# AQUATIC PLANT MANAGEMENT PLAN

## LAKE KEGONSA AND LOWER MUD LAKE
(Including the Yahara River)
Lower Rock River Basin

## DANE COUNTY, WISCONSIN

Lower Mud Lake, looking northwest to lakes Waubesa and Monona, and the Isthmus

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**SUMMARY**

Aquatic plant surveys were performed during the summer of 2006 on Lake Kegonsa and Lower Mud Lake. The two lakes are part of the Yahara River Chain of Lakes and are closely connected with navigation between them unimpeded by dams and locks. A total of 681 sites were sampled in the two lakes. Results from the Lake Kegonsa survey indicated that aquatic plant beds were relatively sparse, however species diversity improved significantly since the early 1990s. While Eurasian watermilfoil remained the dominant plant in the lake, this weedy exotic plant had declined significantly since 1991. The Eurasian watermilfoil decline and native species increase were positive indicators of lake ecological health. Native species richness increased from 3 native species in the early 1990s to 8 native species in 2006. Species sampled in 2006 but were not found in 1990-91 included clasping-leaf pondweed, leafy pondweed, common waterweed, wild celery and horned pondweed. The latter species had not been found in the Yahara Chain of Lakes for decades. Healthy beds of wild celery and water stargrass were found near the mouth of the Yahara River.

Upstream of Lake Kegonsa, aquatic plant densities and diversity were greater in shallower Lower Mud Lake. Coontail was collected in the greatest frequency in Lower Mud Lake followed by filamentous algae and sago pondweed. Lower Mud Lake also supported ecologically valuable species including buttercup, water stargrass, wild celery, white water lily, sago pondweed, clasping-leaf pondweed, and muskgrass *(Chara)*. The latter algal species had not been found in the Yahara Chain of Lakes for many years. Connecting Lower Mud Lake and Lake Kegonsa, the Yahara River supports abundant beds of wild celery and waterstar grass. The collective results of the surveys suggest that the aquatic plant communities have improved in the lower lakes and may mirror trends of declining Eurasian watermilfoil and improved water quality.

In addition to monitoring aquatic plant communities and assessing management strategies, public participation was planned and executed at all stages of plan development. Prior to conducting the aquatic plant surveys, two public meetings were advertised and conducted

to educate the public on ecological and habitat values of aquatic plants and management issues. A final public meeting was held in December 2006 to share results of the aquatic plant surveys and draft aquatic plant management plan for public review and input. Public comment on the draft plan was solicited on the Dane County Office of Lakes and Watersheds/Lakes and Watershed Commission website.

Also, an Aquatic Plant Management Committee created by the Dane County Board met for much of the time coincident with plan field work and preparation. Members of that Committee were invited to provide comments on the draft plan. Recommendations from the Committee's final report (October 20, 2006) are included in Appendix A. This plan will be amended as necessary to implement recommendations that are approved by the County Executive and County Board and implemented by county staff.

Ultimately, the plan recommendations did not represent a significant change from the relatively long history of mechanical harvesting operations on the lake. However, the plan has identified important steps that will enhance the county's aquatic plant harvesting program and protect important habitat features in the lake.

## Lake Kegonsa Recommendations

1. Conduct large-scale mechanical harvesting if Eurasian watermilfoil significantly expands in the lake. Low density of the exotic plant and other species did not warrant significant management in 2006.
2. Chemical treatments should be limited due to low Eurasian watermilfoil densities found within nearshore areas. The sparse plant beds in nearshore areas likely reflected the scoured sandy substrates and low water clarity.
3. Consider experimental plantings of white or yellow water lilies along protected shorelines given the relative dearth of high value plant beds in the lake.
4. Sensitive Areas should include undeveloped portions of the lake including Fish Camp, Lake Kegonsa State Park and the Door Creek wetlands.
5. Dane County mechanical harvesting crews should continue to take steps to prevent the spread of exotic invaders across Dane County lakes. These steps include removing any visible plants, mud, debris, water, fish or animals from the

machinery and thoroughly washing the equipment. The fact sheet in Appendix B is included in the harvesting crews' operations manual.

### Lower Mud Lake Recommendations

1. Conduct large-scale mechanical harvesting to maintain flow between the inlet and outlet of Lower Mud Lake.
2. Limit the harvesting of wild celery in the river between Lower Mud Lake and Lake Kegonsa except during emergency high water and flood conditions. Cutting should continue to be confined to the deepest portion of the channel in an effort improve flow while historical structures are avoided.
3. Chemical treatments should not be conducted in the lake given the general lack of riparian development. Uses within the natural shoreline eliminate the need for treatments typically used to clear swimming areas and piers.
4. The Sensitive Areas designation should include the entire shoreline given the relatively undeveloped condition. The habitat functions in Lower Mud Lake may benefit Lake Kegonsa where critical aquatic plant habitats were scarce.
5. Dane County mechanical harvesting crews should continue to take steps to prevent the spread of exotic invaders across Dane County lakes. These steps include removing any visible plants, mud, debris, water, fish or animals from the machinery and thoroughly washing the equipment. The fact sheet in Appendix B is included in the harvesting crews' operations manual.

### Introduction

As required in Wisconsin Administrative Code NR 109.04(d), the purpose of this plan is to guide mechanical harvesting activities and the effective management of aquatic plants in Lake Kegonsa and Lower Mud Lake. Dane County periodically operates mechanical harvesters in both lakes, managing dense growths of exotic Eurasian watermilfoil (*Myriophyllum spicatum*), exotic curly-leaf pondweed (*Potamogeton crispus*) and native coontail beds (*Ceratophyllum demersum*). Dense stands of the "weedy" plants have occasionally undermined the ecological balance and recreational uses in these lakes.

Harvesting efforts have been designed to enhance both of these important lake management functions.

Aquatic plant communities in the lower Yahara Lakes had been significantly altered since the late nineteenth century. Native plant communities had been undermined by a variety of factors including shoreline development, declining water quality and exotic invasions of carp, curly-leaf pondweed and Eurasian watermilfoil. Plant densities and diversity in Lake Kegonsa have generally been lower than those found in the upper Yahara Lakes. For decades, plant communities in Lake Kegonsa had been limited by poor water clarity. Low plant densities necessitated only sporadic use of herbicides and mechanical harvesting.

The primary goals of this plan are to establish long-term realistic objectives for managing nuisance exotic plant species while protecting valuable native species and their important habitat functions. While the goal is not to create a comprehensive lake management plan, aquatic plant communities are linked to other aspects of lake and watershed management, and these links are identified.

While the plan was designed to develop a variety of strategies for managing aquatic plants, chemical treatments are not performed or sponsored by either Dane County or Wisconsin Department of Natural Resources (WDNR). WDNR regulates chemical herbicide treatments in public waters and permits are required under Administrative Code NR 107.

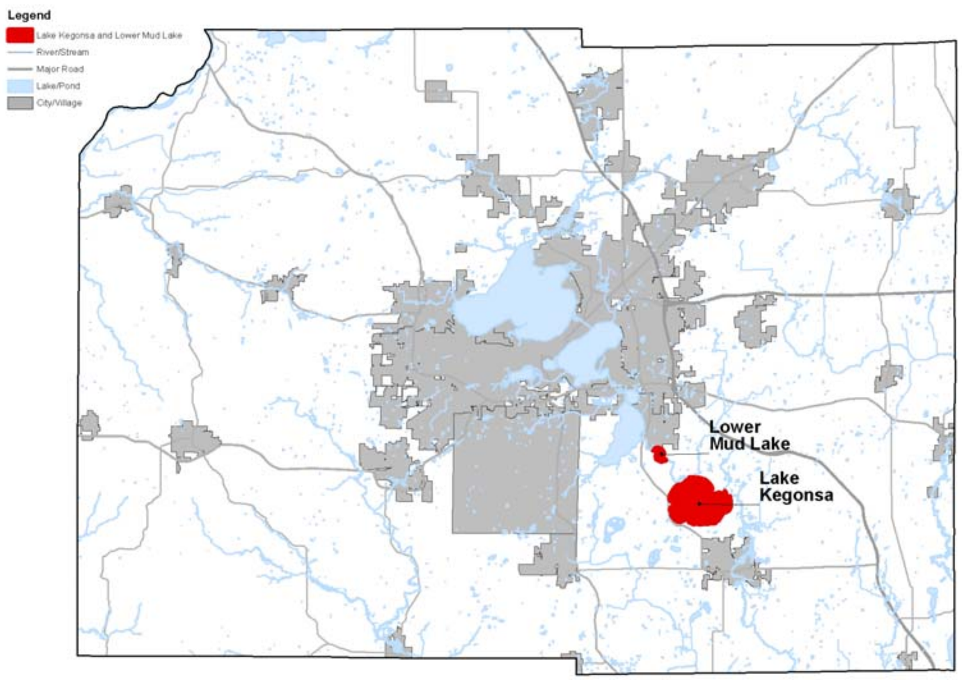
## Lake Kegonsa Goals

Recognizing that Eurasian watermilfoil has dominated the littoral zone for several decades, the goals for managing Lake Kegonsa aquatic plants are to: (1) sustain favorable recreational access in areas where exotic plant densities become a nuisance, (2) identify opportunities for establishing floating-leaf plants and (3) designate undeveloped public shorelines as Sensitive Areas. Floating-leaf plants that could be established include yellow water lily (*Nuphar variegatum*), white water lily (*Nymphaea odorata*), and American lotus (*Nelumbo lutea*). Favorable nearshore habitat is generally lacking in Lake Kegonsa, however publicly owned shorelines and wetlands may provide opportunities for improving nearshore submersed and floating-leaf habitat.

### Background Information

Lake Kegonsa (3,209 acres) is a highly eutrophic lake located within the Towns of Dunn and Pleasant Springs (Figure 1). Residential and commercial developments surround much of the lake but approximately 16% of the 9.6 mile shoreline is undeveloped. Six boat ramps provide public access including Amundson boat landing, Fish Camp boat landing and Lake Kegonsa State Park. Maximum and mean depths in Lake Kegonsa are 31 feet and 16.7 feet respectively. The average flushing rate is 2.2 times per year.

Figure 1: Lake Kegonsa and Lower Mud Lake location within Dane County




Lake Kegonsa is the last in the line of Yahara River Lakes, draining a total area of 385 square miles. The watershed encompasses gently rolling to hilly glaciated terrain with productive farmland and expanding urbanization. The position of the lake in the watershed has played a significant role in the long-term water quality and ecological history of the lake. For decades, Lake Kegonsa had the highest phosphorus and chlorophyll-a concentrations and lowest water clarity in the Yahara Chain (Lathrop 1990, Dane County

Regional Planning Commission – DCRPC 1979). These conditions reflected in part the combination of long-term polluted runoff from the large watershed and historic wastewater discharges. While conditions have generally improved in the lake since the diversion of municipal wastewater discharges from the watershed, lack of sustained thermal stratification allows mixing of nutrient rich bottom water to fuel blue-green algae blooms during the summer. Internal loading of long-term cultural phosphorus sources has contributed to periodic fish kills and toxic blue-green algae blooms. During the 2006 aquatic plant survey, numerous dead sheepshead were observed floating across the surface of the lake.

The long history of blue-green algae blooms and poor water clarity has affected native aquatic plant communities. Common aquatic plants found in Lake Kegonsa during the early part of the 20$^{th}$ century included shade tolerant sago pondweed (*Struckenia pectinatus*), wild celery (*Vallisneria americana*), and coontail (*Ceratophyllum demersum*) (Nichols and Lathrop 1994, DCRPC 1979). In addition to poor water quality, other factors limiting aquatic plant growth in the lake have included wind fetch across the relatively large surface area and invasions of carp, Eurasian watermilfoil (EWM), and curly-leaf pondweed (CLP). While EWM had created significant management issues in the upper lakes, the nuisance levels had been lower in Lake Kegonsa and in part reflect poor water clarity.

The Yahara lakes have a diverse and productive fishery. The value of the fishery in numbers is striking. More than 246,000 fishing trips have been projected annually on Lakes Mendota, Monona, Waubesa and Kegonsa, with anglers harvesting more than one million fish. Lake Kegonsa contributes to watershed sport fisheries and other non-game species. Table 1 contains a list of fishes reported from Lake Kegonsa (Day et al. 1985).

## Recent Mechanical Harvesting and Chemical Herbicide Applications

Dane County records indicate that Lake Kegonsa has been harvested sporadically and reflect lower densities of plants compared to the upper Yahara lakes (Figure 2). Dane County harvesting priorities for Lake Kegonsa are indicated in Figure 3. Chemical applications (contracted by riparian owners) have also been very sporadic and limited during years when plants were treated (Figure 4). Herbicide applications never exceeded 4 acres and averaged 1.6 acres from 1989 to 2003. The largest applications occurred in 1991 and 1992 and may have reflected the greater EWM growth in the lake based on aquatic plant surveys (Deppe and Lathrop 1993).

Figure 2: Summary of aquatic plant harvesting records from Lake Kegonsa

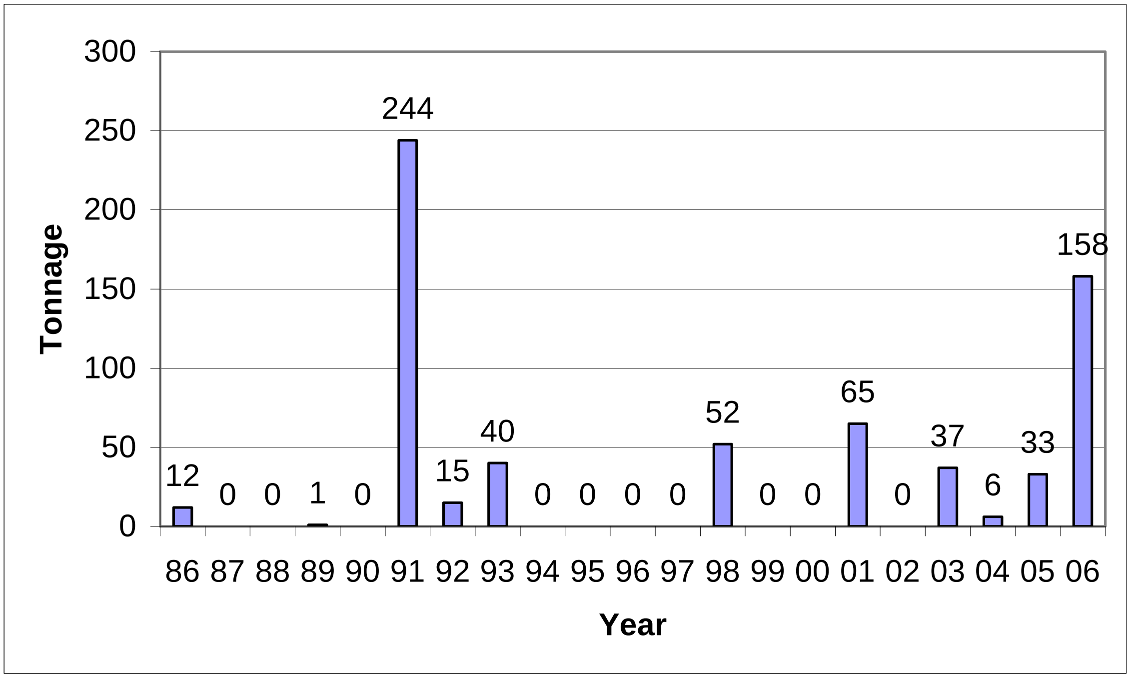



Figure 3: Lake Kegonsa harvesting priorities for aquatic plants

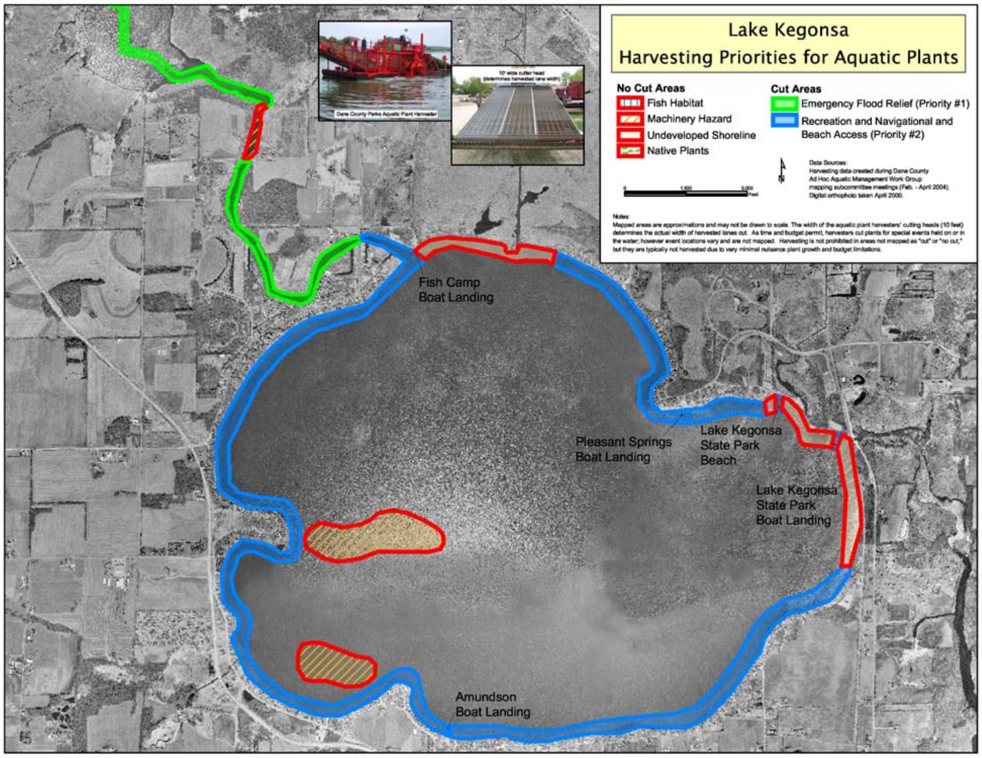
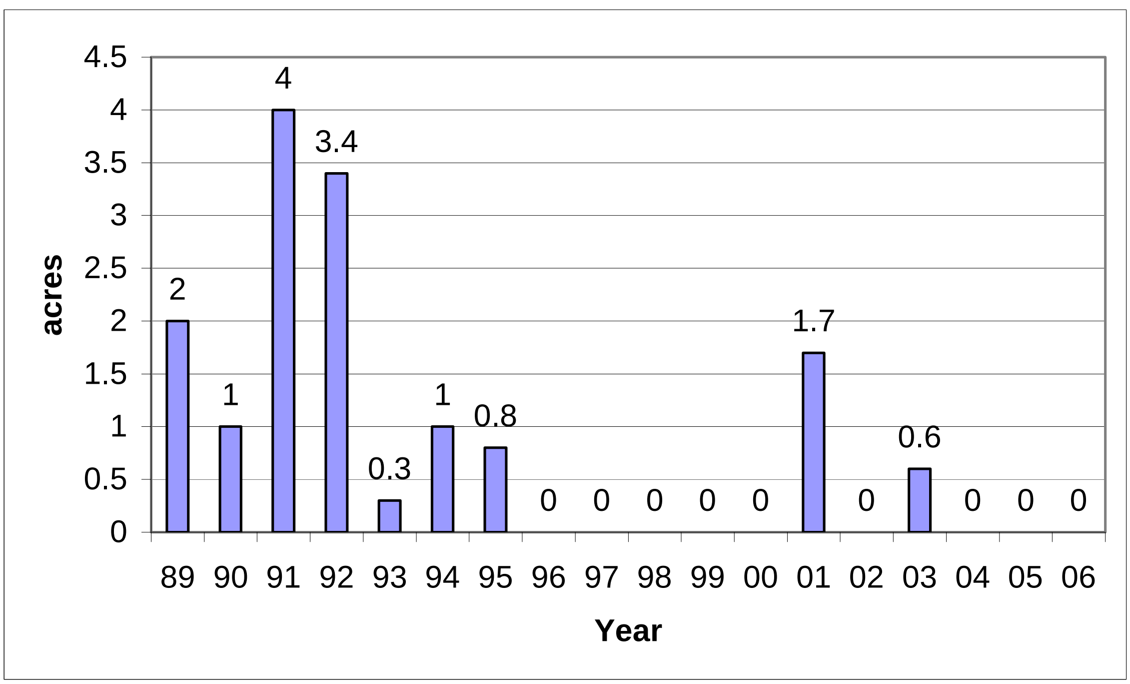



Figure 4: Acres chemically treated in Lake Kegonsa



## Methods

The sampling protocol was developed by Jen Hauxwell, a research scientist with Wisconsin Department of Natural Resources, Bureau of Integrated Science Services. The point intercept method was used where a large number of sampling sites are distributed equidistantly across a lake. GPS units were used to locate the sites and double-headed rakes were used to collect macrophytes. The sampling rakes are constructed in two forms. The pole rake is used for sampling macrophytes up to 15 ft (4.6 m) and rope rake can be used to sample deeper areas. Density ratings from 1-3 are determined by the amount of plant material in the two-headed rake. Plants that were observed near the boat but were not collected in the rake were also noted and recorded. Samples of each species found in a lake were collected, pressed and submitted as voucher specimens to the UW Madison Herbarium.

Statistical analysis included the following:

- Frequency of occurrence within vegetated sites (number of times a species was found divided by the total number of vegetated sites).
- Relative frequency of plant species collected (describes each species contributing a certain percentage of the whole aquatic plant community).

Detailed statistical results appear in Appendix C.

Wisconsin Department of Natural Resources provided the sampling grids and spreadsheet software for data entry and analysis. A more detailed sampling description can be found in Baseline Monitoring of Aquatic Macrophytes (Hauxwell 2006).

Table 1: Lake Kegonsa fishes

| Scientific Name | Common Name |
|---|---|
| *Acipenser fulvescens* | Lake sturgeon |
| *Lepisosteus osseus* | Longnose gar |
| *Amia calva* | Bowfin |
| *Esox lucius* | Northern pike |
| *Esox masquinongy* | Musky |
| *Cyprinus carpio* | Common carp |
| *Notropis atherinoides* | Emerald shiner |
| *Notemigonus crysoleucas* | Golden shiner |

| | |
|---|---|
| *Pimephales notatus* | Bluntnose minnow |
| *Pimephales promelas* | Fathead minnow |
| *Ictiobus cyprinellus* | Bigmouth buffalo |
| *Catostomus commersoni* | White sucker |
| *Ictalurus punctatus* | Channel catfish |
| *I. natalis* | Yellow bullhead |
| *I. melas* | Black bullhead |
| *Nebulosus* | Brown bullhead |
| *Labidesthes sicculus* | Brook silverside |
| *Morone chrysops* | White bass |
| *Ambloplites rupestris* | Rock bass |
| *Lepomis cyanellus* | Green sunfish |
| *L. gibbosus* | Pumpkinseed |
| *L. macrochirus* | Bluegill |
| *Pomoxis nigromaculatus* | Black crappie |
| *P. annularis* | White crappie |
| *Micropterus salmoides* | Largemouth bass |
| *M. dolomieu* | Smallmouth bass |
| *Percina caprodes* | Logperch |
| *Etheostoma exile* | Iowa darter |
| *Perca flavescens* | Yellow perch |
| *Stizostediun vitreum* | Walleye |
| *Aplodinotus grunniens* | Freshwater drum |

## Results and Discussion

The aquatic plant survey was conducted on July 20, 21, 23, 26 2006. Secchi measurements ranged from 4 feet on the north end of the lake near the river inlet to 2.5 feet in the middle of the lake. Trophic State Index (TSI) scores generated from these Secchi measurements were 57 and 64 respectively (indicating eutrophic conditions). The long-term TSI mean for the lake is 62 (Lathrop 1990). The greater Secchi transparency at the north end of the lake apparently reflected clearer water entering from the Yahara River. A 661-point grid was established around the lake containing potential sampling sites (Figure 5). After eliminating points well beyond the maximum rooting depth (9 feet), a total of 435 sites were sampled.

Results from the four day survey indicated that aquatic plant communities had changed since the early 1990's (Deppe and Lathrop 1993). EWM remained the most common species but at significantly reduced frequency since the last surveys. In 1990-91, Deppe and Lathrop (1993) reported relative frequencies of 83.9 and 82.5 percent compared to 22.2 percent in 2006. Coontail had increased from 5.4 and 9.5 percent to 19.5 percent in

2006. Additional positive changes included increased native species richness. Native plant species richness increased from 3 species in the early 1990's to 8 species in 2006. Figures 6 and 7 display greater native species richness and reduced EWM frequency in 2006. Distribution maps for all species collected in 2006 appear in Appendix D. Appendix E notes fish and waterfowl values of desirable native plants in Lake Kegonsa and Lower Mud Lake.

The increased aquatic plant diversity appeared to coincide with reduced EWM, however the maximum rooting depth did not appear to change significantly (9 feet in 2006 compared to 7.8 feet in 1990 and 9.8 feet in 1991. Rooting depths over the last few decades have increased compared with reports from 1948 and 1951 (Nichols and Lathrop 1994). These changes have also coincided with reduced phosphorus concentrations and improved water clarity in Lake Kegonsa (Lathrop 1990).

While nearshore aquatic plant densities were generally very low in Lake Kegonsa, a number of public shorelines offer potential for aquatic plant restorations, and designation as Sensitive Areas (NR 107.05(3)(i) for protection and enhancement of fisheries habitat (Figure 8).

Figure 5: Point intercept sampling grid for Lake Kegonsa

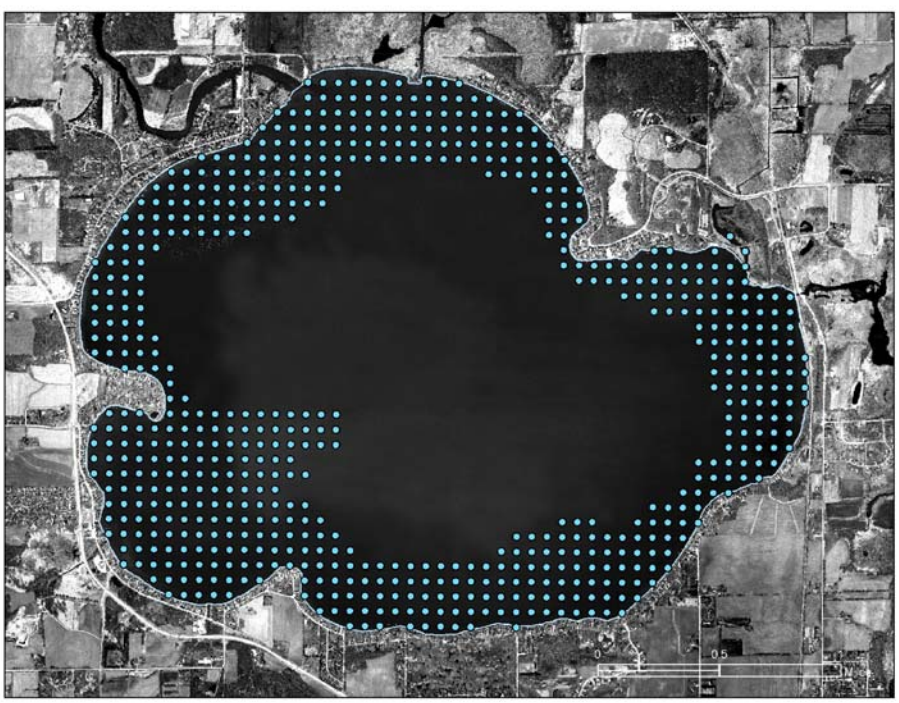
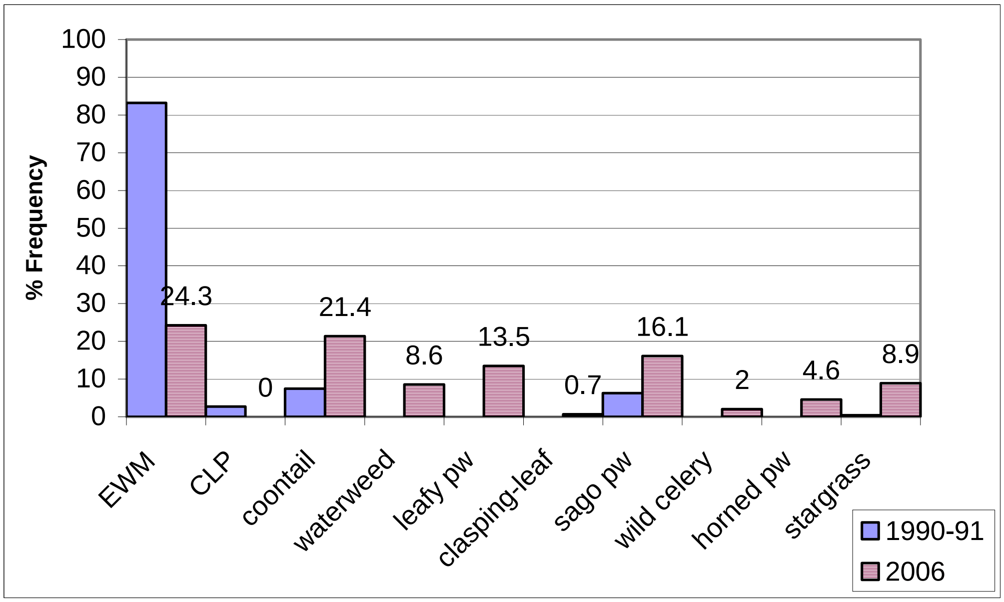


Figure 6: Relative frequency results – 1990-91 and 2006 Lake Kegonsa aquatic plant surveys




The relative frequency describes the percentage that each aquatic plant species contributes to the whole aquatic plant community. Relative frequency is a commonly used metric since survey results can be compared with surveys that used different sampling techniques.

Figure 7: Native plant species richness in Lake Kegonsa

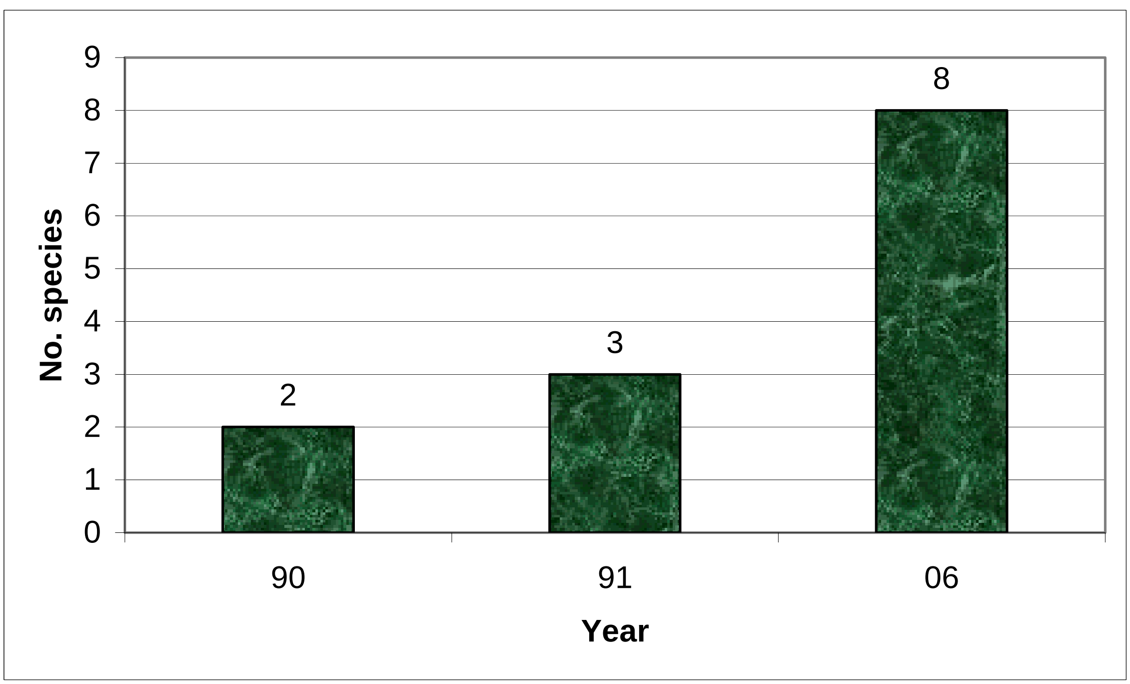
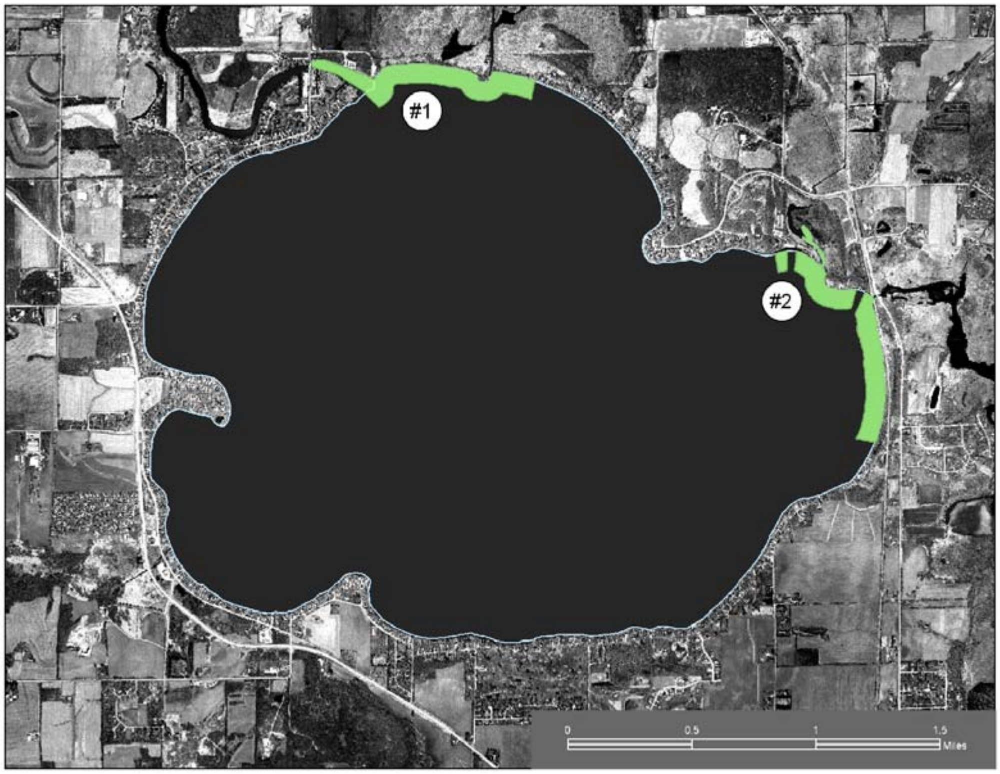



Figure 8: Proposed Lake Kegonsa sensitive areas




## Aquatic Plant Management Alternatives

While the primary emphasis of this plan is to protect important aquatic plant habitats and control nuisance EWM growths with mechanical harvesting equipment, additional management tools are available to individual property owners. Chemical treatments are regulated under Wisconsin Administrative Code NR 107 and permits are required. Herbicide treatments have not been widely used in the past due to relatively low aquatic plant densities. Riparian property owners can also manually remove vegetation to enhance private access in front of their properties. Under NR 109.06 (a-1), a riparian owner is not required to obtain a permit from WDNR if the removal involves invasive species. Removal of native species is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline.

Mechanical harvesting often removes juvenile panfish in the conveyor with the vegetation. However, WDNR biologists consider the inadvertent removal of small panfish to have no effect on population levels. In some cases, removal of juvenile panfish may actually improve size structure when population levels are too high.

**Specific Alternatives**

1) **No treatment**: Rejecting all types of aquatic plant management control efforts can be a realistic goal given the current limited EWM coverage.
2) **Biological control**: This method does not appear realistic at this time. The low EWM densities in Lake Kegonsa do not warrant introduction of weevils or other experimental biological control agents.
3) **Chemical control:** Herbicide use should be restricted to small riparian areas using agents selective at controlling EWM. 2,4-D is the likely agent given the partial selectivity for controlling EWM. However, factors such as wind fetch and heavy blue-green algae blooms already limit EWM densities.
4) **Manual - hand removal and planting**: Manually removing plants around piers and swimming areas is a viable option. However, property owners should be educated about the importance of high value native species so that their efforts should focus on weedy exotics such as EWM. All plants that are cut must be removed. Sensitive Areas cannot be harvested. Introduction of desirable native plants such as water lilies require NR 109 permits from WDNR.
5) **Mechanical harvesting**: Large-scale mechanical harvesting remains a viable option depending on the densities of EWM.
6) **Physical control**: Most physical methods of controlling aquatic plants require permits from WDNR under Chapter 30 Wisconsin State Statutes. Hydraulic dredging can be an option for removing the nutrient-rich sediments within designated navigation channels. This method has the greatest potential for long-term control but can be initially expensive. Whole lake dredging is unrealistic given the vast littoral areas affected by EWM. Sheets of dark fabrics anchored to the bottom covering the plants from any light create bottom or benthic barriers. A benthic barrier eliminates all plants, including non-target species, with the exception of free-floating plants and algae. These types of barriers can interfere with fish spawning and other pond wildlife. Over time, barriers may require maintenance due to siltation, ice damage, bubbling up and normal wear and tear. Fabrics applied in this way will require a permit. Fabrics are rarely used by property owners because of the labor of installation and maintenance. During local

demonstrations, problems arose due to gas collection under the fabric. Drawdown is not an option since there are not dams controlling levels in this reach of the Yahara Chain.

## Lower Mud Lake Goals

The goals for managing Lower Mud Lake aquatic plants are to: (1) improve recreational access along the north – south navigation channel, (2) protect floating-leaf plants and other high value native aquatic plants in the lake, and (3) identify and protect Sensitive Areas defined under Wisconsin Administrative Code NR 107.05(3-i).

## Background

Lower Mud Lake is a shallow widespread in the Yahara River located between Lake Waubesa and Lake Kegonsa (Figure 1). The surface area is 195 acres and the maximum depth is 5 feet. The lake is completely encircled by a cattail marsh, offering boaters an opportunity to enjoy a relatively natural shoreline. The marshy nature of the lake has attracted both waterfowl and hunters for many years.

Consistent with the other Yahara lakes, Lower Mud Lake had received significant nutrient loading from the large agricultural watershed and historic wastewater discharges (Lathrop 1990). Periods of dense aquatic vegetation were common in this shallow nutrient rich lake (Day et al. 1985). Due to the close connection to Lake Waubesa, EWM likely invaded the lake about the same time it reached other Yahara Chain lakes in the early 1960s. Fish species found in Lower Mud Lake are similar to Lake Kegonsa fisheries and may reflect movement between the two lakes.

## Recent Mechanical Harvesting Records

A marked navigation channel is maintained and harvested between the inlet and outlet of Lower Mud Lake. Harvesting within the channel is conducted when motorboat access is blocked by dense aquatic plants and filamentous algae. Downstream of the lake, the Yahara River channel is periodically harvested to reduce flood damage. In 2001, 735 tons of plants (mostly wild celery) were removed from the channel to enhance downstream water movement.

## 2006 Aquatic Plant Survey Update

**Methods** (see page 10)

### Results and Discussion

The aquatic plant survey was conducted on July 14 and 15, 2006. Secchi depth measurements were 4 feet, generating a TSI score of 57 (suggesting eutrophic conditions). A 246-point grid was established and sampled around the lake, and all points were sampled since the maximum depth was well within the maximum rooting depth (Figure 9). Results indicated lower EWM frequency in Lower Mud Lake than in Lake Kegonsa. Coontail was the most abundant plant followed by sago pondweed (Figure 10). In some areas of the lake, dense pockets of coontail with attached algae created a navigation challenge for motorboats. Native species richness was higher in Lower Mud Lake than Lake Kegonsa, and may reflect the marshy nature of the river widespread. Additional species that were found in Lower Mud Lake but were not found in Lake Kegonsa included white water lily (*Nymphaea odorata*), water crowfoot (*Ranunculus* sp), and muskgrass (*Chara* sp.). The marshy character of the lake was also a contributing factor for the growth of small floating plants: lesser duckweed (*Lemna minor*), forked duckweed (*Lemna trisulca*), common watermeal (*Wolffia columbiana*) and great duckweed (*Spirodela polyrhiza*). Water lilies were more abundant along the northwest portion of the lake while wild celery and water stargrass were abundant near the outlet. Plant distributions maps appear in Appendix F. Appendix E notes fish and waterfowl values of desirable native plants in Lake Kegonsa and Lower Mud Lake. Wild celery was very abundant in the river channel between Lower Mud Lake and Lake Kegonsa, but growths were not a problem for motorboat navigation. Over 90% of the shoreline is emergent vegetation and is likely important fisheries habitat given the heavily developed shoreline of Lake Kegonsa. The entire lakeshore meets the criteria to be designated a Sensitive Area (Figure 11). Appendix E notes fish and waterfowl values of desirable native plants in Lake Kegonsa and Lower Mud Lake.

Figure 9: Point intercept sampling grid for Lower Mud Lake

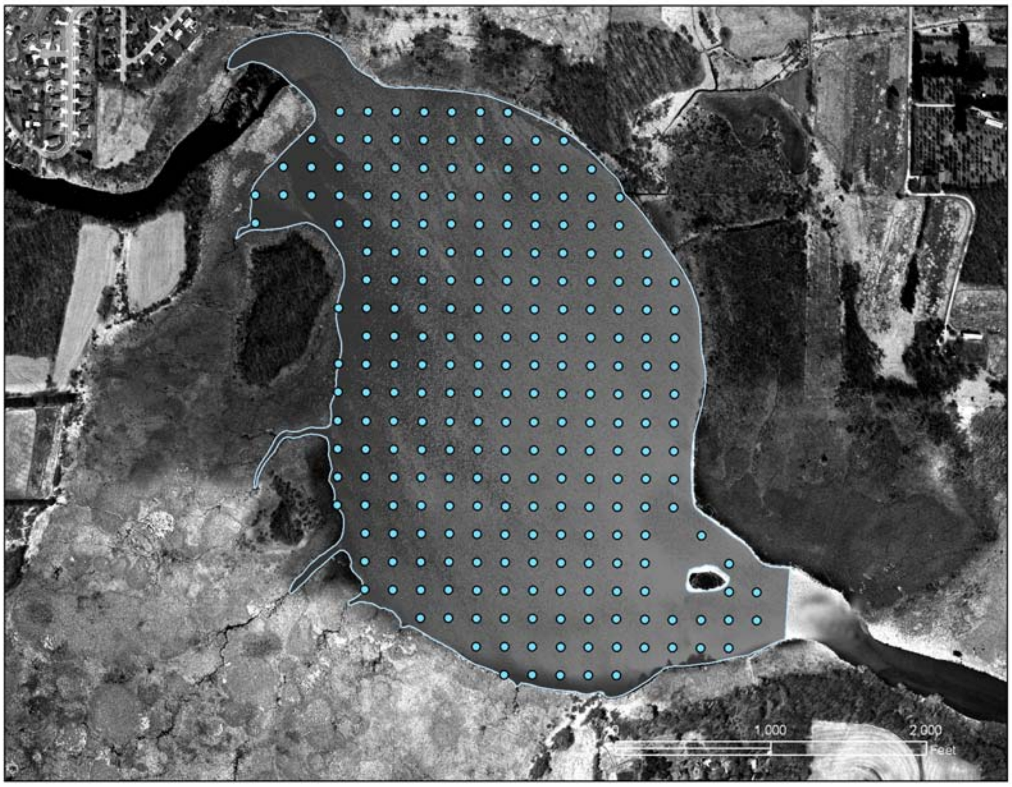
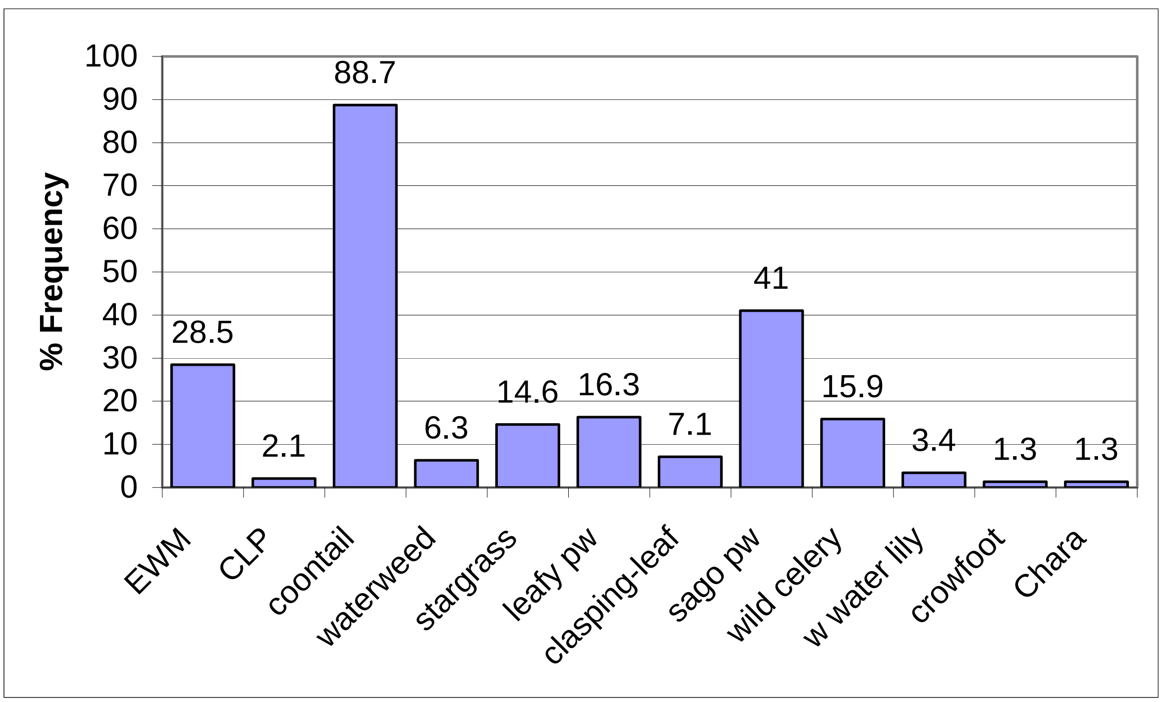



Figure 10: Lower Mud Lake relative frequency results




The relative frequency describes the percentage that each aquatic plant species contributes to the whole aquatic plant community. Relative frequency is a commonly used metric since survey results can be compared with surveys that used different sampling techniques.

Figure 11:  Proposed Lower Mud Lake sensitive areas


## Aquatic Plant Management Alternatives

Lower Mud Lake offers boaters an opportunity to enjoy a relatively undeveloped lake within the heavily developed Yahara Chain.  Large-scale mechanical harvesting can be used to sustain the north-south boating channel.  In the past, harvesting the navigation channel has improved access in the lake without undermining nearshore native plants.

Mechanical harvesting often removes juvenile panfish in the conveyor with the vegetation. However, WDNR biologists consider the inadvertent removal of small panfish to have no effect on population levels.  In some cases, removal of juvenile panfish may actually improve size structure when population levels are too high.

**Specific Options**

1) **No treatment**: Rejecting all types of aquatic plant management is reasonable given the history of dense aquatic plants that undermine river flow.

2) **Biological control**: Use of weevils for EWM control does not appear to be realistic at this time. EWM density is relatively low in the lake while coontail has greater potential for nuisance conditions.
3) **Chemical control:** Herbicides are an unlikely management tool given the undeveloped nature of the lake. An experimental whole-lake treatment would not be advised due to the relatively rapid flushing rate.
4) **Manual - hand removal**: Manually removing plants is a viable option. This method could be beneficial for maintaining open areas around the few piers in the lake. However, property owners should be educated about the importance of high value native species so that their efforts should focus on weedy exotics such as EWM. All plants that are cut must be removed. Plants should not be removed from the Sensitive Areas.
5) **Mechanical harvesting**: In 2006, mechanical harvesting was needed to improve navigation from the inlet to outlet that can become overgrown with coontail or EWM.
6) **Physical control**: Most physical methods of controlling aquatic plants require permits from WDNR under Chapter 30 Wisconsin State Statutes. Hydraulic dredging is an unlikely option for Lower Mud Lake due to high expense. Sheets of dark fabrics anchored to the bottom covering the plants from any light create bottom or benthic barriers. A benthic barrier eliminates all plants, including non-target species, with the exception of free-floating plants and algae. These types of barriers can interfere with fish spawning and other pond wildlife. Over time, barriers may require maintenance due to siltation, ice damage, bubbling up and normal wear and tear. Fabrics applied in this way will require a permit. Fabrics are rarely used by property owners because of the labor of installation and maintenance. Drawdown is not an option without a water control structure.

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## GLOSSARY

**Alleopathy** — Harmful effect of one plant on another caused by the release of chemical compounds produced by the first plant.

**Biomanipulation** — A technique involving using predatory fish to reduce the number of fish that feed on organisms that eat algae.

**Chlorophyll a** — The green pigment present in all plant life and needed for photosynthesis. The amount present in lake water is related to the amount of algae found there and is used as an indicator of water quality.

**Columnaris** — Bacterial infection of fish which especially occurs when they are stressed. The disease is highly contagious to fish and typically enters through gills, mouth or small skin wounds.

**Cyanobacteria** — Another name for blue-green algae. A group of algae that are often associated with “problem” lake blooms. Certain species can produce toxins which can cause illness and even death in animals and humans. Blue-green algae can “fix” nitrogen from the atmosphere and thus are often found when phosphorus levels in water are high.

**Dessicated** — Something that is thoroughly dried.

**Emergent plants** — Species with leaves that extend above the water surface that are usually found in shallow water.

**Eutrophication** — The process by which lakes are enriched with nutrients thereby increasing the amount of rooted plants and algae. The extent to which this process has occurred is reflected in a trophic state classification system.

**Eutrophic** — Within a lake trophic state classification system, this is a lake that is rated as being very productive and fertile.

**Extirpation** — The act of being eliminated.

**Floating-leaf plants** — Rooted plants with leaves that float on the water surface, such as water lilies.

**Filamentous algae** — Algae that forms filaments or mats which attach to the bottom sediments, rooted plants, piers, etc.

**Hectare** — A metric unit of measure which is equivalent to about 2.47 acres.

**Herptiles** — A broad group of cold-blooded animals including turtles and amphibians.

**Hypereutrophic** — A very nutrient-enriched lake characterized by severe and dominant algal blooms and very poor water quality.

**Hypolimnion** — The layer of the lake closest to the bottom and immediately below the metalimnion or thermocline, within lakes deeper than 20 feet stratify, or layer, based on temperature differences.

**Hypolimnetic** — Referring to the hypolimnion.

**Internal loading** — Internal loading refers to sources of phosphorus within a lake, typically from deep water sediment or decaying aquatic plants in the littoral zone.

**Intolerant** — Aquatic species that are impacted by changing conditions. For example, if water quality worsens, certain intolerant species may disappear because of lowered oxygen levels or a loss of their habitat.

**Limnologist** — A specialist in the study of freshwater ponds and lakes.

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| **Littoral zone** | The shallow part of a lake where most of the rooted aquatic plants are found. |
| **Littoriprofundal** | Transition zone below the littoral zone, characterized by its lack of macrophytes; often adjacent to the metalimnion of stratified lakes. |
| **Macrophytes** | The higher (multi-celled) plants found growing in or near the water. They produce oxygen and provide food and cover for lake organisms. |
| **Mesotrophic** | Lakes that are in-between eutrophic (very fertile) and oligotrophic (infertile) waters. They exhibit fairly good water quality and rooted aquatic plant growth. |
| **Monotypic** | Involving only one species. |
| **Moss** | Mosses are bryophytes or non-vascular plants. These primitive plants lack flowers and seeds and produce spore capsules to reproduce. Mosses live in a variety of shady moist environments including deeper areas in clear lakes. |
| **Oligotrophic** | Very low nutrient, clear lakes having lower amounts of rooted aquatic plant growth and productivity, but rich in oxygen throughout their depth. |
| **Pelagic** | The open water zone of a lake outside of the littoral zone. |
| **Phosphorus entrainment** | Movement of phosphorus and other nutrients from the hypolimnion into the epilimnion due to wind-generated mixing and erosion of the thermocline. |
| **Phytoplankton** | Algae-like organisms found in waters that use light to support photosynthesis. Examples include diatoms, cyanobacteria and dinoflagellates. |
| **Planktivores** | A free-floating or drifting organism (example Daphnia) that feeds on phytoplankton. |
| **Planktonic algae** | Small free-floating algae including green algae, blue-green algae and diatoms. |
| **Point source** | Source of pollution (e.g. wastewater treatment plant) with a defined discharge point such as a discharge pipe. |
| **Secchi disc** | An 8-inch diameter disc with four alternating quadrants of black and white. It is lowered into a lake on a rope and used to measure light penetration. Lakes are infertile (oligotrophic) if the depth you can see the disc are great. Lakes are fertile (eutrophic) if the disc disappears quickly. |

**Species richness** The number of different species present.

**Thermocline** The narrow transition zone between the epilimnion (top lake temperature layer) and the hypolimnion (bottom lake temperature layer). This portion of a lake is where the temperature changes most rapidly, and in most waters is found around 20 feet or deeper. Also called the metalimnion.

**Trophic State Index (TSI)** A way to measure, rate and classify the quality of a water body. Trophic state (e.g. eutrophic, mesotrophic, oligotrophic and hypereutrophic) is a measure of biological productivity.

**Turion** The over-wintering bud produced by aquatic plants.

**Two story fisheries** Fisheries that support both warm water and cold water fish species, and that are thermally segregated for most of the year.

**Winter dormancy** Refers to the condition of aquatic plants during the winter months, often in the form of seeds, turions, rhizomes or non-growing vegetation.