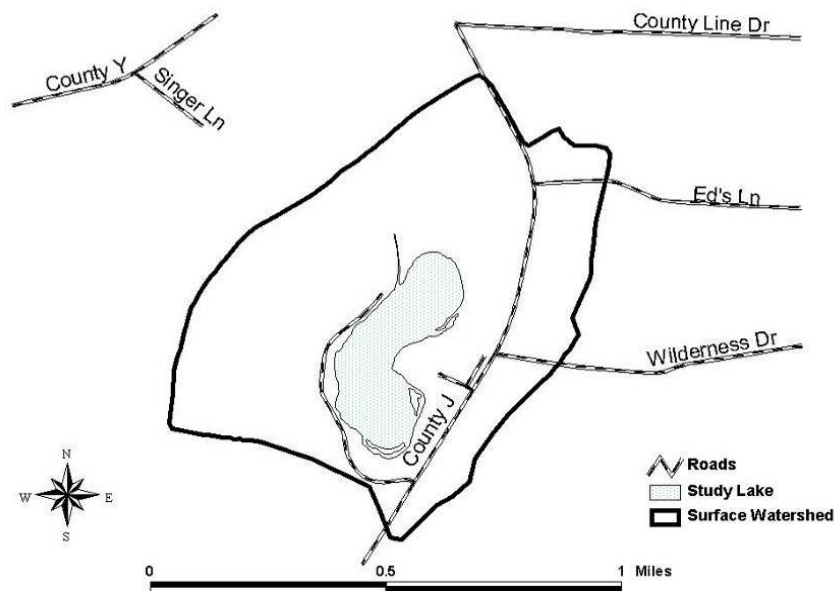
Introduction

Jacqueline Lake is a very **soft water** bog lake located seven miles north of Polonia in the Town of Sharon. This is a 40 acre lake, with a volume of 175 acre-feet, a maximum depth of 17 feet, and an estimated **retention time** of 3.4 years. The bottom consists of sand and muck. It is a unique **seepage lake** with floating bogs and a tamarack-black spruce swamp present on the north shore. There are no inlets or outlets. Without aeration, frequent winterkills limit the fishery; however, northern pike, largemouth bass, and panfish are present. Attempts have been made to control dense aquatic vegetation with only partial success. Floating bog islands, partially submerged, move about the lake and the wind forces them to drift to shore, creating a nuisance for riparian residents. A Milwaukee based realty firm rapidly developed the lake in the 1960s and early 1970s. As a result much of the wildlife use of the lake is gone; however, this lake is rich in rare plant species and the north end provides excellent wetland habitat.

Land Use and Watershed

The surface **watershed** for Jacqueline Lake is 342 acres (Figure 1). The predominant land use has been forest since 1948, with between 140 and 150 acres forested (Figure 3). Residential development boomed along the shoreline in the 1960s and early 1970s resulting in an increase from 6.8 acres (2.0%) of residential development in the entire surface **watershed** in 1948 to 41 acres (12.0%) by 1968, and 49 acres (14.4%) by 2002. As a result, much of the shoreline is developed except the tamarack swamp at the north end of the lake. Non-irrigated agricultural land has significantly decreased since 1948 from 85 acres to 25 acres in 2002. This decrease corresponds to the increase in residential development (Figure 2).

Figure 1. Jacqueline Lake surface watershed boundary.



*Terms in bold, see glossary pp 20-25

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

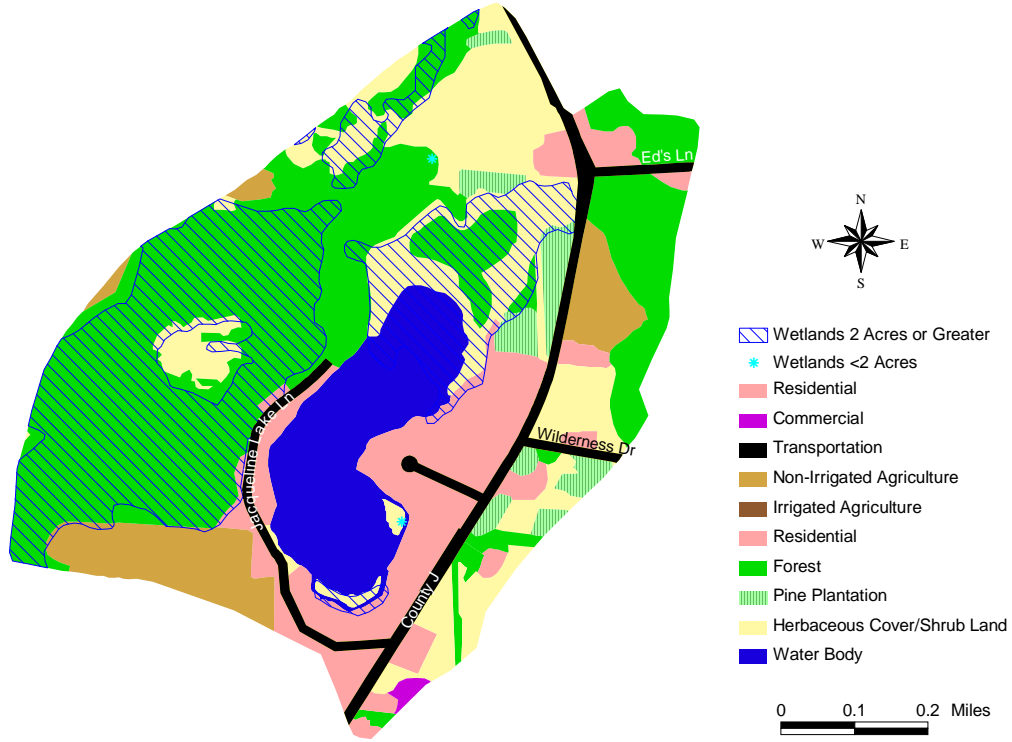
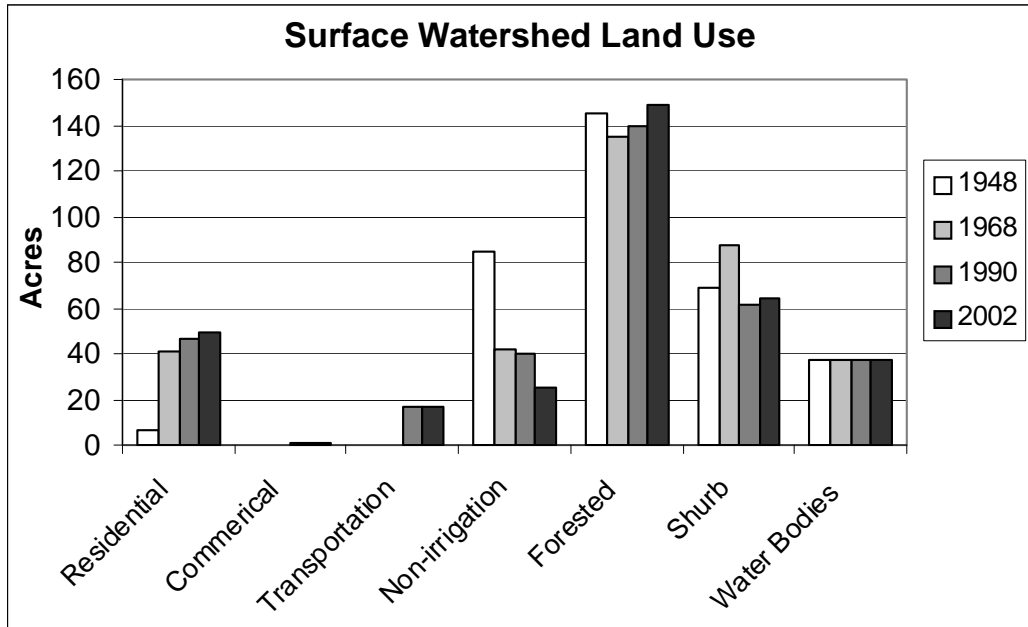


Figure 3. Land use in the Jacqueline Lake surface watershed 1948-2002.

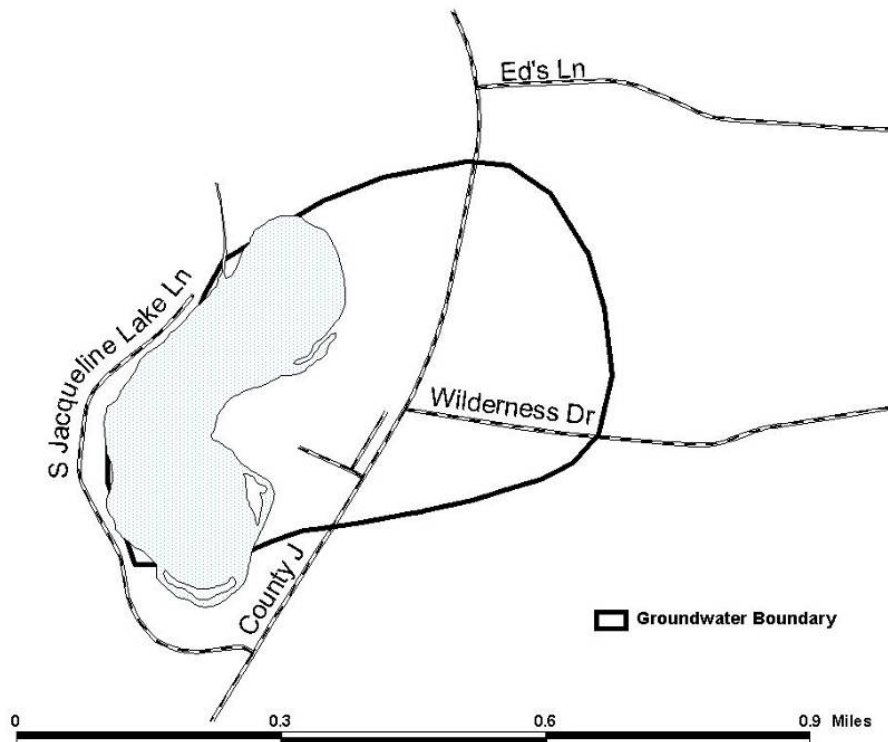


*Terms in bold, see glossary pp 20-25

Jacqueline Lake is a perched soft-water lake that by definition has limited interaction with **groundwater**. Predominant sources of water come from surface water runoff and direct precipitation. **Groundwater** that does interact with the lake is coming from the 117 acres to the east northeast of the lake and very near shore (Figure 4). The development of the lake shore in the 1960s was predominantly along the eastern shore, so the amount of residential land in the **groundwater watershed** increased from one acre (1%) in 1948 to 22 acres (19%) by 1968. The corresponding decrease was again seen in non-irrigated agricultural land as the acres went from 46 acres in 1948 to seven acres by 1968 where it has remained steady (Figure 5, Figure 6).

A 2002 map produced by Portage County staff indicate that based on age there are eight septic systems that are potentially failing in one stretch on the western shore of the lake. There are no records of former landfills within the **watersheds**.

Figure 4. Jacqueline Lake groundwater watershed boundary.



*Terms in bold, see glossary pp 20-25

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

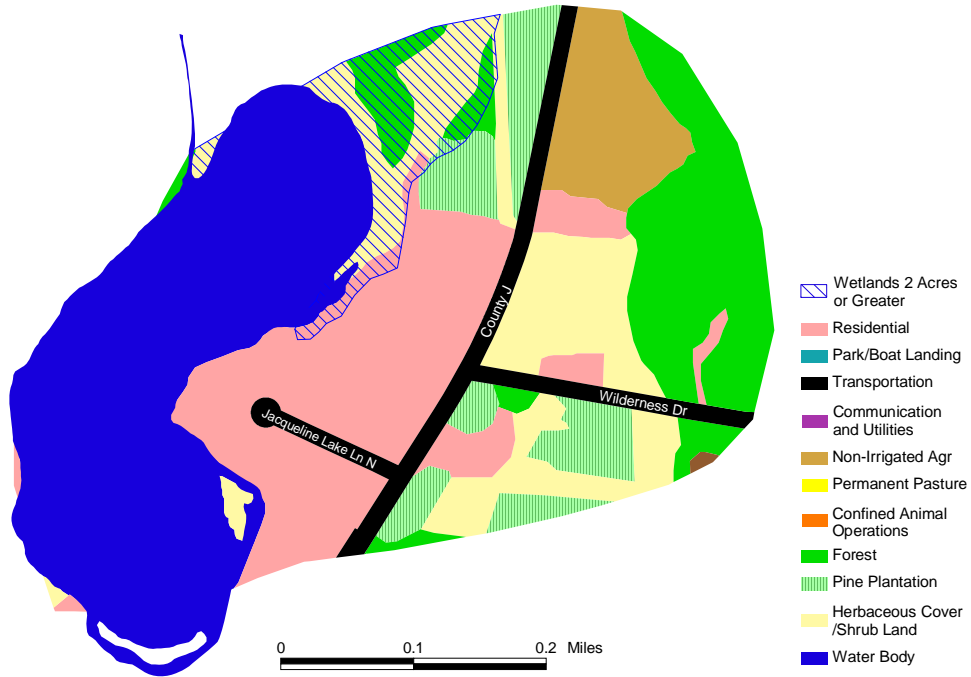
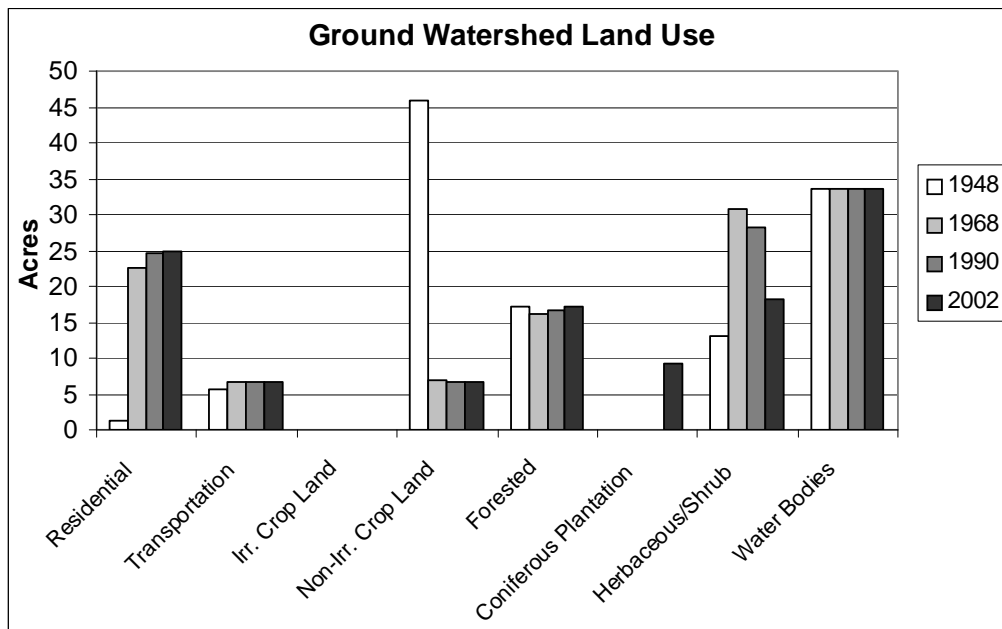


Figure 6. Land use in the Jacqueline Lake groundwater watershed 1948-2002.



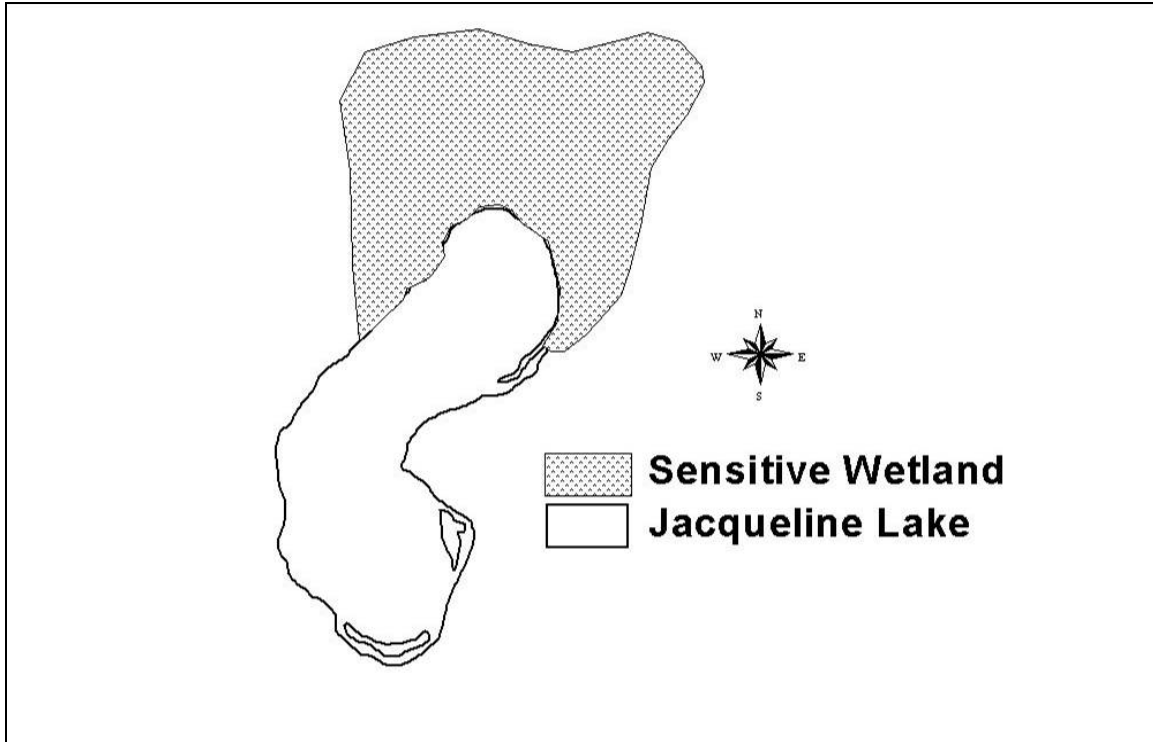
Upland Sensitive Areas

The survey of upland sensitive areas was conducted to identify areas within the surface **watershed** that are particularly valuable habitat, or sensitive to disruption. The primary area associated with Jacqueline Lake is focused in the tamarack and black spruce bog at the north end

*Terms in bold, see glossary pp 20-25

of the lake (Figure 7). This is a unique wetland habitat that is home to a variety of amphibian species and unique/rare plants for this region of the state.

Figure 7. Upland sensitive areas near Jacqueline Lake.



Birds

Lakeshore development can negatively or positively affect habitat quality of birds depending on the ecological requirements of each species. Development can play an 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 (*Sayornis 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 (*Parus atricapillus*), blue jay (*Cyanocitta cristata*), red-bellied woodpecker (*Melanerpes carolinus*), Eastern wood-pewee (*Contopus virens*), indigo bunting (*Passerina cyanea*), and common yellowthroat (*Geothlypis*

*Terms in bold, see glossary pp 20-25

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 Lake Jacqueline.

Common Name	Number Observed	Food	Foraging	Nest Type	Nest Location
American Goldfinch	3	seeds	foliage gleaner	cup	shrub
American Robin	7	insects	ground gleaner	cup	deciduous
Baltimore Oriole	2	insects	ground gleaner	oven	ground
Chipping Sparrow	8	insects	ground gleaner	cup	coniferous
Common Grackle	5	omnivore	ground gleaner	cavity	deciduous
Eastern Kingbird	4	insects	hawker	cup	deciduous
Great Crested Flycatcher	1	insects	hawker	cavity	deciduous
Hairy Woodpecker	1	insects	bark gleaner	cavity	deciduous
House Finch	6	seeds	ground gleaner	cup	deciduous
House Wren	3	insects	ground gleaner	cavity	deciduous
Least Flycatcher	1	insects	hover gleaner	cup	deciduous
Mourning Dove	3	seeds	ground gleaner	saucer	deciduous
Northern Cardinal	1	insects	ground gleaner	cup	shrub
Pileated Woodpecker	1	insects	foliage gleaner	pendant	deciduous
Red-eyed Vireo	2	insects	hover gleaner	cup	shrub
Red-winged Blackbird	3	insects	ground gleaner	cup	reed
Ruby-throated Hummingbird	1	nectar	hover gleaner	cup	deciduous
Song Sparrow	3	insects	ground gleaner	cup	ground
Total	55				

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**.

During the survey of amphibians of Lake Jacqueline five frog species were identified (spring peeper [*Pseudacris crucifer*], chorus frog [*Pseudacris triseriata*], northern leopard frog [*Rana*

*Terms in bold, see glossary pp 20-25

pipiens], American toad [*Bufo americanus*], and green frog [*Rana clamitans*]). The primary amphibian habitat is located on the north side of the lake (identified in red in Figure 8). Some of the key features of this habitat include protected wetland areas with large amounts of submergent, emergent, and floating-leaf vegetation as well as downed trees.

The good news is that a number of frog species are present and stretches of undeveloped shoreline still exist. However, there are also high levels of shoreline development on portions of the lake.

Reptile surveys were not conducted for Jacqueline Lake.

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



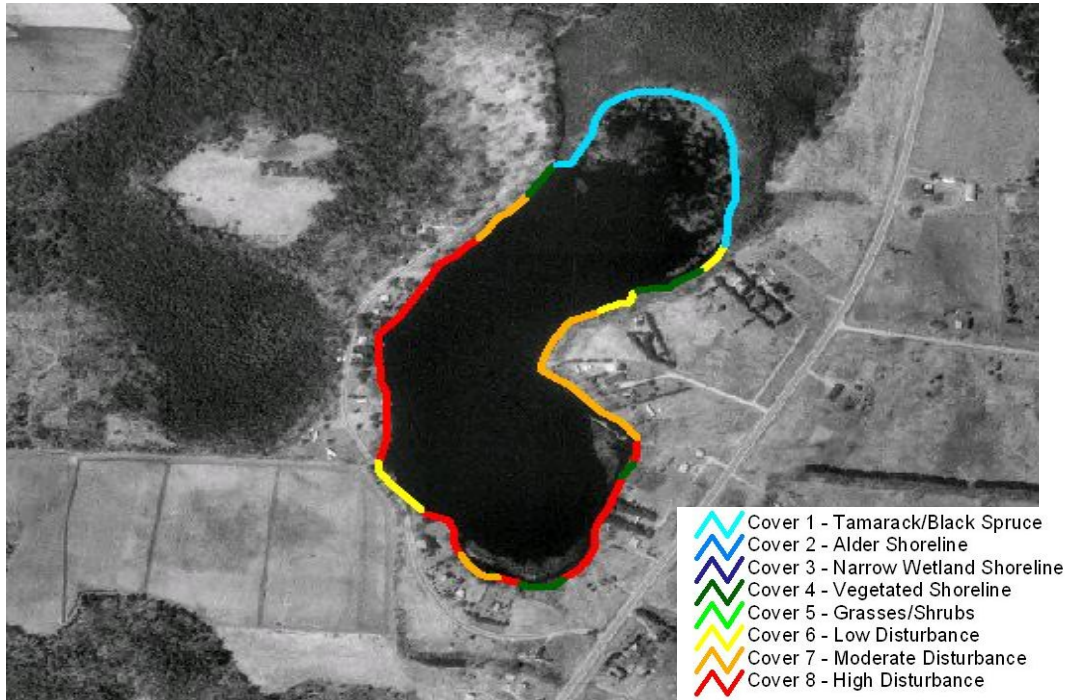
Twenty-four percent of the shoreline of Jacqueline Lake is comprised of black spruce (*Picea mariana*) and tamarack (*Larix laricina*) wetland. Tamarack/black spruce wetlands are characterized as wetland shore zone with a sweet gale or leatherleaf understory and a black spruce or tamarack canopy. This is represented by light blue in Figure 9. Vegetated shoreline comprised 11.3% of the shoreline and is represented by dark green. Vegetated shoreline is characterized as being an upland shore zone that is densely vegetated by tall grasses or shrubs and does not have a rocky component.

Around Jacqueline Lake, 65% of the shoreline is considered to be disturbed. Of that, 9.8% of the lake's shoreline vegetation is considered to be in a low disturbance developed area, 21.3% is moderately disturbed, and 4.1% is highly disturbed development. An area that exhibits low

*Terms in bold, see glossary pp 20-25

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. An area that exhibits high vegetation disturbance is defined as a beach, **rip rap**, sea wall or where the shore is mowed to the water line.

Figure 9. Categories of shoreline vegetation around Jacqueline Lake.



Aquatic Plants

There are **44** species of **vascular plants**, plus peatmoss that have been found in Jacqueline Lake, on shore, or on a small boggy island near the boat landing near the south shore. This is average for the Portage County lakes. The average **coefficient of conservatism (c-value)** is **5.8** which is above average. The **floristic quality index**, including the addition of one point each for three special concern species, is **41.0** which is also above average for Portage County lakes.

Jacqueline Lake has several relatively rare species, especially unusual in the southern two-thirds of Wisconsin, including three species of special concern: water-thread pondweed (*Potamogeton diversifolius*), whorled-leaf bladderwort (*Utricularia purpurea*), and violet bladderwort (*Utricularia resupinata*). The whorled-leaf bladderwort is very abundant, probably as abundant as in any lake in Wisconsin. The flora is typical of a soft-water lake, especially as found in northernmost Wisconsin, and similar to South Twin Lake. Despite a fairly large number of homes around the lake, the shoreline of Jacqueline Lake has few alien or aggressive plants; even reed canary-grass (*Phalaris arundinacea*) is absent from most of the shoreline.

*Terms in bold, see glossary pp 20-25

The Fishery

Jacqueline Lake supports a warm-water fish population. Because of the extensive development around the lake and recreational pressure, this fishery has been extensively surveyed. The lake has experienced a long history of winterkills from low dissolved oxygen, occurring almost every year between 1968 and 1986. An aerator was installed by the Lake Association in 1993 and apparently has prevented winterkills since. Seven species of fish were collected in 2002-2003 compared to six from historical records (Table 2). The low number of fish species present in the lake is probably a result of past episodes of low dissolved oxygen. Three new species were reported including the Iowa darter (*Etheostoma exile*), fathead minnow (*Pimephales promelas*), and central mudminnow (*Umbra limi*). Species not collected in the most recent sampling include black crappie (*Pomoxis nigromaculatus*) and black bullhead (*Ictalurus melas*).

The lake was stocked repeatedly with bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), and northern pike (*Esox lucius*) beginning in 1950, but stocking was reportedly ineffective because of winterkill. The local lake association alleviated this problem by installing an aerator in the early 1990s. The lake has been subject to extensive fishing pressure, and most sport fish caught are small. No largemouth bass greater than 13 inches were collected by electrofishing in 2003, although a few unusually large bluegill were caught. A total of nine species of fish have been reported from Jacqueline Lake since 1950.

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

Note: "S" indicates WDNR stocking record.

Bluegill	2003, 2002, 1999	S ; 1979, 1972, 1971
Largemouth Bass	2003, 2002, 1999	S ; 1994-1992, 1972, 1969, 1950
Black Crappie	1999	
Yellow Perch	2003, 2002, 1983	
Iowa Darter	2002	
Northern Pike	2003, 1999, 1983	S ; 1994-1992, 1979, 1975, 1973, 1969
Black Bullhead	1983	
Fathead Minnow	2002	
Central Mudminnow	2003	

Bottom Substrate, Vegetative Structure, and Critical Habitat

Bottom **substrate** in **littoral** areas is almost entirely muck (Figure 10). A previous study measured depths of muck up to 33 feet by probing with a long metal rod to the original lake bottom. The muck was flocculent with a 3-5% solids content and will not support the weight of an individual wading. It is believed to have accumulated from the decomposition of the luxuriant growth of aquatic plants in the lake over a long period of time. There is no ideal spawning **substrate** for bass or sunfish. In the absence of sand and gravel, largemouth bass will excavate a bed to a hard **substrate** such as accumulations of sticks and twigs that have fallen into the water to lay their eggs. The lack of suitable spawning habitat for sunfish may not be detrimental to the sport fishery, as sunfish typically overpopulate and stunt. The presence of some rather large bluegill in this lake suggests the population may be limited thus the increased size. Yellow perch

*Terms in bold, see glossary pp 20-25

are present and there is evidence of recent reproduction. The spawning requirements of this species are rather nonspecific and adults will usually deposit eggs on submerged branches or in dense aquatic vegetation. Northern pike are present in the lake and although there is an abundance of spawning habitat no young of year were collected in 2002 and 2003.

Jacqueline Lake has extensive beds of emergent and floating aquatic vegetation including a large area in the northern part of the lake covered with a floating bog (Figure 11). Management of the luxuriant growth of aquatic vegetation began in 1968 with herbicides including the currently banned 2,4,5-T and Silvex. Reports in 1982 indicated only 2-3 acres were “weed” free and as many as 85 tons of vegetation were removed in 1986. Spraying ceased in the early 1990s following purchase of a weed harvester. The lake presents an ideal environment for growth of aquatic plants, and annual cutting will be needed to maintain open water.

Figure 10. Littoral bottom map of Jacqueline Lake 10/25/03.



Figure 11. Vegetative cover map of Jacqueline Lake 10/25/03.



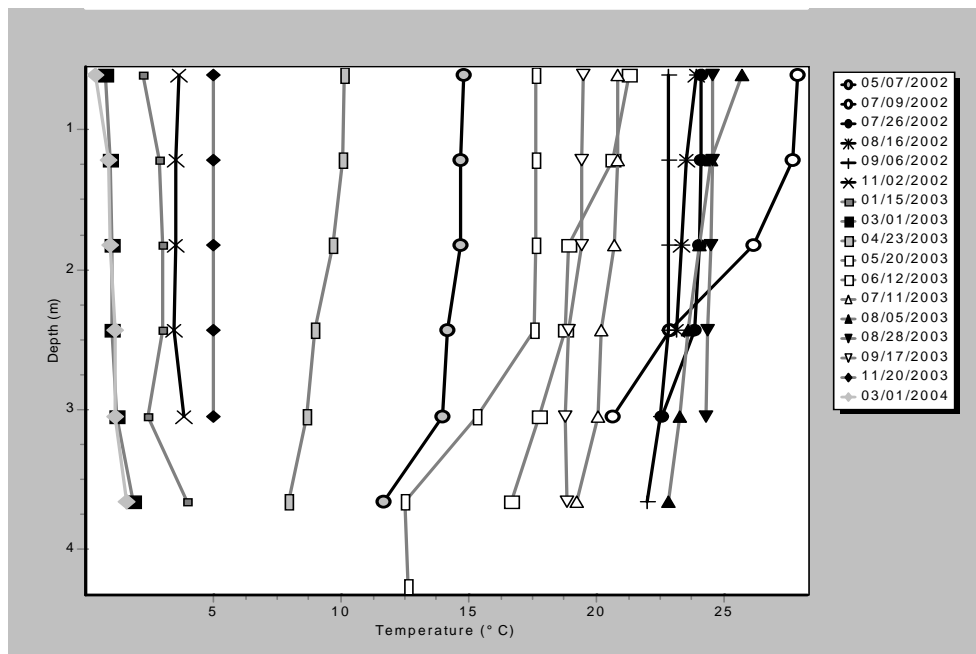
*Terms in bold, see glossary pp 20-25

Current Water Quality Conditions

Water quality of lakes is assessed using a number of measures including temperature, dissolved oxygen, water **clarity**, water chemistry, **chlorophyll *a***, and **algae**. Each of the constituents discussed play a role in water quality. A more detailed discussion of those roles can be found at the beginning of the report and should be consulted for a more complete understanding of each lake.

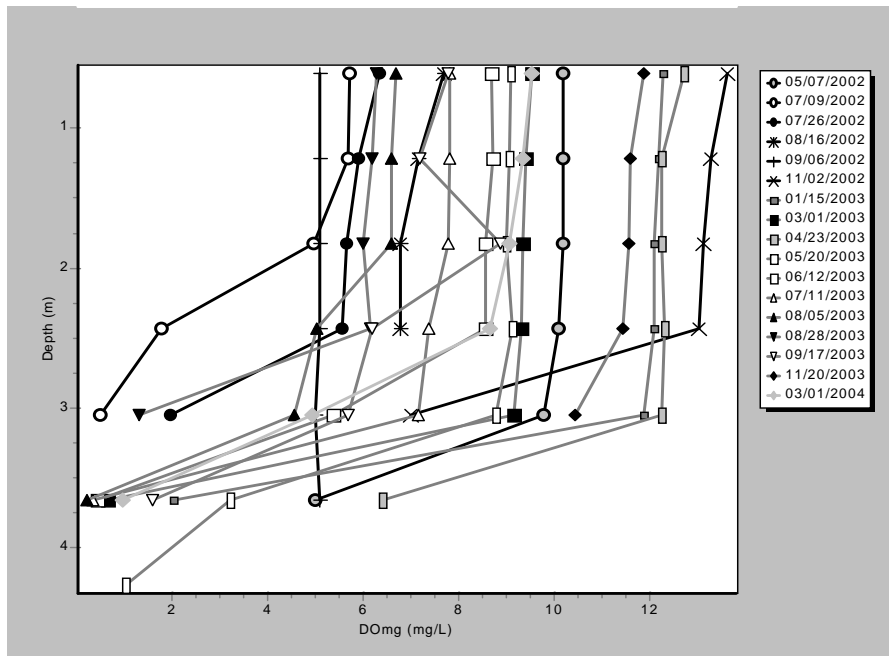
Temperature and dissolved oxygen were measured top to bottom each time a sample was collected. Due to Jacqueline Lake's shallow depth it does not stratify, but tends to reach a maximum temperature throughout the water column in late July or early August (Figure 12) and oxygen levels below about 8 feet in depth drop significantly. In all but the April 2003 sampling event oxygen levels near the bottom of the lake were below the 5 **mg/L** water quality standard for oxygen in "warm water" lakes and streams (Figure 13). Survival of most aquatic biota is difficult when oxygen levels fall below 5 **mg/L**.

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



*Terms in bold, see glossary pp 20-25

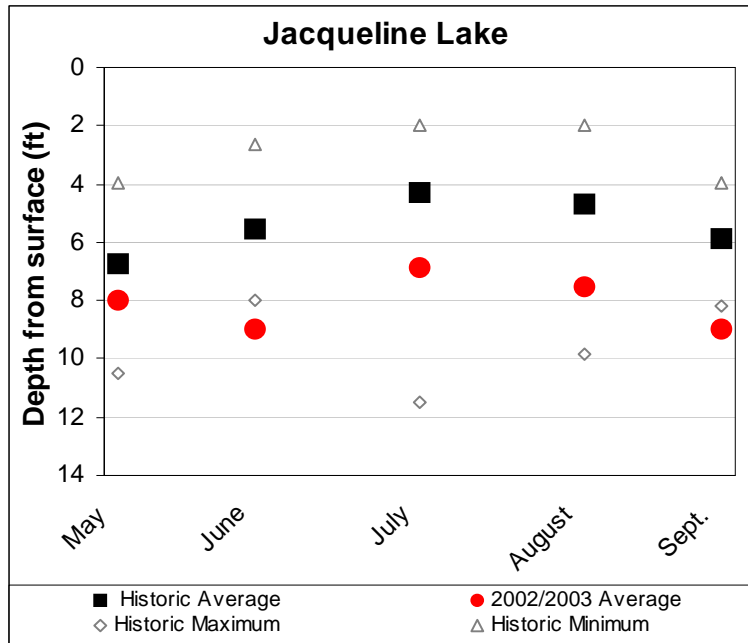
Figure 13. Profile of dissolved oxygen in Jacqueline Lake 2002-2004.



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*)**. When the lake is quiet **turbidity** measurements in Jacqueline Lake were low (Table 3). Water **color** in Jacqueline Lake is considered low, but is higher than many of the Portage County lakes due to the brown staining from organic acids associated with the adjacent wetlands. **Chlorophyll *a*** concentrations varied throughout the summer growing season ranging from 0.005 **mg/L** in May 2003 to 45.9 **mg/L** in July 2002 with a median concentration of 6.9 **mg/L**. The water **clarity** in Jacqueline Lake is considered fair. Similar **seepage lakes** in the area have average **Secchi disc** readings of 9 to 10 feet; on average Jacqueline was a bit less than this. The water **clarity** was the worst in July, about 7 feet, and the best in June and September, approximately 9 feet (Figure 14). It should be noted that the monthly average water **clarity** measured in Jacqueline Lake during 2003/03 was much better than the historic average.

*Terms in bold, see glossary pp 20-25

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



Total and calcium **hardness** concentrations indicate that Jacqueline Lake is a soft-water lake. **Alkalinity** was also low, making the lake naturally less productive and more susceptible to the effects of acid rain. 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). In Jacqueline Lake **nitrogen** concentrations were low; however, concentrations of total **phosphorus** were quite high. These elevated concentrations are increasing aquatic plant growth and **chlorophyll a** (a measure of **algae**). On several occasions exceedingly high concentrations were measured including 107, 60, 61, and 728 ug/L in August 2002, April 2003, July 2003, and September 2003, respectively. The lake sediment is comprised of decaying vegetation which is rich in nutrients. The soft mucky sediment in this shallow lake can be disturbed during heavy storms with strong winds or by boats that are creating wakes or have large engines. When the sediment mixes into the oxygen rich upper waters, **phosphorus** is released and becomes available for use by **algae** and aquatic plants.

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. These concentrations were all low. **Atrazine** was found in low concentrations in the lake water (0.17 and 0.08 ppb), however some toxicity studies have indicated that **endocrine** disruption can occur in frogs at these levels. The presence of **atrazine** indicates that other agri-chemicals may also be entering the lake.

*Terms in bold, see glossary pp 20-25

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

Jacqueline Lake	RP (ug/L)	TP (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	4.0	41.7	1.05	0.10	0.10	9.0	9.0	5.5	23	1.5	0.0
Summer Averages	4.2	21.8	1.04	0.02	0.01	8.5	10.0	4.3	31	1.1	10.8
Fall Averages	5.0	18.0	1.15	0.10	0.18	50.0	7.0	4.5	33	1.6	
Winter Averages	1.5	26.0	1.51	0.15	0.47						
2002-2004 Averages	3.7	25.4	1.17	0.08	0.17	22.5	8.7	4.8	29	1.4	9.7

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

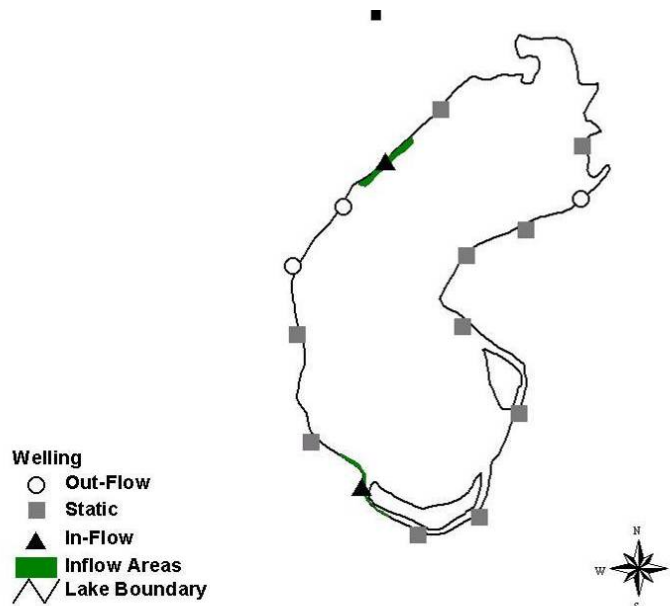
Table 4. 2002-2003 Jacqueline Lake average water chemistry and reference values.

Jacqueline Lake	Low	Medium	High	Reference Values	Low	Medium	High
Sulfate	2.28			Sulfate	<10	10-20	>20
Chloride	0.56			Chloride	<3	3-10	>10
Potassium	1.12			Potassium*	<2.16	2.16-4.30	>4.30
Sodium	0.52			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 can enter lakes from water originating in the **groundwater watershed**, but it can also enter from local sources all around the lake, especially where there are steep slopes. Mini-wells were used to estimate where **groundwater** is entering and leaving Lake Jacqueline. In addition, landowners mapped areas of open water during late winter. **Groundwater** was observed entering the lake on the west side (Figure 15). One **groundwater** sample was collected for analysis; nitrate, **ammonium**, chloride, and **phosphorus** were all at natural background concentrations.

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



*Terms in bold, see glossary pp 20-25

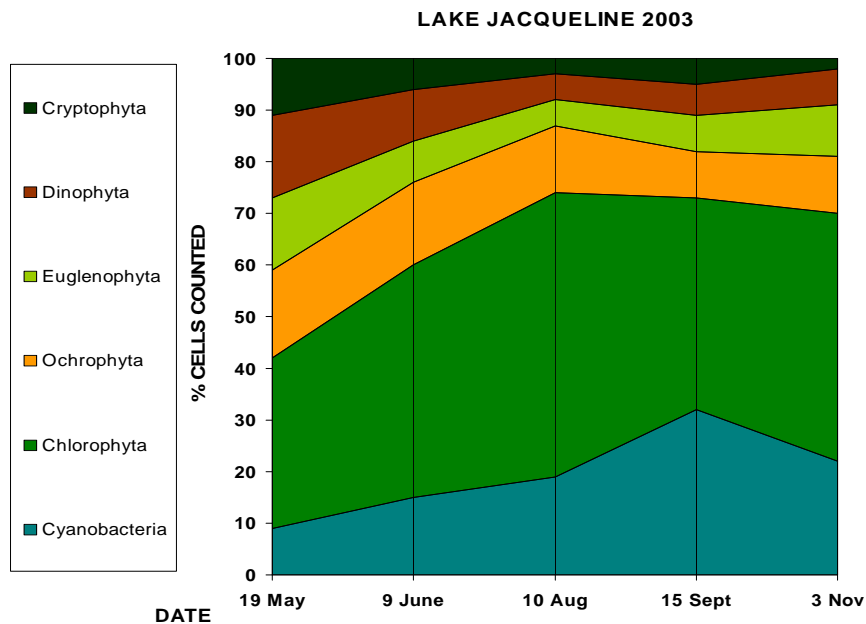
Algal Community

The algal community in Jacqueline Lake (Table 5) was dominated by green **algae** (Chlorophyta) and **blue-green algae** (Cyanobacteria). In the 2400+ cells counted during this period there were 7 genera of Cyanobacteria, 14 genera of Chlorophyta, 14 genera of Ochrophyta (including 11 diatom genera), 4 genera of Euglenophyta, 2 genera of Dinophyta, and 1 genus of Cryptophyta identified. The green **algae** represented between 33-55% (mean = 44%) of all cells counted and the **blue-green algae** represented between 9-32% (19%) of all cells counted (Table 5). The green **algae** were the dominant group in all sample periods while the ochrophytes, mostly **diatoms**, were the next most dominant group in May and June (Figure 16). **Blue-green algae** became the second most common group from July through November. After the May sample period no group other than the greens, blue-greens, and **diatoms** represented more than 10% of cells counted.

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

LAKE JACQUELINE						
PHYLUM	% CELLS COUNTED BY PHYLUM AND DATE					
	19May	9 June	10 Aug	15 Sept	3 Nov	MEAN
Cyanobacteria	9	15	19	32	22	19
Chlorophyta	33	45	55	41	48	44
Ochrophyta	17	16	13	9	11	13
Euglenophyta	14	8	5	7	10	9
Dinophyta	16	10	5	6	7	9
Cryptophyta	11	6	3	5	2	5

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

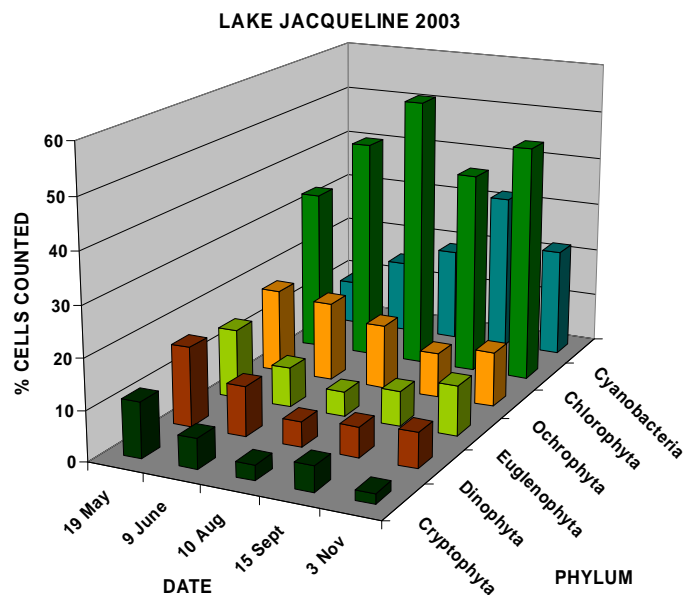


*Terms in bold, see glossary pp 20-25

Green **algae** (*Ankistrodesmus*, *Scenedesmus*, and *Staurastrum*) were the dominant Jacqueline Lake taxa in all sample periods and occupied the top three abundance spots in 7 of 15 samples (Table 6). The unicellular *Ankistrodesmus* bloomed early in the season (May, June) and then dropped to the second most abundant taxon in the August sample falling to a more minor community component in September and November (Figure 17). The small colonial *Scenedesmus* started slowly before becoming dominant in August and September and then dropped to third most abundant in the November sample. The large unicellular desmid, *Staurastrum*, was common throughout the sampling period before blooming into the most abundant taxon in November. The blue-green taxa, *Coelosphaerium* and *Aphanizomenon*, were very abundant in four of 15 samples, including second most abundant taxa in three of five sample periods. A cryptophyte (*Cryptomonas*) and a dinoflagellates (*Ceratium*) were also very common (second or third most abundant) in four of 15 sample periods.

The algal community, when considered relative to the **chlorophyll**, **phosphorus**, and **nitrogen** values for Jacqueline Lake, indicates a very **mesotrophic** lake. The 44 genera identified during the sample periods are all relatively common in the region and the muted dynamics of the algal community during the growing season (dominated by a few taxa of greens and blue-greens) are typical of a fairly **mesotrophic** lake like Jacqueline Lake. Also typical of very **mesotrophic** lakes is the strong presence of facultative heterotrophic genera like the dinoflagellates and cryptophytes. These organisms are an indication of substantial organic matter being present at times in the lake. Motile heterotrophs like *Cryptomonas* and *Ceratium* can use organic materials for food in place of or in supplement to **photosynthesis**. In many cases, an algal community such as seen in this lake can be attributed to some source of organic enrichment such as heavy agricultural runoff or failing septic systems. Water **clarity** was poor most of the sampling period. This **clarity** dropped substantially during the mid-late growing season (August to November) when the green and **blue-green algae** began to dominate.

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



*Terms in bold, see glossary pp 20-25

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

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

*Terms in bold, see glossary pp 20-25

Jacqueline Lake Study Highlights

- The primary upland sensitive area associated with Jacqueline Lake is focused in the tamarack and black spruce bog at the north end of the lake. This is a unique wetland habitat that is home to a variety of amphibian species and unique/rare plants for this region of the state.
- Twenty-four percent of the shoreline of Jacqueline Lake is comprised of black spruce and tamarack wetland. Vegetated shoreline comprised 11% of the shoreline, and 65% of the shoreline is considered to be disturbed.
- The primary amphibian habitat is located on the north side of the lake. The good news is that a number of frog species are present and stretches of undeveloped shoreline still exist. However, there are also high levels of shoreline development on portions of the lake.
- The number of aquatic plant species, plus peatmoss in Jacqueline Lake, on shore, or on a small boggy island near the boat landing near the south shore is average for the Portage County lakes. Both the average **coefficient of conservatism** and the **floristic quality index** are above average for Portage County lakes.
- Jacqueline Lake has several relatively rare aquatic plant species, especially unusual in the southern two-thirds of Wisconsin, including three species of special concern: water-thread pondweed, whorled-leaved bladderwort, and violet bladderwort. The whorled-leaved bladderwort is very abundant, probably as abundant as in any lake in Wisconsin. The flora is typical of a soft-water lake, especially as found in northernmost Wisconsin, and similar to South Twin Lake. Despite a fairly large number of homes around the lake, the shoreline of Jacqueline Lake has few alien or aggressive plants; even reed canary-grass is absent from most of the shoreline.
- The lake has experienced a long history of fish winterkills from low dissolved oxygen, occurring almost every year between 1968 and 1986. An aerator was installed by the Lake Association in 1993 and apparently has prevented winterkills since. A total of nine species of fish have been reported from Jacqueline Lake since 1950. The low number of fish species present in the lake is probably a result of past episodes of low dissolved oxygen. The lake has been subject to extensive fishing pressure and most sport fish caught are small. No largemouth bass greater than 13 inches were collected by electrofishing in 2003, although a few unusually large bluegill were caught.
- Jacqueline Lake has extensive beds of emergent and floating aquatic vegetation including a large area in the northern part of the lake covered with a floating bog. Management of the luxuriant growth of aquatic vegetation began in 1968 with herbicides including the currently banned 2,4,5-T and Silvex. Reports in 1982 indicated only 2-3 acres were “weed” free, and as many as 85 tons of vegetation were removed in 1986. Spraying ceased in the early 1990s following purchase of a weed harvester. The lake presents an ideal environment for growth of aquatic plants and annual cutting will be needed to maintain open water.
- **Chlorophyll *a*** concentrations varied throughout the summer growing season ranging from 0.005 **mg/L** in May 2003 to 45.9 **mg/L** in July 2002 with a median concentration of 6.9 **mg/L**. The water **clarity** in Jacqueline Lake is considered fair.

*Terms in bold, see glossary pp 20-25

- In Jacqueline Lake **nitrogen** concentrations were low; however, concentrations of total **phosphorus** were quite high. These elevated concentrations are increasing aquatic plant growth and **chlorophyll a** (a measure of **algae**). On several occasions exceedingly high concentrations were measured including 107, 60, 61, and 728 ug/L in August 2002, April 2003, July 2003, and September 2003, respectively. The lake sediment is comprised of decaying vegetation which is rich in nutrients. The soft mucky sediment in this shallow lake can be disturbed during heavy storms with strong winds or by boats that are creating wakes or have large engines with deeper propellers. When the sediment mixes into the oxygen-rich upper waters, **phosphorus** is released and becomes available for use by **algae** and aquatic plants. **Atrazine** was found in low concentrations in the lake water. The presence of **atrazine** indicates that other agri-chemicals may also be entering the lake.
- The algal community, when considered relative to the **chlorophyll a**, **phosphorus**, and **nitrogen** values for Jacqueline Lake, indicates a **mesotrophic** lake. In many cases, an algal community such as seen in this lake can be attributed to some source of organic enrichment such as heavy agricultural runoff or failing septic systems. Water **clarity** was poor most of the sampling period. This **clarity** dropped substantially during the mid-late growing season (August to November) when the green and **blue-green algae** began to dominate.
- A 2002 map produced by Portage County staff indicate that based on age there are eight septic systems that are potentially failing in one stretch on the western shore of the lake.
 - Consider special protection for upland sensitive areas near the lake through conservancy easements
 - Compliance with County and State shoreland ordinances would reduce impacts to habitat and water quality in disturbed areas.
 - Protect the unique aquatic plant community by enforcing no-wake rules.
 - Steps should be taken to prevent the establishment of invasive species in or adjacent to Lake Jacqueline. This would include training, routine monitoring, and outreach at boat landings.
 - Fair water **clarity** and elevated **phosphorus** and **chlorophyll a** concentrations should be addressed.
 - Establish appropriate shoreland buffers to reduce/slow runoff to the lake
 - Minimize re-suspension of sediment
 - Enforce no-wake rule
 - Consider carry in only rules if no-wake still results in sediment resuspension

*Terms in bold, see glossary pp 20-25

Glossary

Algae:

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

Alkalinity:

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

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 (NO₃) 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 (NH₄⁺) form, but at high pH values the toxic ammonium hydroxide (NH₄OH) occurs. The water quality standard for fish and aquatic life is 0.02 mg/L of NH₄OH. 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 (N₂) from the air to provide their own nutrient.

Chloride (Cl⁻):

Chlorine in the chloride ion (Cl⁻) form has very different properties from chlorine gas (Cl₂), which is used for disinfecting. The chloride ion (Cl⁻) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll a:

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

Clarity:

see "Secchi disc."

*Terms in bold, see glossary pp 20-25

Coefficient of Conservatism (c-value):

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

Color:

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

Concentration Units:

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

Diatoms:

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

Drainage Lakes:

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

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).

*Terms in bold, see glossary pp 20-25

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 CaCO₃. Amount of hardness relates to the presence of soluble minerals, especially limestone, in the lake watershed. Moderately hard water has 61-120 mg/L CaCO₃, hard water has 121-180 mg/L CaCO₃, and very hard water has more than 180 mg/L CaCO₃.

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 (CaCO₃) 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.

*Terms in bold, see glossary pp 20-25

mg/L:

see "Concentration units"

Nitrate (NO₃⁻):

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 (NO₃-N) plus ammonium-nitrogen (NH₄-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

Nitrite (NO₂⁻):

A form of nitrogen that rapidly converts to nitrate (NO₃⁻) and is usually included in the NO₃⁻ 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 (CO₂) 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.

*Terms in bold, see glossary pp 20-25

Secchi Disc (Secchi Disk):

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

Sedimentation:

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

Seepage Lakes:

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

Sodium:

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

Soft water:

Water with less than 60 mg/L CaCO₃ (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 (SO₄²⁻):

The most common form of sulfur in natural waters. The amounts relate primarily to soil minerals in the watershed. Sulfate (SO₄²⁻) can be reduced to sulfide (S²⁻) and hydrogen sulfide (H₂S) 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 (SO₂) 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.

*Terms in bold, see glossary pp 20-25

Watershed:

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

*Terms in bold, see glossary pp 20-25