# FOX LAKE 2006 INTERIM AQUATIC PLANT MANAGEMENT PLAN

PREPARED FOR:

THE FOX LAKE INLAND LAKE PROTECTION AND REHABILITATION DISTRICT AND THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

TUESDAY, MAY 16, 2006

Hey and Associates, Inc.
Water Resources, Wetlands and Ecology

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# CHAPTER 1 – GOALS

## INTRODUCTION

Fox Lake is a 2,625-acre lake located within the municipal boundaries of the Town of Fox Lake and City of Fox Lake. Fox Lake is a natural glacial drainage lake that was enlarged in 1845 by the construction of a dam on the lake outlet named Mill Creek.

An aquatic plant survey that occurred in 2005 documented abundant plant growth in Fox Lake. The aquatic plant community consists of many native plants and an exotic aquatic invasive species, Eurasian water-milfoil. Many lake residents had difficulty accessing the deep water areas of the lake in 2005 largely due to the abundant Coontail population combined with low water levels. If plant densities occur in 2006 similar to those found in 2005, management will be required to maintain recreational uses in shallow areas of the lake.

A qualitative plant survey in May 2006 revealed abundant plant growth in many areas of the lake. Curly-leaf pondweed was found sporadically throughout the lake and more concentrated on the north shore. This plant will die back in early June. Dense plant growth was found in shallow, protected areas with silty bottom sediment. In these areas the dominant plant was Eurasian water-milfoil (EWM), but Coontail and Elodea were also found. Elodea was competing well with EWM in some areas. In the shallow areas of calm bays EWM was most abundant at depths less than 6 feet and topped out in areas with less than 2 feet depth. A survey scheduled for later in the summer will evaluate the status of the aquatic plant community on a lake-wide scale. The timing of the lake-wide survey will accurately assess the status of the native plant community since many native plants are not well established until later in the growing season. Initial survey results indicate that plant management will be necessary in 2006, and plants may be more widespread than in 2005.

## PURPOSE STATEMENT

The 2006 Fox Lake Interim Aquatic Plant Management Plan is a short-term plan being developed to guide aquatic plant management activities in 2006. A long-term 2007 plan will be developed at the conclusion of the 2006 plan development. The purposes of the 2006 Fox Lake Interim Aquatic Plant Management Plan are to promote a healthy and diverse aquatic plant community, facilitate recreational lake use, and educate local residents on the benefits of maintaining a healthy aquatic plant community. This includes the challenges of managing a shallow eutrophic lake and maintaining a clear water macrophyte dominated state (versus turbid algal dominated state), maintaining habitat areas for fish, wildlife, and zooplankton, and developing strategies to address the management of Eurasian water-milfoil. Recreational use concerns must address an overabundance of plants in many shallow areas of the lake, algae blooms, and weeds being washed to shorelines that may require management to facilitate access for many lake residents.

## GOAL STATEMENT

The purpose of the 2006 Fox Lake Interim Aquatic Plant Management Plan focuses on balancing the ecological needs of the lake and the recreational uses of the district residents. This requires careful maintenance of existing aquatic plants and carefully planned selective aquatic plant management.

The goals of the interim aquatic plant management plan are:

- Maintain and promote the clear water state
- Protect and promote the existing native aquatic plant community, fish, and wildlife
- Educate district residents about the importance of aquatic plants
- Receive public input and opinions for acceptable plant management options
- Facilitate access to deep water areas and recreational uses.

# CHAPTER 2 – BACKGROUND

## MANAGEMENT HISTORY

Fox Lake has a long management history of fish stocking, rough fish removal, various in-lake and watershed surveys, water quality monitoring, aquatic plant management, dredging, and sediment sampling. Much of the history of the lake has been documented in local newspapers by comments made by local residents. Examples of the management history and lake conditions are documented below:

- Fish stocking 1949-2006 including bluegill, walleye, Northern pike, bass, and muskellunge
- Aquatic plants killed with copper sulfate in 150 foot wide band around lake in 1961
- Fisherman's Club requests survey of lake by State Conversation Department due to soil erosion, weed conditions, lake level, pollution, and game feeding
- Rainbow trout caught near Drew Creek inlet
- Fisherman's Club posts signs around lake to deter refuse dumping; water levels causing navigation problems; considering buying a weed cutter
- Bluegill fishkill in winter 1959; bullheads die in spring 1959
- Conservation Department encourage lake residents to shovel ice to prevent fishkill in winter 1962
- Abundant fish reported by Conservation Department in 1962
- Dredging considered by City of Fox Lake in 1962 on Cambra Creek
- In 1963 residents reported weed spraying ruined fishing
- In 1964 local paper reported the lake reeks of pollution smell and lake was a "haven" for algae
- Quarterly water quality monitoring by Wisconsin Department of Natural Resources (WDNR) Bureau of Research in 1970s.
- One year water quality monitoring by Aqua-Tech in 1982-83.
- Fox Lake: Water Quality and Management Study, by the Water Resource Management Workshop, University of Wisconsin - Madison (1984).
- WDNR Long Term Trend Program monitoring from 1986 to the present.
- Aquatic Macrophyte Surveys by WDNR and others in 1954, 1986, 1994, 1998, 2004, 2005, and 2006.
- Various fishery surveys by WDNR most recently in 2003-2005, including a carp capture and recovery survey.
- Carp exclusion study in 1993 and 1994.
- A priority watershed inventory of barnyard runoff and upland, streambank and lake shoreline erosion sources as part of the Beaver Dam Lakes Priority Watershed Project.
- Water quality appraisal report for the priority watershed project.
- Bottom sediment core sampling by WDNR Bureau of Research.
- Expanded Self-Help Monitoring by the Fox Lake Protection and Rehabilitation District.
- Lake and watershed monitoring 2004-2006.
- WDNR Self-help volunteer monitoring 1990-2006.

## LAKE MAP

Fox Lake is a 2,625-acre lake located within the municipal boundaries of the Town of Fox Lake and City of Fox Lake T13N, R13 S13-16, 21-23, 26, and 27 in Dodge County, WI. Table 2-1 summarizes the lake's physical characteristics. Appendix A contains a 1:24,000 USGS topographic map, aerial orthophotographs, a lake bathymetric map, a map of lake sediment characteristics, and locations of historic aquatic plant survey transects.

**Table 2-1**
Physical Characteristics of Fox Lake, Fox Lake, Wisconsin

| Parameter | Size |
|---|---|
| Surface Area (open water) | 2,525 acres |
| Surface Area (with fringe wetlands) | 4,690 acres |
| Maximum Depth | 19 feet |
| Mean Depth | 5 feet |
| Volume | 19,307 acre-feet |
| Shoreline Length | 17.9 miles |

Source: WDNR

## AQUATIC PLANT COMMUNITY

Aquatic plant data was available for Fox Lake from 1950 to the present. A brief explanation of each calculation follows:

1) Frequency of Occurrence: the number of sites a plant species was collected divided by the total number of sites. The abundance of plants is not taken into account with this calculation. Only the presence/absence is noted. This value is also used to calculate the total percentage of littoral zone supporting aquatic plant growth.

2) Maximum Rooting Depth: the deepest sampling point that contained rooted aquatic plants. This measure is an important estimate of water clarity. Aquatic plants usually grow at 2-3 times the Secchi depth.

3) Floristic Quality Index (FQI, Nichols 1999): a biological index value based on the presence/absence of species and the ability of plants to tolerate disturbed conditions. FQI is calculated by multiplying the average C value for all native plant species by the square root of the number of native plant species collected. "C" is the coefficient of conservatism which is a value assigned to native aquatic plants estimating a plant's likelihood to occur in an undisturbed lake. The values range from 0-10, with 10 representing an undisturbed condition and 0 representing severely degraded conditions.

4) Simpson's Diversity Index (SDI, Simpson 1949): the index represents the probability that two individuals randomly selected from a sample will belong to different species. There are two components important to diversity – richness and evenness. Richness is the number of species per sample. Evenness is a measure of how species are distributed across samples. High evenness means that most species have a moderately high relative abundance while low evenness means that one or two species dominate and the rest are rare.

In 2004 and 2005, Fox Lake supported a plant community typical of a shallow lake in southern Wisconsin. This is evident by the frequency of occurrence of aquatic plants (Figure 2-1), the Floristic Quality Index scores (Figure 2-2), Simpson's Diversity Index Score (0.7938), and the presence of exotic invasive species. The recent trends indicate Fox Lake's aquatic plant community is expanding in the littoral zone while maintaining an adequate level of diversity. This is in contrast to initial reports in 1998 that the lake drawdown and Carp removal program was a failure in terms of restoring the aquatic plant community. Since 1998, the percentage of plant cover has more than doubled in the littoral zone and plants are growing at greater depths. Data is summarized in Table 2-2.

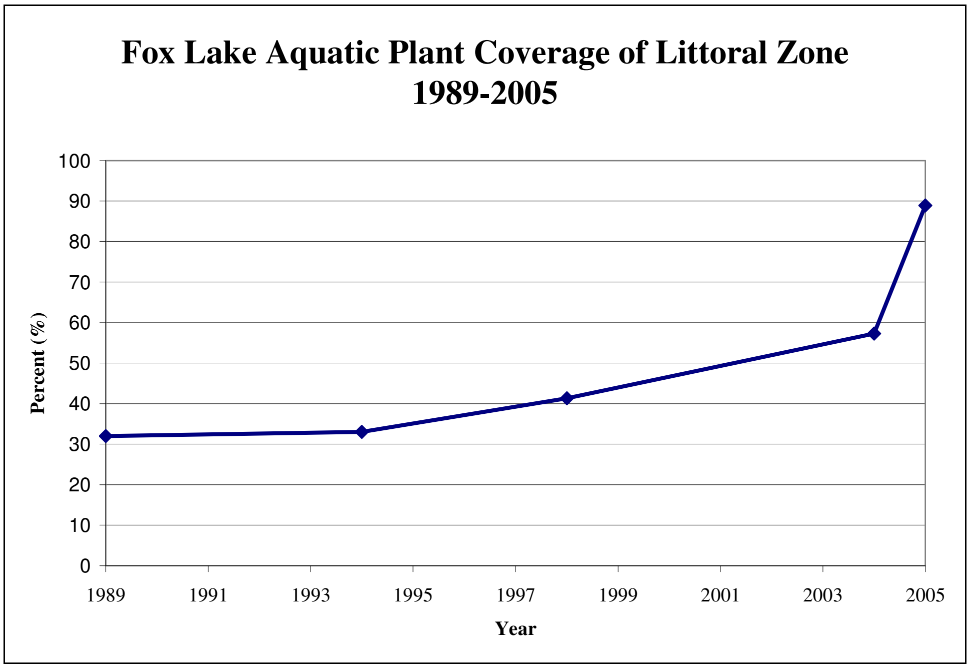


**Figure 2-1**
Percent Plant Cover in Littoral Zone
Source: WDNR and Hey and Associates, Inc.

The native plant community is competing well with the non-native invasive species present in the lake. Typically, exotic invasive species will occupy most, if not the entire, littoral zone and push out native aquatic plants. A monotypic or low diversity aquatic plant community is the result. The frequency of occurrence and relative frequency statistics illustrate the relationship between native plants and EWM over time in Fox Lake and clearly indicate EWM is occupying relatively less of the littoral zone over time.

**Table 2-2**
Aquatic Plant Community Summary Statistics
Source: WDNR and Hey and Associates, Inc

| Scientific Name | Common Name | C | Frequency of Occurrence | | | |
|---|---|---|---|---|---|---|
| | | | 1994 | 1998 | 2004 | 2005 |
| *C. demersum* | Coontail | 3 | 19.0 | 18.3 | 55.6 | 73.3 |
| *Chara spp.* | Muskgrass | 7 | - | - | 5.1 | 8.9 |
| *E. canadensis* | Elodea | 3 | 2.0 | 10.6 | 11.1 | 51.6 |
| *H. dubia* | Water Stargrass | 6 | 3.0 | - | 4.3 | 10.4 |
| *L. minor* | Small Duckweed | 5 | - | 2.6 | 18.8 | 20.5 |
| *L. trisulca* | Star Duckweed | 6 | - | - | 1.0 | 2.6 |
| *M. spicatum* | Eurasian Water-milfoil | NA | 15.0 | 27.9 | 35.9 | 27.4 |
| *N. flexilis* | Slender Naiad | 6 | 1.0 | - | - | - |
| *N. lutea* | American lotus | 8 | - | - | - | - |
| *N. marina* | Spiny Naiad | NA | - | - | 1.0 | - |
| *Nuphar spp.* | Yellow Water Lily | 8 | 1.0 | - | 1.7 | 6.8 |
| *Nymphaea spp.* | White Water Lily | 6 | 5.0 | 5.1 | 5.1 | 4.3 |
| *P. crispus* | Curly-leaf Pondweed | NA | 5.0 | 1.9 | 8.5 | 18.5 |
| *P. foliosus* | Leafy Pondweed | 6 | 1.0 | - | 1.7 | - |
| *P. zosteriformis* | Flat-stem Pondweed | 6 | - | - | - | 14.1 |
| *S. pectinatus* | Sago Pondweed | 3 | 22.0 | 15.4 | 11.1 | 9.9 |
| *S. polyriza* | Large Duckweed | 5 | - | - | 2.6 | - |
| *Sparganium (fluctuans)* | Floating-leaf Bur-reed | 10 | - | - | - | 1.5 |
| *V. americana* | Water Celery | 6 | 1.0 | - | 1.0 | - |
| *W. columbiana* | Watermeal | 5 | - | - | - | 4.3 |
| *Z. palustris* | Horned Pondweed | 7 | 1 | - | - | 1 |
| - | **All Species** | => | 33.0 | 41.3 | 57.3 | 88.9 |
| - | **Average C** | => | 5.4 | 4.0 | 5.6 | 5.8 |
| - | **FQI** | => | 17.1 | 8.9 | 19.3 | 20.9 |
| - | **Maximum Rooting Depth (ft)** | => | 5 | 6 | 6 | 8 |
| - | **Total # Plant Species** | => | 12 | 7 | 15 | 15 |
| | **Simpson's Diversity** | => | 0.75 | 0.75 | 0.74 | 0.79 |

Two of the dominant aquatic plants in Fox Lake were Common waterweed (*Elodea canadensis*) and Coontail in 2004 and 2005. Each of these species may cause navigation and recreational nuisances in high densities. Appendix B contains a full copy of the *Fox Lake Aquatic Plant Survey Report 2004-2005*. Appendix C contains maps of exotic species, native nuisance species, ecologically significant species locations, and plant survey transect locations.

A qualitative plant survey[1] occurred on May 10$^{th}$, 2006 revealed that Eurasian water-milfoil is more abundant in the lake than it was 2005 at the time of the quantitative plant survey. This may indicate that Eurasian water-milfoil will be more dominant in the lake in 2006. Many areas of the lake were experiencing topped out conditions in shallow areas (<2 feet)

[1] Visual estimates of plant density were taken from a boat and potential nuisance areas were identified.

with silty bottom sediment. From 2 foot depths out to approximately 6 feet EWM was generally abundant but has not reached the water's surface.

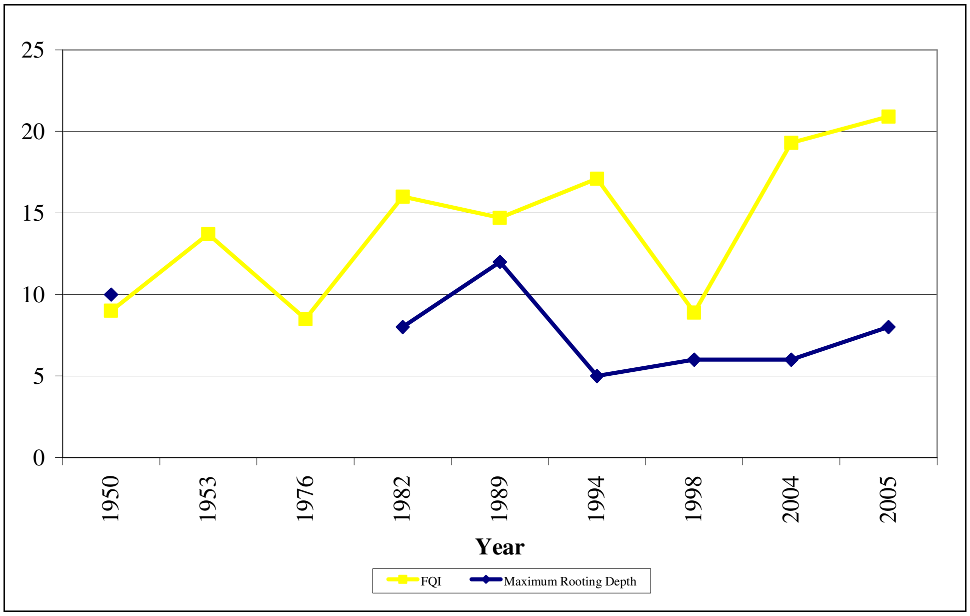


**Figure 2-2**
Floristic Quality Index Scores and Maximum Rooting Depth
Source: WDNR and Hey and Associates, Inc.

## Non-Native and/or Invasive Species

There are a total of 4 invasive species in Fox Lake. They are Coontail, Elodea, Curly-leaf pondweed, and Eurasian water-milfoil. Filamentous algae were also found in Fox Lake, which can also pose a recreational nuisance.

1) Eurasian water-milfoil (*Myriophyllum spicatum*), a non-native invasive species. Eurasian water-milfoil forms dense mats at the water surface that shade out native plants, deposits large amounts of dead plant material as it dies back in the fall that may cause local shifts in water chemistry and dissolved oxygen, and supports fewer invertebrates than native plants (Cheruvelli, et al.). Eurasian water-milfoil was found at relatively few (27.4%) of the sampling sites in Fox Lake in 2005. It was found in 35.9% of sites in 2004. Plant abundance, an estimate of plant density, showed EWM occurred in similar abundance from 1998-2005 both in overall abundance and abundance when present.

2) Curly-leaf pondweed (*Potamogeton crispus*, CLP) is another non-native invasive species that was found in 2004 and 2005. Past surveys have found little CLP in Fox Lake. Mid to late summer surveys are inconsistent at detecting the actual extent of CLP in lakes because their life cycle is atypical. CLP begins to grow in the fall, continues to grow throughout the winter, and dies off in late June or early July. As a result, surveys to detect CLP should occur in late May or early June to provide more accurate information. CLP does not appear to be a problem in Fox Lake during mid to late summer. Curly-leaf pondweed provides minimal value for fish and wildlife.

3) Coontail (*Ceratophyllum demersum*) is a native plant that may form dense beds and impede recreation. Coontail caused problems in some areas of the lake in 2005 by reducing navigability. Coontail provides food for waterfowl, cover for juvenile fish, and supports a diverse invertebrate assemblage. Coontail collects in downwind areas along the shoreline and create a nuisance.

4) Elodea (*Elodea canadensis*) was a dominant feature of the aquatic plant community in 2005. Elodea provides habitat for invertebrates that are a food source for fish and waterfowl and produces more oxygen than most aquatic plants. Elodea can grow abundantly in some lakes and cause recreational and navigational nuisances. It appears that Elodea is one plant in Fox Lake that is competing well with Eurasian water-milfoil.

5) Filamentous algae were found at 65.0% of sites in 2005 and 23.9% of sites in 2004. No data was available from previous surveys regarding its presence in Fox Lake. Excessive algae growth usually indicates excessive nutrients are present and causes recreational use and navigation problems. Filamentous algae were a problem in Fox Lake in 2005.

## WATER QUALITY

The steady decline of Fox Lake's water quality has been the focus of a number of studies. The studies indicate that Fox Lake is eutrophic to hyper-eutrophic and capable of a rapid transition from a clear water macrophyte dominated ecosystem into a turbid algal dominated system. Typical goals to manage a shallow eutrophic lake in the clear water state require total phosphorus <100ug/l (Scheffer et al. 1993 and Hosper and Meijer 1992). In-lake phosphorus concentrations range from 100 ug/l to greater than 200 ug/l during the summer months from 1990-2005 (Figure 2-3) were measured on Fox Lake. Mean chlorophyll-a concentrations increased almost tenfold since 1982 illustrating the general trend of increasing algal populations (Figure 2-4).

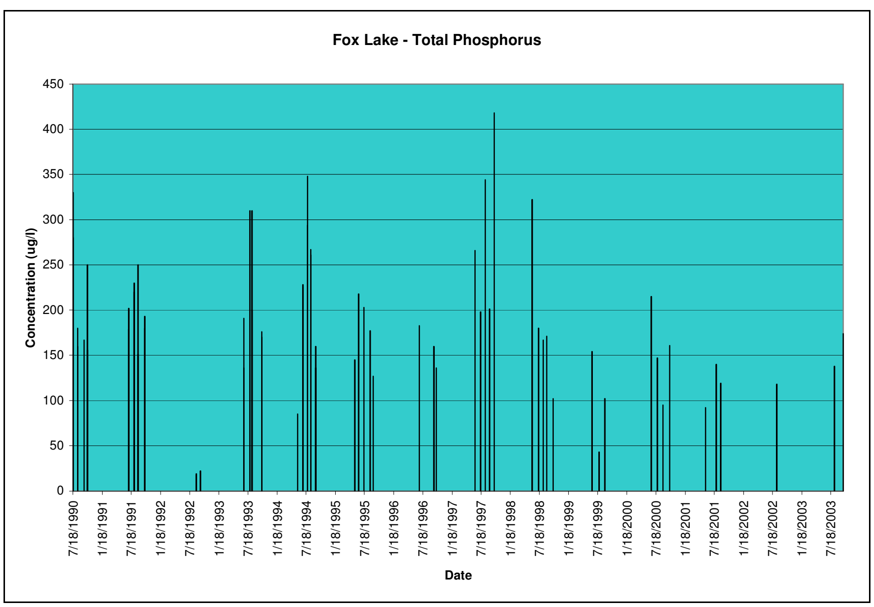


**Figure 2-3**
Fox Lake Total Phosphorus
Source: WDNR

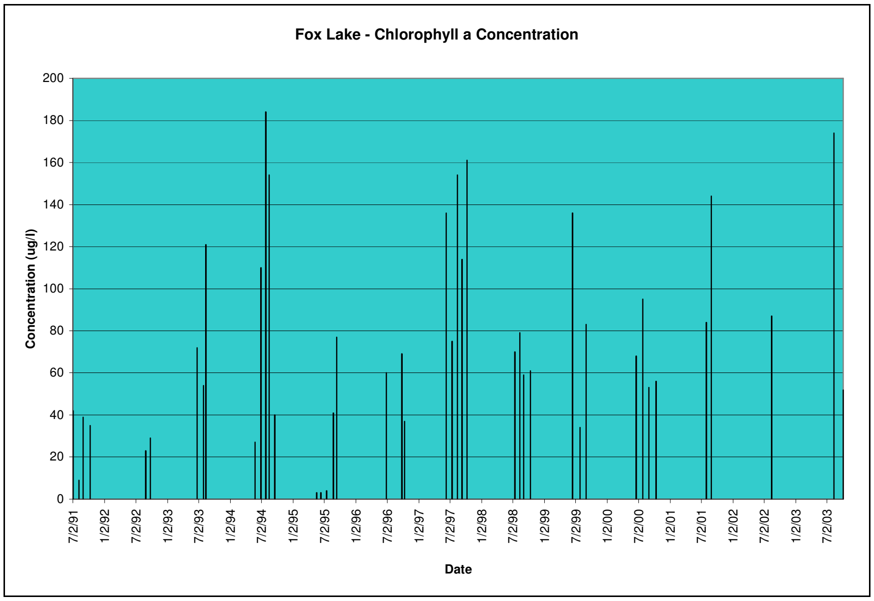


**Figure 2-4**
Fox Lake Chlorophyll-a
Source: WDNR

Secchi disk readings from 1991 - 2005 were generally poor, less than two feet, except in the two years (1995 and 2005) with abundant plant growth (Figure 2-5).

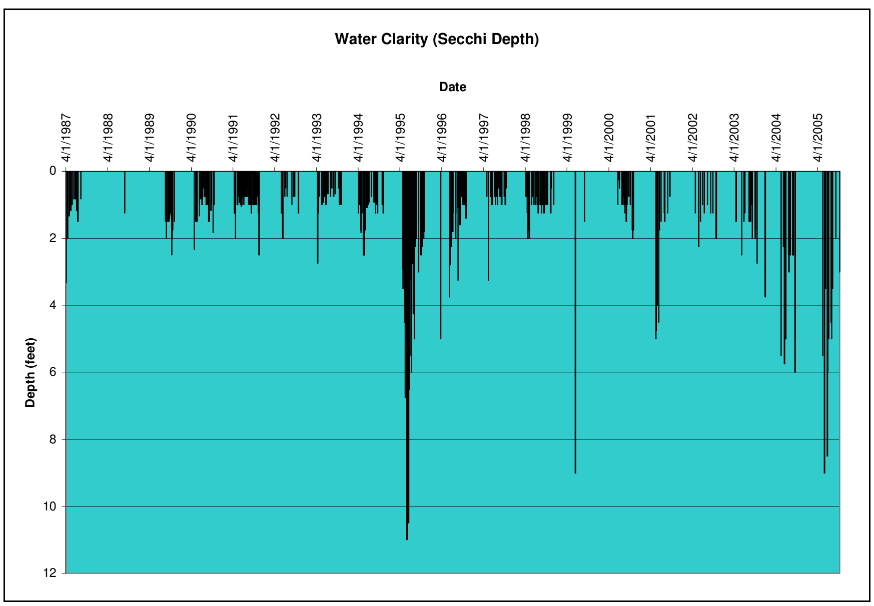


**Figure 2-5**
Fox Lake Secchi Depth
Source: WDNR

Analysis of Trophic State Index values for chlorophyll-a, Secchi disk, and total phosphorus indicate that Fox Lake is eutrophic and that lake turbidity may be due to more than just high algal populations, but may be augmented by suspended sediment from nonpoint source pollution and re-suspension of bottom sediment by wind and bottom feeding fish activity. Since these characteristics all act as forward switches, actions that reduce their effects should help maintain the clear water state in Fox Lake.

Water column profile monitoring in 2005 indicated that Fox Lake does not stratify (Figure 2-6). Dissolved oxygen remained above 5 mg/l even in the deep areas of the lake. Dissolved oxygen levels below 5 mg/l can be harmful to aquatic life. One drawback to a lack of stratification is that one potential refuge for pelagic grazing zooplankton is removed. Pelagic zooplankton seeks refuge in deep areas with low oxygen to avoid fish predation. This effect may be balanced by reducing internal nutrient loading that occurs as lakes stratify. No internal loading via sediment release was detected in 2005 (Table 2-3) probably due to the lake aeration.

**Table 2-3**
Fox Lake Phosphorus at Deep Hole 2005

| Depth (ft) | Number of Samples | Dissolved Phosphorus (mg/l) | Total Phosphorus (mg/l) |
|---|---|---|---|
| 3 | 10 | 0.0829 | 0.1566 |
| 15 | 11 | 0.0833 | 0.1529 |

Source: WDNR

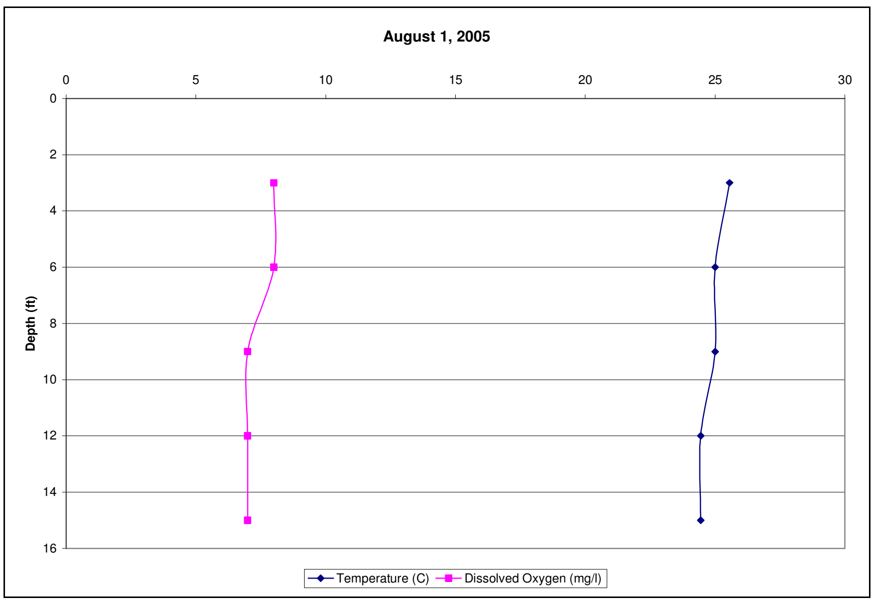


**Figure 2-6**
Fox Lake Depth Profile
Source: WDNR

## WATERSHED DESCRIPTION

The Fox Lake watershed is approximately 35,600 acres in size, draining areas of Dodge, Fond du Lac, Green Lake and Columbia Counties. The Fox Lake watershed was recently studied in depth as part of *Beaver Dam River Priority Watershed Project* sponsored by the Wisconsin Department of Natural Resources Nonpoint Source Pollutant Abatement Program. The watershed project focuses on the control of upland pollutant sources of crop erosion, streambank and shoreline erosion, and barnyard waste runoff. The watershed is made up of four sub-watersheds outlined in Table 2-4.

**Table 2-4**
Fox Lake Sub-watersheds

| Sub-watershed | Acres | Percent of Total |
|---|---|---|
| Alto Creek | 13,693 | 38% |
| Cambra Creek | 14,900 | 42% |
| Drew Creek | 3,894 | 11% |
| Fox Lake Direct Drainage | 3,087 | 9% |
| **Total** | **35,574** | **100%** |

Source: A Nonpoint Source Control Plan for the Beaver Dam River Priority Watershed Project (WDNR, 1993).

The watershed is comprised of rolling hills and plains interspersed with wetlands. While the original vegetation consisted of prairie grasses, marshland, and shrubs, today greater than 70% of the watershed is in agricultural land use. The geology of the area consists of bedrock of sandstone and dolomite formations overlain by glacial deposits of clay, silt, sand, and gravel. The major soil types are silty loams on the uplands and muck soils adjacent to stream courses and along the marsh areas of Fox Lake.

Alto Creek is a polluted tributary to Fox Lake that passes through large tracts of wetlands which buffer the creek from direct surface runoff. Monitoring indicates this stream could support a coldwater fishery if polluted runoff were controlled. Problems in Alto Creek include sediment loading and possibly pesticides. Watershed based sediment controls are being used to improve conditions in the creek (Wisconsin Department of Natural Resources, 2002).

Cambra Creek is another tributary to Fox Lake. It is relatively clear due to extensive filtering and buffering by adjacent cattail-dominated wetlands. Extensive farming within the subwatershed is likely delivering nutrients and sediment to Fox Lake. Carp use the shallow and extensive fringe wetlands adjacent to the stream and lake.

Drew Creek is a small stream tributary to Fox Lake that appears to carry a significant sediment load after storm events (Wisconsin Department of Natural Resources, 1993). Livestock access, animal waste runoff and silage leachate are other concerns. Sediment at the stream's mouth is creating undesirable near-shore conditions by building up a small delta at the confluence with Fox Lake. Nutrient and sediment loadings from each subwatershed are summarized in Table 2-5. Sources of total phosphorus reported as annual loads within the watershed are located in Table 2-6.

**Table 2-5**
Fox Lake Sediment and Nutrient Loads by Subwatershed

| Sub-watershed | Land Area (acres) | Sediment Load (tons/yr) | Phosphorus Load (lbs/yr) | % total Phosphorus Load | % of Total Load Due to Cropland |
|---|---|---|---|---|---|
| Alto Creek | 13,693 | 6,477 | 23,859 | 45% | 98 |
| Cambra Creek | 14,900 | 4,156 | 18,530 | 35% | 96 |
| Drew Creek | 3,894 | 1,861 | 6,834 | 13% | 96 |
| Fox Lake | 3,087 | 1,000 | 3,845 | 7% | 97 |
| **Total** | **35,573** | **13,494** | **53,068** | **100%** | |

Source: WDNR

**Table 2-6**
Estimated Annual Total Phosphorus Load to Fox Lake

| Phosphorus Source | Present Total phosphorus load [lbs/yr] | Priority Watershed Project goal of total phosphorus load [lbs/yr] |
|---|---|---|
| Upland sediment erosion | 53,068 | 32,581 |
| Barnyard runoff | 2,433 | 657 |
| Winter manure spreading | 1,795 | 1,041 |
| Shoreline sediment erosion | 1,237 | 618 |
| Groundwater | 6,041 | 6,041 |
| Precipitation | 383 | 383 |
| Wetland reduction | (13,290) | (9,200) |
| **Total** | **51,668** | **38,728** |

Source: Hey and Associates, Inc.

A trophic model was developed for Fox Lake to determine the relationship between watershed loading and in-lake measurements of total phosphorus. The model is shown in Figure 2-7. The watershed loadings for total phosphorus should be below 30,000 pounds per year to maintain the clear water state (TP<0.1 mg/l).

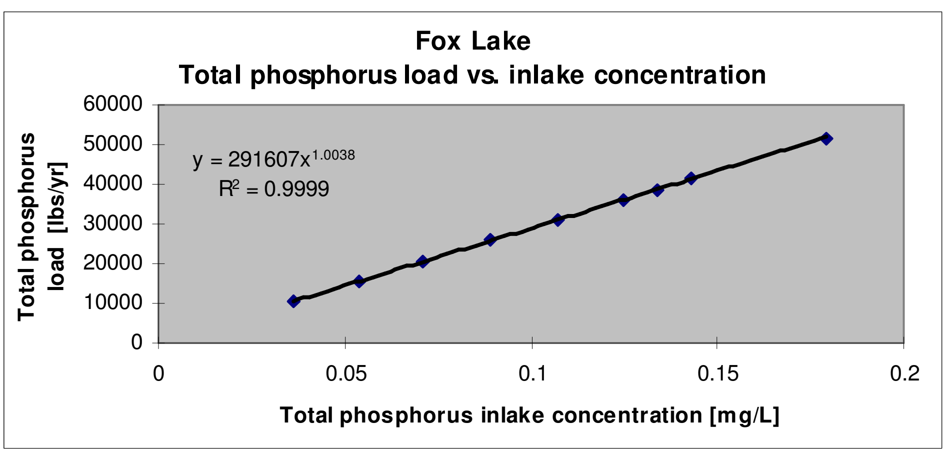


**Figure 2-7**
Trophic Model for Fox Lake

## WATER USE

Fox Lake supports recreational uses typical of many lakes in Wisconsin including: fishing, swimming, pleasure boating, personal watercraft, waterfowl hunting, and water skiing. Currently there are approximately 1000 acres of Slow No Wake on Fox Lake. Appendix D contains maps of the public use areas on the lake, areas typically used for waterskiing, and current “Slow No Wake” zones defined by Town of Fox Lake ordinance.

## FISHERIES AND WILDLIFE

Fox Lake supports diverse fish, wildlife, and waterfowl including state species of concern, state threatened species, and state endangered species. Their state and global element ranks are also included (Table 2-7). A Wisconsin endangered species designation means that its continued existence is in jeopardy based on scientific evidence. A Wisconsin threatened species appears likely--in the near future--to become endangered based on scientific evidence. According to State Statute 29.415 and NR27, it is illegal to take, transport, possess, or sell any threatened or endangered species without a permit. Special Concern species are suspected to have limited abundance or distribution, but no scientific proof has documented their status. State and Global Element Ranks portray the overall species’ status at the statewide and global scales.

Other waterfowl and wildlife known to inhabit the area are: Bald Eagles, otter, Cormorants, many types of ducks, geese, Mute Swan, Loons. The fish community includes Walleye, Largemouth Bass, Northern Pike, and a few Muskie. The panfish community in Fox Lake is dominated by a large Black Crappie population, as well as smaller populations of White Crappie, Bluegill, and Yellow Perch. Other panfish species present in the lake include Pumpkinseed and Green Sunfish. Other species in Fox Lake include Golden Shiner, Common Carp, and Yellow and Black Bullhead. Detailed fall electro-fishing reports are contained in Appendix E.

Many of the species on Fox Lake depend on aquatic plants for their survival. Most waterfowl use aquatic plants as a food source. Many fish species use aquatic plants as habitat over some portion of their life history. Invertebrates eaten by small fish live on aquatic plants while the top predatory gamefish use aquatic plants to ambush their prey. Aquatic plants also provide spawning opportunities for many fish species. Figure 2-8 shows areas of the lake that are important fish nurseries and/or utilized by wildlife.

**Table 2-7**

Species or Natural Communities of Significance near Fox Lake

| Species/Natural Community | WI Status | Special Concern Protection Status | State Element Rank | Global Element Rank | Date Identified |
|---|---|---|---|---|---|
| Wet-Mesic Prairie | NA | - | Imperiled | Imperiled | 1985 |
| Western Harvest Mouse | Special Concern | None | Imperiled | Secure | 1966 |
| Great Egret | Threatened | - | Critically Imperiled | Secure | 1997 |
| Black-Crowned Night Heron | Special Concern | Migratory Bird Act | Imperiled | Secure | 1974 |
| Southern Dry-Mesic Forest | NA | - | Rare or Uncommon | Apparently Secure | 1977 |

| Species/Natural Community | WI Status | Special Concern Protection Status | State Element Rank | Global Element Rank | Date Identified |
|---|---|---|---|---|---|
| Southern Mesic Forest | NA | - | Rare or Uncommon | Very Rare | 1978 |
| Emergent Marsh | NA | - | Secure | Apparently Secure | 1979 |
| Shrub-Carr | NA | - | Secure | Secure | 1979 |
| Banded Killifish | Special of Concern | None | Rare or Uncommon | Apparently Secure | 1995 |
| Blanchard's Cricket Frog | Endangered | - | Imperiled | Secure | 1919 |
| Red-Necked Grebe | Endangered | - | Critically Imperiled | Secure | - |

Source: WDNR

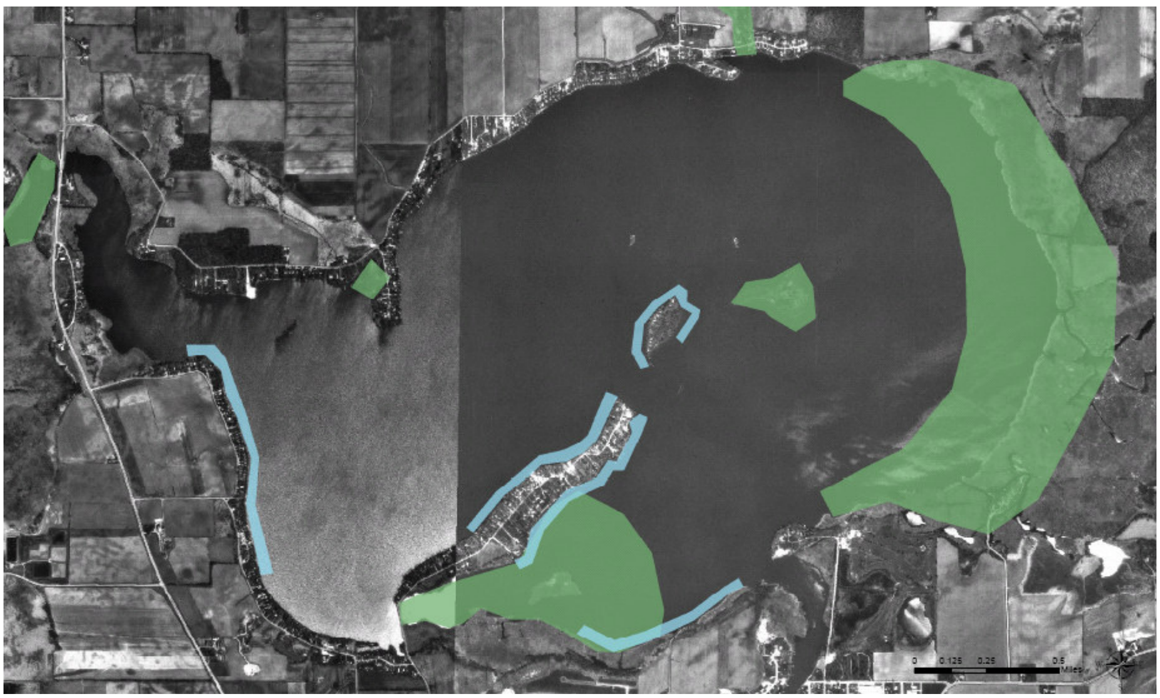

**Figure 2-8**
Wildlife Areas (green) and Fish Nurseries (blue)
Source: Hey and Associates, Inc. and WDNR

# CHAPTER 3 – ANALYSIS AND ALTERNATIVES

## INTRODUCTION

The purpose of this section is to analyze Fox Lake's plant community's ecological characteristics and provide alternatives for plant management activities in 2006. The analysis will identify management objectives, review the current status of the aquatic plant community, provide background on alternate stable states and shallow lake ecology, and identify the potential impacts of different levels of management intensity. The three levels of plant management intensity are: maintenance, low manipulation, and high manipulation. A review of plant management alternatives, their feasibility for use on Fox Lake, and an estimate of cost, is also included.

Development of a long-term plan effective in 2007 is scheduled to begin in late June 2006 upon completion of the interim aquatic plant management plan. A comprehensive aquatic plant survey (point-intercept method) is scheduled for late June – early August 2006. The long-term plan will address issues outside the scope of the interim 2006 plan such as: large-scale plant management activities such as navigation channels, plant community rehabilitation, and controlling the Eurasian water-milfoil population.

### Analysis

The management objective is to provide lake access and nearshore recreational opportunities for lake residents while maintaining the beneficial ecological functions of the aquatic plant community. For Fox Lake, the primary beneficial ecological function of the plant community is to maintain the clear water state. Other secondary benefits provided by the aquatic plant community include enhanced fish and wildlife and shoreline protection.

#### *Aquatic Plant Community*

A thorough review of the status of the aquatic plant community was included in Chapter 2 of this report. Hey and Associates, Inc. has also prepared a historic summary and full analysis of multiple surveys occurring from 1954 to 2005 in the *Fox Lake Aquatic Plant Survey Report 2004-2005* (Appendix B). A planning level summary of the aquatic plant community characteristics follows.

Currently Fox Lake is in a clear water macrophyte dominant state. Previous survey data suggests that as recently as 1998, Fox Lake was in a turbid water state. Since no data was available from 1998 to 2004, the shift to the clear water state was not entirely documented. Nearly 40% more of the littoral zone sampled contained plants in 2004 compared to 1998. From 2004 to 2005 an additional 30%, or 90% total, of the littoral zone supported aquatic plants. Weather conditions in 2005 were favorable for aquatic plant growth. Limited rain in the spring did not add turbidity to the lake. Lake levels were also low for much of the summer, allowing sunlight to reach deeper areas of the lake bottom. A qualitative plant survey in May 2006 showed abundant plant growth throughout the littoral zone. Since much of the littoral zone in Fox Lake is shallow (<6 feet deep), it is likely that nuisance conditions will develop in those areas. Figure 3-1 shows the locations of nuisance areas in 2005. Nuisance conditions are defined as areas of the lake where recreational uses such as swimming, boating, and fishing are impeded. Impeded recreational uses of the lake in 2005 are the primary reason for plant management in 2006.

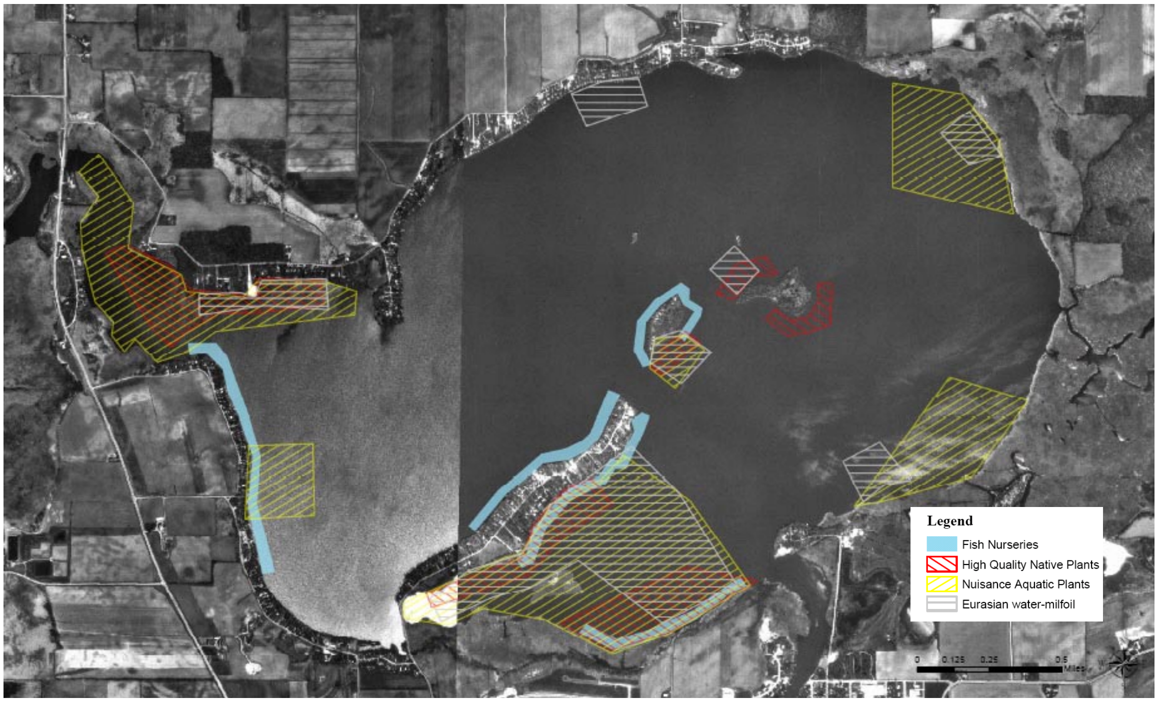


**Figure 3-1**
Overlays of Fish Nurseries, Native Plants, Eurasian water-milfoil, and Nuisance Plants
Source: Hey and Associates, Inc.

Figure 3-1 also shows nuisance areas and areas containing Eurasian water-milfoil as well as ecologically significant areas containing habitats important for fish or valuable native plants. Any management in areas with high quality plants or fish nurseries should carefully balance the ecological impacts of removing vegetation versus supporting recreational use.

### *Alternate Stable States*

"Alternate Stable States" refers to a model used to explain the often rapid shift that occurs in shallow eutrophic lakes from the clear water macrophyte dominant state to a turbid water algal dominant state (Figure 3-2). Eutrophic refers to a nutrient rich condition that is very biologically productive with many plants, algae, and fish. The eutrophic condition is usually caused by watershed development or degradation associated with land use changes, but do occur naturally if lakes have very large watershed areas. Oligotrophic lakes are nutrient poor and very unproductive. They are usually found in more pristine landscapes. Mesotrophic lakes are intermediate in terms of productivity. They lie between eutrophic and oligotrophic lakes.

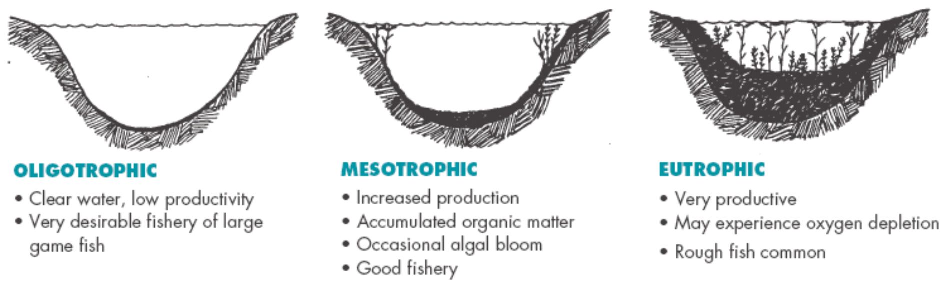


**Figure 3-2**
Aging Stages of Lakes and their Attributes
Source: University of WI-Extension and SEWRPC

A highly eutrophic lake or hyper-eutrophic lake may contain abundant plant growth, but is more likely to develop nuisance algal blooms than support aquatic plants. Hyper-eutrophic lakes have total phosphorus concentrations in excess of 100 ug/l. The excess phosphorus is readily absorbed by algae. As the algae grow the water becomes more turbid. As lake water becomes less transparent, the amount of light reaching the lake bottom decreases. Less light on the lake bottom results in fewer aquatic plants. Plants first become absent from deeper areas of the lake and gradually are lost in shallower areas if water clarity is further decreased. Unfortunately, this cycle operates as a positive feedback loop because plants compete with algae for nutrients and light. When the algae are released from competition with plants, their growth usually increases and may further deplete the aquatic plant community. In some cases hyper-eutrophic lakes reach a clear water state.

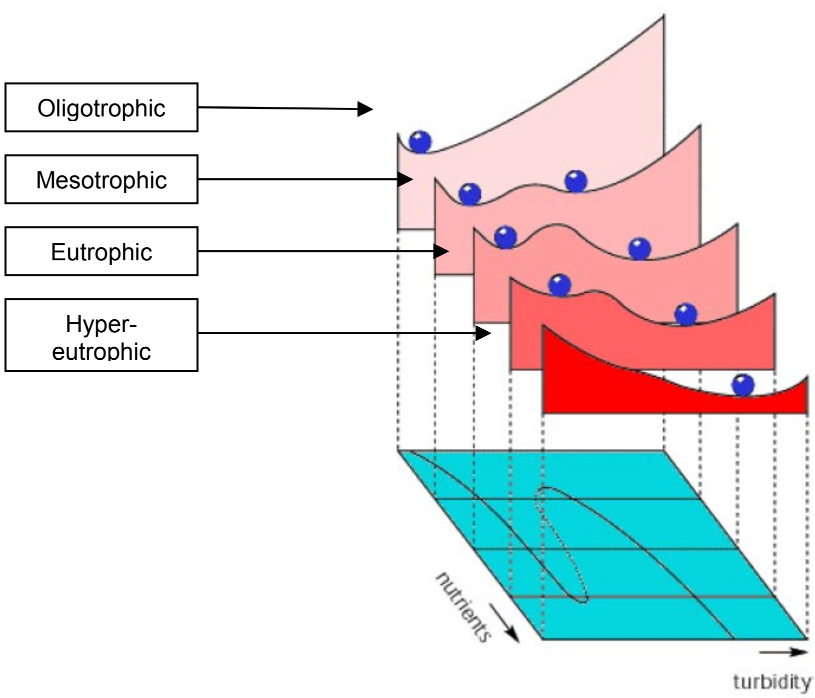


**Figure 3-3**
"Ball and Cup" model of alternate stable states (left side of model is clear water state)
Modified from Sheffer 2001

As Figure 3-3 shows, the clear or turbid water state depends on the amount of nutrients and turbidity. The location of the ball in the model represents the probability that a given state will occur with a combination of nutrient and turbidity conditions. The vertical height of the ball location represents the preferred state of the system at any given time where the lower position is more likely to occur. The humps in the model represent the amount of energy or management required to switch to the alternate stable state. It is clear from this graphical representation that it is unlikely for a hyper-eutrophic lake to persist in the clear water state without management.

Characteristics of the clear water state include abundant aquatic plant growth, a diverse and productive gamefish community, and numerous zooplanktons while the turbid state is free of aquatic plants, produces dense algae populations, and supports an undesirable, bottom feeding fish population (Jeppesen et al. 1990, Hasler and Jones 1949, Wetzel 1996, Van Donk et al. 1993, Kufel and Ozimek 1994, Timms and Moss1984, Schriver et al. 1995). One of these states *will* occur in shallow hyper-eutrophic lakes. An alternate version of the alternate stable states model is depicted in Figure 3-4.

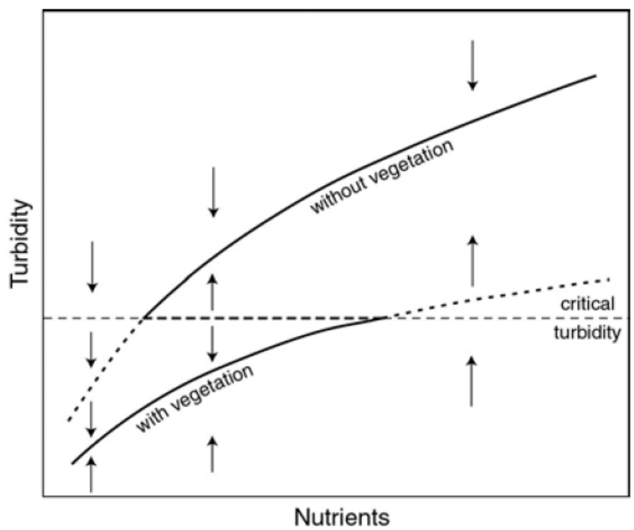


**Figure 3-4**
Graphical model of interaction for turbidity and nutrients for
lakes between alternate stable states
Source: Sheffer 2001

The precise factors causing a lake to switch between stable states vary from lake to lake and are not clearly understood. It is known that certain circumstances, termed buffers, tend to keep a lake in one of the two stable states.

Buffers that maintain a turbid water state include:

1) Re-suspension of bottom sediment through wind action or boating activities may lead to increased turbidity that shades out aquatic plants and/or adding nutrients directly to the water column benefiting algae (Van den Berg et al. 1997, James and Barko 1990, Hamilton and Mitchell 1997).

2) Fish communities with a large number of Common Carp that typically uproot vegetation and re-suspend sediment and/or large numbers of zooplanktivorous fish. Common Carp can have the same effect as wind or boating on bottom sediment (Whillans 1996). Too many zooplanktivorous fish reduces the capacity for algae grazing and is usually caused by a lack of top predatory fish to regulate lower trophic levels (Ozimek et al. 1990, Van Donk et al. 1990, Hanson and Butler 1994).

3) A lack of structure can reduce top predators since many fish use ambush techniques to catch their prey. A lack of structure also allows increased predation on grazing zooplankton. Both of these factors can contribute to increased algae density (Timms and Moss 1984 and Shriver et al. 1995).

4) Algae growth early in the growing season due to high nutrient availability. Since algae populations can expand rapidly under favorable conditions, aquatic plants never get established in the spring. This is in part due to the susceptibility of shallow lakes with large watershed to the impacts of nutrient laden surface runoff (Crosbie and Chow-Fraser 1999).

5) Decaying algae also provide a poor substrate for future plant growth.

Buffers that tend to maintain a clear water state are derived from the benefits of aquatic plants and are the opposite of turbid water buffers:

1) Plants minimize the impacts of wave energy on the lake bottom to minimize sediment re-suspension and protect existing plant beds.

2) Plants compete with algae for light and some nutrients.

3) Plants provide refuges for zooplankton from fish predation. This facilitates grazing on algae.

4) Plants provide spawning habitat and ambush sites for Northern pike. Pike are efficient littoral predators on planktivorous fish.

5) Plants provide their growing material for next year when they die back in the fall. Tightly packed or loosely packed sediment is a difficult medium for plants to grow on, but decaying plants from the previous year provide ideal growing conditions for many aquatic plants.

A trophic cascade is the name for complex biological interactions occurring across a food chain. The presence/absence of aquatic plants plays an important role in trophic cascades. Trophic cascades occur in the following manner with respect to algal abundance in lakes. Top predators such as Northern pike are lost from a lake through over fishing, lack of reproduction, or reduced stocking efforts. Pike no longer feed on panfish populations so they become very large numerically yet the average panfish size decreases or becomes stunted. The overabundant small panfish feed on zooplankton and deplete the zooplankton population. Since zooplankton graze on algae suspended in the water column, reduced populations of zooplankton usually result in lower water clarity. Two of the important ecological services provided by aquatic plants are cover for predatory fish that allow them to ambush their prey (panfish) and refuges for zooplankton to avoid predation by panfish. Sustaining or enhancing the aquatic plant community alters trophic interactions to promote the clear water state. Biomanipulations are management activities that intentionally alter the existing trophic structure to enhance buffers that promote the clear water state (Figure 3-5; Moss et al. 1996 and Sheffer 1998).

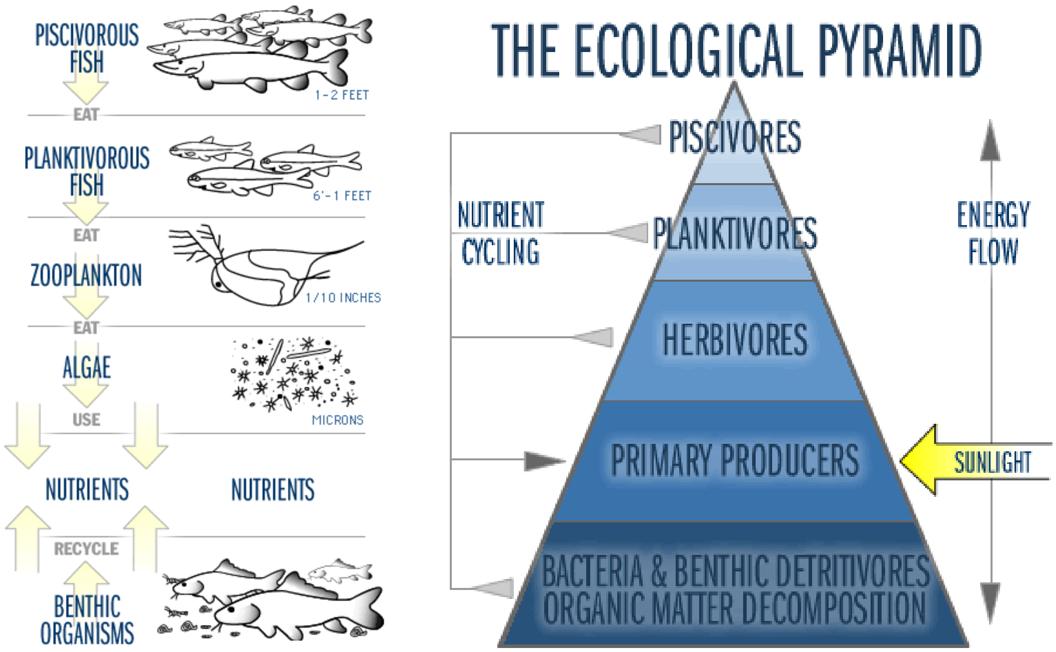


**Figure 3-5**
Trophic Cascade Interactions in Lakes
Source: Water on the Web

Aquatic plant management on Fox Lake must consider the delicate balance of maintaining the clear water state in a hyper-eutrophic lake. Small changes to the lake ecosystem, including the aquatic plant community, may result in a rapid shift back to the turbid water state. The alternate stable states model predicts there is a threshold for ecosystem changes that cause the shift, but there is no way to know what the threshold limit is. Simulation models have shown that even a small amount of plant management may cause the plant community to collapse or become more vulnerable to shifting to the turbid water state due to weather conditions (van Nes et. al 2002). As a result, aquatic plant management on Fox Lake must take a conservative approach.

### *Management Intensity*

There are three levels of plant management identified by the Wisconsin Department of Natural Resources *Aquatic Plant Management in Wisconsin* (2005). The level of plant management required depends on the goals of the plant management plan and the characteristics of the lake ecosystem. The three levels of control are: maintenance, low manipulation, and high manipulation. Figure 3-6 shows the proposed plant management areas in Fox Lake.

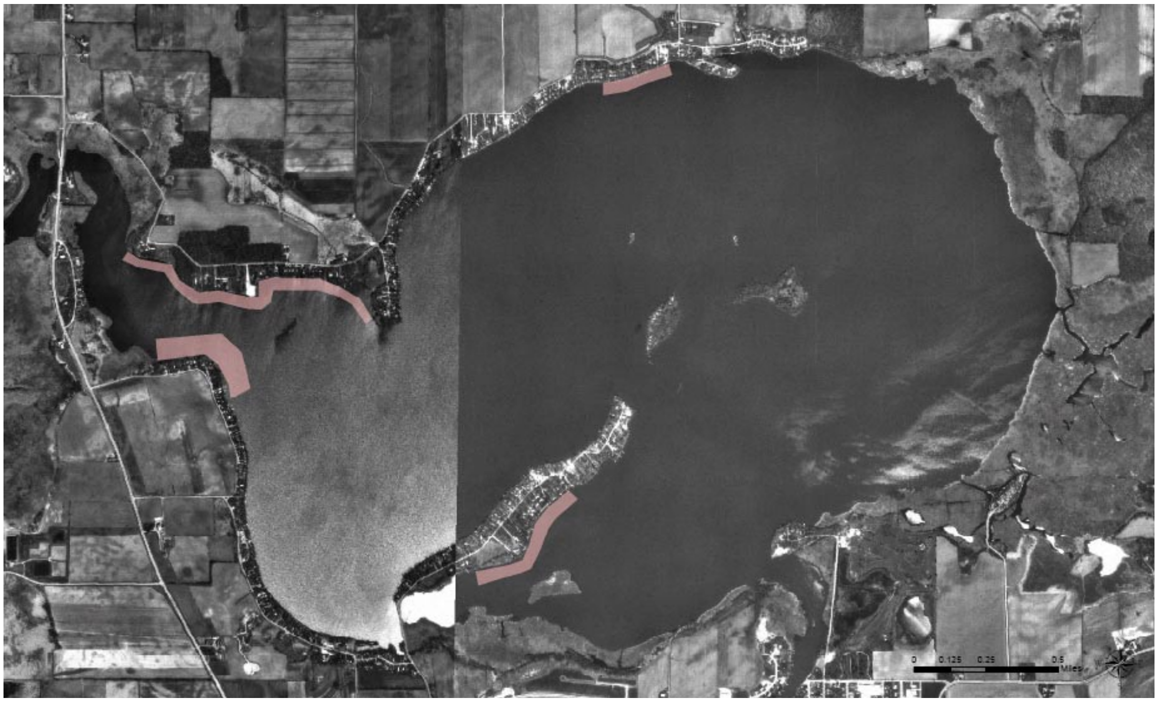

**Figure 3-6**
Proposed Plant Management Areas 2006
Source: WDNR

The shaded areas in Figure 3-6 contain 56 property owners who have requested a 50-foot by 150-foot treatment, or plant management, area. The total treatment area requested is 12 acres. Figure 3-7 shows how proposed management areas overlap with ecologically significant areas on the lake that support wildlife, contain valuable native plants, or are important fish nurseries. Each of these factors must be considered when selecting a level of control. The following paragraphs will analyze how the different levels of control may affect the ecological condition of Fox Lake in the proposed treatment areas.

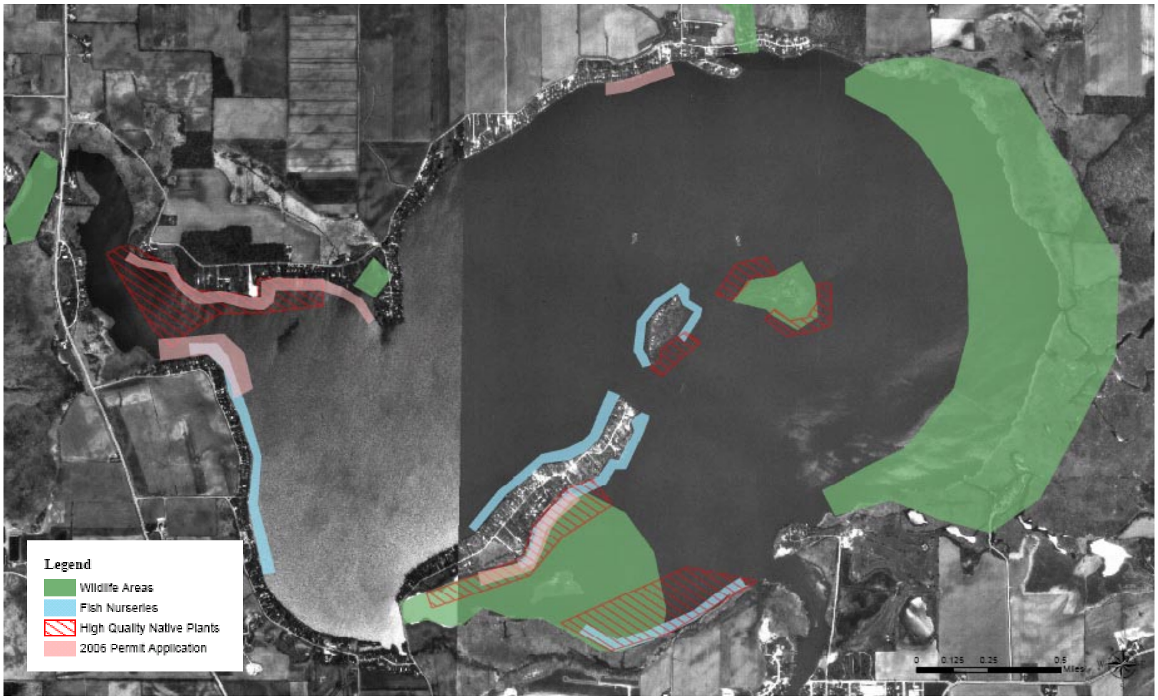


**Figure 3-7**
Proposed Plant Management Areas and Ecologically Significant Areas
Source: WDNR and Hey and Associates, Inc.

Maintenance control is used as part of a protection orientated plan for lakes with no invasive species or nuisance conditions occur. Since Fox Lake contains abundant plant growth with nuisance conditions and invasive species, maintenance level management will not meet the aquatic plant management plan goal of providing lake access and facilitating recreational uses. Maintenance control would meet the plan goal of maintaining a clear water state. If the Eurasian water-milfoil population continues to increase, maintenance control may not be sufficient to protect the fish and wildlife. Research suggests that dense Eurasian water-milfoil beds do not provide the same benefits to fish and wildlife as more diverse native plant beds.

High manipulation is the control option with the most intense plant management. It is appropriate for lakes with moderate to severe problems. This type of program might include large-scale plant management or attempts to minimize the effects of exotic plant species. This level of control would meet the goal of the aquatic plant management plan to provide lake access and facilitate recreational uses. High manipulation level of control could act as a switch and cause Fox Lake to return to the turbid water state. In addition, the Fox Lake Inland Lake Protection and Rehabilitation District has no funds budgeted for aquatic plant management activities in 2006, so large-scale control is not a feasible option until at least the summer of 2007. High manipulation might also remove too many plants and reduce the habitat and food resources available for fish and wildlife.

Low manipulation is an intermediate level of control. This level of control is appropriate for lakes with moderate plant problems but protection is the main goal. A plant management strategy using a low manipulation level of control could meet the needs of lake users and facilitate lake access if local areas of plant control were allowed in nearshore areas. The goal of protecting and promoting the existing native plant community could be met if control methods were selective to remove only invasive plant species. Fish and wildlife may or may not benefit from a low level of plant control depending on how well the native plant community competes with Eurasian water-milfoil.

### Management Alternatives, Feasibility, and Cost

There are number of aquatic plant management options available. Management options can be broken down into the following categories: do nothing, manual removal, mechanical removal, chemical control, physical control, and biological control. Each method can be effective depending on lake conditions. Conversely each method also carries its own set of drawbacks and limitations. As a result some options may not be appropriate for Fox Lake.

#### *Do Nothing*

Do nothing is an option where aquatic plants are not managed in any way, but monitoring typically occurs to track the changes in plant community structure. Programs to monitor for invasive species introduction or expansion are also common. In lakes containing both a healthy aquatic plant community and aquatic invasive or exotic species, allowing the native plant community to function in its natural state may prevent invasive species from spreading extensively through the lake. Other advantages include no financial cost, no harmful effects of chemicals, and no permits are required. The major drawback is that small populations of invasive species may expand and require more extensive management in future years.

No management of the aquatic plants in Fox Lake will meet the goal of maintaining a clear water state, but it will not meet the goals of promoting the native plant community, fish, and wildlife or facilitate lake access and recreational uses. Plant survey data from 2005 and preliminary data from 2006 suggest that aquatic plants will present navigation and recreation nuisances in the summer of 2006. To meet the use and access goals of Fox Lake District residents, some management will be required especially in nearshore areas to facilitate boating and swimming.

#### *Manual Removal*

As the name suggests, manual removal is using a mechanized or non-mechanized implement to physically remove plants from the lake bottom. There are a number of methods in practice to manually remove plants.

*Hand-pulling:* Hand-pulling is removing plants from the lake bottom with your hands and a shovel or rake. This can be a very selective method of plant removal, but it is also very time and labor intensive. The duration of control varies based on the type of plants removed and whether or not entire root systems or just stems are pulled. This method is preferred for small areas and to control nuisance plants with a patchy distribution such as around docks and piers. This would be a very effective management tool for residents on Fox Lake. No permit is required if plants are removed from areas less than 30 feet wide or if the only plant being removed is Eurasian water-milfoil or other aquatic invasive species. A lake rake can be purchased for $80 – $115 on the internet. Care must be taken to minimize removal of native plants or Eurasian water-milfoil may colonize managed areas.

*Hand-cutting:* Hand-cutting is a similar technique to hand-pulling with the exception that the plant roots are not removed. The amount of control provided by hand-cutting is limited. The advantage of hand-cutting is that it provides immediate relief and is low cost. Disadvantages include the short period of relief and the potential for repeated cuttings. Hand-cutting may also spread Eurasian water-milfoil fragments unless the entire cut plant is removed.

### Mechanical Removal

*Mechanical Harvesting:* Mechanical harvesting is using a large machine to cut and remove aquatic vegetation to create navigation channels or improve fish habitat by creating edge. The vegetation is removed by using a conveyance system at the shoreline to unload plant material. The plant material is then disposed of. Harvester cutting depths are adjustable on newer machines. Widths of cuts can vary from 4 to 20 feet while depths may vary from 5 to 10 feet. Benefits of harvesting include immediate relief from nuisance conditions and the removal of plant material from the lake that may reduce biological oxygen demand and release of nutrients during the decay process. Drawbacks to harvesting are considerable start up and maintenance costs, they are not selective, and cutting multiple times a season may be necessary. Even though harvesters are equipped with plant collection devices, some fragments may drift into other sections of the lake and alter the plant community composition. This is especially a concern for Eurasian water-milfoil. Harvesters are also difficult to use around piers and in shallow water. Due to financial limitations, a harvesting program will be difficult to initiate on Fox Lake in 2006. Leasing and contracting services are available. Costs are approximately $300 – $800 per acre for contracted services. The district should consider using harvesters to maintain navigation areas of the lake as part of the long-term plan that will be developed in 2007.

*Mechanical Cutting:* Cutters function identically to harvesters with the exception that plant material is not collected by the machinery. This technique carries enormous risk in lakes with invasive plants and is not recommended for Fox Lake.

### Chemical Control

*Herbicides:* Herbicides are the lone type of chemical control available for aquatic plant management. They are chemical substances that disrupt the growth cycle of plants. There are different types of herbicides. Systemic herbicides are absorbed and transported throughout the plant effectively killing the entire plant. Contact herbicides only kill the exposed portion of the plant so plants may re-grow from the remaining roots. Another distinction between different types of pesticides is the range of plants they affect. Selective herbicides will only damage the target plants versus broad spectrum herbicides which effect most if not all plants they come in contact with. Whether or not a herbicide is selective depends on the chemical mode of action, the dose, how it is applied, and the timing of the application (Table 3-1).

**Table 3-1**
Herbicides Used to Manage Eurasian water-milfoil

| Herbicide Name | Trade Name | Formulation | Mode of Action |
|---|---|---|---|
| 2,4-D Butoxyethlester (BEE) | Aqua-kleen, Navigate | Granular | Selective, systemic growth regulator |
| 2,4-D Dimethylamine (DMA) | DMA 4 IVM | Liquid | Selective, systemic growth regulator |
| Diquat | Reward, Weedtrine-D | Liquid | Nonselective, contact |
| Endothall Dipotassium salt | Aquathol K, Aquathol Super K | Liquid Granular | Rate and timing dependent selectivity, contact |
| Endothall Dimethylalkylamine salt | Hydrothol 191 | Liquid or Granular | Nonselective, contact |
| Fluridone | Avast!, Sonar | Liquid or Granular | *Rate dependent selectivity, systemic* |
| Triclopyr | Renovate 3 | Liquid | Selective, growth regulator |

Italics indicate best suited for large-scale or whole lake treatments; remaining chemical may be used for spot treatments

Source: Aquatic Ecosystem Restoration Foundation (2005)

Many systemic herbicides will provide extended control of target plants often extending into the following growing season. Contact herbicides tend to produce shorter periods of control. Concerns related to herbicide include potential toxic effects on aquatic invertebrates, adding additional decaying plant material to the lake bed that may reduce oxygen levels and increase nutrients, and water use restrictions. Each chemical has its own limitations and it is important to determine whether or not an application will cause use conflicts between lake users (Table 3-2).

**Table 3-2**
Water Use Restrictions for Herbicides Used to Manage Eurasian water-milfoil

| Herbicide Name | Trade Name | Water Use Restrictions |
|---|---|---|
| 2,4-D Butoxyethlester (BEE) | Aqua-kleen, Navigate | Drinking until below 70 ppb<br>Irrigation until below 100 ppb |
| 2,4-D Dimethylamine (DMA) | DMA 4 IVM | Same as Navigate<br>May be toxic to invertebrates |
| Diquat | Reward, Weedtrine-D | Drinking 1-3 days<br>Recommended 1 day recreational use<br>(reduces effectiveness) |
| Endothall Dipotassium salt | Aquathol K, Aquathol Super K | Fish consumption 3 days<br>Irrigation 7-25 days<br>May be toxic to fish |
| Endothall Dimethylalkylamine salt | Hydrothol 191 | Same as Aquathol K |
| Fluridone | Avast!, Sonar | Recommended irrigation tress 7 days, crops 14-30 days |
| Triclopyr* | Renovate 3 | Irrigation 120 days or until below detection<br>Fish 30 days |

Chemical control is an effective management option along shorelines and around piers. Another advantage to chemical control is that it is affordable to many riparian homeowners. Treament of small areas (50 feet by 150 feet) costs ranges from $200 – $400 depending on the number of treatments and chemicals used. Large-scale treatments usually have a lower cost per acre and range from $100 – $1,200 per acre depending on the chemical used. A permit is required for all chemical controls under NR 107. It is highly recommended that riparian homeowners wanting to use chemicals to treat aquatic plants hire a licensed, certified professional applicator. Applying chemicals in a manner inconsistent with label instructions is prohibited by law. A selective herbicide that controls Eurasian water-milfoil and does not harm native plants would be a beneficial management option for the native plant community.

### Physical Control

A number of options for physical control of aquatic plants are available depending on the characteristics of your lake and the management site.

*Dredging:* Dredging the removal of lake sediments using mechanical or hydraulic equipment. It is a non-selective technique that removes all plant material and lake bottom material. Dredging will also increase the depth of management sites and will expose the original lake bed. In many lakes, cultural eutrophication and increased sediment loads have covered the lake bottom with decaying plant material and silt. Removing this material may improve the spawning habitat for some species and decrease it for others. The disadvantages of dredging include high costs ($5 – $30 per cubic yard) and general disruption of the aquatic habitat. This technique is not recommended for Fox Lake's interim plan.

*Water Level Drawdown:* Drawdowns are a common method of aquatic plant control in lakes with water level manipulation capacity. Winter drawdowns are the most common as many plants species cannot tolerate freezing conditions. Drawdowns in the summer months rely on heat and desiccation to reduce plant abundance. Once the lake level is brought up, some species may show a positive response to the drawdown; however, responses from Eurasian water-milfoil are unpredictable. Other potential effects of a drawdown are: reduced oxygen levels in winter due to reduced water volume, benthic organisms may be impacted, and affects to shorelines and wetlands. Water level drawdown during the summer months is likely prohibitive for the residents on Fox Lake due to limited lake access. A drawdown on Fox Lake of 6 feet would be required to limit plant growth in nuisance areas. Due to the timing of management activities, water level drawdown is not applicable because many lake residents would lose access to the lake if a drawdown occurred in the summer of 2006.

*Dyes:* Dyes are water soluble compounds mixed in lake water that limit light penetration and reduce plant growth. Dyes favor species tolerant to low light conditions and may be used to create open water conditions where they might not otherwise occur. The disadvantages to using dye are that they are generally not effective in depths less than 4 feet and require repeated applications as they degrade or flush from the application area. Due to the large water volume, this technique is not applicable to Fox Lake. Costs for using aquatic dyes are approximately $65 per acre.

### Biological Controls

Biological control in lakes is currently in the experimental phases of development. As with many biological interactions, the effects of releasing organisms into a lake are only predictable to a certain degree. In addition, biological controls tend to operate in a cyclical nature so the effectiveness as a management tool may vary from year to year.

*Grass Carp (Ctenopharyngodon idella):* Grass Carp are an exotic carp species native to Eastern Europe and Asia. It is known as an aggressive consumer of aquatic plants, especially elodea and pondweeds. Grass Carp may completely eliminate aquatic plants once introduced. Grass Carp are illegal to introduce in Wisconsin waters.

*Milfoil Weevil (Euhrychiopsis lecontei):* The Milfoil Weevil has been documented in isolated circumstances to control Eurasian water-milfoil populations in Wisconsin, Illinois, and Vermont. Adult females lay eggs on the tips of the plant. The larval weevils emerge and attack milfoil at its growth points and stems. Most evidence to date suggests that the feasibility of long-term control is unknown and that intensive stocking is required for lake-wide control (3,000 adults per acre) for a cost of $15,000 per acre. Evidence also suggests that Milfoil Weevils are most effective on dense stands of milfoil and tend to avoid other plants. This technique is relatively unreliable and results are unpredictable. This technique is best applied on a whole-lake scale.

*Native Plants:* Native plants may compete with Eurasian water-milfoil if there is a healthy, diverse community present. Eurasian water-milfoil thrives in disturbed conditions whether natural or human induced. Even in cases where herbicide treatments have been highly effective, the most likely plant to re-colonize a treated area is an invasive plant. Two strategies to prevent re-colonization are spreading seeds of native species or transplanting adult plants. Spreading the seeds over a treatment area must occur early in the growing season so plants may complete their life cycle. If annuals go to seed, control may be effective the following year. This technique requires planning and the acquisition of seeds from in-lake sources or reputable nurseries. Transplanting adult plants to treatment areas should occur after plants reach full-size and before seeds are dropped. Both of these techniques are effective at enhancing the native plant community and prevent re-infestations of invasive plants. Costs for plant relocation are approximately $150 per hour. Large-scale native plant relocation is an option that should be considered for the long-term plan, but is not financially feasible to implement in 2006.

## Summary

Fox Lake is currently in a clear water macrophyte dominant state. Clear water states are difficult to maintain in hyper-eutrophic lakes. Any plant management activities should be minimized to promote the clear water state while still facilitating lake access and recreational uses. Due to Fox Lake Inland Lake Protection and Rehabilitation District‘s lack of plant management funding in 2006, activities will be limited to privately funded projects at a low manipulation level. The most applicable management techniques for Fox Lake in 2006 are a mix of hand-pulling and chemical treatments around lake resident’s shoreline and piers. The upcoming long-term aquatic plant management plan should address creating navigation channels, controlling Eurasian water-milfoil on a lake-wide scale, and promoting the native plant community by planting.

# CHAPTER 4 – RECOMMENDATIONS, IMPLEMENTATION, AND MONITORING AND EVALUATION

## INTRODUCTION

The following sections will provide a set of recommendations for aquatic plant management in 2006, implementation of key activities, and strategies for monitoring and evaluation. These recommendations should be reviewed at the end of 2006 and incorporated into the long-term aquatic plant management plan scheduled for completion in 2007. Based on the alternatives analysis and financial limitations of the Fox Lake Inland Lake Protection and Rehabilitation District in 2006, the recommendations will focus on plant management activities related to facilitation of lake access and recreational use in nearshore areas.

### Recommendations

The general recommendations for the Fox Lake Inland Lake Protection and Rehabilitation District are:

- Develop an integrated plant management strategy to facilitate lake access and recreational use in nearshore areas that minimizes impacts to the overall aquatic plant community and protects ecologically significant areas of the lake
- Educate the public on the value of a healthy native aquatic plant community and shallow lake ecology
- Identify components that should be addressed in the long-term plan to be completed in 2007

#### *Integrated Plant Management Strategy*

Potential control actions are limited in 2006 due to the budgetary constraints of the Fox Lake Inland Lake and Protection District and the shore planning period before management action must be taken to facilitate recreational use and lake access in 2006. Proposed management actions for 2006 are: herbicide treatments and manual removal in nearshore areas.

The Fox Lake residents should adopt an integrated aquatic plant management strategy that focuses on minimizing native plant removal while promoting lake access and recreational use. For 2006 plant management will be limited to nearshore areas around docks and piers to increase swimming and boating opportunities. Control techniques will be limited to hand-pulling or raking, selective chemical treatments targeting Eurasian water-milfoil and Coontail, or relatively small treatments with contact herbicides to control other native aquatic plants.

It is essential that beneficial native plants such as Elodea or pondweeds are not removed or minimally removed because they may restrict the spread of Eurasian water-milfoil. Visual evidence suggests Elodea is competing well with Eurasian water-milfoil in infested areas. Sago pondweed is a high value aquatic plant for fish and wildlife and should receive no treatment or be removed.

Manual removal control should rely on hand-pulling or raking methods that focus on selective removal of Eurasian water-milfoil and Coontail. Residents are allowed to remove native and non-native plants without a permit in a 30-foot wide area around their piers to allow for navigation and recreation. Eurasian water-milfoil may be selectively removed (hand-pulled or raked) outside of the 30-foot area without a permit, but other plants are limited to a 30-foot wide area. All removed plants should be disposed of on dry land in a manner that will not allow the plants to wash back into the lake and infest other areas. Composting is one way to dispose of plant material.

Chemical treatments should be allowed for property owners affected by Eurasian water-milfoil. Each property owner should be allowed to chemically treat Eurasian water-milfoil using a selective herbicide. The granular formulation of 2,4-D should be used to promote longer relief and extended contact time. Residents may treat an entire 50-foot wide by 150-foot long channel with 2,4-D.

Contact herbicides that may also affect native plants should be avoided, but may be used in areas where aquatic plant other than Eurasian water-milfoil and Coontail are a nuisance, but consideration also needs to be given for the ecological benefits of promoting the native aquatic plant community. Contact herbicides create disturbed areas on the lake bottom where the fast growing Eurasian water-milfoil may gain a competitive advantage. Treatment areas using contact herbicides should be limited to the *lesser* of ½ of the length of homeowner's shoreline or 50 feet to minimize the effects of plant removal. If adjacent property owners qualify and contracted for a contact herbicide treatment, the centerline of the treatment should be the property boundary between parcels (Figure 4-1A). This would increase the average size of the remaining plant beds. Increased boat traffic through a common channel may also reduce plant re-growth.

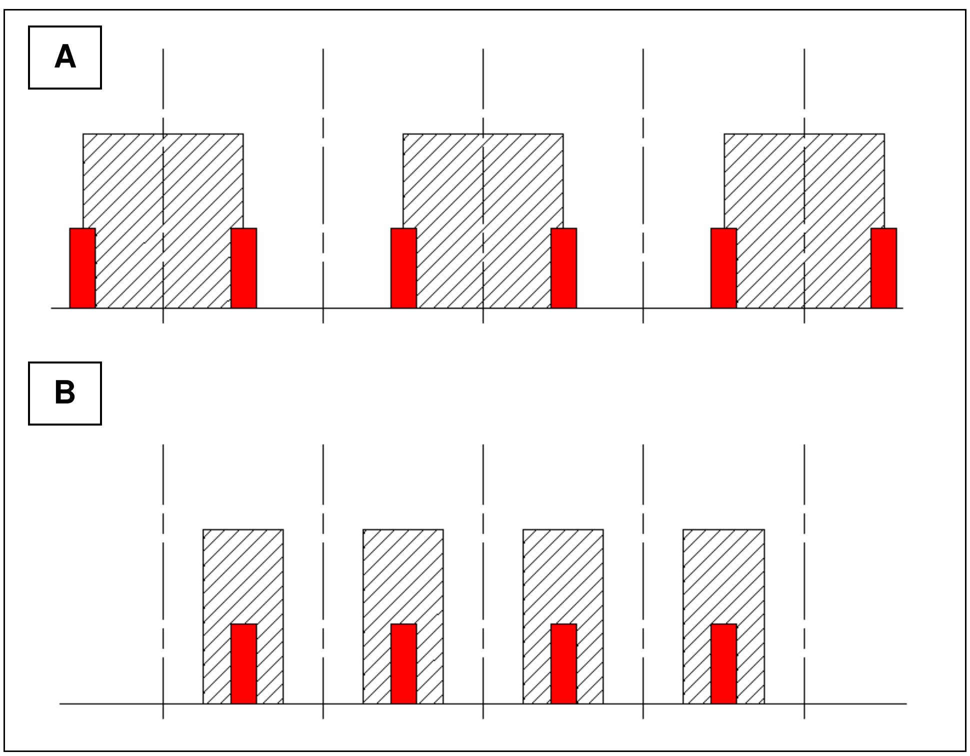


**Figure 4-1**
Alternate Contact Herbicide Application Strategy (not to scale)
Source: Hey and Associates, Inc.

If an adjacent property owner does not need or want a chemical treatment, then the second plant treatment option should be followed where the pier is used as the treatment centerline (Figure 4-1B). The treatment width restrictions still apply where the lesser width of 50 feet or ½ of the shoreline frontage may be treated out to 150 feet from the shoreline. Figure 4-1B also illustrates how consecutive small treatments centered in the middle of each property leaves relatively small plant beds compared to Figure 4-1A.

It is important to note that manual removal is not allowed in addition to chemical treatments. In other words, a property may receive a chemical treatment along 50 feet or ½ of a property's shoreline OR manually remove all plants within a 30 foot wide area. Conversely, if a property receives a chemical treatment, Eurasian water-milfoil may be removed from adjacent areas without a permit. The decision making framework suggested to guide aquatic plant management activities on Fox Lake is outlined in Figure 4-2.

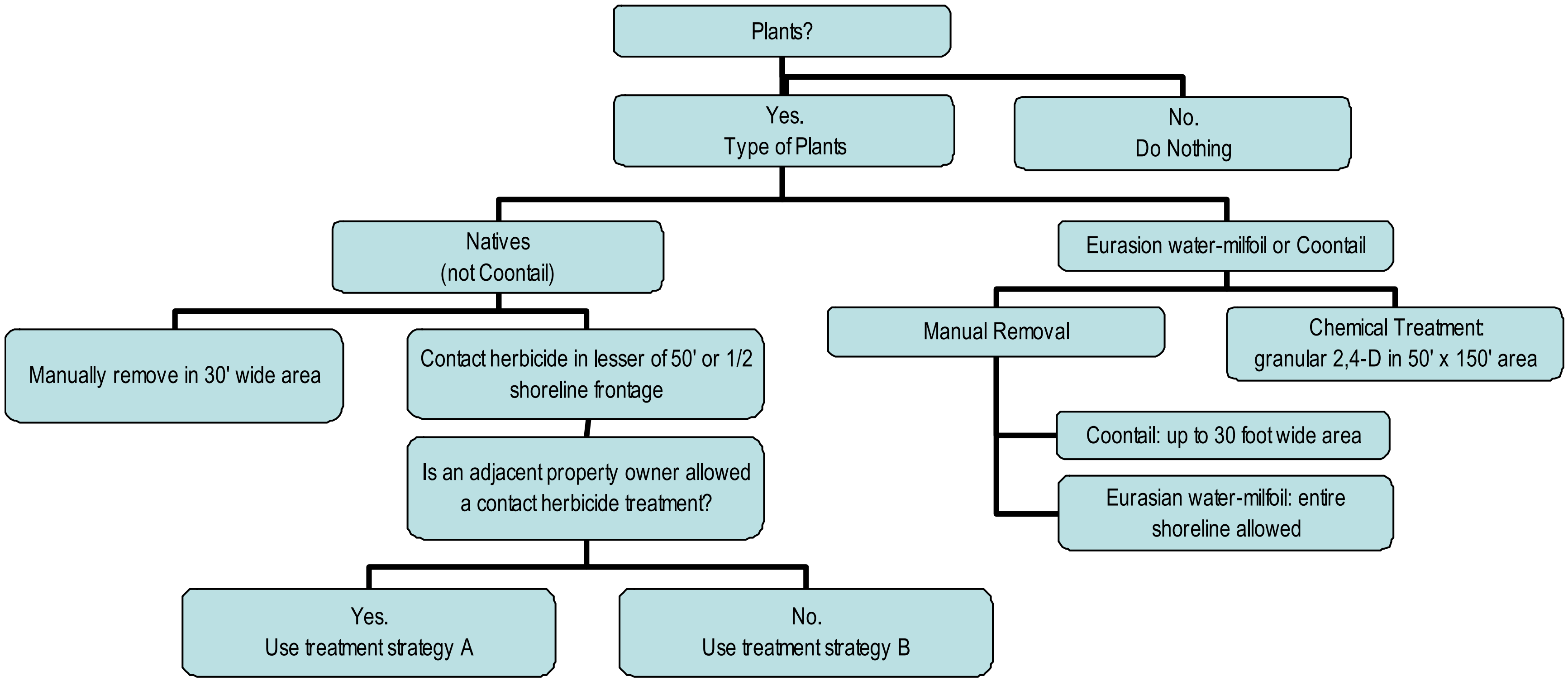


**Figure 4-2**
Aquatic Plant Management Decision-Making Framework

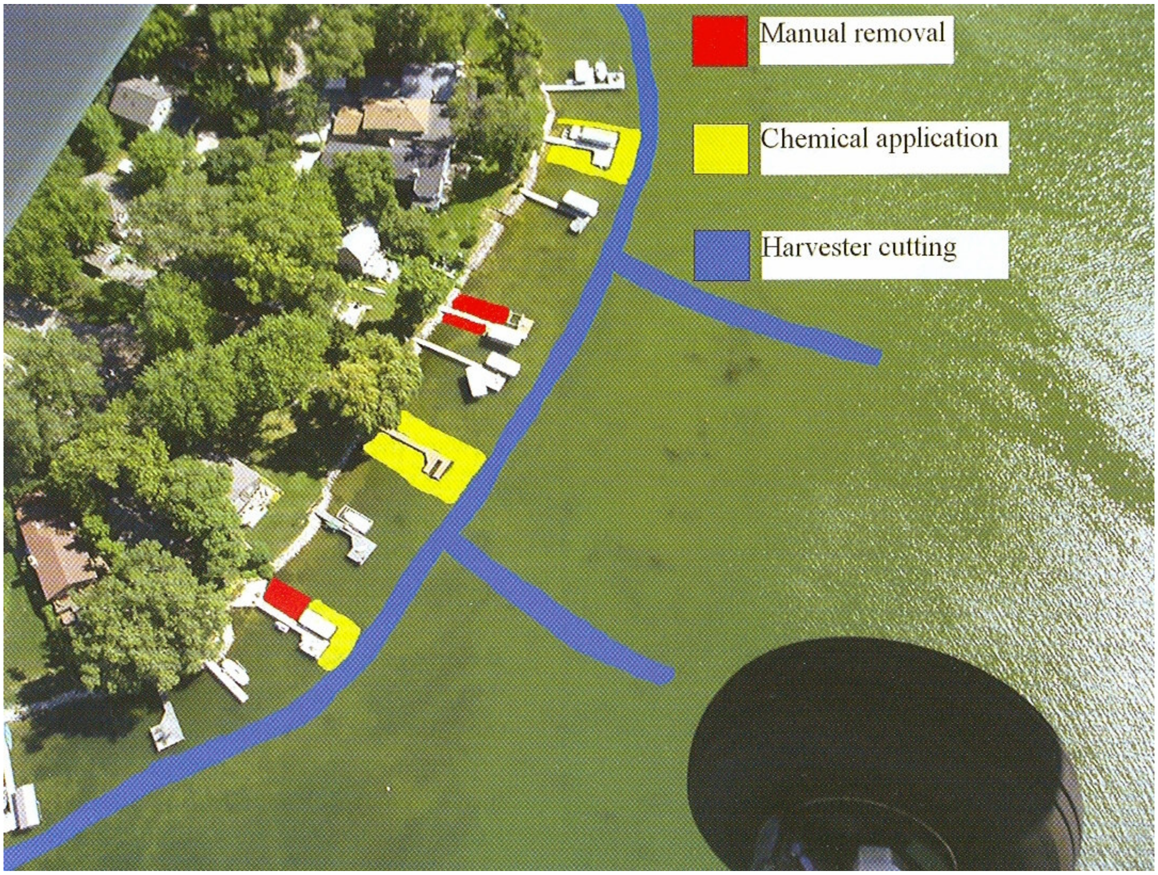


**Figure 4-3**
Integrated Aquatic Plant Management Strategy
Source: NALMS and WDNR

Figure 4-3 illustrates an integrated plant management strategy combining manual removal, chemical application, and harvesting. Integrated plant management will be a combination of manual removal and chemical applications in 2006. Harvesting to create navigation lanes will be a management option considered for the 2007 long-term plan.

Figure 4-4 shows areas where low intensity manipulation of the plant community should occur to enhance recreational use and facilitate lake access. These areas coincide with the 2006 proposed management areas.

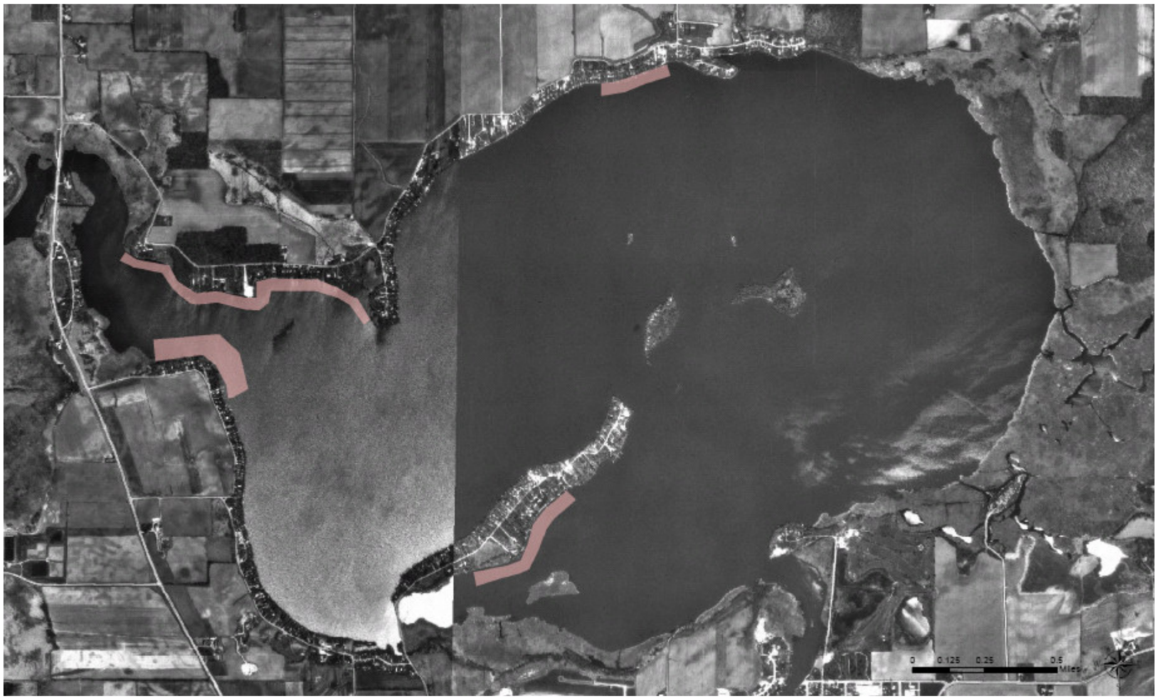

**Figure 4-4**
Low Intensity Plant Management Areas
Source: WDNR

### *Public Education*

A public meeting will be held to introduce the interim plan to the district residents. Four education and planning meetings were held that were open to the public during plan development. Topics covered include: shallow lake ecology and alternate stable states, aquatic plant identification, and aquatic plant management options.

### *Future Planning*

In future planning and development of the long-term aquatic plant management plan in 2007, the Fox Lake Inland Protection and Rehabilitation District should consider implementing a “Clean Boats, Clean Waters” program; update the existing watershed and water quality plan; encourage public involvement in promoting overall lake health; develop a lake-wide Eurasian water-milfoil management strategy; and sponsor plant management in high use areas such as navigation channels.

The “Clean Boats, Clean Waters” watercraft inspection program is a volunteer based effort to minimize the spread of aquatic invasive species. Volunteers are trained to organize and conduct a boater education program in their community. Adults and youth teams educate boaters on how and where invasive species are most likely to hitch a ride into water bodies. Volunteers perform boat and trailer checks for invasive species, distribute informational brochures, and collect and report any new water body infestations.

## Implementation

A public meeting will help to present the 2006 interim plant management plan to the public that will include educational information related to the value of a healthy aquatic plant community and the benefits of selective plant management. This will include a discussion on how to identify the invasive and nuisance plants and how to properly manually remove and dispose plant material.

Manual removal of aquatic plants may occur as needed without a permit as long as the area is limited to a 30 foot wide channel. Eurasian water-milfoil may be removed at any time without a permit from the lake. It is the responsibility of individual homeowners to remove and dispose of manually removed aquatic plants. The Fox Lake Inland Lake Protection and Rehabilitation District will attempt to provide a list of individuals willing to remove aquatic plants manually for a fee.

Chemical applications in 50 by 150 foot areas using 2,4-D granular products should occur in late May or early June to minimize impacts to the native plant community. The target plants of 2,4-D are Eurasian water-milfoil and Coontail which are the primary nuisance species in Fox Lake. All chemical applications require a permit issued by the Wisconsin Department of Natural Resources. All chemical treatments on the lake should be completed by a certified and licensed aquatic pesticide applicator to jointly protect human and aquatic life health. Suspected illegal chemical applications should be reported to the District and the Wisconsin Department of Natural Resources. The use of aquatic herbicides without a permit and/or in violation of label instructions is a legally punishable offense.

Contact herbicides may be used to manage areas with no Eurasian water-milfoil but be limited to the lesser of ½ a homeowner's shoreline frontage or 50 feet. The length of treatment should not exceed 150 feet. These dimensions should provide an acceptable area to recreate while protecting the aquatic plants in nearshore areas using the suggested alternate treatment strategies outlined in Figure 4-1A and Figure 4-1B. All chemical applications should be performed by a licensed and certified aquatic applicator. The financial burden of all chemical applications and permit fees will be the responsibility of the homeowners requesting aquatic plant management.

Public involvement in activities during 2006 will be limited due to the short timeframe for planning. Programs such as "Clean Boats, Clean Waters" or volunteer aquatic plant monitoring should be encouraged while developing the 2007 long-term aquatic plant management plan.

The Fox Lake Inland Lake Protection and Rehabilitation District has no funding available for aquatic plant management activities in 2006. All management actions will be at the cost of lake residents. A Wisconsin Department of Natural Resources Large-Scale Planning Grant has been awarded to aid in the completion of a 3- to 5-year aquatic plant management plan that will be more comprehensive than the 2006 interim plan.

The 2006 Interim Aquatic Plant Management Plan will be submitted to the Fox Lake Aquatic Plant Management Committee for review on May 17th, 2006. It will be presented to the full Fox Lake Inland Lake Protection and Rehabilitation District Board on May 24th, 2006. The final plan will be submitted to the Wisconsin Department of Natural Resources Aquatic Plant Management Coordinator, Susan Graham, for approval by June 1st, 2006.

## Monitoring and Evaluation

Since Fox Lake is in a hyper-eutrophic state and currently in a clear water state, monitoring activities should occur multiple times during the growing season to track plant community. A qualitative survey was completed on May 10th, 2006 to determine potential plant management areas in 2006. A comprehensive point-intercept survey is scheduled for mid-summer to provide lake-wide baseline data to evaluate future management activities and track the health of the aquatic plant community. The comprehensive point-intercept survey should be repeated at least every 3 to 5 years. A cyclical monitoring strategy incorporating WDNR recommended procedures will be included in the 2007 long-term aquatic plant management plan.

All proposed management areas should be individually surveyed prior to and post treatment in 2006 to ensure treatment effectiveness and to evaluate the status of native and non-native plants. Coontail is moderately resistant to 2,4-D and may require multiple treatments for effective control. Water quality monitoring for pH and dissolved oxygen should also occur in treatment areas on the date of treatment and at least once 5-7 days following treatment once vegetation has begun to decay. Residents should submit either a written evaluation of the treatment or pictures before and after treatment to the Fox Lake District Inland Lake Protection and Rehabilitation District to be used as an educational tool for other lake residents considering aquatic plant management.

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