The Aquatic Plant Community in Easton Lake, Adams County 2001 MWBC 1243600

I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Easton Lake was conducted during August 2001 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR) and Adams County Land Conservation Department Staff. This was the first quantitative vegetation study of Easton Lake 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 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 the lake bottom, 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 levels (Dennison et. al. 1993).

The present study was conducted as part of a water quality assessment of Easton Lake and the Campbell Creek Watershed. The study will also provide information that is important for effective management of the lake: 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: Easton Lake is a 24-acre impoundment on Campbell Creek in southern Adams County, Wisconsin. Easton Lake has a maximum depth of 10 feet and an average depth is 5 feet. The watershed of Easton Lake encompasses 13,440 acres; this means that the water eventually entering Easton Lake, drains from 13,440 acres. This gives a drainage area:lakes size ratio of 560:1. Lakes with drainage area/lake size ratios greater than 10:1 tend to have water quality problems (Field 1994). The watershed is used primarily for agriculture (Klish 2000).

Easton Lake was created as a millpond in 1855. In 1978, the residents on Easton Lake formed a Lake District and have sponsored projects for the management of the lake.

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 13 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment, using a random numbers table. Because of the shallowness of the upper end of the impoundment, the research boat could not navigate the upper end and transects 6-10 were eliminated. The upper end of the impoundment has likely silted in significantly since the maps were made.

One sampling site was randomly located in each depth zone (0-1.5 ft., 1.5-5 ft. and 5-10ft.) 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. The species recorded include aquatic vascular plants and several types of algae that have morphologies similar to vascular plants, such as muskgrass and nitella.
Each species was given a density rating (0-5) based on the number of rake samples at each sampling site on which it was present.
A rating of 1 for each species present on one rake sample;
A rating of 2 for each species present on two rake samples;
A rating of 3 for each species present on three rake samples;
A rating of 4 for each species present on four rake samples;
A rating of 5 indicates that a species was abundant on all rake samples at that sampling site.)

The presence of filamentous algae was recorded. The sediment type at each sampling site was also 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 back from the shore, was evaluated. The percentage of each cover type within this 100' x 30' rectangle was visually estimated and verified by a second researcher.

Data Analysis

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 based on the number of occurrences of a species relative to 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 based on a species density relative to 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 calculating Simpson's Diversity Index (Appendix I).

III. RESULTS

PHYSICAL DATA

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).

Easton Lake has a narrow impoundment with gradually sloped littoral zone in the upper end and some steeply sloped littoral zone in the lower end (Appendix V). The gradually sloped areas of the littoral zone should favor plant growth.

SEDIMENT COMPOSITION - 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.

Silt, an intermediate density sediment, was the predominant sediment in Easton Lake, especially in the deeper zones (Table 1). The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986.

Sand and silt mixtures were common in the shallow depth zone (Table 1).

Table 1. Sediment Composition in Easton Lake, 2001

Sediment Type		0-1.5' Depth	1.5-5' Depth	5-10' Depth	Percent of all Sample Sites
Soft Sediments	Silt	62%	83%	100%	79%
	Muck	12%			5%
	Silt/Muck		17%		5%
Mixed Sediments	Sand/Silt	25%			10%

All sediment types supported vegetation.

SHORELINE LAND USE - Land use practices can 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 on Easton Lake and had the highest mean coverage (Table 2). Native herbaceous, shrub, cultivated lawn and eroded soil cover was also commonly encountered. Cultivated lawn occurred at half of the sites and had a high mean coverage. Based on coverage at the transect sites, cultivated lawn covered over a quarter of the shoreline (Table 2).

Table 2. Shoreline Land Use

Cover Type		Frequency of Occurrences at Transects	Mean % Coverage
Natural Shoreline	**Wooded**	75%	44%
	Native Herbaceous	62%	12%
	Shrub	25%	4%
Disturbed Shoreline	**Cultivated Lawn**	50%	29%
	Hard Structures	12%	2%
	Eroded Soil	25%	8%

Coverage of natural shoreline (wooded, native herbaceous, shrub) was found at 88% of the sites and covered 60% of the shoreline. Disturbed shoreline (cultivated lawn, hard structures and eroded soil) was found at 75% of the sites and had a coverage of 39% over the shoreline (Table 2).

MACROPHYTE DATA

SPECIES PRESENT

Of the 13 species of plants found in Easton Lake, 1 was an emergent species, 2 were floating-leaf species and 10 were submergent species (Table 3). No threatened or endangered species were found.

One non-native species, *Potamogeton crispus*, was found.

Table 3. Easton Lake Aquatic Plant Species

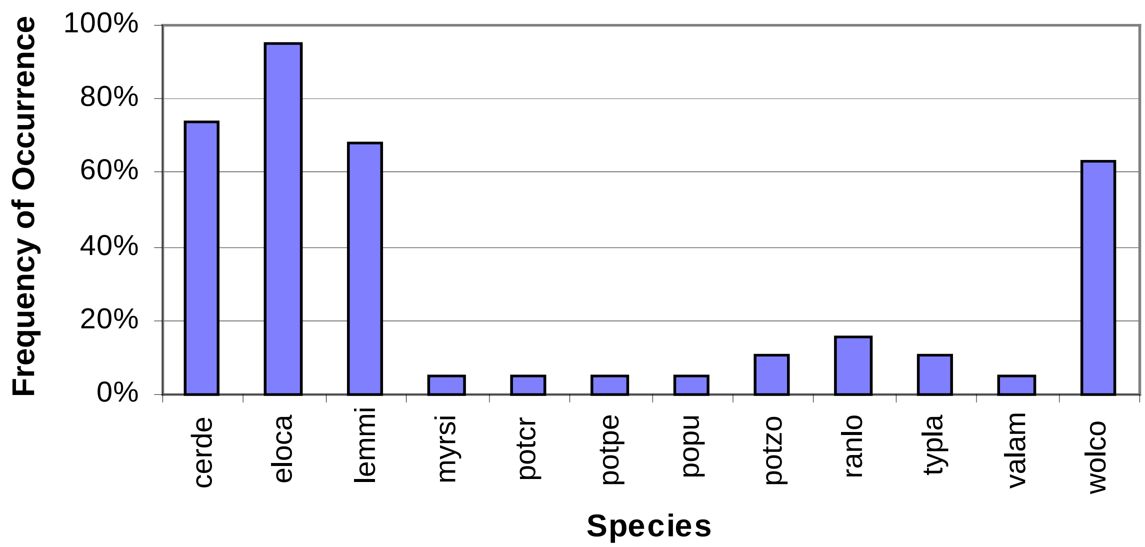
Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Typha latifolia* L.	common cattail	typla
Floating-leaf Species		
2) *Lemna minor* L.	small duckweed	lemmi
3) *Wolffia columbiana* Karsten.	common watermeal	wolco
Submergent Species		
4) *Ceratophyllum demersum* L.	coontail	cerde
5) *Elodea canadensis* Michx.	common waterweed	eloca
6) *Myriophyllum sibiricum* Komarov.	common water milfoil	myrsi
7) *Potamogeton crispus* L.	curly pondweed	potcr
8) *Potamogeton pectinatus* L.	sago pondweed	potpe
9) *Potamogeton pusillus* L.	small pondweed	potpu
10) *Ranunculus longirostris* Godron.	white water crowfoot	ranlo
11) *Potamogeton zosteriformis* Fern.	flatstem pondweed	potzo
12) *Vallisneria americana* Michx.	wild celery	valam
13) *Zosterella dubia* (Jacq.) Small.	water stargrass	zosdu

FREQUENCY OF OCCURRENCE

Elodea canadensis was the most frequently occurring species in Easton Lake, (95% of sample sites) (Figure 1). *Ceratophyllum demersum, Lemna minor* and *Wolffia columbiana* were also commonly occurring species, (74%, 68% and 63%).

Figure 1. Macrophyte frequencies in Easton Lake

Filamentous algae occurred at 89% of the sample sites.
At 75% of the sites in the 0-1.5 ft. depth zone;



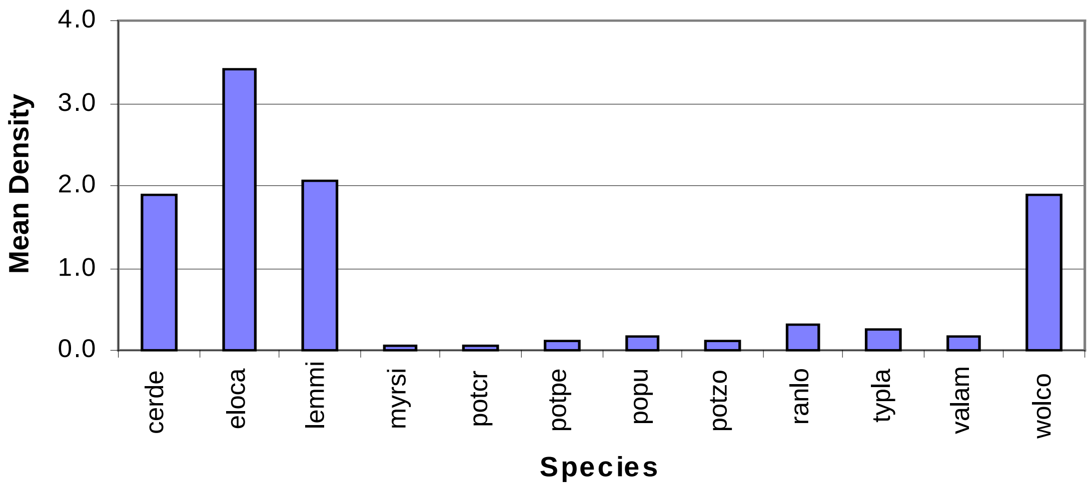
At 100% of the sites in the 1.5-5 ft. depth zone;
At 100% of the sites in the 5-10 ft. depth zone.

DENSITY

Elodea canadensis was also the species with the highest mean density in Easton Lake (3.42 on a density scale of 0-4) (Figure 2).

Figure 2. Densities of macrophytes in Easton Lake, 2001

Elodea canadensis had a 'mean density where present' of (3.42). The 'mean density where present' indicates that, where *E.*



canadensis occurred it grew at an above average density in Easton Lake (Appendix II). *Ceratophyllum demersum, Lemna minor, Potamogeton pusillus* and *Wolffia columbiana* were other species in Easton Lake that had above average 'densities where present', indicating that they grew at above average densities (Appendix II).

DOMINANCE

Combining relative frequency and relative density into a Dominance Value indicates how dominant a species is within the macrophyte community (Appendix III). Based on the Dominance Value, *Elodea canadensis* was the dominant species in Easton Lake (Figure 3). *Ceratophyllum demersum* and *Lemna minor* were sub-dominant.

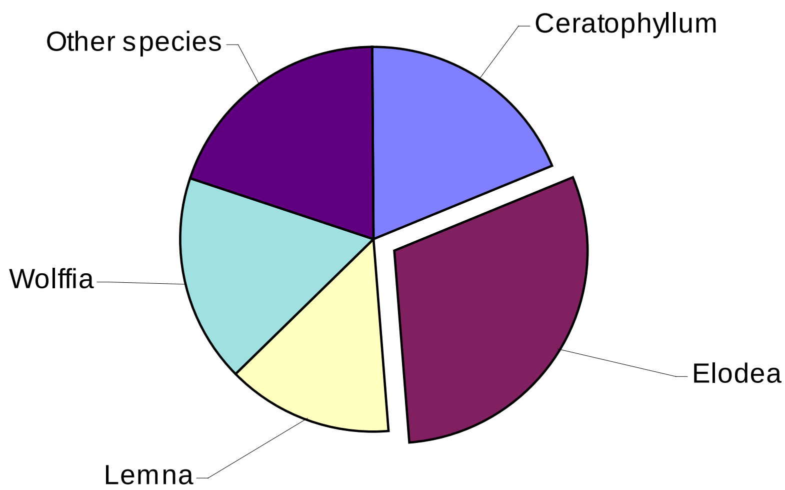


Figure 3. Dominance within the macrophyte community, of the most prevalent macrophytes in Easton Lake, 2001.

DISTRIBUTION

Aquatic macrophytes occurred throughout Easton Lake, at all of the sample sites, to a maximum depth of 9 feet. *Ceratophyllum demersum* and *Elodea canadensis* occurred at the maximum rooting depth.

The 0-1.5ft depth zone had the greatest amount of plant growth. The highest total occurrence and total density of plant growth was recorded in the 0-1.5ft zone and decreased with increasing depth (Figure 4). The highest mean number of species per site was also found in the 0-1.5ft zone (Figure 5).

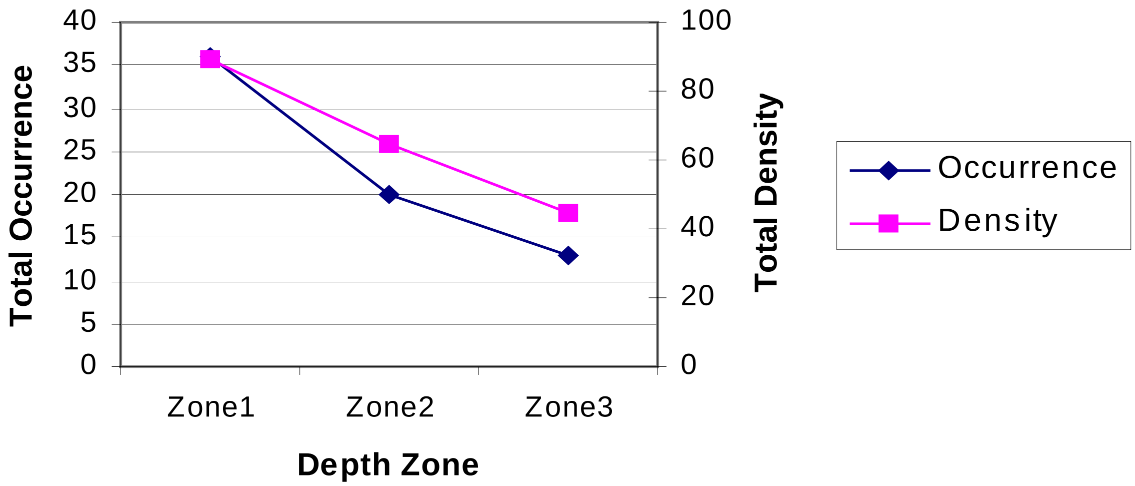


Figure 4. Total occurrence and density of plants by depth zone.

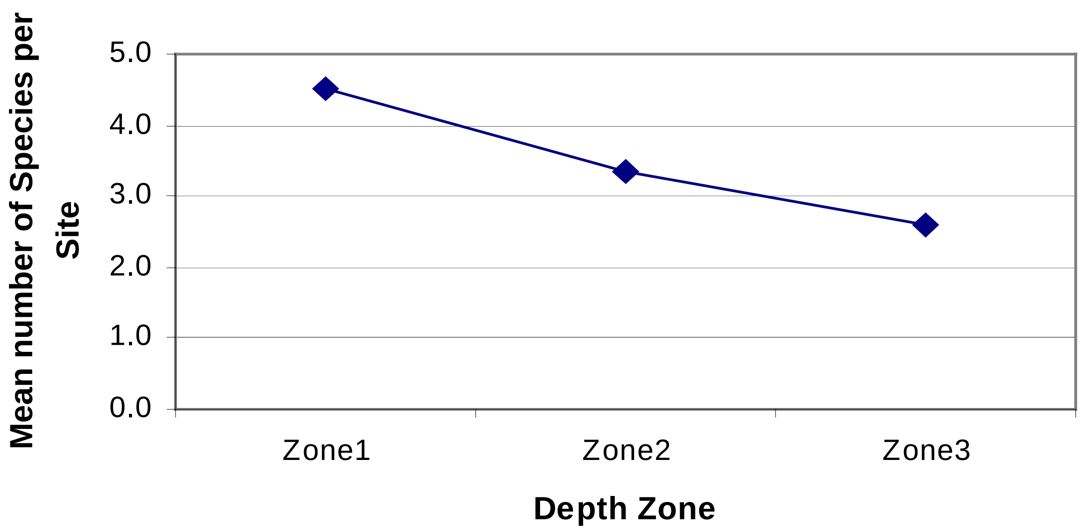
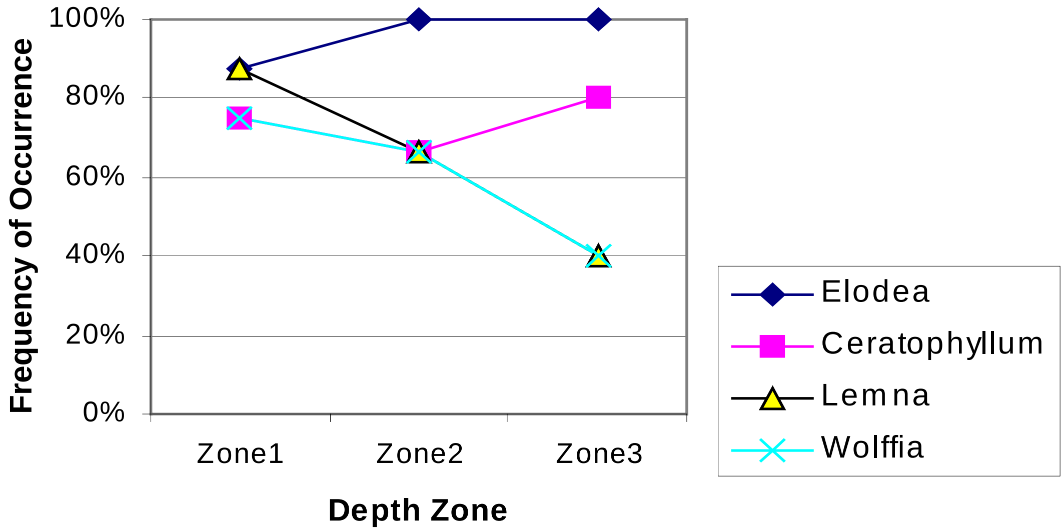


Figure 5. Mean number of species per site in Easton Lake, by depth zone.

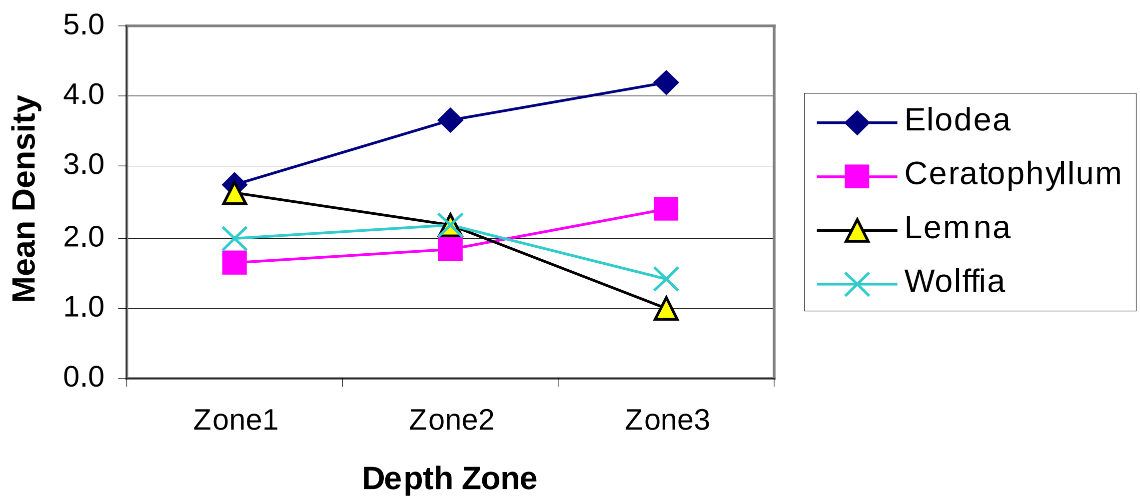
The mean number of species occurring at the sampling sites was 3.63.

As the dominant species, *Elodea canadensis* was found throughout the lake and was the most frequent and the dense species in all depth zones. *E. canadensis* and the sub-dominant species, *Ceratophyllum demersum,* occurred at their highest frequency and density in the 5-10 foot depth zone. Two other sub-dominants, the duckweeds: *Lemna minor* and *Wolffia columbiana,* occurred at their highest frequency and density in the shallow zone and decreased with increasing depth (Figure 6, 7).

Figure 6. Frequency of occurrence of the most prevalent



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



zone.

The sub-dominant species occurred throughout Easton Lake also.

THE COMMUNITY

Simpson's Diversity Index was 0.82, indicating an average diversity. A rating of 1.0 would mean that each plant in the lake would be a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) developed by Weber et. al. (1995) was applied to Easton Lake (Table 4). Values between 0 and 10 are given for each of six categories that characterize a plant community. The highest value for this index is 60. AMCI for Easton Lake is 31. This is below average (40) for lakes in Wisconsin.

Table 4. Aquatic Macrophyte Community Index – Easton Lake

Category		Value
Maximum Rooting Depth	2.7 meters	4
% Littoral Zone Vegetated	100%	10
Simpson's Diversity	0.82	8
# of Species	13 (no exotics)	4
% Submergent Species	38% Rel. Freq.	5
% Sensitive Species	0% Relative Freq.	0
Totals		31

Nichols (1998) recently outlined a method for evaluating the plant community in a lake with regard to its disturbance tolerance.

A coefficient of conservatism (C) is an assigned value, 0-10, the probability that a species will occur in a relatively undisturbed habitat. The Average Coefficient of Conservatism is the mean of the Coefficients of Conservatism for each species found in a lake.

Floristic quality (FQI) is calculated from the Coefficient of Conservatism and is a measure of entire plant community's closeness to an undisturbed condition.

When Nichols applied this metric to a sample of 554 lakes throughout Wisconsin, the 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) (Table 5).

The lowest Floristic Quality was 3.0 (the most disturbance tolerant), the mean value was 22.2, and the high was 44.6 (the least disturbed) (Table 5).

In the North Central Hardwoods Region (NCHR), the region in which Easton Lake is located, the Average Coefficient of Conservatism mean was 5.6 and the Floristic Quality mean was 20.9 (Table 5).

Table 5. Floristic Quality and Coefficient of Conservatism of Easton Lake, Compared to Wisconsin Lakes and Northern Wisconsin Lakes.

	(C)Average Coefficient of Conservatism	Floristic Quality (FQI)
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
Easton Lake 2001	4.33	15.01

* - Values indicate the highest value of the lowest quartile, the mean and the lowest value of the upper quartile.

The Average Coefficient of Conservatism for Easton Lake was in the lowest quartile for all Wisconsin lakes analyzed and for lakes in the North Central Hardwood Region (Table 5). This suggests that the aquatic plant community in Easton Lake is among the group of lakes in Wisconsin that are most tolerant of disturbance.

The Floristic Quality of the plant community in Easton Lake was also within the lowest quartile of Wisconsin lakes and North Central Hardwood Lakes (Table 5). This suggests that Easton Lake is within the group of lakes in Wisconsin and the North Central Hardwood Region subject to the most disturbance.

Disturbances can be of many types:

1) Direct disturbances to the plant beds result from boat traffic, plant harvesting, chemical treatments, the placement of docks and other structures, etc.
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, etc.

V. DISCUSSION

The large watershed of Easton Lake and the predominant agricultural use of the watershed could contribute abundant nutrients to the lake. These nutrients would promote abundant algae and plant growth.

The predominance of silt sediments, the shallow depths and the gradual slope in the majority of the littoral zone would favor aquatic plant growth in Easton Lake.

Aquatic plant growth occurred throughout Easton Lake, at all sampling sites, to a maximum depth of 9 ft. The 0-1.5ft depth zone had the greatest amount of plant growth. The highest total occurrence of plants, highest total density of plants and greatest mean number of species per sample site occurred in this depth zone. Filamentous algae occurred at 89% of the sample sites, and at all sites at depths greater than 1.5ft.

Elodea canadensis was the dominant plant species in Easton Lake, occurring throughout the lake and dominant in all depth zones. *Ceratophyllum demersum* and *Lemna minor* were the sub-dominant macrophyte species in Easton Lake. All prevalent species in Easton Lake occurred throughout the lake. Five aquatic plant species, including the dominant and all prevalent species, grew at above average densities in Easton Lake.

Nearly all the aquatic plant species that occurred in Easton Lake are species that are associated with water of high pH and alkalinity (hard water) (Nichols 1999). Most of the aquatic plant species in Easton Lake (including all dominant and sub-dominant species) are tolerant of poor water clarity and prefer soft sediments (Nichols and Vennie 1991).

The Aquatic Macrophyte Community Index (AMCI) for Easton Lake was 31, indicating that the quality of the macrophyte community in Easton Lake is below average (40) for Wisconsin lakes. Simpson's Diversity Index (0.84) indicates that the macrophyte community had an average diversity. The mean number of plant species per sample site was 3.63.

The Floristic Quality Index indicates that Easton Lake is within the group of lakes in Wisconsin and in the North Central Hardwoods Region of Wisconsin that are most tolerant of disturbance. This suggests that Easton Lake is among the group of lakes that has been subjected to the most disturbance.

Easton Lake has some protecting buffer of natural shoreline (wooded, shrub and native herbaceous growth). Wooded cover was the predominant shoreline cover. However, cultivated lawn also had a high mean coverage, 29% of the shoreline. Based on transect data, disturbed shoreline covers 39% of the shoreline on Easton Lake.

VI. CONCLUSIONS

The aquatic plant community in Easton Lake is characterized by average diversity, a high tolerance to disturbance and below average quality. Aquatic plants occurred throughout Easton Lake, at above average densities, to a maximum depth of 9 feet. The greatest amount of plant growth was found in the 0-1.5ft. depth zone. Filamentous algae was abundant.

Elodea canandensis was the dominant species within the Easton Lake aquatic plant community, dominating all depth zones. *Ceratophyllum demersum* and *Lemna minor* were the sub-dominant species. The composition of the aquatic plant community in Easton Lake is likely determined by the soft sediments, poor water clarity, high alkalinity (hard water) and high pH of the water.

The large watershed in agricultural land use, the shallow depth of the lake, the gradual slope over much of the lake and the favorable silt sediments promote algae and plant growth.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play 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.

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

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 6).

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 as monocultural stands (Engel 1990). Diversity in the plant community creates more microhabitats for the preferences of more species.

Cover within the littoral zone should be 25-85% to support a healthy fishery. Macrophyte beds of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990). The aquatic plant beds in Easton Lake provide cover over 100% of the littoral zone. This amount of coverage provides more than adequate cover for fish and may be too dense for a balanced fish community.

In order to protect Easton Lake:

1) Push for efforts in the watershed to reduce erosion and run-off of fertilizers and pesticides into the streams that feed Easton Lake.
2) Protect and expand the buffer zone of natural shoreline along the shore. Natural shoreline reduces run-off of nutrients and sediments into the lake and filters the run-off that does enter the lake. Wooded cover is the predominant shoreline cover, but more than one-quarter of the shoreline has been disturbed with cultivated lawn. Lawn cover can result in increased run-off of nutrients, pesticides and pet wastes into the lake. More than one-third of the shoreline around Easton Lake has some type on disturbance cover. Preserving and expanding the buffer of natural vegetation along the shore will help prevent shoreline erosion and reduce additional nutrient/chemical run-off that can add to algae blooms and sedimentation.
3) Continue to harvest vegetation to remove plant material and provide open channels for navigation and fish movement. The only way to permanently control vegetation would be to create areas with rapid water movement and/or deep bottoms.

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