The Aquatic Plant Community in the Chippewa River, 2001

MWBC:2050000

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I. INTRODUCTION

A study of the aquatic macrophytes (plants) in the Lower Chippewa River in Chippewa, Eau Claire, Dunn, Pepin and Buffalo Counties was conducted during July 2001 by Water Resources staff of the West Central Region - Department of Natural Resources (DNR). This was the first quantitative aquatic vegetation study conducted in the Lower Chippewa River by the DNR.

A study of the diversity, density, and distribution of aquatic plants is an essential component of understanding a body of water 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 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 river bottoms, add aesthetic quality 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 resource, including fish habitat improvement, protection of sensitive wildlife areas, aquatic plant management, and water resource regulations. The baseline data that it provides can be compared to future macrophyte inventories and offer insight into any changes occurring.

Background and History: The lower Chippewa River below the Dells Dam in Eau Claire is the free-flowing section of the river that eventually enters the Mississippi River at Pepin, WI.

The lower Chippewa River is impacted by several hydroelectric dams above Eau Claire. Peaking at these facilities may change water velocity and water levels in the river.

II. METHODS

Study Sites

Six segments, each a one-mile long segment, were chosen as study sites on the Lower Chippewa River (Figure 1).

The first segment is a one-mile length of river below the Chippewa Falls dam at the Hwy 124 bridge. This segment was nearly dewatered when the study was conducted. No sign of submergent vegetation could be seen when walking along the exposed riverbed. No data was recorded for this segment.

The second segment is a one-mile length of river below the Dells dam in the city of Eau Claire, WI.

The third segment is a one-mile length below the Highway H bridge near Caryville, WI.

The fourth segment is a one-mile length of river above the Red Cedar's confluence with the Chippewa River near Dunville, WI.

The fifth segment is a one-mile length of river at Durand, WI, at the Highway 10/25 bridge.

The sixth segment is a one-mile length north of Ella, WI.

Figure 1. Location of study sites on the lower Chippewa River.

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 two miles of shoreline (one mile on both banks of the river) at each segment was divided into 10-12 equal segments and a transect, perpendicular to the shoreline, was randomly placed within each segment, using a random numbers table.

One sampling site was randomly located in each depth zone (0-1.5 ft., 1.5-5 ft., 5-10ft and 10-20ft.) along each transect. Using a long-handled, thatching rake, four rake samples were taken at each sampling site. The four samples were taken from each quarter of a 6-foot diameter quadrat. The aquatic plant species that were present on each rake sample were recorded.

The species recorded include aquatic vascular plants and several types of algae that have morphologies similar to vascular plants, such as muskgrass and nitella.

Each species was given a density rating (0-5), the number of rake samples at each sampling site on which it was present.
A rating of 1 for each species present on one rake sample;
A rating of 2 for each species present on two rake samples;
A rating of 3 for each species present on three rake samples;
A rating of 4 for each species present on four rake samples;
A rating of 5 indicates that a species was abundant on all rake samples at that sampling site.)

The presence of filamentous algae was recorded.

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

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

Data Analysis

The data from each segment was analyzed separately and together as a combined site. The percent frequency of each species was calculated (number of sampling sites at which it occurred / total number of sampling sites) (Appendix I-III). Relative frequency was calculated based on the number of occurrences of a species relative to total occurrence of all species (Appendix I-III). The mean density was calculated for each species (sum of a species' density ratings / number of sampling sites) (Appendix IV-VI). Relative density was calculated based on a species density relative to total plant densities. A "mean density where present" was calculated for each species (sum of a species' density ratings / number of sampling sites at which the species occurred) (Appendix IV-VI). The relative frequency and relative density was summed to obtain a dominance value (Appendix XII-XVIII). Simpson's Diversity Index Species was used to calculate species diversity (Appendix I-III).

III. RESULTS

PHYSICAL DATA

SEDIMENT COMPOSITION - Bedrock was the predominant sediment at the sample sites in the Chippewa River, especially at depths greater than 5 ft. (Table 1). Sand sediments were also commonly found at the sample sites. Rock and sand are hard, high-density sediments.

Table 1. Sediment Composition by Depth

Sediment Type		0-1.5’ Depth	1.5-5' Depth	5-10' Depth	10-20’ Depth	Percent of all Sample Sites
Hard Sediments	Bedrock	20%	31%	59%	100%	37%
	Sand	24%	31%	26%		26%
	Sand/Gravel	28%	23%	3%		19%
	Sand/Rock	18%	6%			8%
	Gravel		6%	12%		5%
Mixed Sediments	Sand/Silt	8%	4%			4%

There were some differences in the sediments at the different segments. Bedrock was the predominant in the Dells Dam segment and sand/rock was common (Table 2). Sand and gravel was the predominant sediment at the County H segment and bedrock was common. Sand sediments, alone and mixed with gravel were the predominant sediments at the Dunville segment and bedrock was common (Table 2). Sand was the predominant sediment at the Durand and Ella segments (Figure 2).

Table 2. Sediment Composition by Study Segment

Sediment Type		Dells	County H	Dunville	Durand	Ella
Hard Sediments	Bedrock	76%	30%	24%	32%	4%
	Sand	3%		32%	36%	75%
	Sand/Gravel		52%	32%	11%	8%
	Sand/Rock	22%			14%	
	Gravel		7%	12%	7%	
Mixed Sediments	Sand/Silt		11%			12%

SHORELAND USE – Land use practices can impact the aquatic plant community and, therefore, the entire aquatic community. These practices can directly impact the plant community through increased sedimentation from erosion, increased nutrient input from fertilizer run-off and soil erosion and increased run-off of toxic substances from farmland and urban areas.

Native herbaceous plant growth was the most frequently encountered shoreline cover at the transects on the Chippewa River and wooded cover had the highest mean coverage (Table 3). Native herbaceous growth occurred at nearly three-quarters of the transects and covered nearly one-quarter of the shoreline at the study sites. Wooded cover occurred at more than half of the sites and covered more than one-third of the shoreline at the sites. Eroded soil and rip-rap were also commonly encountered (Table 3).

Table 3. Shoreland Use on the Chippewa River

Cover Type		**Frequency of Occurrences at Transects**	**Mean % Coverage**
Natural Shoreline	Wooded	67%	38%
	Native Herbaceous	71%	23%
	Shrub	15%	4%
	Bare Sand	10%	8%
	Bedrock	13%	4%
Disturbed Shoreline	Eroded Soil	33%	9%
	Rip-rap	25%	7%
	Cultivated Lawn	6%	4%
	Pavement	4%	2%

Some coverage of natural shoreline (wooded, shrub, native herbaceous, sand, bedrock) was found at 98% of the transects. The mean coverage of all types of natural shoreline was 77%. Disturbed shoreline (eroded soil, cultivated lawn, rip-rap and pavement) was found at 60% of the sites and had a mean coverage of 22%.

Wooded cover had the highest mean coverage overall and the highest coverage at four of the segments (Table 4). Eroded soil had the highest coverage at the Dunville segment.

Table 4. Mean Coverage of Shoreland Use at the Study Segments

Cover Type		Dells	County H	Dunville	Durand	Ella
Natural Shoreline	Wooded	34%	66%	10%	25%	52%
	Native Herbaceous	25%	32%	18%	23%	19%
	Shrub	2%		1%	13%	1%
	Bare Sand	1%		25%	9%	9%
	Bedrock	8%			1%	
	Gravel			12%		
Disturbed Shoreline	Eroded Soil	8%	2%	27%	9%	11%
	Rip-rap	22%		6%	4%	1%
	Cultivated Lawn				9%	8%
	Hard Structure				2%	
	Pavement	6%			4%	

MACROPHYTE DATA

SPECIES PRESENT

Of the 14 species found at the Chippewa River sites, 11 were emergent species and 3 were submergent species (Table 5).

No threatened or endangered species were found.

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

Table 5. Chippewa River Aquatic Plant Species

Scientific Name	Common Name	I. D. Code
Emergent Species		
1) *Acorus calamus* L.	sweet flag	acoca
2) *Carex* sp.	sedge	carsp
3) *Eleocharis* sp.	spike rush	elesp
4) *Ludwigia palustris* (L.) Ell.	false loosestrife	ludpa
5) *Lysimachia hybrida* Michx.	hybrid loosestrife	lyshy
6) *Phalaris arundinacea* L.	reed canary grass	phaar
7) *Physostegia parviflora* Nutt.	false dragonhead	phypa
8) *Polygonum* sp.	smartweed	polsp
9) *Sagittaria* sp.	arrowhead	sagsp
10) *Scirpus validus* Vahl.	softstem bulrush	sciva
11) *Sium suave* Walt.	water parsnip	siusu
Submergent species		
12) *Elodea canadensis* Michx.	common waterweed	eloca
13) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
14) *Potamogeton foliosus* Raf.	leafy pondweed	potfo

FREQUENCY OF OCCURRENCE AND DENSITY OF AQUATIC PLANTS

Aquatic macrophytes occurred at only 8% of the study sites in the Chippewa River. Much of this vegetation was emergent species. The County H segment supported vegetation at 36% of the sites; the Durand segment supported emergent vegetation at 4% of the sites; the other segments did not support vegetation at any of the sites.

Submerged macrophytes occurred at only 1% of the study sites, 7% of the sites at the County H segment.

Phalaris arundinacea was the most frequently occurring species (6%) (Figure 2, 3) and the species with the highest mean density (0.11, scale of 0-5) (Figure 4, 5), both overall and at the County H site.

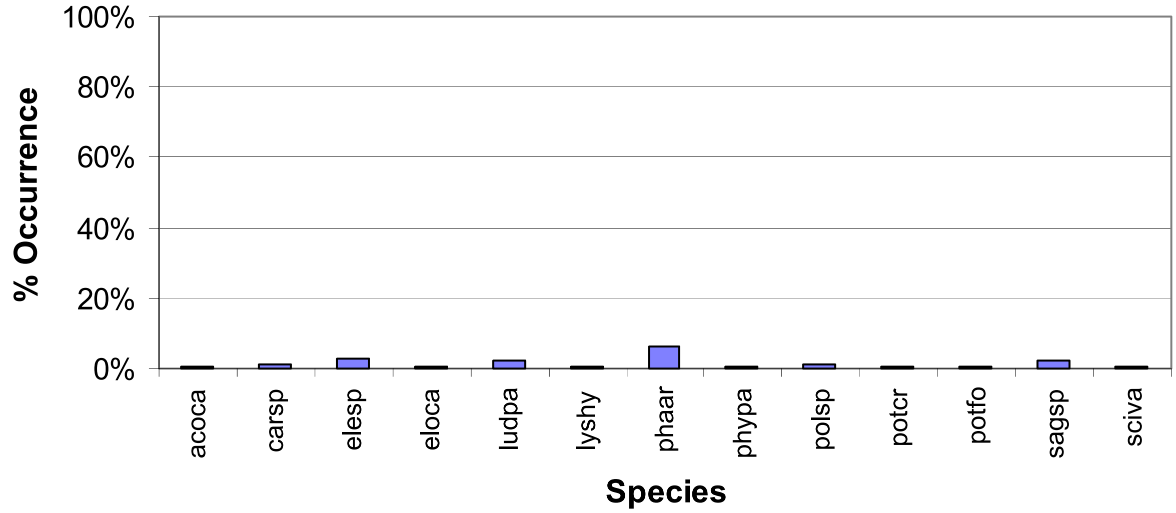

Figure 2. Aquatic plant frequencies in the Chippewa River

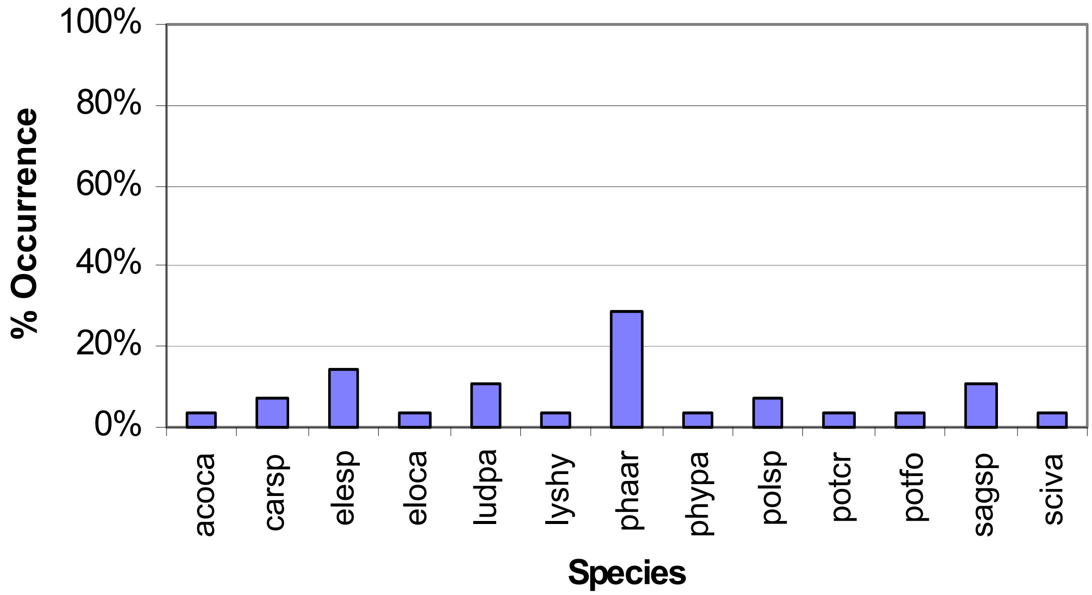

Figure 3. Frequencies of aquatic plants in the County H segment

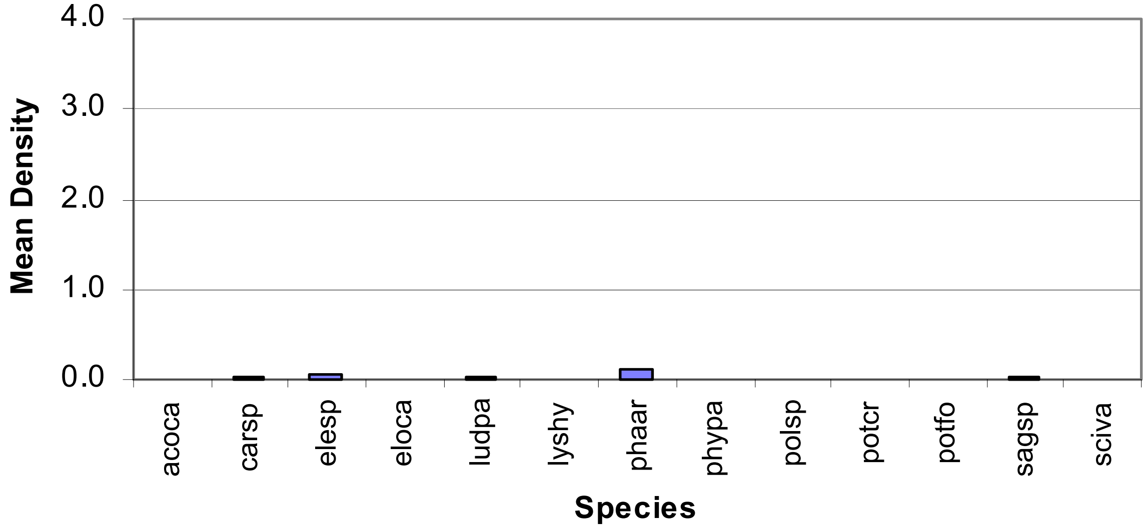

Figure 4. Densities of aquatic plants in the Chippewa River

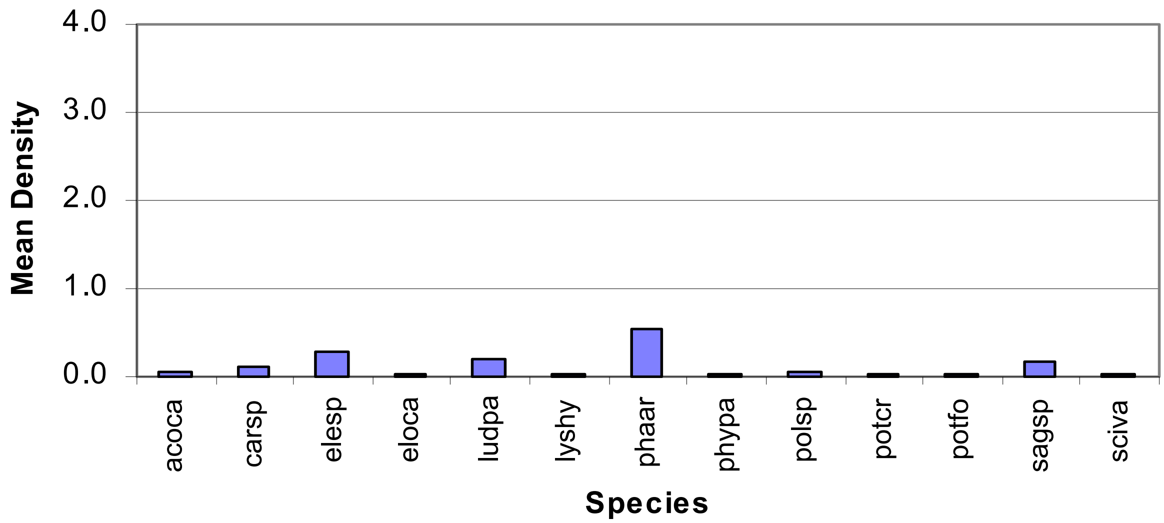

Figure 5. Densities of aquatic plants in the County H Segment of the Chippewa River

All species were found at below average densities.

Filamentous algae was not recorded at any of the sample sites.

DISTRIBUTION

Aquatic macrophytes occurred only in scattered locations in the Chippewa River. Rooted plant growth was found at a maximum depth of 1.5ft (*Phalaris arundinacea*). Emergent vegetation occurred at scattered sites in the Durand segment; emergent and submergent vegetation occurred along the shallow water edges at the County H segment.

The mean number of species found at each sampling sites was 0.19 species:
0.54 species per site in the 0-1.5 ft. depth zone
0.019 species per site in 1.5-5 ft. depth zone.

131 sites had 0 species
3 sites had 1 species
5 sites had 2 species
1 sites had 4 species
1 sites had 5 species
1 sites had 8 species

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 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). Silt occurred only at two of the segments and only mixed with sand. Sand/silt sediments supported the highest percentage of vegetation, but occurred at only 4 percent of sites. Sand/gravel sediments were commonly vegetated, but occurred infrequently at the Chippewa River study sites (Table 6). Sand/gravel sediment was only common at the County H and Dunville sites.

Bedrock was the predominant sediment found in the Chippewa River and would exclude macrophyte growth due to the inability of roots to penetrate the rock for plants. In Chippewa River, no rooted vegetation occurred at the sites with bedrock (Table 6).

Table 6. Sediment Influence

Sediment Type		**Occurrence**	**Percent Vegetated**
Hard Sediments	Bedrock	37%	0%
	Sand	26%	0%
	Sand/Gravel	19%	22%
	Sand/Rock	8%	0%
	Gravel	5%	0%
Mixed Sediments	Sand/Silt	4%	50%

THE COMMUNITY

Simpson's Diversity Index was 0.86 for the entire Chippewa River study sites and 0.87 for the County H segment only. This indicates a good diversity. A rating of 1.0 would mean that each plant recorded would be a different species (the most diversity achievable).

The diversity of the aquatic plant community is within the emergent community. Considering only sumbergent species, the diversity of the submerged aquatic plant community at the County H site and overall sites in the Chippewa River is poor (0.67).

V. DISCUSSION

Aquatic plant growth was sparse in the lower Chippewa River, occurring only 8% of the sites and at below average densities where it did occur. The mean number of species per sample site was 0.2. Aquatic vegetation grew to a maximum rooting depth of only 1.5 ft. The greatest amount of vegetation was found at the County H site at which vegetation occurred at 36% of the sites.

The greatest amount of plant growth was also in the emergent plant community. Submergent vegetation was found at only 1% of the sites in the Chippewa River and at 7% of the sites at the County H site.

Changes in water levels and water velocity in the Chippewa River and the dominance of high-density sediments at the sample sites may limit plant growth.

1) Changes in water levels can stress aquatic plants.
    a) When water levels rise, emergent and floating-leaf vegetation are inundated with more water than they are adapted to withstand. Submerged vegetation in the deeper water may not get sufficient light for survival if the water becomes too deep for light penetration.
    b) When water levels drop, aquatic vegetation can be left exposed and desiccated if the water levels do not return to normal in a short period of time
2) Water velocity can limit plant growth. Borman and Schreiber (1992) found that study sites in the Red Cedar River above Tainter Lake with water velocities greater than 0.54m/sec (1.78 ft/sec) did not support plant growth.
    a) High water velocities can result in removal of plants and tearing injury to the plant tissue.
    b) Water velocities can produce enough force to cause shifting of sand substrates, thus making the sediments unstable for rooted plant growth.
3) The abundance of high-density sand, rock and gravel sediments can limit plant growth.
    a) The availability of nutrients is low in these high-density sediments.
    b) Sand sediments may shift with high water velocities, providing unstable substrate for rooting (Madsen and Adams 1989).
    c) Bedrock would exclude rooted plant growth due to the inability of roots to penetrate the rock.

The operation of hydroelectric dams cam impact water velocities and water levels. The hydroelectric facilities upstream of the would likely result in large changes in both water velocity and water levels in the lower Chippewa River.

The County H segment study segment supported the highest frequency and density of aquatic plants and was the only study segment that supported submergent plant growth. This segment had the lowest mean coverage of disturbed shoreline.

Phalaris arunundinacea was the dominant macrophyte species in the Chippewa River, but occurred at a very low frequency and density (6% of the sample sites and mean density of 0.11). All of the species found during the Chippewa survey are tolerant of poor water clarity (Nichols and Vennie 1991).

Simpson's Diversity Index (0.86) indicates that the macrophyte community in the Chippewa River had a good diversity. However, most of the diversity was in the emergent plant community and the diversity in the submergent plant community was poor. Fourteen species were found during the survey and only 3 species were submergent species.

The river corridor of the Lower Chippewa River is protected by a high coverage of natural shoreline (wooded, shrub and native herbaceous growth). Natural shoreline was found at 98% of the transects with a mean coverage of 77%.

VI. CONCLUSIONS

The aquatic plant community in the lower Chippewa River is characterized by good diversity, scattered occurrence of plant beds at below average densities and a tolerance to poor water clarity. Aquatic plant growth occurred only in two study segments and submergent plant growth occurred at only one study segment. The macrophyte community is restricted to depths less than 1.5ft.

Phalaris arundincaea was the dominant species within the lower Chippewa River plant community, although even as the dominant species, it occurred at a low frequency and density.

The County H study segment supported the greatest amount of aquatic plant growth. However, the occurrence of aquatic plants was only 36% and the occurrence of submergent vegetation was only 7% at this site. This segment had the lowest mean coverage of disturbed shoreline.

Several factors that may be limiting plant growth.

1) Changes water levels.
2) High water velocities.
3) The predominance of high-density sediments at the study sites.

A healthy aquatic plant community plays a vital role within a natural community. This is due to the benefits plants provide: 1) improving water quality 2) providing valuable resources for fish and wildlife 3) resisting invasions of non-native species and 4) checking excessive growth of tolerant species that could crowd out the more sensitive species and reduce diversity.

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

2) Aquatic plant communities provide important fishery and wildlife resources. Plants (including algae) start the food chain that supports many levels of wildlife, and at the same time produce oxygen needed by animals. Plants are used as food, cover and nesting/spawning sites by a variety of wildlife and fish (Table 8).

Compared to non-vegetated sites, macrophyte beds support larger, more diverse invertebrate populations that in turn will support larger and more diverse fish and wildlife populations (Engel

1985). Additionally, mixed stands of macrophytes support 3-8 times as many invertebrates and fish as monocultural stands (Engel 1990). Diversity in the plant community creates more microhabitats for the preferences of more species. Macrophyte beds of moderate density support adequate numbers of small fish without restricting the movement of predatory fish (Engel 1990).

Recommendations

1) Conduct a follow-up study to determine if changes in the hydropower operations upstream, required under the new license, favorably impact the aquatic plant community.
2) Cooperate with programs to reduce nutrient run-off in the Chippewa River watershed.
3) Protect any aquatic plant communities that may occur in backwaters in other segments not surveyed during the 2001 study.
4) Preserve the natural buffer zones of native vegetation along the shore. Restore shoreline vegetation in areas that are disturbed.

The Chippewa River is a unique resource. Protecting the aquatic plant community will protect water quality and the fish and wildlife resources.