LAKE RIPLEY AQUATIC PLANT INVENTORY & MANAGEMENT PLAN

Lake Ripley Management District

INTERNATIONAL
Environmental Management Services Limited
"Integrating Development and Environment through Education and Planning"

AN AQUATIC PLANT INVENTORY AND MANAGEMENT PLAN FOR LAKE RIPLEY, JEFFERSON COUNTY, WISCONSIN

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ASSESSMENT OF AQUATIC PLANT COMMUNITY

- Statistically comparable, comprehensive surveys of Lake Ripley's aquatic plant community were conducted in 1989, 1991, 1996 and 2001. A comprehensive survey was also performed in 1976, but it was based upon significantly different transects and sampling methodology. The only other documented aquatic plant survey of Lake Ripley was performed in 1953, but it cannot be considered comprehensive since only six species were studied.

- Twenty-seven (27) species of aquatic plants were documented in Lake Ripley over the 25-year period of record (1976-2001). These included 19 submersed, four floating-leaf, and four emergent plant types. Aquatic plant growth was generally found throughout the lake to a depth of about 15 feet. This depth zone represents about 54% of the lake in terms of surface area.

- Fourteen (14) species of aquatic plants and eight plant communities were documented during the 2001 survey. Muskgrass (*Chara vulgaris*) and Eurasian water milfoil (*Myriophyllum spicatum*) were the dominant plant species, with spiny naiad (*Najas marina*), eel grass (*Vallisneria americana*), and Sago pondweed (*Potamogeton pectinatus*) also contributing significantly to the aquatic plant flora of the lake.

- The distribution of aquatic plants has become less uniform and increasingly patchy over the 25-year period of record. This shift, however, may be the result of variations in sampling technique, as the mean density of aquatic plants has remained relatively unchanged. Data since 1976 indicate that the aquatic plant flora of Lake Ripley has become somewhat more diverse and spatially balanced, suggesting a shift toward a healthier lake ecosystem. Muskgrass, Eurasian water milfoil, and spiny naiad remain the most commonly occurring species, but the importance values show that other species have increased in importance in recent years; specifically, eel grass, Sago pondweed, and bushy pondweed.

- While the precise reasons for changes in the plant community are unclear, they are most likely related to a combination of factors. These factors include the implementation of aquatic plant management practices; changes in land use that affect nutrient supply and availability; alterations in lake-use patterns and behavior; climatic factors; and natural biological processes contributing to inter-annual variability among plant communities.

- The dominance of eel grass (*Vallisneria americana*) and pondweeds (*Potamogeton* sp.) first documented in 1953 was largely replaced by the non-native Eurasian water milfoil (*Myriophyllum spicatum*) during the 1980s. This milfoil was abundant since as early as 1976, and continued to be present in quantities that approximate between one-fifth and one-third of the aquatic plant flora of the lake. Although its relative frequency of occurrence has decreased significantly, milfoil remains one of the more dominant and densely occurring species.

- The health and integrity of Lake Ripley's aquatic plant community is threatened by a number of factors, including polluted runoff, shoreline development, loss of riparian wetlands, disturbance of the lake bottom by motorized watercraft, and exotic species introductions. Degradation is evident in the form of declining plant diversity in which pollution- and disturbance-tolerant species tend to dominate, creating an oversimplified and unbalanced ecosystem. For instance, the non-native milfoil thrives under eutrophic (turbid and nutrient-rich) water quality conditions, has few natural predators to keep it in check, and is generally the first "weed" to colonize disturbed areas of the lake bottom.

- Milfoil boom and bust growth cycles are well documented in other lakes and characteristic of ecosystems dominated by only a few species. Extreme growth cycles of Eurasian water milfoil highlights the importance of maintaining bio-diversity for ecological stability. The non-native milfoil reached its peak density on Lake Ripley in the late 1980s, and was one of the motivating factors leading to the formation of the Lake Ripley Management District in 1991.

- The use of herbicides by individual property owners was the primary plant-control method on Lake Ripley prior to 1989. Herbicide applications were then discontinued and replaced by an organized mechanical harvesting program implemented by the Lake District. Mechanical harvesting continues to be employed on an annual basis to manage excessive weed growth.

MANAGEMENT GUIDANCE

- A diverse native plant community provides the foundation for a healthy and balanced lake ecosystem. Plants protect water quality, stabilize the bottom sediment, oxygenate the water through photosynthesis, provide shelter and spawning habitat for fish, act as refuges for zooplankton (algae consumers), serve as food sources for both fish and wildlife, and offer a variety of other benefits. These benefits should be recognized prior to implementing any type of management program.

- The Wisconsin Department of Natural Resources has designated Lake Ripley's south and southeast bays as ecologically significant 'sensitive' areas. These areas were found to support high quality plant communities, as well as rare and threatened aquatic species and habitats. Herbicide treatments, sand blankets, shoreline modifications, piers, swim rafts and motorized watercraft are now subject to additional regulation in these areas as a result of this designation.

- Non-native, or exotic, species like Eurasian water milfoil often develop into dense, expansive stands of monotypic (single-species) plant growth. The resulting problems can range from impaired navigation to fish stunting. These problematic species should be the focus of control efforts, while mixed communities and native plant beds should be protected for water quality and wildlife habitat purposes.

- Every attempt should be made to understand and address the root causes of excessive weed growth, rather than myopically attacking the symptoms of these larger problems. Some proven methods include: 1) reducing the use of herbicides and phosphorus-based fertilizers, 2) controlling soil erosion, 3) limiting vegetative clear-cutting, 4) restoring plant-denuded shorelines, 5) protecting wetlands, 6) minimizing bottom scouring by motorized watercraft, 6) preventing exotic species introductions, and 7) preserving ecologically significant 'sensitive' areas. The 2001 Lake Ripley Management Plan should be consulted for specific recommendations on addressing these issues.

- Mechanical harvesting is recommended as the primary weed-control measure for Lake Ripley, as long as it is used on a conservative and targeted basis. The specific habitat requirements and recreational needs of a particular location will dictate cutting intensity. Mechanical harvesting is recommended strictly for managing dense, monotypic stands of Eurasian water milfoil just prior to or following canopy formation at the water surface. Canopy removal eliminates the shading effect that prevents other rooted plant species from competing with the milfoil. It also helps to reduce the incidence of floating plant fragments caused by motor boat "prop chop." Priority control areas include popular boating lanes and weed-choked public access points. Past efforts have focused on isolated pockets of milfoil, especially near the inlet where pollutant loading appears to encourage weed growth. Harvesting can also be used to establish fish cruising lanes through dense weed beds. This technique creates additional edge habitat for gamefish, and eliminates the conditions that lead to fish stunting.

- Mechanical harvesting may be supplemented with other compatible strategies if warranted. For example, spot herbicide treatments and manual harvesting may be appropriate in certain areas and situations that preclude mechanical harvesting (e.g. less than 3-foot water depths or around piers and boatlifts). Each has its own advantages and disadvantages that should be carefully considered prior to implementation. Although a variety of other control methods are available, most were deemed unsuitable for Lake Ripley, or incompatible and counterproductive to an established weed-harvesting effort.

- Dividing the lake into recreational user zones through boating ordinances is recommended to better support multiple, mutually exclusive activities. Examples include boat-restricted swim areas, buoyed slow-no-wake protection zones within shallow water depths, and open water "wake" areas. Lake surface zoning can also help direct plant control techniques in a manner that would best serve these different lake uses. While some areas may require intensive management for recreational purposes, others may be best served if left protected from any type of disturbance. Management strategies will be most effective when implemented at specific times and in specific locations, depending on spatial and seasonal variations in plant growth, fish and wildlife behavior, recreational use of the water, and other factors.

- The public should be made fully aware of the goals and objectives of aquatic plant management, as well as program limitations. Continued public education is needed to dispel common misperceptions, and to garner support and cooperation in carrying out management programs. Being able to draw distinctions between plants versus "weeds," understanding the root causes of weed growth, and recognizing the objectives of control efforts are integral prerequisites to a successful program. Lakefront property owners should also be encouraged to properly manage nuisance weed growth that occurs around their own piers, boatlifts and swimming rafts, and to remove floating plant fragments that wash onto their shorelines.

- The aquatic plant inventory should be repeated at least every several years for monitoring purposes. The updated information could then be used to re-evaluate and adjust various management approaches recommended in the Aquatic Plant Management Plan.

CHAPTER 1: INTRODUCTION

BACKGROUND

Lake Ripley is located in Sections 7 and 8, of U.S. Public Land Survey Township 6 North, Range 13 East, in the Town of Oakland, Jefferson County, Wisconsin. The lake lies within the Lower Koshkonong Creek Watershed, which is a component of the Lower Rock River Basin. It is considered a valuable natural resource offering a variety of recreational and related opportunities to the resident community and its visitors.

Nevertheless, many perceive that excessive aquatic plant growth is adversely affecting the recreational and aesthetic values of the lake. The infestation and rapid proliferation of Eurasian water milfoil, a non-native and invasive aquatic plant species, was the initial driving force behind the establishment of the Lake Ripley Management District (LRMD) in 1991. Two years earlier, peak milfoil growth reduced useable surface area by roughly 40%, causing user conflicts and increasing the potential for boating hazards within the remaining 60%.[1] The LRMD has subsequently undertaken a program of study that has included watershed, water quality, and lake management planning investigations, funded in part under the Chapter NR 190 Lake Management Planning Grant Program and NR 120 Wisconsin Nonpoint Source Pollution Abatement Program.

To evaluate and effectively manage the lake's aquatic plant community, the LRMD partnered with International Environmental Management Services Ltd. (IEMS), Wisconsin Department of Natural Resources (DNR) and Jefferson County Land and Water Conservation Department (LWCD) to complete an updated aquatic plant inventory and management plan. Prior aquatic plant inventories were conducted by the DNR on Lake Ripley in 1989, 1991 and 1996 as part of its long-term trends monitoring program. The DNR also developed an aquatic plant management plan for the lake in September 1992 to help guide weed harvesting activities.[2] Information from these earlier efforts was used in conjunction with 2001 plant inventory data to assess current conditions, evaluate long-term trends, and prepare a revised management strategy.

This Aquatic Plant Management Plan is designed to guide the LRMD in its efforts to control nuisance vegetation growth while protecting beneficial plant communities that contribute to a healthy and stable aquatic environment. The plan is intended to outline the most cost-effective strategies that properly balance lake-protection needs with recreational-use demands, and that minimize the likelihood of unintentionally exacerbating an existing problem or creating entirely new problems. This is best achieved by implementing control measures at specific times and in specific locations, depending on spatial and seasonal variations in plant growth, fish and wildlife behavior, recreational use of the water, and other factors. Without such a plan, objectives remain unclear, treatments become haphazard, and plant communities might be removed or damaged that did not require control in the first place.

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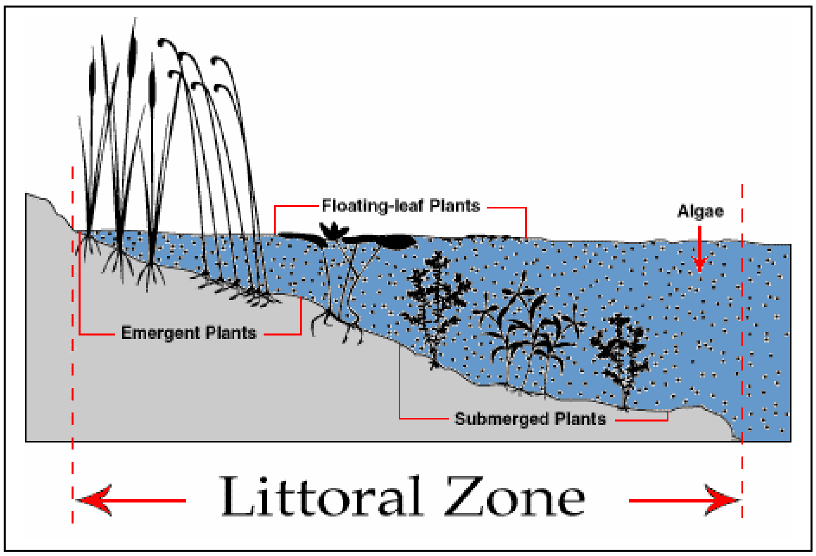
[1]*Wisconsin Department of Natural Resources. 1990. Aquatic Plant Control Reconnaissance Report for Lake Ripley.*

[2]*Wisconsin Department of Natural Resources. 1992. Lake Ripley Aquatic Plant Management Plan.*

To effectively manage aquatic plant growth, it is necessary to understand the underlying physical, chemical and biological characteristics and relationships that are unique to the larger ecosystem—namely the lake and its watershed. It is these factors that ultimately govern the type, amount and distribution of plant growth in the system.

PHYSICAL CHARACTERISTICS

Lake Ripley is part of an approximately eight-square-mile, agriculturally dominated watershed. It is described as a 418-acre drainage lake with one inlet and one uncontrolled outlet. The lake has extensive shallow areas that support rooted aquatic plant growth, called the littoral zone, and contains a single deep basin near its center. The water body has a maximum depth of approximately 44 feet, a mean depth of 18 feet, a volume of 7,524 acre-feet, and 4.85 miles of shoreline. In terms of surface area, approximately 34% of the lake is less than five feet deep, while about 41% is greater than 20 feet deep.[3]



Lake Ripley's physical characteristics are set forth in Table 1. A bathymetric map illustrating water depth contours is presented as Figure 1.

Table 1: Physical Characteristics of Lake Ripley and its Watershed

Watershed Area	5,120 acres
Lake Surface Area	418 acres
Lake Type	Drainage
Water Volume	7,524 acre-feet
Maximum Depth	44 feet
Mean Depth	18 feet
Max. Littoral Zone	0-15 feet (54% of surface area)
Shore Length	4.85 miles

[3]*Lake Ripley Management District. 2001. Lake Ripley Management Plan.*

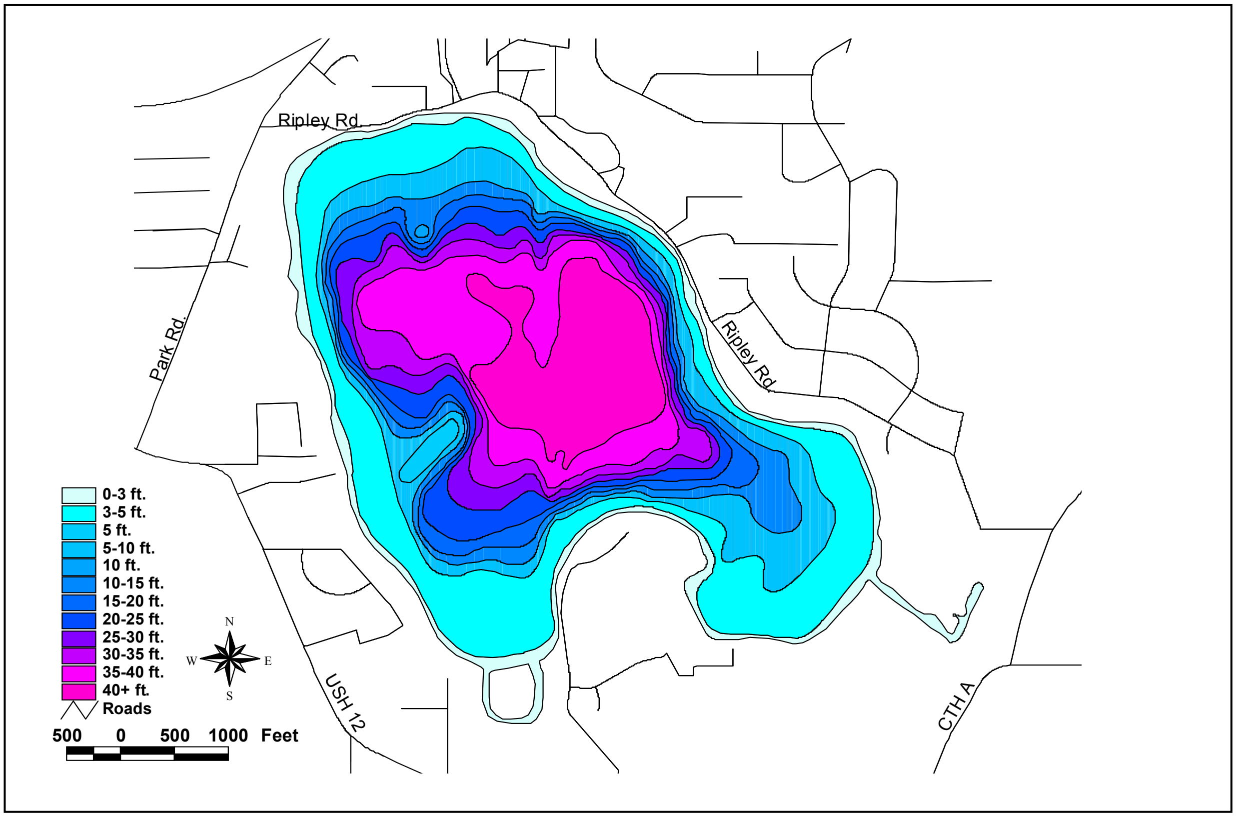


Figure 1: Lake Ripley Bathymetry

WATER QUALITY

Lake Ripley is classified as upper-mesotrophic to eutrophic according to total phosphorus, chlorophyll-**a**, and Secchi transparency measurements.[4] It is considered a fertile and biologically productive water body, and is characterized by high nutrient concentrations, fair water clarity, and an abundance of rooted aquatic plant growth. Applying the Lillie and Mason Water Quality Index to Lake Ripley reveals that the measured surface total-phosphorus and chlorophyll-**a** concentrations are generally indicative of "good" water quality, while Secchi depths are generally indicative of "fair" water quality.[5]

Secchi disk transparency readings ranged from 3.0-21.0 feet during the 1986-2002 sampling period, with the majority of readings falling between 4.0 and 9.0 feet (see Figure 2 below). The average Secchi depth for the period of record was 6.5 feet. Sunlight can typically penetrate the water column to a depth of 1.7 times the Secchi depth—defined as the photic zone. Rooted aquatic plant growth

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[4] *R.A. Lillie, S. Graham, and P. Rasmussen. 1993. Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes - Research and Management Findings. Wisconsin Department of Natural Resources' Publication No. PUBL-RS-735 93.*

[5] *R.A. Lillie and J.W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Technical Bulletin No. 138.*

usually occurs in areas where the lake bottom intersects the photic zone, which can vary from year to year depending on water clarity conditions.

Lake Ripley is also a hard water lake with high alkalinity. This indicates that the lake has high concentrations of calcium carbonate ($CaCO_3$), and is well buffered against the affects of acid rain.

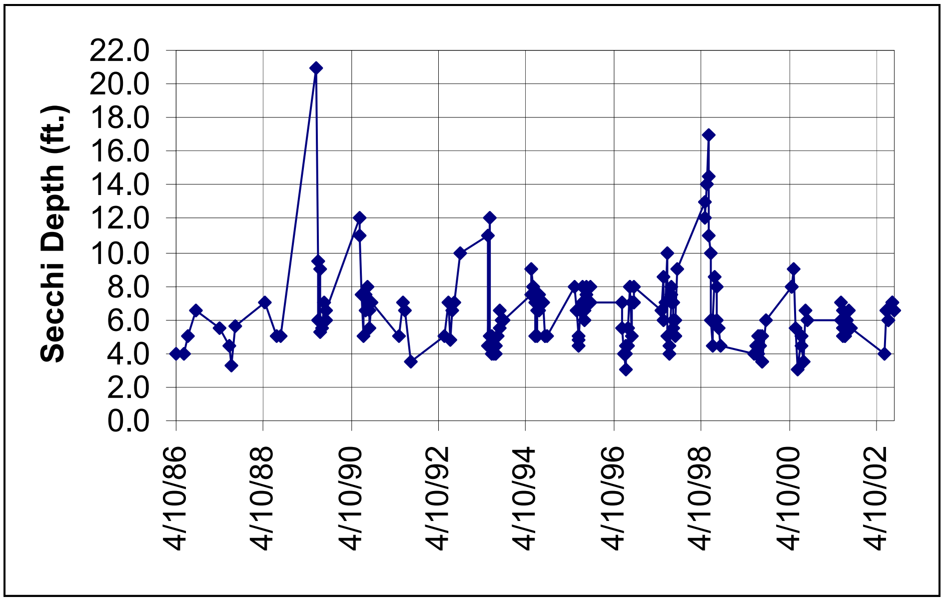

Figure 2: Secchi Transparency (1986-2002)

FISHERY

Lake Ripley has long been considered one of Wisconsin's finest largemouth bass lakes, and is famous for producing the state record in 1940 (11 pounds, 3 ounces.). In addition to largemouth bass, a 1982 Wisconsin Fish Distribution Study found the lake to support as many as 33 other fish species.[6]

The earliest available records were from 1946, where it was reported that bluegills, walleyes, northern pike, largemouth bass, yellow perch, crappies, and bullheads were major contributors to the sport fisheries.[7] During the 1950s and early 1960s, the former Wisconsin Conservation Department removed bowfin (dogfish) and longnose gar from Lake Ripley as "rough fish", but fisheries managers have come to appreciate the importance of these species for aquatic diversity and control of slow-growing panfish and young carp. The lake has been stocked with an average of 21,000 walleye fingerlings every two years since 1986. Walleye stocking is intended to supplement natural

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[6] *Fago, Don. 1982. Distribution and Relative Abundance of Fishes in Wisconsin. Greater Rock River Basin. Wisconsin Department of Natural Resources Technical Bulletin No. 136.*

[7] *Mackenthun, Kenneth M. and Kenneth Flakas. 1946. A Biological Survey of Lake Ripley. Wisconsin Conservation Department. Fisheries Biology Section. Investigative Report No. 580.*

reproduction and control the stunted perch population. Current fisheries management focuses on sustaining largemouth bass, which is considered the primary gamefish in the lake. Management efforts are also directed toward protecting existing shoreland wetlands to enhance northern pike spawning.[8]

Annual fisheries surveys have been performed on Lake Ripley since 1992 as part of the DNR's long-term trends monitoring program. Survey results indicate no obvious trends toward increasing or decreasing gamefish populations. The most diverse species assemblage was consistently found in the southwest bay area, reflecting the variety of habitats available in this location. This particular area presently consists of a relatively diverse native aquatic plant community, riparian wetlands, and minimal shoreline development. The presence of wetland and aquatic vegetation is a key element providing cover, spawning sites and structure for fish. Water lilies are particularly abundant within both bays, and their rhizomes provide the critical firm substrate for bass nests.

Survey results are summarized for the largemouth bass and walleye fisheries in Figures 3 and 4 (respectively) below. The graphs depict the minimum, maximum and average lengths that were surveyed from 1992-2002, as well as the number of fish caught per hour of sampling, referred to as "Catch Per Unit of Effort" (CPUE). Size-frequency distributions were representative of similar lakes in Southern Wisconsin, and no unusual trends were evident. A list of species documented during each sampling event is presented in Table 2.

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[8] *Marshall, Dave, Ron Kroner, Paul Garrison, John Panuska and Don Bush. 1994. Lake Ripley Priority Lake Project Water Resources Appraisal. Wisconsin Department of Natural Resources and Lake Ripley Management District.*

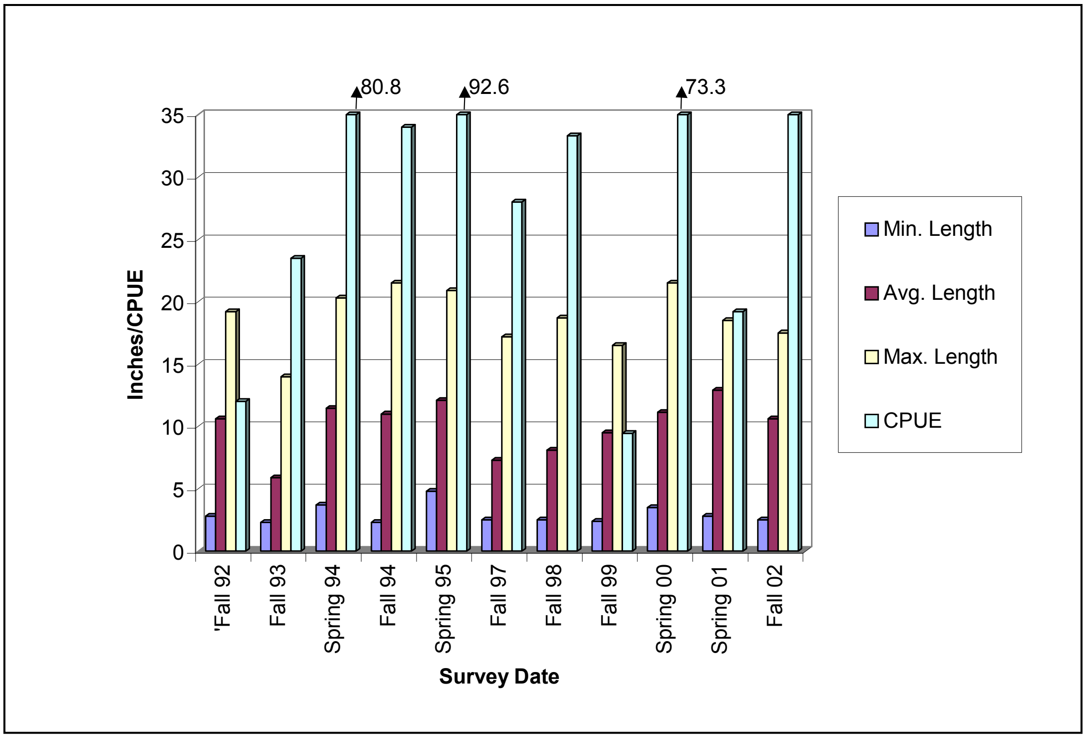

Figure 3: Fishery Survey Results for Largemouth Bass (1992-2002)

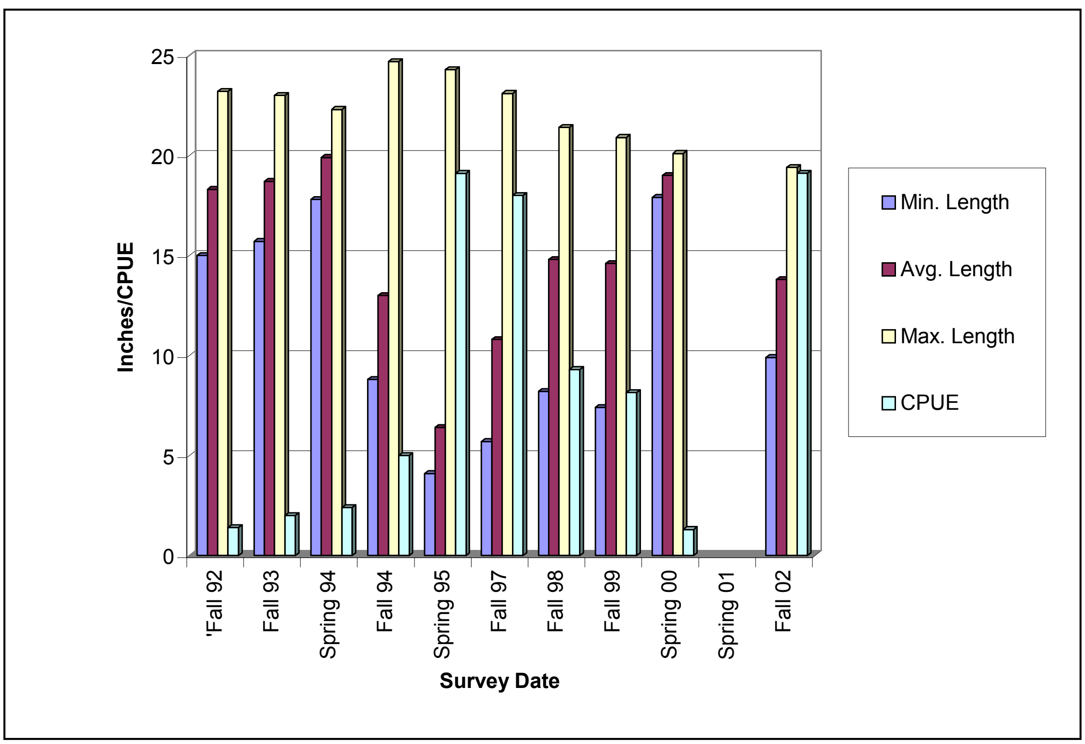

Figure 4: Fishery Survey Results for Walleye (1992-2002)

Table 2: Fish Species Presence and Overall Species Diversity (1992-2002)

Species of Fish	Fall 1992	Fall 1993	Spring 1994	Fall 1994	Spring 1995	Fall 1997	Fall 1998	Fall 1999	Spring 2000	Spring 2001	Fall 2002
Longnose Gar *(Lepisosteus osseus)*	X	X	X	X		X	X	X	X		X
White Sucker *(Catostomus commersoni)*	X	X	X	X		X	X	X	X	X	X
Common Carp *(Cyprinus carpio)*	X		X	X		X	X	X	X	X	X
Brook Silverside *(Labidesthes sicculus)*	X	X	X	X		X	X	X		X	X
Yellow Bullhead *(Ictalurus natalis)*			X	X		X	X	X	X	X	X
Golden Shiner *(Notemigonus crysoleucas)*	X	X	X	X			X	X	X	X	
Common Shiner *(Luxilus cornutus)*			X								
Lake Chubsucker *(Erimyzon sucetta)*	X	X	X	X			X	X	X	X	X
Green Sunfish *(Lepomis cyanellus)*	X		X	X				X		X	
Bowfin *(Amia calva)*			X	X		X	X	X	X		X
Bluntnose Minnow *(Pimephales notatus)*	X			X		X	X	X		X	
Pumpkinseed Sunfish *(Lepomis gibbosus)*	X		X	X		X	X		X		X
White Bass *(Morone chrysops)*				X		X	X		X	X	X
Black Bullhead *(Ictalurus melas)*				X			X			X	
Grass Pickeral *(Esox americanus)*				X			X				X
Rock Bass *(Ambloplites rupestris)*					X					X	
Central Mudminnow *(Umbra limi)*						X	X				
Johnny Darter *(Etheostoma nigrum)*						X	X				
Emerald Shiner *(Notropis atherinoides)*								X			
Burbot *(Lota lota)*							X				
Yellow Perch *(Perca flavescens)*	X	X	X	X		X	X	X	X	X	X
Black Crappie *(Pomoxis nigromaculatus)*			X	X		X	X	X	X	X	X
Bluegill *(Lepomis macrochirus)*	X	X	X	X		X	X	X	X	X	X
Northern Pike *(Esox lucius)*	X	X	X	X	X	X	X	X		X	X
Walleye *(Stizostedion vitreum)*	X	X	X	X	X	X	X	X	X	X	X
Largemouth Bass *(Micropterus salmoides)*	X	X	X	X	X	X	X	X	X	X	X
Smallmouth Bass *(Micropterus dolomieui)*											X
Species Diversity:	14	10	17	20	4	17	22	17	14	17	17

CHAPTER 2: PLANT MANAGEMENT HISTORY

PRIOR WEED-CONTROL EFFORTS

In the past, both chemical control measures and mechanical harvesting have been employed to address nuisance aquatic plant growth. Herbicide use was first documented in 1977, and was discontinued by 1990. In contrast to many lakes in southern and southeastern Wisconsin, Lake Ripley is not reported to have been subject to the use of sodium arsenite as an aquatic plant control measure.[9] Likewise, although some copper sulfate use was reported on Lake Ripley in the past, there are few records of the widespread use of this algaecide in the lake.[10] The chemical treatment history on Lake Ripley is summarized in Table 3, and is based on DNR permit records dating back to 1950.

Table 3: Chemical Treatment History on Lake Ripley (1950-Present)

Date	Acres Treated	Herbicides	Quantity	Target Species
7-77	1.65	Hydrothol 47	150 lbs.	Wild celery
8-81	0.13	Aquathol granual	20 lbs.	Milfoil
5-82	0.16	Aquathol granual	50 lbs.	Milfoil
6-83	0.03	Aquathol granual	50 lbs.	Milfoil
6-86	26.00	Cu, Diquat, Aquathol K	26 gals.	Milfoil
6-88	10.00	Same	22 gals.	Milfoil
6-89	9.00	Same	15 gals.	Milfoil
6-89	0.04	Aquathol granual	37 lbs.	Milfoil
6-90	0.04	Aquathol granual	30 lbs.	Milfoil
6-90	3.60	2,4-D	11 gals.	Milfoil

From about 1989 to the present, mechanical harvesting has been used as the primary control method. The LRMD currently uses an Aquarius Systems Model HM-420 mechanical harvester with a 7.0-foot cutting width and a 5.5-foot cutting depth. Ancillary equipment includes a 28.5-foot shore conveyor, 1977 GMC Sierra Series 6000 dump truck, and a 42-foot Aquarius Systems harvester trailer with electric winch. Further details on the LRMD's mechanical harvesting program are provided in Chapter 7.

SENSITIVE AREAS DESIGNATION

In 1989, changes in the DNR Administrative Code (NR 107) governing the Aquatic Plant Management Program went into effect. Recognizing that responsible management of aquatic plants can enhance water recreation is only one aspect of the program. The new NR 107 also underscores the value of many native aquatic plants to lake ecology and the need to protect them.

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[9] *L.A. Lueschow. 1972. Biology and Control of Aquatic Nuisances in Recreational Waters. Wisconsin Department of Natural Resources Technical Bulletin No. 57.*

[10] *Ibid.*

Among several program changes, the DNR is required to identify sensitive or critical areas in lakes where aquatic plants are managed. Sensitive areas are designated to protect water quality, high-value native aquatic plants, fisheries and wildlife habitat, and shorelines susceptible to erosion. On Lake Ripley, the principle sensitive areas are located adjacent to relatively undeveloped shorelines in the southeast and southwest bays which border riparian wetlands and support excellent biodiversity (see map in Appendix A). These areas presently contain water lilies, bulrush stands and riparian wetlands that are important for shoreline protection, fish and wildlife habitat, and water quality protection.

A Town of Oakland ordinance was subsequently adopted prohibiting the placement of piers, wharves and swimming rafts within these areas without a DNR permit.[11] Another Town ordinance was amended for the purpose of expanding an existing no-wake buoyed restricted zone to better protect these designated sensitive areas.[12] The LRMD recently proposed a second amendment to the ordinance. If adopted by the Town of Oakland, the revised ordinance would further expand no-wake areas to generally protect shallow water depths throughout the lake.

Historically, these important habitats were abundant around the lake, but have largely disappeared due to wetland drainage and shoreline development. The few remaining sensitive areas along the southern shoreline are protected, and herbicide treatments, dredging, and sand blankets are prohibited in those areas. Mechanical harvesting is allowed in these areas, but it is recommended that operations be limited to a few navigational channels within waterlily beds. Wild celery and several pondweeds (Potamogeton species) also deserve protection but occur in low densities and are widely dispersed throughout the lake. These species cannot be protected within defined sensitive areas.

DNR PLANT MANAGEMENT RULES

2001 Wisconsin Act 16 included new legislative language for the protection of native aquatic plant communities and control of invasive aquatic plant species. The DNR was directed, under Section 23.24 of the Wisconsin Statutes, to establish a program for the waters of this state to: 1) protect and develop diverse and stable communities of native aquatic plants; 2) regulate how aquatic plants are managed; and 3) provide education and conduct research concerning invasive aquatic plants. The DNR was further directed to designate by rule which aquatic plants are invasive species, and to administer and establish by rule procedures and requirements for the issuance of aquatic plant management permits.

A second law, under Section 30.715 of the Wisconsin Statutes, prohibits the launching of boats, boating equipment or trailers in navigable waters if the owner has reason to believe that this equipment has any aquatic plants or zebra mussels attached.

Major changes as a result of these new laws include:

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[11]*Town of Oakland. 1995. Ordinance No. 42: An Ordinance to Regulate the Location of Piers, Wharves and Swimming Rafts on Lake Ripley.*

[12]*Town of Oakland. 1995. Ordinance No. 2: An Ordinance to Create Section 4.AMN of Ordinance No. 2 to Create an Additional "Buoyed Restricted Area" in the South Bay of Lake Ripley.*

- A permit is needed for the removal and harvesting of aquatic plants. As in the past, all harvested plant material must be removed from the lake.
- Mechanical harvesting will require a permit. Permits are valid for five years for applicants with an approved Aquatic Plant Management Plan.
- The launching of a boat in navigable waters is prohibited if there is reason to believe the equipment has aquatic plants or zebra mussels attached.
- Manual cutting and raking will be exempt from the permit requirement if the area of plant removal is no more than 30 feet along the shoreline of any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet.

CHAPTER 3: PLANT INVENTORY METHODOLOGY

AQUATIC PLANT SAMPLING

The Minnesota Department of Conservation developed a methodology for conducting quantitative surveys of aquatic plants in lakes.[13] This methodology has been widely used in the upper Midwest and has been modified for use in Wisconsin lakes by the Wisconsin Department of Natural Resources (DNR). The Jessen and Lound technique, as it is known, utilizes perpendicular transects extending lakeward from the shoreline as the basis for conducting the sampling program, and a rake-based sampling device to harvest plant material from the lakebed.

The Jessen and Lound technique was employed during the aquatic plant survey conducted on Lake Ripley in July and August 2001. This method was selected to maintain data consistency over the 12-year study period for trend identification and comparative analysis purposes. The 2001 inventory is intended to support a refinement of the aquatic plant management plan prepared for Lake Ripley nearly a decade earlier. Because plant communities can change dramatically in composition and distribution over time, recommended management measures must be routinely re-evaluated to appropriately compensate for these changes.

The baseline transects established for the survey were derived from a series of transects previously established and used in prior aquatic plant surveys by the DNR. Additional transects were established for the 2001 survey to obtain a more precise delineation of the plant community. Transects were added in those areas where the DNR-designated transects were widely spaced. The location of the sampling transects are mapped in Appendix B. Detailed site descriptions and photographs of each transect are also included in Appendix B. Fifteen (15) transects were used to describe the aquatic plant community, with eight (8) additional sampling transects being established during the 2001 survey. The addition of these transects, however, did not significantly alter the analyses conducted on the community composition data.

Using a composite garden rake with extended handle as set forth in the Jessen and Lound methodology, samples were obtained from depth-related sampling points along each of the transects. Samples were taken at 1.5, 3.0, 6.0, 9.0, 12.0, and 15.0 feet of lake depth. Rake hauls were also done at 18.0 feet of lake depth, but no aquatic plants were found below 15.0 feet during the 2001 aquatic plant surveys. This depth limitation is consistent with the likely maximum depth of colonization of aquatic plants,[14] which is a function, *inter ala*, of light penetration, substrate composition, and likelihood of disturbance by wind action, etc. The sampling depths corresponded, for the most part, with depths at which previous aquatic plant samples were obtained. The locations of these sampling points were identified precisely through the use of Jefferson County's Global Positioning System during the 2001 aquatic plant survey.

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[13]*Jessen, Robert and Richard Lound. 1962. An Evaluation of a Survey Technique for Submerged Aquatic Plants. Minnesota Department of Conservation. Investigational Report No. 6.*

[14]*D.E. Canfield, K.A. Langeland, S.B. Linda , and W.T. Haller 1985. Relationships between Water Transparency and Maximum Depth of Macrophyte Colonization in Lake. Journal of Aquatic Plant Management, volume 23, pages 25-28: log MDC = 0.79 log (SDT) + 0.25, where MDC is the maximum depth of colonization and SDT is Secchi disc transparency, in meters.*

At each sample point, four rake hauls were completed, one rake haul in each quadrant, approximately defined as the four "corners" of the pontoon boat from which the samples were obtained.

For each rake haul, plants were separated and identified on board the vessel used for sampling. Presence or absence of each species was noted on the worksheets, with additional notes regarding unusual features or abundances recorded whenever appropriate. When plants were obtained in each of the four rake hauls, a score of "4" was noted. Similarly, where a specific plant was observed in only three of the hauls, a score of "3" was noted. A score of "0" was assigned to those hauls where no plants were obtained in any rake haul.

This scoring system differed slightly from that employed by Jessen and Lound, and in some previous DNR aquatic plant surveys conducted on Lake Ripley. In these studies, a score of "5" could be assigned to those samples where a plant species was recorded in each of the four rake hauls and where the plant was exceptionally abundant. The maximum score of "5" was not consistently used in previous studies. For this reason, the maximum score used in the statistical analysis of the data was set at "4", and scores of "5" were normalized to "4".

STATISTICAL ANALYSIS

Seven indices were used to determine if the aquatic plant community had changed significantly since the previous comprehensive surveys. These tests, which examined a variety of factors, parallel the suite of statistical analyses identified by Nichols.[15]

1. The frequency of occurrence (FREQ) is the number of occurrences of a species divided by the number of sampling points with vegetation, expressed as a percentage. It is the percentage of times a particular species occurred when there was aquatic vegetation present, and is analogous to the Jesson and Lound point system.

   [EXAMPLE: Based upon data obtained during the 2001 sampling program, muskgrass was observed at 45 sites. The 45 occurrences represent the presence of muskgrass in at least one rake haul at a given sampling depth. There were a total of 90 possible occurrences, representing the total number of sampling sites visited, including the 45 sites at which no muskgrass was collected. Dividing the number of occurrences (45) by the total possible number of occurrences of muskgrass in Lake Ripley (90), results in a FREQ of 50.0 percent.]

2. The relative frequency of occurrence (RFREQ) is the frequency of a species divided by the total frequency of all species. The sum of the relative frequencies should equal 100 percent. This statistic presents an indication of how the plants occur throughout a lake in relation to each other. It is used in the calculation of the Importance Value and Simpson's Diversity Index set forth below.

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[15] *Memorandum from Stan Nichols, to J. Bode, J. Leverence, S. Borman, S. Engel, D., Helsell, entitled "Analysis of Macrophtye Data for Ambient Lakes-Dutch Hollow and Redstone Lakes Example," Wisconsin Geological and Natural History Survey and University of Wisconsin-Extension, February 4, 1994.*

[EXAMPLE: Based upon data obtained during the 2001 sampling program, muskgrass was observed at 45 sites in the lake. Other plants also were observed. Summing the total number of occurrences of the other aquatic plant species resulted in a total of 209 reports. Dividing the number of occurrences of muskgrass (45) by the total number of occurrences of aquatic plants at the sites sampled (209), yields a RFREQ of 21.5 percent.]

3. The average density (ADEN) is the sum of the density ratings for a species divided by the number of sampling points with vegetation. The maximum density possible of 4.0 is assigned to plants that occur at all points sampled at a given depth—the modified Jesson and Lound protocol adopted by the DNR uses four sampling points per depth sampled. The average density presents an indication of how abundant the growth of a particular plant is throughout the lake. This measure along with the percent occurrence gives a good indication of the distribution of aquatic plant communities in a lake.

   [EXAMPLE: Based upon data obtained during the 2001 sampling program, muskgrass was observed at 45 sites in the lake. Summing the density values for muskgrass at the 45 sites at which muskgrass occurred yields a total of 137. Dividing this total by the number of sites at which the plant occurred (45) results in an ADEN of 3.04.]

4. The Simpson Diversity Index (SDI) is defined as one minus the sum of each of the relative frequencies squared, and is expressed in equation form as:

   $$SDI = 1 - \Sigma(RFREQ^2)$$

   where SDI is the Simpson Diversity Index and RFREQ is the relative frequency value defined above. Based upon this index of community diversity, the closer the SDI value is to one, the greater the diversity is between the communities being compared.

   [EXAMPLE: Using data obtained during the 2001 sampling program, the sum of the squared RFREQ values is 0.140, resulting in an SDI of about 0.86.]

5. The importance value (IV) is defined as the product of the relative frequency and the average density, expressed as a percentage:

   $$IV = (RFREQ)\ (ADEN)\ (100)$$

   where IV is the importance value, RFREQ is the relative frequency, and ADEN is the average density. This number provides an indication of the dominance of a species within a community based upon both frequency and density. It also somewhat addresses the problem of difference in stature between different plant species.

   [EXAMPLE: The values for relative frequency (RFREQ = 0.215) and average density (ADEN = 3.04) of muskgrass in Lake Ripley during 2001 are derived from the equations set forth above. Therefore, for the muskgrass community during the 2001aquatic plant survey, the importance value can be calculated as the product: (0.215) (3.04) (100), which equals 65.36.]

6. The similarity index (SI) is a means of comparing two communities by estimating the degree to which the communities share common components. The index is calculated as:

   $$SI = 2W / A + B$$

where SI is the similarity index value, W is the amount two communities have in common or the lowest relative frequency of a species pair, and A plus B is the sum of the relative frequency for both communities, which should always be about 200 since the relative frequency of each community should equal 100 percent. This index could be calculated based upon average density or the importance values. However, relative frequency is a better measure since it does not change much during the growing season. Consequently, results remain comparable, even if the timing of sampling is not exactly the same. Given that there are several methods for assigning average density, use of average density may yield a result that is not directly comparable, while use of relative frequency avoids such interpretation problems. It should be noted that although a 100 percent similarity is theoretically possible, repeated sampling studies from the same community have shown that a similarity index of 85 percent or higher should be considered indicative of no community change.

[EXAMPLE: The aquatic plant communities observed in Lake Ripley during 1996 and 2001 had nine species of plants in common. Each of these species was observed during the two sampling periods. Based on 2001 survey data, W would be 71.8 percent. This value is comprised of the 2001 RFREQ values for Eurasian water milfoil, spiny naiad, coontail and bladderwort, and the 1996 RFREQ values for muskgrass, eel grass, Sago pondweed, bushy pondweed and elodea. The value of A, or the cumulative value of the RFREQ values reported during 1996, was 100 percent, while the value of B, or the cumulative value of the RFREQ values reported during 2001, was 99.8. Solving for SI results in a similarity index value of 71.9 percent between these two years.]

7. <u>The p-value</u>, or Pearson chi-squared test, is calculated using a statistical program for personal computers.[16] A p-value of less than or equal to 0.05 is the limit used to identify a significant difference between two populations. This means that at $p = 0.05$, there is a 95 percent probability that two populations are different, or that, after comparing 100 mean values from each data set, 95 would be different and five would overlap. Data obtained during the 2001sampling program were used to calculate these values.

HERBARIUM PREPARATION

Some representative plant specimens sampled during the 2001 inventory were pressed, mounted and preserved in a herbarium. The following species were included in the herbarium for later reference and to assist with future plant identification: muskgrass (*Chara vulgaris*), native milfoil (*Myriophyllum* sp.), Eurasian water milfoil (*Myriophyllum spicatum*), bushy pondweed (*Najas flexilis*), spiny naiad (*Najas marina*), variable pondweed (*Potamogeton gramineus*), Illinois pondweed (*Potamogeton illinoensis*), floating-leaf pondweed (*Potamogeton natans*), sago pondweed (*Potamogeton pectinatus*), flat-stem pondweed (*Potamogeton zosteriformis*), white water crowfoot (*Ranunculus longirostris*), water bulrush (*Scirpus subterminalis*), bladderwort (*Utricularia* sp.), and eel grass (*Vallisneria americana*). Additional plant species will be added to the herbarium if discovered during future inventories.

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[16] *Microsoft Excel, Office 98, was used for statistical analysis of the data.*

CHAPTER 4: INVENTORY FINDINGS

DESCRIPTION OF PLANT COMMUNITY

Comprehensive surveys of the aquatic plant community in Lake Ripley were conducted in 1989, 1991, 1996 and 2001. Although a 1976 survey was also performed, it was based upon significantly different transects and sampling methodology, and is used only as a basis for statistical analysis of changes in the aquatic plant community insofar as the data allow. The only other documented aquatic plant survey of Lake Ripley was performed in 1953 by two University of Wisconsin graduate students.[17] At that time, the researchers monitored seasonal changes of six dominant species: Muskgrass (*Chara contraria*), bushy pondweed (*Najas flexilis*), Illinois pondweed (*Potamogeton illinoensis*), sago pondweed (*Potamogeton pectinatus*), water celery (*Vallisneria americana*), and Fries' pondweed (*Potamogeton friesii*). All six species are indigenous to Wisconsin. The 1953 study cannot be considered a comprehensive survey since only six species were studied.

Twenty-seven species of aquatic plants were documented in Lake Ripley during the period between 1989 and 2001. Although the total number of species found in the lake appears to have declined in later surveys, it may largely be attributed to changes in surveying methods. For instance, the 1989 and 1991 surveys consisted of a reconnaissance to identify most of the species in the lake prior to systematic sampling to determine species abundance.

Table 4 outlines the positive ecological values of the various plant species found in Lake Ripley. Table 5 provides the frequency of occurrence and average density of each plant species sampled during the 2001 survey. Tables 6 through 10 show the average density ratings (ADEN), percent relative frequencies of occurrence (RFREQ), numbers of sites at which specific plants were found, percent frequencies of occurrence (FREQ), and importance values (IV) of each of the species found during the four surveys. In addition, data from the initial 1976 survey are shown in these tables.

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[17] *Swindale, D.N. and J.T. Curtis. 1957. Phytosociology of Larger Submerged Plants in Wisconsin Lakes. Ecology, Vol. 38, p. 397-408.*

Table 4: Ecological Attributes of Aquatic Plant Species in Lake Ripley

Aquatic Plant Species	Plant Type[a]	Ecological Significance[b]
Ceratophyllum demersum (coontail)	S	Many waterfowl eat the shoots; provides cover for young bluegills, perch, largemouth bass and northern pike; often found on drop-offs, producing tree-like cover for fish; supports insects valuable as food for fish and ducklings
Chara vulgaris (muskgrass)	S	Excellent producer of fish food, especially for young trout, bluegill, small-and largemouth bass; stabilizes bottom sediments, and has softening effect on the water by removing lime and carbon dioxide
Elodea canadensis (waterweed)	S	Provides cover for bluegills and perch; supports insects valuable as fish food
Heteranthera dubia (water star grass)	S	Provides food and shelter for fish
Lemna minor (common duck weed)	FF	Provides cover for largemouth bass and northern pike; important food for most waterfowl, marsh birds, small aquatic mammals; supports insects valuable as food for fish; may shade out larger, submerged plants; not ideal fish habitat due to excessive shading and poor food value
Myriophyllum spicatum[c] (Eurasian water milfoil)	S	Provides some cover for bluegills, crappies, perch, walleyes and muskellunge (most prefer broad-leaved pondweeds, however); supports insects used as fish food; waterfowl occasionally eat the fruit and foliage, although growth characteristics often destroy waterfowl habitat; not native to the U.S. and may cause problems due to excessive growth
Myriophyllum sibiricum (northern water milfoil)	S	Provides shelter, and is a valuable food producer supporting many insects; roots provide nesting habitat for fish
Najas flexilis (bushy pondweed)	S	Provides food for waterfowl and some marsh birds; cover for young largemouth bass and northern pike, and small bluegills and perch
Najas marina (spiny naiad)	S	Provides good food and shelter for fish and food for ducks
Nuphar adrena (yellow water lily)	FL	Leaves, stems, and flowers are eaten by deer; roots eaten by beaver and porcupine; seeds eaten by waterfowl; leaves provide harbor to insects, in addition to shade and shelter for fish
Nymphaea tuberosa (white water lily)	FL	Provides shade and shelter for fish; seeds eaten by waterfowl; rootstocks and stalks eaten by muskrat; roots eaten by beaver, deer, moose, and porcupine
Potamogeton crispus[c] (curly-leaf pondweed)	S	Provides food, shelter, and shade for some fish and food for waterfowl; provides valuable habitat for early-spawning fishes such as carp; not native to the U.S. and may cause problems due to excessive growth
Potamogeton gramineus (variable pondweed)	S	Provides cover for panfish, largemouth bass, muskellunge and northern pike; bluegills nest near them and eat insects found on leaves; supports insects valuable as food for fish and ducklings.
Potamogeton illinoensis (Illinois pondweed)	S	Provides cover for panfish, largemouth bass, muskellunge, and northern pike; nesting grounds for bluegill; supports insects valuable as food for fish and ducklings
Potamogeton natans (floating-leaf pondweed)	FL	Broad-leaved pondweeds provide cover for panfish, largemouth bass, muskellunge and northern pike; bluegills nest near them and eat insects found on the leaves; supports insects valuable as food for fish and ducklings
Potamogeton pectinatus (Sago pondweed)	S	Provides some cover for bluegills, perch, northern pike and muskellunge (most prefer broad-leaved pondweeds, however); good cover for walleye; extremely valuable food source for waterfowl; supports insects valuable as food for fish and ducklings

Potamogeton pusillus (small pondweed)	S	Provides some cover for bluegills, perch, northern pike and muskellunge (most prefer broad-leaved pondweeds, however); good cover for walleye; provides food for waterfowl; supports insects valuable as food for fish and ducklings
Potamogeton richardsonii (clasping-leaf pondweed)	S	Fruit can be a locally important food source for a variety of waterfowl; leaves and stem are colonized by invertebrates and offer foraging opportunities and cover for fish
Potamogeton zosteriformis (flat-stem pondweed)	S	Provides some cover for bluegills, perch, northern pike and muskellunge (most prefer broad-leaved pondweeds, however); good cover for walleye; provides food for waterfowl; supports insects valuable as food for fish and ducklings
Sagittaria latifolia (arrowhead)	E	One of the highest value aquatic plants for wildlife; tubers and seeds consumed by a variety of waterfowl; provides shade and shelter for young fish
Scirpus americanus (chairmaker's rush)	E	Rigid stems survive winter and provide important spawning areas for northern pike and cover for other fish in early spring; attracts marsh and song birds; provides food for ducks, geese and swans; provides shoreline erosion control
Scirpus subterminalis (water bulrush)	S	Grass-like meadows provide invertebrate habitat and shelter for fish
Typha angustifolia (narrow-leaf cattail)	E	Helps stabilize marshy borders of lakes and ponds; protects shorelines from wave erosion; submersed stalks provide spawning habitat and cover for fish; provides cover and nesting sites for marsh birds and waterfowl; muskrat and beaver eat the stalks and roots
Typha latifolia (broad-leaf cattail)	E	Helps stabilize marshy borders of lakes and ponds; protects shorelines from wave erosion; submersed stalks provide spawning habitat and cover for fish; provides cover and nesting sites for marsh birds and waterfowl; muskrat and beaver eat the stalks and roots
Utricularia sp. (bladderwort)	S	Trailing stems on this free-floating plant provide good food and cover for fish, especially in areas with loosely consolidated sediment that are not readily colonized by rooted plants
Vallisneria americana (water celery)	S	Provides shade and shelter for bluegills, young perch and largemouth bass; good food for waterfowl, preferring the winter buds and root stocks; also attracts marsh and shore birds, muskrat
Zannichellia palustris (horned pondweed)	S	Fruit and foliage are grazed by waterfowl; considered a fair food producer for trout

[a] *Plant-type codes: S=submerged, FF=free-floating, FL=floating-leaf, E=emergent*

[b] *Information obtained from* A Manual of Aquatic Plants *by Norman C. Fassett and* Guide to Wisconsin Aquatic Plants*, Wisconsin Department of Natural Resources.*

[c] *Non-native species*

Table 5: Frequency of Occurrence and Density Ratings (2001)

Plant Species	Sites Found[a]	Frequency of Occurrence (percent)	Density in Whole Lake
Ceratophyllum demersum (coontail)	5	5.6	3.4
Chara vulgaris (musk grass)	45	50.0	3.0
Elodea candensis (waterweed)	3	3.3	1.3
Heteranthera dubia (water star grass)	3	3.3	3.0
Myriophyllum spicatum (Eurasian water milfoil)	41	45.6	2.1
Najas flexilis (bushy pondweed)	13	14.4	1.9
Najas marina (spiny naiad)	35	38.9	2.4
Potamogeton gramineus (variable pondweed)	8	8.9	1.5
Potamogeton crispus (curly-leaf pondweed)	1	1.1	1.0
Potamogeton pectinatus (Sago pondweed)	20	22.2	2.0
Potamogeton natans (floating-leaf pondweed)	1	1.1	1.0
Potamogeton zosteriformis (flat-stem pondweed)	12	13.3	2.2
Utricularia sp. (bladderwort)	1	1.1	1.0
Vallisneria americana (water celery)	21	23.2	2.0

[a] *90 sampling points.*

Table 6: Results of Statistical Analyses (2001)

Species	Frequency of Occurrence (percent)	Average Density	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	5.6	3.4	2.4	8
Chara vulgaris (musk grass)	50.0	3.0	21.5	66
Elodea candensis (waterweed)	3.3	1.3	1.4	2
Heteranthera dubia (water star grass)	3.3	3.0	1.4	4
Myriophyllum spicatum (Eurasian water milfoil)	45.6	2.1	19.6	42
Najas flexilis (bushy pondweed)	14.4	1.9	6.2	12
Najas marina (spiny naiad)	38.9	2.4	16.7	41
Potamogeton gramineus (variable pondweed)	8.9	1.5	3.8	6
Potamogeton crispus (curly-leaf pondweed)	1.1	1.0	0.5	0
Potamogeton pectinatus (Sago pondweed)	22.2	2.0	9.6	19
Potamogeton natans (floating-leaf pondweed)	1.1	1.0	0.5	0
Potamogeton zosteriformis (flat-stem pondweed)	13.3	2.2	5.7	13
Utricularia sp. (bladderwort)	1.1	1.0	0.5	0
Vallisneria americana (water celery)	23.3	2.0	10.0	20

Table 7: Results of Statistical Analyses (1996)

Species	Frequency of Occurrence (percent)	Average Density	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	23.3	1.9	10.8	21
Chara vulgaris (musk grass)	25.6	2.2	11.9	26
Elodea candensis (waterweed)	1.1	1.0	0.5	1
Heteranthera dubia (water star grass)	0.0	- -	0.0	- -
Myriophyllum spicatum (Eurasian water milfoil)	58.9	2.6	27.3	70
Najas flexilis (bushy pondweed)	12.2	2.2	5.7	12
Najas marina (spiny naiad)	51.1	2.3	23.7	54
Potamogeton gramineus (variable pondweed)	0.0	- -	0.0	- -
Potamogeton crispus (curly-leaf pondweed)	0.0	- -	0.0	- -
Potamogeton pectinatus (Sago pondweed)	20.0	2.0	9.3	19
Potamogeton natans (floating-leaf pondweed)	0.0	- -	0.0	- -
Potamogeton zosteriformis (flat-stem pondweed)	0.0	- -	0.0	- -
Utricularia sp. (bladderwort)	2.2	1.5	1.5	2
Vallisneria americana (water celery)	11.1	1.4	1.4	7

Table 8: Results of Statistical Analyses (1991)

Species	Frequency of Occurrence (percent)	Average Density	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	21.1	2.5	11.9	30
Chara vulgaris (musk grass)	20.0	2.3	11.3	26
Elodea candensis (waterweed)	2.2	1.0	1.3	1
Heteranthera dubia (water star grass)	0.0	- -	0.0	- -
Myriophyllum spicatum (Eurasian water milfoil)	53.3	3.0	30.0	89
Najas flexilis (bushy pondweed)	13.3	2.6	5.0	13
Najas marina (spiny naiad)	41.1	2.5	23.1	58
Potamogeton gramineus (variable pondweed)	0.0	- -	0.0	- -
Potamogeton crispus (curly-leaf pondweed)	0.0	- -	0.0	- -
Potamogeton pectinatus (Sago pondweed)	13.3	2.3	7.5	18
Potamogeton natans (floating-leaf pondweed)	0.0	- -	0.0	- -
Potamogeton zosteriformis (flat-stem pondweed)	0.0	- -	0.0	- -
Utricularia sp. (bladderwort)	2.2	1.5	1.3	2
Vallisneria americana (water celery)	7.8	1.6	4.4	7

Table 9: Results of Statistical Analyses (1989)

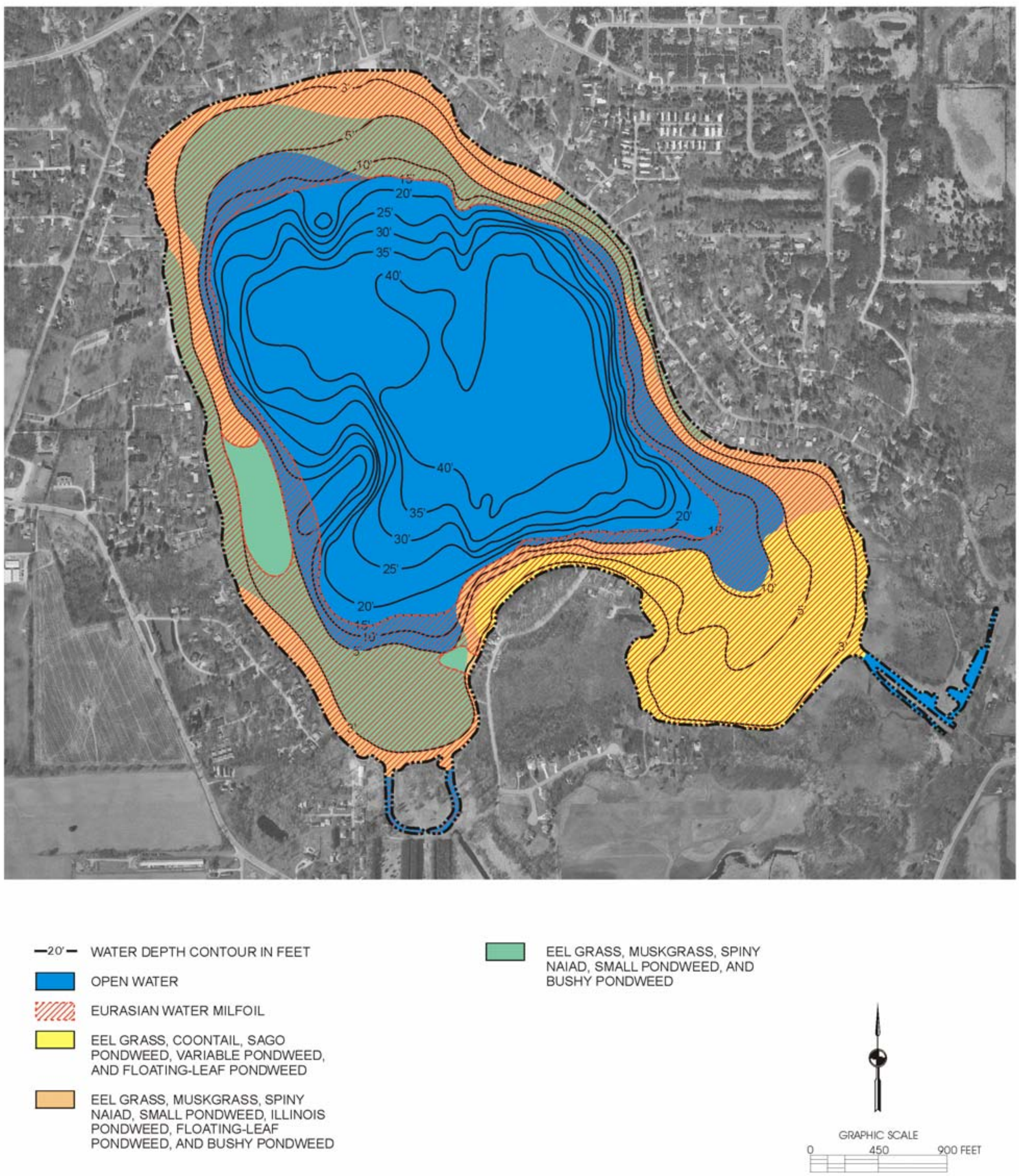
Species	Frequency of Occurrence (percent)	Average Density	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	5.0	3.0	2.5	8
Chara vulgaris (musk grass)	11.7	1.3	5.8	8
Elodea candensis (waterweed)	0.0	- -	0.0	- -
Heteranthera dubia (water star grass)	0.0	- -	0.0	- -
Myriophyllum spicatum (Eurasian water milfoil)	75.0	2.8	37.5	105
Najas flexilis (bushy pondweed)	11.7	1.1	5.8	7
Najas marina (spiny naiad)	18.3	1.0	9.2	18
Potamogeton gramineus (variable pondweed)	3.3	1.0	1.7	2
Potamogeton crispus (curly-leaf pondweed)	1.7	1.0	0.8	8
Potamogeton pectinatus (Sago pondweed)	5.0	1.0	2.5	7
Potamogeton natans (floating-leaf pondweed)	13.3	1.1	6.7	8
Potamogeton zosteriformis (flat-stem pondweed)	0.0	- -	0.0	- -
Utricularia sp. (bladderwort)	0.0	- -	0.0	- -
Vallisneria americana (water celery)	11.7	1.6	5.8	9

Table 10: Results of Statistical Analyses (1976)

Species	Frequency of Occurrence (percent)	Average Density	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	20.6	- -	9.6	- -
Chara vulgaris (musk grass)	69.1	- -	32.2	- -
Elodea candensis (waterweed)	2.9	- -	1.4	- -
Heteranthera dubia (water star grass)	0.0	- -	0.0	- -
Myriophyllum spicatum (Eurasian water milfoil)	27.9	- -	13.0	- -
Najas flexilis (bushy pondweed)	0.0	- -	0.0	- -
Najas marina (spiny naiad)	0.0	- -	0.0	- -
Potamogeton gramineus (variable pondweed)	0.0	- -	0.0	- -
Potamogeton crispus (curly-leaf pondweed)	1.5	- -	0.7	- -
Potamogeton pectinatus (Sago pondweed)	17.6	- -	8.2	- -
Potamogeton natans (floating-leaf pondweed)	14.7	- -	6.8	- -
Potamogeton zosteriformis (flat-stem pondweed)	0.0	- -	0.0	- -
Utricularia sp. (bladderwort)	8.8	- -	4.1	- -
Vallisneria americana (water celery)	36.8	- -	17.1	- -

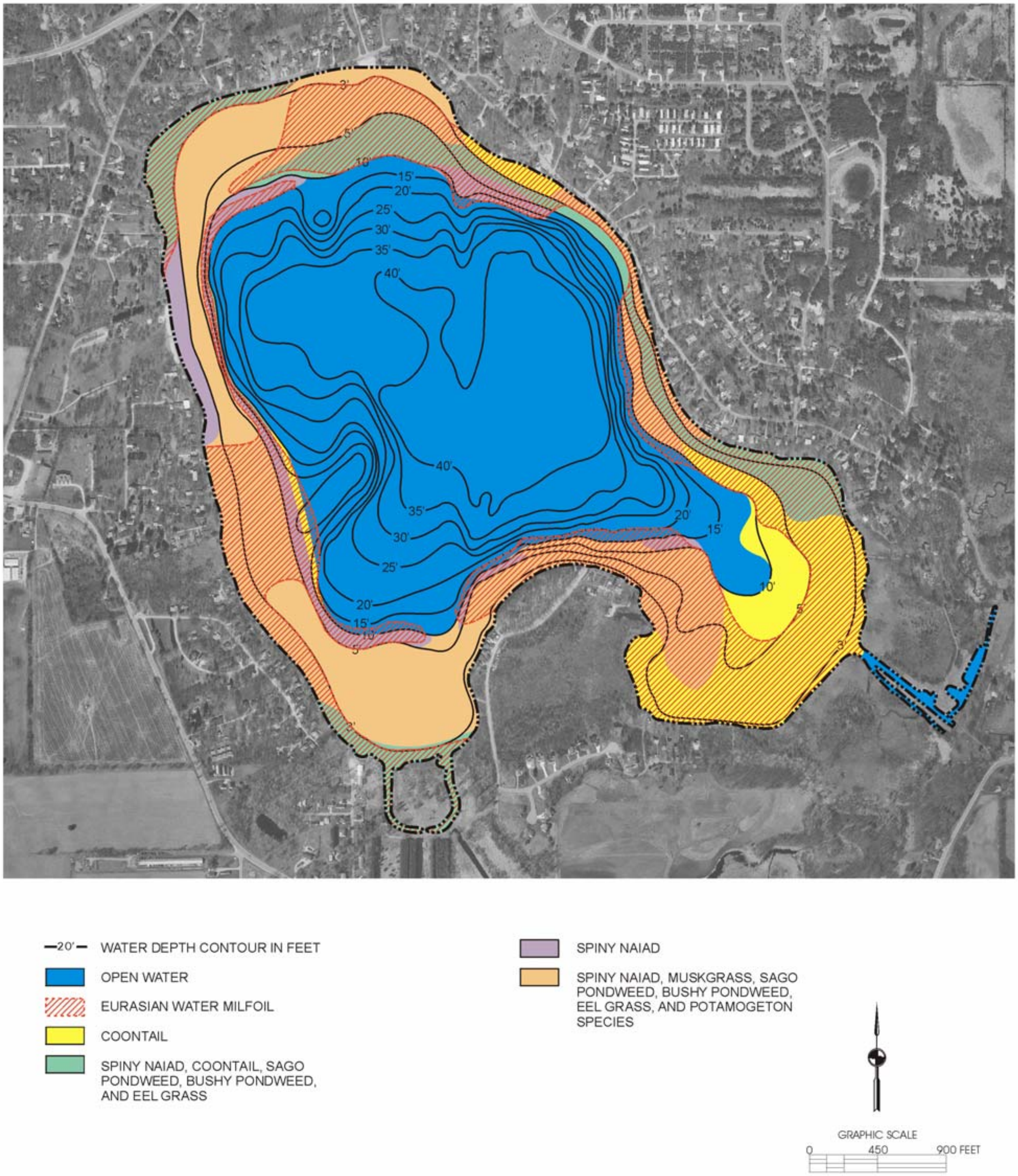
The 1976 survey reported 11 species of aquatic plants, with muskgrass and eel grass being the dominant species reported. Eurasian water milfoil and coontail were also frequently observed in the aquatic plant community at this time. The 1989 survey reported 12 species of plants. Eurasian water milfoil was the most frequently observed plant, with Illinois and small pondweeds and spiny naiad also being recorded. During the 1991 survey, 11 plant species were reported, with Eurasian water milfoil again being the most frequently observed plant. Spiny naiad was the next most frequently reported, followed by coontail and muskgrass. This situation was also reflected in the 1996 survey. By 2001, there were 14 species of aquatic plants documented during the survey. Muskgrass was slightly more frequently observed in the samples than Eurasian water milfoil during this survey. Spiny naiad, eel grass, and Sago pondweed were the next most frequently observed plants. The slight variation in number of species recorded during the various surveys is not considered significant. These results most likely reflect inter-annual variability, differences in sampling technique, and the influence of seasonality in plant growth consequent to the time of year during which the surveys were conducted.

The distribution of aquatic plants within Lake Ripley during the 1989, 1991, 1996 and 2001 surveys is shown in Figures 5 through 8. These data also are presented in Figure 9, which graphically summarizes the aquatic plant communities observed along each transect around the lake, and identifies the relative abundance of Eurasian water milfoil. Figure 9 confirms the ubiquitous nature of Eurasian water milfoil growth in the lake, and suggests there are inter-annual variations in the abundance of the plant during the period of record.



Source: Wisconsin Department of Natural Resources.

Figure 5: Aquatic Plant Community Distribution (1989)



Source: Wisconsin Department of Natural Resources.

Figure 6: Aquatic Plant Community Distribution (1991)

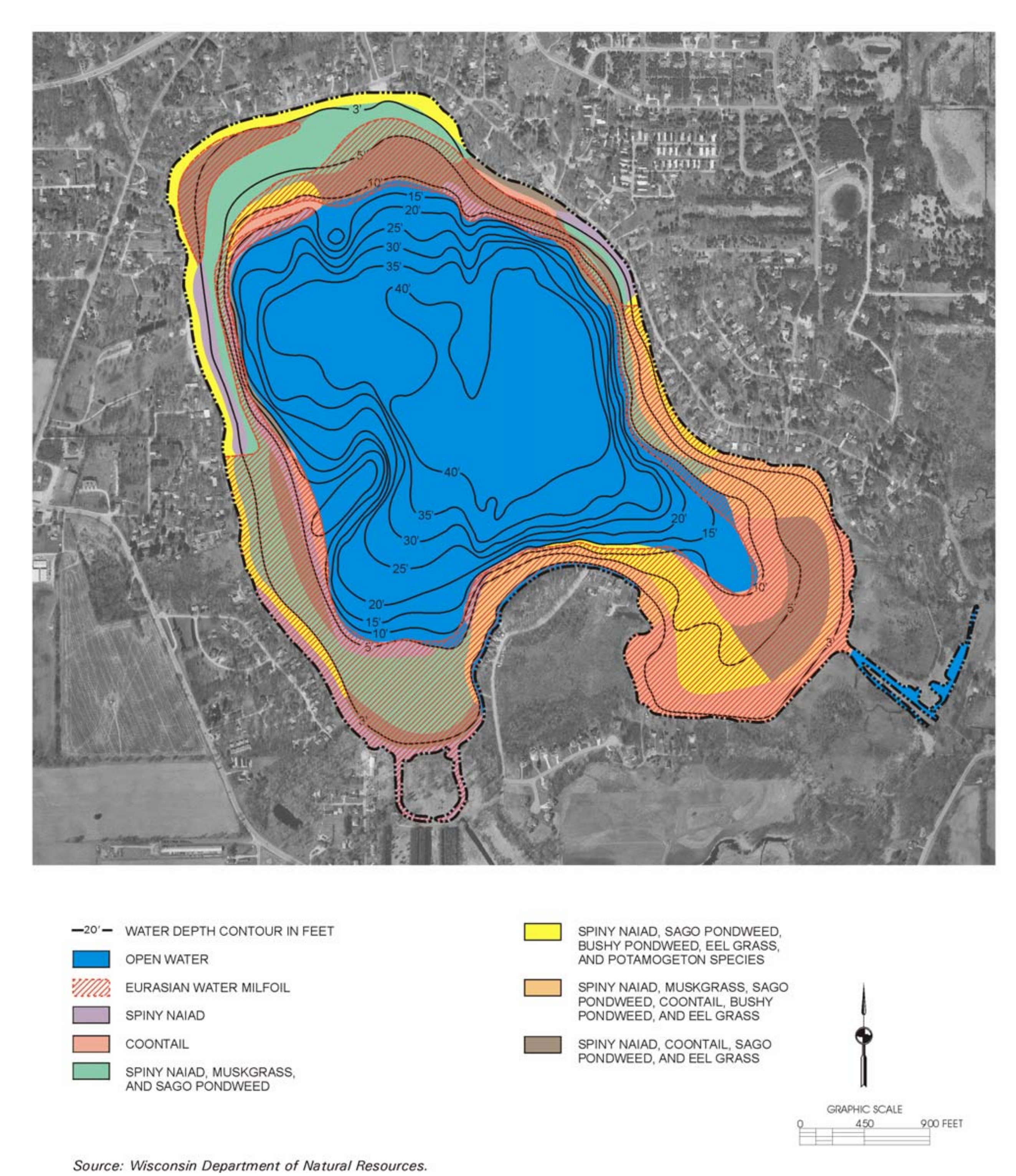
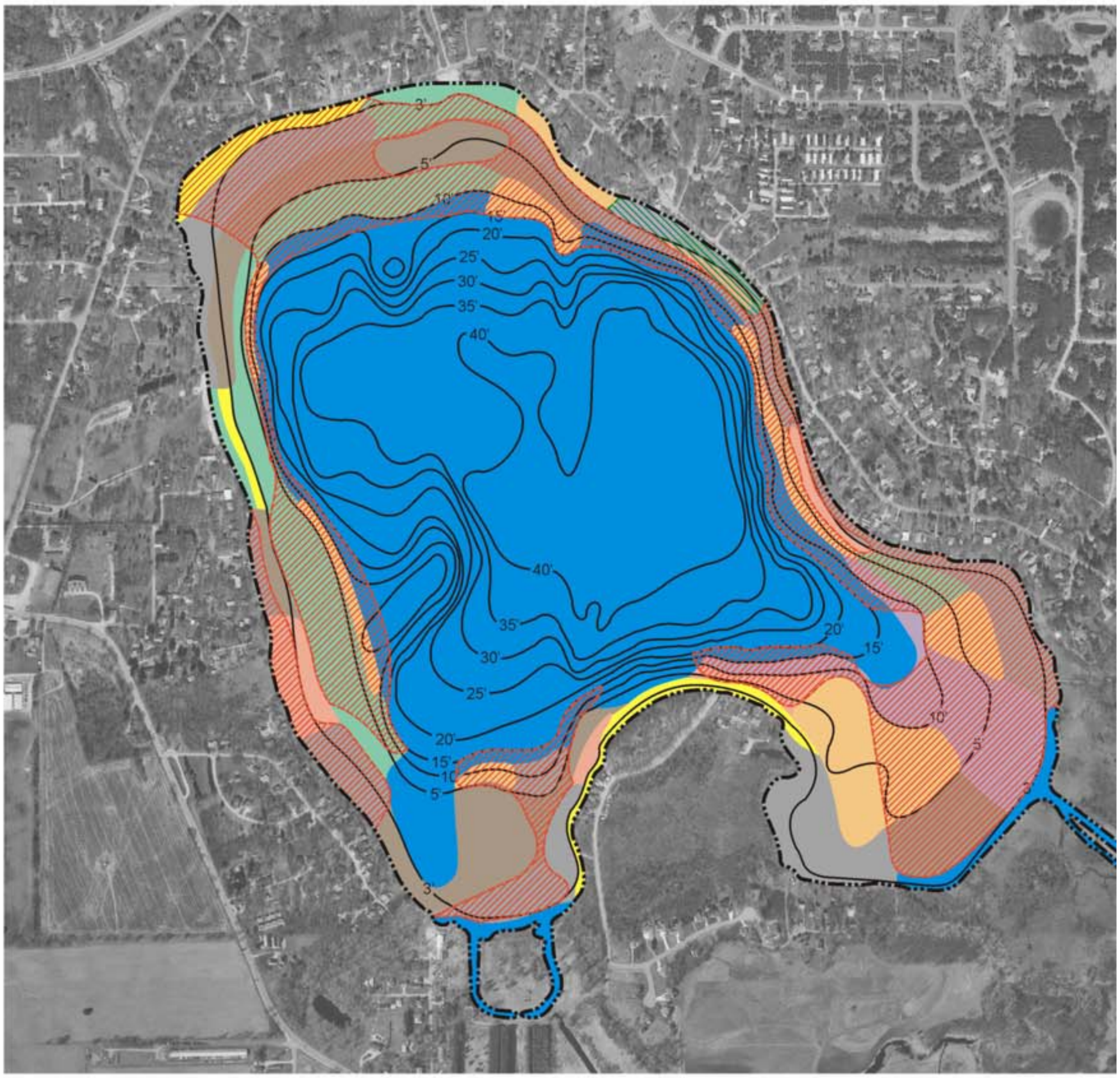


Figure 7: Aquatic Plant Community Distribution (1996)

Map A-5

AQUATIC PLANT COMMUNITY DISTRIBUTION IN LAKE RIPLEY: 2001



- 20' — WATER DEPTH CONTOUR IN FEET
- OPEN WATER
- EURASIAN WATER MILFOIL
- WATER BULRUSH
- MUSKGRASS
- MUSKGRASS AND SPINY NAIAD
- MUSKGRASS, SPINY NAIAD, AND SAGO PONDWEED
- SPINY NAIAD, SAGO PONDWEED, BUSHY PONDWEED, AND COONTAIL
- EEL GRASS, BUSHY PONDWEED, FLAT-STEM PONDWEED, AND COONTAIL
- MUSKGRASS, EEL GRASS, SAGO PONDWEED, BUSHY PONDWEED, FLAT-STEM PONDWEED
- MUSKGRASS, SPINY NAIAD, SAGO PONDWEED, EEL GRASS, BUSHY PONDWEED, VARIABLE PONDWEED, FLAT-STEM PONDWEED, AND WATER STAR GRASS

GRAPHIC SCALE
0 450

Source: Wisconsin Department of Natural Resources.

2001-Survey

Depth	1	2	2A	3	3A	4	5	5A	6	7	7A	8	9	9A	10	10A	11	12	12A	13	14	15	15A
1.5		1			3	2	1	2					1			4	1	1					
3			1	4	3	2		4			1	1	2					1		1			
6	2		3	4	4	2		1	2	3	1		2			2	1				1		
9	4	4	4	4		2		1	3	4	3	4	1	4	2	3	2	3		4	1	4	
12	1		2		1						4		1	2	1	1	1			4		3	
15																							

Transect (column headings)

3 Eurasian water milfoil (number indicates density)

Muskgrass

Muskgrass, Spiny Naiad

Muskgrass, Spiny Naiad, Sago pondweed

Spiny Naiad, Sago pondweed, Bushy Pondweed, Coontail

Eel grass, Bushy Pondweed, Flatstem pondweed, Coontail

Muskgrass, Sago pondweed, Eel grass, Bushy Pondweed, Flatstem pondweed

Muskgrass, Spiny Naiad, Sago pondweed, Eel grass, Variable pondweed, Flatstem pondweed

Muskgrass, Spiny Naiad, Sago pondweed, Eel grass, Bushy Pondweed, Variable pondweed, Flatstem pondweed, Water star grass

1996-Survey

Depth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.5		1		1	1						1	1	1		
3	4	4	2	2	2	1	2		3		2	2	4	1	
6	4	4	2	2	2		4	3			1				1
9	4	1	4	4	2	4	4	4	4	2	3	2			1
12	4				2	3	4	4		3	2	4			1
15					2	4			3		3				

Transect (column headings)

3 Eurasian water milfoil (number indicates density)

Spiny Naiad

Coontail

Spiny Naiad, Muskgrass, Sago pondweed

Spiny Naiad, Coontail, Sago pondweed, Eel grass

Spiny Naiad, Sago pondweed, Bushy Pondweed, Eel grass, Potamogeton Spp.

Spiny Naiad, Muskgrass, Coontail, Sago pondweed, Bushy Pondweed, Eel grass

1991-Survey

Depth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	4	4	1	2	2	1	2		3		2	2	4		
6	4	4	3	2	3		4	3			1				1
9	4	1	4	4	4	4	4	4	4	2	3	2	4		1
12	4				2	4	4	4		3	3	4	4		1
15					2	4			3		3				
18															

Transect (column headings)

3 Eurasian water milfoil (number indicates density)

Spiny Naiad

Coontail

Spiny Naiad, Coontail, Sago pondweed, Bushy Pondweed, Eel grass

Spiny Naiad, Muskgrass, Sago pondweed, Bushy Pondweed, Eel grass, Potamogeton Spp.

1989-Survey

Depth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.5	3	3	4	1	3	1	4	2	4	1	4	4	4		1
6	4	2	4	4	1	2	4	4	4	4		1	1	1	1
12	4	4	1	2	4	4	3	4	3	1	3	3	4	4	4
18	1	1													

Transect (column headings)

3 Eurasian water milfoil (number indicates density)

Eel grass, Coontail, Sago pondweed, Variable pondweed, Floating-leaf pondweed

Small pondweed, Spiny Naiad, Muskgrass, Eel grass, Bushy Pondweed

Illinois Pondweed, Small pondweed, Spiny Naiad, Floating-leaf pondweed, Muskgrass, Eel grass, Bushy Pondweed

Note: Individual plant species with less than 4% frequency occurrence were not included.

Figure 9: Aquatic Plant Community Distribution Among Transect and Depth (1989-2001)

During the 1989 survey, aquatic plant growth occurred throughout the lake to depths of about 15 feet, as shown in Figure 5. Eurasian water milfoil was observed throughout the lake and at all depths sampled. No plant growth was reported from depths in excess of 18 feet. Three distinct communities of aquatic plants were observed: an eel grass-pondweed community dominated the southeastern portion of the lake, an eel grass-muskgrass community was common in the shallower areas along the northern, eastern and southwestern shores, and an eel grass-naiad community typically fringed the eel grass-muskgrass community.

During the 1991 survey, Eurasian water milfoil was not as prevalent throughout the lake as during the 1989 survey, although the plant continued to be reported at all depths sampled (see Figure 6). Three communities of spiny naiad were observed. A naiad-coontail-pondweed community was observed in the southeastern portion of the lake, a naiad-muskgrass-pondweed community was common in the shallower areas of the northern and southwestern portions of the lake, and a community dominated by spiny naiad was reported along the western shoreline. A fourth community consisting of coontail was observed at depths of greater than 5 feet in the southeastern portion of the lake, and fringing the naiad-coontail-pondweed community.

During the 1996 survey, Eurasian water milfoil continued to be present but remained less widespread than during the 1989 survey (see Figure 7). Greater aquatic plant diversity was observed, with six plant communities being distinguished. The southeastern portion of the lake was dominated by a coontail community at depths in excess of 5 feet and along the shoreline. Three spiny naiad communities were also observed at mid-depths of 3-10 feet in this portion of the lake. These included a naiad-coontail community in the central portion of the southeastern lobe of the lake, a naiad-pondweed community in the west-central portion of the lobe, and a naiad-muskgrass community along the eastern shoreline in shallow water. A naiad-muskgrass-pondweed community was observed throughout much of the remainder of the water body.

During the 2001 survey, plant growth was mostly concentrated in those areas where the water depth was less than 12 feet deep (see Figure 8). Eurasian water milfoil continued to be observed throughout the lake, but overall diversity continued to increase with eight aquatic plant communities being distinguished.

Aquatic plants were found at 70-80 percent of the sites sampled. In terms of spatial distribution, Figure 10 suggests that the plants in Lake Ripley have become less evenly distributed and increasingly patchy over the 25-year period of record. It also shows that the distribution of aquatic plants in the lake during 1976 was consistent with the forecast distribution, indicating a uniform distribution of plants in the water body. However, during 1989, 1991 and 1996, the distribution became multimodal. By 2001, the distribution deviated significantly from the forecast distribution, indicating a non-uniform distribution of plants in the lake. This apparent shift toward conditions of greater patchiness in the distribution of aquatic plants may reflect a real shift in plant community composition, from a more uniform plant community composition to a less uniform composition, and/or it may reflect increasingly more refined sampling methodologies employed during successive surveys. The combination of these functions best reflects the observed distribution of aquatic plants in Lake Ripley during 2001. The relative constancy in the numbers of species likely to be sampled at any given site, indicated by the mean density of about 2.0, would suggest that the apparent shift is most likely to be the result of sampling technique.

Figure 11 shows the variation in frequency of occurrence of the five most common aquatic plant species over the 25-year period. Since 1989, Eurasian water milfoil has remained a relatively significant part of the aquatic plant flora of the lake. This species was abundant since as early as 1976, and continued to be present in quantities that approximate between one-fifth and one-third of the aquatic plant flora of the lake (see Tables 6 through 10). Since 1989, when Eurasian water milfoil comprised an estimated 40 percent of the aquatic plant population in the lake, its relative frequency of occurrence has decreased through 2001 when it was determined to comprise about 20 percent of the plant community. Where the plant is present within the lake, its abundance has also been relatively stable at about a moderate 2.6 density value. Although there has been a decrease in the number of sites at which the most abundant rank value of four was recorded (see Figure 12), it remains one of the more densely occurring species in Lake Ripley. This fact is reflected in the Importance Values of the plant, shown in Tables 6 through 10, which are estimated to be among the highest in the lake. The Importance Values indicate Eurasian water milfoil dominance over the aquatic flora of Lake Ripley.

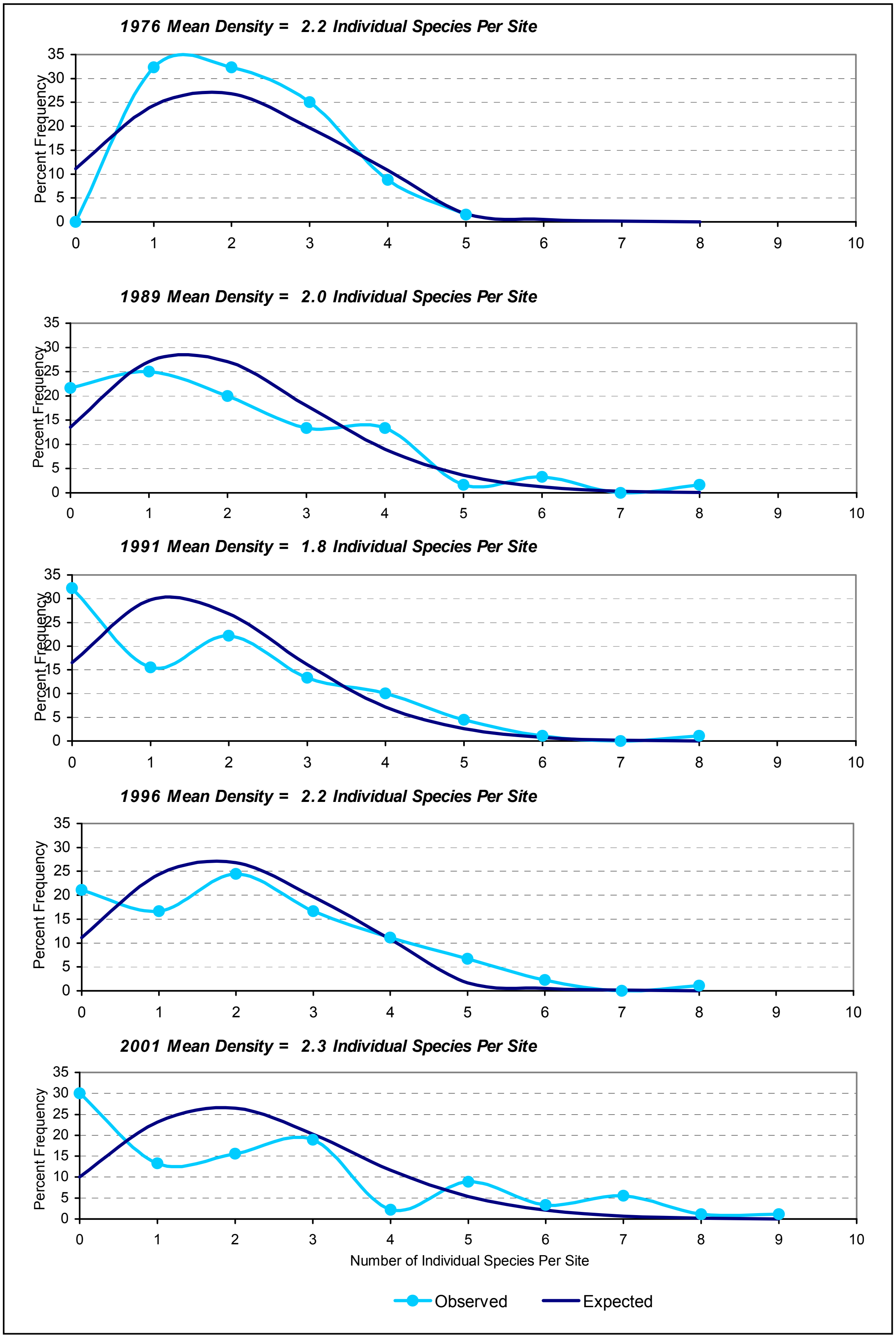


Figure 10: Observed Spatial Distribution of Aquatic Plant Populations and Random Probabilities of Occurrence Predicted from the Poisson Distribution (1976-2001)

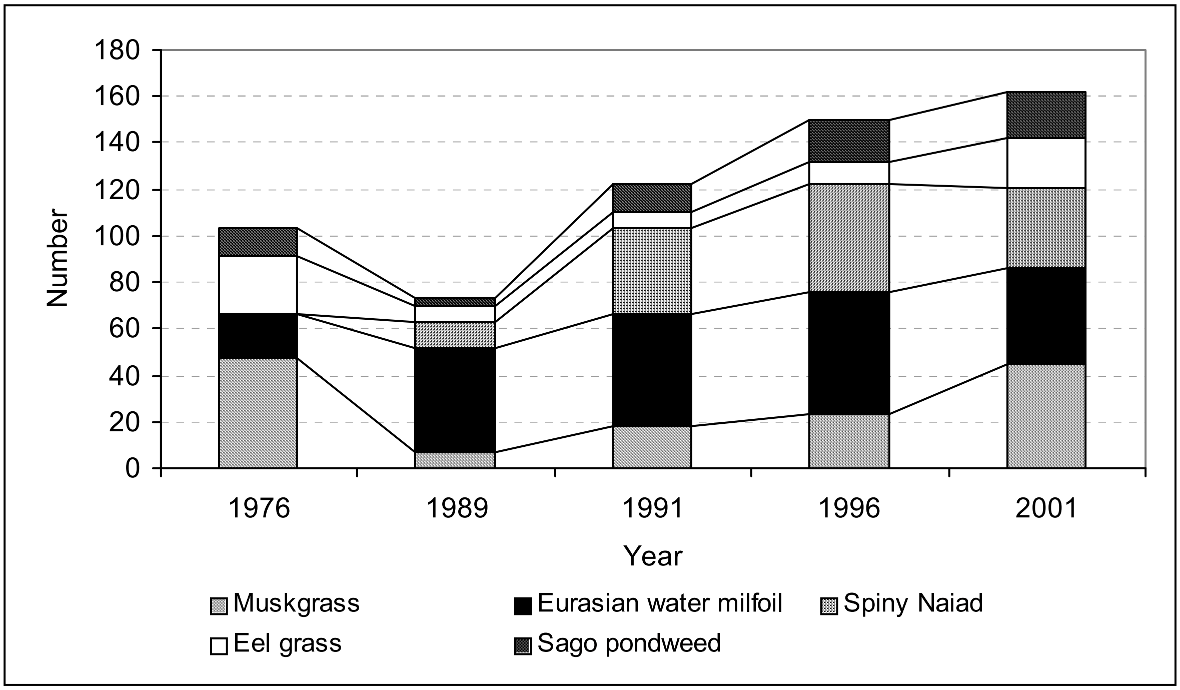
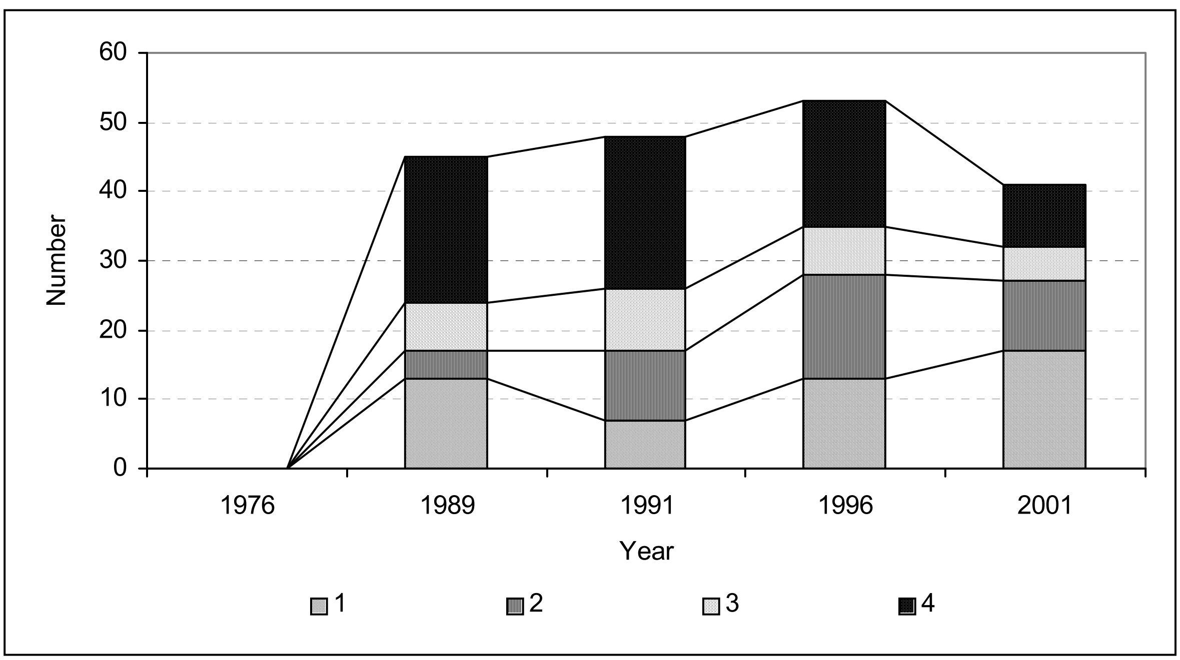


Figure 11: Total Number and Composition of Dominant Aquatic Plant Species Found Among Sample Sites (1976-2001)



Note: Density data were not available from the 1976 aquatic plant survey.

Figure 12: Total Number and Composition of Eurasian Water Milfoil Found Among Density Categories 1-4 (1976-2001)

Muskgrass (*Chara vulgaris*) and eel grass (*Vallisneria americana*) are low-growing native plants that pose few problems for recreational lake users. Lake Ripley also contained bladderwort (*Utricularia vulgaris*), waterweed (*Elodea canadensis*), numerous species of pondweed (*Potamogeton* spp.), and water star grass (*Heteranthera dubia*). Each of these native species provides good fish and aquatic wildlife habitat and poses little interference with the recreational uses of the lake. Eurasian water milfoil (*Myriophyllum spicatum*), in contrast, is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. This plant can quickly displace native plant species and interfere with the aesthetic and recreational use of the water bodies.

During the 2001 survey, an extensive stand of the emergent aquatic plant *Scirpus subterminalis*, a bulrush, was observed on the northeastern shoreline of the lake. This plant provides exceptional habitat for fishes and wildlife, and is of considerable ecological value to the lake and its ecosystem.

Analyses of the data sets reported during each of the five surveys (shown in Table 11) suggest changes in the Lake Ripley aquatic plant community, especially between the communities reported during 1976 and 1989 ($r = 0.29$). Greater similarity between communities was observed during subsequent surveys, where correlations were 0.75 (1989-1991), 0.99 (1991-1996), and 0.85 (1996-2001). While the precise reasons for the observed changes are unclear, they are most likely related to a combination of factors. These factors include aquatic plant management practices, changes in land use (which affect nutrient supply and availability), lake uses, climatic factors and natural biological processes contributing to inter-annual variability among plant communities.

The similarity indices, calculated using data obtained from the five aquatic plant surveys, confirm these statistical observations. The Similarity Index (SI) values ranged from 0.38 to 0.94. The greatest similarity was observed between the 1991 and 1996 data sets, while the least similarity was recorded between the 1976 and 1989 data sets. Notwithstanding, significant differences were also noted between 1989 and 1991, and between 1996 and 2001, where similarity index values of 0.59 and 0.72, respectively, were calculated. An SI value of 0.85 or greater is indicative of essentially no change in the communities. With the exception of the surveys conducted during 1991 and 1996, the plant communities have been undergoing significant changes. However, the SI values alone do not provide any indication of whether the change is positive or negative from a recreational, aesthetic, or habitat value perspective, so care must be taken when using this number.

The Simpson Diversity Index during the period between 1976 and 2001 ranged from 0.82 to 0.86. This would seem to suggest that the community has remained somewhat diverse during the entire period of record. In this regard, the Simpson Diversity Index confirms the pattern discerned in the spatial distribution analysis set forth in Figure 10; namely that there has been, and continues to be, a moderate degree of diversity in the plant communities as indicated by a mean density of about 2.0. However, the problem with the Simpson Index is that there is currently a lack of consensus as to what degree of difference between the values is significant.

The importance values, shown in Table 15 and calculated for the periods between 1976 and 1989, 1989 and 1991, 1991 and 1996, and 1996 and 2001, suggest that there has been some change in the distribution of plants within the community. Muskgrass, Eurasian water milfoil, and spiny naiad remain the most commonly occurring species, but the importance values show that other species have increased in importance in recent years; specifically, eel grass, Sago pondweed, and bushy pondweed. The more uniform, overall decline in the importance values of the plant species recorded also suggests a healthier lake ecosystem.

While the importance value incorporates both the relative frequency and average density of the plant species present, the relative frequencies shown in Table 14 also suggest a shift toward a healthier plant community. The relative frequency gives a good indication as to how the plants occur relative to one another. These data clearly show a community that is changing to one with a more balanced plant distribution. In 1976, for example, the relative frequencies of the three most common plants (muskgrass, milfoil, and eel grass) were 32 percent, 13 percent, and 17 percent, respectively, adding up to 63 percent out of 100 percent. In contrast, the 2001 numbers are much different. These three plants had relative frequencies of 21 percent, 19 percent, and 10 percent, respectively, adding up to 50 percent out of 100 percent. Spiny naiad and Sago pondweed contributed a further 27 percent. This means these plants are of relatively equal abundance and fairly evenly distributed in the lake.

Table 16 shows the results of including eight additional transects—for a total of 23 transects to the historical 15 transects—on the aquatic plant species abundance and distribution during 2001.

Table 11: Number of Aquatic Plant Species Found Among Sample Sites (1976-2001)

Species	Year				
	1976	1989	1991	1996	2001
Muskgrass	47	7	18	23	45
Eurasian water milfoil	19	45	48	53	41
Spiny Naiad	0	11	37	46	35
Eel grass	25	7	7	10	21
Sago pondweed	12	3	12	18	20
Bushy Pondweed	0	7	8	11	13
Flatstem pondweed	0	0	0	0	8
Variable pondweed	0	2	0	0	8
Coontail	14	3	19	21	5
Scirpus subterminalis	0	0	0	0	4
Elodea	2	0	2	1	3
Water star grass	0	0	0	0	3
Curly-leaf pondweed	1	1	0	0	1
Floating-leaf pondweed	10	8	0	0	1
Illinois Pondweed	0	13	0	1	0
Small pondweed	0	13	0	0	0
Water milfoil (M. exalbescens)	0	0	2	0	0
Water milfoil (M. sibiricum)	0	0	0	1	0
Bladderwort	6	0	2	2	1
Potamogeton spp.	7	0	5	7	0
Naiad spp.	3	0	0	0	0
Total Number of Species	11	12	11	12	15

Table 12: Percent Frequency Occurrence of Aquatic Plant Species (1976-2001)

Species	Year				
	1976	1989	1991	1996	2001
Muskgrass	69.1	11.7	20.0	25.6	50.0
Eurasian water milfoil	27.9	75.0	53.3	58.9	45.6
Spiny Naiad	0.0	18.3	41.1	51.1	38.9
Eel grass	36.8	11.7	7.8	11.1	23.3
Sago pondweed	17.6	5.0	13.3	20.0	22.2
Bushy Pondweed	0.0	11.7	8.9	12.2	14.4
Flatstem pondweed	0.0	0.0	0.0	0.0	8.9
Variable pondweed	0.0	3.3	0.0	0.0	8.9
Coontail	20.6	5.0	21.1	23.3	5.6
Scirpus subterminalis	0.0	0.0	0.0	0.0	4.4
Elodea	2.9	0.0	2.2	1.1	3.3
Water star grass	0.0	0.0	0.0	0.0	3.3
Curly-leaf pondweed	1.5	1.7	0.0	0.0	1.1
Floating-leaf pondweed	14.7	13.3	0.0	0.0	1.1
Illinois Pondweed	0.0	21.7	0.0	1.1	0.0
Small pondweed	0.0	21.7	0.0	0.0	0.0
Water milfoil (M. exalbescens)	0.0	0.0	2.2	0.0	0.0
Water milfoil (M. sibiricum)	0.0	0.0	0.0	1.1	0.0
Bladderwort	8.8	0.0	2.2	2.2	1.1
Potamogeton spp.	10.3	0.0	5.6	7.8	0.0
Naiad spp.	4.4	0.0	0.0	0.0	0.0

Table 13: Average Density of Aquatic Plant Species (1976-2001)

Species	Year				
	1976	1989	1991	1996	2001
Muskgrass	--	1.29	2.33	2.17	3.04
Eurasian water milfoil	--	2.80	2.96	2.57	2.15
Spiny Naiad	--	2.00	2.51	2.28	2.43
Eel grass	--	1.57	1.57	1.40	2.00
Sago pondweed	--	1.00	2.33	2.00	2.00
Bushy Pondweed	--	1.14	2.63	2.18	1.92
Flatstem pondweed	--	--	--	--	1.75
Variable pondweed	--	1.00	--	--	1.50
Coontail	--	3.00	2.53	1.95	3.40
Scirpus subterminalis	--	--	--	--	3.25
Elodea	--	--	1.00	1.00	1.33
Water star grass	--	--	--	--	3.00
Curly-leaf pondweed	--	1.00	--	--	1.00
Floating-leaf pondweed	--	1.13	--	--	1.00
Illinois Pondweed	--	1.38	--	1.00	--
Small pondweed	--	1.23	--	--	--
Water milfoil (M. exalbescens)	--	--	1.00	--	--
Water milfoil (M. sibiricum)	--	--	--	1.00	--
Bladderwort	--	--	1.50	1.50	1.00
Potamogeton spp.	--	--	1.20	1.14	--
Naiad spp.	--	--	--	--	--

Note: Average densities could not be calculated from the 1976 survey.

Table 14: Percent Relative Frequency of Occurrence of Aquatic Plant Species (1976-2001)

Species	Year				
	1976	1989	1991	1996	2001
Muskgrass	32.2	5.8	11.3	11.9	21.5
Eurasian water milfoil	13.0	37.5	30.0	27.3	19.6
Spiny Naiad	0.0	9.2	23.1	23.7	16.7
Eel grass	17.1	5.8	4.4	5.2	10.0
Sago pondweed	8.2	2.5	7.5	9.3	9.6
Bushy Pondweed	0.0	5.8	5.0	5.7	6.2
Flatstem pondweed	0.0	0.0	0.0	0.0	3.8
Variable pondweed	0.0	1.7	0.0	0.0	3.8
Coontail	9.6	2.5	11.9	10.8	2.4
Scirpus subterminalis	0.0	0.0	0.0	0.0	1.9
Elodea	1.4	0.0	1.3	0.5	1.4
Water star grass	0.0	0.0	0.0	0.0	1.4
Curly-leaf pondweed	0.7	0.8	0.0	0.0	0.5
Floating-leaf pondweed	6.8	6.7	0.0	0.0	0.5
Illinois Pondweed	0.0	10.8	0.0	0.5	0.0
Small pondweed	0.0	10.8	0.0	0.0	0.0
Water milfoil (M. exalbescens)	0.0	0.0	1.3	0.0	0.0
Water milfoil (M. sibiricum)	0.0	0.0	0.0	0.5	0.0
Bladderwort	4.1	0.0	1.3	1.0	0.5
Potamogeton spp.	4.8	0.0	3.1	3.6	0.0
Naiad spp.	2.1	0.0	0.0	0.0	0.0

Table 15: Importance Value of Aquatic Plant Species (1976-2001)

Species	Year				
	1976	1989	1991	1996	2001
Muskgrass	--	8	26	26	66
Eurasian water milfoil	--	105	89	70	42
Spiny Naiad	--	18	58	54	41
Eel grass	--	9	7	7	20
Sago pondweed	--	3	18	19	19
Bushy Pondweed	--	7	13	12	12
Flatstem pondweed	--	--	--	--	7
Variable pondweed	--	2	--	--	6
Coontail	--	8	30	21	8
Scirpus subterminalis	--	--	--	--	6
Elodea	--	--	1	1	2
Water star grass	--	--	--	--	4
Curly-leaf pondweed	--	1	--	--	0
Floating-leaf pondweed	--	8	--	--	0
Illinois Pondweed	--	15	--	1	--
Small pondweed	--	13	--	--	--
Water milfoil (M. exalbescens)	--	--	1	--	--
Water milfoil (M. sibiricum)	--	--	--	1	--
Bladderwort	--	--	2	2	0
Potamogeton spp.	--	--	4	4	--
Naiad spp.	--	--	--	--	--

Note: Importance values could not be calculated from the 1976 survey.

Table 16: Results of Including Eight Additional Transects on Species Abundance and Distribution (2001)

Species	Population Parameters									
	Number of Sites Found		Percent Frequency of Occurrence		Average Density		Percent Relative Frequency		Importance Value	
	23 Transects	Difference = 23 - 15 Transects[a]	23 Transects	Difference = 23 - 15 Transects[a]	23 Transects	Difference = 23 - 15 Transects[a]	23 Transects	Difference = 23 - 15 Transects[a]	23 Transects	Difference = 23 - 15 Transects[a]
Muskgrass	62	17	47	-3.0	2.97	-0.08	20	-2.0	58	-7.6
Eurasian water milfoil	63	22	48	2.2	2.25	0.11	20	0.2	45	2.6
Spiny Naiad	58	23	44	5.1	2.53	0.11	18	1.5	47	5.7
Eel grass	27	6	20	-2.9	2.15	0.15	9	-1.6	18	-1.8
Sago pondweed	40	20	30	8.1	1.98	-0.02	13	3.0	25	5.8
Bushy Pondweed	19	6	14	-0.1	2.00	0.08	6	-0.2	12	0.0
Flatstem pondweed	12	4	9	0.2	2.25	0.50	4	0.0	9	1.8
Variable pondweed	13	5	10	1.0	1.46	-0.04	4	0.3	6	0.2
Coontail	10	5	8	2.0	3.40	0.00	3	0.8	11	2.6
Scirpus Subterminalis	0	-4	0	-4.4	0.00	-3.3	0	-1.9	0	-6.2
Elodea	3	0	2	-1.1	1.33	0.00	1	-0.5	1	-0.7
Water star grass	4	1	3	-0.3	2.50	-0.50	1	-0.2	3	-1.2
Curly-leaf pondweed	1	0	1	-0.4	1.00	0.00	0	-0.2	0	-0.2
Floating-leaf pondweed	1	0	1	-0.4	1.00	0.00	0	-0.2	0	-0.2
Illinois Pondweed	3	3	2	2.3	1.00	1.00	1	0.9	1	0.9

[a] Values were calculated by subtracting totals generated from data using 23 transects minus totals generated from data using the historic 15 transects. Positive values indicate increases and negative values decreases in aquatic plant species for each of the population parameters.

DENSITY-DISTRIBUTION TREND ANALYIS

A Geographic Information System (GIS) was employed to help quantify and delineate plant density-distribution trends.[18] Data from the 1989, 1991, 1996 and 2001 inventories were used to map these trends as they applied to the five most dominant species found during the 12-year sample period (see Figures 13 through 22). These species included muskgrass (*Chara* spp.), Eurasian water milfoil (*Myriophyllum spicatum*), spiny naiad (*Najas marina*), sago pondweed (*Potamogeton pecinatus*), and water celery—or eel grass (*Vallisneria americana*). The purpose of the analysis was to gain a clearer understanding of plant growth patterns, especially in relation to changes in Eurasian water milfoil distribution and abundance. Theoretically, predictions could then be made as to how the plant community might respond following a re-insurgence or decline in Eurasian water milfoil.

The analysis identified a gradual decline in milfoil abundance over the period of study. This finding corresponded with an increase in muskgrass and spiny naiad (and to a lesser extent sago pondweed and eel grass) abundance. It was also shown that areas of high native plant diversity remained less susceptible of being displaced by milfoil.

[18] *Kokkonen, Gerald A. 2002. Analysis of Aquatic Plant Density-Distribution Trends for Years 1989, 1991, 1996 and 2001, Lake Ripley, Oakland Township, Wisconsin. GIS/Cartography Certificate Internship Project. University of Wisconsin-Madison Geography Department.*

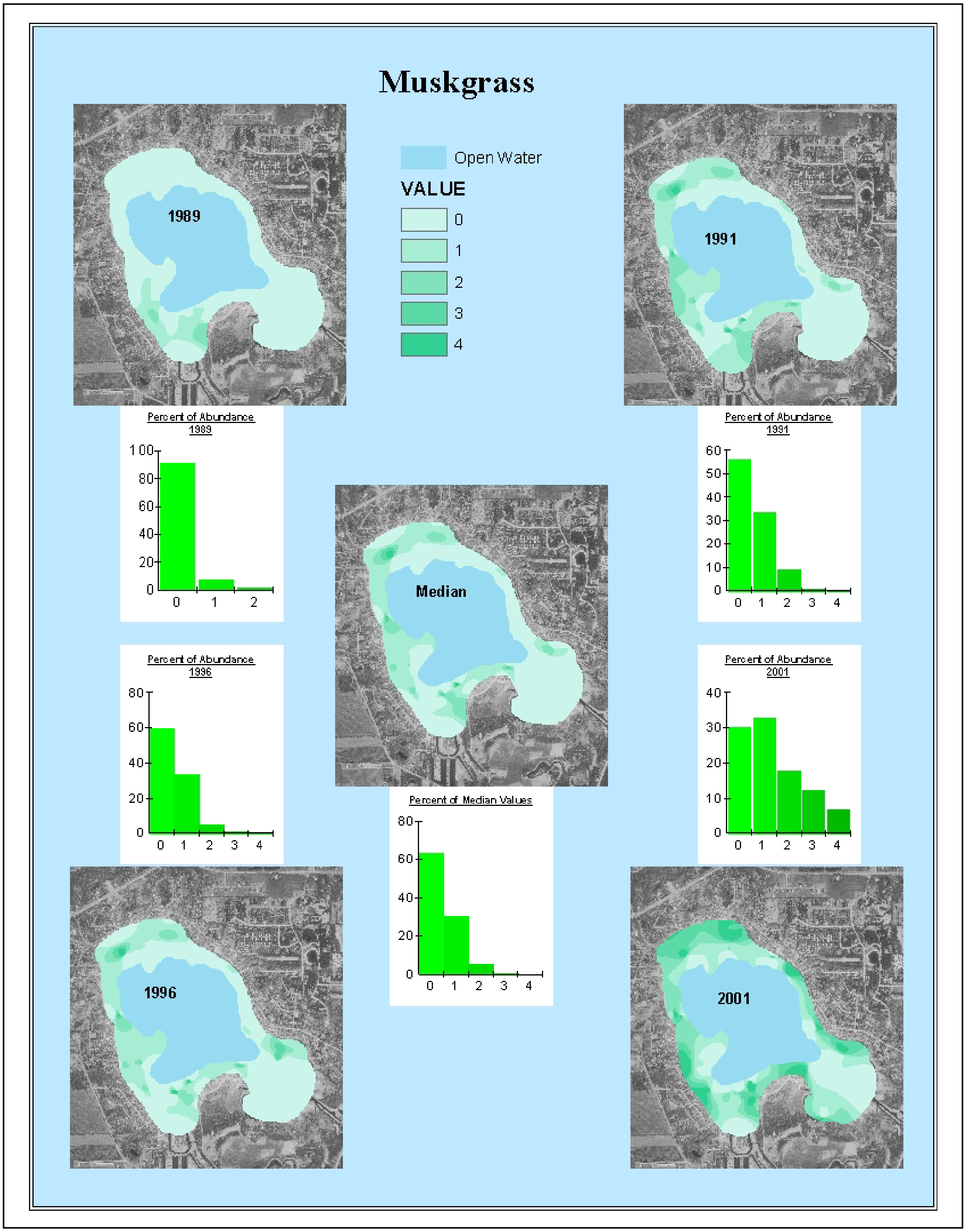


Figure 13: Muskgrass Density-Distribution Trends (1989-2001)

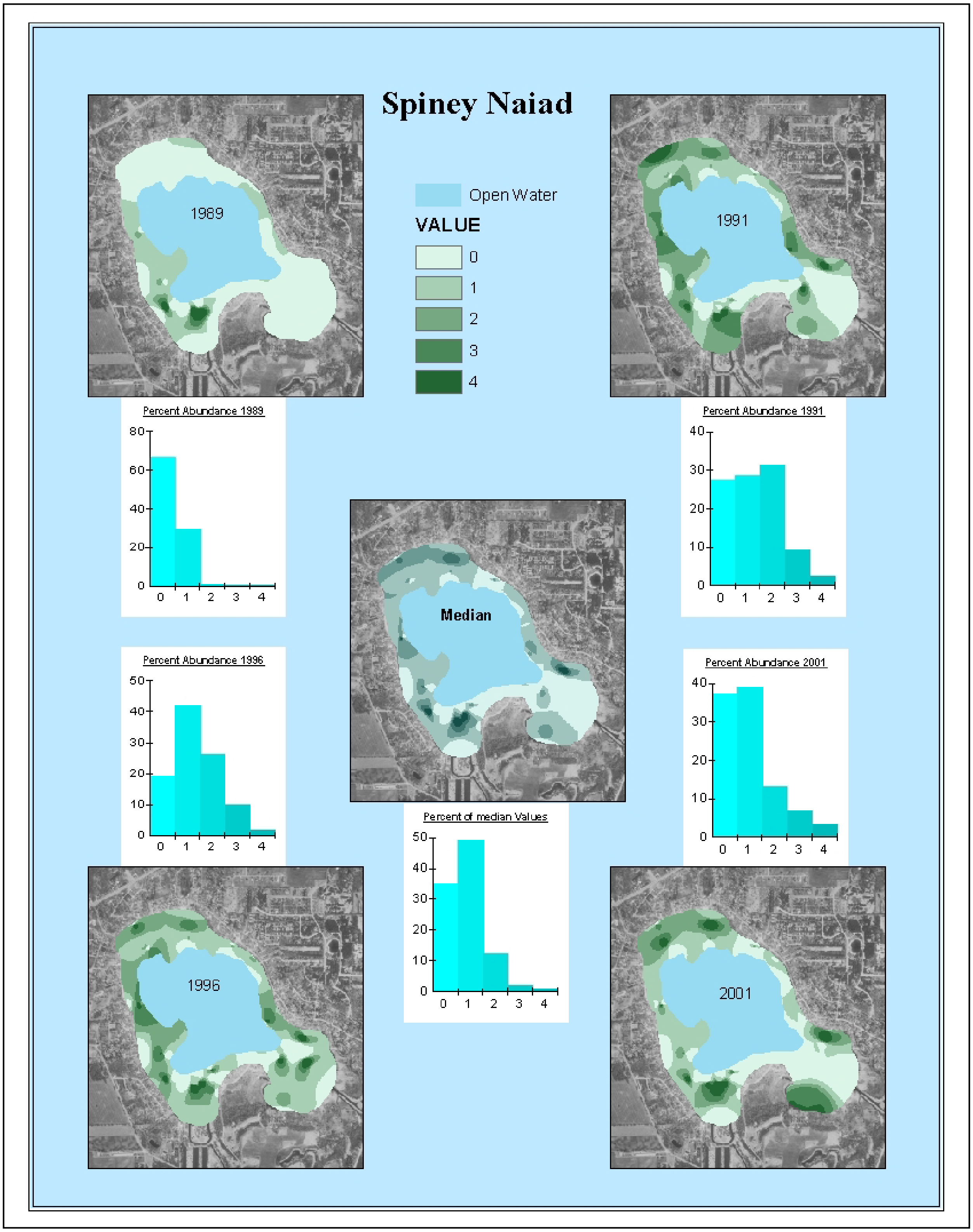


Figure 14: Spiny Naiad Density-Distribution Trends (1989-2001)

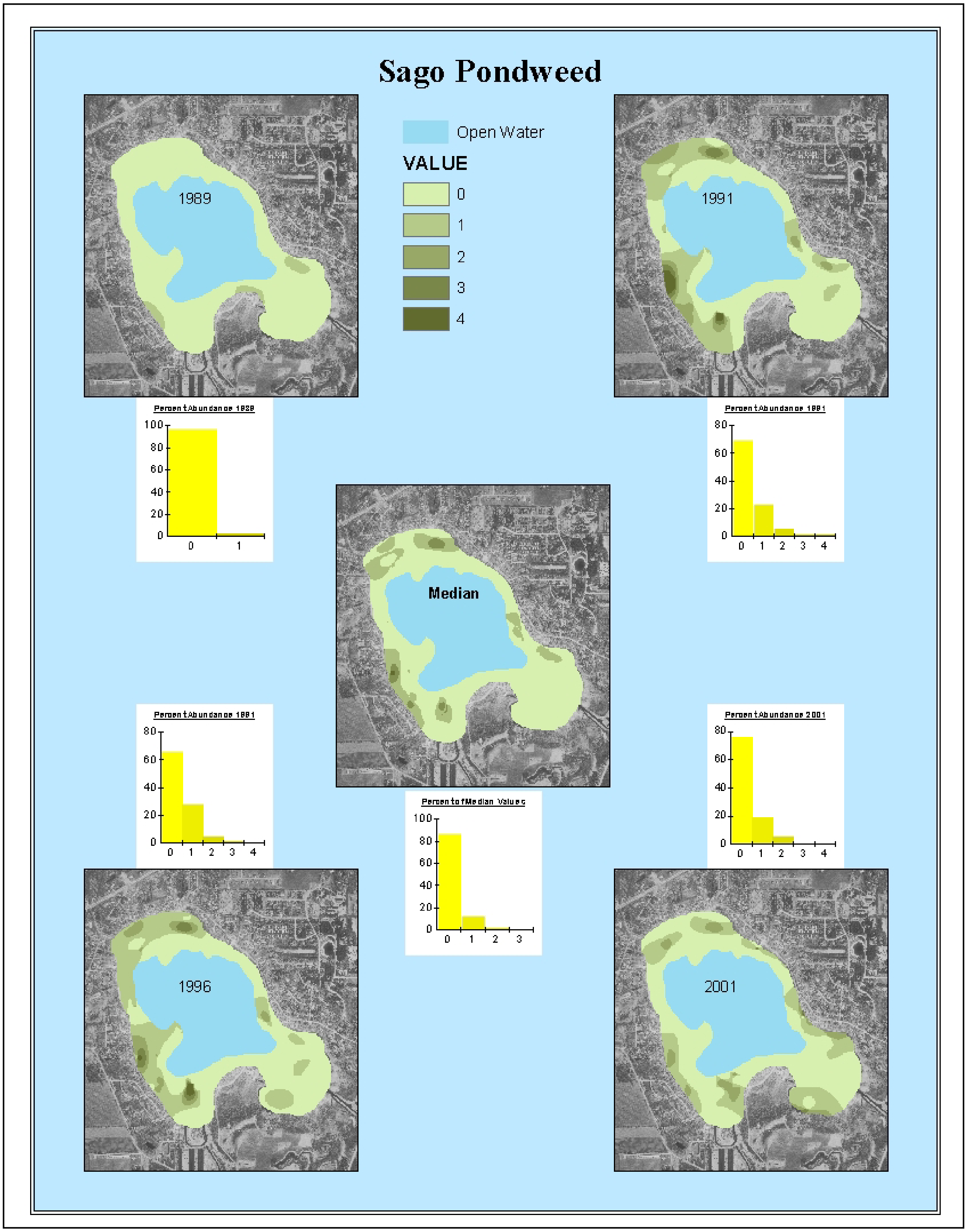


Figure 15: Sago Pondweed Density-Distribution Trends (1989-2001)

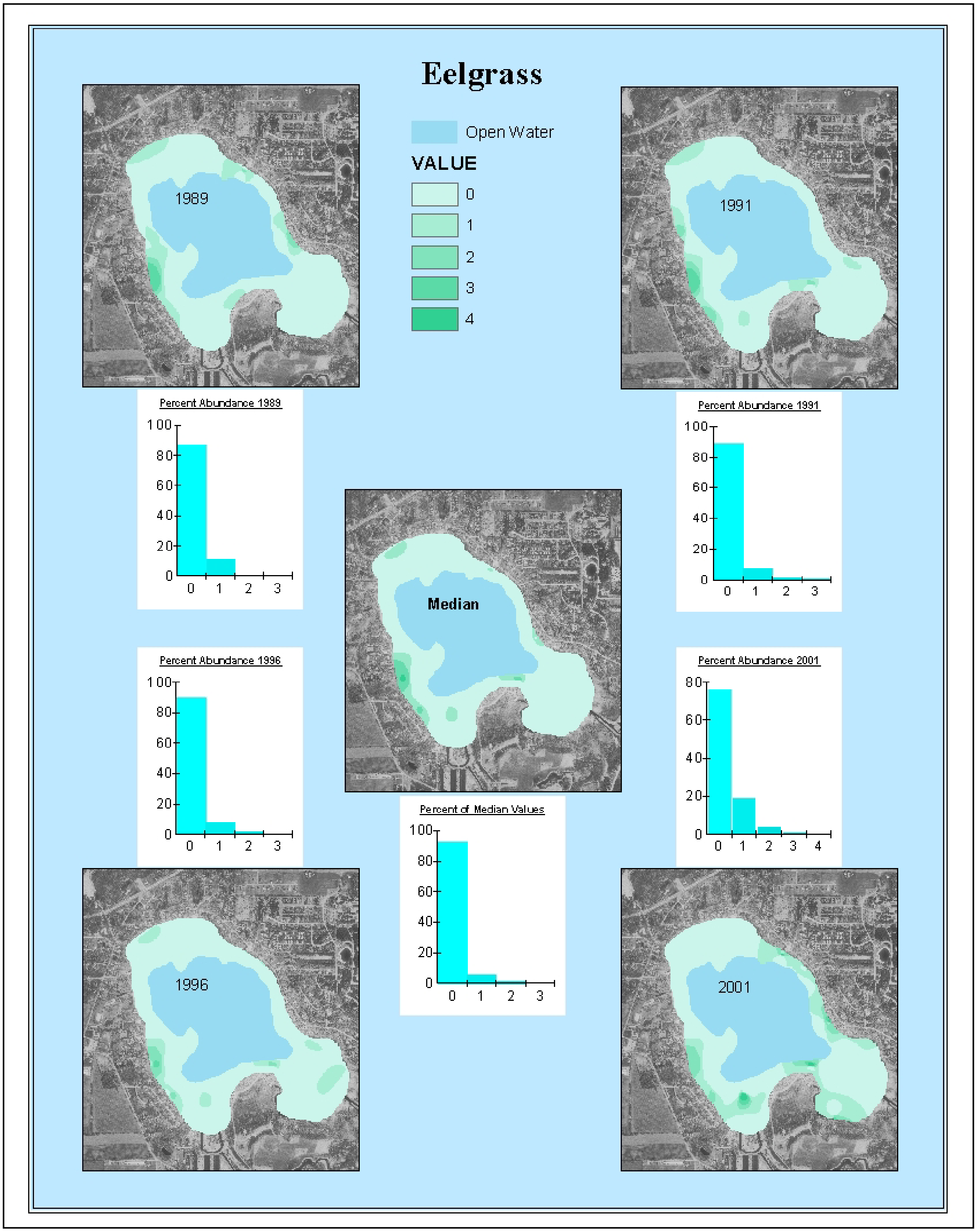


Figure 16: Eel Grass Density-Distribution Trends (1989-2001)

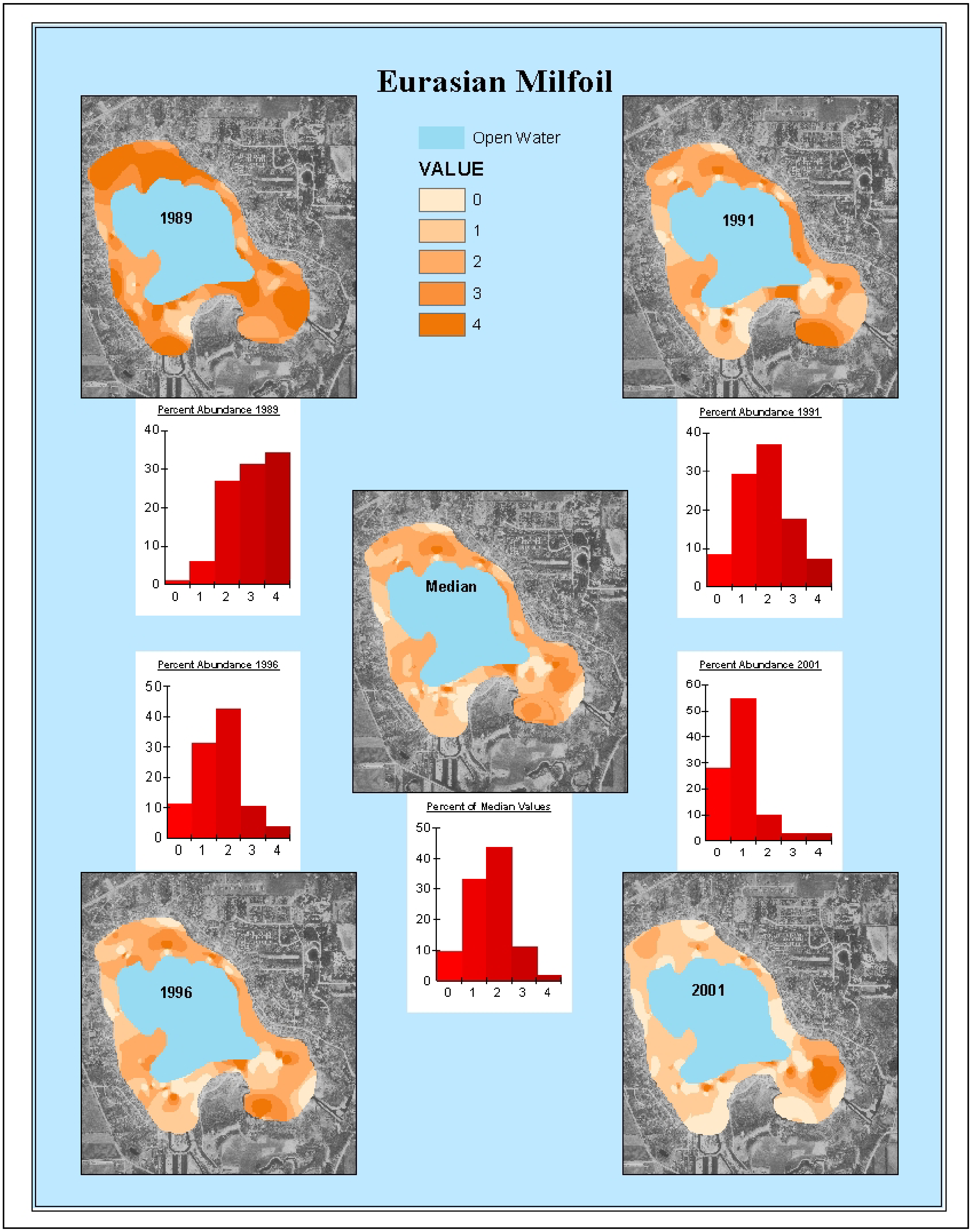


Figure 17: Eurasian Water Milfoil Density-Distribution Trends (1989-2001)

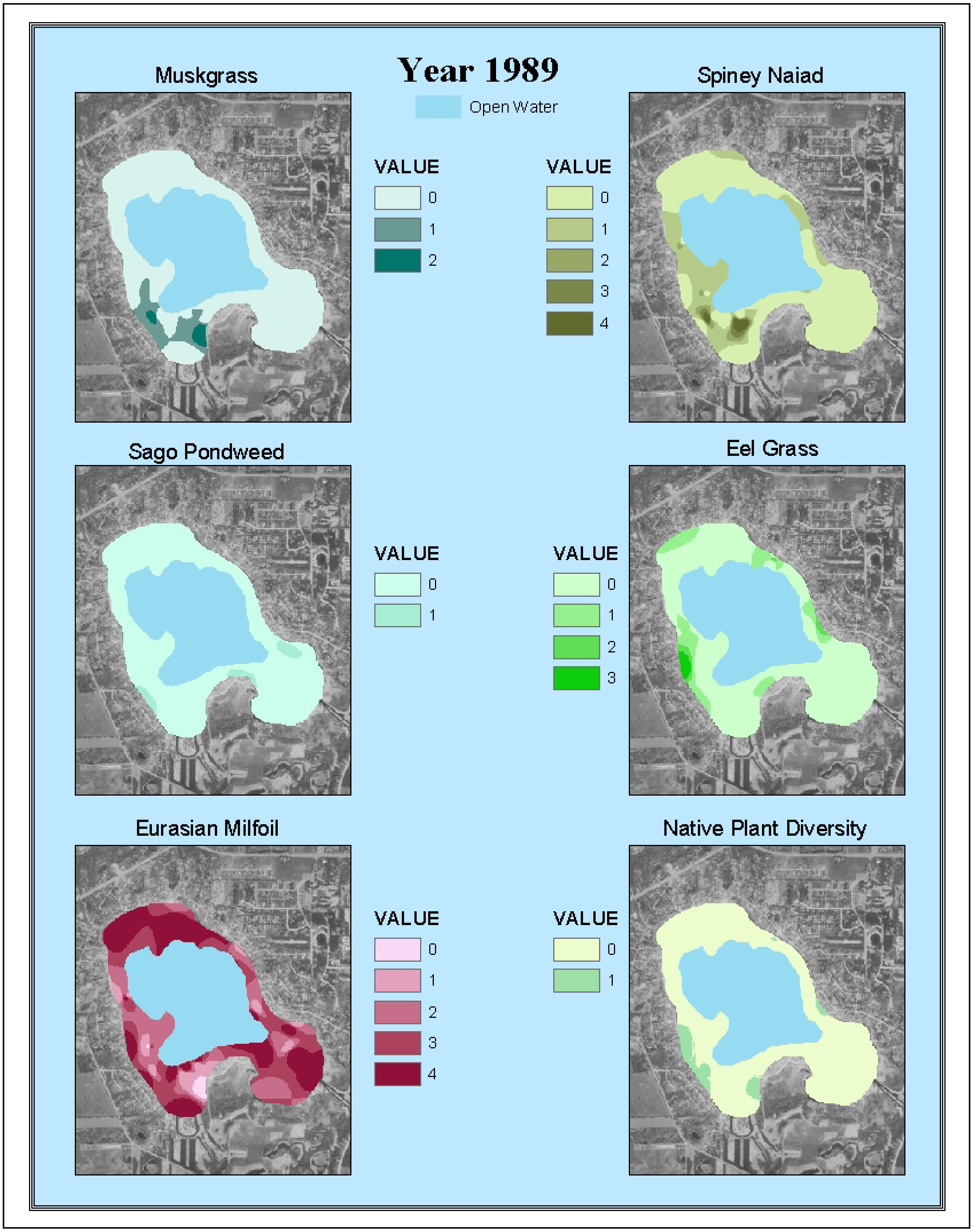


Figure 18: Density-Distributions of Historically Dominant Species (1989)

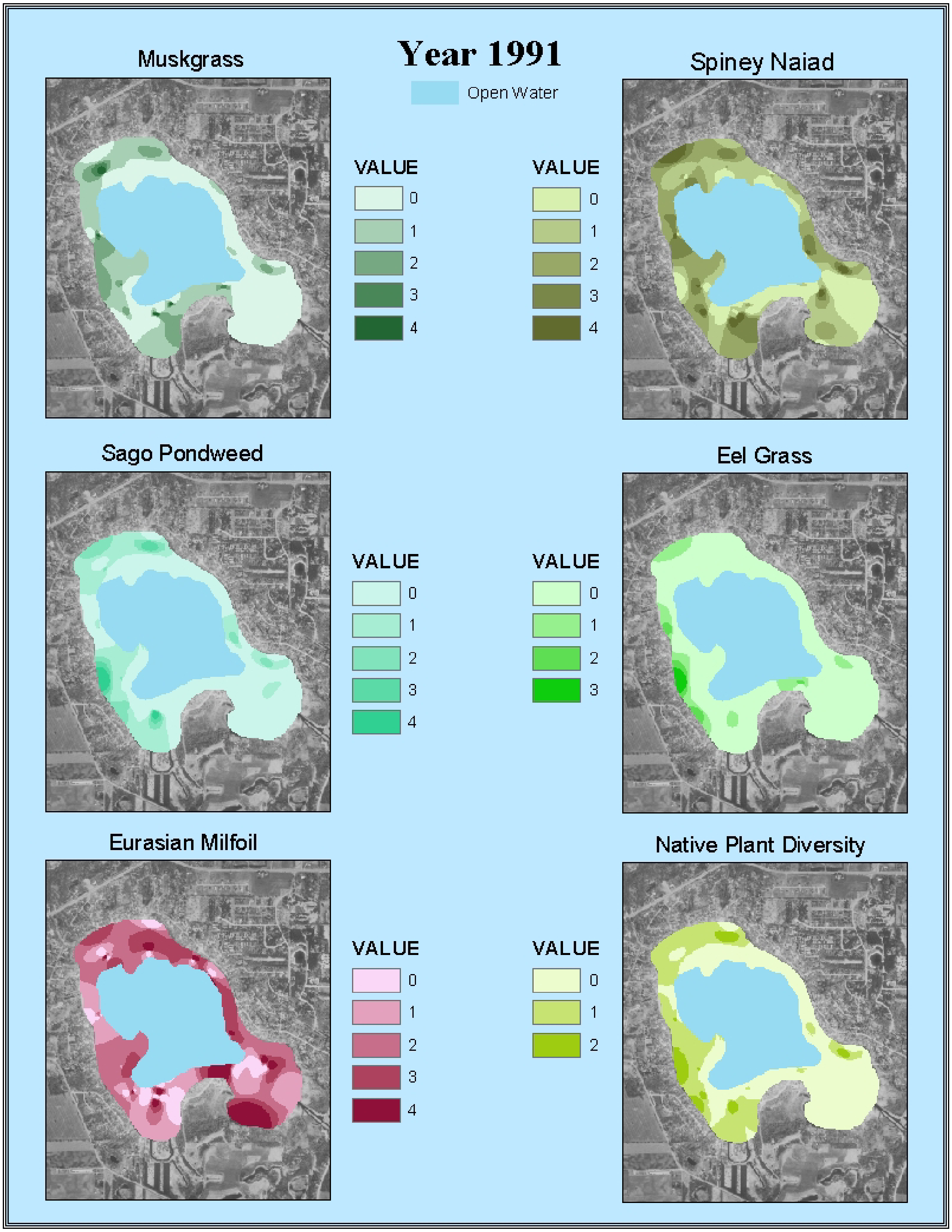


Figure 19: Density-Distributions of Historically Dominant Species (1991)

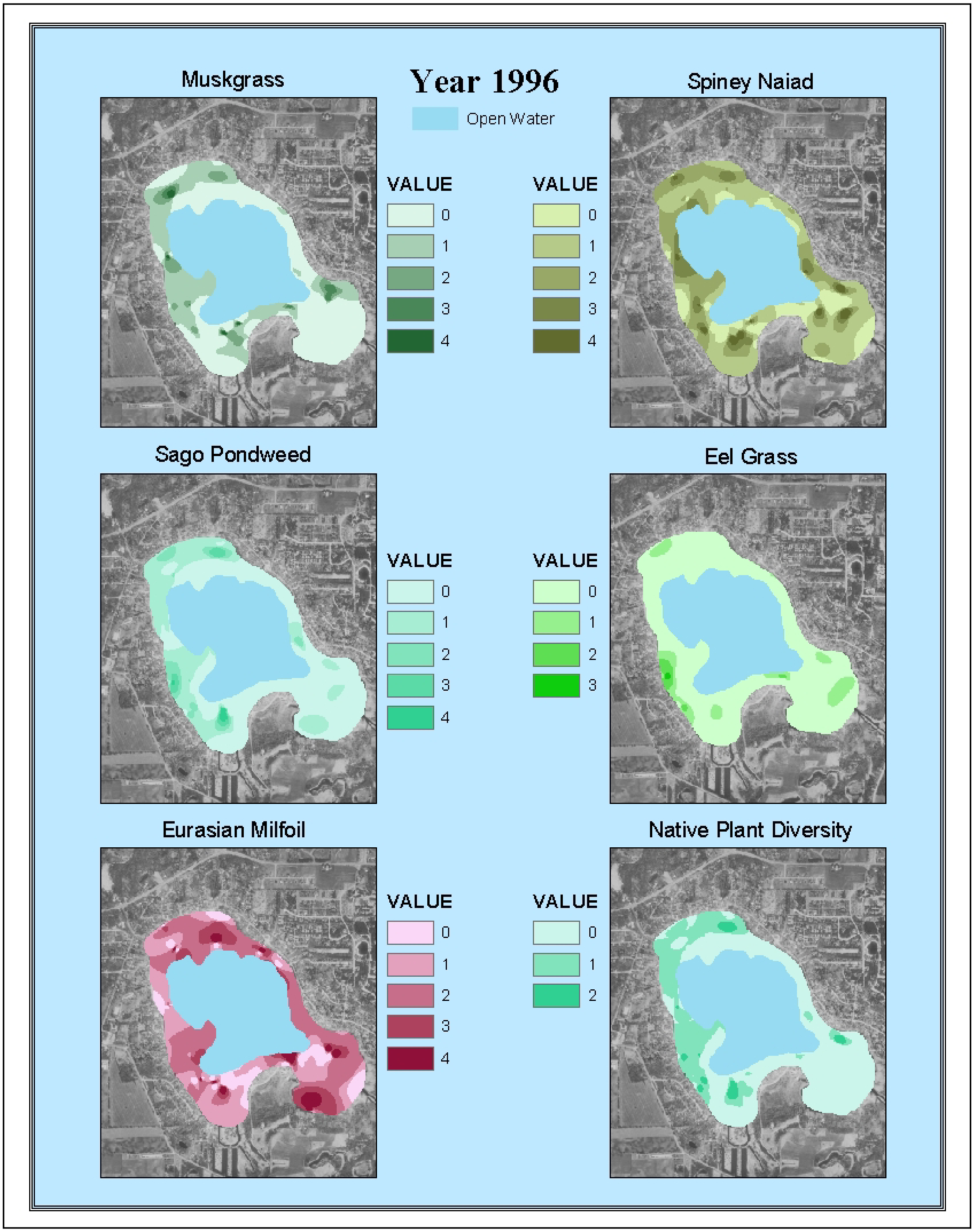


Figure 20: Density-Distributions of Historically Dominant Species (1996)

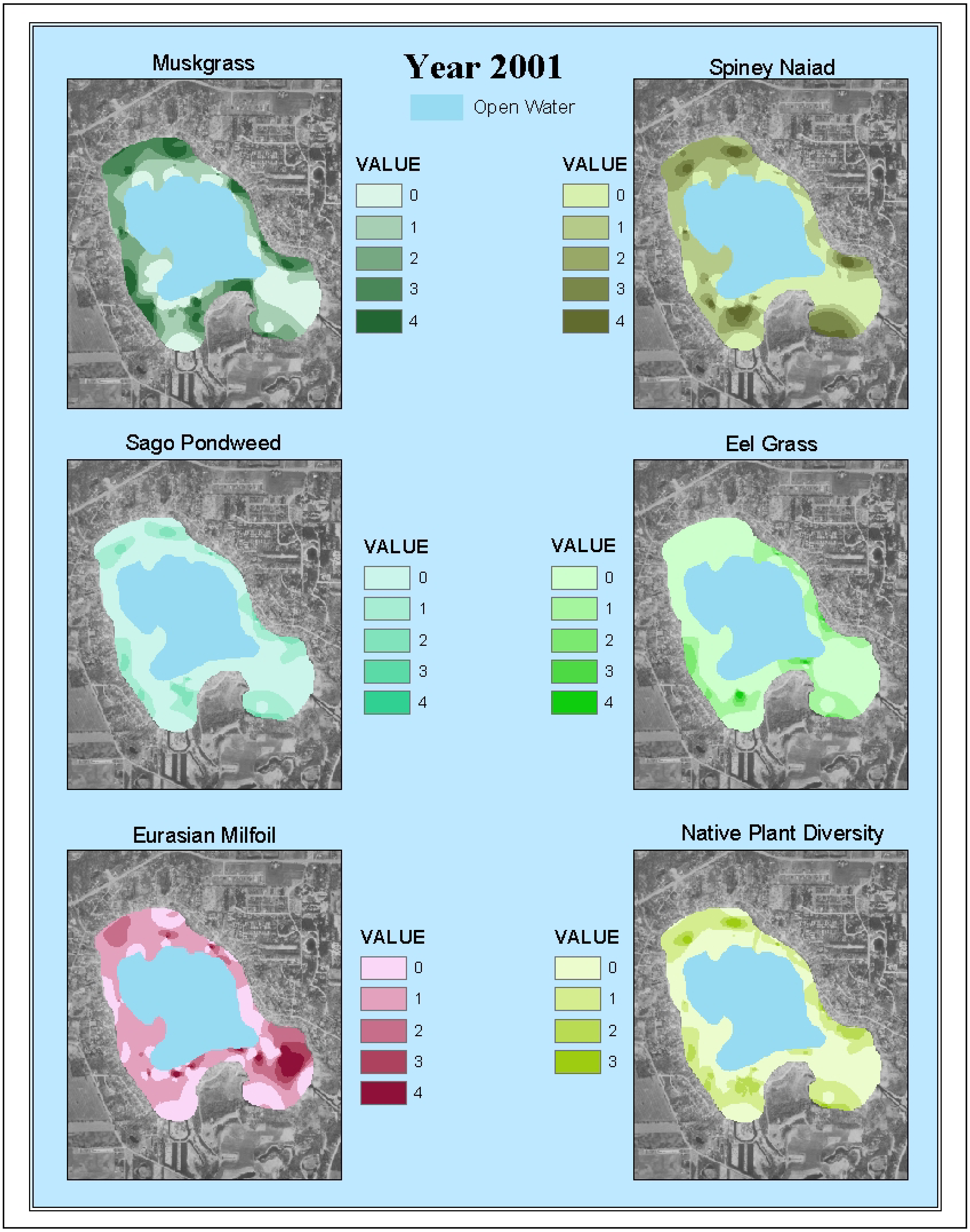


Figure 21: Density-Distributions of Historically Dominant Species (2001)

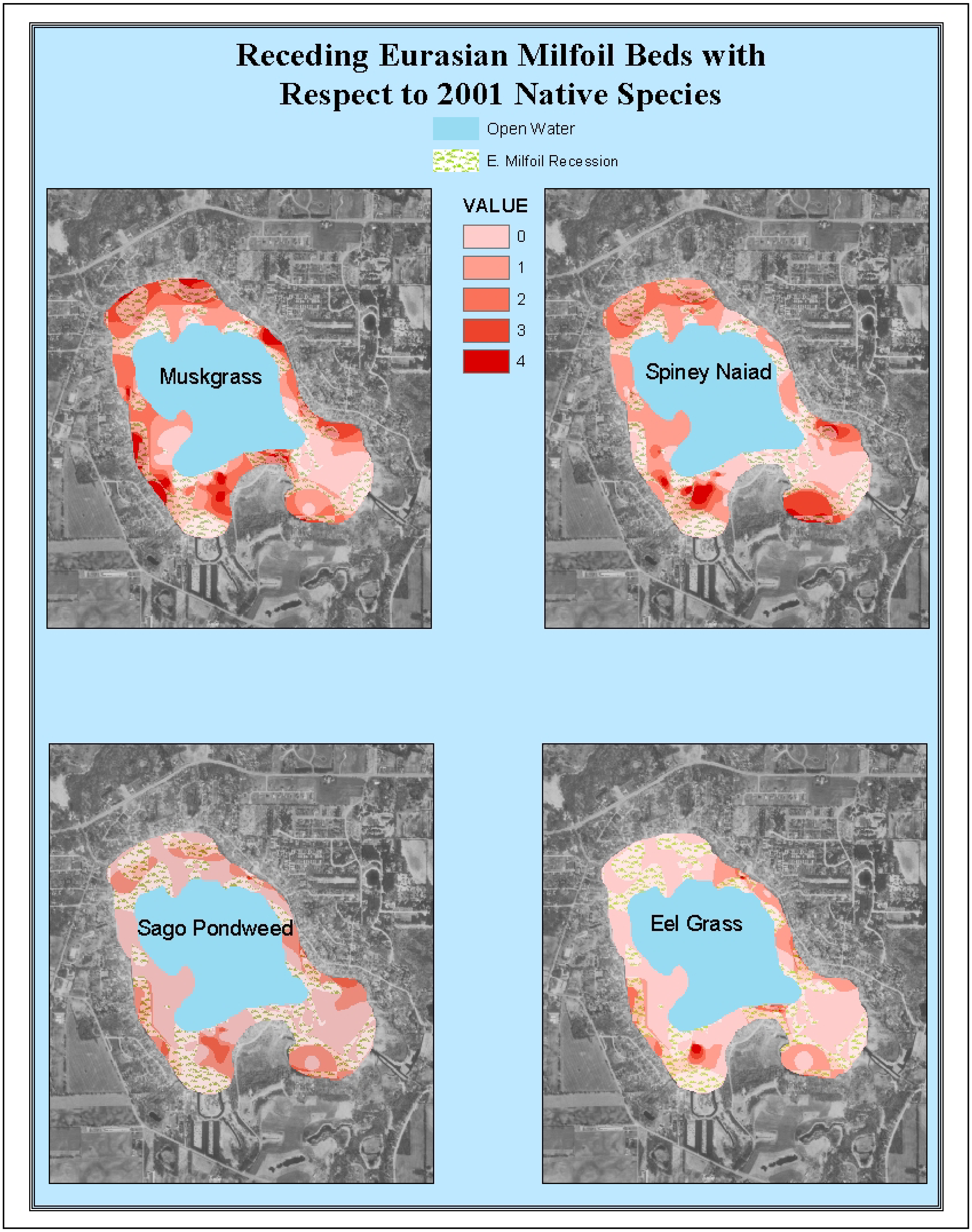


Figure 22: Density-Distributions of Dominant Native Plants Relative to Areas of Eurasian Water Milfoil Decline (2001)

CHAPTER 5: AQUATIC PLANT ECOLOGY

INTRODUCTION

Aquatic plants, also called macrophytes, include all macroscopic plants (observable with the naked eye) found in aquatic environments. They are represented by a diverse group of aquatic and wetland plants, including flowering vascular plants, mosses, ferns and macroalgae. Aquatic vegetation is naturally present to some extent in all lakes, and represents an important component of a healthy ecosystem. There are four basic plant types: emergent, free-floating, floating-leaf and submersed.

Emergents (e.g. cattail and bulrush) are rooted in water-saturated or submerged soils, but have stems that grow above the water surface. These plants most often grow in shallow-water areas along lakeshore margins and within riparian wetlands. Free-floating plants (e.g. duckweed) are not rooted in the lake bottom, but have extensive root systems that hang beneath floating leaves. They obtain most of their required nutrients from the surrounding water column. These plants are often quite small, and may completely cover the water surface in small, fertile water bodies. Floating-leaf macrophytes (e.g. water lilies) have leaves that float on the lake surface with a long rooted stem anchored to the lake bottom. Because the leaves of these plants are delicate and easily torn by wave action, they are typically found only in quiet, sheltered bays. Submersed plants (e.g. milfoil, water celery and Illinois pondweed) grow entirely under the water surface in areas where there is sufficient sunlight penetration. They may or may not be rooted to the lake bottom.

Aquatic plants can also be described in terms of their regional nativity. Native species are those that were historically found in a particular geographic region. On the other hand, non-native or "exotic" species evolved outside the region of interest and are frequently referred to as weeds. These transplanted species are no longer controlled by their native predators, and can sometimes take over an entire water body, forming large monotypic colonies. This prolific and uncontrolled growth can threaten biodiversity, water quality and the recreational value of the invaded water body.

PLANT SPECIES DESCRIPTIONS

There were 27 species of aquatic plants identified in Lake Ripley during the period between 1989 and 2001. Plant types include submersed (19), floating-leaf (4) and emergent (4). Descriptions and illustrations of each species are provided below.[19]

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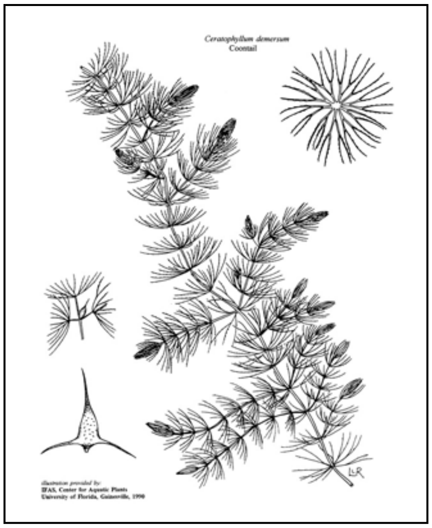
[19]*Nichols, Stanley A. 1999. Distribution and Habitat Descriptions of Wisconsin Lake Plants. Wisconsin Geological and Natural History Survey.*

Welsch, Jeff. 1992. Guide to Wisconsin Aquatic Plants. Wisconsin Department of Natural Resources. PUBL-WR-173 92rev.

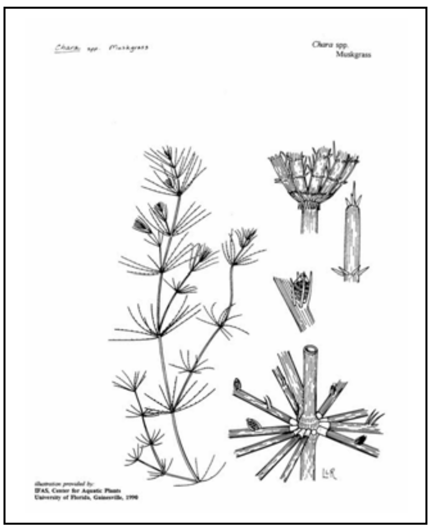
Borman, Susan, Robert Korth and Jo Temte. 1997. Through the Looking Glass… A Field Guide to Aquatic Plants. Wisconsin Lakes Partnership. DNR Publication No. FH-207-97.



Common Name: **Coontail**
Scientific Name: ***Ceratophyllum demersum***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

Coontail typically grows in clear water up to 15 feet deep. It is found over a broad range of water chemistries, prefers soft substrates, and is tolerant of turbid waters. New plants are formed primarily by stem fragmentation because seeds rarely develop. This plant has long trailing stems that lack true roots, but may be loosely anchored to the sediment by pale modified leaves. Because it is not rooted, it can drift between depth zones. Coontail can tolerate cool temperatures and low light conditions. These qualities allow it to overwinter as an evergreen plant, continuing photosynthesis at a reduced rate under the ice.

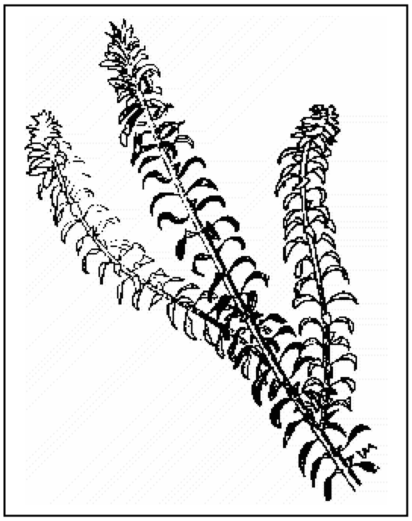
Although coontail has the capacity to grow at nuisance levels, it should not be entirely eliminated from a water body since it offers good habitat for fish and invertebrates. The plant is often found on drop-offs, producing tree-like cover for bluegills, perch, largemouth bass and northern pike. Bushy stems of coontail harbor many invertebrates and provide important shelter and foraging opportunities for fish. Both foliage and fruit of coontail are grazed by a variety of waterfowl. Coontail is also effective at removing phosphorus from the water column.



Common Name: **Muskgrass**
Scientific Name: ***Chara vugaris***
Plant Type: Submersed (Algae)
Duration: Perennial
U.S. Nativity: Native

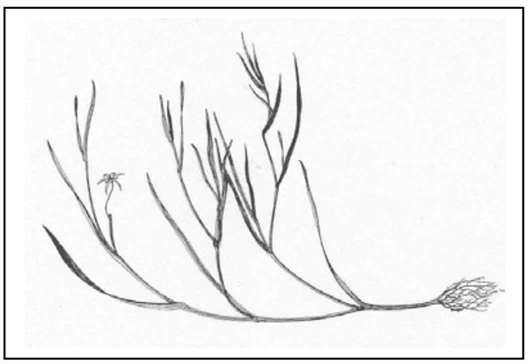
Muskgrass is actually an unusual type of algae, but has a growth form that resembles a higher plant. This plant is simple in structure and has rhizoids rather than true roots. It ranges in size from ankle-high to knee high, and grows entirely below the water surface. The main branches of muskgrass have ridges that are often encrusted by calcium carbonate, giving the plant a harsh, crusty feel. Muskgrass is usually found in hard waters, and prefers muddy or sandy substrate. It can often be found in deeper water than other plants, and its dense growth is capable of covering an entire lake bottom.

Muskgrass has several ecological benefits. It is a favorite food for waterfowl. It also supports algae and invertebrates that provide additional grazing. Beds of muskgrass are considered valuable fish habitat, offering cover and food for young largemouth and smallmouth bass. As far as enhancing water quality, the rhizoids of muskgrass slow the movement and suspension of sediments. It is a good bottom stabilizer and is often the first plant to colonize open areas. It also softens water by removing lime and carbon dioxide. This plant is best left alone since it grows close to the bottom and generally doesn't interfere with water uses.



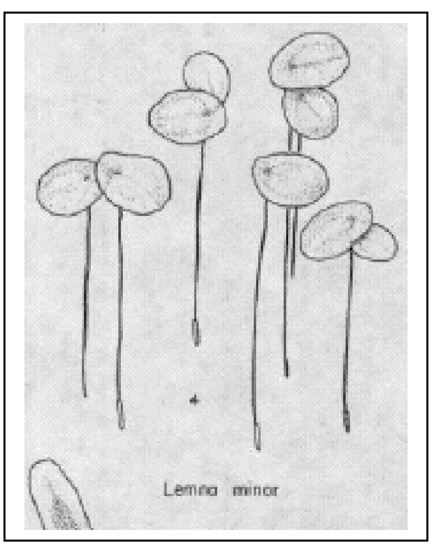
Common Name: **Common waterweed**
Scientific Name: ***Elodea canadensis***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

Common waterweed prefers soft, silty substrate, and is tolerant of turbid, low-light water conditions. This plant grows in a range of water depths, but prefers cool, nutrient-rich waters. It has a broad but generally alkaline pH distribution and moderate conductivity and alkalinity distributions. Common waterweed lives entirely underwater with the exception of small white flowers that bloom at the surface and are attached to the plant by delicate stalks. In the fall, leafy stalks will detach from the parent plant, float away, root, and start new plants. This is its most important method of spreading, with seed production playing a relatively minor role. This plant generally over-winters as an evergreen, allowing photosynthesis to continue at a reduced rate under the ice. The branching stems of this plant provide excellent habitat for fish and invertebrates, but dense stands can obstruct fish movement and become a nuisance. The plant provides food for muskrats and waterfowl.



Common Name: **Water stargrass**
Scientific Name: ***Zosterella/Heteranthera dubia***
Plant Type: Submersed
Duration: Annual/Perennial
U.S. Nativity: Native

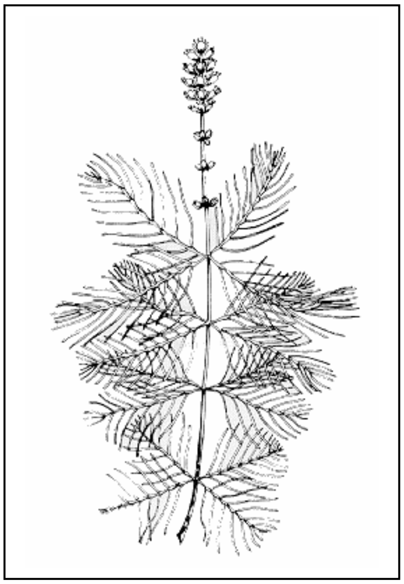
Water stargrass is found in water depths to 10 feet, shows no substrate preference, and is tolerant to turbidity. It grows over a moderate and somewhat alkaline pH range, and moderate conductivity and alkalinity ranges. This plant can be a locally important source of food for geese and ducks. It also offers good cover and foraging opportunities for fish.



Common Name: **Small duckweed**
Scientific Name: ***Lemna minor***
Plant Type: Floating-leaf, Free-floating
Duration: Perennial
U.S. Nativity: Native

These tiny, free-floating plants grow in bays and quiet areas protected from wind and wave action. Small duckweed drifts with the wind or current and is not dependent on depth, sediment type or water clarity. It is found over a moderate pH range and broad ranges of alkalinity and conductivity. Duckweed is often associated with eutrophic conditions, and can become a nuisance in stagnant, fertile water bodies. It has the ability to rapidly reproduce in nutrient-rich water, doubling in population within three to five days. Since the plant is free-floating, it must obtain all of its nutrition from the water by absorbing nutrients through dangling roots and leaf undersurface. In fact, it is capable of removing large amounts of nutrients from the water in this way.

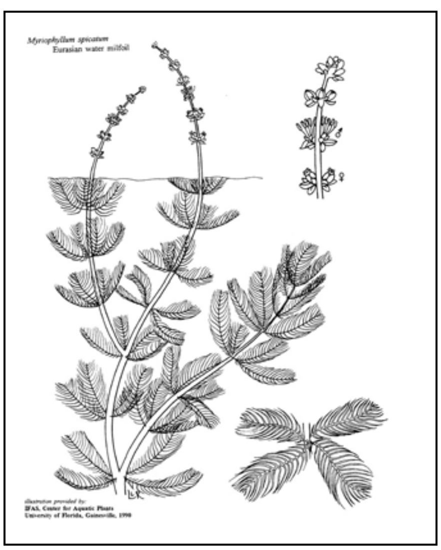
Rafts of small duckweed provide shade and cover for fish and invertebrates. The plant is a food source for waterfowl and marsh birds (providing up to 90% of the dietary needs for a variety of ducks and geese), and supports insects valuable as food for fish. It is also consumed by muskrat, beaver and fish. Conventional physical removal and chemical control are usually ineffective. Limiting growth of duckweed is best accomplished through nutrient-reduction strategies.



Common Name:	**Northern/spiked water milfoil**
Scientific Name:	***Myriophyllum sibiricum***
Plant Type:	Submersed
Duration:	Perennial
U.S. Nativity:	Native

This species is easily confused with the non-native Eurasian water milfoil (*Myriophyllum spicatum*). The plant can grow in water more than 13 feet deep, prefers soft sediment, and is sensitive to turbidity. It grows over a broad alkalinity range and moderate conductivity and pH ranges. Since it is sensitive to reduced water clarity, this plant has been shown to decline in lakes that become increasingly eutrophic. Stems emerge in spring and can produce flower spikes by early to midsummer that stick out of the water.

Leaves and fruit of northern water milfoil are consumed by a variety of waterfowl. The feathery foliage traps detritus and provides invertebrate habitat. Beds of northern water milfoil offer shade, shelter and foraging opportunities for fish.



Common Name:	**Eurasian water milfoil**
Scientific Name:	***Myriophyllum spicatum***
Plant Type:	Submersed
Duration:	Perennial
U.S. Nativity:	Non-native

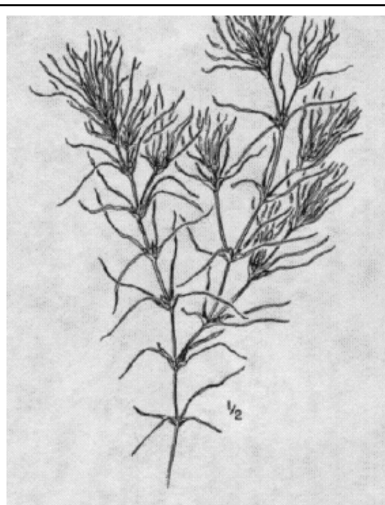
This plant is not native to the U.S., and is considered a nuisance weed in many lakes. It can grow in water depths of over 13 feet deep, and is found over broad alkalinity, moderate conductivity, and moderate but high pH ranges. The average fruiting date is middle to late summer; however, it can flower and fruit twice, once in early summer and once in late summer. The late flowering can be prolonged and fruiting plants can be found into early November. Flower stalks do not develop until the stems reach the surface.

In the spring, shoots begin to grow rapidly in response to rising water temperatures (starting at about 59°F). As shoots grow, lower leaves drop off in response to shading. When the plant reaches the surface, shoots branch profusely to form a dense, floating canopy above leafless vertical stems. Plants then reproduce by flowering at the surface and through fragmentation. Both broken stems and plant fragments are able to regenerate into new plants if they are not removed from the water.

Dominance by this species is often established early in the growing season, owing to a combination of high over-wintering biomass and rapid spring growth. In general, conditions of low light and high water temperature, characteristics of many eutrophic environments, stimulate shoot elongation and canopy formation. This plant grows most poorly on highly organic sediments and coarse substrates like sand and gravel, and best in finely textured, inorganic sediment. Shallow, moderately turbid lakes with nutrient-rich sediments will experience the most severe problems.

Eurasian water milfoil is an invasive, pioneer species that quickly colonizes disturbed areas of the lake bottom. Disturbances may be in the form of sediment deposition, plant removal, water level fluctuations, or bottom scouring caused by motor boats. Once introduced to a water body, milfoil can quickly out-compete and displace other species. Milfoil boom and bust growth cycles are well documented in other lakes, and are characteristic of ecosystems dominated by only a few species. These extreme growth cycles illustrate why it is important to maintain biodiversity for ecological stability. Excessive milfoil growth primarily affects recreation by interfering with swimming and boating following canopy formation, by reducing the quality of sport fisheries, and by reducing the aesthetic appeal of water bodies. As for ecological value, this species provides limited cover for fish when poor water clarity prevents other species from growing. Waterfowl graze on fruit and foliage to a limited extent. Milfoil beds also provide invertebrate habitat, but studies have shown mixed stands of pondweeds and wild celery have higher invertebrate numbers and diversity.[20]

Eurasian water milfoil is commonly treated with aquatic herbicides such as 2,4-D early in the summer before plants flower. However, there are a number of negative consequences that can occur following chemical treatments. These include dissolved oxygen depletion and nutrient releases from the resulting plant decay, as well as the creation of "disturbance" areas that can be re-colonized by other milfoil. Most control efforts have been directed toward maintenance (e.g. mechanical harvesting), since eradication of this particular species is rarely if ever likely to succeed due to its aggressive growth and propagation characteristics. Since growth usually covers large areas, treatment efforts should be directed at well-defined areas where they will produce the greatest benefits.



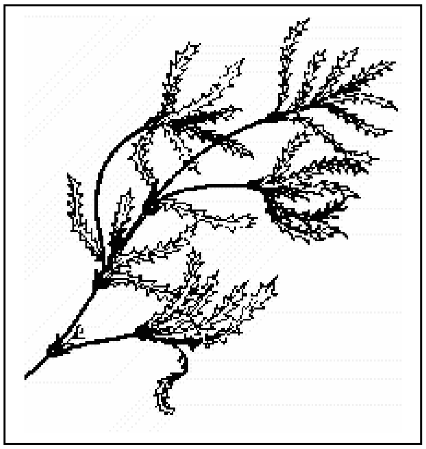
Common Name:	**Bushy pondweed, slender naiad**
Scientific Name:	***Najas flexilis***
Plant Type:	Submersed
Duration:	Annual
U.S. Nativity:	Native

This plant grows at a wide range of depths, prefers hard substrates like sand and gravel, and is not sensitive to turbidity. It is an annual plant that often acts as a pioneer species by invading open or disturbed areas. It can tolerate broad alkalinity and conductivity ranges and a moderate pH range. Bushy pondweed is firmly rooted and has slender, bright green leaves that are crowded near the tip. Fruits or seeds appear as tiny swellings at the base of the leaves. It usually grows in clumps or beds among other species.

Bushy pondweed is an important plant for waterfowl, marsh birds and

[20] *Engel, Sandy. 1990. Ecosystem Responses to Growth and Control of Submerged Macrophytes: A Literature Review. Wisconsin Department of Natural Resources. Technical Bulletin No. 170.*

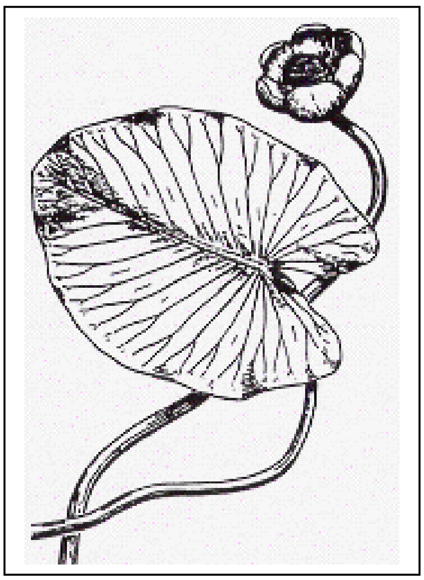
muskrats. Stems, leaves and seeds are all consumed by a wide variety of ducks. It is also a good producer of food and shelter for fish. Bushy pondweed is often best left alone since it's a low-growing plant that usually does not overpopulate an area.



Common Name: **Spiny naiad**
Scientific Name: ***Najas marina***
Plant Type: Submersed
Duration: Annual
U.S. Nativity: Native

This annual plant is found in high alkalinity, conductivity and pH waters. It prefers soft substrate and can grow up to about 10 feet deep. Spiny naiad is tolerant of higher than normal chloride concentrations, and often grows were concentrations exceed 10 mg/l. It is not shown to associate with any other species.

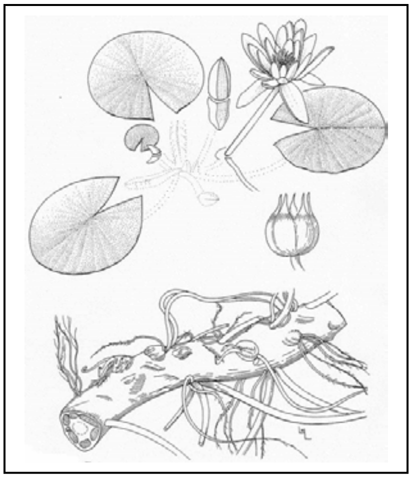
Spiny naiad provides food and shelter for fish, and is a food source for waterfowl.



Common Name: **Yellow water lily, spatterdock**
Scientific Name: ***Nuphar advena***
Plant Type: Floating-leaf
Duration: Perennial
U.S. Nativity: Native

This plant usually grows in shallow, soft sediment areas of lakes, ponds or slow-moving streams. It is found in water 6.5 feet or less deep. Turbidity tolerance is not a consideration since the plant has floating leaves that quickly reach the water surface in the spring. Most of the leaves are emergent, growing at an assortment of angles above the water's surface. It can grow in sun or shade, but flowering is more abundant in good light.

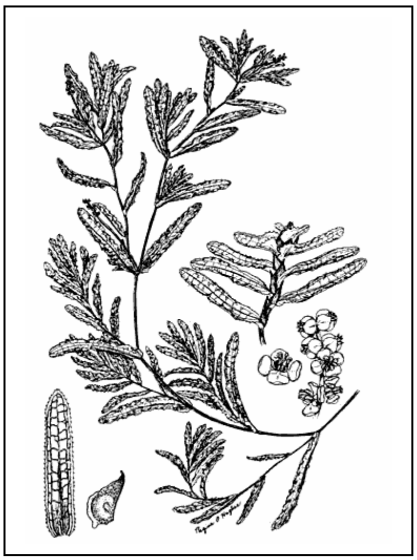
In addition to their aesthetically pleasing yellow flowers, water lilies provide good shade and shelter for fish as well as habitat for invertebrates. The insects that grow under the leaves are a food source for fish. Waterfowl and marsh birds eat the seeds, muskrat and beaver eat the rhizomes, and deer graze on the leaves, stems and flowers.



Common Name: **White/fragrant water lily**
Scientific Name: ***Nymphaea odorata/tuberosa***
Plant Type: Floating-leaf
Duration: Perennial
U.S. Nativity: Native

This species is found over moderate alkalinity and conductivity ranges and a wide pH range. It grows at a median depth of about 3-3.5 feet, and shows no substrate or turbidity preference. Leaves and stems are round, with most of the leaves floating on the water's surface. White water lily is usually found in quiet water of lakes or ponds.

Waterfowl eat the seeds of this plant, while deer, muskrat, beaver and moose eat the rhizomes. The leaves offer shade and shelter for fish.



Common Name: **Curly-leaf pondweed**
Scientific Name: ***Potamogeton crispus***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Non-native

This plant is not native to the U.S., and has a tendency to become a nuisance weed in many lakes. It is usually one of the first plants visible in the spring, and may cause temporary problems due to its early, rapid growth. It has wavy and finely serrated leaves that help distinguish it from other pondweeds. The plant can grow under the ice while most plants are dormant, but declines by early to mid-July when other species are realizing peak growth. In the spring, curly-leaf pondweeds produce flower spikes that stick up above the water surface. It typically grows in soft sediments and shallower water depths up to 12 feet. It can tolerate cool temperatures and low light, and will grow in turbid water. Curly-leaf is found over a broad conductivity range, and moderate pH and alkalinity ranges.

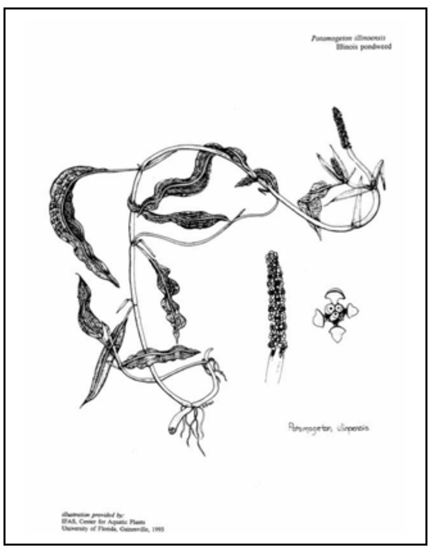
Young curly-leaf plants emerge from the sediments during fall, remain dormant during winter, and grow rapidly after ice-out, forming dense surface mats over expansive meadows. This growth cycle allows curly-leaf pondweed to out-compete other species for nutrients, sediment area and light. It grows especially well in areas where mechanical harvesting or herbicides were used inappropriately and without careful planning. The dead vegetation tends to either wash onto the lakeshore or sink to the lake bottom. Plant decay can deplete dissolved oxygen levels, eliminating habitat and causing the internal release of phosphorus from sediments on the lake bottom. Curly-leaf pondweed provides habitat for fish and invertebrates, especially in the winter and spring when most other aquatic plants are reduced to rhizomes and winter buds. However, the midsummer die-off creates a sudden loss of habitat and releases nutrients into the water column that can trigger algal blooms and create turbid water conditions.

Early seasonal control during the initial stages of growth is recommended, allowing plants to be controlled before the population collapses after full growth. Chemical treatment of the young plants during fall or spring may prevent formation of nuisance mats and depletion of oxygen while allowing other native macrophyte species to re-vegetate those areas. Protection and restoration of native species, and improving water clarity can help keep this plant in check without the use of aquatic herbicides.

Common Name: **Variable-leaf pondweed**
Scientific Name: ***Potamogeton gramineus***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

This plant is an extremely variable species that has a number of varieties that may be the result of habitat differences. It also hybridizes with most broad-leaved pondweeds. It is found over broad alkalinity and pH ranges, and a limited conductivity range. Variable pondweed grows at a median depth of about 3.5 feet, prefers firm substrate, but shows no turbidity preference. It is often found growing in association with muskgrass (*Chara spp.*), slender naiad (*Najas flexilis*) and wild celery (*Vallisneria americana*).

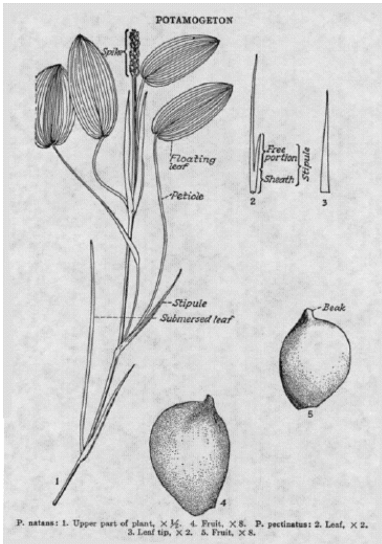
The fruits and tubers of variable pondweed are grazed by a variety of waterfowl, including geese and wood duck. Muskrat, beaver, deer and moose may also eat the foliage and fruit. An extensive network of leafy branches offers invertebrate habitat and foraging opportunities for fish.



Common Name: **Illinois pondweed**
Scientific Name: ***Potamogeton illinoensis***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

This plant is found over a broad alkalinity range, a moderate and high pH range, and a moderate conductivity range. It flowers and fruits in midsummer and shows no substrate preference. Illinois pondweed is not turbidity tolerant and is probably becoming increasingly rare where water clarity has decreased. It is commonly found in water less than 6.5 feet deep, but its maximum depth distribution is greater than 10 feet.

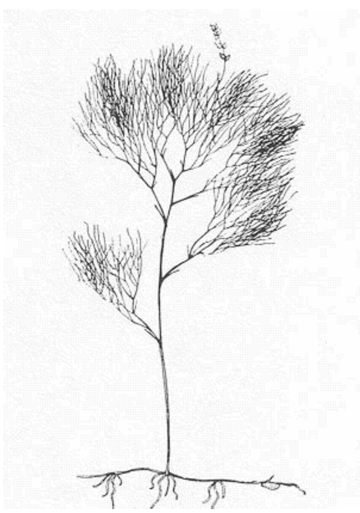
The fruit produced by Illinois pondweed can be a locally important food source for a variety of ducks and geese. Muskrat, deer, beaver and moose are known to consume this plant. This pondweed offers excellent shade and cover for fish and good surface area for invertebrates.



<u>Common Name</u>: **Floating-leaf pondweed**
<u>Scientific Name</u>: ***Potamogeton natans***
<u>Plant Type</u>: Submersed & floating-leaf
<u>Duration</u>: Perennial
<u>U.S. Nativity</u>: Native

This plant shows no substrate preference and is most commonly found in water less than 5 feet deep. It can grow in highly turbid water, but shows no turbidity preference. It is found over a broad range of water chemistries. Floating-leaf pondweed has firmly rooted thick stems, and can have both submersed and floating leaves. Submersed leaves are typically thin and slender, while floating leaves are oval shaped. Flower or seeds may extend above the water surface.

The fruit of floating-leaf pondweed is held on the stalk until late in the growing season. This provides valuable grazing opportunities for ducks and geese. Muskrat, beaver, deer and moose may also consume portions of the plant. Floating-leaf pondweed is considered good fish habitat as it provides shade, cover and foraging opportunities.

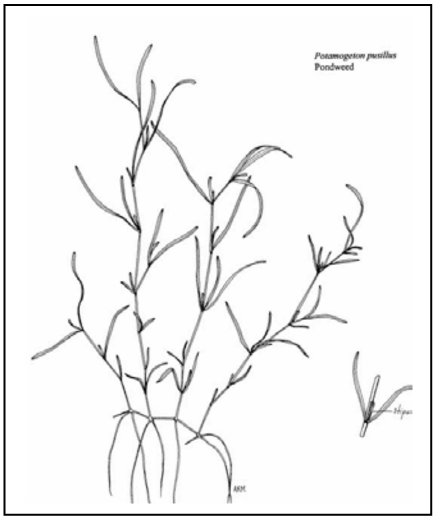


<u>Common Name</u>: **Sago pondweed**
<u>Scientific Name</u>: ***Potamogeton pectinatus***
<u>Plant Type</u>: Submersed
<u>Duration</u>: Perennial
<u>U.S. Nativity</u>: Native

Sago pondweed grows below the water surface at depths greater than 13 feet, although it is most common in 3-7-foot water depths. It grows in a variety of sediment types and a wide range of water conditions. In fact, it is often the last surviving rooted plant in very turbid water. It has a broad alkalinity range and moderate conductivity and pH ranges. Flowers and fruit are produced on a slender stalk that may be submersed or floating on the water surface.

Sago's rapid growth rate allows it to quickly occupy large areas and smother potential competitors. It is also very pollution tolerant and can rapidly colonize unoccupied habitats. This may be one reason why the plant is typically not found with a diversity of other species, but tends to occur in discrete beds in stressed environments. Sago pondweed is firmly rooted and has branched, slender stems and grass-like narrow leaves.

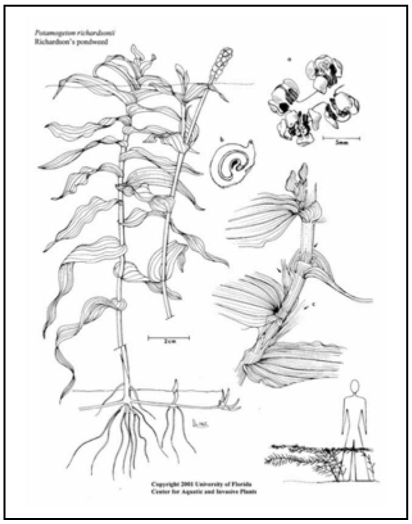
This plant provides limited cover for bluegills, perch, northern pike and muskellunge, and is good cover for walleye. It supports insects valuable as food for fish and ducklings, and is considered one of the top food producers for waterfowl. Both the fruit and tubers are heavily grazed and are considered critical for a variety of migratory waterfowl. Sago communities also provide escape cover for invertebrates, thus allowing them to thrive in the presence of small fish.



Common Name: **Small pondweed**
Scientific Name: ***Potamogeton pusillus***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

Small pondweed is found over moderate ranges of alkalinity and pH, and a limited conductivity range. It grows in soft substrate to a depth of about 9 feet, and is tolerant to turbid water conditions. The plant grows below the surface, but may have flowers or seeds extending out of the water. It is firmly rooted to the bottom, and has branched, slender stems and grass-like narrow leaves.

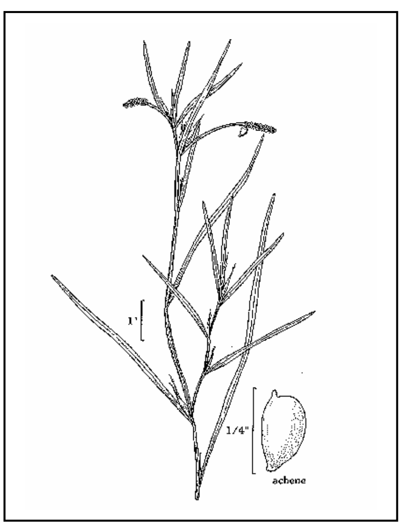
This plant can be a locally important food source for a variety of ducks and geese. It is also provides a food source and cover for fish.



Common Name: **Clasping-leaf/Richardson's Pondweed**
Scientific Name: ***Potamogeton richardsonii***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

This plant shows no turbidity or substrate preference and can withstand environmental disturbance. It is many times the only broad-leaf pondweed found in degraded water. Clasping-leaf pondweed is found over moderate ranges of water chemistries and in water depths to 13 feet. It is often found growing with coontail (*Ceratophyllum demersum*) and small pondweed (*Potamogeton pusillus*).

The fruit produced by clasping-leaf pondweed can be a locally important food source for a variety of waterfowl. Muskrat, deer, beaver and moose may also eat the plant. The leaves and stem are colonized by invertebrates and offer foraging opportunities and cover for fish.



Common Name: **Flat-stem pondweed**
Scientific Name: ***Potamogeton zosteriformis***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

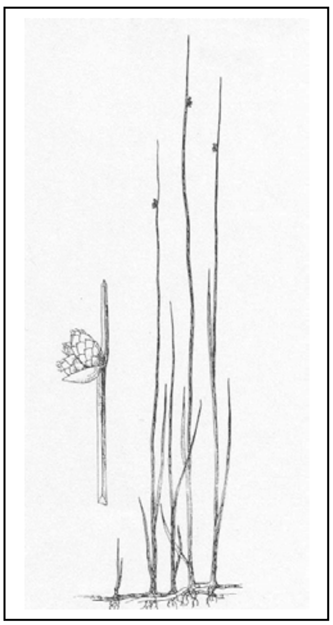
This plant grows in soft sediment, below the water surface, and in a variety of water depths up to about 13 feet. It is found over broad alkalinity and pH ranges and a moderate conductivity range. Because of its sensitivity to turbidity, the plant does not do well in lakes with poor water clarity. It is firmly rooted with branched, slender stems and grass-like narrow leaves.

Flat-stem pondweed provides limited cover for bluegills, perch, northern pike and muskellunge. It also provides good cover for walleye, and supports insects valuable as food for fish and ducklings. Flat-stem pondweed is a food source for waterfowl, muskrat, deer and beaver.

Common Name: **Arrowhead, duck potato**
Scientific Name: ***Sagittaria latifolia***
Plant Type: Emergent
Duration: Perennial
U.S. Nativity: Native

This plant grows above the surface in shallow water up to 4 feet deep, and shows no substrate or turbidity preference. It is found over broad pH and alkalinity ranges and a moderate conductivity range. Reaching about 3-4 feet tall, the plant has individual leaves that can be more than a foot long. Leaves are usually arrow-shaped with backward-pointing lobes, but vary in shape and may be long, linear, and grass-like. White flowers are about an inch in diameter, with three rounded petals, growing from the thick stem in whorls of three. Arrowhead's horizontal roots have short, thick stems or tubers at their tips in autumn.

Arrowhead protects shorelines from wave erosion. It is also one of the highest value aquatic plants for wildlife. It provides cover for waterfowl and young fish, and spawning areas for northern pike. Muskrats, beaver, and other wildlife eat the tubers. Geese and ducks eat both seeds and tubers, giving this plant the name "duck potato." Arrowhead is capable of rapidly removing phosphorus from sediments and can store high levels in its leaf tissue.



Common Name: **Three-square bulrush, chairmaker's rush**
Scientific Name: ***Scirpus americanus***
Plant Type: Emergent
Duration: Perennial
U.S. Nativity: Native

Three-square bulrush grows in deep and shallow marshes and along lakes and streams. It is found in higher pH waters than many other species, and grows in moderate conductivity and alkalinity ranges, but with low median values. It is found in water depths to 6 feet, shows no substrate preference, and is not tolerant of turbidity. This plant has moderately tall (up to 5 feet), sharply triangular stems that emerge from a firm rhizome. Short, inconspicuous leaves sheath the base of each stem.

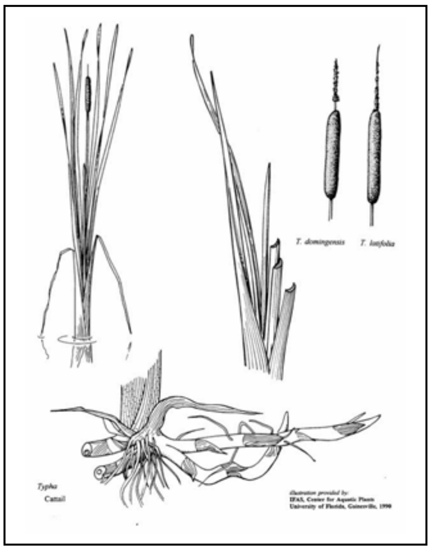
A wide variety of ducks rely on three-square bulrush as a food source. It is heavily grazed by muskrat and provides cover for waterfowl and other shallow marsh wildlife.

ILLUSTRATION NOT AVAILABLE

<u>Common Name</u>: **Water bulrush**
<u>Scientific Name</u>: ***Scirpus subterminalis***
<u>Plant Type</u>: Submersed
<u>Duration</u>: Perennial
<u>U.S. Nativity</u>: Native

Water bulrush is mostly submersed with only the tips of fertile stems poking out of the water. This plant is found over a moderate range of pH, conductivity and alkalinity conditions. It is found growing in shallow water and on a variety of substrates, including sand, marl, muck and peat. Slender, limp stems (up to more than 3 feet in length) extend from a fine rhizome. The stems float in the water along with hair-like leaves that arise near the base.

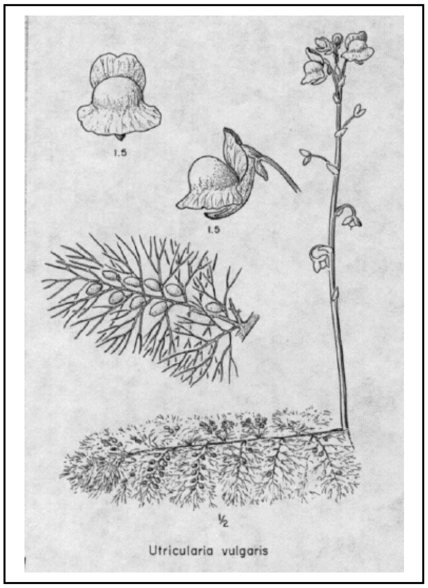
Grass-like meadows of water bulrush provide invertebrate habitat and shelter for fish.



<u>Common Name</u>: **Narrow-leaf & broad-leaf cattail**
<u>Scientific Name</u>: ***Typha angustifolia & Typha latifolia***
<u>Plant Type</u>: Emergent
<u>Duration</u>: Perennial
<u>U.S. Nativity</u>: Native

These plants grow 3-10 feet tall above the water surface in marshes, along shorelines, and in quiet water up to 2.5-3 feet deep, often in disturbed areas. They are found over broad alkalinity and pH ranges and a moderate conductivity range. Narrow-leaf is more tolerant of chloride and alkalai than broad-leaf cattail.

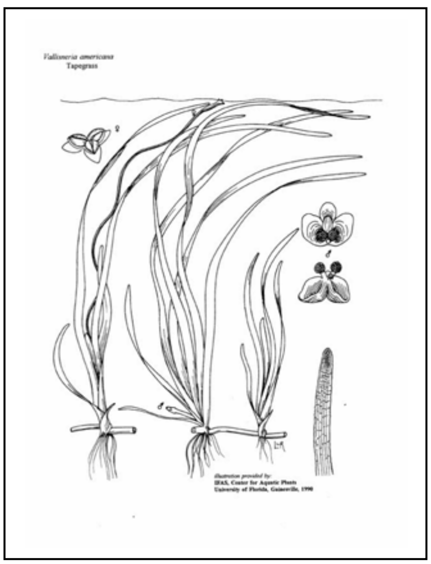
Cattails help stabilize marshy borders of lakes, protect shorelines from wave erosion, provide spawning sites for northern pike, and provide cover and nesting sites for marsh birds and waterfowl. Muskrat and beaver eat the stalks and roots. Cutting stalks under water during the early summer before the “cattail” appears works best to control growth. Cutting under water just before the lake freezes is also effective.



Common Name: **Common/great bladderwort**
Scientific Name: ***Utricularia vulgaris***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

Bladderwort is a carnivorous, free-floating plant that prefers soft substrate, tolerates turbid water, and grows in water depths from only a few inches to about 8 feet. It is found over a broad pH range, including some acid water with a pH of less than 5. Its alkalinity range is moderate and conductivity range is limited. This plant is most successful in still water where the bladders that trap prey can function properly, and where the finely divided stems are not torn by wave action.

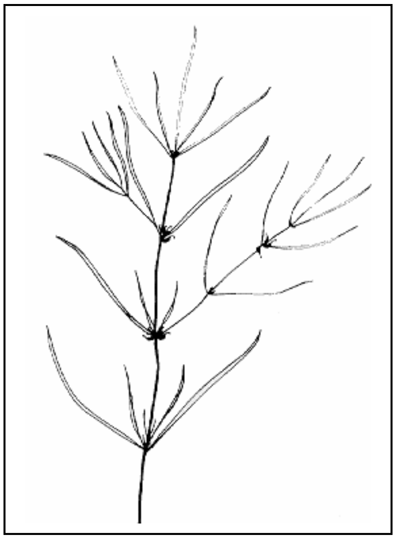
The trailing stems of common bladderwort provide food and cover for fish. Because it is free-floating, the plant can grow in areas with very loosely consolidated sediment. This provides needed fish habitat in areas that are not readily colonized by rooted plants.



Common Name: **Eel/tape grass, water/wild celery**
Scientific Name: ***Vallisneria americana***
Plant Type: Submersed
Duration: Perennial
U.S. Nativity: Native

This species prefers semi-hard substrate, is turbidity tolerant, and grows in water depths up to 10-15 feet. It is found over broad pH and alkalinity ranges and a moderate conductivity range. Flowering occurs in late summer on a coiled stalk. It spreads by rhizomes and tuberous tips that, along with the fruits, are relished by waterfowl. Wild celery often grows in beds near pondweeds such as bushy pondweed.

Wild celery is a premiere source of food for waterfowl, especially for canvasback ducks in the fall. All portions of the plant are consumed, including foliage, rhizomes, tubers and fruit. This plant is also important for marsh birds and shore birds, including rail, plover, sand piper and snipe. Muskrats are also known to graze on it. Beds of wild celery are considered good fish habitat providing shade, shelter and feeding opportunities. Wild celery is usually best left alone unless excessive growth in shallow water presents a problem.



Common Name: **Horned Pondweed**
Scientific Name: ***Zannichellia palustris***
Plant Type: Submersed
Duration: Annual
U.S. Nativity: Native

Horned pondweed has long, narrow leaves and slender stems that emerge from an equally slight rhizome. This annual species is found in high alkalinity, high pH, and high conductivity water. It is turbidity tolerant and prefers hard substrate. Horned pondweed is commonly found in water less than 12 feet deep, and is often partly buried in silt or mud.

Waterfowl eat the fruit and foliage of horned pondweed. It is also considered a fair food producer for trout.

ALGAL SPECIES DESCRIPTIONS

Several varieties of algae are found in Lake Ripley, including green, bluegreen and filamentous algae. Brief descriptions are provided below.[21]

Filamentous algae *(Cladophora, Spirogyra)*: This type of macroalgae consists of single cells that are connected end-to-end. It appears as green-colored thin threads, branched filaments or an interwoven net. Filamentous algae do not have roots, stems or leaves. It begins growing along the shoreline or on the lake bottom, and later buoys to the surface forming green mats that frequently attach to rocks or other plants. Abundant growth identifies lakes polluted with excessive nutrients. Although filamentous algae provide cover for insects valuable as fish food, it is often viewed as an unsightly nuisance. Preventative actions that reduce the flow of nutrients into the lake are the best means of control.

Plankton algae: These are microscopic, single-celled organisms that may form multi-cellular colonies or filaments. Common varieties include green algae, bluegreen algae and diatoms. Abundant growth results in "blooms" that color water green or brown. Scums of bluegreen algae may form on the water surface during the summer. Abundant growth identifies lakes polluted with excessive nutrients such as nitrogen and phosphorus. Plankton algae provide food for zooplankton and some food for fish fry. Preventative actions to reduce the flow of nutrients into the lake are the best means of control.

[21] *Welsch, Jeff. 1992 Guide to Wisconsin's Aquatic Plants. Wisconsin Department of Natural Resources. PUBL-WR-173 92rev.*

GROWTH DETERMINANTS

A few of the important factors affecting the abundance and distribution of aquatic plants in Lake Ripley are light and nutrient availability, water chemistry, sediment type and wind/wave energy. Each of these factors is discussed briefly below.

Light availability: Light availability, which is directly linked to water clarity, is often considered the single most crucial factor regulating the maximum depth of plant growth. The amount and spectral quality of light at the lake bottom diminishes as water clarity decreases, generally as a result of increasing water depth. Submersed macrophytes typically grow to a depth of about two times the Secchi depth, or the depth at which an eight-inch, black and white disk is no longer visible below the water surface. Other factors that influence light availability are phytoplankton (algae) concentrations, water color, and the concentration of suspended particulate matter (turbidity). Turbidity may be caused by runoff entering the lake, or through sediment re-suspension caused by boat traffic, wind mixing, and biotic factors such as carp-feeding activities. The extent of the littoral zone, or the area that can support rooted aquatic plant growth, will fluctuate based on these and other photosynthesis-limiting factors.

Nutrient availability: Plant growth can be limited if at least one nutrient that is critical for growth (e.g. phosphorus or nitrogen) is in short supply. However, nutrients supplied from bottom sediments combined with those in solution are generally adequate to meet nutritional demands of rooted aquatic plants, even in oligotrophic, or nutrient poor systems. Rooted plants usually fulfill most of their phosphorus and nitrogen requirements by direct uptake from sediments, although the preferred source of some nutrients such as potassium, calcium, magnesium, sulfate and sodium appears to be the open water. Oligotrophic lakes generally maintain less total biomass of aquatic plants and usually different species than eutrophic lakes.

Water chemistry: Water chemistry is another environmental factor that can control plant growth. For instance, some species are very tolerant of acidic conditions while other species are very intolerant of these conditions. Most plants prefer slightly alkaline water chemistries as opposed to acidic environments. Lake Ripley is considered a hardwater, alkaline water body that is capable of supporting an abundance of aquatic vegetation.

Sediment type: Variations in the quality and quantity of bottom sediment play a significant role in controlling the distribution and growth of rooted aquatic vegetation. Rocky, sandy, silty and mucky substrates will each favor different plants. The distribution of various substrates along the lake bottom is dictated by a number of factors. For instance, wave action and currents cause coarse material to remain in shallow water (a higher energy environment) while finer materials are transported and deposited in deep water. The strength and direction of the wind in conjunction with the morphology of the lake basin will play a large role in determining where the substrates will move. In general, points and shallows where wind and wave energy are highest tend to be swept clean, while bays and deep areas in a lake tend to fill with sediment.

Wind/wave energy: Finally, high-energy environments caused by wind, water current and/or wave action can significantly limit plant growth. These and similar disturbances, if frequent, will prevent vegetation from being able to take root in the substrate, especially if the substrate is unsuitable for most plants due to scouring. As noted above, these factors are usually greatest in unprotected and wind-swept, near-shore areas.

PLANT-INDUCED ECOSYSTEM CHANGES

The preceding section dealt with some of the factors that can control the amount and type of plant growth in a particular lake. This section describes how the resulting plant growth (or lack thereof) can impact the overall ecosystem. The presence or absence of plant growth can have a dramatic effect on the aquatic environment. A number of these plant-induced, ecosystem impacts are discussed briefly below.

Littoral Zone Productivity: As explained earlier, the littoral zone is the shallow portion of a lake that is able to support rooted aquatic plant growth. Small and irregularly shaped lakes usually have more miles of shoreline per acre of lake surface area, so they have greater potential for a more productive littoral zone. The accumulation of organic sediments from the decay of plant matter causes expansion of this littoral zone and filling in of the lake.

Water Clarity: Rooted aquatic plant growth exhibits an inverse relationship with water clarity. As rooted plant abundance increases in a lake, the abundance of suspended solids (e.g. algae cells, dead organic matter and clay particles) decreases, and vice versa. This relationship exists because aquatic plants act as water quality filters, stabilize bottom sediments, and compete for the same nutrients that fuel algae blooms.

Water Temperature/Circulation: Shading and reduced water circulation caused by dense stands of aquatic plants affects the lake environment by producing vertical temperature gradients as steep as 18°F over three feet of water depth. Reduction in water flow through macrophyte beds also enhances trapping and deposition of fine sediment and organic matter. This process improves water clarity and increases the accumulation of sediments or organic material in shallow areas. The reduction in water circulation, if significant, can limit the ability of the lake to naturally aerate.

Dissolved Oxygen: Changes in daily dissolved oxygen concentrations are heavily regulated by dense submersed macrophyte stands. The water column can become supersaturated with dissolved oxygen when peak photosynthesis occurs during daylight hours. This can be followed by anoxia (oxygen depletion) as respiration exceeds photosynthesis during non-daylight hours, especially in the absence of sufficient water circulation, or when microbial decomposition increases as a result of a plant die-off. Whenever anoxic conditions are produced, the survivability of oxygen-dependent aquatic organisms is compromised. Dense growths of floating vegetation can exacerbate the situation by restricting atmospheric oxygen exchange at the water surface.

pH: Changes in pH of up to two standard units are known to occur within a 24-hour period due to the metabolic processes of submersed plants. A high degree of primary productivity can cause the pH of a water body to increase significantly, and vice versa.

Phosphorus Availability: Sediment re-suspension is shown to be a mechanism for introducing phosphorus into the water column. The root systems of plants help stabilize loose bottom sediment to prevent this from happening. Aquatic vegetation also influences nutrient cycles by assimilating phosphorus from the sediments during the growing season, and releasing phosphorus during death and decay. This means fewer nutrients are available for algae growth during the growing season, resulting in better water clarity. If nutrients are then released in the fall during decomposition of plant matter, water temperatures are usually cool enough to prevent noxious algae blooms from occurring. Those that do occur will generally pose fewer problems since the peak recreational period has passed. If anoxic conditions are caused as a result of plant decomposition, phosphorus may be released from the bottom sediment into the surrounding water column, fueling additional algal blooms.

Habitat & Water Quality: Too few plants generally do not provide enough cover for fish and aquatic life, while too many plants may lead to stunted panfish populations and poor predator growth. The latter is caused by an overabundance of structural habitat for small fish, allowing them to escape predation and achieve high population densities. This means there is not enough food available for the existing fish, so both panfish and predators become small or stunted. The Trophic Cascade Hypothesis predicts that water quality is linked to the success of certain fish species, which can cause a "cascading" effect down the food chain. Simply stated, water quality improves as larger gamefish (piscivores) become more successful at feeding on the smaller panfish (planktivores). As planktivore populations are diminished, there is less consumption of the microscopic animals (zooplankton) that graze on algae (phytoplankton). The amount and quality of the vegetative habitat usually plays a sizeable role in determining the outcome of this process. A moderate amount of high quality aquatic vegetation with plenty of edge habitat is generally the most conducive to larger fish populations and better water quality.

MANAGEMENT IMPLICATIONS

The first step toward implementing a successful aquatic plant management program is to recognize the important functions and values of a healthy plant community. A diversity of emergent and submersed, native aquatic vegetation provides critical habitat for fish and wildlife, primarily in the form of structural refuge and spawning substrate. Fish and wildlife also rely on plants as a source of food. Some plant varieties are consumed directly, while others support large populations of invertebrates that form the base of the food chain. Through photosynthesis, aquatic vegetation produces the aerobic conditions that oxygen-dependent species rely upon for their survival. Aquatic plants also stabilize loose bottom sediment, trap suspended particles, protect against shoreline erosion, provide refuge for zooplankton (algae consumers), and compete for the same nutrients that fuel algal blooms—each of which is vitally important for maintaining optimal water quality.

Fertile lakes with nutrient-rich bottom sediment, shallow water depths, and relatively clear water generally support the most abundant plant growth. This growth occurs in the littoral zone—the most biologically diverse and productive part of the lake—that extends from the shoreline out to about the 15-foot water depth in Lake Ripley. Unfortunately, this critical area is also the most vulnerable to the affects of shoreline development, runoff pollution and recreational pressure. As a result, ecologically valuable but sensitive plant species are often displaced by less desirable species that are more tolerant of disturbances and poor water quality. These “weeds” may aggressively out-compete native, beneficial plants until the entire plant community is dominated by only one or two species. Without proper management intervention, such changes could lead to a host of water quality, habitat and recreational impairments. Clogged boating lanes, reduced species diversity and habitat value, stunted fish growth, dramatic fluctuations in dissolved oxygen concentrations, and boom-and-bust plant growth cycles are just some of the problems that may be experienced.

Control methods should be employed that do not significantly disrupt native, beneficial plant communities that provide critical fish and wildlife habitat and water quality protection benefits. Maintaining these more desirable plant communities should prevent the continued spread of the more aggressive, nuisance species such as Eurasian water milfoil. In most instances, the control of native aquatic plants should be discouraged or limited to only high-use areas like public swimming beaches and boat access channels. This is because a plant-barren lake bottom is an open invitation for a host of problems. These include:

- High turbidity caused by the re-suspension of bottom sediment and accelerated shoreline erosion;
- Poor fishing and wildlife-observation opportunities due to the absence of adequate habitat;
- Greater potential for the infestation and prolific growth of exotic species; and
- More frequent and intense algal blooms as a result of less competition for nutrients.

Algae and rooted aquatic plant growth are inversely related given that each depends upon and competes for the same nutrients and available sunlight. This relationship allows for two alternate states of equilibrium: a lake that is clear and thick with vegetation, and one that is murky and plagued with algae blooms. Consequently, a large-scale, plant-eradication effort could potentially trade a clear and “weedy” lake for a turbid, algae-covered and plant-barren lake with little nutrient buffering capabilities or aquatic habitat.

CHAPTER 6: MANAGEMENT GUIDANCE

OVERVIEW

Goal: Promote a diverse, balanced and sustainable native plant community—both on shore and throughout Lake Ripley's shallow littoral zone—to protect water quality and maximize habitat benefits.

Strategy: Selectively control non-native weed beds while minimizing disturbances to valuable native plant communities. Target control efforts in a priority-driven manner that 1) first attempts to address the root causes of nuisance weed growth; 2) preserves important ecological values of the larger plant community; 3) facilitates reasonable public access and navigation of the water body, and 4) balances the needs of competing recreational uses.

Methods:

- Educate the public on the goals and objectives for managing aquatic plants, and what steps need to be taken to achieve the desired outcome.
- Monitor land-use changes and promote Best Management Practices (BMPs) in the watershed to prevent sediment and polluted runoff from reaching the lake.
- Adopt policies that protect shallow, ecologically sensitive areas that remain susceptible to disturbance and degradation.
- Use mechanical harvesting to manage non-native, nuisance weed growth in approved locations.
- If warranted, complement mechanical harvesting with species-specific, spot herbicide treatments or manual harvesting in approved locations.
- Instruct lakefront property owners on how to properly manage plant growth that occurs around their own piers, boatlifts and swimming rafts.
- Update the aquatic plant inventory every few years to monitor harvesting impacts on species diversity, distribution and densities.

In 1990, the Wisconsin Department of Natural Resources issued an Aquatic Plant Control Reconnaissance Report for Lake Ripley.[22] The report assessed the lake's Eurasian water milfoil problem, and reviewed the feasibility of several aquatic plant management strategies. Based on the analysis, four strategies were recommended that eventually formed the basis of the 1992 Aquatic Plant Management Plan. These strategy recommendations remain valid to this day.

1. Large-scale mechanical harvesting was recommended as the most effective method for controlling Eurasian water milfoil and improving access and recreation in the lake. Mechanical harvesting was considered the most environmentally sound technique for controlling milfoil in large, off shore areas.

2. Herbicide use was not advocated as a lake-wide control method due to concerns that the chemicals were potentially harmful to non-target species and the aquatic environment. However, limited herbicide use was considered acceptable if applied as spot treatments in near-shore areas that could not be accessed with a mechanical harvester. Only herbicides that selectively destroy Eurasian water milfoil (e.g. 2,4-D) would be allowed.

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[22]*Marshall, Dave. 1990. Aquatic Plant Control Reconnaissance Report for Lake Ripley, Jefferson County, Wisconsin. Wisconsin Department of Natural Resources.*

3. Small-scale harvesting techniques were considered effective for localized management, offering an alternative to chemical treatment in shallow, near-shore areas. Hand-held cutters, specialized rakes and other devices could be used by lakefront property owners to clear nuisance weed growth around piers, boatlifts and swimming areas. Deep cutting by SCUBA divers (6-12 feet) could also supplement large-scale harvesting to provide relatively long-term access channels. Channels cut within dense Eurasian water milfoil beds was also cited as a strategy for improving fish habitat.

4. Planting valuable native aquatic plants was recommended to restore the lake's ecological balance and recreational potential. While the effectiveness of transplanting aquatic plants was still being investigated, the potential benefits warranted consideration as part of an overall management plan. It was recommended that native plants be re-established in areas following Eurasian water milfoil decline or eradication.

COMPREHENSIVE ACTION PLAN

STEP 1: ADDRESS ROOT CAUSES OF NOXIOUS WEED PROBLEM

The first step is to attack the nuisance weed problem through preventative measures that reduce the amount of sediment and nutrients washing into the lake. Nuisance aquatic plant conditions are typically a biological symptom of accelerated, or human-induced, eutrophication. Shallow, nutrient-rich lakes are prime candidates for heavy plant growth, especially following the influx of sediment and polluted runoff (e.g. fertilizers, manure, eroded soil, organic debris, etc.) from the contributing watershed. Water bodies located in fertile soil regions with high erosion rates will support more plant life than those situated in areas with less fertile soils and lower erosion rates. Most aquatic plants derive a majority of their nutrient requirements from the lake bottom, so nutrient-rich bottom sediment can support dense stands of vegetation for years. This explains why even when nutrient inputs from the watershed are significantly reduced, nuisance plant growth may still occur for a considerable period of time.

Preventative actions that target the source of a problem rather than the symptoms are the best means of achieving a long-term reduction in excessive weed growth. Reducing the influx of surplus nutrients and sediments into the lake, for example, can limit the extent of a nuisance plant problem and prevent it from worsening. Adopting and enforcing zoning and land-use ordinances that protect the shoreline and lakeshore wetlands, reducing construction site erosion, and minimizing stormwater runoff are effective means of controlling this external nutrient and sediment loading. The impacts of watershed disturbances must be minimized to the greatest extent possible before any in-lake, symptom oriented management technique will prove cost-effective. The 2001 Lake Ripley Management Plan should be consulted for detailed descriptions of pollutant-reduction strategies and advice on the proper implementation of these strategies.[23]

STEP 2: MANAGE LAKE USE THROUGH SURFACE ZONING

The second step is to plan better lake use through the implementation of surface zoning. Lake zoning can be used to more effectively separate and equitably accommodate competing recreational interests. It can also allow for a greater number of people to use the lake at one time. Examples include buoyed no-wake zones for fishing and the protection of ecologically sensitive areas, wake zones for high-speed boating and waters skiing, and boat-restricted swim areas. By dividing a lake into separate and distinct user zones, conflicting recreational uses can occur with limited interference.

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[23] *Lake Ripley Management District. 2001. Lake Ripley Management Plan.*

The manner in which aquatic plant life is distributed throughout the lake can help dictate the locations of specific user zones. Deep, off shore, open water areas with little plant growth are probably best suited for speed boating and higher-impact activities. On the other hand, shallow, near-shore areas with dense stands of native vegetation might be more appropriate for fishing, paddling and lower-impact activities. Plant control strategies can then be tailored to each zone, and unnecessary treatments (e.g. applying herbicides to areas best left for fish spawning or endangered species) can be avoided.

As a sidebar, it is well documented that motorboat traffic can have a detrimental impact on native plant communities. Prop wash from boat motors causes scouring of the lake bottom in shallower areas, while propeller blades inflict physical damage to any plant within reach. These disturbances are conducive to the spread of exotic, invasive species that are able to tolerate harsher environments and exploit recently disturbed areas. Whenever possible, no-wake zones should attempt to incorporate shallow water depths (less than several feet deep) to help prevent these problems from occurring.

STEP 3: TARGET CONTROL STRATEGIES APPROPRIATE TO EACH USER ZONE

Plant control strategies should be selected that cost-effectively address the unique needs of each recreational user zone identified in Step 2. Manipulating habitat, selectively removing undesired plants or plants that occur in undesired locations, and encouraging desired plant growth in desired locations are all ways of managing aquatic plants to improve the quality of a lake. Strategy selection will depend on the nature of the particular problem that is being addressed, as well as the desired outcome that is sought in terms of recreational enhancement. Lake-use patterns and location preferences should be identified with respect to water quality and habitat protection needs to help target control efforts appropriately. A review of the various plant-control strategies considered appropriate for Lake Ripley are presented in Tables 17 - 19.

Table 17: Mechanical Harvesting Evaluation & Guidance

Strategy:	**MECHANICAL HARVESTING**
Approved Locations:	- Greater than 3-ft. water depths - Where expansive, off-shore milfoil stands are growing at or near the surface - Safe distance from piers, boat hoists, swim rafts, and other structures
Advantages:	- Direct, physical cutting and removal of problem weeds and associated nutrients - Immediate relief of nuisance condition - Targets growth within five feet of the surface where it is most problematic - Quicker and more efficient than manual harvesting - Minimum health and safety risk - Limited interference imposed on most lake uses - Some species selectivity achieved due to timing and location of cutting - May favor slower and lower growing species - Effectively clears boating lanes and provides edge habitat through dense weed beds - Reduces the potential for floating plant debris caused by motor boats and storms - Avoids the need for chemicals that can affect sensitive aquatic organisms - Lower long-term costs and environmental impacts compared to other strategies
Disadvantages:	- Short-term effectiveness - Requires repeated implementation throughout growing season - High initial cost for the acquisition of equipment (financial assistance available) - Involves annual costs for insurance, equipment maintenance/storage, labor, etc. - Not as effective on fast growing and non-rooted plant species - Minimum species selectivity achieved in areas with mixed plant communities - May benefit disturbance-tolerant species

	- Not appropriate within less than three-foot water depths and in confined areas - Potential to remove small fish and other organisms along with the cut plant material - Overuse could eliminate critical aquatic habitat - Improper operation could disturb the lake bottom and stir up sediment - Collection of all floating plant debris may not be possible - Attacks symptoms rather than root cause of nuisance weed growth - Requires DNR permit - Requires the use and maintenance of multiple pieces of heavy machinery
Recommendation:	This strategy should continue to be deployed as the primary plant-management tool for Lake Ripley. The District has already invested in the necessary capital equipment, and has established its own successful harvesting program. Other complimentary measures, such as spot herbicide treatments or manual harvesting, may become appropriate in locations or situations that preclude mechanical harvesting.

Table 18: Manual Harvesting Evaluation & Guidance

Strategy:	**MANUAL HARVESTING**
Approved Locations:	- Shallow, near-shore areas subject to nuisance weed growth - Confined areas such as around piers, boat hoists and swim rafts
Advantages:	- Nuisance plants are cut or uprooted and then removed from the lake - Most methods are very simple and inexpensive - High species selectivity achieved through hand pulling or targeted raking - Immediate relief of nuisance condition - Few negative environmental impacts - No chemicals or expensive machinery is needed - Will not interfere with typical lake uses - Does not generally require a DNR permit
Disadvantages:	- Very labor and time intensive - Harvested plant material will require off-lake disposal - Only suitable for smaller areas, and not as a lake-wide management technique - Short- to medium-term effectiveness due to plant regeneration or re-colonization - Attacks symptoms rather than root cause of nuisance weed growth - Overuse can eliminate critical aquatic habitat
Recommendation:	This strategy is ideal for the individual lakefront property owner who needs to address weed-choked areas around private piers, boatlifts and swimming rafts. SCUBA divers can be employed to hand pull or cut weeds in deeper areas and within defined boat channels.

Table 19: Aquatic Herbicide Evaluation & Guidance

Strategy:	**AQUATIC HERBICIDES**
Approved Locations:	- Isolated pockets of non-native weed growth away from non-target species and ecologically significant 'sensitive' areas - Areas where nuisance vegetation cannot be effectively controlled by other means
Advantages:	- Herbicides can be either broad spectrum or fairly species specific - Timing of treatment can increase effectiveness while limiting unwanted side effects - Fish toxicity is generally not a problem when used in recommended doses - Chemical applications can clear large areas of nuisance vegetation relatively fast
Disadvantages:	- Short- to medium-term effectiveness

	- Applications must generally be repeated on a seasonal and annual basis - Chemical drift can cause damage to non-target species - Plants are left in the lake to decompose - May result in dissolved oxygen depletion, nutrient release, and silt accumulation - Long-term environmental risks of certain chemicals are not well understood - Attacks symptoms rather than root cause of nuisance weed growth - Plants differ considerably in their susceptibility to chemical treatment - Certain water uses may be temporarily restricted following application - Requires a DNR permit and licensed applicator - Treated areas may be prone to re-colonization by more aggressive, pioneer species - Overuse can eliminate critical aquatic habitat
Recommendation:	Spot herbicide treatments should be used as a last resort when other methods fail or prove infeasible. Endothall, diquat and copper are contact herbicides that may be effective on annuals. Dichlobenil, 2,4-D, fluridone and glyphosphate are more species specific, systemic herbicides that may be effective on perennials. The herbicide 2,4-D (2,4-dichlorophenoxyacetic acid) is probably most commonly and effectively used to control Eurasian water milfoil.

Maintaining and facilitating the propagation of native plants in lakes is often the most effective and ecologically responsible means of nuisance plant control -– regardless of the user zone. The right types of native plants can be planted to increase species diversity, attract waterfowl, promote fish spawning, retard shoreline erosion, improve water clarity, and prevent the continued spread of exotic species. Lakefront property owners should be encouraged to engage in shoreline restorations on their own or through the Lake Ripley Priority Lake Project. Plantings can occur both on land and in the water to recreate an aesthetically appealing and environmentally beneficial lakescape.

A number of other strategies were evaluated but found to be inappropriate for Lake Ripley. Table 20 lists some of these strategies and offers brief explanations as to why each strategy was dismissed as a viable option.

Table 20: Strategies Deemed Impractical for Lake Ripley

Strategy	Limiting Considerations
Aquatic plant screens & sediment barriers	- Materials can be expensive and difficult to install even for small treatment areas - Requires routine, labor-intensive cleaning and reapplication - Not a species-specific control technique - Most applicable for small swimming areas where complete plant removal is desired
Water level manipulation	- Physically infeasible due to lack of outlet control structure and low recharge rate - Aquatic plant responses vary widely and sometimes unpredictably - Recreational use of the lake would be dramatically impacted
Dredging	- May be prohibitively expensive - High potential for adverse environmental impacts - Not a species-specific control technique - Disturbance of lake bottom may invite re-colonization by nuisance species
Biological control using milfoil weevils	- Effectiveness may be compromised by an ongoing mechanical harvesting program - Eurasian water milfoil stands may no longer be sufficiently

	extensive to warrant this strategy - Technique is relatively new and unproven

STEP 4: EDUCATE THE PUBLIC

The support and cooperation of the public should be solicited through a public information and education campaign. This will increase the lake community's understanding of what can and cannot be done with an aquatic plant management program. For instance, the public should be informed as to why certain areas of the lake are harvested and others are not. The public should also know the harvesting timetable, and the possibilities and reasons for delay. Brochures, fact sheets, signs, press releases, newsletters and televised public meetings represent some effective methods for conveying information. Communicating the goals and objectives of an aquatic plant management program is an excellent way of garnering community support through increased awareness and understanding.

Specifically, lakefront property owners should be encouraged to properly manage nuisance plant growth around their own piers, boatlifts and swim rafts. These areas are simply too shallow and confined for a large mechanical harvester to safely operate. Residents should be educated on the benefits of aquatic plants, how to distinguish between native and exotic species, and approved methods for nuisance plant control. Lakefront property owners should also be encouraged to remove floating plant debris from the water when it washes onto their shorelines. Finally, highly visible signs should be posted at launch sites that explain important boating ordinances, the location of no-wake zones, and other lake rules and regulations.

STEP 5: CONDUCT FOLLOW-UP PLANT INVENTORIES

Continued monitoring is needed to document changes in the type, abundance and distribution of the different plant species found in Lake Ripley. Knowing how the aquatic plant community responds to various management actions is essential in ensuring that the program remains cost-effective over the long-term. Because a plan is only as good as the information it is based upon, maintaining accurate and current plant survey data is very important. It is recommended that the LRMD repeat the aquatic plant survey at least every several years to evaluate the effectiveness of existing programs.

CHAPTER 7: HARVESTING PLAN

INTRODUCTION

Mechanical harvesting should be viewed as a long-term commitment where operational intensity will vary from year to year depending on actual need. An effective harvesting program requires a great deal of work and a significant time commitment. It involves maintaining, storing and deploying multiple pieces of equipment. It also involves finding and training employees or volunteers; providing insurance; securing launching, unloading and off-season storage sites; locating disposal areas; record keeping; and maintaining public relations. However, once a program is established, significant cost savings and other benefits can be realized.

Harvesting involves cutting and collecting aquatic vegetation growing within a few feet of the water surface. Root systems remain in place after harvesting, allowing plants to quickly regenerate. About one acre of lake surface can typically be harvested per hour, and relief can last as little as several days or up to three months depending on the situation.

Mechanical harvesting exhibits both selective and non-selective impacts on aquatic plants. Non-selectivity is demonstrated by the removal of all plant species that fall within the reach of the cutter bars. Some species selectivity is achieved by targeting monotypic stands of nuisance vegetation, operating at different times during the growing season, and altering the depth of cut. It may be possible for harvesting to alter the composition of a plant community by encouraging the success of shorter-growing and disturbance-tolerant species, and by allowing additional sunlight to reach the understory.

HARVESTING STRATEGY

EQUIPMENT

The Lake Ripley Management District currently owns and operates a 1993 Aquarius Systems' Model HM-420 mechanical harvester with a 7.0-foot cutting width, 5.5-foot cutting depth, 10.8-19.8" draft, and a 440 cubic feet capacity (8,500 lbs.). It was purchased for $66,000 with the help of a 50% matching grant through the Wisconsin Waterways Commission.

The harvester is constructed upon a low-draft barge controlled by side-mounted paddle wheels, and is equipped with one horizontal and two vertical cutter bars that can be hydraulically positioned to a depth of 5.5 feet. Hydraulic conveyors built into the harvester hoist cut plant debris onto the deck of the barge. When full, the plant material can be transported back to shore to be off-loaded into an awaiting dump truck using another conveyor system.

Ancillary equipment presently includes an aging 28.5-foot shore conveyor, 1977 GMC Sierra Series 6000 dump truck, and a 42-foot Aquarius Systems' harvester trailer with mounted electric winch. The shore conveyor and dump truck are quite old and have started to require increasing levels of maintenance. These two pieces of equipment may need to be replaced at some point in the near future. At the close of each season, all equipment is cleaned, inspected, lubricated and winterized for storage.

Table 21: Dimensional Data for Harvester and Accessories

	Length	Width	Height
Harvester (on trailer)	42 ft. (39 ft. off trailer)	14.2 ft. (with paddles) 9 ft. (without paddles)	9 ft.
Conveyor	28.5 ft.	6.5 ft. (at wheels)	9.5 ft. (max.) 6.7 ft. (min. – center pivot)
Dump truck	21 ft.	8 ft.	7.5 ft.

LAUNCHING & OFF-LOADING SITE

Launching occurs at the Island Lane public boat landing each summer, and the harvester and shore conveyor are parked at the Hoard-Curtis Scout Camp throughout the operating season (approximately mid-June to late-October). Launching and removal of the harvester remains problematic due to the absence of an adequately sized turnaround. The turnaround should be a minimum of 60 x 60 feet since the trailer cannot be rotated at greater than a 90-degree angle when hitched. Consequently, the trailer must be slowly backed into position starting from Forested Road.

DISPOSAL SITE

Harvested plant material is currently trucked to the Roger Rude farm at W9156 USH 12 in Cambridge for composting. Many farmers are more than willing to accept aquatic plants since they compare favorably with cow manure as a source of nutrients (2.5% nitrogen, 0.6% phosphorus, and 2.3% potassium) and can add valuable, seed-free organic matter to the soil. Locating a disposal site in close proximity to the off-loading conveyor station is one of the keys to managing costs and increasing program efficiency.

EQUIPMENT STORAGE SITES

The harvester, dump truck and shore conveyor are currently kept parked at the Hoard-Curtis Scout Camp during the operating season, while the harvester trailer gets stored at the Roger Rude farm. The equipment is later taken to the Gerald Pooch facility at 656 Koshkonong Road in Cambridge for off-season storage and maintenance (approximately late-October to mid-June).

OPERATIONAL PROCEDURE & CHECKLIST

	Pre-season Preparations
1.	Review prior year expenses and budget for upcoming season
2.	Hire and train 2-3 seasonal, part-time employees or volunteers (Establish wage rate; complete payroll tax reporting forms; provide timesheets; and review safety, maintenance and operational procedures)
3.	Schedule tentative launch date and confirm arrangements with interested parties (Contact insurance agent, harvester operators, off-season and summer storage providers, maintenance crew, disposal site manager, and Town of Oakland)
4.	Work with mechanic to ensure all equipment is serviced and operational (Check battery charges, tire pressure, fuel & oil levels, filters, hydraulics, lubricated fittings, spark plugs, bearings, hoses, etc.)
5.	Inspect launch facility and staging area to identify any potential obstructions or maintenance needs
6.	Provide certificate of liability insurance to Scout Camp
	Equipment Mobilization & Launching
1.	Finalize launch date, re-activate insurance for dump truck, and pay invoices for off-season maintenance

	and storage services
2.	Coordinate with operators and storage provider to move harvesting equipment back to the lake (Gather supplies such as tire blocks, work gloves, waders, gate/harvester/truck keys, two-way radios, emergency tools, 12-volt battery, first aid kit, road barricades, rope, pruning saw, etc.)
3.	Barricade entry to the public landing and disassemble pier
4.	Transport harvester to the public landing, launch and park at the Scout Camp (Cover operator's console to protect against weather)
5.	Take the harvester trailer to the Roger Rude farm for summer storage (Cover tires and electric winch to weatherize)
6.	Transport and park the shore conveyor at the Scout Camp (Cover tires and engine to protect against weather)
	Summer Operations
1.	Provide operators with gate/harvester/truck keys, two-way radios, work gloves, pitch forks, small ladder, hand tools, extra timesheets, polarized sunglasses, sun protection, etc.
2.	Review safety protocol, operating procedure and maintenance requirements
3.	Identify target species and locations
4.	Maintain detailed records on hours worked, locations harvested, and number of loads removed
	Off-Season Removal & Storage
1.	Schedule equipment removal date following pier disassembly (Contact insurance agent, harvester operators, off-season and summer storage providers, maintenance crew, disposal site manager, and Town of Oakland)
2.	Finalize new storage contract and exchange certificates of insurance
3.	Charge battery for trailer winch and go over supply needs (Gather supplies such as harvester/truck/gate keys, waders, work gloves, tire blocks, tools, cable guard for cutter blades, road barricades, two-way radios, first-aid kit, etc.)
4.	Transport shore conveyor back to the storage facility, and then return for the trailer and harvester
5.	Review off-season maintenance needs with mechanic/storage provider
6.	Deactivate insurance on the dump truck
7.	Collect keys, radios, timesheets, etc. from all employees
8.	Pay invoice from Scout Camp for the summer rental of their shoreline

OPERATING COSTS

Operating costs are highly variable but generally average around several thousand dollars per year. Costs include fuel, equipment storage, maintenance/repairs, payroll and insurance. Actual operating expenses depend on the number of people employed to operate the equipment, the nature of their employment (volunteer, part-time or full-time), and the hours of operation. The LRMD should recognize that it takes dedicated and skilled individuals to properly maintain and operate the equipment. Appropriate compensation incentives must be provided to maintain a qualified operating crew and to avoid a high, annual staff turnover rate.

Item	Approximate Annual Cost
Insurance (general liability, marine & truck, workman's compensation, errors and emissions for board members)	$3,500
Payroll ($12.50 wage rate)	$2,000
Equipment storage (all year)	$1,200
Fuel, supplies, maintenance & repairs	$1,200
TOTAL:	$7,900

SAFETY PRECAUTIONS

There are numerous safety precautions that should be taken when operating heavy machinery. The following safety measures will help prevent personal injuries and damage to the harvesting equipment and other property. This is not an exhaustive list, and should be used only as a guide.

- Operators shall be experienced and have sufficient training on the safe and proper use of the machinery.
- Operators shall be trained in how to respond in the event of a system malfunction or other emergency.
- Operators shall posses a coast guard approved personal floatation device.
- Operators shall not drink alcohol, smoke, wear headphones, or operate the machinery when tired or sick.
- Operators shall wear the proper, weather protective gear (polarized sunglasses, hat, etc.).
- Operators shall abide by all equipment safety and operational rules.
- No swimming or fishing shall be allowed to occur in the area of the harvester.
- No person shall be allowed within the immediate vicinity of the harvester during operations.
- Harvesting shall be postponed during inclement weather conditions or when boat traffic is excessive.
- The equipment shall not be operated after dark or in high winds.
- The equipment shall not be operated in less than 3-foot water depths, or around piers and other structures.
- The harvester shall be equipped with the proper safety equipment (first aid kit, fire extinguisher, etc.)
- No pets or extra people shall be allowed on the harvester during operations.
- The harvester shall not be overloaded with plant material at any time.
- The harvester engine shall be shut off before any repairs are made, or before any obstructions are cleared.
- The harvester engine shall never be allowed to idle unattended.
- Regular inspections shall be performed to ensure all mechanical parts are in proper operating condition.

GENERAL OPERATING PROCEDURE

Operators must first be trained on how to safely and properly use and maintain the equipment. It is also important that they understand their objective, and that they are able to distinguish between native and exotic plant species. Operators should become familiar with the locations of nuisance weed beds, potential underwater obstructions, shallow water depths, and any areas that might be off limits to mechanical harvesting (i.e., critical spawning habitat, high quality plant beds, etc.).

Large-scale clear cutting, which aims to open as much area of water surface as machine, budget and daylight allow, is not recommended for Lake Ripley. This method is typically employed to open large areas of the lake for water sports, remove exotic foliage that stymies less aggressive native plants, and reduce the level of stunting by plant-dwelling panfish. However, if performed too aggressively, the clear-cutting strategy causes numerous problems with shoreline erosion, sediment re-suspension, loss of habitat, and the proliferation of undesirable species. Furthermore, recreational activities such as fishing and wildlife viewing will suffer while the lake becomes a haven for speed boating and other open water activities. Large-scale clear cutting also increases the chances of removing significant quantities of juvenile fish, turtles and other aquatic organisms that fail to escape the path of the harvester. Although nutrients are removed with harvested plants, large-scale harvesting rarely offsets nutrient loading to lakes.

Selective harvesting, on the other hand, involves targeted cutting in certain areas. This method involves reshaping as much habitat as lake users need, and leaving the rest for aquatic communities. Cutting intensity will vary depending on the extent of weed growth and the nature of the particular user zone. This approach is recommended for Lake Ripley as a planned approach to multiple lake use.

Operations should commence no sooner than mid-June to allow time for the vegetation to grow within reach of the harvester, as well as to avoid most of the fish-spawning season. Cutting is best performed during calm weather conditions and when there is minimal boat traffic. The actual amount of time needed for harvesting each season can vary dramatically, making scheduling difficult at best. The amount of lake surface area covered, number of plant loads collected, or hours spent on the lake harvesting is irrelevant to a successful program and should not be used to gauge success. Changes in plant abundance and rate of growth are dependent upon a number of variables independent of a harvesting program. Instead, operators should simply focus their efforts on safely and efficiently harvesting nuisance weed growth within approved locations, while avoiding high quality native plant beds.

Some areas may need to be cut as often as two or three times per season during heavy growth, while certain "hot spots" might require cutting as many as 4-5 times during the summer. Exotic plant species such as Eurasian water milfoil should be harvested when they are at high densities and visible at the surface within designated target areas. Harvesters work best in waters that are three to six feet deep, and where nuisance vegetation begins to canopy at the surface. To avoid disturbing bottom sediments, no harvesting is performed any closer than one foot from the bottom of the lake or in water less than three feet deep. Loose, mucky or silty substrates and stump fields in shallow areas should be avoided to prevent the re-suspension of bottom sediments or damage to the machinery.

Operators should be instructed to monitor the number and types of fish picked up by the harvester. Larger fish and turtles should be safely and expeditiously returned to the lake. When large numbers of fish are encountered, harvesting is temporarily stopped in that area until the fish have moved on. Spawning beds should be avoided entirely during the early part of the season. The operator can return to these areas later in the season when spawning has ended.

While harvesting, all floating plant debris must be immediately removed from the water. The operator should make every effort to pick up floating plant fragments when making turns and during trips to and from the loading site. Lakefront property owners should be encouraged to manage weed growth and collect floating plant debris around their own piers, boatlifts and swimming rafts. Operating a large weed harvester in such tight, shallow areas is hazardous given the risk of damaging the equipment or private property. Although many people associate floating plant debris with harvesting, other factors are usually to blame. These factors include "prop chop" from motor boats, severe weather, and auto-fragmentation of certain plant species.

Operators should submit a daily log every two weeks as a time sheet (see Appendix D). Harvesting logs are a good way of documenting program activities (methods, locations, management intensity), keeping track of costs, estimating downtime, and identifying weed growth patterns. A typical harvesting log will ask for name, date, start/finish times, mapped harvest areas, number of loads collected/disposed, plant types harvested, equipment maintenance performed, expenses incurred, and any problems encountered.

CHAPTER 8: CONCLUSION

Aquatic plant inventories of Lake Ripley indicate a moderately diverse plant community that shows some signs of degradation. Evidence of degradation includes the presence of non-native (exotic) vegetation, dominance of pollution- and disturbance-tolerant species, and limited overall biodiversity. Eurasian water milfoil continues to play a dominant role in the aquatic plant community, and is largely responsible for observed recreational impairments.

It appears that the LRMD's mechanical weed harvesting program is effectively keeping nuisance milfoil growth in check. Continuation of the program is recommended, but cutting should only be performed in approved locations to meet programmatic goals and objectives. Lakefront property owners should be encouraged to manage nuisance weed growth around their own piers, boatlifts and swim rafts. Pollution control, shoreline restorations, lake-use zoning, and the protection of wetlands and ecologically significant 'sensitive' areas are also recommended.

It is important to recognize that any weed-control strategy will have both advantages and disadvantages. Although several strategies may be applicable to Lake Ripley, careful consideration should be given to such tradeoffs prior to implementation. The prevailing management objective is to target monospecific stands of non-native weed growth, while protecting mixed communities and native plant beds. This overriding strategy is designed to alleviate nuisance conditions, and, at the same time, promote a healthy aquatic plant community that improves water quality and provides critical habitat benefits.

To date, a wealth of information has been collected on Lake Ripley's aquatic plant communities through repeated inventories. This information is tremendously useful in diagnosing potential problems and gauging the success of ongoing management programs, especially when used in conjunction with long-term water quality and fisheries data. The LRMD is advised to continue its monitoring efforts, and may want to revisit management recommendations whenever conditions change or new information and technologies becomes available.

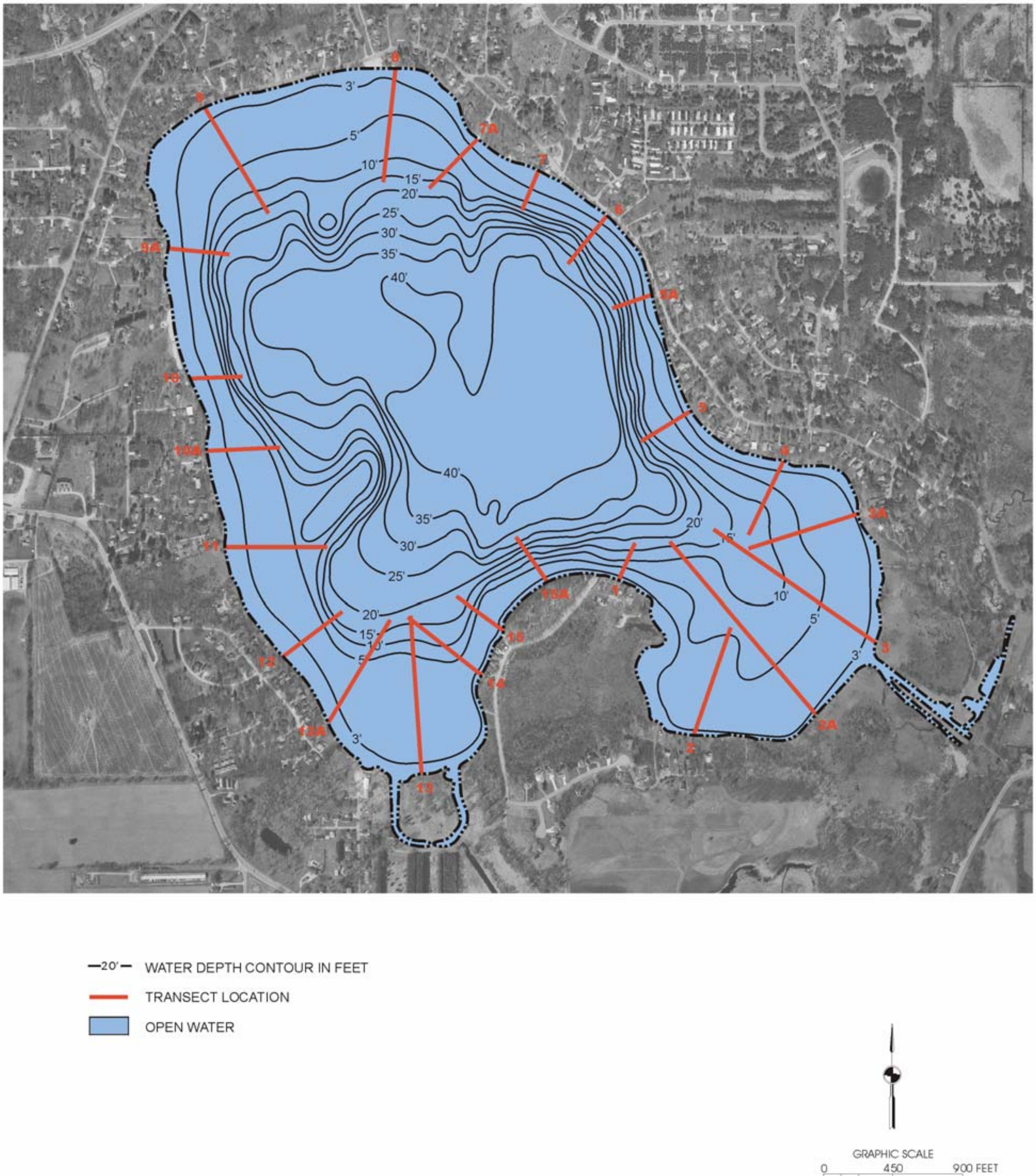
Appendix A

SENSITIVE AREAS MAP

Appendix B

TRANSECT LOCATIONS & DESCRIPTIONS

Transect Location Map



Source: Wisconsin Department of Natural Resources

Transect #1
(Fourth cottage east of public boat landing)

Transect #2
(Adjacent to last cottage in East Bay going east toward inlet)

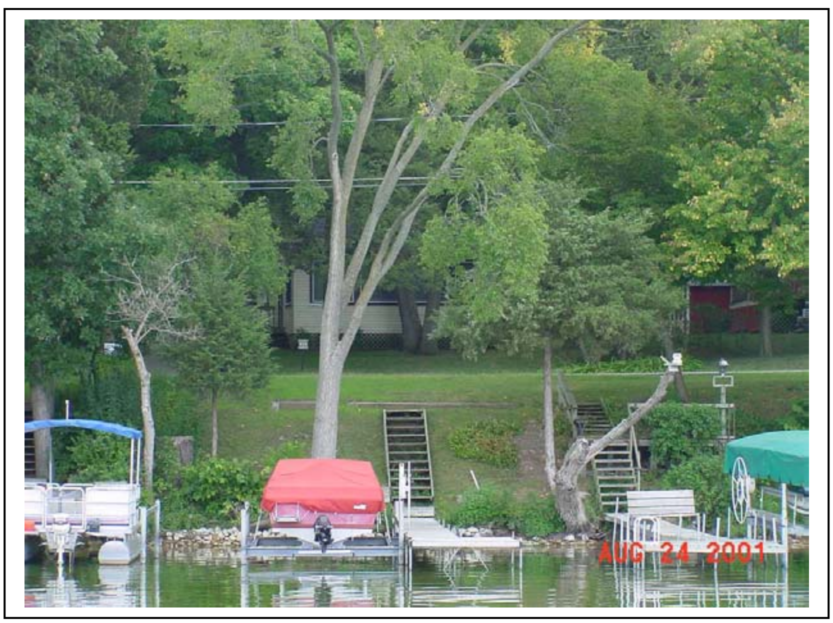
Transect #2A
(Halfway between inlet and house furthest east on south shore)

Transect #3
(100 feet north of inlet on the east shore)

Transect #3A
(Grey/blue house with fieldstone foundation, steps up left side of porch, and small matching 'guest house' to right and closer to lake; large natural-sided home to right further back from lake on hill)

Transect #4
(Third house west of Beach Drive, or 13 houses going northwest from wetland)

Transect #5
(White house with concrete steps to the lake and a grouping of seven pine trees)



Transect #5A
(On pier of W9140 to W9142 Ripley Road; house across road is tan/cream with horizontal siding, lattice beneath porch, and steps up left side)

Transect #6
(Fourth house east of the old Arbor Dell restaurant with five concrete steps to the lakefront)

Transect #7
(Right in the center of the old Arbor Dell restaurant)

Transect #7A
(Log-sided home midway between Shore Place beach and Arbor Dell; wooded lot, shoreland buffer and rock shoreline)

Transect #8
(Brown house adjacent and east of shore Shore Place beach)

Transect #9
(Red brick cottage five houses west of A-frame)

Transect #10
(Second white house south of community beach with "Bible Camp" on front)

Transect #10A

(Yellow house north of Alpine Village apartments; off pier on right and north of sandy beach area between yellow and white house)

Transect #11
(five houses south of the “bar” and 100 feet south of the last house into the wetland)

Transect #12
(Gray house about nine houses south of wetland)

Transect #12A
(Third house north of wetland lying just west of marina; small, two-story grey house, second floor all windows, door in middle; brown house to right and back)

Transect #13
(Middle of Vasby's Island between the two channel openings)

Transect #14
(First lot, part of wetland on the east shore of South Bay)

Transect #15
(200 feet from last visible home on the east shoreline of South Bay)

Transect #15A
(300 feet west of public landing on Scout Camp property)

Appendix C

FIELD DATA

Aquatic Plant Species Survey Data (1976)

Transect	Depth[a]	Species[b]										
		Chara sp.	*Myriophyllum spicatum*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Ceratophyllum demersum*	*Elodea canadensis*	*Potamogeton crispus*	*Potamogeton natans*	*Utricularia spp.*	*Potamogeton spp.*	*Naiad spp.*
I	--					1				1		
	--		1		1	1	1				1	
	--					1	1				1	
	--		1			1						
	--		1			1					1	
	--		1			1						
	--		1		1	1						
	--		1			1						
	--		1			1						
	--		1			1						
	--	1	1									
	--	1	1			1						
	--		1		1	1					1	
	--	1	1		1							
	--	1		1	1							
	--	1			1				1			
	--			1							1	1
II	--		1						1			
	--	1		1					1			1
	--	1		1	1							
	--	1		1								
	--			1								
	--	1		1	1							
	--	1		1								
	--	1			1							
	--		1	1	1	1						
III	--	1		1								
	--	1		1								
	--	1		1							1	
	--		1	1		1					1	
IV	--	1			1							1
	--	1		1								
	--	1		1	1							
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V	--	1	1	1					1			
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VI	--								1			
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	--	1						1		1		
VII	--	1										
	--	1		1						1		
	--	1		1								
	--	1		1								
VIII	--			1								
	--	1		1								
	--								1			
	--	1	1	1								

[a]Depth data were not recorded for this survey.
[b]Species data numbers only reflect presence and absence (not abundance) from this survey.

Source: Wisconsin Department of Natural Resources

Aquatic Plant Survey Data (1989)

		Species											
Transect	Depth	*Chara spp.*	*Myriophyllum spicatum*	*Najas marina*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Najas flexilis*	*Potamogeton gramineus*	*Ceratophyllum demersum*	*Potamogeton crispus*	*Potamogeton natans*	*Potamogeton Illinoensis*	*Potamogeton pusillus*
1	1.5		3			1							
	6		4				2					2	
	12		4	1									1
	18		1										
2	1.5		3										
	6		2						1				
	12		4										
	18		1										
3	1.5		4						4				
	6		4						3				
	12		1										
	18												
4	1.5		1									1	
	6		4			1					1	1	1
	12		2										
	18												
5	1.5		3	1	2		1			1			1
	6		1									1	
	12		4										
	18												
6	1.5		1				1						1
	6		2	1							1		1
	12		4										
	18												
7	1.5		4				1					3	2
	6		4		2						1	1	
	12		3										1
	18												
8	1.5		2	1								1	
	6		4									1	
	12		4				1						
	18												
9	1.5		4		1		1				1	1	2
	6		4										1
	12		3										
	18												
10	1.5		1	1									
	6		4	2	1							2	
	12		1										
	18												
11	1.5		4		3			1					1
	6	1		2									1
	12		3										
	18												
12	1.5	1	4		1	1	1				1	1	2
	6	2	1	4									
	12		3										
	18												
13	1.5		4								2		
	6	1	1	4									
	12		4										
	18												
14	1.5	2									1	2	1
	6	1	1	4									
	12		4										

	18												
15	1.5		1		1			1			1		
	6	1	1	1								1	
	12		4										
	18												

Source: Wisconsin Department of Natural Resources

Aquatic Plant Species Survey Data (1991)

		Species										
Transect	Depth	*Chara spp.*	*Myriophyllum spicatum*	*Najas marina*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Najas flexilis*	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum exalbescens*	*Utricularia spp.*	*Potamogeton spp.*
1	3	1	4				4					
	6	3	4		2		3					
	9		4	1	1							
	12		4				1					
	15											
	18											
2	3		4					4	1			
	6		4	2		1				1		
	9		1	4								
	12											
	15											
	18											
3	3		1					4				
	6		3					4	1			
	9		4					4				1
	12							4				
	15											
	18											
4	3		2	1			1	1				
	6	2	2	4	1	2		3				
	9		4					3				
	12											
	15											
	18											
5	3		2	2			2					
	6		3	3		2		3				
	9	1	4	4							1	
	12		2									
	15		2									
	18											
6	3	1	1	2								
	6			1				1				
	9		4									
	12		4									
	15		4									
	18											
7	3		2					2				
	6		4	2				2				
	9		4	1								
	12		4									
	15											
	18											
8	3	1		1								
	6	2	3	3		3						
	9		4	2				2				
	12		4									
	15											
	18											
9	3		3	4	1	2	4	4			2	1
	6	4		1								
	9		4	2		2						
	12							2				
	15		3	3								
	18											
10	3			2								

	6	4		4								
	9	3	2	4		2						
	12		3	3								
	15			2				1				
	18											
11	3	2	2		3	4	2					
	6	3	1	4		2						
	9		3	3				1				
	12		3	1								
	15		3					1				
	18											
12	3		2	2	2	2						1
	6	2		4		2						
	9		2	2								
	12		4									
	15											
	18											
13	3		4	4	1	4		2				
	6	4		1								
	9		4									
	12		4	1								
	15											
	18											
14	3	2		3						1		2
	6	2		4								
	9											
	12											
	15											
	18											
15	3	1										
	6	4	1	2			4					1
	9		1	4								
	12		1									
	15											
	18											

Source: Wisconsin Department of Natural Resources

Aquatic Plant Species Data (1996)

Transect	Depth	Species											
		Chara spp.	*Myriophyllum spicatum*	*Najas marina*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Najas flexilis*	*Ceratophyllum demersum*	*Elodea canadensis*	*Potamogeton Illinoensis*	*Myriophyllum sibiricum*	*Utricularia spp.*	*Potamogeton spp.*
1	1.5												
	3	1	4				4						
	6	3	4		2		3						
	9		4	1	1								
	12		4				1						
	15												
2	1.5		1					1					
	3		4					4	1				
	6		4	2		2					1		
	9		1	4									
	12												
	15												
3	1.5							1					
	3	1	2	1	1		1	1					
	6		2	4		1		3					
	9		4					3					
	12												
	15												
4	1.5	1	1	1			1						
	3	1	2	1			1	1					
	6	3	2	4	1	1		2					
	9	3	4					3					
	12												
	15												
5	1.5		1	1									1
	3		2	2			2						
	6	1	2	3		2		3					
	9	1	2	4								1	
	12		2										
	15		2										
6	1.5			1									
	3	1	1	2									
	6			1				1					
	9		4										
	12		3										
	15		4										
7	1.5			1	1			1		1			
	3		2					2					
	6		4	2				2					
	9		4	1									
	12		4										
	15												
8	1.5			1		1	1						
	3	1		1									
	6	2	3	3		3							
	9		4	2				2					
	12		4										
	15												
9	1.5					1							1
	3		3	4	1	2	4	4				2	1
	6	4		1									
	9		4	2		2							
	12							2					
	15		3	3									
10	1.5					1							1
	3			2									
	6	4		4									

	9	3	2	4		2							
	12		3	3									
	15			2				1					
11	1.5		1		1	1							
	3	2	2		3	4	2						
	6	3	1	4		1							
	9		3	3				1					
	12		2	1									
	15		3					1					
12	1.5		1	1									
	3		2	2	2	2							1
	6	2		4		2							
	9		2	2									
	12		4										
	15												
13	1.5		1	1									
	3		4	4	1	4		2					
	6	4		1		4							
	9			1									
	12												
	15												
14	1.5												
	3	2	1	3									2
	6	2		4									
	9												
	12												
	15												
15	1.5												
	3	1											
	6	4	1	2			4						
	9		1	4									
	12		1										
	15												

Source: Wisconsin Department of Natural Resources

Aquatic Plant Species Survey Data (2001)

		Species														
Transect	Depth	*Chara spp.*	*Myriophyllum spicatum*	*Najas marina*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Najas flexilis*	*Potamogeton zosteriformis*	*Potamogeton gramineus*	*Ceratophyllum demersum*	*Scirpus subterminalis*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton crispus*	*Potamogeton natans*	*Utricularia spp.*
1	1.5	4			1		4									
	3	4														
	6	4	2		4			1	2							
	9	3	4		2											
	12		1		2											
	15															
2	1.5	3	1	4	3	2	1	2				1	3			
	3	4		4	1	3	2	2								
	6			3												
	9		4							4						
	12															
	15															
3	1.5															
	3		4							3		1				
	6		4				2			3		2	2			
	9	1	4	1		1				4						
	12															
	15															
4	1.5	3	2	1	1	2	1		1							
	3	3	2	4	1	2										
	6	4	2	4												
	9		2							3						
	12															
	15															
5	1.5	3	1	1	4	4	1						4	1		
	3	4			1											
	6		1	1												
	9															
	12															
	15															
6	1.5	4		2	2	2	1		1		3					
	3	4									4					
	6	4	2	1	1				1							
	9		3													
	12															
	15															
7	1.5				2		1				4					
	3				1				2		2					
	6	3	3	2	4	3	1	1								
	9		4													
	12															
	15															
8	1.5	4		1												
	3	3	1	1												
	6	4		4		2										
	9	2	3	3												
	12															
	15															
9	1.5	4	1													
	3	3	2	3			4		1							
	6	4	2	4		2										
	9	1	1	2												
	12		1													
	15															
10	1.5	1		1												
	3	4														
	6	4		4												
	9	1	2	1												
	12	1	1													

	15															
11	1.5	4	1		2	1	4	3								
	3	4			2	2										
	6	1	1	3												
	9		2	1												
	12		1													
	15															
12	1.5	4	1	1	1	1	1		1							
	3	4	1	1	2	2	2									
	6	4		4												
	9	1	3	1												
	12															
	15															
13	1.5															
	3	1	1	4	4			3							1	1
	6	2		4		2										
	9		4	1		2										
	12		4													
	15															
14	1.5	2														
	3	4		2	1	1			3							
	6	3	1	4		2										
	9	2	1	4		2		1								
	12															
	15															
15	1.5	2														
	3	4						1								
	6	4		3		2										
	9		4													
	12		3													
	15															

Source: Wisconsin Department of Natural Resources

Additional Transect Survey Data of Aquatic Plant Species (2001)

		Species									
Transect	Depth	*Chara spp.*	*Myriophyllum spicatum*	*Najas marina*	*Vallisneria americana*	*Potamogeton Pectinatus*	*Najas flexilis*	*Potamogeton gramineus*	*Ceratophyllum demersum*	*Heteranthera dubia*	*Potamogeton Illinoensis*
2A	1.5										
	3	4	1	4		2					
	6		3	4							
	9		4						4		
	12		2	1		1			4		
	15										
3A	1.5	3	3	4	2	2	4				
	3	4	3	4	1	2					
	6		4			1	1		4		
	9			3			1		4		
	12		1								
	15[a]	--	--	--	--	--	--	--	--	--	--
5A	1.5	1	2	1		1					
	3	2	4	2		2				1	
	6	4	1	1		1	3	2			1
	9		1	1		1	1				
	12										
	15[a]	--	--	--	--	--	--	--	--	--	--
7A	1.5			3	4	4		1			1
	3	1	1	1	2	1		1			1
	6	4	1	4		4					
	9		4			2					
	12		3	1					1		
	15										
9A	1.5	3		1	4	3		1			
	3	4		4		2					
	6	3		4							
	9		4								
	12		2	1							
	15										
10A	1.5	1	4	4	3	3	3	2			
	3	1		2		1					
	6	1	2	4							
	9		3			1					
	12		1								
	15										
12A	1.5	4		4		1					
	3	4		4		4					
	6[a]	--	--	--	--	--	--	--	--	--	--
	9[a]	--	--	--	--	--	--	--	--	--	--
	12[a]	--	--	--	--	--	--	--	--	--	--
	15[a]	--	--	--	--	--	--	--	--	--	--
15A	1.5										
	3	3									
	6										
	9										
	12										
	15										

[a]Denotes areas where no data were taken due to inability to achieve depth category or crossing established transects.

Source: Wisconsin Department of Natural Resources

Appendix D

SAMPLE OPERATOR LOG SHEET