# The Aquatic Plant Community of Firth Lake,

# Chippewa County, Wisconsin

# 2006

**Submitted by:**

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## Executive Summary

Firth Lake is a mesotrophic/oligotrophic lake with fair-to-good water clarity and good-to-very good water quality. Filamentous algae was not found in the Firth Lake.

Aquatic plant community colonized slightly more than half of the littoral zone and less than half of the total lake area, to a maximum rooting depth of 5 feet. The 0-1.5ft depth zone supported the most abundant aquatic plant growth.

Sixteen (16) aquatic plant species were recorded in Firth Lake. *Nymphaea odorata* (white water lily) was the dominant species within the plant community, especially in the 0-1.5ft depth zones, occurring at more than one-third of the sample sites and exhibiting a growth form of above average density. *Ceratophyllum demersum* (coontail) was sub-dominant, occurring at more than one-third of the sites also and dominating the 1.5-5ft depth zone.

The aquatic plant community in Firth Lake is a community of soft water, soft sediment species. The community is characterized by below average quality, fair species diversity, a below average tolerance to disturbance and a condition that is 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 owners preserve the natural shoreline cover that is found around Firth Lake. Wooded cover, shrubs and native herbaceous growth protected all of the shoreline. Maintaining natural shoreline cover is critical to maintaining water quality and wildlife habitat.
2) Any development on the lake should incorporate best management practices to prevent nutrient enrichment, erosion and stormwater run-off to the lake.
3) DNR to consider designating sensitive areas within Firth Lake. These are areas that are most important for habitat and maintaining water quality.

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# The Aquatic Plant Community in Firth Lake, Chippewa County 2006

## I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Firth Lake was conducted during August 2006 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Firth 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 can 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 critical habitat 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:** Firth Lake is a 51-acre seepage lake in northern Chippewa County, Wisconsin. Firth Lake has a maximum depth of 18 feet. There is a creek outlet from the lake.

Firth Lake is near the boundary of the Chippewa County Forest, with County Forest land close on three sides, however the shoreline of the entire lake is in private ownership.

## 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 14 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), 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 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 each side of the transect intercept with the shore and 30 feet deep was evaluated. The percentage of each shore cover type (Table 3) 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 "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 are 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 Firth Lake (Table 5) to quantify the quality of the 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 Average 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. Nutrient, algae 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 nutrient enrichment in a lake. Increases in phosphorus in a lake can feed algae blooms and, occasionally, excess plant growth.

**No nutrient data was found for Firth 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 data was found for Firth Lake.**

No filamentous algae was found in Firth Lake at the time of the survey.

#### 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 can be measured with a Secchi disc which shows the combined impacts. Satellite images can be used to estimate Secchi disc water clarity.

**2000-2001 Summer Satellite Estimated Secchi Disc water clarity in Firth Lake ranged from 6-10.5 ft.**

Water clarity data suggests (Table 1) that Firth Lake varied between a mesotrophic/oligotrophic lake with fair to good water clarity and good to very good water quality. This trophic state would favor moderate plant growth and infrequent algae blooms.

**Table 1. Trophic Status**

| | Quality Index | Phosphorus ug/l | Chlorophyll ug/l | Satellite 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 |
| **Firth Lake – 2000-01** | **Good to Very Good** | | | **6-10.5 ft.** |

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

**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).

Firth Lake has an oval basin and a moderately-sloped littoral zone over most of the lake (Appendix IV). Gradual slopes provide a more stable substrate for rooting and a broader band of water shallow enough for plant growth. This means the Firth Lake will tend to have a ring of vegetation around most of the lake.

**SEDIMENT COMPOSITION** – Silt sediment was the dominant sediment in Firth Lake, dominating the 5-20ft depth zones (Table 2). Peat sediment was common, dominant in the 0-5ft depth zone. Silt and peat mixtures were common in the 1.5-5ft depth zone (Figure 1).

**Table 2. Sediment Composition, 2006**

| Sediment Type | | 0-1.5' Depth | 1.5-5' Depth | 5-10' Depth | 10-20' Depth | Percent of all Sample Sites |
|---|---|---|---|---|---|---|
| **Soft Sediment** | Silt | | 7% | 77% | 100% | 42% |
| | Peat | 50% | 50% | 23% | | 33% |
| | Silt/Peat | | 36% | | | 10% |
| | Muck/Peat | 14% | | | | 4% |
| | Muck | 7% | | | | 2% |
| **Mixed Sediment** | Sand/Peat | 14% | | | | 4% |
| | Sand/Silt/Rock | | 7% | | | 2% |
| **Hard Sediment** | Sand/Gravel | 7% | | | | 2% |
| | Sand | 7% | | | | 2% |

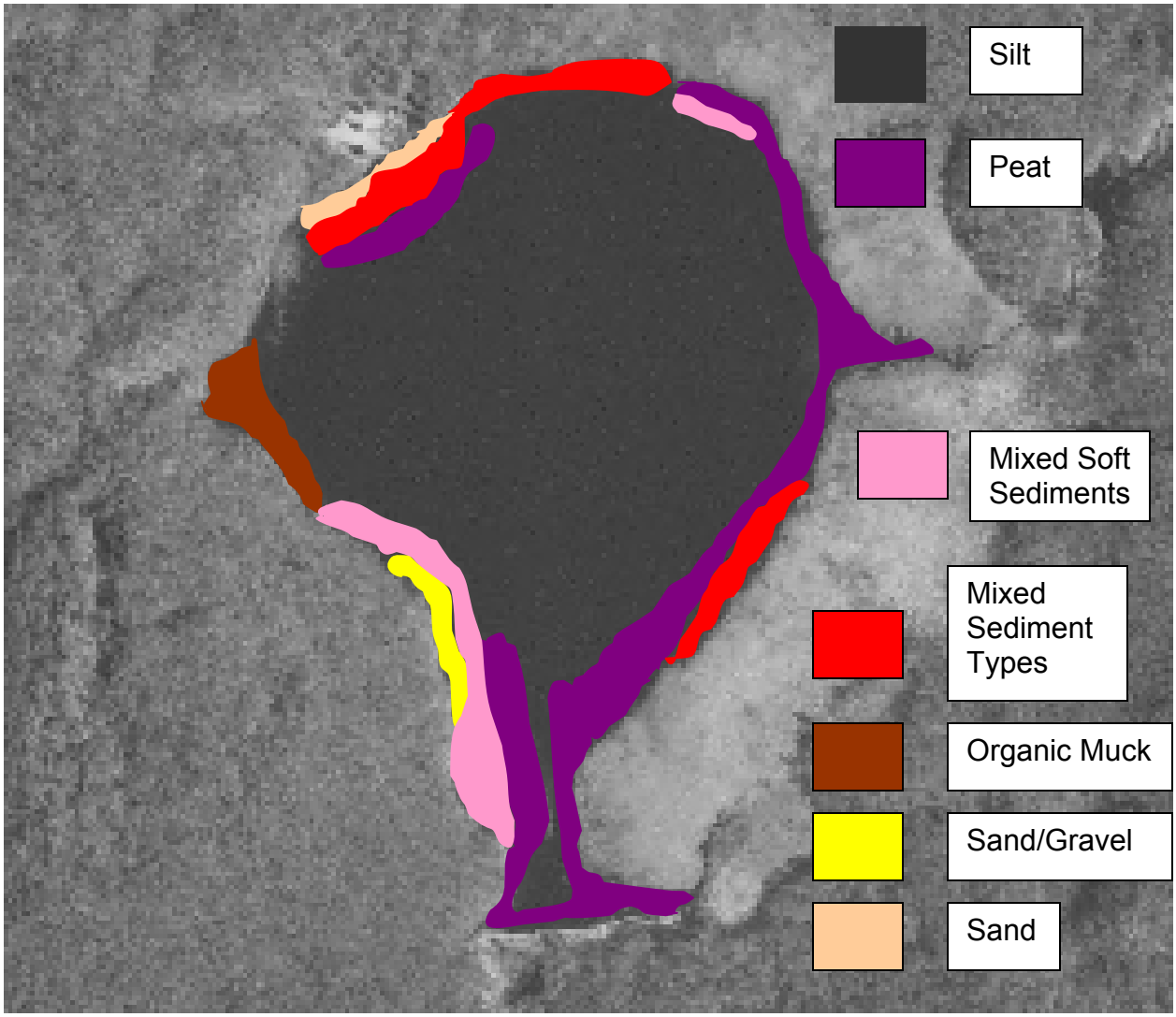



**Figure 1. Sediment distribution in Firth Lake, 2006.**

**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.

Silt sediments are intermediate density sediments and considered most favorable for plant growth. The availability of mineral nutrients for growth is highest in sediments of intermediate density (Barko and Smart 1986). Silt was the dominant sediment in the lake, but was most abundant at deeper depth zones and supported the lowest occurrence of plant growth. Peat was common, dominant in the shallowest zones, in Firth Lake and can be limiting to plant growth due to it flocculent nature. Peat however supported more vegetation than silt, which may be due to the occurrence of peat in shallow water where light availability is greatest. Light may be a more important factor for plant growth than sediment in Firth Lake.

**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.

Herbaceous growth was the most frequently encountered shoreline cover at the transects and had the highest mean coverage. The occurrence of wooded and shrub cover was also high (Table 3). Some type of natural shoreline occurred at all sites and covered all of the shore. Disturbed shoreline was not found on Firth Lake in 2006 except for the small area where the county forest road ends in a canoe launch.

**Table 3. Shoreline Land Use, 2006**

| **Cover Type** | | **Frequency of Occurrences at Transects** | **Mean % Coverage** |
|---|---|---|---|
| Natural Shoreline | Native Herbaceous | 100% | 76% |
| | Wooded | 28% | 12% |
| | Shrub | 57% | 11% |
| | Bare Sand | 7% | 1% |
| Total Natural | | | 100% |
| Disturbed Shoreline | Hard Structure | | |
| | Mowed Lawn | | |
| | Eroded | | |
| Total Disturbed | | | 0% |

## MACROPHYTE DATA

### SPECIES PRESENT

Sixteen (16) aquatic plant species were found in Firth Lake: 9 emergent species, 3 floating-leaf species and 4 submergent species (Table 4). 73% of the aquatic plant species that exhibit a preference prefer soft water and 83% prefer soft substrates (Nichols 1999). No threatened, endangered or non-native species were found in the survey.

**Table 4. Firth Lake Aquatic Plant Species, 2006**

| Scientific Name | Common Name | I. D. Code |
|---|---|---|
| Emergent Species | | |
| 1) *Carex* spp. | sedge | carsp |
| 2) *Dulichium arundinaceum* (L.) Britton | three-way sedge | dular |
| 3) *Eleocharis ovata* (Roth) Roemer & Schultes. | blunt spikerush | eleob |
| 4) *Eleocharis smallii* Britt. | creeping spikerush | elesm |
| 5) *Leersia oryzoides* (L.) Swartz. | rice cut-grass | leeor |
| 6) *Pontederia cordata* L. | pickerelweed | ponco |
| 7) *Scirpus acutus* Muhl. | hardstem bulrush | sciac |
| 8) *Sparganium* spp. | bur-reed | spasp |
| 9) *Typha latifolia* L. | common cattail | typla |
| Floating-leaf Species | | |
| 10) *Brasenia schreberi* J. F. Gmelin. | watershield | brasc |
| 11) *Nuphar variegata* Durand. | bull-head pond lily | nupva |
| 12) *Nymphaea odorata* Aiton. | white water lily | nymod |
| Submergent Species | | |
| 13) *Ceratophyllum demersum* L. | coontail | cerde |
| 14) *Potamogeton epihydrus* Raf. | ribbon-leaf pondweed | potep |
| 15) *Potamogeton zosteriformis* Fern. | flatstem pondweed | potzo |
| 16) *Utricularia vulgaris* L. | great bladderwort | utrvu |

### FREQUENCY OF OCCURRENCE

*Ceratophyllum demersum* (coontail) and *Nymphaea odorata* (white water lily) were the most frequently occurring species in Firth Lake in 2006, (each 38% of sample sites) (Figure 2). *Nuphar variegata* (yellow pond lily) and *Pontederia cordata* (pickerelweed) were commonly occurring species, (23%, 25%) (Figure 2).

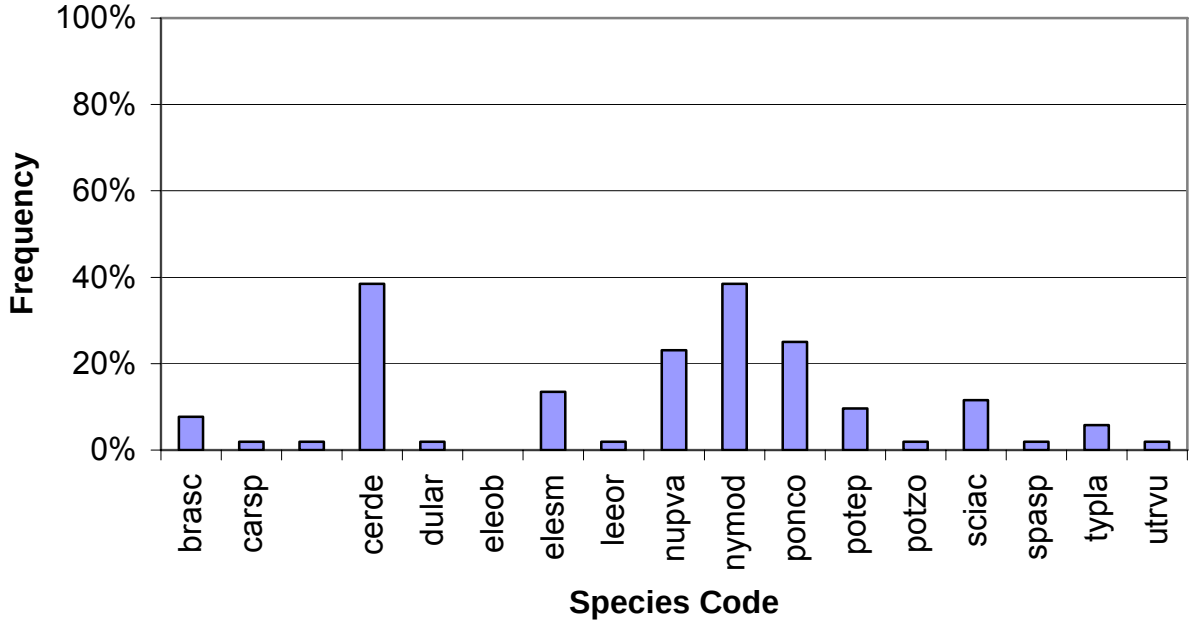



**Figure 2. Frequency of aquatic plant species in Firth Lake, 2006.**

**DENSITY**

*Nymphaea odorata* (white water lily) was the species with the highest mean density (1.10 on a density scale of 0-4) in Firth Lake (Figure 3). All aquatic plant species were found at low mean densities in Firth Lake.

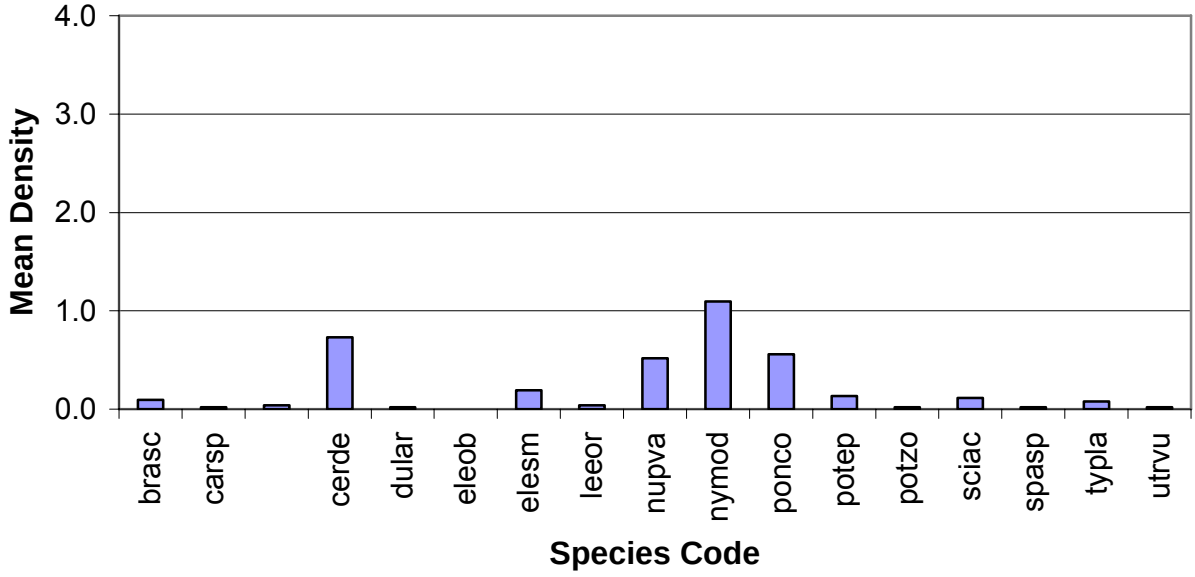



**Figure 3. Densities of aquatic plant species in Firth Lake, 2006.**

Only *Nymphaea odorata* (white water lily) had a "density where present" greater than 2.5 (2.85 on a density scale of 0-4) (Figure 4), indicating that *N. odorata* exhibited a growth form of above average density in Firth Lake.

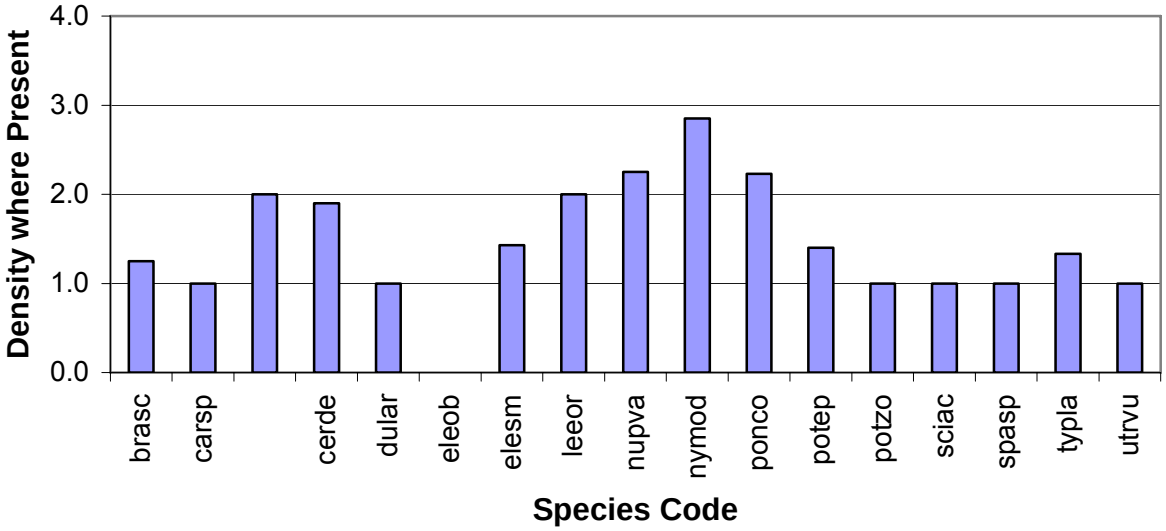



**Figure 4. "Density where present", density of growth form in Firth Lake, 2006.**

**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, *Nymphaea odorata* (white water lily) was the dominant aquatic plant species in Firth Lake (Figure 5). *Ceratophyllum demersum* (coontail) was sub-dominant.

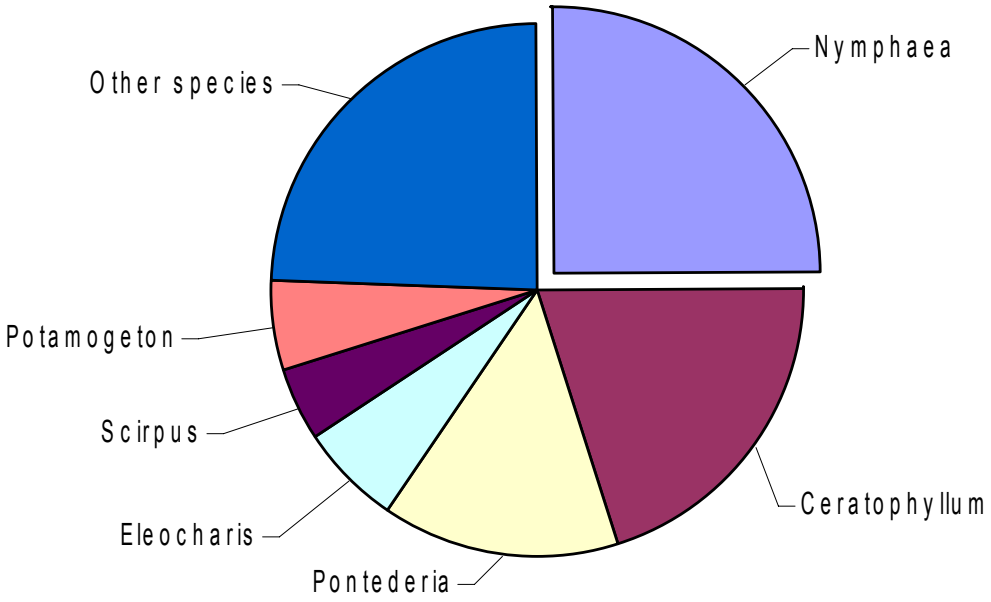



**Figure 5. Dominance within the plant community, of the most prevalent aquatic plant species in Firth Lake, 2006.**

*Nymphaea odorata,* the dominant species, dominated the 0-1.5ft depth zones and occurred at its highest frequency and density in this depth zone (Appendices I, II) (Figure 6, 7). *Ceratophyllum demersum*, the sub-dominant species, dominated the 1.5-5ft depth zone, occurring at its highest frequency and density in this depth zone (Figure 6, 7). Both species shared dominance in the 5-10ft depth zone.

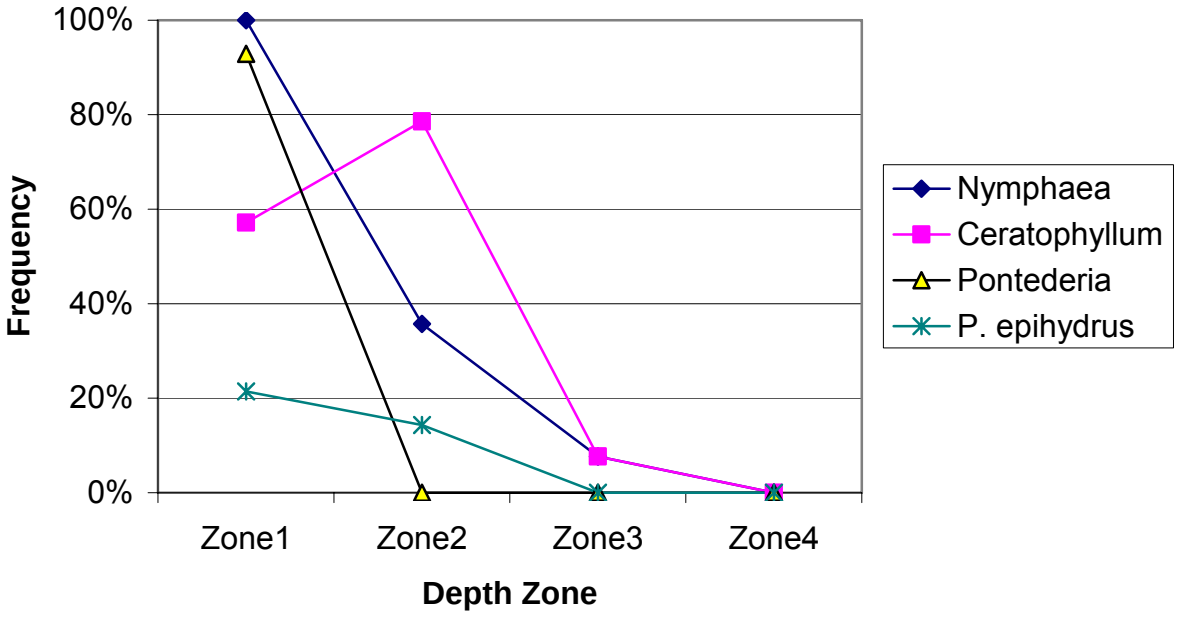



**Figure 6. Frequency of most prevalent species in Firth Lake, by depth, 2006.**

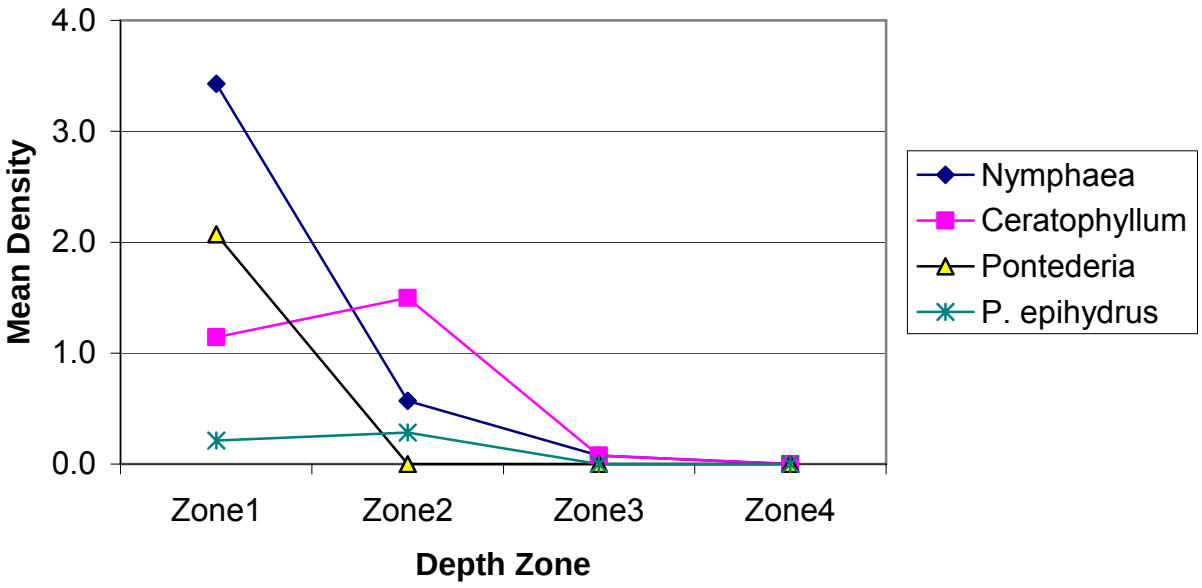



**Figure 7. Density of the most prevalent plant species, by depth zone.**

**DISTRIBUTION**

Aquatic plants occurred throughout the littoral zone of Firth Lake to a maximum rooting depth of 5 feet. *Nymphaea odorata* (white water lily) was found at the maximum rooting depth.

Vegetation colonized 58% of the littoral zone, 47% of the lake surface (24 acres). In 2006, approximately 18 acres (35% of the lake surface, 44% of the littoral zone) was vegetated with submergent vegetation. Rooted floating-leaf vegetation colonized about 24 acres (47% of the lake surface, 50% of the littoral zone) and emergent vegetation colonized about 2 acre (4% of the lake surface, 27% of the littoral zone) (Figure 8).

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

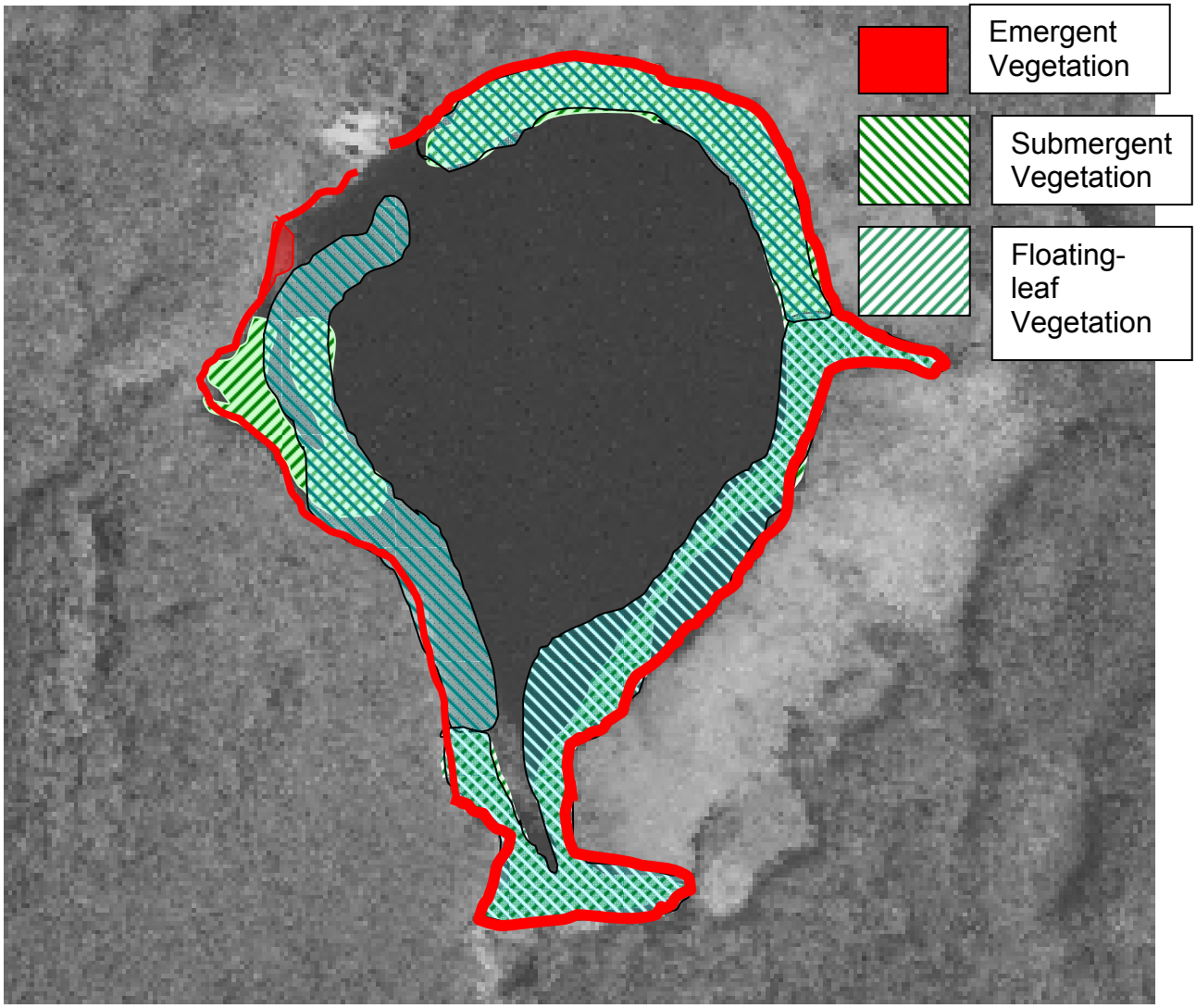



**Figure 8. Distribution of aquatic plants in Firth Lake, Chippewa County, 2006.**

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

Predicted Rooting Depth (ft.) = (Secchi Disc (ft.) * 1.22) + 2.73

**Based on the 2000-01 Satellite Estimated Secchi disc water clarity (6-10.5ft), the predicted maximum rooting depth in Firth Lake would be 10-15.5 ft.**

The maximum rooting depth of 5 feet is much less than the predicted maximum rooting depth based on water clarity. This may be due to either using clarity data from a different year than the plant study was conducted or less reliability in estimating water clarity from satellite data.

The highest total occurrence and total density of plants was in the 0-1.5ft depth zone and declined rapidly with increasing depth (Figure 9).

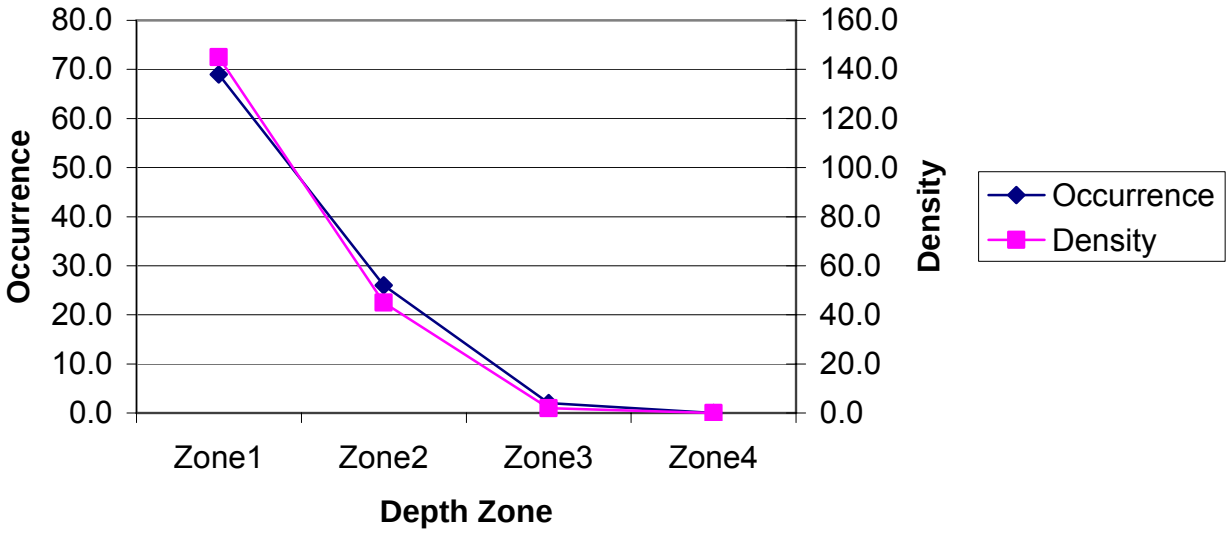



**Figure 9. Total occurrence and total density of aquatic plants by depth zone in Firth Lake, 2006.**

The highest percent of vegetated sites was in the 0-5ft depth zone and the greatest species richness (mean number of species per site) were recorded in the 0-1.5ft depth zone, both declining with increasing depth (Figure 10). Overall Species Richness in Firth Lake was 1.86.

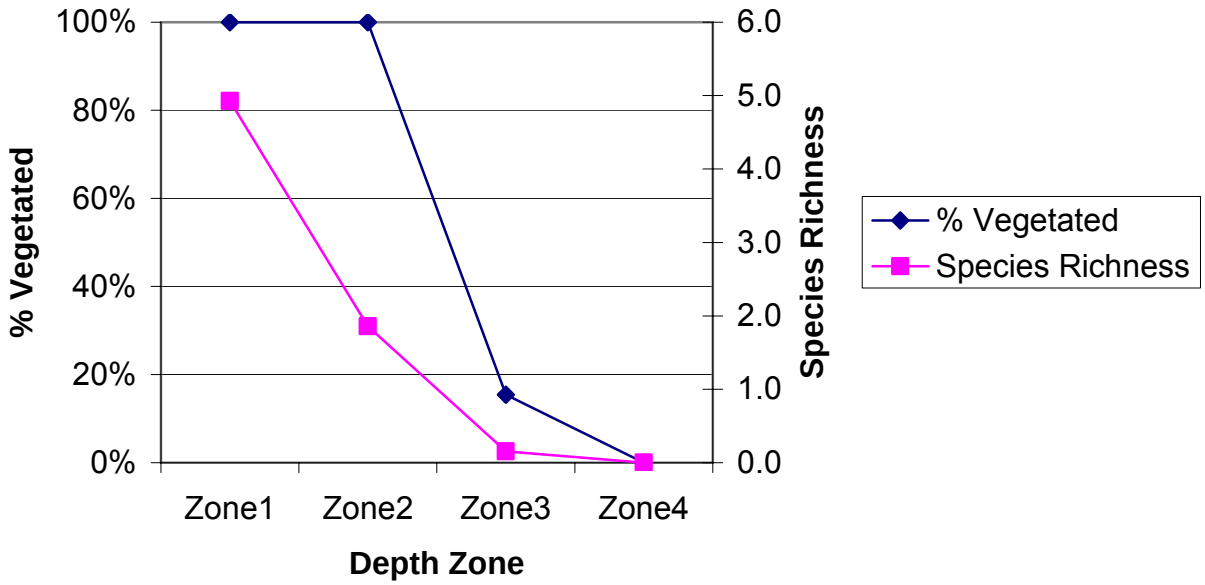



**Figure 10. Percent vegetated sites and Species Richness (mean number of species per sample site) by depth zone in Firth Lake, 2006.**

## THE COMMUNITY

Simpson's Diversity Index was 0.87, indicating fair 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 Firth Lake (Table 5) is 46, indicating a below average quality plant community. This value places Firth Lake below average quality for lakes in Wisconsin and in lowest quartile of North Central Hardwood Region lakes. The shallow rooting depth and low frequency of submerged species are limiting the quality of the aquatic plant community in Firth Lake.

**Table 5. Aquatic Macrophyte Community Index: Firth Lake 2006**

| Category | | Value |
|---|---|---|
| Maximum Rooting Depth | 1.52 meters | 2 |
| % Littoral Zone Vegetated | 58% | 10 |
| % Submergent Species | 7% Rel. Freq. | 1 |
| # of Species | 16 | 8 |
| % Exotic species | 0% | 10 |
| Simpson's Diversity | 0.87 | 7 |
| % Sensitive Species | 21.6% Relative Freq. | 8 |
| Totals | | 46 |

The highest value for this index is 70.

The Average Coefficient of Conservatism for Firth Lake was average for lakes in Wisconsin and in the upper quartile for lakes in the North Central Hardwood Region (Table 6). This suggests that the aquatic plant community in Firth Lake has an average tolerance to disturbance when compared with other Wisconsin Lakes and in the group of lakes least tolerant of disturbance in the North Central Hardwood Region.

**Table 6. Floristic Quality and Coefficient of Conservatism of Firth 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 |
| Firth Lake 2006 | 6.00 | 24.74 |

* - 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 Index of the plant community in Firth Lake is above average for lakes in the North Central Hardwood Lakes Region and Wisconsin (Table 6). This suggests that the plant community in Firth Lake is closer to an undisturbed condition than average.

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.

Disturbance in Firth Lake is likely limited to past logging in the watershed.

## IV. DISCUSSION

Firth Lake is a 51-acre seepage lake with a maximum depth of 18 feet. Based on 2001-02 satellite-estimated water clarity data, Firth Lake is a mesotrophic/oligotrophic lake with fair-to-good water clarity and good-to-very good water quality. No filamentous algae occurred at the time of the survey.

The good water clarity, moderately-sloped littoral zone and dominance of fertile sediments in Firth Lake would favor plant growth.

Aquatic plants colonized 58% of the littoral zone (47% of the lake surface), to a maximum depth of 5 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 0-1.5ft depth zone.

Sixteen (16) aquatic plant species were recorded in Firth Lake. The majority of the species are ones that prefer low alkalinity water and soft sediments (Nichols 1999). *Nymphaea odorata* (white water lily) was the dominant plant species in Firth Lake, especially in the 0-1.5ft depth zone, occurring at more than one-third of the sample sites and exhibiting a growth form of above average density. *Ceratophyllum demersum* was sub-dominant in Firth Lake, also occurring at more than one-third of the sites. *C. demersum* (coontail) dominated in the 1.5-5ft depth zones. The dominant and common species were found distributed throughout the lake; all species occurred at low densities.

The Aquatic Macrophyte Community Index (AMCI) for Firth Lake was 46, indicating that Firth Lake's aquatic plant community is of below average quality compared to other Wisconsin lakes. The Simpson's Diversity Index (0.87) for Firth Lake indicates that the aquatic plant community had a fair diversity of species. Species Richness was 1.86 species per sample site.

The Average Coefficient of Conservatism suggests that Firth Lake is less tolerant of disturbance than the average lake. The Floristic Quality Index shows Firth Lake is closer to an undisturbed condition than the average lake in the state and region.

Firth Lake is protected by natural shoreline cover around all of the shore; all natural cover types (wooded, shrub, native herbaceous growth, natural sand bench) were commonly occurring. Preserving this natural shoreline is critical to maintaining water quality and wildlife habitat. Conversion of the natural shoreline to lawn, rip-rap or hard structures would result in significant loss of shoreline habitat loss for wildlife. The loss of natural shoreline would also destroy the buffer that infiltrates stormwater run-off to the lake. Run-off volume from developed lawn is approximately 10 times greater than run-off from natural wooded cover and more run-off events occurred at sites with lawn (Graczyk et. al. 2003). This increased run-off carries more nutrients to the lake. Nitrogen and phosphorus input was 10-100 times greater at developed lawn than wooded areas (Hunt et. al. 2006).

## V. CONCLUSIONS

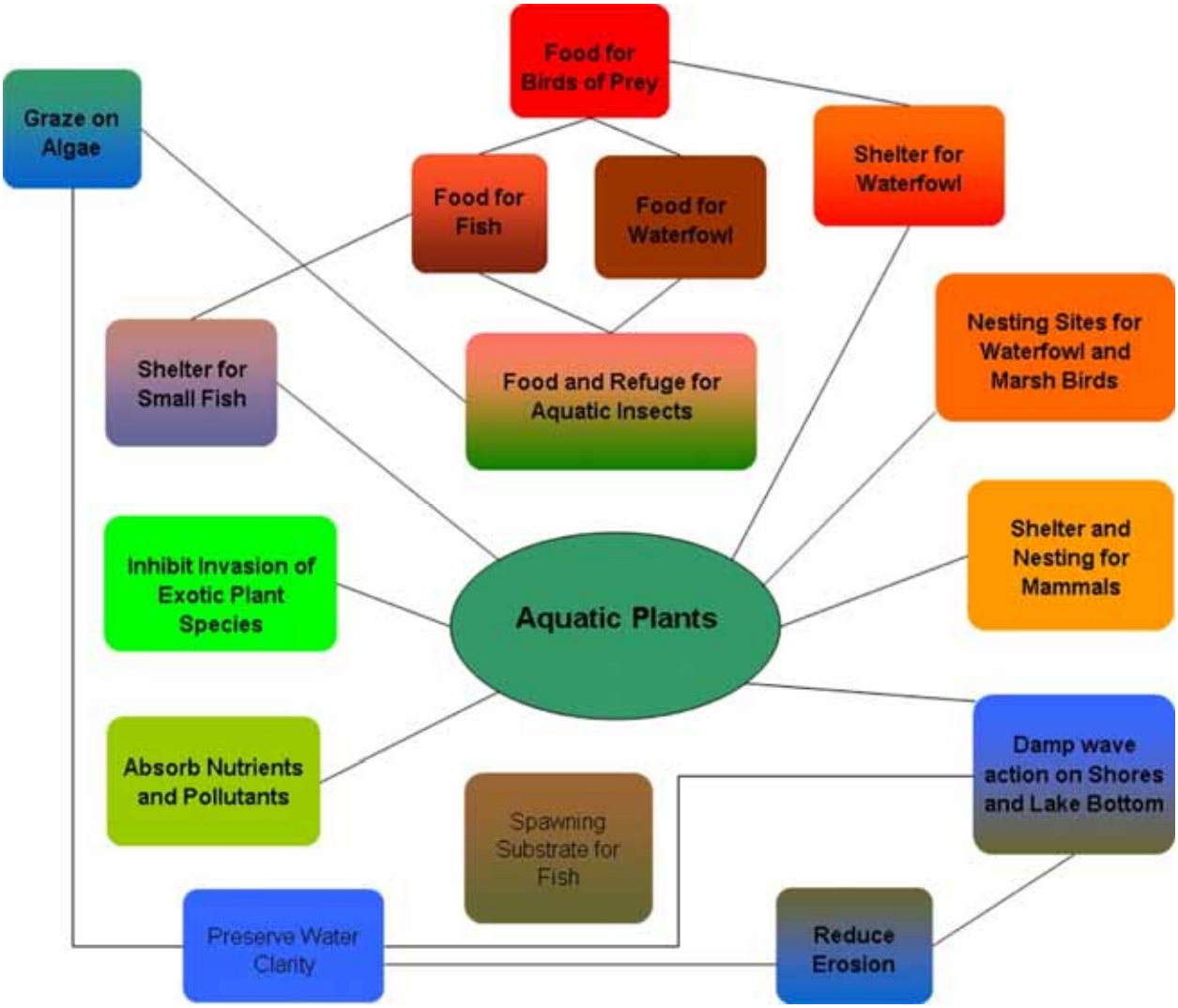
Firth Lake is a mesotrophic/oligotrophic lake with fair-to-good water clarity and good-to-very good water quality based on 2000-01 satellite estimated water clarity data. Filamentous algae was not found in the Firth Lake in 2006.

Aquatic plant community colonized slightly more than half of the littoral zone and less than half of the total lake area, to a maximum rooting depth of 5 feet. The 0-1.5ft depth zone supported the most abundant aquatic plant growth.

Sixteen (16) aquatic plant species were recorded in Firth Lake. *Nymphaea odorata* (white water lily) was the dominant species within the plant community, especially in the 0-1.5ft depth zones, occurring at more than one-third of the sample sites and exhibiting a growth form of above average density. *Ceratophyllum demersum* (coontial) was sub-dominant, occurring at more than one-third of the sites also and dominating the 1.5-5ft depth zone.

The aquatic plant community in Firth Lake is a community of soft water, soft sediment species (Nichols 1999). The community is characterized by below average quality, fair species diversity, a below average tolerance to disturbance and a condition that is 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 of aquatic plants in 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.




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, 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 7). Game fish populations have been found to decline when submerged aquatic vegetation is less than 10% and greater than 60% (Valley et. al. 2004). Plant cover within the littoral zone of Firth Lake is 58% and over the entire lake is 47%. This is appropriate 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

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

| Aquatic Plants | Fish | Water Fowl | Song / Shore Birds | Upland Game Birds | Muskrat | Beaver | Deer |
|---|---|---|---|---|---|---|---|
| **Submergent Plants** | | | | | | | |
| *Ceratophyllum demersum* | F,I*, C, S | F(Seeds*), I, C | | | F | | |
| *Potamogeton epihydrus* | F, I, S*,C | F*(All) | | | F* | F | F |
| *Potamogeton zosteriformis* | F, I, S*,C | F*(Seeds) | | | F* | F | F |
| *Utricularia spp.* | F, C, I | I | | | F | | |
| | | | | | | | |
| **Floating-leaf Plants** | | | | | | | |
| *Brasenia schreberi* | S, I, C | F(Seeds) | | | F | F | F |
| *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** | | | | | | | |
| *Carex* spp. | S* | F* | F* (Roots, Sprouts, Seeds) | F* (Roots, Sprouts, Seeds) | F* (Roots, Sprouts) | F | F |
| *Eleocharis smallii* | I | F, C | | | | | |
| *Eleocharis* sp. | F, S, C | F(Tubers, Seeds), C | F(Seeds) | F (Seeds) | F | F | F |
| *Leersia oryzoides* | | F | | | F | | |

| Aquatic Plants | Fish | Water Fowl | Song / Shore Birds | Upland Game Birds | Muskrat | Beaver | Deer |
|---|---|---|---|---|---|---|---|
| *Scirpus acutus* | F, S, C, I | F*(Seeds, tubers) | F(Seeds, Tubers), C | F | F* | | |
| *Sparganium* spp. | | F, 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 Invertebrates, a valuable 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.

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

**Management Recommendations**

1) Lake property owners preserve the natural shoreline cover that is found around Firth Lake. Wooded cover, shrubs and native herbaceous growth protected all of the shoreline. Maintaining natural shoreline cover is critical to maintaining water quality and wildlife habitat.
2) Any development on the lake should incorporate best management practices to prevent nutrient enrichment and stormwater run-off to the lake.
3) DNR to consider designating sensitive areas within Firth Lake. These are areas that are most important for habitat and maintaining water quality.

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**Appendix IV. Location of Study Transects on Firth Lake, Chippewa County**