METHODS

Site Description

Lake Wissota is located east of Chippewa Falls, Wisconsin (T 28-29 N, R 8-9 W). It is a 6,300-acre impoundment and has a maximum depth of 72 feet and approximately 56 miles of shoreline. Lake Wissota is generally considered to be a eutrophic lake. It has a characteristic reddish-brown color from humic and tannic acids originating from decomposing vegetation. It is subject to frequent algal blooms particularly in late summer. Much of the lake has a steeply sloping littoral zone and wave action plays a large role in the littoral zone composition (Borman, 1991).

Field Sampling

The surveys for this study were done using the rake sampling method described in Jesson and Lound (1962) and Deppe and Lathrop (1992). It is a stratified random design where evenly spaced transects are established around a water body and random quadrats at predetermined depths are located along each transect. Using long-handled steel-thatching rakes, four rake samples are taken, one in each quarter of the quadrat. The aquatic plant species present on each rake sample are recorded. Each species is given an occurrence rating (0-5) based on the number of rake samples on which it is present at each quadrat.

A rating of 1 indicates the species was present on 1 rake sample.
A rating of 2 indicates the species was present on 2 rake samples.
A rating of 3 indicates the species was present on 3 rake samples.
A rating of 4 indicates the species was present on 4 rake samples.
A rating of 5 indicates the species was abundantly present (covering more than half of the rake) on all 4 rake samples at the quadrat.

In 1989/90, 160 transects perpendicular to shore were established at 500 foot intervals around the lake. Shoreline interception points were marked on lake maps and Loran-C readings were taken. Three depth zones were sampled within each transect; Zone 1 (0-1.5 ft), Zone 2 (1.5–5 ft) and Zone 3 (5–10 ft). With this methodology 480

quadrats would have been established however, not all transects reached adequate depths so in practice only 477 quadrats were sampled.

In 2005 and 2009 the same transects were located. An additional depth zone (4) was established at 10-20 ft as vegetation was observed in deeper waters. Maximum depth constraints resulted in 610 quadrats sampled in 2005 and 609 in 2009. GPS coordinates were taken at each quadrat in 2005 and relocated in 2009. These points were translated into maps using Arcview GIS 9.2 (ESRI, Redlands, CA) and can be found in Appendix B. Digital photographs of the shoreline were taken in 2005 and 2009 to aid in transect location in future studies.

The actual depth of the quadrat, sediment type and distance from shore were recorded at each depth. An underwater camera (Aqua-Vu Explorer 5) was used to determine the maximum depth of plant growth at each transect.

The shoreline at each transect (50 ft on either side of the transect interception point and 30 ft back from the water line) was evaluated and the percentage of each cover type was estimated. The number of transects at which each type of cover occurred was also recorded. The major categories of cover type were wooded, herbaceous, shrub, cultivated lawn, hard structure, eroded and rip rap. Other types of cover that were infrequent included things like retaining walls, beach, corn fields etc. Wooded, herbaceous and shrub were considered natural and the remaining types of cover were considered disturbed.

During the 2009 survey, researchers surveyed along the shoreline of the entire lake at the five foot depth zone and noted the locations where plants occurred. Visual estimations of plant bed size were made for larger areas of plants and for areas where shallow water depths extended farther from the shore. These areas were transcribed to maps by noting the outside edges of each patch. The shoreline vegetation and plant beds were entered as polylines and polygons in Arcview GIS 9.2 (ESRI, Redlands, CA) and distances and areas were calculated from those data.

Secchi disc readings measure the maximum rooting depth based on water clarity (Secchi * 3) (Dunst, 1982). Secchi disc measurements were taken twice a week for the duration of each study. Four sites were sampled based on previous DNR GPS records: one site on Moon Bay, one site on Little Lake Wissota, one site on the northwestern side of the main basin near the inlet of the Chippewa River and one site on the southeastern side of the main basin. GPS coordinates were taken at each point and can be found on the maps in Appendix B.

Data Analysis

The data for each year were analyzed separately and compared. Data for 2005 and 2009 were analyzed using depth zones 1 – 3 as well as zones 1 – 4. This allowed for a total comparison as well as a more equal comparison to 1989/90 data where only three depth zones were sampled. The percent frequency (number of quadrats at which species occurred / total number of quadrats), relative frequency (number of quadrats at which

species occurred / sum of all species occurrences), mean density (sum of species' occurrence ratings / number of quadrats), relative density (sum of species' occurrence ratings / sum of all plant densities), and mean density where present (sum of species' occurrence ratings / number of quadrats at which the species occurred) were calculated for each species. The relative frequency and relative density were summed to obtain a dominance value for each species.

One test is insufficient to assess changes in the aquatic plant community. Therefore several metrics were used to asses each year's community and to compare communities.

Simpson's Diversity Index was used to measure and compare the diversity of the plant communities in each study. The formula for Simpson's Diversity Index is $1-\Sigma (n/N)^2$ where n = the frequency of occurrence of one species and N = the sum frequency of all species. The formula measures the probability that two individuals from the same community will be the same species. Values for Simpson's Diversity Index range from 0-1 where a value of 0 indicates two individuals will always be the same species and a value of 1 indicates two individuals will always be different species.

Sorenson's Coefficient of Community Similarity was used to compare similarity between communities. The formula for Sorenson's Coefficient of Community Similarity is $(2N)/(n_1*n_2)$ where N = the number of plants common to two communities, n_1 = the number of species in Community 1 and n_2 = the number of species in Community 2. Sorenson's Coefficient of Community Similarity values less than 0.75 are considered significantly different.

The Floristic Quality Index (FQI) was used to assess the communities' resemblance to undisturbed conditions. The formula for the FQI is $\hat{C} * \sqrt{N}$ where $\hat{C}$ = the average coefficient of conservatism and N is the number of species. Coefficients of conservatism are values assigned to plants based on their ties to a pre-settlement condition. Plants are given a value on a scale of 1 to 10 based on the probability that a species will occur in a disturbed habitat with higher values given to plants that are less likely to occur in a disturbed habitat (Nichols, 1999). The $\hat{C}$ value includes only native species that would normally be found in a lake environment. The state and regional average coefficients of conservatism in Wisconsin are 5.5-6.9 and 5.2-5.8 respectively. The average state and regional FQI are 16.9-27.5 and 17-24.4 respectively (Nichols, 1999).

The Aquatic Macrophyte Community Index (AMCI) was used to define the quality of the aquatic plant communities based on seven parameters: the maximum rooting depth, the percentage of the littoral zone vegetated, the relative frequencies of submersed species, sensitive species and exotic species, Simpson's Diversity Index and the total number of taxa. Each parameter was scaled from 1-10 with 10 representing the most desirable condition. The scaled values were then summed to obtain the AMCI (Nichols et al., 2000).