The Aquatic Plant Community of Wadley Lake, Marathon County, Wisconsin 2006

Wisconsin Department of Natural Resources
Eau Claire, WI
March 2007

The Aquatic Plant Community

of

Wadley Lake,

Marathon County, Wisconsin

2006

Submitted by:

Deborah Konkel
Wisconsin Department of Natural Resources
Eau Claire, WI

March 2007

Executive Summary

Wadley Lake is a mesotrophic/oligotrophic lake with good water clarity and very good water quality. Water clarity has declined since 1999. No filamentous algae was found during the study.

Aquatic plant community colonized nearly of the littoral zone, approximately half of the total lake area, to a maximum depth of 17 feet. It was composed of species indicative of hardwater, clear water systems. The 0-1.5 ft. depth zone supported the most abundant aquatic plant growth.

Chara spp., a macrophytic algae, was the dominant species within this plant community, especially in the 0-10ft depth zones, occurring at three-quarters of the sample sites and exhibiting a dense growth form. *Najas flexiis* (slender naiad, bushy pondweed) was the sub-dominant species, occurring at more than half of the sites and abundant in the 10-20ft depth zone.

The aquatic plant community in Wadley Lake is characterized by high quality, very poor species diversity, an average tolerance to disturbance and a condition closer to an undisturbed condition than the average lake in the state and region.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of tolerant species that could out-compete sensitive species, thus reducing diversity.

Management Recommendations

1) Lake property owner preserve the natural shoreline cover that is found around Wadley Lake. Wooded cover, shrubs and native herbaceous growth protected nearly three-quarters of the shoreline. Maintaining natural shoreline cover is critical to maintaining water quality and wildlife habitat.
2) Lake residents restore natural shoreline buffer on areas with lawn and hard structure. Disturbed shore covers one-quarter of the shoreline and does not protect water quality.
3) Lakes residents use best management practices on shoreland property to prevent nutrient enrichment and stormwater run-off to the lake.
4) Lake residents begin monitoring the water quality through the Self-Help Volunteer Lake Monitoring Program. Monitor water quality to expand knowledge of water quality in Wadley Lake.
5) DNR to designate sensitive areas within Wadley Lake.
6) Lake residents and DNR maintain exotic species educational signs at the boat landing to educate lake users about invasive species issues and prevent exotic species introductions into Wadley Lake.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

The Aquatic Plant Community in Wadley Lake, Marathon County 2006

I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Wadley Lake was conducted during July 2006 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Wadley 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 plant inventories and offer insight into any changes occurring in the lake.

Background and History: Wadley Lake is a 46-acre lake in southeast Marathon County, Wisconsin. Wadley Lake has a maximum depth of 22 feet and a mean depth of 9-feet.

II.METHODS

Field Methods

The study design was based 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 (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, 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 site.

Visual inspection and periodic samples were taken between transect lines 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.

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 (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 density). A "mean density where present" was calculated for each species (sum of a species' density ratings/number of sampling sites at which that species occurred) (Appendix II). The relative frequency and relative density of each species was summed to obtain a dominance value for each species (Appendix III). Species diversity was measured by calculating Simpson's Diversity Index $1-(\sum(\text{Relative Frequency}^2))$ (Appendix I).

The Aquatic Macrophyte Community Index (AMCI) developed for Wisconsin Lakes by Nichols (2000) was applied to Wadley Lake (Table 5) to quantify the quality of the aquatic plant community. Values between 0 and 10 are given for each of seven categories that characterize a plant community and summed.

The Average Coefficient of Conservatism and Floristic Quality Index were calculated, as outlined by Nichols (1998), to determine disturbance in the plant community. 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 for all species found in the lake. The Floristic Quality Index is calculated from the Coefficient of Conservatism (Nichols 1998) and is a measure of a plant community's closeness to an undisturbed condition.

III. RESULTS

PHYSICAL DATA

Many physical parameters impact the aquatic plant community. Water quality (nutrients, algae and clarity) influence the plant community as the plant community can in turn modify these parameters. Lake morphology, sediment composition and shoreline use also impact the aquatic plant community.

WATER QUALITY - The trophic state of a lake is an indication of its water quality. Phosphorus concentration, chlorophyll a 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 populations of fish.

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 nutrients in a lake. Increases in phosphorus in a lake can feed algae blooms and, occasionally, excess plant growth.

No nutrient data was found for Wadley Lake.

Algae

Chlorophyll a concentrations measure the amount of algae in lake water. Algae are natural and essential in lakes, but high algae populations can increase turbidity and reduce the light available for plant growth.

No chlorophyll monitoring data was found for of Wadley Lake.

No filamentous algae occurred at the sample sites In Wadley Lake during the study.

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.

A volunteer lake monitor in the Self-Help Volunteer Lake Monitoring Program, gathered water clarity data during 1991. The data is only for one growing season, so it is not known if that was a typical year.

1991 Mean summer Secchi disc water clarity in Wadley Lake was 13.38 ft.

Satellite images have been used to estimate the water clarity during 1999-2001.

1999-2001 Summer Satellite estimated water clarity ranged from 7.5 feet to 10.6 feet.

Water clarity during summer 1999-2001 (Table 1) indicates that Wadley Lake was an oligotrophic/mesotrophic lake with good water clarity and very good water quality.

Table 1. Trophic Status

	Quality Index	Phosphorus ug/l	Chlorophyll a ug/l	Satelitte Estimated 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
Wadley Lake – 1999-2001	**Good-to-Very Good**			**7.5-10.6**

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

If 1991 was a typical year and the satellite data is accurate, this indicates that water clarity has declined significantly in Wadley Lake, from an oligotrophic lake with good water clarity and very good water quality, to a mesotrophic lake with fair water clarity and good water quality (Figure 1).

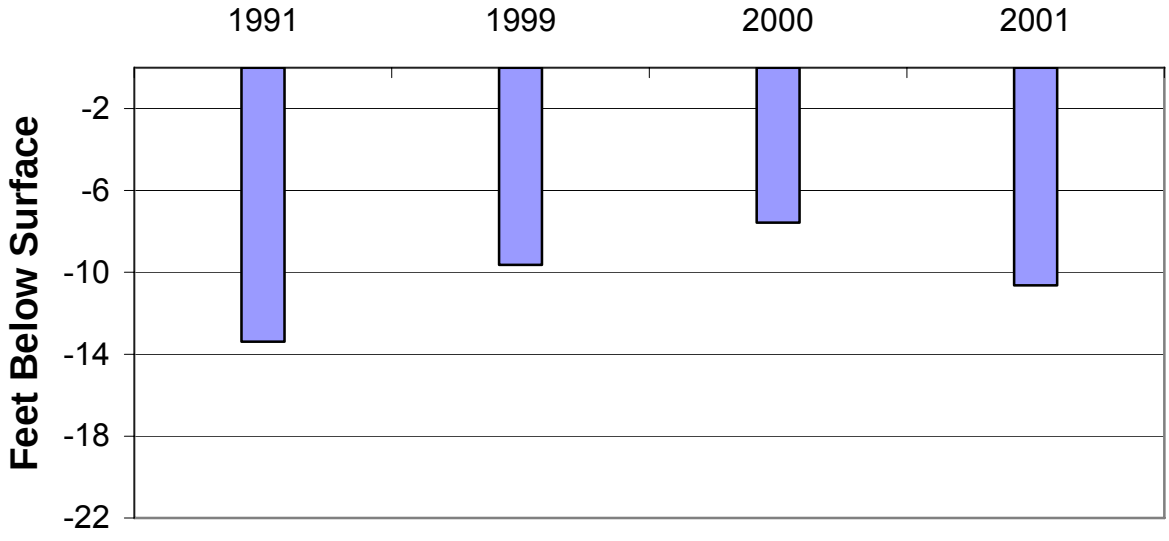


Figure 1. Change in Wadley Lake water clarity, 1991-2001.

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).

Wadley Lake has a roughly-rounded basin with two shallow lobes. Much of the littoral zone is gradually-sloped in Wadley Lake (Appendix IV). The gradual slopes provide a more stable substrate for aquatic plant growth and a broader band of shallow waters favorable for plant growth.

SEDIMENT COMPOSITION – The most common sediments in Wadley Lake were mixtures of silt/marl and peat/marl (Table 2). The mixture of silt and marl was dominant in the 1.5-5ft depth zone and peat and marl in the 5-10ft depth zone. Sand/gravel sediment, not common over the whole lake was the dominant sediment in the shallowest zone. Peat, also not common in the whole lake, dominated the deepest zone (Figure 2).

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/Marl	15%	31%	30%		22%
	Peat/Marl		23%	50%	20%	22%
	Marl		23%	10%		10%
	Silt/Peat	8%	15%			7%
	Peat				60%	7%
	Silt	15%				5%
Mixed Sediments	Sand/Peat	8%				2%
	Sand/Marl		8%			2%
Hard Sediments	Sand/Gravel	54%				17%
	Sand			10%	20%	5%

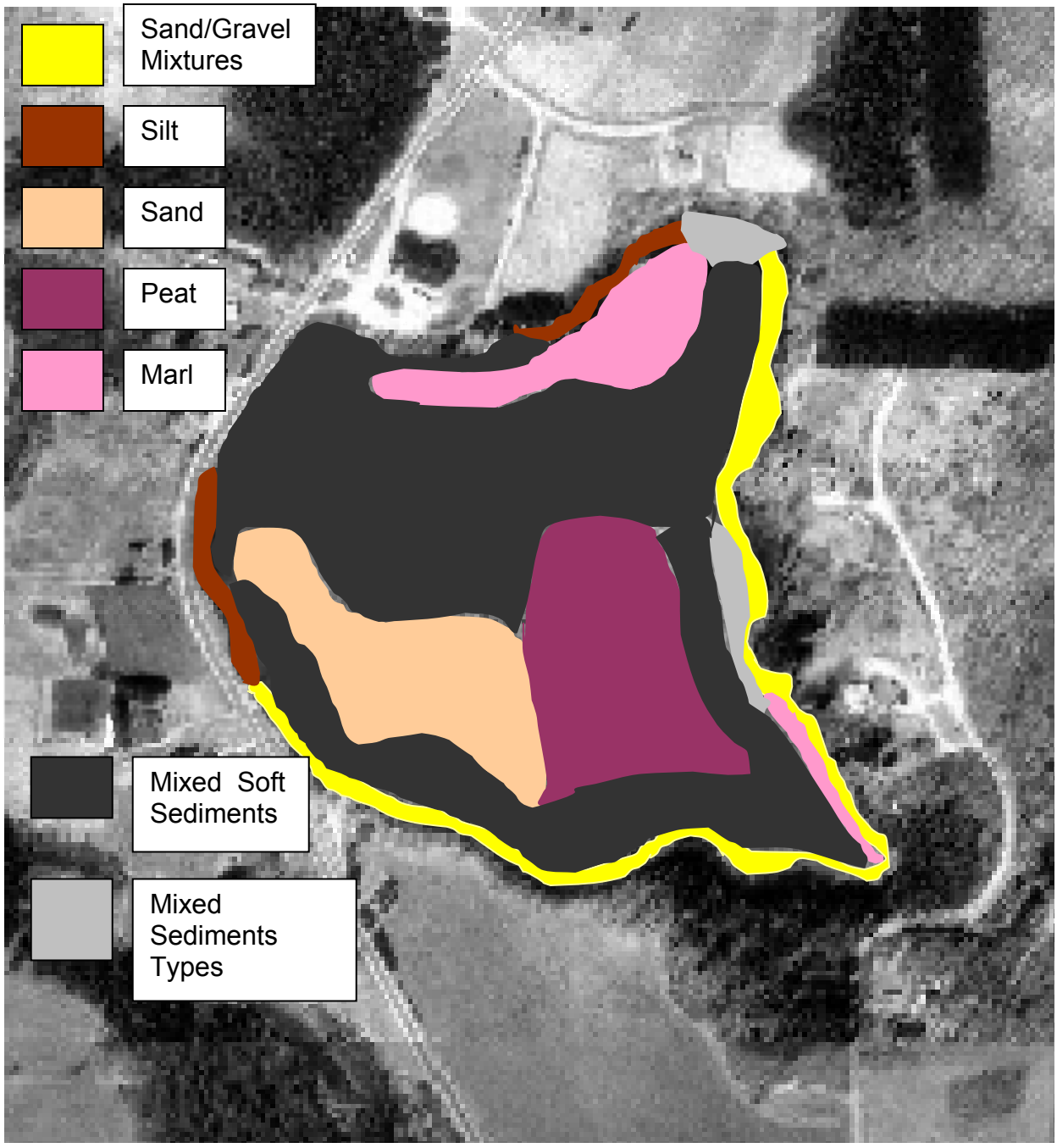


Figure 2. Sediment distribution in Wadley Lake, 2006.

INFLUENCE OF SEDIMENT - Some 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 plant species that can survive in a location.

Peat sediment, which mixed with marl was one of the dominant sediments in Wadley Lake, may limit plant growth due its flocculent nature, resulting in an unstable rooting

substrate. Sand/gravel sediment was common in the shallowest zone, but may also be limiting for plant growth due to its high-density (Barko and Smart 1986). Silt is an intermediate density sediment considered most favorable for plant growth because of its intermediate density. The availability of mineral nutrients for growth is highest in sediments of intermediate density (Barko and Smart 1986). Silt mixed with marl and peat mixed with marl were the most common sediments.

However, all sample sites except one supported vegetation in Wadley Lake. In Wadley Lake, it appears that sediment is not a major factor in determining plant distribution.

SHORELINE LAND USE – Land use can strongly impact the aquatic plant community and therefore the entire aquatic community. Land use can directly impact the plant community by increased erosion and sedimentation and increased run-off of nutrients, fertilizers and toxics applied to the land. These impacts occur in both rural and residential settings.

Wooded cover was the most abundant shoreline cover at the transects. The occurrence and coverage of native herbaceous growth was also high. Bare sand as a narrow band at the shore was common (Table 3). However, two disturbed shore types, cultivated lawn and hard structures, were also abundant. Run-off is increased on cultivated lawn and hard structures without filtering of the run-off and may contain toxics. Run-off from lawn can carry pesticides, pet wastes and nutrients into the lake.

Table 3. Shoreline Land Use

Cover Type		Frequency of Occurrences at Transects	Mean % Coverage
Natural Shoreline	Wooded	85%	40%
	Native Herbaceous	85%	21%
	Shrub	15%	4%
	Bare Sand	62%	7%
	Rock	31%	3%
Total Natural			75%
Disturbed Shoreline	Cultivated Lawn	46%	18%
	Hard Structures	46%	5%
	Pavement	8%	2%
Total Disturbed			25%

Some type and amount of natural cover occurred at all sample sites and protected 75% of the shore. Disturbed shoreline (cultivated lawn, hard structures, pavement) was found at 69% of the sample sites and covered 25% of the shore.

MACROPHYTE DATA

SPECIES PRESENT

Fifteen (15) species were found in Wadley Lake: 3 were emergent species, 2 were floating-leaf species and 10 were submergent species (Table 4). The plants in the community are species that favor hard water and clear water (Nichols 1999).
No non-native species were found. No threatened or endangered species were found.

Table 4. Wadley Lake Aquatic Plant Species

Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Scirpus validus* Vahl.	softstem bulrush	sciva
2) *Sparganium* spp.	bur-reed	spasp
3) *Typha latifolia* L.	common cattail	typla
Floating-leaf Species		
4) *Nuphar variegata* Durand.	bull-head pond lily	nupva
5) *Nymphaea odorata* Aiton.	white water lily	nymod
Submergent Species		
6) *Chara* sp.	muskgrass	chasp
7) *Najas flexilis* (Willd.) Rostkov and Schmidt	slender water-nymph	najfl
8) *Potamogeton illinoensis* Morong.	Illinois pondweed	potil
9) *Potamogeton natans* L.	floating pondweed	potna
10) *Potamogeton nodosus* Poiret.	long-leaf pondweed	potno
11) *Potamogeton praelongus* Wulf.	white-stem pondweed	potpr
12) *Potamogeton pusillus* L.	small pondweed	potpu
13) *Potamogeton strictifolius* Ar. Benn.	pondweed	potst
14) *Potamogeton zosteriformis* Fern.	flatstem pondweed	potzo
15) *Vallisneria americana* L.	water celery	valam

FREQUENCY OF OCCURRENCE

Chara spp., a macrophytic algae, was the most frequently occurring species in Wadley Lake in 2006, (78% of sample sites) (Figure 3). *Najas flexilis* and *Potamogeton illinoensis* were also commonly occurring species, (69%, 22%) (Figure 3).

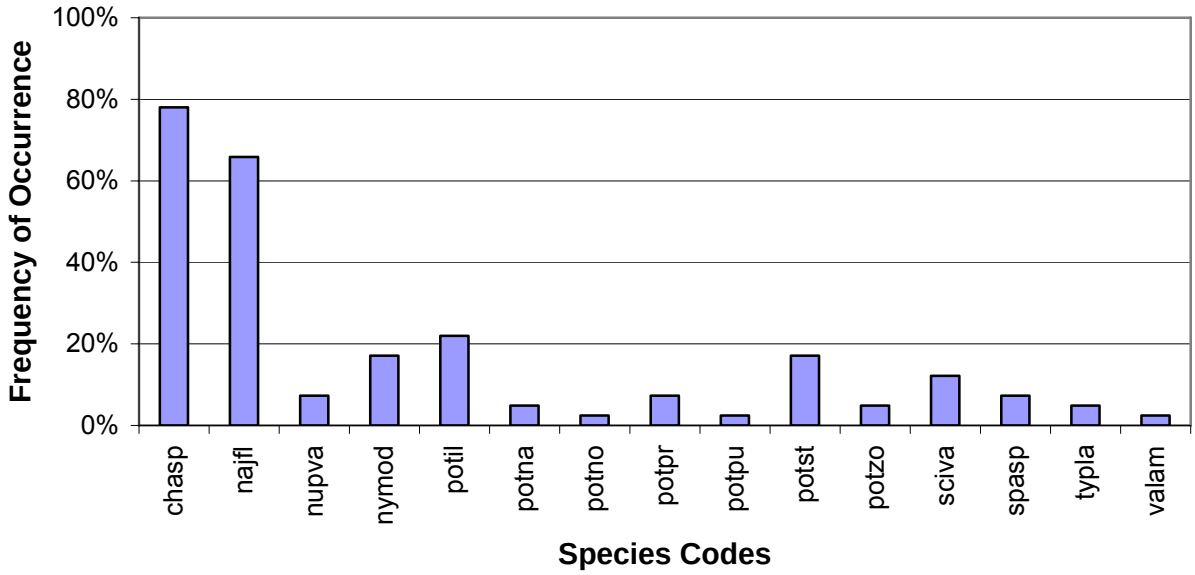


Figure 3. Frequency of aquatic plant species in Wadley Lake, 2006.

DENSITY

Chara spp. was also the species with the highest mean density (2.54 on a density scale of 1-4) in Wadley Lake (Figure 4).

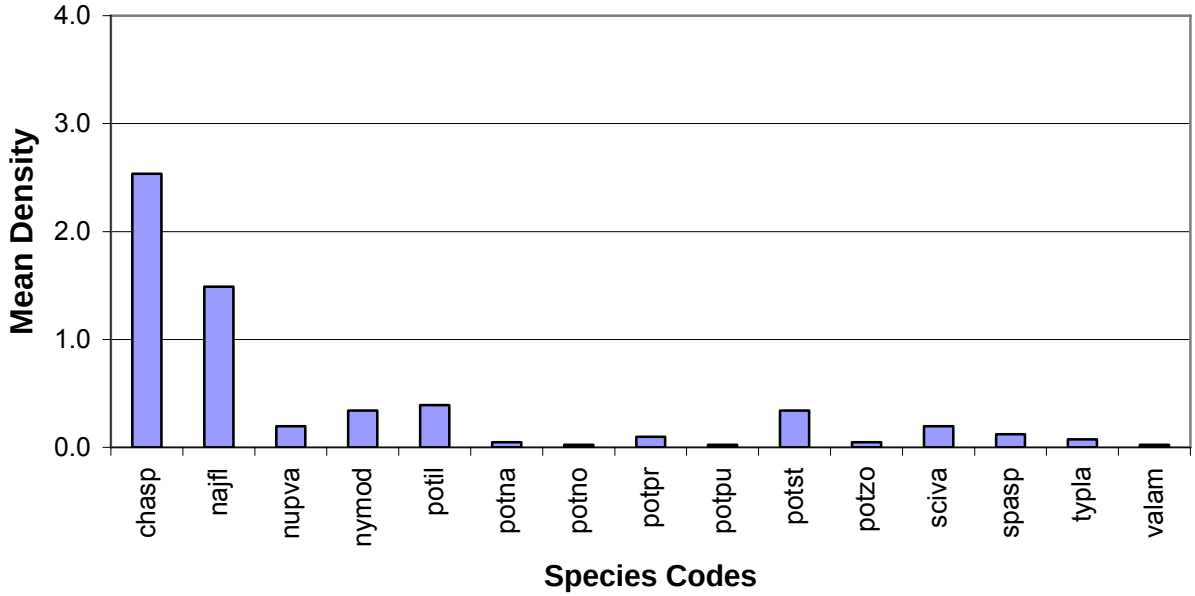


Figure 4. Densities of aquatic plant species in Wadley Lake, 2006.

Chara spp. (the macrophytic algae) had a "mean density where present" of 3.25. Its "mean density where present" indicates that where *Chara* occurred, it exhibited a dense growth form in Wadley Lake (Appendix II). *Nuphar variegata* (yellow pond lily) also had a "density where present" of 2.5 or more, indicating it exhibited an aggregated growth form or a growth form of above average density (Figure 5). However, *N. variegata* was not commonly occurring and was aggregated in only a couple locations in the lake.

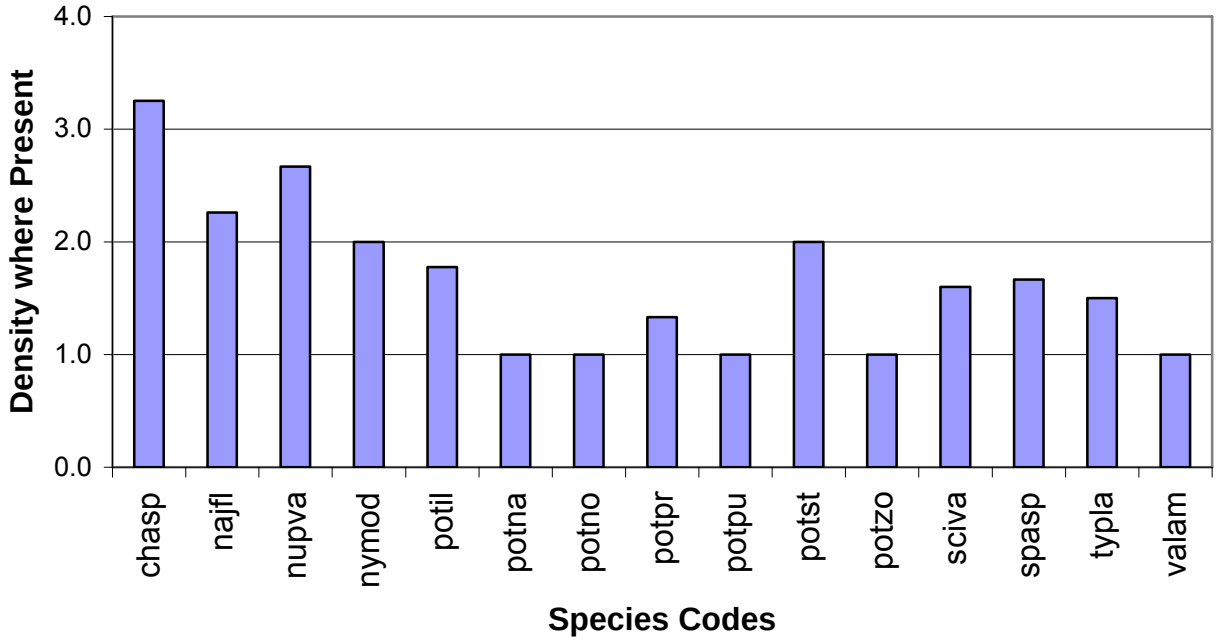


Figure 5. "Density where Present" of aquatic plant species in Wadley Lake, 2006.

DOMINANCE

Combining the relative frequency and relative density of a species into a Dominance Value illustrates how dominant a species is within the plant community (Appendix III). Based on the Dominance Value, *Chara* spp., a macrophytic algae, was the dominant aquatic plant species in Wadley Lake (Figure 6). *Najas flexilis* (slender naiad or bushy pondweed) was sub-dominant.

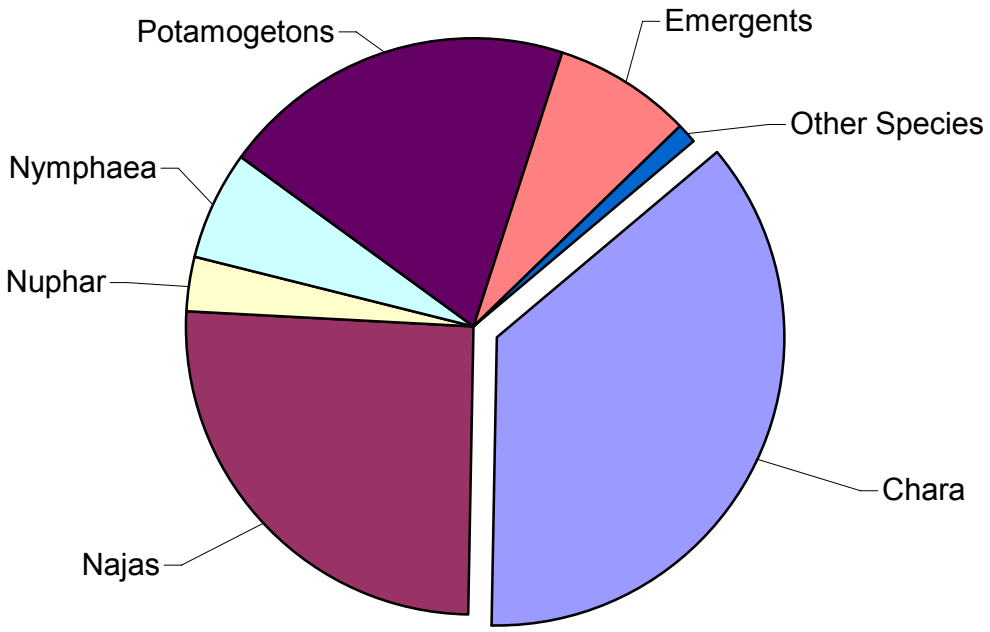


Figure 6. Dominance within the plant community, of the most prevalent species in Wadley Lake, 2006.

Chara spp., the dominant species, dominated the 0-10ft depth zones and occurred at its highest frequency and density in the 5-10ft depth zone (Figure 7, 8). *Najas flexilis,* the sub-dominant species, dominated the 10-20ft depth zone (Appendices I, II) (Figure 7, 8).

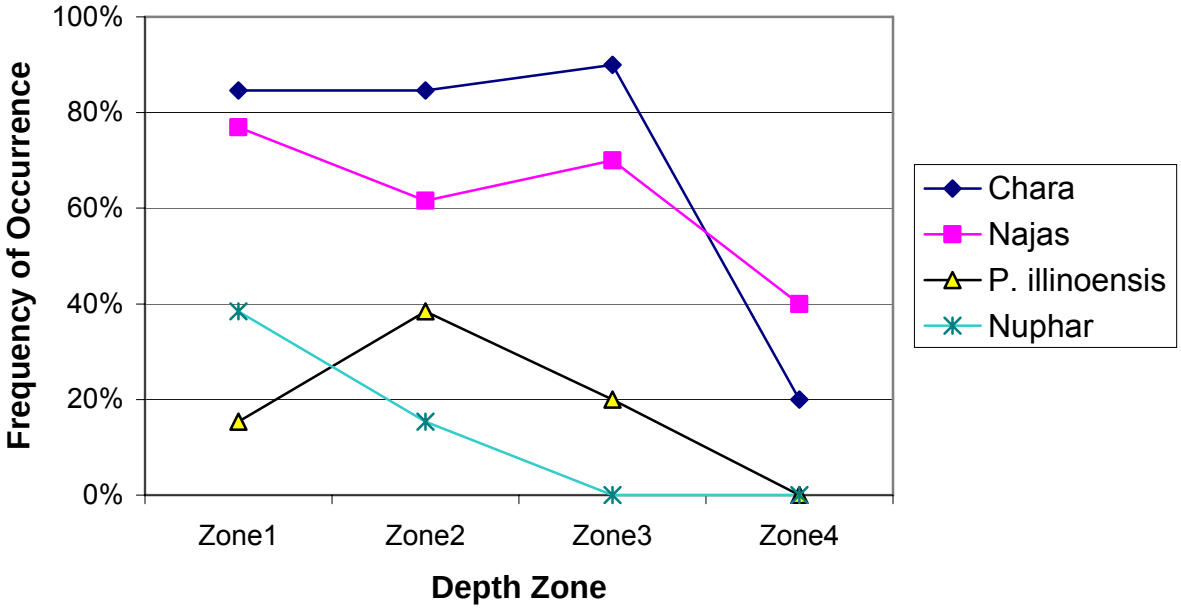


Figure 7. Frequency of most prevalent species in Wadley Lake, by depth.

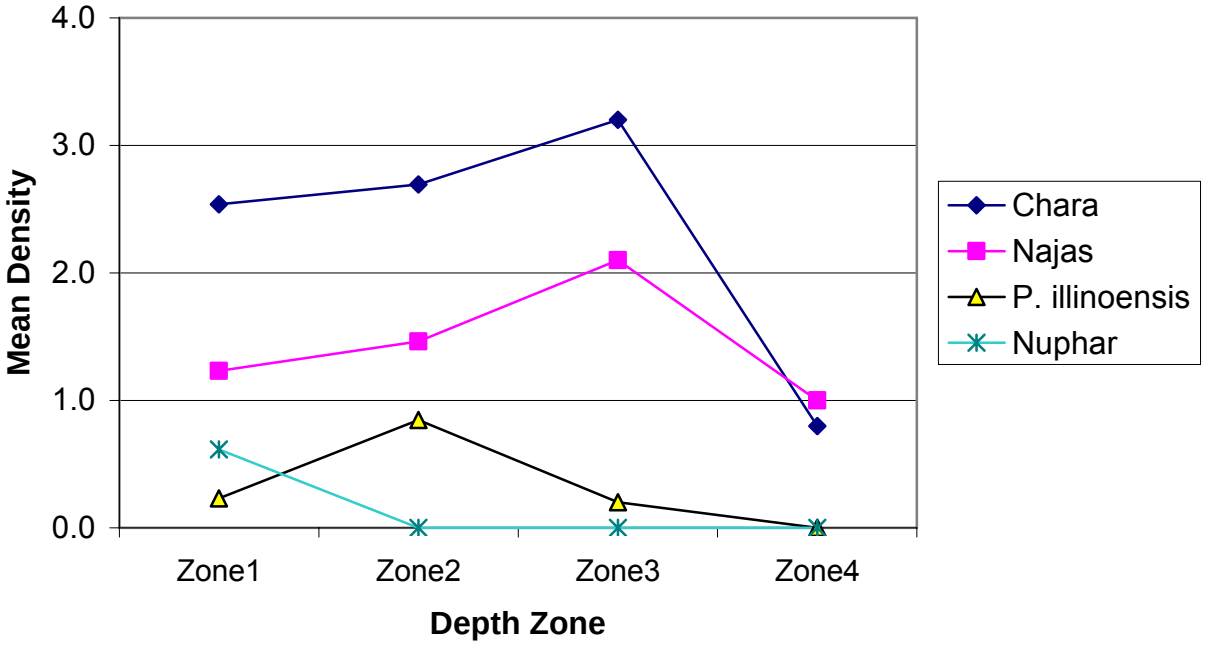


Figure 8. Density of the most prevalent plant species, by depth zone.

DISTRIBUTION

Aquatic plants occurred throughout Wadley Lake to a maximum rooting depth of 17 feet. *Potamogeton praelongus* (white stem pondweed) was found at the maximum rooting depth.

Over the whole lake, 98% of the littoral zone (sampling sites) was vegetated. Approximately 56% (26 acres) of the entire lake was vegetated. Submergent vegetation colonized 98% of the littoral zone - 54% of the lake surface (25 acres); floating-leaf vegetation colonized about 20% of the littoral zone - 10% of the lake surface (4 acres) and emergent vegetation colonized about 15% of the littoral zone - 1% of the lake surface (0.4 acres) (Figure 9).

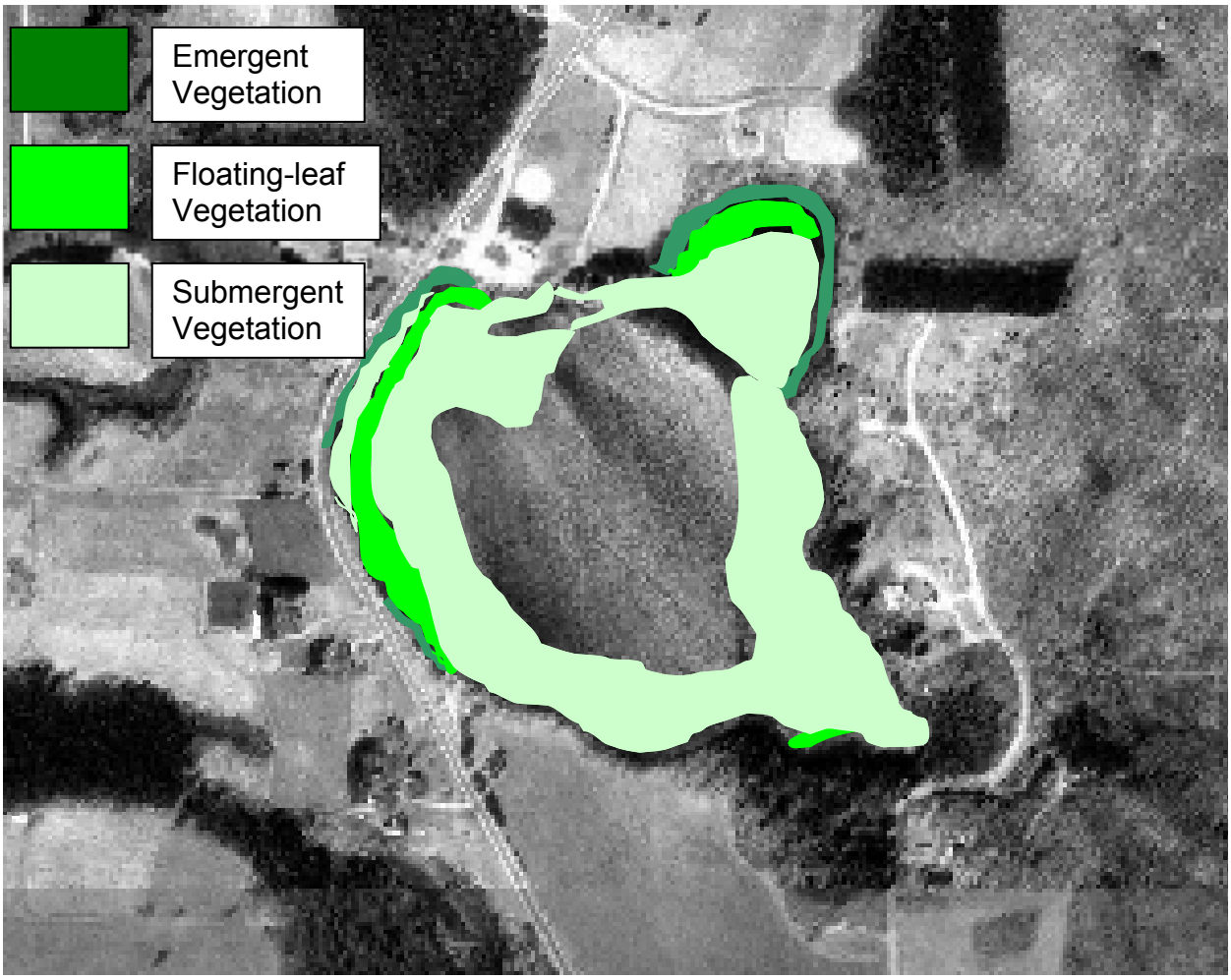


Figure 9. Distribution of aquatic plants in Wadley Lake, Marathon County, 2006.

The dominant and common species in Wadley Lake were found distributed throughout the littoral zone.

Water clarity data is used to calculate a predicted maximum rooting depth for plants in a lake (Dunst 1982).

Predicted Rooting Depth (ft.) = (water clarity (ft.) * 1.22) + 2.73

Based on the 2001 summer satellite estimated water clarity (10.6ft), the predicted maximum rooting depth in Wadley Lake would be 15.7 ft.

The maximum rooting depth of 17 feet is greater than the predicted maximum rooting depth based on water clarity. This may be due to less accurate data from the satellite or better water clarity early in the spring or summer when aquatic plant growth is first starting.

The highest total occurrence and total density of plant growth was recorded in the 0-1.5ft depth zone and declined with increasing depth (Figure 10).

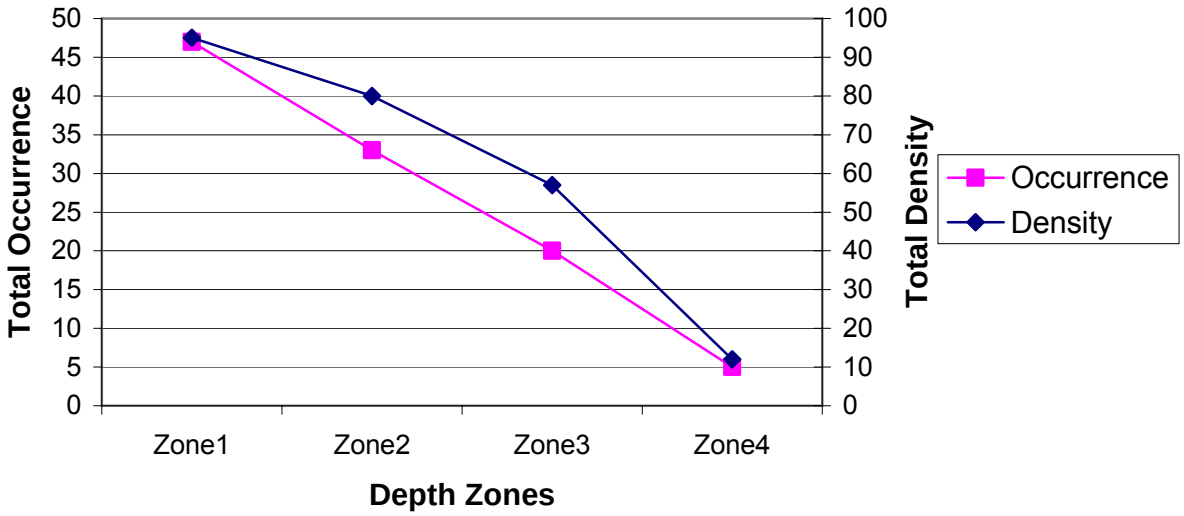


Figure 10. Total occurrence and total density of aquatic plants by depth zone in Wadley Lake, 2006.

The greatest species richness (mean number of species per site) was also found in the 0-1.5 ft. depth zone (Figure 11). Overall Species Richness in Wadley Lake was 2.56.

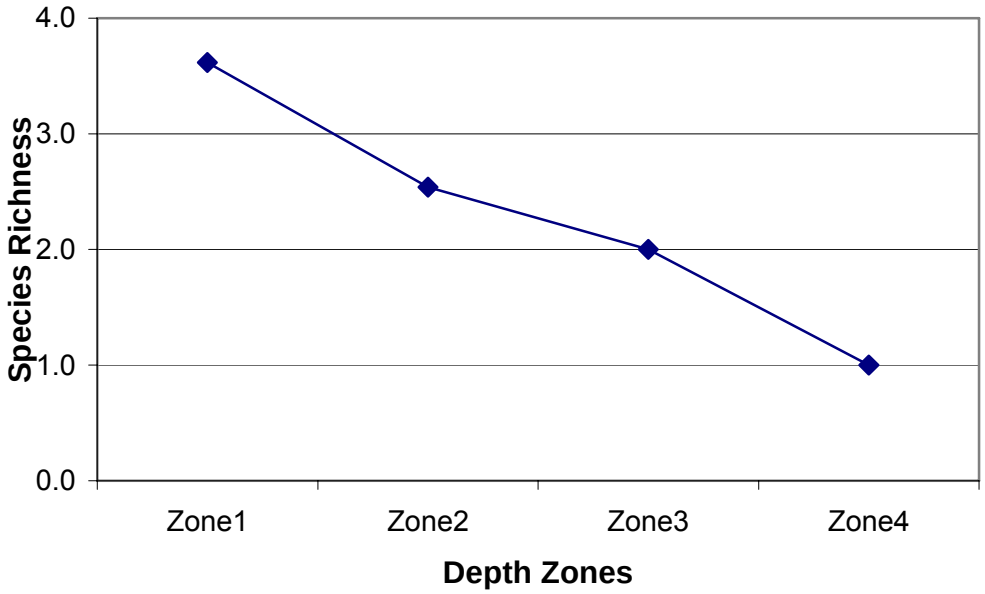


Figure 11. Mean number of species per site (Species Richness) in Wadley Lake, by depth zone.

THE COMMUNITY

Simpson's Diversity Index was 0.82, indicating very poor species 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) for Wadley Lake (Table 5) is 60, indicating a high quality plant community. This value places Wadley Lake in the upper quartile of lakes in Wisconsin and the North Central Harwood Region of the state as far as quality of the aquatic plant community.

Table 5. Aquatic Macrophyte Community Index: Wadley Lake

Category		Value
Maximum Rooting Depth	5.18 meters	10
% Littoral Zone Vegetated	98%	10
% Submergent Species	82% Rel. Freq.	10
# of Species	15	7
% Exotic species	0	10
Simpson's Diversity	0.82	5
% Sensitive Species	21% Relative Freq.	8
Totals		60

The highest value for this index is 70.

The Average Coefficient of Conservatism for Wadley Lake was in the upper quartile for lakes in the North Central Hardwood Region lakes and below average for all Wisconsin lakes (Table 6). This suggests that the aquatic plant community in Wadley Lake is among the group of lakes in the North Central Hardwoods Region least tolerant of disturbance and with an above average tolerance to disturbance for lakes in Wisconsin.

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

	Average Coefficient of Conservatism †	Floristic Quality ‡
Wisconsin Lakes *	5.5, 6.0, 6.9	16.9, 22.2, 27.5
NCH Region *	5.2, 5.6, 5.8	17.0, 20.9, 24.4
Wadley Lake 2006	5.93	22.96

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

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

The Floristic Quality of the plant community in Wadley Lake was above the mean for lakes in Wisconsin and the North Central Hardwood Lakes Region (Table 6). This suggests that the plant community in Wadley Lake closer to an undisturbed condition than the average lake in the state and region.

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 are the result of factors that impact water clarity and thus stress species that are more sensitive: resuspension of sediments from wave action and boat traffic, sedimentation from erosion and 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 and destruction of plant beds by the fish population.

Disturbances in Wadley Lake are likely run-off of toxics and salts from the road and shoreline development.

IV. DISCUSSION

Wadley Lake is a 46-acre lake with a maximum depth of 22 feet. Based on 1999 -2001 satellite estimated water clarity data, Wadley Lake is an oligotrophic/mesotrophic lake with good water clarity and very good quality. Water clarity appears to have declined since 1999. No filamentous algae occurred in Wadley Lake at the time of the survey.

The gradually-sloped littoral zone and good water clarity in Wadley Lake would favor plant growth. Aquatic plants colonized 56% of the lake bed surface, occurring throughout the lake at 98% of the sites, to a maximum depth of 17 feet.

The greatest amount of plant growth occurred in the shallowest depth zone, 0-1.5ft. The highest total occurrence of plants, highest total density of plants and the greatest species richness occurred in the shallowest depth zone (0-1.5ft).

Fifteen (15) aquatic plant species were recorded in Wadley Lake, the majority were species of clear water, hardwater lakes. *Chara* spp., a macrophytic algae, was the dominant plant species in Wadley Lake, occurring at three-quarters of the sample sites and exhibiting a dense growth form. *Chara* was especially dominant in the 0-10ft depth zone. *Najas flexilis* (slender naiad or bushy pondweed) was the sub-dominant plant species in Wadley Lake, occurring at more than one-half of the sites. *N. flexilis* was dominant in the 10-20ft depth zone. The dominant and common species were distributed throughout the lake.

The Aquatic Macrophyte Community Index (AMCI) for Wadley Lake was 60, indicating that Wadley Lake's aquatic plant community is of high quality compared to other Wisconsin lakes and lakes in the North Central Hardwoods Region. Simpson's Diversity Index (0.82) indicates that the aquatic plant community had very poor diversity of species. Species Richness was 2.56 species per sample site.

The Average Coefficient of Conservatism and the Floristic Quality Index suggests that Wadley Lake is intolerant of disturbance. It ranks within the group of lakes in the North Central Hardwoods Region least tolerant of disturbance and with an average tolerance for lakes in Wisconsin. Wadley Lake is closer to an undisturbed condition than the average lake in the state or region.

Wadley Lake is protected by natural shoreline cover (wooded, shrub, native herbaceous growth) at approximately three-quarters of the shoreline; all natural cover types were commonly occurring. However, disturbed shoreline was common at the shoreline; mowed lawn and hard structures were abundant. Disturbed shore was found at more than half of the sites and covered about one-quarter of the shore. Run-off is increased on cultivated lawn and hard structures without filtering of the run-off. Run-off from lawn can carry pesticides, pet wastes and nutrients into the lake. Preserving and restoring natural shoreline is critical to maintaining water quality and wildlife habitat.

V. CONCLUSIONS

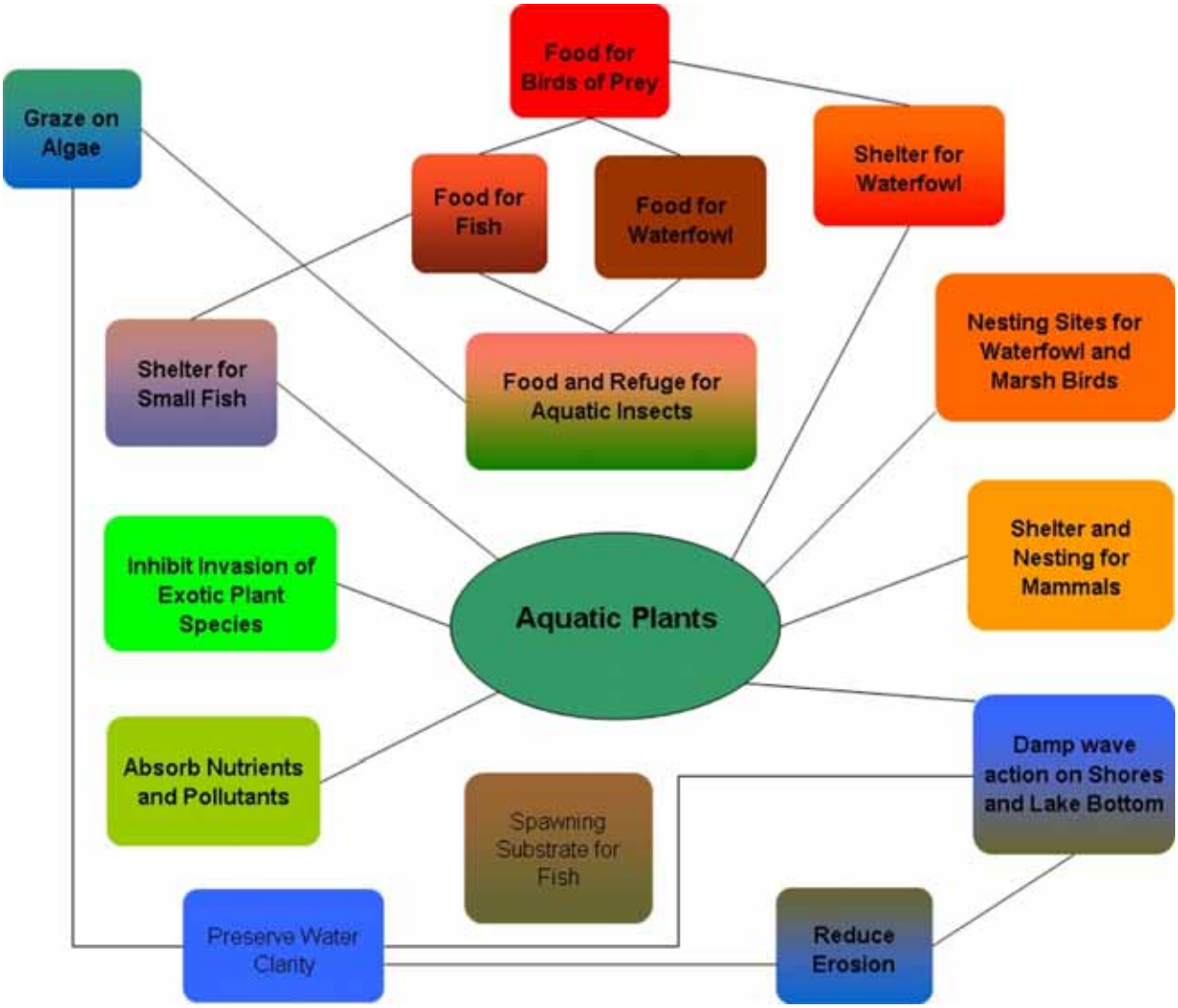
Wadley Lake is a mesotrophic/oligotrophic lake with good water clarity and very good water quality. Water clarity has declined since 1999. No filamentous algae occurred at the time of the study.

Aquatic plant community colonized nearly the entire littoral zone, approximately half of the total lake area, to a maximum depth of 17 feet. The 0-1.5 ft. depth zone supported the most abundant aquatic plant growth.

Fifteen (15) aquatic plant species, the majority were species indicative of clear water, harewater lakes, were recorded in Wadley Lake. *Chara* spp., a macrophytic algae, was the dominant species within the plant community, especially in the 0-10ft depth zones, occurring at three-quarters of the sample sites and exhibiting a dense growth form. *Najas flexiis* (slender naiad) was the sub-dominant species, occurring at more than half of the sites and most abundant in the 10-20ft depth zone.

The aquatic plant community in Wadley Lake is characterized by high quality, very poor species diversity, an above average tolerance to disturbance and a condition closer to an undisturbed condition than the average lake in the state and region.

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



1) Aquatic plant communities improve water quality in many ways: they trap nutrients, debris, and pollutants entering a water body, absorb and break down some pollutants, reduce erosion by damping wave action and stabilizing shorelines and lake bottoms and 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). Plant cover within the littoral zone of Wadley Lake is 98% and over the entire lake is 56%. This is appropriate (25-85%) to support a balanced fishery.

Compared to non-vegetated lake bottoms, plant 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 plants 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. Plant beds

Table 7. Wildlife and Fish Uses of Aquatic Plants in Wadley Lake

Aquatic Plants	Fish	Water Fowl	Song and Shore Birds	Upland Game Birds	Muskrat	Beaver	Deer
Submergent Plants							
Chara sp.	F*, S	F*, I*					
Najas flexilis	F, C	F*(Seeds, Foliage)	F(Seeds)				
Potamogeton illinoensis	F, I, S*,C	F*(Seeds)	F		F*	F	F
Potamogeton natans	F, I, S*,C	F*(Seeds, Tubers)			F*	F	F
Potamogeton nodosus	F, I, S*,C	F*(Seeds)			F*	F	F
Potamogeton praelongus	F, I, S*,C	F*(All)			F*	F	F
Potamogeton pusillus	F, I, S*,C	F*(All)			F*	F	F
Potamogeton strictifolius	F, C	F(Seeds)					
Potamogeton zosteriformis	F, I, S*,C	F*(Seeds)			F*	F	F
Vallisneria americana	F*, C, I, S	F*, I	F		F		
Floating-leaf Plants							
Nuphar variegata	F,C, I, S	F, I	F		F*	F	F*
Nymphaea odorata	F,I, S, C	F(Seeds)	F		F	F	F
Emergent Plants							
Scirpus validus	F, C, I	F (Seeds)*, C	F(Seeds, Tubers), C	F (Seeds)	F	F	F

Aquatic Plants	Fish	Water Fowl	Song and Shore Birds	Upland Game Birds	Muskrat	Beaver	Deer
Sparganium spp.	I	F(Seeds), C	F, C		F		F*
Typha latifolia	I, C, S	F(Entire), C	F(Seeds), C, Nest	Nest	F* (Entire), C*, Lodge	F	

F=Food, I= Shelters Invertbrates, a valuble food source C=Cover, S=Spawning

***=Valuable Resource in this category**

*Current knowledge as to plant use. Other plants may have uses that have not been determined.

After Fassett, N. C. 1957. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI

Nichols, S. A. 1991. Attributes of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Info. Circ. #73

of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990).

Management Recommendations

1) Lake property owner preserve the natural shoreline cover that is found around Wadley Lake. Wooded cover, shrubs and native herbaceous growth protected nearly three-quarters of the shoreline. Maintaining natural shoreline cover is critical to maintaining water quality and wildlife habitat.
2) Lake residents restore natural shoreline buffer on areas with lawn and hard structure. Disturbed shore covers one-quarter of the shoreline and does not protect water quality.
3) Lakes residents use best management practices on shoreland property to prevent nutrient enrichment and stormwater run-off to the lake.
4) Lake residents begin monitoring the water quality through the Self-Help Volunteer Lake Monitoring Program. Monitor water quality to expand knowledge of water quality in Wadley Lake.
5) DNR to designate sensitive areas within Wadley Lake. These are areas that are most important for habitat and maintaining water quality.
6) Lake group and DNR maintain exotic species educational signs at the boat landing to prevent the spread of exotic species into Wadley Lake. No exotic species found during the survey; lake users need to be educated about invasive species issues to prevent exotic introductions into Wadley Lake.

LITERATURE CITED

Barko, J. and R. Smart. 1986. Sediment-related mechanisms of growth limitation in submersed macrophytes. Ecology 61:1328-1340.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S.Kollar, P. Bergstrom, and R. Batuik. 1993. Assessing water quality with submersed vegetation. BioScience 43(2):86-94.

Duarte, Carlos M. and Jacob Kalff. 1986. Littoral slope as a predictor of the maximum biomass of submerged macrophyte communities. Limnol. Oceanogr. 31(5):1072-1080.

Dunst, R.C. 1982. Sediment problems and lake restoration in Wisconsin. Environmental International 7:87-92.

Engel, Sandy. 1990. Ecosystem Response to Growth and Control of Submerged Macrophytes: A Literature Review. Technical Bulletin #170. Wisconsin Department of Natural Resources. Madison, WI.

Engel, Sandy. 1985. Aquatic Community Interactions of Submerged Macrophytes. Wisconsin Department of Natural Resources. Technical Bulletin No. 156. Madison, WI

Fassett, Norman C. 1957. A Manual of Aquatic Plants. University of Wisconsin Press. Madison, WI.

Gleason, H. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada (Second Edition). New York Botanical Gardens, NY.

Jessen, Robert and Richard Lound. 1962. An evaluation of a survey technique for submerged aquatic plants. Minnesota Department of Conservation. Game Investigational Report No. 6.

Lillie, R. and J. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Tech. Bull. #138. Madison, WI.

Nichols, Stanley, S. Weber, B. Shaw. 2000. A proposed aquatic plant community biotic index for Wisconsin lakes. Environmental Management 26:491-502.

Nichols, Stanley. 1999. Distribution and Habitat Descriptions of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey, Bulletin 96. Madison, WI

Nichols, Stanley. 1998. Floristic quality assessment of Wisconsin lake plant communities with example applications. Journal of Lake and Reservoir Management 15(2):133-141.

Nichols, Stanley A. and James G. Vennie. 1991. Attributes of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey. Information Circular 73.

Shaw, B, C. Mechenich and L. Klessig. 1993. Understanding Lake Data. University of Wisconsin – Extension. Madison, WI

Appendix IV. Transect Locations on Wadley Lake, 2006 Aquatic Plant Survey