The Aquatic Plant Communities of the Eau Claire River Impoundments, Lake Altoona and Lake Eau Claire (MWBC 2128100)

2003

<u>Eau Claire County, Wisconsin</u>

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EXECUTIVE SUMMARY

Lake Altoona and Lake Eau Claire are physically very similar. Although both lakes are impoundments on the same river in the same county, are the same in shape, size and maximum depth, and similar in the slope of littoral zone and sediment composition, they are very different in at least one biological characteristic - the aquatic plant communities. The aquatic plant communities are significantly different as measured by the Coefficient of Community Similarity.

Measured differences between the two lakes are:

1) The quality of the aquatic plant community Lake Altoona is of lower quality than the plant community in Lake Eau Claire as measured by the Aquatic Plant Community Index (AMCI).
2) The Floristic Quality Index indicates that the plant community in Lake Altoona has been subjected to more disturbance than the plant community in Lake Eau Claire. Lake Altoona is among the group of lakes in the state and region whose plant community is farthest from an undisturbed condition and most tolerant of disturbance, while Lake Eau Claire's plant community is closer to an undisturbed condition than the average lake.

The biggest disturbance factor that impacts Lake Altoona and not Lake Eau Claire is the winter drawdown. Lake Altoona is impacted by a winter drawdown each year and Lake Eau Claire does not have winter drawdowns. Many of the differences in the aquatic plant communities in Lake Altoona and Lake Eau Claire can be attributed to winter drawdown.

1) **Reduced plant biomass on Lake Altoona** Maps of vegetation beds prepared during the survey show that Lake Eau Claire supported much more plant biomass.
2) **Fewer species and lower species diversity on Lake Altoona** Four of the species that Lake Eau Claire supports and Lake Altoona does not are known to decrease or disappear with winter drawdowns.
3) **Less rooted vegetation, yet more non-rooted free-floating vegetation in Lake Altoona** Because rooted plant species can not move with changes in water levels, sensitive species within the drawdown zone will be impacted. Free-floating species can move with changes in the water level and therefore are favored by drawdowns.
4) **Lake Altoona does not support any rooted, floating-leaf vegetation** Lily pads (an important habitat component) are sensitive to freezing and do not occur in in Lake Altoona, but are found in Lake Eau Claire.
5) **Dominance of aquatic plants tolerant and sensitive to winter drawdown within each lake.** Lake Altoona is almost entirely composed of species either favored by winter drawdown, neutral to winter drawdown or of unknown status; more than 3/4 of the plant community in Lake Altoona is made up of species that increase with winter drawdown.
6) **Distribution of disturbance tolerant species with each lake.** The species most adapted to disturbance, an annual, is more dominant in Lake Eau Claire in the 0-1.5ft depth zone, the wave wash zone. In Lake Altoona this species is dominant in the 1.5-5ft depth zone, the zone that would be impacted most by a winter drawdown of up to 3.5 feet.

Impact to habitat
Impacts to the aquatic plant community impact the entire lake community. A plant community with a lower diversity of plant species will have a less diverse habitat, which will in turn support less diversity in the fish and wildlife community. Some aquatic plant species missing from Lake Altoona are sensitive to winter drawdown, but are considered premier habitat plants: white water lily and large-leaf pondweed.

A healthy aquatic plant community plays a vital role within the lake community. This is due to the benefits plants provide in

1) improving water quality
2) providing valuable resources for fish and wildlife
3) resisting invasions of non-native species
4) limiting excessive growth of tolerant species that could crowd out the more sensitive species, therefore reducing the diversity.

Management Recommendations
Protecting the habitat in the Eau Claire River Impoundments can have positive impacts on the habitat.

1) Preserving the natural buffer zones of native vegetation around the lake will be beneficial to the water quality and wildlife habitat. Shoreland restoration projects should be started on Lake Altoona and Lake Eau Claire to restore natural shoreline and provide habitat and wildlife corridors
2) Managing nutrient inputs from watershed sources by:
    a) reducing nutrient run-off from lawn and agricultural fertilizer applications
    b) reducing erosion in the watershed and around the lake
3) Eliminate winter drawdowns on Lake Altoona to improve the quality and habitat value of the aquatic plant community.

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I. INTRODUCTION

A study of the aquatic macrophytes (plants) in Lake Altoona was conducted during August of 1990 and 2003 and in Lake Eau Claire during August 2003 by Water staff in the West Central Region - Department of Natural Resources (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.

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).

In addition, plants can improve water quality, protect shorelines and lake bottoms, add to the aesthetic quality of the lake and impact recreation.

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 added data that it provides will be compared to past and future plant inventories to track any changes occurring in the lake.

Background: Lake Altoona is a 840-acre impoundment and Lake Eau Claire is a 860-acre impoundment, both on the Eau Claire River in Eau Claire County, Wisconsin. The maximum depth of both lakes is 25 feet.

II.METHODS

Field Methods

The study design was based primarily on the rake-sampling method developed by Jessen and Lound (1962) and repeated on both lakes. 22 transects, perpendicular to the shoreline, were randomly placed on each lake.

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

a rating of 1 indicates that a species was present on one rake sample;
a rating of 2 indicates that the species was present on two rake samples;
a rating of 3 indicates that the species was present on three rake samples;
a rating of 4 indicates that the species was present on all four rake samples;
a rating of 5 indicates that the species was abundantly present on all four rake samples.

The exact depth and sediment type at each sampling site was also recorded.

Visual inspection and periodic samples were taken between transect lines in order to record additional species. 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 in 2003. 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

Data from each survey were analyzed separately and compared. The percent frequency of each species was calculated (number of sampling sites at which it occurred / total number of sampling sites) (Appendices III, IV, V). Relative frequency was calculated (number of occurrences of a species / total occurrence of all species) (Appendices III, IV, V). The mean density was calculated for each species (sum of a species' density ratings / number of sampling sites) (Appendices VI, VII, VIII). Relative density was calculated (a species density / 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 that species occurred) (Appendices VI, VII, VIII). The relative frequency and relative density was summed to obtain a dominance value (Appendix IX, X, XI). Simpson's Diversity Index was calculated (Appendices III, IV, V).

The Average Coefficient of Conservatism and Floristic Quality Index (FQI) was calculated to measure the plant communities' closeness to an undisturbed condition (Nichols 1998). A Coefficient of Conservatism is an assigned value, 0-10, the probability that a species will occur in a relatively undisturbed habitat. The FQI is calculated from the coefficients.

The Aquatic Macrophyte Community Index (AMCI), developed by Weber et. al. (1995) to evaluate the quality of an aquatic plant community, was applied to both lakes. Values between 0 and 10 are given for each of six important measures of a plant community and summed.

III. RESULTS

PHYSICAL DATA

Many physical parameters are important determinants of the type of macrophyte community that will ultimately inhabit a lake. Lake morphology, sediment composition and shoreline use can impact the macrophyte community.

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).

Lake Altoona and Lake Eau Claire have maximum depths of 25 ft. and mean depths of 10 feet. Most of the basin in both lakes has a gradually sloped littoral zone with some steeply sloped shoreline in the west portion of the lakes. The gradual slope and shallow depths would favor plant growth.

SEDIMENT COMPOSITION - Sand, a hard (high-density) sediment was the dominant sediment in both Lake Altoona and Lake Eau Claire. Sand and rock mixtures were also commonly occurring in both impoundments, especially at the shallow depths (Table 1, 2).

In both lakes, silt was only common at the deeper depths, likely deeper than aquatic plants could grow due to light penetration (Table 1, 2).

Table 1. Lake Altoona 2003 Sediment Composition

		0-1.5 ft.	1.5-5 ft.	5-10 ft.	10-20 ft.	Overall
Hard Sediments	Sand	38%	77%	85%	67%	67%
	Sand/Rock	19%	9%	5%	8%	11%
	Rock	24%	9%			9%
Mixed Sediments	Sand/Silt	9%	4%	5%	17%	8%
Soft Sediments	Silt	5%		5%	8%	4%
	Muck	5%				1%

Table 2. Lake Eau Claire 2003 Sediment Composition

		0-1.5 ft.	1.5-5 ft.	5-10 ft.	10-20 ft.	Overall
Hard Sediments	Sand	32%	68%	67%	57%	56%
	Sand/Rock	64%	23%	10%		26%
	Rock					
Mixed Sediments	Sand/Silt	4%	9%	24	43%	18%
Soft Sediments	Silt					
	Muck					

SEDIMENT INFLUENCE - Many plants depend on the sediment in which they are rooted for their nutrients. The richness or 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). Low-density and high-density sediments can be limiting for plant aquatic growth. Highly organic muck sediments are low-density; sand, gravel and rock are high-density sediments.

Sand was the dominant sediment found in both lakes. All types of sediments had similar percentages of vegetation (Table 3). This suggests that the sediment is unlikely the limiting factor for plant growth in the Eau Claire impoundments.

Table 3. Influence of Sediment, 2003

		Altoona		Eau Claire	
		Percent of sites	Percent vegetated	Percent of sites	Percent vegetated
Hard Sediments	Sand	67%	40%	56%	41%
	Sand/Rock	11%	50%	26%	38%
	Rock	9%	43%		
Mixed Sediments	Sand/Silt	8%	50%	18%	36%
Soft Sediments	Silt	4%	67%		
	Muck	1%	100%		

SHORELINE LAND USE - Land use practices strongly impact the aquatic plant community and, therefore, the entire aquatic community. Practices on shore can directly impact the plant community through increased sedimentation from erosion, increased nutrients from fertilizer run-off and soil erosion and increased toxics from farmland, suburban and urban run-off.

Wooded cover was the most frequently encountered shoreline cover on Lake Altoona and wooded cover and bare sand were the most frequently encountered shoreline cover on lake Eau Claire (Table 4). Native herbaceous plants, shrubs, cultivated lawn and rip-rap also had high occurrence on both lakes.

Table 4. Occurrence of Shoreline Cover Types Around the Eau Claire Impoundments, 2003

	Cover Type	Altoona	Eau Claire
Natural Shoreline	Wooded	73%	59%
	Native Herbaceous	68%	68%
	Shrub	50%	54%
	Bare Sand	4%	60%
	Rock	4%	4%
Disturbed Shoreline	Cultivated Lawn	50%	27%
	Rip-rap	32%	22%
	Hard Structure	18%	14%
	Pavement	4%	
	Eroded soil	4%	

Some type of natural shoreline cover occurred at all transects on both impoundments. Some type of disturbed shoreline occurred at 59% of the sites on Lake Altoona 50% of the sites on Lake Eau Claire.

The shoreline cover with highest percent mean coverage on both impoundments was wooded cover (Table 5). Native herbaceous plant growth had a high mean coverage on the shore of both impoundments.

Table 5. Mean coverage of Shoreline Cover Types Around the Eau Claire Impoundments, 2003

	Cover Type	Altoona	Eau Claire
Natural Shoreline	Wooded	38%	37%
	Native Herbaceous	23%	22%
	Shrub	14%	17%
	Bare Sand	1%	10%
	Rock	1%	2%
Disturbed Shoreline	Cultivated Lawn	17%	7%
	Rip-rap	3%	3%
	Hard Structure	2%	2%
	Pavement	1%	
	Eroded soil	1%	

Natural shoreline covered 77% of the shoreline on Lake Altoona and 88% of the shoreline on Lake Eau Claire. Conversely, disturbed shoreline (cultivated lawn, rip-rap, hard structure, pavement and eroded soil) covered 24 % of the shoreline on Lake Altoona and 12% of the shoreline on Lake Eau Claire.

MACROPHYTE DATA
SPECIES PRESENT

A total of 14 species was found in Lake Altoona and 21 species were found in Lake Eau Claire (Table 6). Of the total number of species, Lake Altoona supported 5 emergent species, 2 floating-leaf species and 7 submergent species; Lake Eau Claire supported 6 emergent species, 3 floating-leaf species, and 12 submergent species (Table 6).

No endangered or threatened species were found in either lake. One non-native species was found in both lakes: *Potamogeton crispus*.

Table 6. Lake Altoona and Lake Eau Claire Aquatic Plant Species, 2003

Altoona	Eau Claire	Scientific Name	Common Name	I. D. Code
		Emergent Species		
X		1) *Acorus americanus* (Raf.) Raf.	Sweet flag	acoam
X		2) *Asclepias incarnata* L.	swamp milkweed	ascin
X		3) *Carex comosa* Boott.	brislty sedge	carco
	X	4) *Eleocharis palustris* L.	creeping spikerush	elepa
	X	5) *Eupatorium maculatum* L.	spotted Joe-Pye weed	eupma
	X	6) *Sagittaria latifolia* Willd.	common arrowhead	sagla
	X	7) *Scirpus validus* Vahl.	softstem bulrush	sciva
	X	8) *Sparganium americanum* Nutt.	bur-reed	spaam
X	X	9) *Typha latifolia* L.	common cattail	typla
X		10) *Typha x glauca*	hybrid cattail	typgl
		Floating-leaf Species		
X	X	11) *Lemna minor* L.	small duckweed	lemmi
	X	12) *Nymphaea odorata* Aiton.	white water lily	nymod
X	X	13) *Spirodela polyrhiza* (L.) Schleiden.	greater duckweed	spipo
		Submergent Species		
X	X	14) *Ceratophyllum demersum* L.	coontail	cerde
X	X	15) *Elodea canadensis* Michx.	common water-weed	eloca
X	X	16) *Najas flexilis* (Willd.) R. & S.	northern water-nymph	najfl
X	X	17) *Nitella* sp.	nitella	nitsp
	X	18) *Potamogeton amplifolius* Tuckerm.	large-leaf pondweed	potam
	X	19) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
	X	20) *Potamogeton epihydrus* Raf.	ribbon-leaf pondweed	potep
	X	21) *Potamogeton foliosus* Raf.	leafy pondweed	potfo
X	X	22) *Potamogeton pusillus* L.	slender pondweed	potpu
	X	23) *Potamogeton richardsonii* (Ar. Benn.) Rydb.	clasping-leaf pondweed	potri
	X	24) *Potamogeton zosteriformis* Fern.	flatstem pondweed	potzo
X	X	25) *Vallisneria americana* L.	water celery	valam

FREQUENCY OF OCCURRENCE

The species with the highest frequency of occurrence in Lake Altoona was *Elodea canadensis* (common waterweed, 36%) and in Lake Eau Claire was *Vallisneria americana* (wild celery 30%) (Figure 1, 2, 3). Between 1990 and 2003, *E. canadensis* increased in frequency in Lake Altoona (23% - 36%) (Figure 1, 2).

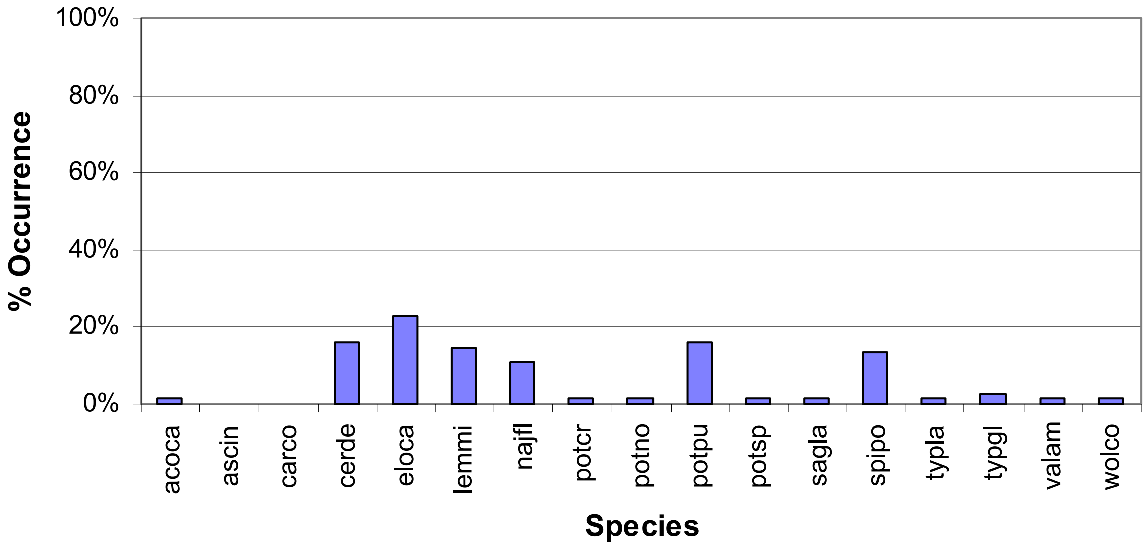


Figure 1. Frequency of macrophyte species in Lake Altoona, 1990.

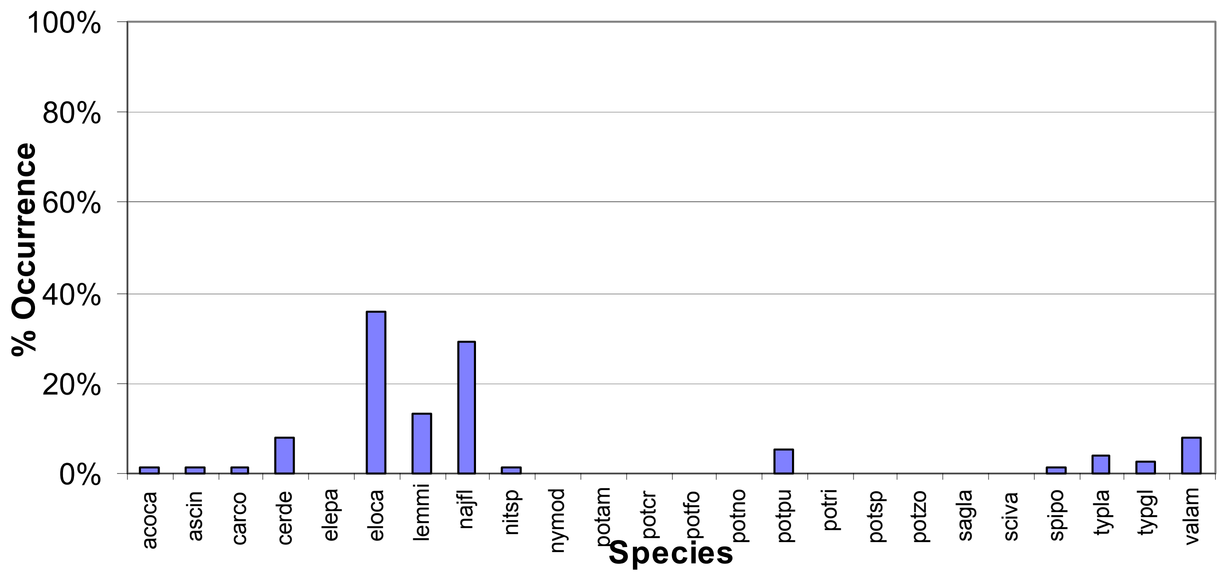


Figure 2. Frequency of macrophyte species in Lake Altoona, 2003.

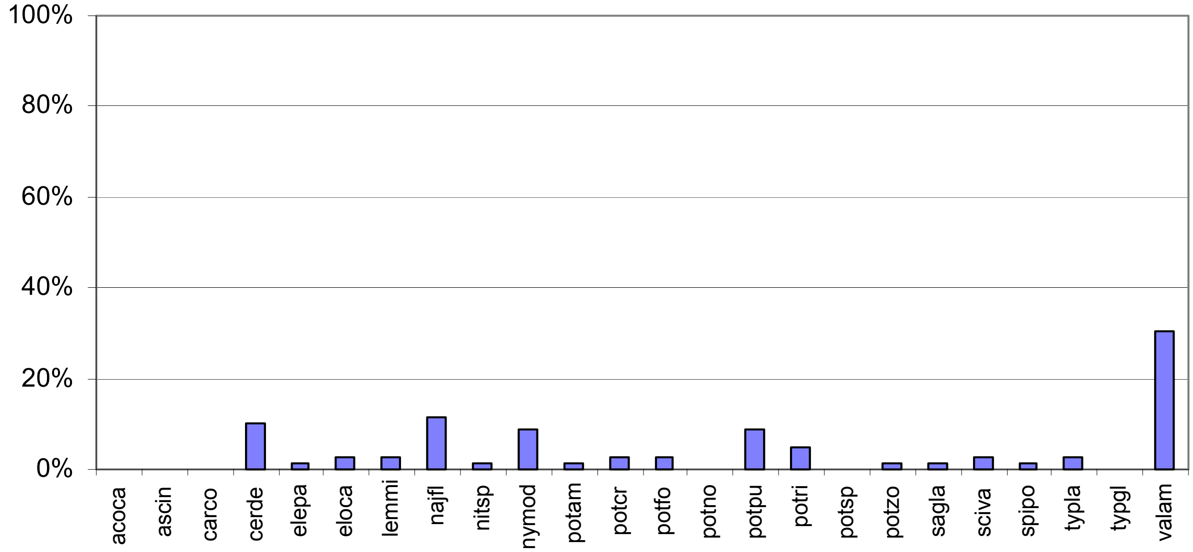


Figure 3. Frequency of macrophyte species in Lake Eau Claire, 2003.

The occurrence of filamentous algae at the sample sites was 83% in Lake Altoona and 77% in Lake Eau Claire.

DENSITY

Elodea canadensis and *Vallisneria americana* were also the species with the highest mean density (0.93 and 0.91 on a density scale of 1-4) in Lake Altoona and Lake Eau Claire, respectively (Figure 5, 6). The mean density of *Elodea canadensis* increased in Lake Altoona between 1990 and 2003 (0.71, 0.93) (Figure 4, 5).

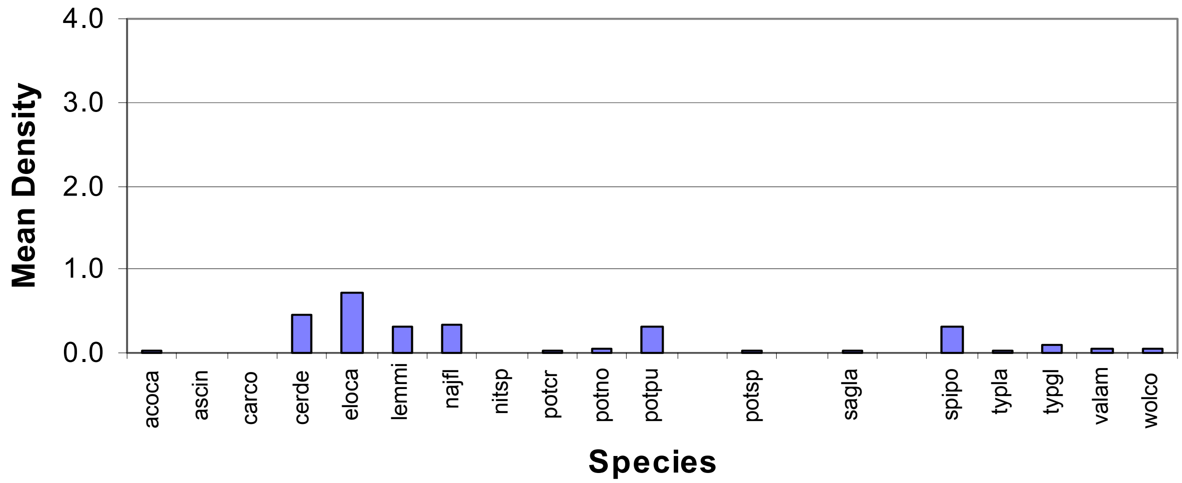


Figure 4. Mean density of macrophyte species in Lake Altoona, 1990.

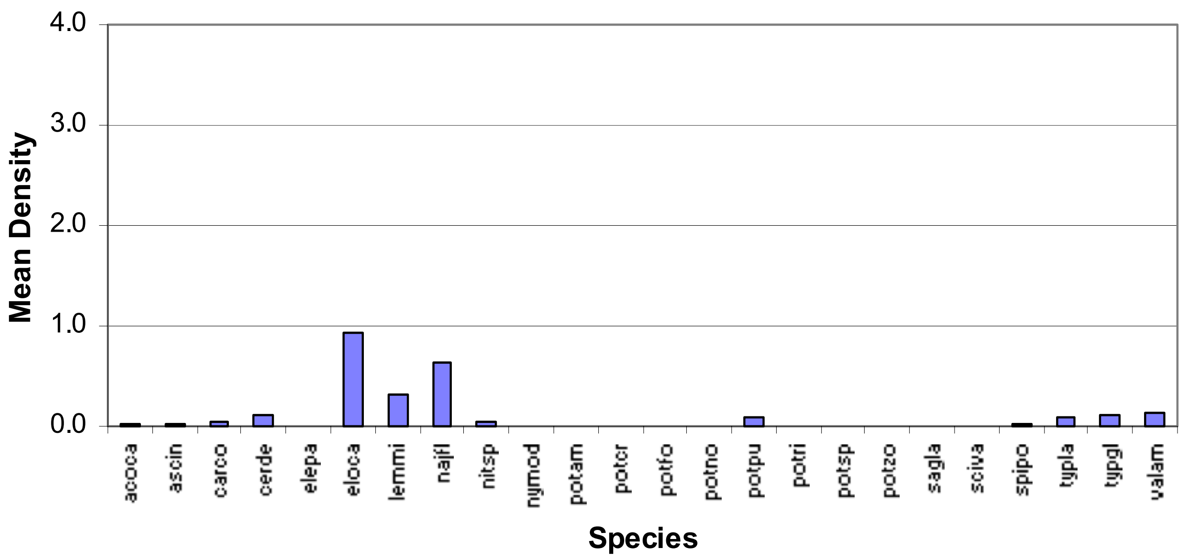


Figure 5. Mean density of macrophyte species in Lake Altoona, 2003.

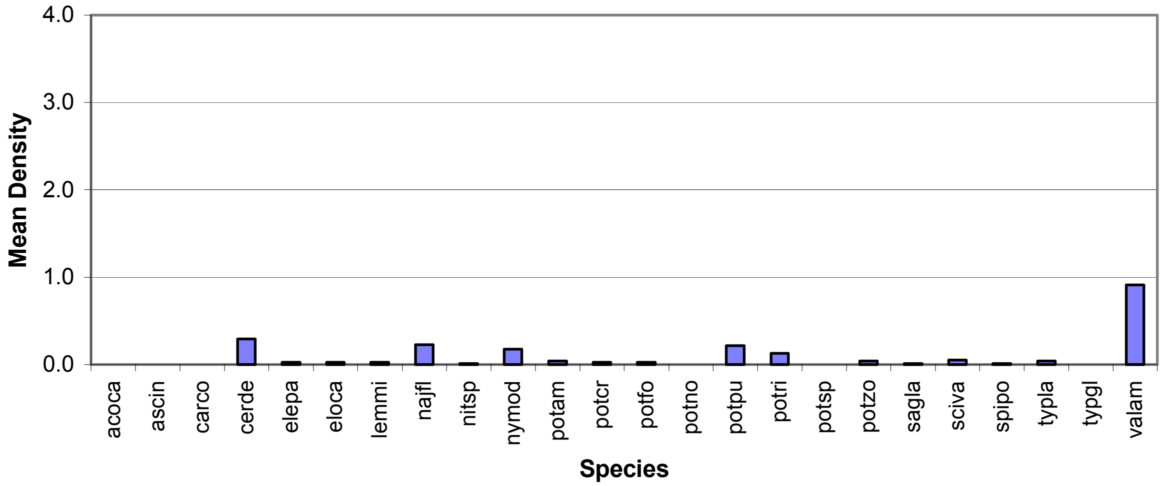
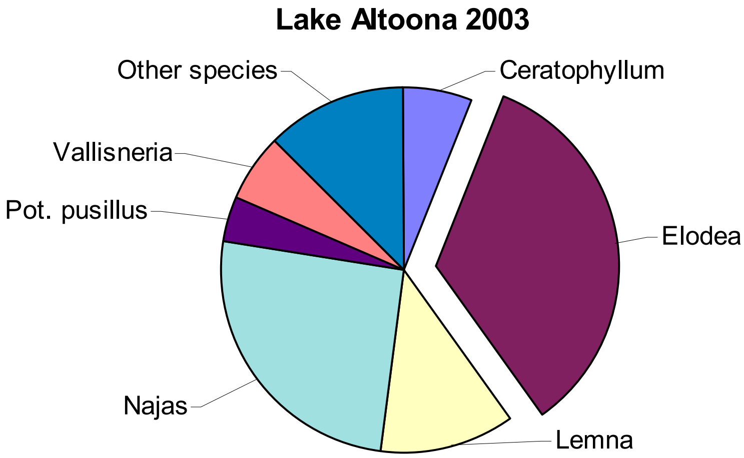


Figure 6. Mean density of macrophyte species in Lake Eau Claire, 2003.

Species with a high "mean density where present" are those species with a more aggregated or denser growth form. Although the mean density of the species throughout the lake may be low, at the sites in which they occur, they grow at high densities. Species with an above average "density where present" in Lake Altoona in 1990 were *Ceratophyllum demersum, Elodea canandensis, Najas flexilis, Typha x glauca, Vallisneria americana, Wolffia columbiana*; in 2003 were *Elodea canandensis, Nitella, Typha x glauca.* Species with an above average "density where present" in Lake Eau Claire in 2003 were *Ceratophyllum demersum, Potamogeton crispus, P. zosteriformis, Vallisneria americana*.

DOMINANCE

Combining relative frequency and relative density into a dominance value indicates the dominance of species within the macrophyte community (Appendix X-XI). Based on the dominance values, the dominant species in Lake Altoona was *Elodea canadensis* (common waterweed) with *Najas flexilis* (bushy pondweed) as the sub-dominant species within the macrophyte community (Figure 7). The dominant species in Lake Eau Claire was *Vallisneria americana* (wild celery) with *Ceratophyllum demersum* (coontail), *N. flexilis* and *Potamogeton pusillus* (small pondweed) as the subdominants. The dominance of *E. canadensis* and *N. flexilis* in Lake Altoona increased from 1990 to 2003.



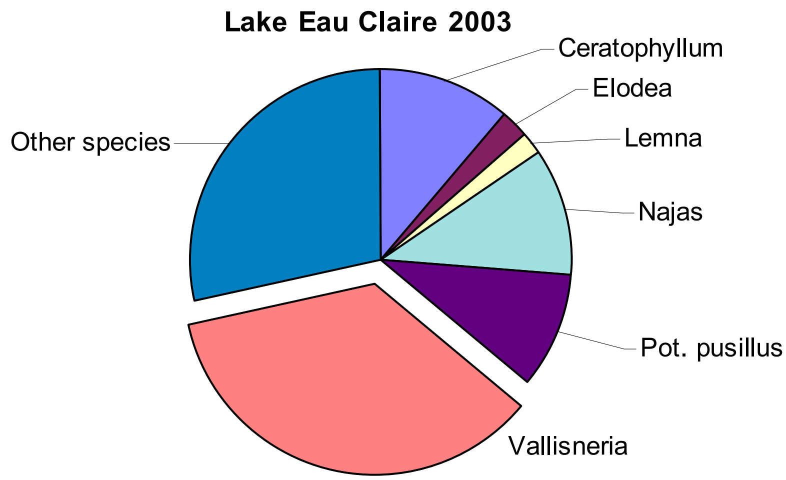


Figure 7. Dominance within the macrophyte community, of the most prevalent species in Lake Altoona and Lake Eau Claire, 2003.

The frequencies and densities of individual species varied with depth zone and year of study. *Elodea canadensis,* the dominant species in Lake Altoona, dominated all vegetated depth zones in Lake Altoona (Appendices III, IV, VI, VII) and was found throughout the east half of the lake and along the entire south shoreline up to depths of 7 feet.

Elodea canadensis (common waterweed) occurred at its highest frequency and density in Lake Altoona in the 1.5-5 ft depth zone (Figure 8). *E. canadensis* occurred at lower frequencies and densities in Lake Eau Claire in all depth zones. It was found in scattered locations in the east end up to depths of 2 feet.

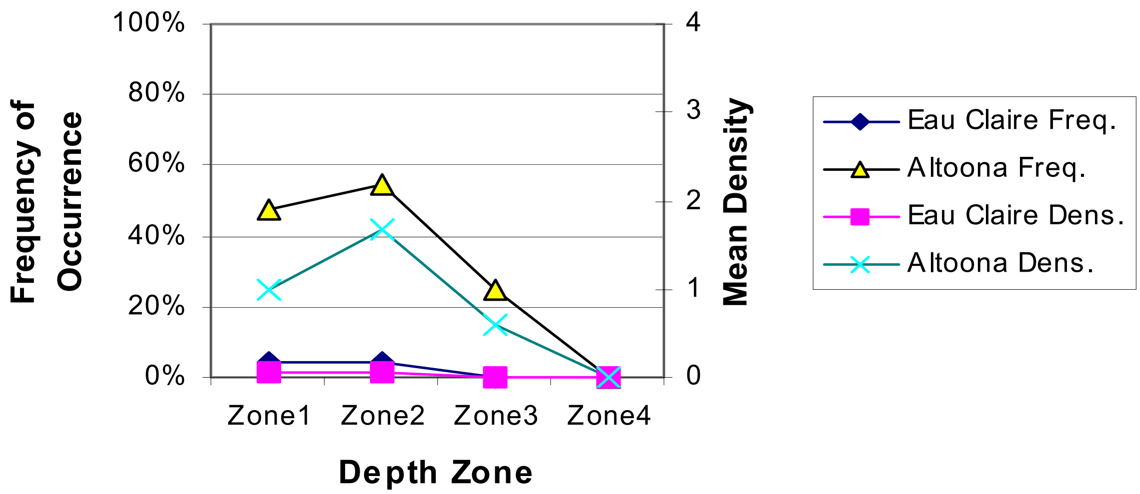


Figure 8. Frequency and density of *Elodea canandensis* by depth zone, 2003.

Vallisneria americana (wild celery) was the dominant species in Lake Eau Claire and dominated the 0-5 ft depth zone (Appendices V, VIII), along the entire north shore and scattered along the south shoreline up to depths of 5 feet. *V. americana* occurred at its highest frequency and density in the 1.5-5 ft depth zone of Lake Eau Claire, its frequency and density in Lake Altoona was much lower (Figure 9), occurring only scattered in the east end up to depths of 5.5 feet.

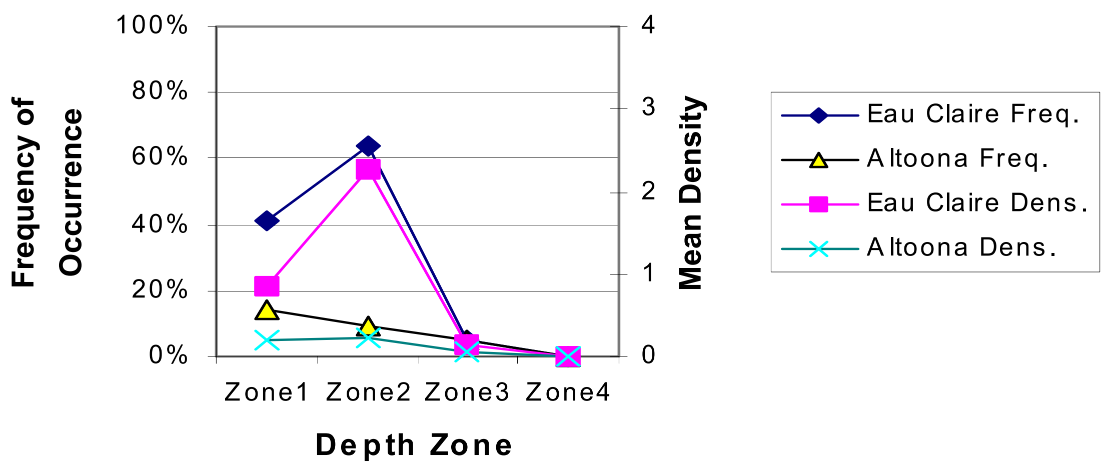


Figure 9. Frequency and density of *Vallisneria americana* by depth, 2003.

In Lake Altoona, *Ceratophyllum demersum* (coontail) was only found in the northeast bay up to depths of 6 feet and occurred at its highest frequency and density in the 0-1.5ft depth zone and decreased with increasing depth (Figure 10). *C. demersum* was the dominant species in the 5-10 ft depth zone of Lake Eau Claire, but occurred at its highest frequency and density in the 1.5-5ft depth zone (Figure 10). It occurred up to depths of 8 feet in the bays in the east end.

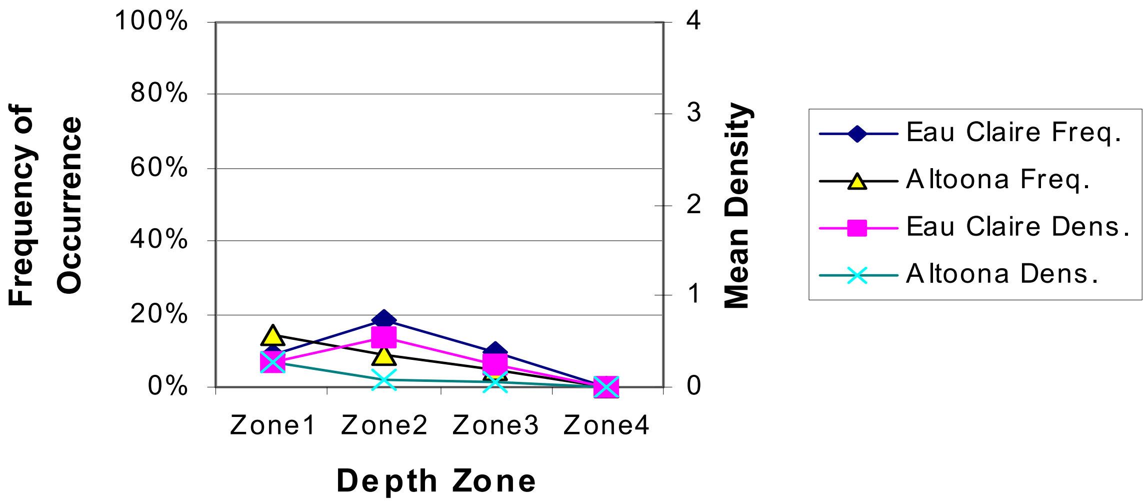


Figure 10. Frequency and density of *Ceratophyllum demersum* by depth zone, 2003.

The frequency of *Najas flexilis* (bushy pondweed) was high in the 1.5-5ft depth zone in Lake Altoona and occurred at its highest frequency and density in the 1.5-5ft depth zone. *Najas flexilis* was abundant in the east half of Lake Altoona and scattered in the west half up to depths of 6 feet. In Lake Eau Claire, *N flexilis* occurred scattered, up to depths of 2 feet. The frequency and density of *N flexilis* in Lake Eau Claire was highest in the 0-1.5 foot depth zone (Figure 11) and decreased with increasing depth.

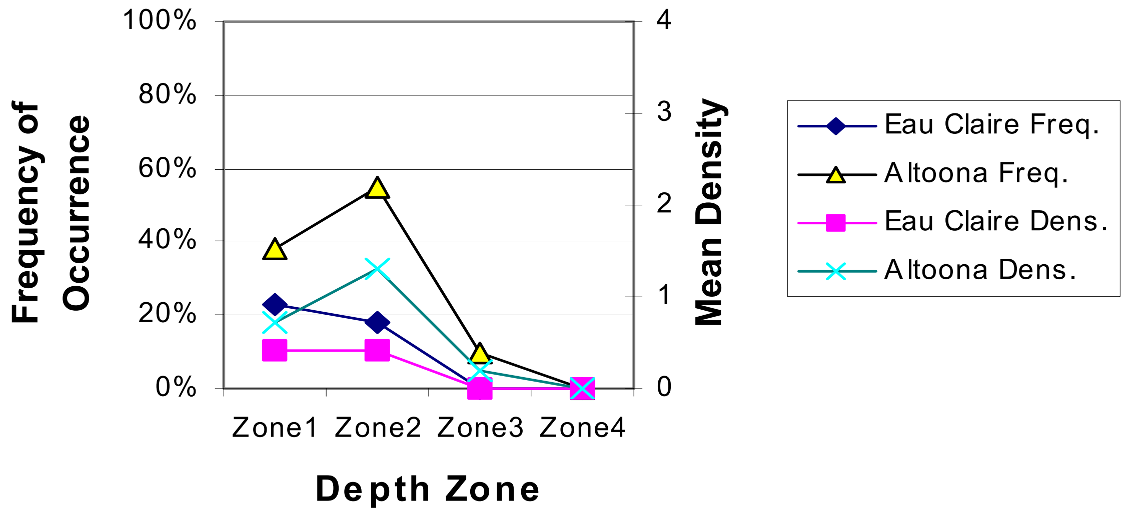


Figure 11. Frequency and density of *Najas flexilis* by depth zone, 2003

DISTRIBUTION

Aquatic vegetation occurred at 40-45% of the sample sites in 2003 in the Eau Claire River Impoundments. In 2003, rooted aquatic plant growth was found throughout Lake Altoona to a maximum depth of 7 feet, except in the two west bays and throughout Lake Eau Claire to a maximum depth of 8 feet, except along the southwest shore and in near the outlet ravine. *Elodea canadensis* occurred at the maximum rooting depth in Lake Altoona and *Potamogeton pusillus* occurred at the maximum rooting depth in Lake Eau Claire.

Vegetation maps prepared during the surveys indicate that Lake Eau Claire supports much more rooted vegetation in the upper end than does Lake Altoona (Appendices I, II).

The 1.5-5 ft depth zone had the highest percentage of vegetated sites in both Lake Altoona and Lake Eau Claire (Figure 12).

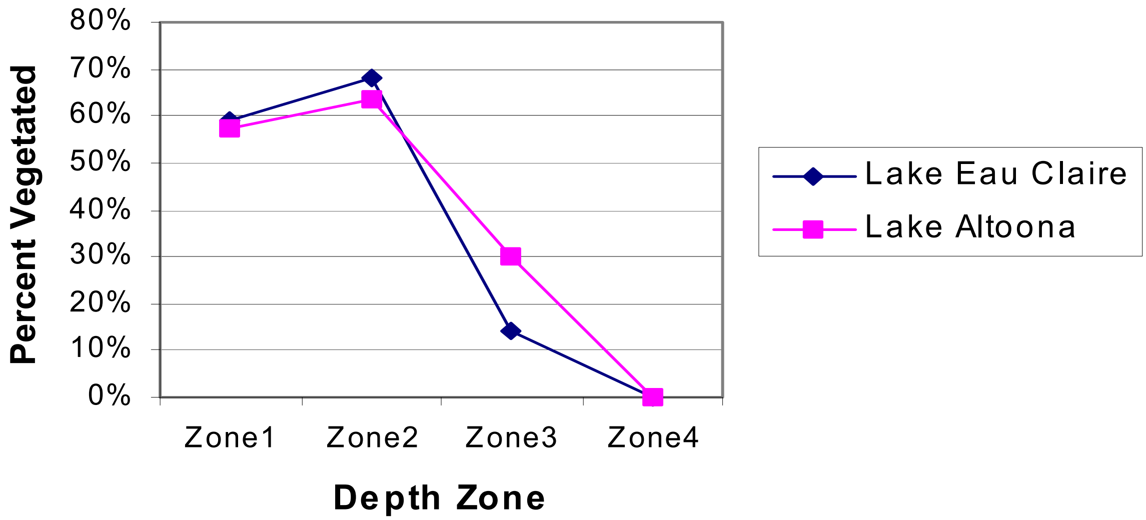


Figure 12. Percentage of vegetated sites by depth zone in Lake Altoona and Lake Eau Claire, 2003.

In Lake Altoona, the 0-1.5 ft. depth zone had the highest total occurrence of plants, highest total density of plants and greatest species richness (mean number of species per sample site) (Figure 13, 14). In Lake Eau Claire, the 1.5-5 ft. depth zone had the highest total occurrence of plants, highest total density of plants and greatest species richness (mean number of species per sample site) (Figure 13, 14).

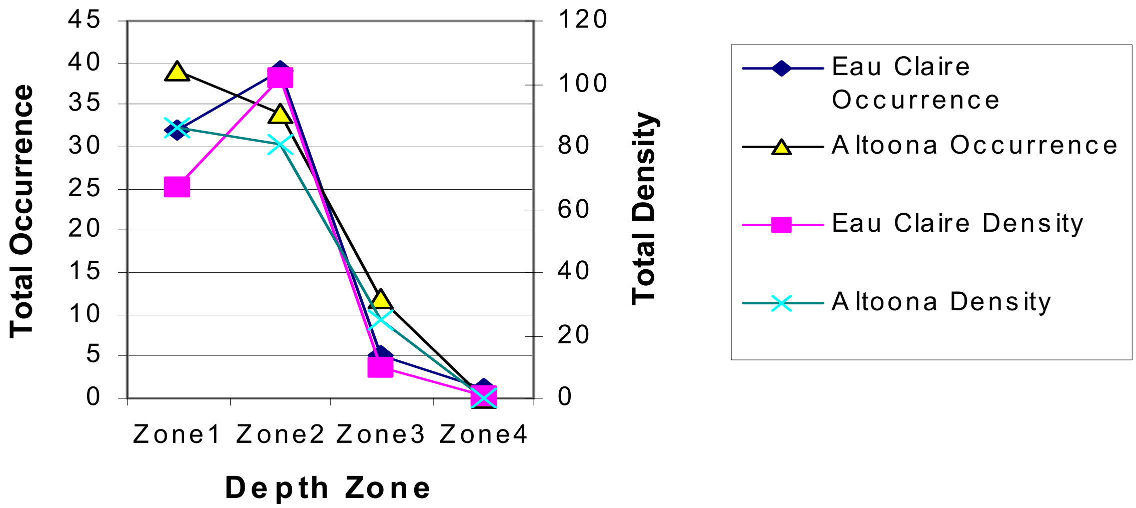


Figure 13. Total occurrence and total density of aquatic plants by depth zone

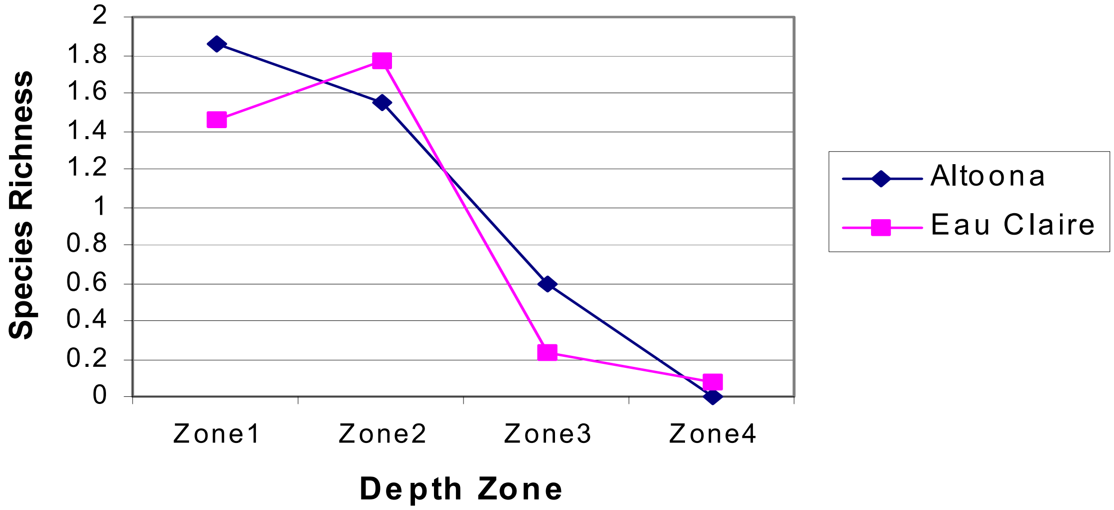


Figure 14. Species Richness (mean number of species per site), by depth zone.

THE AQUATIC PLANT COMMUNITY

The Coefficients of Community Similarity is a measure of the percent similarity between two communities. Coefficients less than 75% indicate that the two communities are only 75% similar and considered to be significantly different. The coefficient for Lake Altoona and Lake Eau Claire indicate that their 2003 aquatic plant communities were significantly different (Appendix XII). The two communities have a coefficient of 0.42, which indicates that they are only 42% similar.

Many indices can be used to compare the aquatic plant communities of different lakes. There are some differences in the plant communities of Lake Altoona and Lake Eau Claire (Table 7).

The number of species at the sampling sites is greater in Lake Eau Claire as is Simpson's Diversity. An index of 1.0 would mean that each species in the lake would be a different species (the most diversity achievable). Lake Altoona has a good species diversity and Lake Eau Claire has a very good species diversity.

The maximum rooting depth is slightly greater in Lake Eau Claire and the percentage of sites with rooted aquatic vegetation was greater. Lake Eau Claire supported floating-leaf vegetation and Lake Altoona did not have this form of plant structure. The percentage of sites with emergent vegetation, submergent vegetation and free-floating duckweed species was greater in Lake Altoona.

The Aquatic Macrophyte Community Index and Floristic Quality Index (which will be discussed later) is greater in Lake Eau Claire.

Table 7. Differences in the Macrophyte Communities of Lake Altoona and Lake Eau Claire, 2003.

	Lake Altoona	Lake Eau Claire
Number of Plant Species	14	21
Simpson's Diversity Index	0.80	0.85
Maximum rooting depth of plants	7 feet	8 feet
% Rooted Vegetation	41%	46%
% Sites with Emergents	7%	4%
% Sites with Submergents	41%	39%
% Sites with Floating-leaf	0	9%
% Sites with Free-floating	17%	14%
Aquatic Macrophyte Comm. Index	31	37
Floristic Quality Index	16.92	20.27

The Aquatic Macrophyte Community Index (AMCI), developed by Weber et. al. (1995), indicate that the quality of the plant communities in both impoundments were below average (40) for lakes in Wisconsin. The highest value for this index is 60. The quality of the plant community in Lake Eau Claire was higher, but still below average.

Table 8. Aquatic Macrophyte Community Index

Category	Lake Altoona	Lake Eau Claire
Maximum Rooting Depth	4	4
% Littoral Zone Vegetated	8	10
Simpson's Diversity	8	9
# of Species	3	5
% Submersed Species	8	8
% Sensitive Species	0	1
Totals	31	37

The Floristic Quality Index for the Lake Altoona plant community was in the lowest quartile of both the 554 Wisconsin lakes in the statewide study and the lakes in the North Central Hardwood Region (Table 9). The plant community of Lake Eau Claire was at the mean for lakes in the region and below the mean for Wisconsin lakes (Table 9).

Table 9. Floristic Quality of Lake Altoona and Lake Eau Claire, Compared to Wisconsin Lakes and Region Lakes.

	(I) Floristic Quality	(I) Based on Relative Frequency	(I) Based on Dominance Values
Wisconsin Lakes	16.9, 22.2, 27.5 †		
NCHF *	17.0, 20.9, 24.4 ‡		
Lake Altoona	16.64	15.99	15.64
Lake Eau Claire	20.27	22.32	22.65

***** - North Central Hardwood Forest Region (NCHF), the region in which Lake Altoona and Lake Eau Claire are located

† - Of 554 Wisconsin lakes, the lowest Floristic Quality was 3.0 (farthest from an undisturbed condition), the mean was 22.2, the upper quartile was 27.5 and the high was 44.6 (closest to an undisturbed condition)

‡ - regional Floristic Quality lower quartile was 17, the mean was 20.9 and the upper quartile was 24.4.

These values were based only on the presence or absence of disturbance tolerant and intolerant plant species and did not take into consideration their frequency or dominance in the community. The Floristic Quality was recalculated and the coefficient for each species was weighted by its 1) relative frequency and then 2) its dominance value.

The FQI based on relative frequency and dominance indicates that the quality of the Lake Altoona plant community was still in the lowest quartile of lakes in the state and region. The quality of the Lake Eau Claire plant community was above the mean of lakes in the state and region (Table 9). This suggests that the plant community in Lake Altoona is among those lakes in the state and region most tolerant of disturbance and farthest from an undisturbed condition. The Lake Eau Claire plant community is less tolerant of disturbance than the average lake in the state and region and closer to an undisturbed condition than in the average lake.

V. DISCUSSION

Lake Altoona and Lake Eau Claire have many similarities. Both lakes are impoundments on the Eau Claire River in Eau Claire County. Lake Altoona and Eau Claire both have a maximum depth of 25 feet and are very nearly the same size. Both lake basins are the same shape with some steeply-sloped littoral zone in the west end, but mostly a gradually-sloped littoral zone that would favor plant growth.

Sand is the dominant sediment in both Lake Altoona and Lake Eau Claire. Sand is a high-density sediment that can be nutrient-limiting for plant growth.

Both impoundments had a high coverage of wooded cover and herbaceous plant growth at the shoreline. There was more disturbed shoreline on Lake Altoona. Based on the transect data, disturbed shoreline covered 24% of the lakeshore on Lake Altoona and 12% of the shore on Lake Eau Claire.

There was a significant difference in the aquatic plant communities of Lake Altoona and Lake Eau Claire. The Coefficient of Community Similarity for Lake Altoona and Lake Eau Claire was 0.42 (scale 0-1) and coefficients less than 0.75 indicate a significant difference. This coefficient can be interpreted that the two plant communities are only 42% similar.

Similarities in the plant community were the percent of the littoral zone vegetated and the maximum depth of rooted vegetation. These similarities are likely due to similar sediment composition and water clarity.

There were many differences between the two plant communities:

1) Lake Eau Claire supported more species (21 species) than Lake Altoona (14 species).
2) Lake Eau Claire supported more species in all categories: emergent, floating-leaf and submergent.
3) Lake Eau Claire supported had a higher species diversity. Simpson's Diversity Index was 0.80 for Lake Altoona and 0.85 for Lake Eau Claire (maximum value 1.00).
4) Lake Eau Claire had a slightly greater number of sites with rooted vegetation (46%, 41%).
5) Lake Eau Claire supported floating-leaf vegetation (lily pads) and Lake Altoona did not support any of this important habitat structure.
6) Lake Altoona supported a slightly greater percent of sites with submergent vegetation, a greater percentage of sites with free-floating species and a greater percentage of sites with emergent vegetation.
7) The quality of the aquatic plant community as measured by the Aquatic Macrophyte Community Index (AMCI) was greater in Lake Eau Claire (37) than in Lake Altoona (31). The quality was higher in Lake Eau Claire due to the factors of 1) greater percentage of coverage of rooted vegetation, greater number of species and higher species diversity and more species sensitive to disturbance factors. The quality of

both aquatic plant communities were below average (40) for lakes in Wisconsin.

8) The Floristic Quality Index indicates that the plant community in Lake Altoona is more tolerant of disturbance and farther from an undisturbed condition than the plant community in Lake Eau Claire. Lake Altoona is among the group of lakes in the state and region whose plant community is farthest from an undisturbed condition and most tolerant of disturbance. The plant community in Lake Eau Claire is less tolerant of disturbance than the average lake in the state and region and closer to an undisturbed condition than the average lake.

The dominant species in both lakes were the most frequently occurring species with the highest mean density. *Elodea canadensis* (common waterweed) was dominant and *Najas flexilis* (bushy pondweed) was sub-dominant in Lake Altoona. *Vallisneria americana* (wild celery) was dominant in Lake Eau Claire. Three species were sub-dominant in Lake Eau Claire: *Ceratophyllum demersum* (coontail)*, Najas flexilis, Potamogeton pusillus* (small pondweed)*.* The dominant species in Lake Altoona occurred at a higher frequency and greater mean density than the dominant species in Lake Eau Claire. Because Lake Eau Claire had more sub-dominant species and the dominance of "other species" was higher, this points to greater diversity in the Lake Eau Claire plant community and less problems with a few species becoming over-abundant and dominating the entire habitat.

Najas flexilis is one of the few annual aquatic plant species; it must return each year from seed, unlike perennial species that are adapted to stable conditions, returning from their root systems each year. Because *N. flexilis* is an annual that relies on seed production, it is adapted to disturbance. The dominance of *Najas flexilis* is higher in Lake Altoona than in Lake Eau Claire, indicating that Lake Altoona is subjected to more disturbance.

The occurrence and mean coverage of natural shoreline (wooded, shrub and native herbaceous growth) on both Lake Altoona and Lake Eau Claire was high (77-88% of the shoreline. Disturbed shoreline did cover nearly one-quarter of the shoreline on Lake Altoona, with 17% of the disturbed shoreline in cultivated lawn. Preserving and expanding this buffer of natural vegetation along the shore will protect the water quality of the lake from erosion and nutrient/chemical run-off that could feed algae blooms and increase sedimentation. Cultivated lawn and eroded areas can result in increased run-off of fertilizers and other nutrients and increased sedimentation if there is not an adequate buffer zone.

VI. CONCLUSIONS

Lake Altoona and Lake Eau Claire are very similar in their physical characteristics: similar shape, size, maximum depth, slope of littoral zone, sediment composition and impoundments on the same river.

Because the physical characteristics are similar and at least one biological characteristic (the aquatic plant communities) is significantly different (Coefficient of Community Similarity 0.42), an explanation should be explored.

The Floristic Quality Index indicates that the plant community in Lake Altoona has been subjected to more disturbance than the plant community of Lake Eau Claire. Lake Altoona is among the group of lakes in the state and region whose plant community is farthest from an undisturbed condition and most tolerant of disturbance (Figure 15). The plant community in Lake Eau Claire is less tolerant of disturbance than the average lake in the state and region and closer to an undisturbed condition than the average lake (Figure 15).

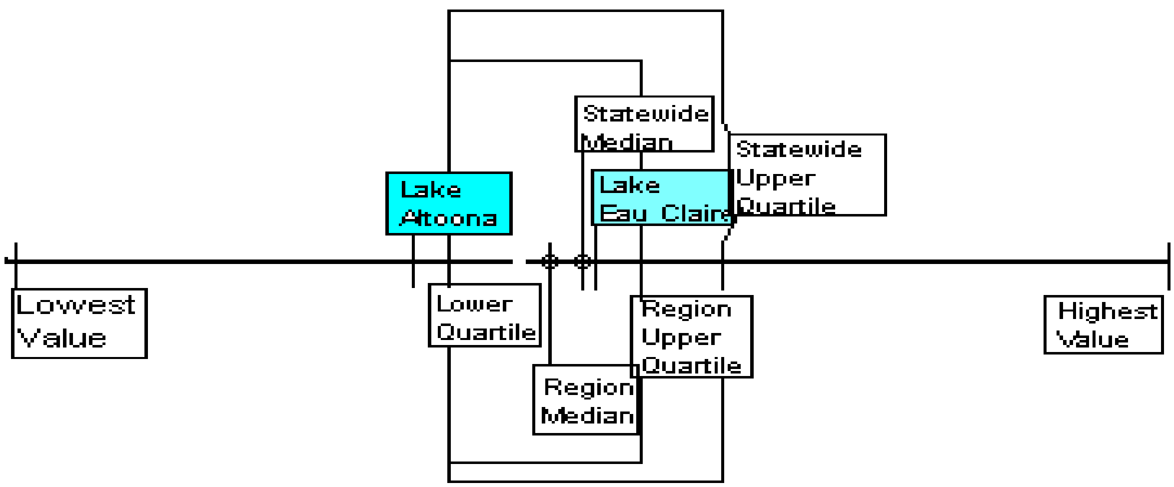


Figure 15. Location of Lake Altoona and Lake Eau Claire on the continuum of Floristic Quality Index (closeness to undisturbed condition) for Wisconsin Lakes.

The biggest disturbance factor that impacts Lake Altoona and not Lake Eau Claire is likely the winter drawdown. Lake Altoona is impacted by a winter drawdown each year and Lake Eau Claire does not have winter drawdowns. Winter drawdowns have been shown to cause a large reduction in biomass and a shift in aquatic plant species dominance with in a lake (Godshalk and Barko 1988). Many of the differences in the aquatic plant communities in Lake Altoona and Lake Eau Claire can be attributed to winter drawdown.

1) **Reduced plant biomass on Lake Altoona** Although the transect data for Lake Altoona and Lake Eau Claire did not appear to indicate that Lake Eau Claire supported

greater plant biomass, maps of vegetation beds prepared during the survey, show that Lake Eau Claire supported much more plant biomass (Appendices I, II).

2) **Fewer species and lower diversity on Lake Altoona** Lake Eau Claire supports more aquatic plant species and had a greater species diversity than Lake Altoona. Four of the species that Lake Eau Claire supports that Lake Altoona does not are known to decrease or disappear with winter drawdowns(Table 10). Four species that occur only in Lake Eau Claire, *Nymphaea odorata* (white lily pad), *Potamogeton* zosteriformis (flatstem pondweed) (Nichols 1974), *Potamogeton amplifolius* (large-leaf pondweed) (Beard 1973) and *Potamogeton crispus* (curly-leaf pondweed) (Crosson 1990) are known to be sensitive to winter drawdown. The drawdown sensitivity of three species in Lake Eau Claire have not been studied and these species may have been eliminated from Lake Altoona by drawdown.

Table 10. Lake Altoona and Lake Eau Claire Aquatic Plant Species, 2003

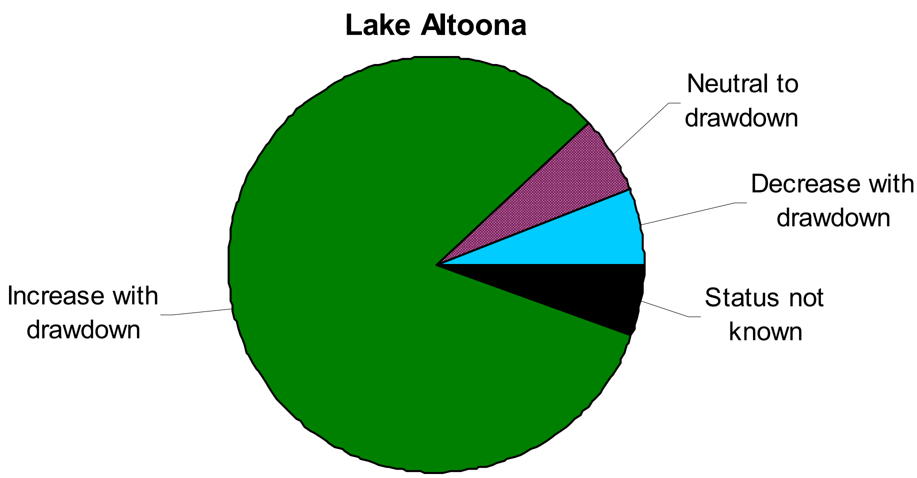
Altoona	Eau Claire	Scientific Name	Common Name	I. D. Code
		Species that Increase with winter drawdown		
X		1) *Acorus americanus* (Raf.) Raf.	Sweet flag	acoam
X		2) *Asclepias incarnata* L.	swamp milkweed	ascin
X		3) *Carex comosa* Boott.	brislty sedge	carco
	X	4) *Eleocharis palustris* L.	creeping spikerush	elepa
X	X	5) *Elodea canadensis* Michx.	common water-weed	eloca
	X	6) *Eupatorium maculatum* L.	spotted Joe-Pye weed	eupma
X	X	7) *Lemna minor* L.	small duckweed	lemmi
X	X	8) *Najas flexilis* (Willd.) R. & S.	northern water-nymph	najfl
	X	9) *Potamogeton foliosus* Raf.	leafy pondweed	potfo
	X	10) *Potamogeton richardsonii* (Ar. Benn.) Rydb.	clasping-leaf pondweed	potri
	X	11) *Sagittaria latifolia* Willd.	common arrowhead	sagla
	X	12) *Scirpus validus* Vahl.	softstem bulrush	sciva
	X	13) *Sparganium americanum* Nutt.	bur-reed	spaam
X	X	14) *Spirodela polyrhiza* (L.) Schleiden.	greater duckweed	spipo
X	X	15) *Typha latifolia* L.	common cattail	typla
X		16) *Typha x glauca*	hybrid cattail	typgl
		Species Neutral to winter drawdown		
X	X	17) *Vallisneria americana* L.	water celery	valam
		Species that decrease with winter drawdown		
X	X	18) *Ceratophyllum demersum* L.	coontail	cerde
	X	19) *Nymphaea odorata* Aiton.	white water lily	nymod
	X	20) *Potamogeton amplifolius* Tuckerm.	large-leaf pondweed	potam
	X	21) *Potamogeton crispus* L.	curly-leaf pondweed	potcr
	X	22) *Potamogeton zosteriformis* Fern.	flatstem pondweed	potzo
		Species of Unknown Status		
X	X	23) *Nitella* sp.	nitella	nitsp
	X	24) *Potamogeton epihydrus* Raf.	ribbon-leaf pondweed	potep
X	X	25) *Potamogeton pusillus* L.	slender pondweed	potpu

3) **Less rooted vegetation, yet more non-rooted free-floating vegetation in Lake Altoona** Lake Eau Claire has a slightly higher percentage of sites with rooted vegetation according to the transect data and noticeably more according to the vegetation maps. Because rooted plant species can not move with changes in water levels, sensitive species within the drawdown zone will be impacted. Conversely, Lake Altoona has a higher percentage of sites with free-floating species. These species can move with changes in the water level and therefore are favored by drawdowns.

4) **Lake Altoona does not support rooted, floating-leaf vegetation** Lake Eau Claire supported rooted, floating-leaf vegetation, (lily pads) which is an important component of habitat, but are sensitive to freezing during drawdown. Lake Altoona is lacking this important habitat component.

5) **Differences in the dominant species between Lake Altoona and Lake Eau Claire** The dominant species, common waterweed *(Elodea canadensis),* and sub-dominant species, bushy pondweed *(Najas flexilis),* in Lake Altoona are both species which are favored by winter drawdown (Nichols 1975). These two species dominate a greater portion of the plant community than the dominant species in Lake Eau Claire, resulting in an over-dominance a fewer species. The dominant species in Lake Eau Claire, wild celery *(Vallisneria americana),* is a species that is neither favored or negatively impacted by winter drawdown (Nichols 1975). The sub-dominant species in Lake Eau Claire are: one species negatively impacted by winter drawdown, coontail *(Ceratophyllum demersum)* (Beard 1973), one species favored by winter drawdown *(Najas flexilis)* (Nichols 1975) and one species whose drawdown tolerance is not known, small pondweed *(Potamogeton pusillus).*

6) **Dominance of aquatic plants tolerant and sensitive to winter drawdown within each lake.** Lake Altoona is almost entirely dominated by species either favored by winter drawdown, neutral to winter drawdown or of unknown status (Figure 16). In addition, over 3/4 of the plant community in Lake Altoona is dominated by species that increase with winter drawdown. The only species in Lake Altoona which is sensitive to drawdown is *Ceratophyllum demersum*; this is a free-floating species which can move with the drawdown, survive over winter in the deeper water and move into the shallower water during the next growing season. The aquatic plant species in Lake Eau Claire are more evenly divided between species favored by winter drawdown, neutral to winter drawdown and sensitive to winter drawdown (Figure 16).



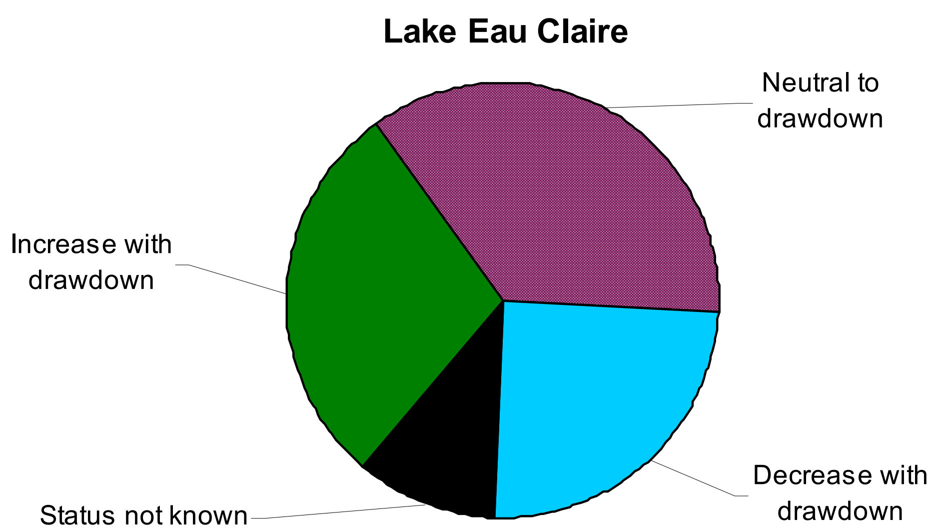


Figure 16. Tolerance of aquatic plant communities in Lake Altoona and Lake Eau Claire to winter drawdown, based on species dominance.

7) **Distribution of tolerant and sensitive species with each lake.** *Najas flexilis,* as an annual species, is the species most adapted to disturbances such as drawdowns. Looking at the depth zone in which *N. flexilis* is dominant in each lake provides a clue as to the possible disturbance. In Lake Eau Claire, in which *N. flexilis* is less dominant, its dominance is greatest in the 0-1.5ft depth zone. This is in the wave wash zone and indicates that wave action is the likely disturbance. In Lake Altoona, *N. flexilis* is dominant in the 1.5-5ft depth zone. This is the zone that would be impacted most by a winter drawdown of up to 3.5 feet (Figure 11).

Impact to habitat

Because of several of these factors, the quality of the aquatic plant community Lake Altoona is considered to be of lower quality than the plant community in Lake Eau Claire as measured by the Aquatic Plant Community Index (AMCI).

A plant community with a lower diversity of plant species will have a less diverse habitat, which will in turn support less diversity in the animal species. Some aquatic plant species missing from Lake Altoona are both sensitive to winter drawdown and considered premier habitat plants: *Nymphaea odorata* and *Potamogeton amplifolius.*

A healthy aquatic plant community plays a vital role within the lake community. This is due to the benefits plants provide in

5) improving water quality
6) providing valuable resources for fish and wildlife
7) resisting invasions of non-native species
8) checking excessive growth of tolerant species that could crowd out the more sensitive species, therefore reducing the diversity.

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

2) Aquatic plant communities provide important fishery and wildlife resources. Plants (including algae) start the food chain that supports many levels of wildlife, and at the same time produce oxygen needed by animals. Aquatic plants are used as food, cover and nesting/spawning sites by a variety of wildlife and fish (Table 11). Aquatic plants also provide indirect feeding opportunities by forming the substrate on which aquatic insects feed, find shelter and reproduce. Fish and wildlife feed upon this insect resource also.

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

Management Recommendations

Protecting the habitat in the Eau Claire River Impoundments can have positive impacts on the habitat.

4) Preserving the natural buffer zones of native vegetation around the lake will be beneficial to the water quality and wildlife habitat. Shoreland restoration projects should be started on Lake Altoona to put shoreline back into habitat and wildlife corridors
5) Managing nutrient inputs from watershed sources by:
    c) reducing nutrient run-off from lawn and agricultural fertilizer applications
    d) reducing erosion in the watershed and around the lake
6) Eliminate winter drawdowns on Lake Altoona to improve the quality and habitat value of the aquatic plant community.

Table 11. Wildlife Uses of Aquatic Plants in Lake Eau Claire and Lake Altoona

Aquatic Plants	Fish	Water Fowl	Shore Birds	Upland Birds	Muskrat
Found Only in Lake Eau Claire					
Eleocharis palustris	F, S, C	F(Tubers, Seeds), C	F(Seeds)	F (Seeds)	F
Nymphaea odorata	F,I, S, C	F(Seeds)	F		F
Potamogeton amplifolius	F, I, S*,C	F*(Seeds)			F*
Potamogeton crispus	F, C, S	F(Seeds, Tubers)			
Potamogeton epihydrus	F, I, S*,C	F*(All)			F*
Potamogeton foliosus	F, I, S*,C	F*(All)			F*
Potamogeton richardsonii	F, I, S*,C	F*(All)			F*
Potamogeton zosteriformis	F, I, S*,C	F*(Seeds)			F*
Sagittaria latifolia		F, C	F(Seeds), C	F	F
Scirpus validus	F, C, I	F (Seeds)*, C	F(Seeds, Tubers), C	F (Seeds)	F
Sparganium americanum		F (Seedf), C	F, C		F*

Aquatic Plants	Fish	Water Fowl	Shore Birds	Upland Birds	Muskrat
<u>Found in both lakes</u>					
Ceratophyllum demersum	F,I*, C, S	F(Seeds*), I, C			F
Elodea canadensis	C, F, I	F(Foliage) I			
Lemna minor	F	F*, I	F	F	F
Najas flexilis	F, C	F*(Seeds, Foliage)	F(Seeds)		
Nitella sp.		F, I*			
Potamogeton pusillus	F, I, S*,C	F*(All)			F*
Spirodela polyrhiza	F	F		F	
Typha latifolia	I, C, S	F(Entire), C	F(Seeds), C, Nest	Nest	F* (Entire), C*, Lodge
Vallisneria americana	F*, C, I, S	F*, I	F		F
<u>Found only in Lake Altoona</u>					
Acorus calamus		F, C			F, S
Asclepias incarnata				Fibers for nests	Roots
Carex comosa	S	F(Seeds), C	F(Seeds)	F(Seeds)	F
Typha x *glauca*	I	C	F(Seeds), C		F*

F=Food, I= Shelters Invertbrates, a valuble food source C=Cover, S=Spawning
***=Valuable Resource in this category**

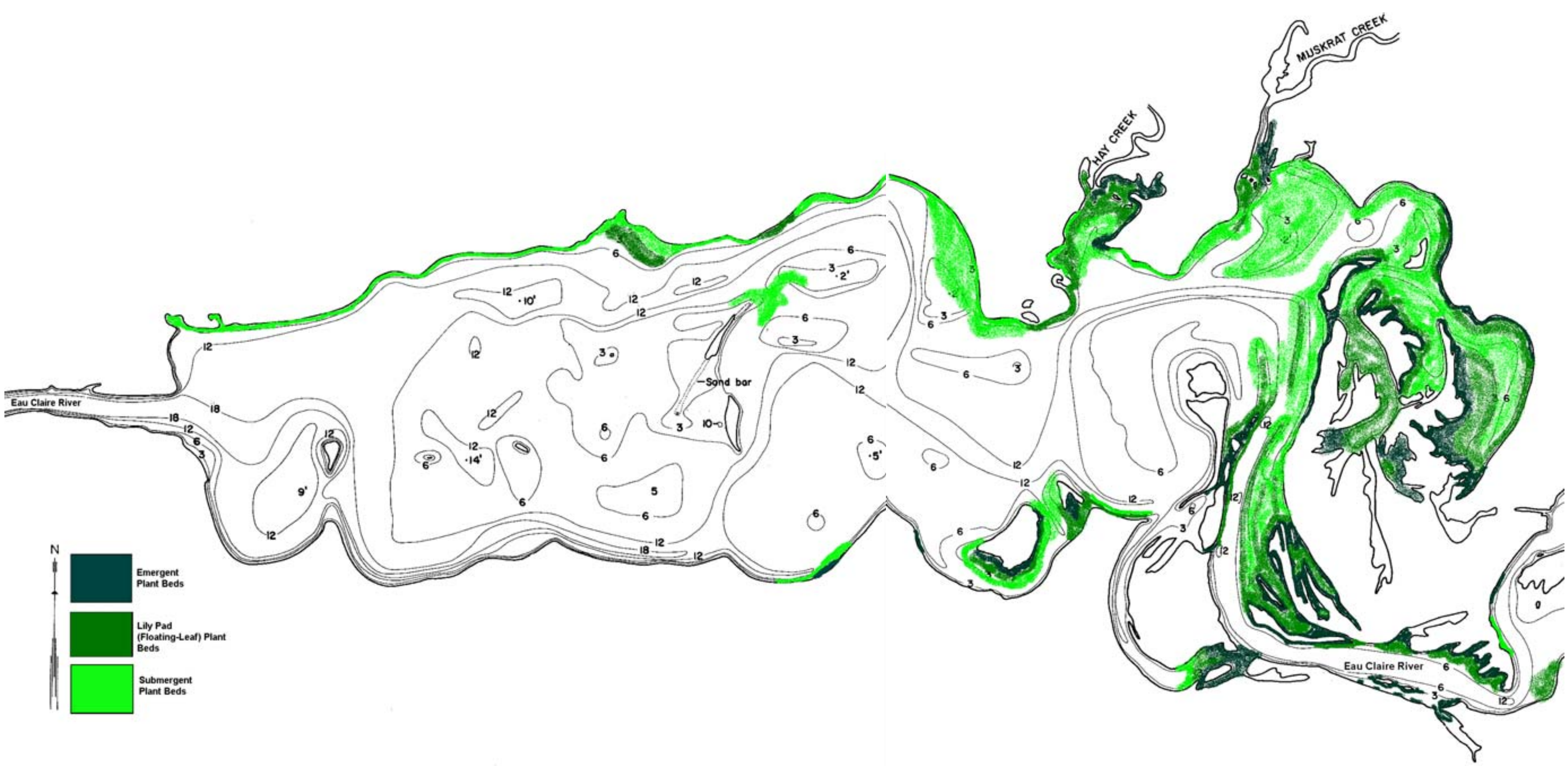
*Current knowledge as to plant use. Other plants may have uses that have not been determined.

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

Appendices

Appendix I. Coverage of Emergent and Submergent Vegetation on Lake Altoona


Eau Claire River
Sand bar
HAY CREEK
MUSKRAT CREEK
Eau Claire River
N
Emergent Plant Beds
Lily Pad (Floating-Leaf) Plant Beds
Submergent Plant Beds