**The Aquatic Plant Community of Wazeecha Lake**

**I. INTRODUCTION**

A study of the aquatic macrophytes (plants) of Wazeecha Lake was conducted during July 1997 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative vegetation study of Wazeecha Lake by the DNR. A qualitative vegetation study was conducted during August 1992 by the DNR.

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

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

**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.

Wazeecha Lake is a 148-acre impoundment on Buena Vista Creek that impounds both Buena Vista Creek and Fourmile Creek in Wood/Portage County, Wisconsin. The maximum depth of Wazeecha Lake is 20 feet (Figure 1). Wazeecha Lake was dredged between the 1992 and 1997 macrophyte surveys.

**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 20 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment, using a random numbers table. One transect was eliminated due to silting in of the upper end of the lake.

One sampling site was randomly located in each depth zone (0-1.5ft., 1.5-5ft., 5-10 ft., 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 square 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 4 indicates that it was present on all four rake samples and a rating of 5 indicates that it was abundantly present on all rake samples at that sampling site.) The sediment type at each sampling site was also recorded.

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

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

Data Analysis

The percent frequency of occurrence 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 all species occurrences (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 its average density relative to all plant densities. A "mean density where present" was calculated for each species (sum of a species' density ratings / number of sampling sites at which it occurred) (Appendix II). The relative frequency and relative density was summed to obtain an importance value (Appendix III). Simpson's Diversity Index was calculated (Appendix I).

**III. RESULTS**

 **PHYSICAL DATA**

 **WATER QUALITY** - The trophic state of a lake is an indicator of water quality. Phosphorus concentration, chlorophyll concentration, and water clarity data are collected and combined to determine the trophic state. Eutrophic lakes are high in nutrients and therefore support a large biomass. Oligotrophic lakes are low in nutrients and support limited plant growth and smaller fish populations. Mesotrophic lakes have intermediate levels of nutrients and biomass.

Phosphorus is a limiting nutrient in many Wisconsin lakes. Increases in phosphorus in a lake can feed algal blooms and excess plant growth.

**1997 mean summer phosphorus in Wazeecha Lake was 44 ug/l.**

The level of phosphorus in Wazeecha Lake 1997 was indicative of an eutrophic lake (Table 1).

**Table 1. Trophic Status**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Phosphorus ug/l | Chlorophyll ug/l | Secchi Disc ft. |
| Oligotrophic | 3-10 | 2-5 | > 8 |
| Mesotrophic | 18-27 | 8-10 | 6 |
| Eutrophic | 30-50 | 11-15 | < 5 |
| Wazeecha Lake 1997 | 44 | 11.6 | 4.5 |

Measuring the level of chlorophyll in the water gives an indication of algal levels. Algae is natural and essential in lakes, but high algal levels can cause problems, increasing the turbidity and reducing the light available for plant growth.

**1997 mean summer chlorophyll in Wazeecha Lake was 11.6 ug/l**.

The chlorophyll concentration in Wazeecha Lake indicates that it was a eutrophic lake (Table 1).

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 that shows the combined effect of turbidity and color. Secchi disc readings can be used to calculate a predicted maximum rooting depth for plants in the lake.

**1997 Mean summer Secchi Disc Clarity was 4.5 Ft.**

**Based on the Mean 1997 Secchi Disc Clarity, the predicted maximum rooting depth was 8.2 ft. in the lake.**

The Secchi disc depth also indicates that Wazeecha Lake was a eutrophic lake that had poor clarity in 1997 (Table 1).

The combination of the phosphorus, chlorophyll, and clarity values indicate the trophic state. These values for Wazeecha Lake indicate that it was a eutrophic lake. This trophic state favors high levels of plant or algae growth with periods of turbidity common.

The pH of a lake indicates the acidity or alkalinity of the water.

**The 1997 mean summer pH of the surface water in Wazeecha Lake was 8.2.**

This would favor plants adapted to slightly alkaline conditions.

 **LAKE MORPHOMETRY** - The morphometry of a lake is an often overlooked factor in analyzing 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). Wazeecha Lake is a long, narrow impoundment with a moderately sloped littoral zone throughout much of the lake and is shallow in the east half of the lake. This would favor plant growth throughout much of the lake.

 **SHORELINE LAND USE** - There has been an increased awareness recently, that land use practices strongly impact the aquatic plant community. Practices on shore can directly effect the plant community through increased sedimentation from erosion, increased nutrient levels from fertilizer run-off and soil erosion and increased toxics from farmland and urban run-off.

Wooded cover was the most frequently encountered shoreline cover found at the transects, but cultivated lawn had slightly higher mean coverage. Native herbaceous growth was also found at many of the transects at relatively high mean coverage. Shrub growth, bare soil and hard surfaces (pavement, gravel, rock or rip-rap) were also commonly encountered (Table 2).

Natural shoreline (wooded, shrub, native herbaceous) was found at 74% of the sites and had a mean coverage of 57%. Disturbed shoreline (cultivated lawn, bare soil, hard surface or structures) was also found at 74% of the sites and had a mean coverage of 43%.

**Table 2.** **Shoreline Land Use**

|  |  |  |
| --- | --- | --- |
| **Cover Type** | **Frequency of Occurrences at Transects**  | **Mean % Coverage** |
| Cultivated lawn | 47.4% | 33.4% |
| Wooded | 63.2% |  33.2% |
| Native Herbaceous | 47.4% | 20.8% |
| Shrub | 26.3% | 3.4% |
| Bare Soil | 31.6% | 3.4% |
| Hard Surface | 21.0% | 3.2% |
| Hard Structures | 10.5% | 2.6% |

 **SEDIMENT COMPOSITION** - Sand was the predominant sediment type, found throughout the lake, especially in the shallower areas of the littoral zone (Table 3). Sand sediments mixed with rock or silt were also common; with rock at depths up to 10 ft. and with silt more commonly at depths greater than 5 ft.

Organic muck was found mixed with the silt sediments at the east end of the lake where the creek enters and mixed with sand at the public beach on the northwest bay.

**Table 3. Sediment Composition**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 0-1.5' Depth | 1.5-5' Depth | 5-10' Depth | 10-20' Depth  | Percent of all Sample Sites  |
| **Hard Sediments** | Sand | 55.6% | 61.1% | 41.2% | 29.4% | 47.1% |
|  | Sand/Rock | 38.9% | 22.2% | 35.5% |  | 24.3% |
| **Mixed Sediments** | Sand/Silt | 5.6% | 5.6% | 23.5% | 47.0% | 20% |
|  | Sand/Muck |  |  |  | 5.9% | 1.4% |
| **Soft Sediments** | Silt |  |  |  | 17.6% | 4.2% |
|  | Silt/Muck |  | 5.6% |  |  | 1.4% |

 **MACROPHYTE DATA**

 **SPECIES PRESENT**

A total of 17 species was found in Wazeecha Lake. Of the 17 species, 2 were emergent species, 1 was a floating-leaf species, and 14 were submergent species (Table 4). No endangered or threatened species were found. Two non-native species were found: *Myriophyllum spicatum* and *Potamogeton crispus*.

**Table 4. Wazeecha Lake Aquatic Plant Species**

 Scientific Name Common Name I. D. Code

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Emergent Species

1) *Sparganium* sp. burreed spasp

2) *Typha latifolia* L. broad-leaf cattail typla

Floating-leaf Species

3) *Nymphaea odorata* Aiton. white water lily nymod

Submergent Species

4) *Ceratophyllum demersum* coontail cerde

5) *Ceratophyllum echinatum* A. Gray. spiny hornwort cerec

6) *Elodea canadensis* common waterweed eloca

7) *Myriophyllum spicatum*  . Eurasian water milfoil myrsp

8) *Najas flexilis* . bushy pondweed najfl

9) *Nitella* sp. stonewort nitsp

10) *Potamogeton crispus* . curly-leaf pondweed potcr

11) *Potamogeton epihydrus* . ribbon-leaf pondweed potep

12) *Potamogeton foliosus* . leafy pondweed potfo

13) *Potamogeton natans* L. floating-leaf pondweed potna

14) *Potamogeton nodosus* . pondweed potno

15) *Potamogeton pectinatus* . sago pondweed potpe

16) *Potamogeton zosteriformis* . flat-stem pondweed potzo

17) *Zosterella dubia* water stargrass zosdu

 **FREQUENCY OF OCCURRENCE**

Of the 17 species found in Wazeecha Lake, 11 occurred at sampling sites. The frequency occurrence of all aquatic plant species was low. The species with the highest frequency of occurrence was *Potamogeton zosteriformis* (5.7%) (Figure 2).

**Figure 2. Macrophyte Frequencies in Wazeecha Lake**

 **DENSITY**

Macrophyte densities were also very low. *Typha latifolia* had the highest mean density (0.09 on a density scale of 1-4) (Figure 3). *T. latifolia* was the only truly emergent species found (*Sparganium* grew in deeper water, draped on the top). *T. latifolia* occurred as a small colony near the public beach and in a dense, extensive stand at the shallow east end into which the creeks flow.

**Figure 3. Densities of Macrophytes in Wazeecha Lake.**

*Potamogeton zosteriformis* had the highest density where present (4.0). A high density at sites at which it was present indicates that *P. zosteriformis* had dense growth form in Wazeecha Lake (Figure 3).

 **DOMINANCE**

Combining relative frequency and relative density into an importance value indicates the relative dominance of species within the macrophyte community (Appendix III). Due to the low occurrence and density of macrophytes, no species could be considered dominant in the lake. Based on the importance value, *Potamogeton zosteriformis* was the most dominant species in the lake (Figure 4).

**Figure 4. Dominance within the Macrophyte Community, of the Most Prevalent Macrophytes, based on Importance Value.**

 **DISTRIBUTION**

Aquatic plants were found growing at 14% of all sampling sites. Rooted vegetation was found at all of the vegetated sampling sites. The maximum rooting depth was 8 ft. *Nitella* sp., a macrophytic algae was found at the maximum depth.

22% of the sites in the 0-5 ft. depth zones were vegetated.

12% of the sites in the 5-10 ft. depth zone were vegetated.

None of the sites in the 10-20 ft. depth zone were vegetated.

The mean number of species found at each sampling site was 0.2.

In the 0-1.5' depth zone, the mean number of species per sample site was 0.2. In the 1.5-5' depth zone, the mean number of species per site was 0.4.

In the 5-10' depth zone, the mean number of species per site was 0.3.

In the 10-20' depth zone, the mean number of species per site was 0.

 60 sites had 0 species

 6 sites had 1 species

 3 sites had 2 species

 1 sites had 4 species

The 1.5-5 ft. depth zone had the highest total occurrence and total density of macrophytes (Figure 5). The occurrence and density of macrophyte growth was less in the 0-1.5ft. and 5-10ft. depth zones. Plant growth was not found in the 10-20ft. depth zone.

**Figure 5. Total Occurrence and Density of Macrophytes by Depth Zone.**

The frequency and densities of individual species varied with depth zone. Each depth zone had a different dominant species. *Typha latifolia* was the most frequent and most dense species in the 0-1.5 ft. depth zone (Figure 6) and occurred only in this depth zone.

**Figure 6. Macrophyte Frequencies in the 0-1.5 Foot Depth Zone.**

*Potamogeton zosteriformis* was the most frequent and most dense species in the 1.5-5 ft. depth zone (Figure 7). It had its highest frequency and density in this depth zone. Its presence was lower in the shallow zone and it did not occur in the deeper zones.

**Figure 7. Macrophyte Frequencies in the 1.5-5 Foot Depth Zone.**

Five species occurred at one sample site each in the 5-10 ft. depth zone (Figure 8). *Nitella* sp. had the highest density in this depth zone.

**Figure 8. Macrophyte Frequencies in the 5-10 Foot Depth Zone.**

 **SEDIMENT COMPOSITION** - Some plants depend on the sediment for their nutrients. The richness of sterility of the sediment will determine the type and abundance of macrophyte species that can survive in a location.

The availability of mineral nutrients for growth is highest in sediments of intermediate density, such as silt (Barko and Smart 1986). Highly organic muck sediments are low density; sand, gravel and rock are high density sediments.

Sand sediments were the predominant sediments found in Lake Wazeecha and sand mixed with rock were commonly found. Sand and rock sediments may limit plant growth because of the high density. Silt/muck sediments had a low occurrence in the lake but had a high level of vegetation because of the high nutrient level of organic muck and the intermediate density of silt (Table 5).

**Table 5. Sediment Influence**

|  |  |  |
| --- | --- | --- |
|  | Percent Occurrence | Percent Vegetated  |
| Sand | 47.1 | 15.2 |
| Sand/Rock | 24.3 | 5.9 |
| Sand/Silt | 20 | 14.3 |
| Silt | 4.2 | 0 |
| Sand/Muck | 1.4 | 0 |
| Silt/Muck | 1.4 | 100 |

 **THE COMMUNITY**

Simpson's Diversity Index was 0.88, indicating a moderate diversity. A rating of 1.0 would mean that each species in the lake would be a different species (the most diversity achievable).

The Aquatic Macrophyte Community Index (AMCI) developed by Weber et. al. (1995) was applied to Wazeecha Lake (Table 6). Values between 0 and 10 are given for each of six categories: maximum rooting depth, % of littoral zone vegetated, Simpson's Diversity Index, relative frequency of submersed vegetation, relative frequency of sensitive species, and ratio of native to non-native species. The highest value for this index is 60. AMCI for Wazeecha Lake is 31. This is below average (40) for lakes in Wisconsin.

**Table 6. Aquatic Macrophyte Community Index**

|  |  |  |
| --- | --- | --- |
| Category |  | Value |
| Maximum Rooting Depth | 2.4 meters | 4 |
| % Littoral Zone Vegetated | 14% | 2 |
| Simpson's Diversity | 0.88 | 9 |
| # of Species | 11 | 4 |
| % Submersed Species | 72% Rel. Freq. | 8 |
| % Sensitive Species | 24% Relative Freq. | 4 |
| Totals |  | 31 |

**V. DISCUSSION**

Based on the clarity, chlorophyll and phosphorus levels, Wazeecha Lake was an eutrophic lake with very limited plant growth. The trophic status, the moderate to gradual-sloped littoral zone and shallow depths of much of the lake basin would favor macrophyte growth. The dominance of high density sediments and poor clarity could limit the biomass of macrophytes.

Simpson's Diversity Index indicates that the macrophyte community, though sparse, had a moderate diversity. The very low level of plant growth is reflected in the low number of species present (17), low mean number of species at each sample site: 0.2 and the large proportion of unvegetated sampling sites: 86% The Aquatic Macrophyte Community Index indicates that the macrophyte community in Wazeecha Lake is below average for Wisconsin lakes. This is due to the lack of plant growth.

The occurrence of natural shoreline (wooded, shrub and native herbaceous growth) and disturbed shoreline (mowed lawn, bare soil, hard surface and structures) around Wazeecha Lake was equal. Natural shoreline had a slightly higher mean coverage. Cultivated lawn had a high occurrence and coverage. Bare soil occurred commonly on the lakeshore. Preserving a buffer of natural vegetation along the shore will protect the water quality of the lake from excess nutrients and chemicals that could feed algal blooms and erosion that could increase sedimentation.

Plant growth was very low, but of the plant growth present, *Potamogeton zosteriformis* was the dominant species in Wazeecha Lake, based on its higher frequency of occurrence as compared with the frequency of other species.

The highest occurrence and density of macrophytes and the highest mean number of species at each sample site was found in the 1.5-5 foot depth zone. Macrophyte occurrence, density, and mean number of species was lower in the 0-1.5ft. and 5-10ft. depth zones and did not occur in the 10-20ft. depth zone.

The maximum rooting depth (*Nitella* sp. at 8 feet) was in agreement with the maximum predicted rooting depth based on water clarity (8.2 feet).

A few of the species in Wazeecha Lake (*Ceratophyllum demersum, Elodea canadensis, Myriophyllum spicatum, Najas flexilis, Nymphaea odorata, Potamogeton crispus, P. pectinatus, Typla latifolia, Zosterella dubia*) have been known to grow to over-abundance when there is an excess of nutrients in the lake (Nichols and Vennie 1991). Two of these species, *M. spicatum* and *P. crispus*, are not native and have grown to nuisance conditions in many lakes.

Because the nutrient levels are high in the lake, these plant species may recover to pre-dredging levels of growth if nutrients are not limited and sedimentation increases.

**Comparison with the 1992 Macrophyte Community**

The 1992 and 1997 macrophyte surveys were different types of surveys so the direct comparison of data is not appropriate, but trends can be interpreted. The species present in both the 1992 and 1997 surveys showed some changes (Table 7).

**Table 7. Difference in Species Present in Macrophyte Surveys.**

**Present in 1992 &1997 Occurred only in 1992 Occurred only in 1997**

‡*Ceratophyllum demersum †Chara sp. Ceratophyllum echinatum*

*‡Elodea canadensis †Lemna minor Nitella* sp.

‡*Myriophyllum spicatum †Potamogeton amplifolius Potamogeton epihydrus*

*\*Najas flexilis †Wolffia columbiana Potamogeton foliosus*

*†Nymphaea odorata ‡Vallisneria americana P. natans*

*†Potamogeton crispus Carex* spp. *P. nodosus*

*‡P. pectinatus Iris versicolor Sparganium* sp.

*‡P. zosteriformis Nuphar variegata*

*Typha latifolia Potamogeton illinoensis*

*Zosterella dubia P. richardsonii*

 *Sagittaria latifolia* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\*Different species were recorded in each survey *Najas guadalupensis* in 1992 and *N. flexilis* in 1997, but these species are difficult to separate without fruiting bodies.

†Considered common in 1992 (Sorge 1992)

‡Considered abundant in 1992 (Sorge 1992)

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Several species that were considered common and one species considered abundant were lost between 1992 and 1997. Five of the species that disappeared are intolerant of turbidity: *Chara, Nuphar variegata, Potamogeton amplifolius, P. illinoensis, P. richardsonii.*

The species that either remained after dredging or recolonized after dredging are either favored by disturbance (*Myriophyllum spicatum, Najas flexilis*), favored by turbidity (*Ceratophyllum demersum, Elodea canadensis, Nymphaea odorata, Potamogeton crispus, P. foliosus, P. nodosus, P. pectinatus, Zosterella dubia*) or turbidity tolerant, except *Potamogeton zosteriformis.*

The most noticeable difference between the surveys is in the amount of vegetation. In 1992, much of the littoral zone was considered non-navigable due to heavy plant growth (Sorge 1992)(Figure 8). In 1997, scattered beds of macrophytes were found (Figure 9) but the presence and occurrence of macrophytes was too low.

Dredging Lake Wazeecha removed sediment favorable to plant growth and much of the seed bank and rootstock of the macrophyte community. Macrophytes may recolonize the lake if viable seeds, plant fragments and sediments enter the lake.

**VI. CONCLUSIONS**

Wazeecha Lake was an eutrophic lake with a very sparse, limited macrophyte growth. The aquatic macrophyte community has moderate diversity, but is below average for Wisconsin lakes. *Potamogeton zosteriformis* is the dominant species within this sparse plant community.

Macrophyte growth was abundant in 1992, but removal of sediments and plants during dredging is probably the reason for the lack of plant growth in 1997. The plant species that have either survived the dredging or recolonized since ate species that are either favored by disturbance or are favored by or at least tolerant of turbid conditions, except *Potamogeton zosteriformis.* This may mean that the turbidity in the lake has increased due to increased algal growth taking up available nutrients formerly used by macrophytes.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants provide 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, therefore reducing the diversity.

1) Macrophyte communities improve water quality in many ways: they trap nutrients, debris, and pollutants entering a water body; they may absorb and break down the 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). By intercepting the sunlight, plants can have a cooling effect on the water (Engel 1985).

2) Aquatic plant communities provide important fishery and wildlife resources (Table 7). 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 spawning/nesting sites by a variety of wildlife and fish.

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).

It is important to protect the water quality in Wazeecha Lake to prevent the macrophyte community from regaining its previous over-abundant growth. An important first step in protecting water quality would be to limit nutrients entering the lake from the watershed.

An equally important priority is preserving a natural buffer zone of native vegetation along the shore. Leaving a strip of shoreline unmowed and allowing native vegetation to grow would reduce and filter the run-off into the lake. Since a large portion of the lakeshore is in county park ownership, leaving an unmown strip on park property would positively impact a large portion of the lake. This protected shoreline would withstand public shoreline use better and thus decrease areas with bare soil.

These practices will protect the water quality and wildlife habitat in Wazeecha Lake, an important public recreation resource.

**Figure 1. Map of Wazeecha Lake and Transect Locations**

**Figure 9. Macrophyte distribution in Wazeecha Lake in 1992**

**Figure 10. Macrophyte distribution in 1997**

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