The Aquatic Plant Community in Lake Eau Galle, Dunn County 2002

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EXECUTIVE SUMMARY

Lake Eau Galle is hypereutrophic, shallow lake with very poor water quality and poor water clarity. Nutrients and algae have increased since 1995 and water clarity and quality has decreased. As a lake, Eau Galle is high in nutrients and can support a large biomass. In Lake Eau Galle, this biomass is found as planktonic and filamentous algae. Filamentous algae was abundant in the shallow depth zone.

A buffer of natural shoreline protects much of Lake Eau Galle.

The aquatic plant community in Lake Eau Galle is of below average quality for Wisconsin lakes and is characterized by good species diversity and high disturbance tolerance and dominated by species tolerant of poor water clarity. Poor water clarity is probably the major disturbance and factor limiting the growth of aquatic vegetation.

Aquatic plants occurred at low densities and frequencies, scattered throughout the north half of Lake Eau Galle, mainly in the shallowest zone. One-quarter of the littoral zone supported rooted vegetation to a maximum depth of 5.5 feet. Eurasian watermilfoil was the dominant species within the plant community, but also occurred at low densities and frequencies and only in the upper end of the impoundment.

The coverage of submergent vegetation (22%) is inadequate for support of a balance fishery. Aquatic plant communities start the food chain, produce oxygen needed by aquatic organisms, provide cover and nesting/spawning habitat for a variety of wildlife and fish.

Recommendations for Lake Residents and Lake Users

1) Protect the submergent and floating-leaf plant communities to preserve habitat.
2) Preserve the natural shoreline buffer zone to protect water quality.
3) Cooperate with efforts in the watershed to reduce nutrient input to the lake.
4) Investigate the feasibility of introducing emergent plants in Lake Eau Galle
5) Monitor expansion of the Eurasian watermilfoil. Control is not recommended at this time since the control would not likely be effective long-term. Currently the milfoil is not causing a nuisance situation and is providing habitat in a lake that lacks sufficient plant beds.

I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Lake Eau Galle was conducted during August 2002 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Lake Eau Galle by the DNR.

A study of the diversity, density, and distribution of aquatic plants is an essential component of understanding a lake due to the important ecological role of aquatic vegetation in the lake ecosystem and the ability of the vegetation to characterize the water quality (Dennison et al. 1993).

Ecological Role: All other life in the lake depends on the plant life (including algae) - the beginning of the food chain. Aquatic plants provide food and shelter for fish, wildlife, and the invertebrates that in turn provide food for other organisms. Plants improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake and impact recreation.

Characterize Water Quality: Aquatic plants serve as indicators of water quality because of their sensitivity to water quality parameters, such as water clarity and nutrient concentrations (Dennison et. al. 1993).

The present study will provide information that is important for effective management of the lake including: fish habitat improvement, protection of sensitive wildlife areas, aquatic plant management, and water resource regulations. The baseline data that it provides will be compared to future macrophyte inventories and offer insight into any changes occurring in the lake.

Background and History: Lake Eau Galle is a 351-acre, hardwater impoundment on the Eau Galle River in southwest Dunn County, Wisconsin. The maximum depth of Lake Eau Galle is 18 feet and the mean depth is 6 feet; this would classify Lake Eau Galle as a shallow water resource.

Lake Eau Galle was drawn down during the summer of 1971 to conduct a chemical control of rough fish.

II.METHODS

Field Methods

The study design was based primarily on the rake-sampling method developed by Jessen and Lound (1962), using stratified random placement of the transect lines. The shoreline was divided into 22 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment (Appendix IV) and mapped, using a random numbers table. Four transects were eliminated because of siltation that has occurred in the upper end.

One sampling site was randomly located in each depth zone (0-1.5ft, 1.5-5ft, 5-10ft and 10-20ft)

along each transect. Using a long-handled, steel, thatching rake, four rake samples were taken at each sampling site. The four samples were taken from each quarter of a 6-foot diameter quadrat. The aquatic plant species that were present on each rake sample were recorded. Each species was given a density rating (0-5) based on the number of rake samples on which it was present at each sampling site.
A rating of 1 indicates that a species was present on one rake sample.
A rating of 2 indicates that a species was present on two rake samples.
A rating of 3 indicates that it was present on three rake samples.
A rating of 4 indicates that it was present on all four rake samples.
A rating of 5 indicates that a species was abundantly present on all rake samples at that sampling site.

The sediment type at each sampling site was recorded. Visual inspection and periodic samples were taken between transect lines in order to record the presence of any species that did not occur at the sampling sites. Specimens of all plant species present were collected and saved in a cooler for later preparation of voucher specimens. Nomenclature was according to Gleason and Cronquist (1991).

The type of shoreline cover was recorded at each transect. A section of shoreline, 50 feet on either side of the transect intercept with the shore and 30 feet deep, was evaluated. The percentage of each cover type within this 100' x 30' rectangle was visually estimated and verified by a second researcher.

<u>Data Analysis</u>
The percent frequency of each species was calculated (number of sampling sites at which it occurred / total number of sampling sites) (Appendix I). Relative frequency was calculated (number of occurrences of a species / total occurrence of all species (Appendix I). The mean density was calculated for each species (sum of a species' density ratings / number of sampling sites) (Appendix II). Relative density was calculated (sum of a species density / total plant densities. A "mean density where present" was calculated for each species (sum of a species' density ratings / number of sampling sites at which the species occurred) (Appendix II). The relative frequency and relative density was summed to obtain a dominance value (Appendix III). Species diversity was measured by Simpson's Diversity Index (Appendix I).

The Aquatic Macrophyte Community Index (AMCI) developed by Weber et. al. (1995) was applied to Lake Eau Galle. Values between 0 and 10 are given for each of six parameters that characterize the plant community as outlined in Weber et. al. (1995).

The Average Coefficient of Conservatism and Floristic Quality Index was calculated for Eau Galle Lake (Nichols (1998) to measure disturbance in the community. The coefficient of conservatism (C) is an assigned value, 0-10, the probability that a species will occur in an undisturbed habitat. The Average Coefficient of Conservatism is the mean of the Coefficients for each species recorded. The Floristic Quality (FQI) is calculated from the Coefficient of Conservatism.

III. RESULTS

PHYSICAL DATA

Many physical parameters impact the macrophyte community. Water quality (nutrient concentration, algae concentration, water clarity, pH, hardness) influences the macrophyte community as the macrophyte community can in turn modify water quality. Lake morphology, sediment composition and shoreline use also impact the macrophyte community.

WATER QUALITY - The trophic state of a lake is an indication of its water quality. Nutrient concentration, algae concentration and water clarity data are collected and combined to determine the trophic state.

Eutrophic lakes are high in nutrients and therefore support a large biomass.
Oligotrophic lakes are low in nutrients and support limited plant growth and smaller fish populations.
Mesotrophic lakes have intermediate levels of nutrients and biomass.

Nutrients

Phosphorus is a limiting nutrient in many Wisconsin lakes and is measured as an indication of the nutrient concentration in lake water. Increases in phosphorus in a lake can feed algae blooms and, occasionally, excess plant growth.

July 2002 phosphorus in Lake Eau Galle was 73ug/l

This concentration of phosphorus in Lake Eau Galle was indicative of a eutrophic lake (Table 1).

Table 1. Trophic Status

	Quality Index	Phosphorus ug/l	Chlorophyll ug/l	Secchi Disc ft.
Oligotrophic	Excellent	<1	<1	> 19
	Very Good	1-10	1-5	8-19
Mesotrophic	Good	10-30	5-10	6-8
	Fair	30-50	10-15	5-6
Eutrophic	Poor	**50-150**	15-30	3-4
Hypereutrophic	Very Poor	>150	**>30**	**>3**
Lake Eau Galle 1995	Poor	66	36	3.5
Lake Eau Galle 2002	Very Poor	73	56	2.8

After Lillie & Mason (1983) & Shaw et. al. (1993)

Algae

Measuring the concentration of chlorophyll in a lake measures the algae concentrations. Algae are natural and essential in lakes, but high algae levels can cause problems, increasing the turbidity and reducing the light available for plant growth.

July 2002 chlorophyll in Lake Eau Galle was 56 ug/l.

The chlorophyll concentration in Lake Eau Galle indicates that it was a hypereutrophic lake (Table 1).

Water Clarity

Water clarity is a critical factor for plants. When plants receive less than 1 - 2% of the surface illumination, they can not survive. Water clarity is reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color the water. Water clarity is measured with a Secchi disc that shows the combined effect of turbidity and color.

July 2002 Secchi disc clarity was 2.8 ft.

Water clarity indicates (Table 1) that Lake Eau Galle was a hypereutrophic lake with poor clarity.

Secchi disc readings can be used to calculate a predicted maximum rooting depth for plants in a lake (Dunst 1982).

Based on the July 2002 Secchi disc clarity, the predicted maximum rooting depth in Lake Eau Galle would be 6.1 ft.

The relationship of the phosphorus, chlorophyll and water clarity in Eau Galle Lake indicates that it is a eutrophic/hypereutrophic lake. This would favor frequent algae blooms and/or abundant aquatic plant growth.

The phosphorus and chlorophyll concentrations have increased from 1995 to 2002. The water clarity has subsequently decreased during the same time period (Figure 1). The water quality has decreased from poor quality to very poor quality (Table 1).

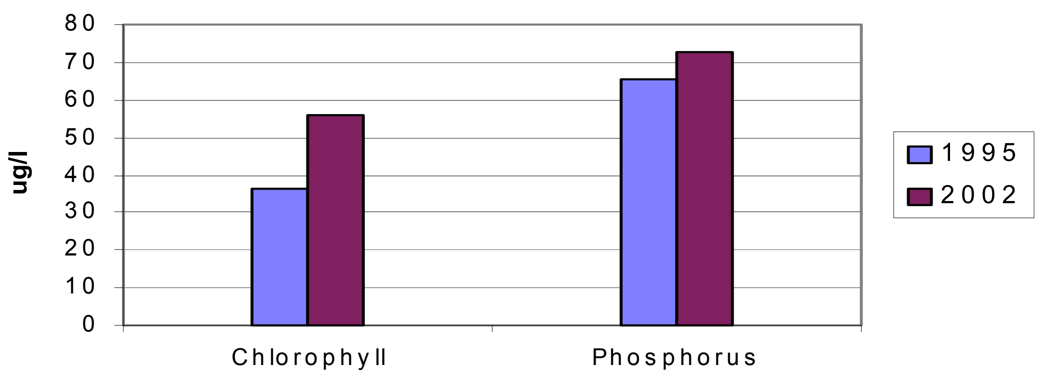


Figure 1. Change in water quality in Lake Eau Galle, 1995-2002.

While phosphorus is the limiting nutrient in most Wisconsin lakes, nitrogen can be the limiting nutrient in some lakes. The nitrogen:phosphorus ratio in Lake Eau Galle is approximately 12:1 to 14:1. Lakes with N:P ratios in this range are considered transitional as to their limiting nutrient and are associated with blue-green algae blooms (Shaw et. al. (1993)). This means that at times nitrogen can be a limiting nutrient, so that addition of nitrogen can increase plant and algae growth.

pH

The pH of a lake indicates the acidity or alkalinity of the water, with a pH of 7.0 indicating neutral water.
The 1995-2002 summer pH of the surface water in Lake Eau Galle has varied from 8.1 to 9.0.
This would favor plants adapted to alkaline conditions.

Hardness

1995-2002 hardness measures in Lake Eau Galle varied from 190-220mg CaCO3/l.
Water with hardness levels greater than 180mg CaCO3/l is considered very hard. Hard water lakes tend to have more plant growth.

LAKE MORPHOMETRY - The morphometry of a lake is an important factor in determining the distribution of aquatic plants. Duarte and Kalff (1986) found that the slope of the littoral zone could explain 72% of the observed variability in the growth of submerged plants. Gentle slopes support more plant growth than steep slopes (Engel 1985).

Portions of the littoral zone in Lake Eau Galle are steeply-sloped and portions are gradually sloped. Shallow depths are found in most of the lake (Appendix IV). The shallow depths and the gradually sloped littoral zone in areas would favor plant growth.

SEDIMENT COMPOSITION –

Sand was the dominant sediment in Lake Eau Galle, occurring throughout the lake, especially at depths less than 10 feet (Table 2).

Sand and silt mixtures were commonly occurring, especially in the 5-20ft depth zone. Rock was common in the shallow zone; silt occurred throughout the lake and was abundant at depths greater than 10 feet.

Table 2. Sediment Composition

Sediment Type	0-1.5' Depth	1.5-5' Depth	5-10' Depth	10-20' Depth	Percent of all Sample Sites

Hard Sediments	Sand	33%	67%	58%		46%
	Rock	33%				11%
	Sand/Rock	11%				4%
	Bedrock	11%				4%
Mixed Sediments	Sand/Silt	6%	17%	42%	50%	22%
Soft Sediments	Silt	6%	17%		50%	13%

Bedrock occurred south, near the dam, along the west shore.

SHORELINE LAND USE – Land use practices strongly impact the aquatic plant community and, therefore, the entire aquatic community. These practices can directly impact the plant community through increased sedimentation from erosion, increased nutrient input from fertilizer run-off and soil erosion and increased toxics from farmland and urban run-off.

Wooded cover was the most frequently encountered shoreline cover at the transects and had the highest mean coverage (Table 3). Herbaceous growth and shrub growth were commonly encountered and herbaceous growth protected nearly one-quarter of the shore.

However, cultivated lawn and rip-rap (disturbed shoreline) were commonly occurring at the sample sites (Table 3).

Table 3. Shoreline Land Use

Cover Type		Frequency of Occurrences at Transects	Mean % Coverage
Natural Shoreline	Wooded	72%	58%
	Native Herbaceous	50%	24%
	Shrub	22%	2%
	Total Natural		84%
Disturbed Shoreline	Cultivated Lawn	22%	12%
	Hard Structures	17%	2%
	Rip-rap	27%	2%
	Total Disturbed		16%

Some type of natural shoreline occurred at 89% of the sample sites and, based on the sample sites, covered 84% of the shoreline. Disturbed shoreline occurred at 44% of the sites and covered 16% of the shoreline (Table 3).

MACROPHYTE DATA

SPECIES PRESENT

Of the 11 species of aquatic plants found in Lake Eau Galle, 1 was an emergent species, 4 were floating-leaf species and 6 were submergent species (Table 4).
No threatened or endangered species were found.
Two non-native species were found:
Myriophyllum spicatum
Potamogeton crispus

Table 4. Lake Eau Galle Aquatic Plant Species, 2002

Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Sparganium* sp.	burreed	spasp
Floating leaf Species		
2) *Lemna minor* L.	small duckweed	lemmi
3) *Nelumbo lutea* (Willd.) Pers.	American lotus	nellu
4) *Spirodela polyrhiza* Schleiden.	duckweed	spipo
5) *Wolffia columbiana* Karsten.	water meal	wolco
Submergent Species		
6) *Ceratophyllum demersum* L.	coontail	cerde
7) M*yriophyllum spicatum* L.	Eurasain watermilfoil	myrsp
8) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
9) *Potamogeton nodosus* Poiret.	long-leaf pondweed	potno
10) *Potamogeton pectinatus* L.	sago pondweed	potpe
11) *Zosterella dubia* (Jacq.) Small	water stargrass	zosdu

FREQUENCY OF OCCURRENCE

Frequency of aquatic plants was very low in Lake Eau Galle.
Myriophyllum spicatum was the most frequently occurring species in Lake Eau Galle (25% of sample sites) (Figure 1).

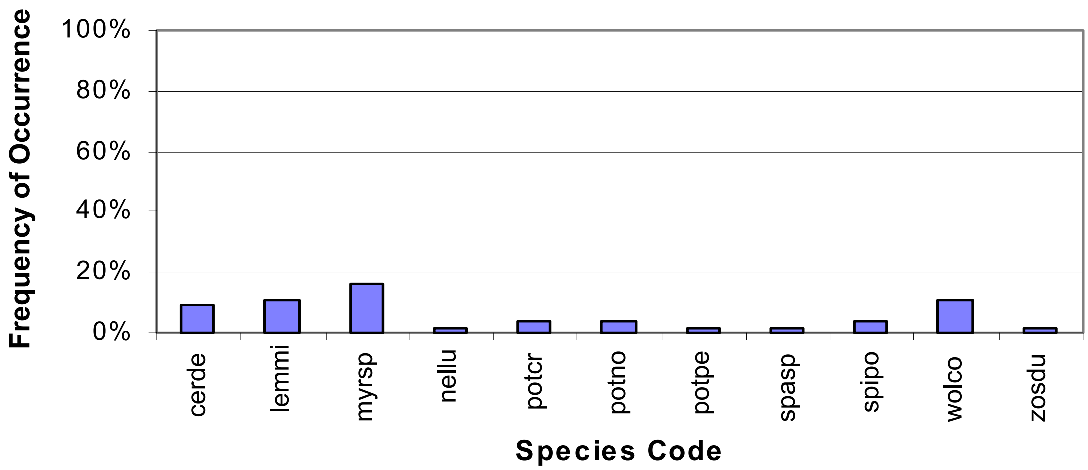


Figure 1. Aquatic plant frequencies in Lake Eau Galle, 2002

Filamentous algae occurred at 17% of the sample sites.
44% of the sample site in the 0-1.5ft depth zone
5% of the sample site in the 1.5-5ft depth zone

DENSITY

Density of aquatic plants was also very low in Lake Eau Galle; *Myriophyllum spicatum* was also the species with the highest mean density (0.31 on a density scale of 0-5) in Lake Eau Galle (Figure 2).

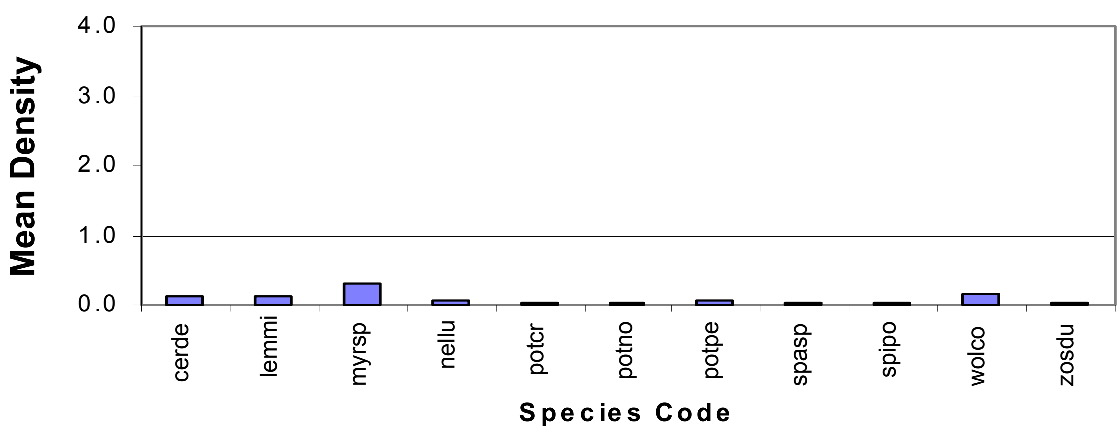


Figure 2. Densities of aquatic plants in Lake Eau Galle, 2002

Nelumbo lutea had a "mean density where present" of 4.0 (on a scale of 0-5). The high "mean density where present" indicates that *N. lutea* exhibited a dense growth form in Lake Eau Galle (Appendix II). The other species in Lake Eau Galle that had a "density where present" of 2.5 or more, indicating that it grew at above average density, was *Potamogeton pectinatus* (3.0). However, each of these species occurred infrequently.

DOMINANCE

Based on the Dominance Value, *Myriophyllum spicatum* (Eurasian watermilfoil) was the dominant plant species in Lake Eau Galle (Figure 3), although it occurred at a low frequency and density (Appendix III).

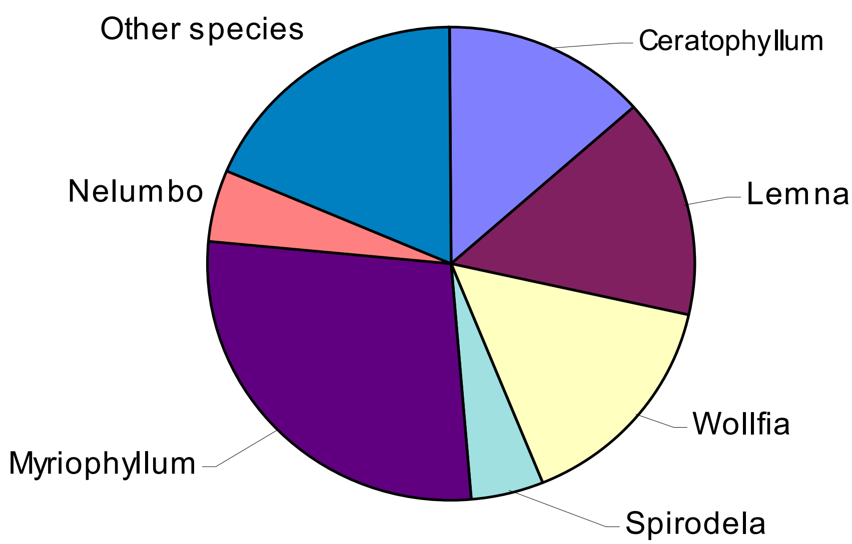


Figure 3. Dominance within the macrophyte community, of the most prevalent macrophytes in Lake Eau Galle, 2002.

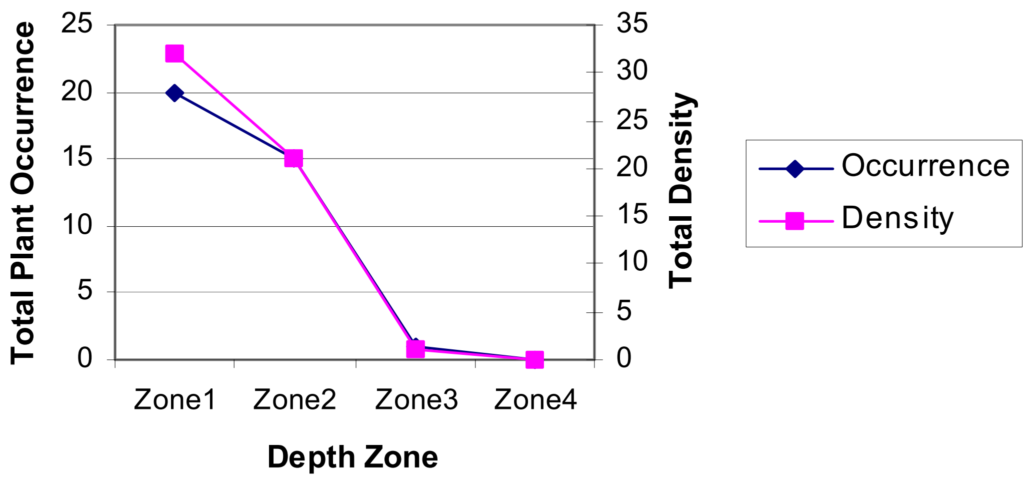
DISTRIBUTION

Aquatic macrophytes occurred at only one-third of the sites and only 26% of the sampling sites were vegetated with rooted aquatic macrophytes. Aquatic plants were scattered throughout Lake Eau Galle, to a maximum rooting depth of 5.5 feet. The maximum rooting depth of 5.5 feet is close to the predicted rooting depth of 6.1 feet, based on water clarity. *Potamogeton crispus* occurred at the maximum rooting depth.

Myriophyllum spicatum (Eurasian watermilfoil) occurred only in the far north end of the reservoir. The other species occurred in scattered locations around the lake.

The 0-1.5ft depth zone supported the greatest amount of plant growth. The highest total occurrence and total density of aquatic plants were recorded in the 0-1.5ft depth zone (Figure 4). The highest percent of vegetated sites and the greatest mean number of species per site were also recorded in the 0-1.5ft depth zone (Figure 5).

Figure 4. Total occurrence and density of plants by depth zone.



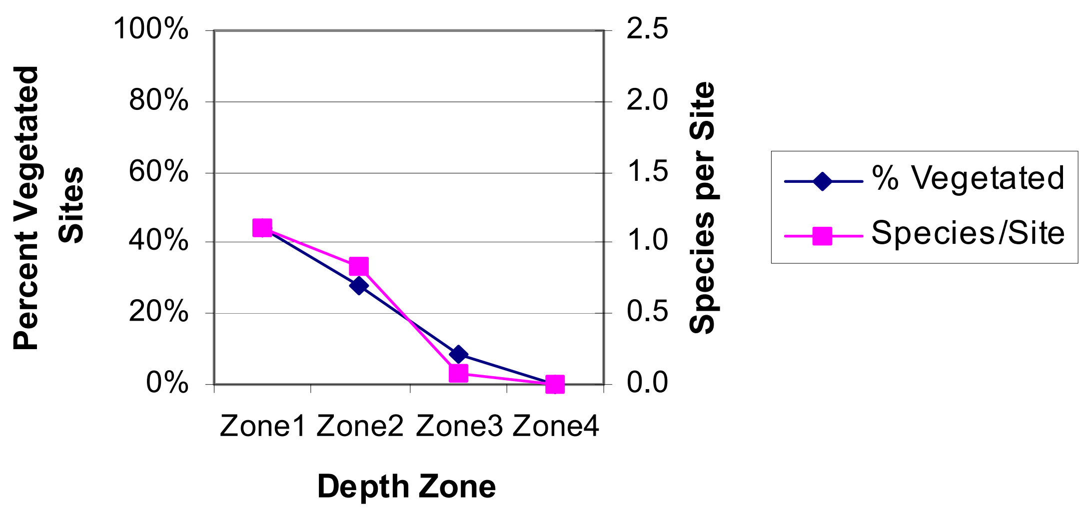


Figure 5. Percentage of vegetated site and mean number of plant species per site in Lake Eau Galle, by depth zone.

The mean number of aquatic plant species found at each sampling sites was 0.7.
36 sites had 0 species
9 sites had 1 species
2 sites had 2 species
5 sites had 3 species
2 sites had 4 species

Myriophyllum spicatum (Eurasian watermilfoil) was the most frequent and the most dense species in the 0-1.5ft depth zone (Appendix I, II). *M. spicatum* occurred at its highest frequency and density in the 0-1.5ft depth zone and declined with increasing depth (Figure 6, 7).

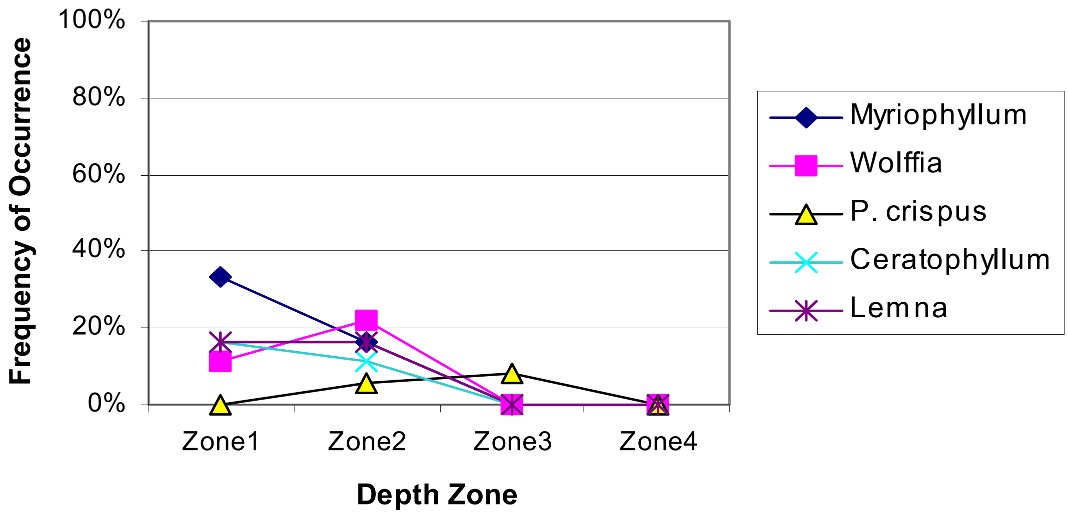


Figure 6. Frequency of occurrence of the most prevalent macrophytes in Lake Eau Galle, by depth zone.

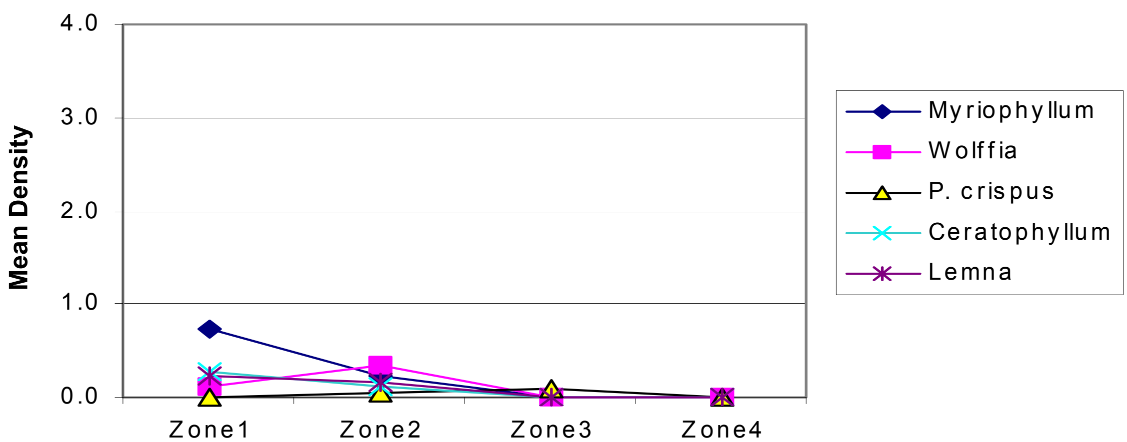


Figure 7. Density of the most prevalent macrophytes in Eau Galle Lake, by depth zone.

Wolffia columbiana was the most frequent and dense species in the 1.5-5ft depth zone (Appendix I, II) and occurred at its highest frequency and density in this depth zone (Figure 6, 7).

Potamogeton crispus was the only species that occurred in the 5-10ft depth zone (Appendix I, II). *P. crispus* occurred at its highest frequency and density in the 1.5-5ft depth zone (Figure 6, 7).

The other aquatic plant species in Lake Eau Galle declined in frequency and density with increasing depth.

INFLUENCE OF SEDIMENT – Many species of plants depend on the sediment in which they are rooted for their nutrients. The richness or sterility and texture of the sediment will determine the type and abundance of macrophyte species that can survive in a location.

The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986). Silt was not commonly occurring in Lake Eau Galle, except in deeper water, below the photic zone. Silt supported vegetation at 43% of the sites at which it occurred and mixed with sand, it supported vegetation at 25% of those sites (Table 5).

Sand was the dominant sediment found in Lake Eau Galle. Because of its high-density, sand can be limiting in nutrient availability (Table 5). Sand supported vegetation at 16% of the sites at which it occurred. Other high-density sediments supported widely variable amounts of vegetation.

Table 5. Sediment Influence

Sediment Type		Percent of Sites	Percent Vegetated
Hard Sediments	Sand	46%	16%
	Rock	11%	33%
	Sand/Rock	4%	100%
	Bedrock	4%	0%
Mixed Sediments	Sand/Silt	22%	25%
Soft Sediments	Silt	13%	43%

THE COMMUNITY

Simpson's Diversity Index was 0.85 (Appendix I), indicating a good diversity of species in the plant community in Lake Eau Galle. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index for Lake Eau Galle is 32, which is below average (40) for lakes in Wisconsin. The highest value for this index is 60.

Table 6. Aquatic Macrophyte Community Index

Parameters		Value
Maximum Rooting Depth	1.7 meters	2
% Littoral Zone Vegetated	33%	6
Simpson's Diversity	0.85	9
# of Species	11 (2 exotics)	2
% Submergent Species	43% Relative Freq.	5
% Sensitive Species	3% Relative Freq.	8
Totals		32

The shallow maximum rooting depth and the limited number of aquatic plant species reflect the lower quality of the plant community in Lake Eau Galle (Table 6).

The Average Coefficient of Conservatism for Lake Eau Galle was in the lowest quartile for all Wisconsin lakes and North Central Hardwood Region lakes (Table 7) analyzed by Nichols (1998). This suggests that the aquatic plant community in Lake Eau Galle among the group of lakes most tolerant of disturbance.

Table 7. Coefficient of Conservatism and Floristic Quality of Lake Eau Galle, Compared to Wisconsin Lakes and Northern Wisconsin Lakes.

	Average Coefficient of Conservatism	Floristic Quality (FQI)†	(FQI) Based on Relative Frequency‡
Wisconsin Lakes *	5.5, 6.0, 6.9	16.9, 22.2, 27.5	
NCHR *	5.2, 5.6, 5.8	17.0, 20.9, 24.4	
Lake Eau Galle 2002	4.09	13.57	10.96

* - Values indicate the upper limit of the lowest quartile, the mean and the lower limit of the upper quartile.

† - Average Coefficient of Conservatism for all Wisconsin lakes ranged from a low of 2.0 (the most disturbance tolerant) to a high of 9.5 (least disturbance tolerant).

‡ – The lowest Floristic Quality was 3.0 (farthest from undisturbed condition) and the high was 44.6 (closest to undisturbed condition).

The Floristic Quality of the aquatic plant community in Lake Eau Galle was also in the lowest quartile for Wisconsin lakes and North Central Hardwood Lakes (Table 7). This indicates that Lake Eau Galle be among the group of lakes in Wisconsin and the region farthest from an undisturbed condition.

Disturbances can be of many types:

1) Direct disturbances to the plant beds result from activities such as boat traffic, plant harvesting, chemical treatments, the placement of docks and other structures and fluctuating water levels.
2) Indirect disturbances can be the result of factors that impact water clarity and thus stress species that are more sensitive: resuspension of sediments, sedimentation from erosion, increased algae growth due to nutrient inputs.
3) Biological disturbances include the introduction of a non-native or invasive plant species, grazing from an increased population of aquatic herbivores, destruction of plant beds by the fish population.

V. DISCUSSION

Based on water clarity, chlorophyll and phosphorus data, Lake Eau Galle is a hypereutrophic, shallow lake with poor clarity and very poor water quality. Water quality decreased from poor quality in 1995 to very poor quality in 2002. Nutrient and algae concentrations have increased since 1995 and water clarity has decreased.

Lake Eau Galle appears to be transitional between a phosphorus or nitrogen limited lake. Additions of either nutrient can increase algae growth.

Abundant nutrients (hypereutrophic status), hardwater, shallow depth and gradually sloped littoral zone in much of Lake Eau Galle would favor aquatic plant growth. Poor water clarity and dominance of high density rock and sand sediments (65% occurrence) would limit aquatic plant growth. Sediments favorable for plant growth occur in deeper water, below the photic zone.

Aquatic plant growth occurred scattered throughout Lake Eau Galle at low frequencies and densities, to a maximum depth of 5.5 feet. The maximum rooting depth is close to the predicted maximum rooting depth of 6.1 feet. One-third of the sites were vegetated; only one-quarter of the sites supported rooted vegetation. The shallow depth zone, 0-1.5ft, supported the greatest amount of plant growth in Lake Eau Galle: the highest total occurrence of plants, highest total density of plants, greatest percentage of vegetated sites, and greatest mean number of species per sample site.

Eleven species were recorded in Lake Eau Galle only 1 species was an emergent. *Myriophyllum spicatum* (Eurasian watermilfoil) was the dominant macrophyte species in Lake Eau Galle, especially in the 0-1.5ft depth zone, but occurred only in the far upper end of the reservoir. *Wolffia columbiana*, was second in dominance, epsecially in the 1.5-5ft depth zone. *Potamogeton crispus* was the only aquatic plant species found at depths greater than 5 feet. Filamentous algae occurred at 17% of the sample sites throughout the lake, at nearly half of the sites in the 0-1.5ft depth zone.

The Aquatic Macrophyte Community Index (AMCI) for Lake Eau Galle was 32, indicating that the quality of the macrophyte community in Lake Eau Galle was below average (40) for Wisconsin lakes. The limited number of species (11) and shallow maximum rooting depth are limiting the quality of the aquatic plant community. Simpson's Diversity Index (0.85) indicates that the macrophyte community had good diversity of species. The mean number of species per sample site was only 0.7.

The Floristic Quality Index suggests that Lake Eau Galle is in the group of lakes in Wisconsin and in the North Central Hardwoods Region of Wisconsin that are most tolerant of disturbance and farthest from an undisturbed condition. This suggests that Lake Eau Galle is in the group of lakes that have been subjected to the most disturbance. Poor water clarity is likely the major disturbance factor.

Lake Eau Galle is protected by a buffer of natural shoreline (wooded, shrub and native herbaceous growth) along approximately 84% of the shore. Wooded cover occurred at the highest frequency and coverage. Disturbed shoreline (mowed lawn, rip-rap, hard structures) occurred at 44% of the sites and covered 16% of the shoreline. Mowed lawn occurred at 22% of the sites and covered 12% of the shoreline. Mowed grass results in increased runoff to the lake, carrying pesticides, fertilizers and other lawn chemicals and pet wastes.

VI. CONCLUSIONS

Lake Eau Galle is shallow lake with very poor water quality and poor water clarity. Nutrients and algae have increased since 1995 and water clarity and quality has decreased. As a hypereutrophic lake, Eau Galle is high in nutrients and can support a large biomass. In Lake Eau Galle, this biomass is found as planktonic and filamentous algae. Filamentous algae was abundant in the 0-1.5ft depth zone.

A buffer of natural shoreline protects Lake Eau Galle. Mowed lawn or grass covers approximately 12% of the shoreline.

The aquatic plant community in Lake Eau Galle is of below average quality for Wisconsin lakes and is characterized by good species diversity. Lake Eau Galle is among the quartile of lakes in Wisconsin and the region that are most disturbance tolerant and farthest from an undisturbed condition, likely due to a large amount of disturbance. Poor water clarity is probably the major disturbance.

Aquatic plants occurred at low densities and frequencies, scattered throughout the north half of Lake Eau Galle. One-quarter of the littoral zone supported rooted vegetation to a maximum depth of 5.5 feet; the most abundant plant growth occurred in the 0-1.5ft-depth zone. *Myriophyllum spicatum* (Eurasian watermilfoil) was the dominant species within the plant community, but occurred at low densities and frequencies in the upper end of the impoundment.

Poor water clarity and dominance of sediments less favorable to plant growth are likely inhibiting the aquatic plant community. Eight of the eleven species recorded in Lake Eau Galle are tolerant of poor water clarity and the plant community is concentrated in the shallowest depth zone where light would be greatest in poor clarity situations.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the benefits plants provide in
1) improving water quality 2) providing valuable resources for fish and wildlife 3) resisting invasions of non-native species and 4) checking excessive growth of tolerant species that could crowd out the more sensitive species and reduce diversity.

1) Macrophyte communities improve water quality in many ways:
   - they trap nutrients, debris, and pollutants entering a water body;
   - they absorb and break down some pollutants;
   - they reduce erosion by damping wave action and stabilizing shorelines and lake bottoms;
   - they remove nutrients that would otherwise be available for algae blooms (Engel 1985).

2) Aquatic plant communities provide important fishery and wildlife resources. Plants (including algae) start the food chain that supports many levels of wildlife, and at the same time produce oxygen needed by animals. Plants are used as food, cover and nesting/spawning sites by a variety of wildlife and fish (Table 8). The macrophyte community in Lake Eau Galle provides habitat in 22% of the littoral zone. This amount of vegetation is inadequate for a good balance of cover (25-85%) and open water needed to support a healthy fishery.

Compared to non-vegetated lake bottoms, macrophyte beds support larger, more diverse invertebrate populations that in turn will support larger and more diverse fish and wildlife populations (Engel 1985). Additionally, mixed stands of macrophytes support 3-8 times as many invertebrates and fish than monocultural stands (Engel 1990). Diversity in the plant community creates more microhabitats for the preferences of more species. Macrophyte beds of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990).

Recommendations

It is important to take measures to protect the aquatic plant community that plays a key role in protecting water quality and providing habitat:

1) Protect the submergent and floating-leaf plant communities to preserve habitat.
2) Preserve the natural shoreline buffer. Native vegetation reduces run-off into the lake and filters the run-off that does enter the lake.
3) Cooperate with efforts in the watershed to reduce nutrient input to the lake.
4) Investigate the feasibility of introducing emergent plants in Lake Eau Galle. Currently, based on the sample sites, only one emergent species occurs in the lake and provides habitat at only 5% of the shoreline.
5) Monitor expansion of the Eurasian watermilfoil. Control is not recommended at this time since the control would not likely be effective. The milfoil covers too large of an area to make spot treatment feasible. If the milfoil could be controlled, it would likely become reintroduced from upstream. Currently the milfoil is not causing a nuisance situation and is providing habitat in a lake that lacks sufficient plant beds.

Lake Eau Galle is an important resource for the County. Taking steps to protect the aquatic plant community in Lake Eau Galle will preserve water quality and protect fish and wildlife resources.