EXECUTIVE SUMMARY

Runge Hollow Lake is a mesotrophic lake with fair water quality and water clarity. Water clarity declined during 1999-2001. Filamentous algae was abundant in Runge Hollow Lake.

The aquatic plant community in Runge Hollow Lake possesses an average species diversity. The aquatic plant community is of below average quality for Wisconsin lakes and is among the group of lakes in the state and region with the highest tolerance to disturbance. High disturbance tolerance indicates that the plant community has been subjected to high disturbance.

Aquatic plants occurred throughout Runge Hollow Lake to a maximum depth of 12 feet, providing habitat in 97% of the littoral zone. The most abundant plant growth occurred in the 0-5ft depth zone.

1)

Elodea canadensis is the dominant species within the plant community, dominating all depth zones, growing at high densities. *Ceratophyllum demersum* was sub-dominant, also occurring at above average densities.

Recommendations

As a shallow lake, Runge Hollow Lake is a unique resource that can not be forced to act like a deep-water lake.

1) Designate sensitive areas, those portions of the plant communities most important to providing habitat and other water quality benefits.
2) Preserve the natural buffer zones of shoreline.
3) Designate the lake as a no-wake lake due to its small size and shallow depths.
4) Investigate adding floating-leaf species (lily beds) to add structural diversity to the habitat. Runge Hollow lacks a floating-leaf community.

The Aquatic Plant Community in Runge Hollow Lake, Vernon County 2002

By
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I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Runge Hollow Lake was conducted during July 2002 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Runge Hollow 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 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 levels (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: Runge Hollow Lake is a 45-acre impoundment on the North Fork of the Bad Axe River in northwest Vernon County, Wisconsin. Runge Hollow Lake has a maximum depth of 15 feet. The dam was constructed in 1974 and some dredging was done to provide fill for county road construction.

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 11 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment (Appendix IV), using a random numbers table.

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 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.

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).

The Aquatic Macrophyte Community Index (AMCI) developed by Weber et. al. (1995) was applied to Runge Hollow Lake (Table 4). Values between 0 and 10 are given for each of six categories that characterize a plant community.

The Average Coefficient of Conservatism and Florsitic Quality (FQI) was calculated to determine disturbance as outlined in Nichols (1998). A coefficient of conservatism 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 of Conservatism for all species found in a lake. The Floristic quality (FQI) is calculated from the Coefficient of Conservatism and is a measure of a plant community's closeness to an undisturbed condition.

III. RESULTS

PHYSICAL DATA

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 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 a lake. Increases in phosphorus in a lake can feed algae blooms and, occasionally, excess plant growth.
1994 mean summer phosphorus in Runge Hollow Lake was 38ug/l
This concentration of phosphorus in Runge Hollow Lake was indicative of a mesotrophic 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	-6
Eutrophic	Poor	50-150	15-30	3-4
Hypereutrophic	Very Poor	>150	**>30**	< 3
Runge Hollow Lake - 1994	Fair	38	34.9	6.1

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

Algae

Measuring the concentration of chlorophyll in lake water gives an indication of 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.
1994 mean summer chlorophyll in Runge Hollow Lake was 34.9 ug/l.

The chlorophyll concentration in Runge Hollow Lake indicates a hypereutrophic status (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.

1994 Mean summer Secchi disc clarity was 6.1 ft.

Water clarity indicates (Table 1) that Runge Hollow Lake was a mesotrophic lake with fair clarity.

Secchi disc readings can be used to calculate a predicted maximum rooting depth for plants in the lake (Dunst 1982). **Based on the 1994 mean Secchi disc clarity, the predicted maximum rooting depth in Runge Hollow Lake would be 10.2 ft.**

Vere Vance monitored the water clarity in Runge Hollow Lake 1995-1998; Peter Vick has been monitoring water clarity since 1999. They monitored the water clarity as volunteer lake monitors in the Self-Help Lake Monitoring Program. The Self-Help Volunteer Monitoring data is valuable because volunteers collects data more frequently throughout the season and for more consecutive years than Department of Natural Resource monitoring.

The volunteer data indicates that the mean water clarity was greatest in 1997 (17.25 feet). The mean clarity decreased during 1998-2000 and increased slightly in 2001 to 7.3 feet (Figure 1).

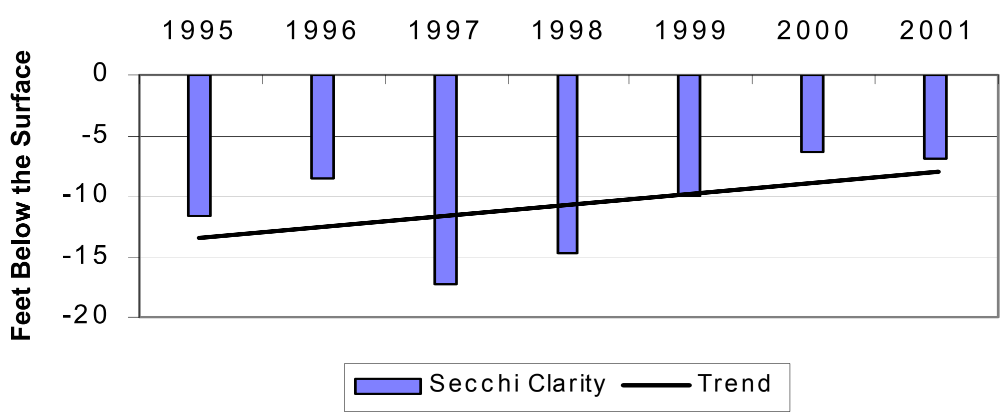

Figure 1. Mean water clarity in Runge Hollow Lake, 1995-2001.

However, water clarity data in 1995 and 1996 did not include samples from July and the 1997 and 1998 data was based on only a few samples early and late in the season. The most applicable data is that from 1999-2001. There has been a decline in water clarity since 1999 (Figure 1).

The data collected by the volunteer monitors also shows that the clarity changes during the season. The 1995-2001 mean clarity for the same time period each year varies widely during the growing season. The water clarity in Runge Hollow may be impacted to a large extent by storm events (Figure 2).

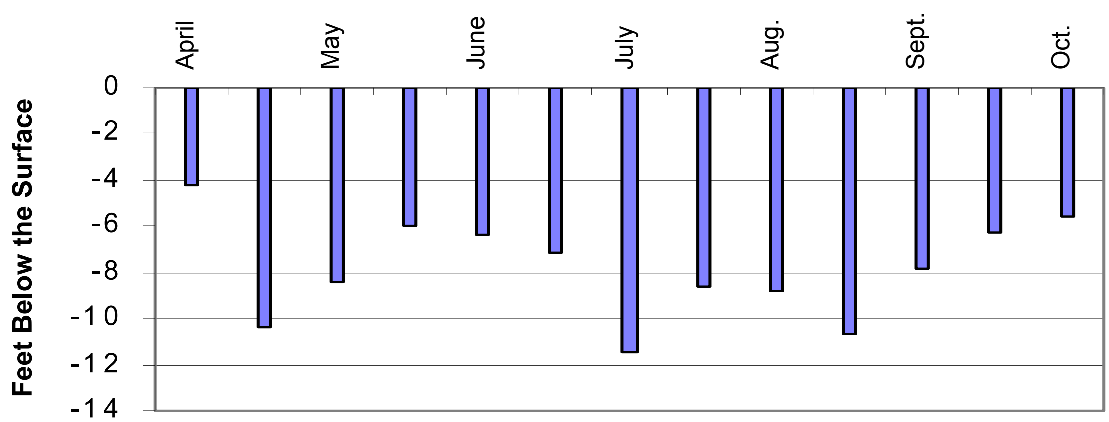

Figure 2. Change in water clarity during the year, Runge Hollow.

pH

The pH of a lake indicates the acidity or alkalinity of the water, with a pH of 7.0 indicating neutral water.

The 1994 mean summer pH of the surface water in Runge Hollow Lake was 9.0.

The plant community is likely raising the pH of the lake water by removing CO_2 from the water during photosynthesis. The high pH would favor plants adapted to alkaline conditions.

Hardness

1994 hardness in Runge Hollow Lake was 245mg $CaCO_3$/l.

Water with hardness levels greater than 180mg $CaCO_3$/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).

Runge Hollow Lake is a shallow lake with a gradually sloped littoral zone (Appendix IV). The shallow depths in a large portion of the lake and the gradually sloped littoral zone would favor plant growth.

SEDIMENT COMPOSITION – Silt was the predominant sediment in Runge Hollow Lake, especially in the 1.5-10 ft. depth zone (Table 2). Silt is an intermediate density sediment. The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986).

Sand mixed with silt was commonly encountered in the 0-5ft depth zones (Table 2).

Sand mixed with rock was common in the 0-1.5ft depth zone, encountered along the west shore. Sand and rock sediments are high density sediments that can be limiting for plant growth (Barko and Smart 1986).

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**
Soft Sediments	Silt		70%	100%	100%	68%
Mixed Sediments	Sand/Silt	62%	30%			23%
	Silt/Rock	12%				3%
Hard Sediments	Sand/Rock	25%				6%

All sediment types supported abundant vegetation in Runge Hollow Lake.

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.

Native herbaceous growth was the most frequently encountered shoreline cover at the transects and wooded cover had the highest mean coverage (Table 3).

Mowed lawn occurred at the earthen dam (Table 3).

Table 3. Shoreline Land Use

Cover Type		**Frequency of Occurrences at Transects**	**Mean % Coverage**
Natural Shoreline	Wooded	64%	44%
	Native Herbaceous	73%	40%
	Shrub	36%	7%
Disturbed Shoreline	Cultivated Lawn	9%	9%

Natural shoreline covered 91% of the shoreline.

MACROPHYTE DATA

SPECIES PRESENT

Of the 13 species of aquatic plants found in Runge Hollow Lake, 3 were emergent species, 2 were free-floating species and 8 were submergent species (Table 4).

No threatened or endangered species were found.

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

Table 4. Runge Hollow Lake Aquatic Plant Species

Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Phalaris arundinacea* L.	reed canary grass	phaar
2) *Sagittaria* sp.	arrowhead	sagsp
3) *Typha latifolia* L.	common cattail	typla
Floating leaf Species		
4) *Lemna minor* L.	small duckweed	lemmi
5) *Wolffia columbiana* Karsten.	common watermeal	wolco
Submergent Species		
6) *Ceratophyllum demersum* L.	coontail	cerde
7) *Elodea canadensis* Michx.	common waterweed	eloca
8) *Najas flexilis* (Willd.) Rostkov and Schmidt.	slender naiad	najfl
9) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
10) *Potamogeton nodosus* Poiret.	long-leaf pondweed	potno
11) *Potamogeton pectinatus* L.	sago pondweed	potpe
12) *Potamogeton pusillus* L.	small pondweed	potpu
13) *Zosterella dubia* (Jacq.) Small	water stargrass	zosdu

FREQUENCY OF OCCURRENCE

Elodea canadensis was the most frequently occurring species in Runge Hollow Lake (92% of sample sites) (Figure 3). *Ceratophyllum demersum, Lemna minor, Potamogeton crispus*, and *P. pectinatus* were also commonly occurring species, (86%, 25%, 25% and 39%).

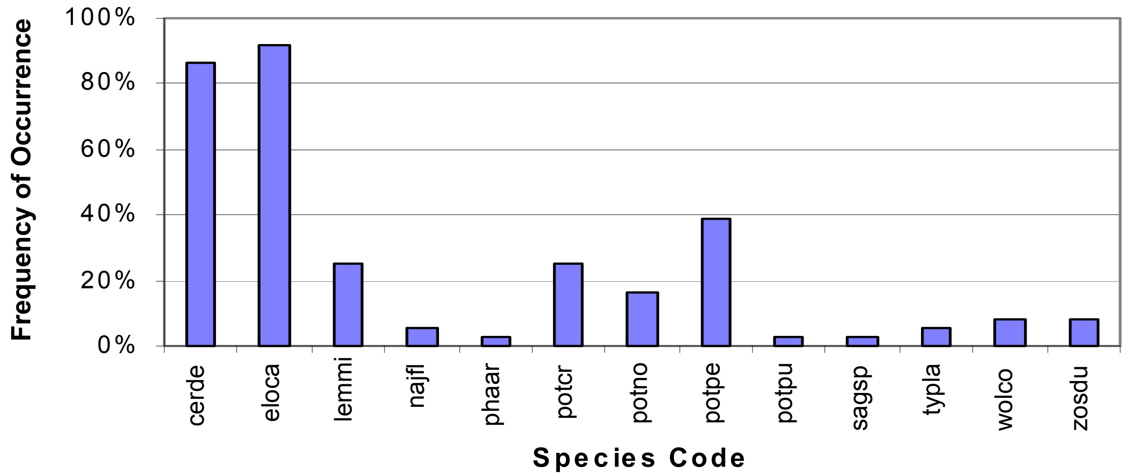

Figure 3. Aquatic plant frequencies in Runge Hollow Lake, 2002

Filamentous algae occurred at 64% of the sample sites.
- 100% of the sites in the 0-1.5ft depth zone
- 80% of the sites in the 1.5-5ft depth zone
- 50% of the sites in the 5-10ft depth zone
- 14% of the sites in the 10-20ft depth zone

DENSITY

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

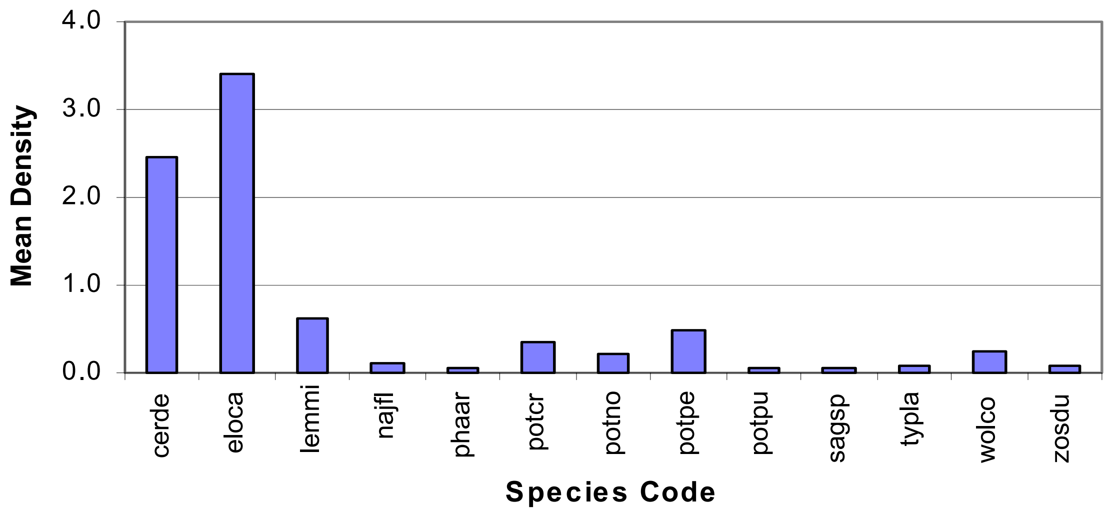

Figure 4. Densities of aquatic plants in Runge Hollow Lake, 2002

Elodea canadensis had a "mean density where present" of 3.73. Its "mean density where present" indicates that *E. canadensis* exhibited a dense growth form in Runge Hollow Lake (Appendix II). The other species in Runge Hollow Lake that had a "density where present" of 2.5 or more, indicating that they grew at above average densities in Runge Hollow Lake, was *Ceratophyllum demersum* and *Wolffia columbiana* (2.87 and 3.0).

DOMINANCE

The Dominance Value indicates how dominant a species is within the macrophyte community (Appendix III). Based on the Dominance Value, *Elodea canadensis* was the dominant plant species in Runge Hollow Lake (Figure 5). *Ceratophyllum demersum* was sub-dominant. The two dominant species made up more than 60% of the aquatic plant community.

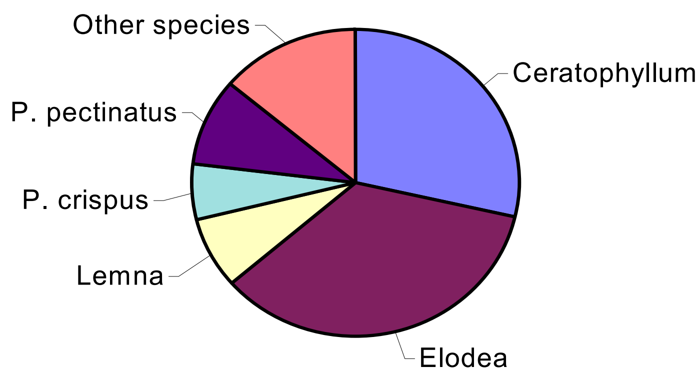

Figure 5. Dominance within the macrophyte community, of the prevalent macrophytes in Runge Hollow Lake, 2002.

Elodea canadensis dominated all depth zones (Appendix I, II). *E. canadensis* occurred at its highest frequency and density in the 1.5-5ft depth zone (Figure 6, 7).

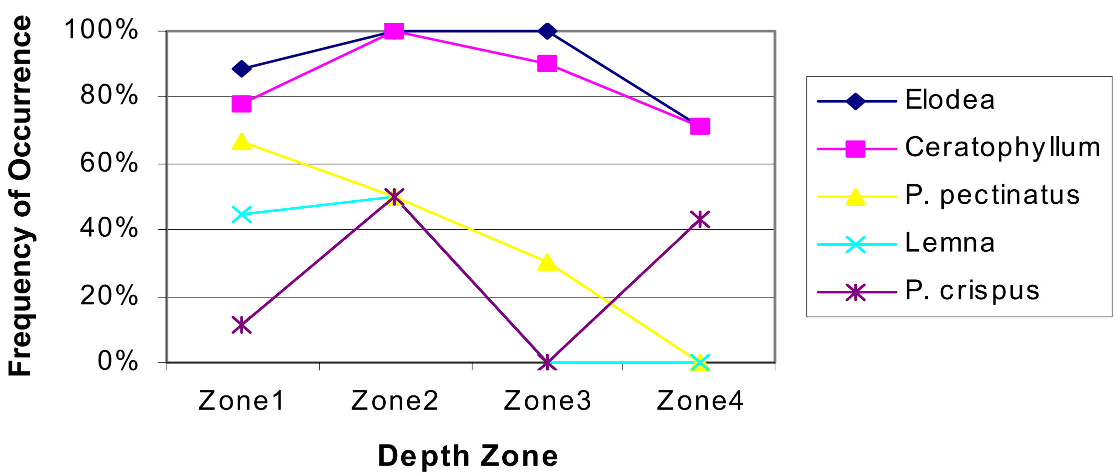

Figure 6. Frequency of occurrence of the prevalent macrophytes in Runge Hollow Lake, by depth zone, 2002.

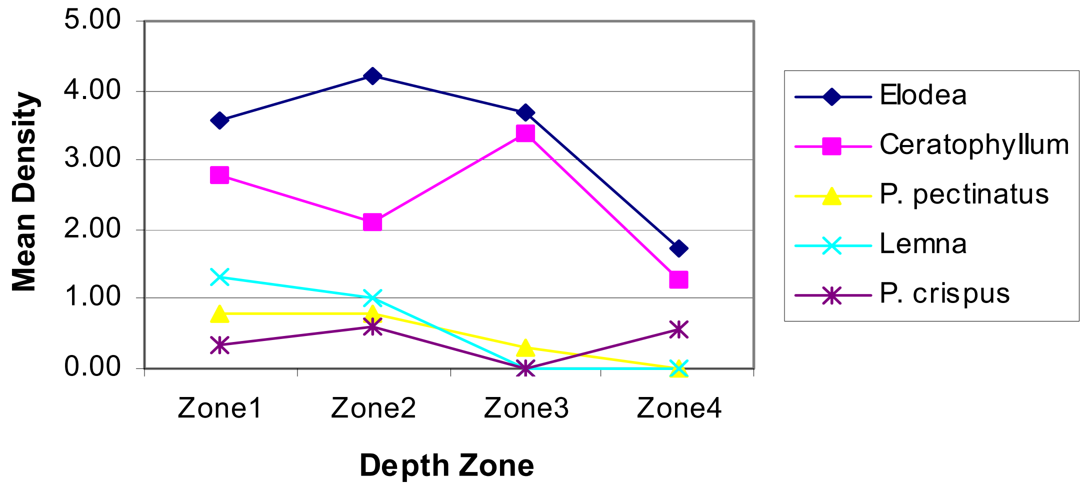

Figure 7. Density of the prevalent macrophytes in Runge Hollow Lake, by depth zone, 2002.

Ceratophyllum demersum, the sub-dominant species, was as frequent as *E. canadensis* in the 1.5-5ft depth zone (Appendix I, II). *C. demersum* occurred at its highest frequency in the 1.5-5ft depth zone and its highest density in the 5-10ft depth zone (Figure 6, 7).

DISTRIBUTION

Aquatic macrophytes occurred throughout Runge Hollow Lake to a maximum rooting depth of 12 feet and the prevalent species were distributed throughout the lake. 97% of the sampling sites were vegetated with rooted aquatic macrophytes.

The dominant plant species, *Elodea canadensis* and *Ceratophyllum demersum*, and *Potamogeton crispus*, occurred at the maximum rooting depth. The maximum rooting depth of 12 feet is more than the predicted rooting depth of 10.2 feet, based on water clarity.

The 0-5ft depth zone supported the greatest amount of plant growth. The highest total occurrence of aquatic plants was recorded in the 1.5-5ft depth zone; the highest total density of plant growth was recorded in the 0-1.5ft depth zone (Figure 8).

The greatest mean number of aquatic plant species per site was found in the 0-1.5ft zone (Figure 9).

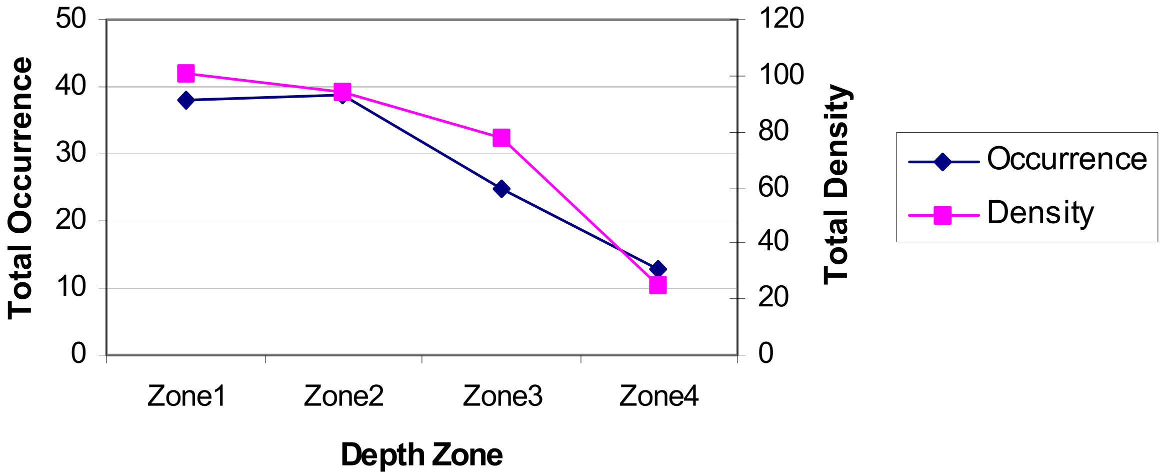

Figure 8. Total occurrence and density of plants by depth zone.

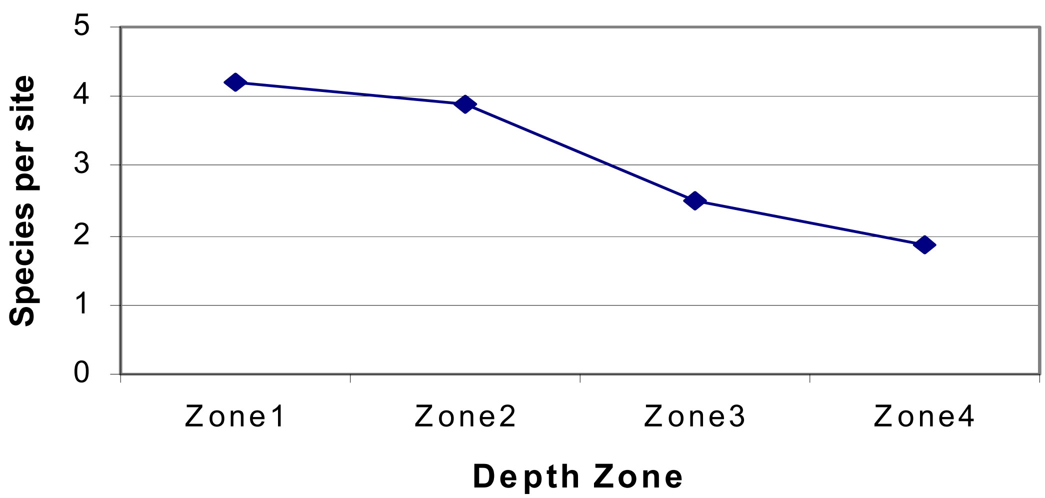

Figure 9. Mean number of plant species per site in Runge Hollow Lake, by depth zone.

The mean number of species found at each sampling sites was 3.2
5 sites had 1 species
9 sites had 2 species
11 sites had 3 species
2 sites had 4 species
6 sites had 5 species
2 sites had 6 species
1 sites had 8 species

THE COMMUNITY

Simpson's Diversity Index was 0.81 (Appendix I), indicating an average species diversity in the plant community. 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 (AMCI) for Runge Hollow Lake is 34 (Table 5). This is below the average (40) for lakes in Wisconsin. The highest value for this index is 60.

Table 5. Aquatic Macrophyte Community Index, Runge Hollow, 2002

Parameters		Value
Maximum Rooting Depth	3.6 meters	6
% Littoral Zone Vegetated	100%	10
Simpson's Diversity	0.81	8
# of Species	13 (1 exotic)	3
% Submergent Species	55% Rel. Freq.	7
% Sensitive Species	0% Relative Freq.	0
0% Relative Freq.		34

The limited number of plant species and the lack of sensitive species in Runge Hollow Lake point to the lower quality (Table 5).

The Average Coefficient of Conservatism for Runge Hollow Lake was in the lowest quartile of all Wisconsin lakes and lakes in the North Central Hardwood Region (Table 6). This suggests that the aquatic plant community in Runge Hollow Lake is among the lakes most tolerant of disturbance.

Table 6. Floristic Quality and Coefficient of Conservatism of Runge Hollow Lake, Compared to Wisconsin Lakes and Northern Wisconsin Lakes.

	©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
Runge Hollow Lake 2002	3.77	13.59

1) * - Values indicate the highest value of the lowest quartile, the mean and the lowest value of the upper quartile. The North Central Hardwoods Region (NCHR), the region in which Runge Hollow Lake is located.
† - Average Coefficient of Conservatism for all Wisconsin lakes ranged from a low of 2.0 (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 plant community in Runge Hollow Lake was within the lowest quartile of Wisconsin lakes and North Central Hardwood Lakes (Table 6). This suggests that the plant community in Runge Hollow Lake is among the group of lakes in the state and 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, 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, Runge Hollow Lake is a mesotrophic lake with fair water quality and clarity. Water clarity has declined during 1999-2001.

Dominance of favorable silt sediments, very hard water, adequate nutrients, shallow depth and the gradually sloped littoral zone in Runge Hollow Lake favor macrophyte growth.

Rooted aquatic plant growth occurred throughout Runge Hollow Lake, at 97% of the sites, to a maximum depth of 12 ft. This maximum rooting depth is greater than the predicted maximum rooting depth of 10.2ft. This may be due to better water clarity in the spring when aquatic plants are stating their growth. The 0-5ft depth zone supported the greatest amount of plant growth: the highest total occurrence of plants, highest total density of plants and the greatest mean number of species per sample site.

Elodea canadensis was the dominant macrophyte species, dominating all depth zones and occurring throughout the lake at high densities. *Ceratophyllum demersum* was the sub-dominant plant species in Runge Hollow Lake, also occurring throughout the lake at above average density. Filamentous algae was abundant in Runge Hollow Lake, especially in the 0-10ft depth zone, occurring at all sites in the shallow depth zone.

The Aquatic Macrophyte Community Index (AMCI) for Runge Hollow Lake was 34, indicating that the quality of the macrophyte community in Runge Hollow Lake is below average (40) for Wisconsin lakes. The limited number of species and lack of sensitive species are limiting the quality of the aquatic plant community. Simpson's Diversity Index (0.81) indicates that the macrophyte community had an average diversity of species. The mean number of species per sample site was 3.2. There were free-floating species, but no floating-leaf species. Floating-leaf species would add structural diversity to the aquatic plant community in Runge Hollow Lake.

The Floristic Quality Index suggests that Runge Hollow Lake is among 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. disturbance.

Runge Hollow Lake is protected by a buffer of natural shoreline (wooded and native herbaceous growth). Natural shoreline occurred at all of the sample sites, except at the dam.

VI. CONCLUSIONS

Runge Hollow Lake is a mesotrophic lake with fair water quality and water clarity. Water clarity declined during 1999-2001. Filamentous algae was abundant in Runge Hollow Lake.

Runge Hollow Lake is well protected by a buffer of natural vegetation at the shoreline.

The aquatic plant community is of below average quality for Wisconsin lakes and is characterized by an average diversity and is among the group of lakes in the state and region with the highest tolerance to disturbance. High disturbance tolerance indicates that the plant community has been subjected to high disturbance.

Aquatic plants occurred throughout Runge Hollow Lake to a maximum depth of 12 feet, the most abundant plant growth occurred in the 0-5 ft. depth zone.

Elodea canadensis is the dominant species within the plant community, dominating all depth zones, growing at high densities. *Ceratophyllum demersum* was sub-dominant, also occurring at above average densities. Runge Hollow lacks a floating-leaf community that would add structural diversity in the habitat.

As a shallow lake, Runge Hollow Lake is a unique resource that can not be forced to act like a deep-water lake. Shallow lakes exist as two, alternate types:
clear water with abundant aquatic plant growth
or
turbid, algae-dominated with sparse aquatic plant growth
Once the balance is tipped from a clear water state to a turbid water state, it is very hard to bring a shallow lake back to a clear water state. Shallow lakes are much more susceptible to certain disturbances than deep water lakes. Wind has a much greater impact on shallow lakes. Boat motors have a greater impact on shallow lakes: a 25hp motor can disturb sediments 10 ft. below the surface (Asplund and Cook 1997).

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:
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 7). The macrophyte community in Runge Hollow Lake provides habitat in 97% of the littoral zone. This amount of vegetation provides more than adequate cover (25-85%) 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 as 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) Designate sensitive areas, those portions of the plant communities most important to providing habitat and other water quality benefits.
2) Preserve the natural buffer zones of shoreline. Native vegetation reduces run-off into the lake and filters the run-off that does enter the lake.
3) Designate the lake as a no-wake lake due to its small size and shallow depths.
4) Investigate adding floating-leaf species (lily beds) to add structural diversity to the habitat.

Taking steps to protect the aquatic plant community in Runge Hollow Lake will preserve water quality and protect fish and wildlife resources.