# 2001 SUMMARY REPORT
# of
# HONEY LAKE

## Lake County, Illinois


**Prepared by the**

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# TABLE OF CONTENTS

# EXECUTIVE SUMMARY

Honey Lake is a 66 acre glacial lake in Cuba township near the intersection of Routes 22 and 59 and is within the Village of North Barrington. Access to Honey Lake is fully private with bottom ownership divided between Biltmore Country Club and eleven private landowners. The lakes main use is recreational boating (no motors allowed), fishing, and swimming. There is an Illinois Department of Public Health licensed beach located at Biltmore Country Club, which is only open to members. The Country Club has been located on the lake for 75 years and is the main manager of Honey Lake. Management activities have included nuisance aquatic vegetation control and fish stocking.

Overall, Honey Lake is in very good condition and has above average water quality. Data collected by the Lakes Management Unit found that nutrient concentrations were below median concentrations for County lakes. Honey Lake has *above average* water clarity (average Secchi disk depth of 8.4 feet). Additionally, dissolved oxygen concentrations were good and a large majority of the lake volume (61%-99%) is able to support aquatic life. Other water quality parameters were also at acceptable levels.

Aquatic plant assessments revealed that Honey Lake has adequate plant *densities*, which contributed to the above average water quality. However, plant *diversity* is below average for lakes in the County. The country club uses copper sulfate to treat blooms of nuisance algae around their beachfront. The Lakes Management Unit found no Eurasian water milfoil despite past sightings of this very aggressive invasive exotic weed. Biltmore should monitor the aquatic plant population of the lake to ensure that diversity continues to increase and milfoil does not return. Aquatic plant management activities should only be used on an *as needed* basis.

The majority of Honey Lake's shoreline is undeveloped (51%). This undeveloped shoreline is predominantly made up of wetlands. The major types of developed shoreline include buffered areas (49%), seawall (21%), and manicured lawns (16%). The high occurrence of undeveloped shoreline and buffered areas provides good shoreline stabilization, which has kept the amount of erosion on Honey Lake to a minimum. Additionally, these two shoreline types provide excellent wildlife habitat. Several state threatened and endangered species were sighted on Honey Lake during the 2001 study including the common tern, pied bill grebe, and osprey.

The best management strategy for a lake of Honey's undisturbed nature and above average water quality is to minimize human impacts from the surrounding watershed. Additionally, shoreline condition should be monitored for the presence of any developing erosion and presence of invasive species, which should be immediately addressed in order to minimize disturbance.

## LAKE IDENTIFICATION AND LOCATION

Honey Lake is a 66 acre glacial lake that is located near the intersection of Route 22 and 59 and is within the Village of North Barrington, Cuba township (T43N, R9E, Section 13) (Figure 1). Honey Lake has a current maximum depth of 18+ feet with an average depth of 8.8 feet and a lake volume of approximately 584 acre-feet (Figure 2). Honey Lake is part of the Flint Creek drainage basin, which is part of the Fox River watershed. Honey Lake's watershed is approximately 1250 acres (Figure 3). The main inflow to the lake is from two creeks on the east side of the lake and the wetland just north of the lake. These two creeks receive drainage from an area that extends to the south and southeast of the lake (Figure 3). Honey Lake's watershed is mainly residential and open space. The drainage from the Biltmore Country Club (Biltmore) golf course is in the Grassy Lake watershed and does not drain into the lake. The lake was dammed in 1950 in order to control water level fluctuations. There is a spillway on the west side of the lake (west of Biltmore Drive), which controls the drainage from Honey Lake into Grassy Lake to the west. This drainage continues to flow to the west and eventually into the Fox River.

## BRIEF HISTORY OF HONEY LAKE

Biltmore County Club, which is located on the west shore of the lake, was built over 75 years ago. This is possibly the first development on Honey Lake. They have been the main management entity of the lake for the last 75 years. However, they have only been actively managing Honey Lake since the mid 1980's after a partial fish rehabilitation despite the fact that they only own half of the bottom. Recreational opportunities on Honey Lake have gone unchanged for the last 75 years and largely consist of boating (no motors of any kind allowed), swimming, and fishing. Due to the private nature of Honey Lake, these will continue to be the main uses of the lake.

## SUMMARY OF CURRENT AND HISTROICAL LAKE USES

Access to Honey Lake is entirely private. Biltmore owns about half of the bottom of the lake. Biltmore provides lake access to its members via a boat launch and storage area. However, launching of watercraft by non-members and non-approved personal is prohibited. Additionally, Biltmore has an Illinois Department of Public Health licensed bathing beach on the lake, which is monitored for fecal coliform bacteria levels and is tested on a bimonthly basis by the Lake County Health Department-Lakes Management Unit (LMU) from May through September. During the 2001 sampling season the beach was never closed. In past years the beach has experienced some closures. These closures were linked to excessive amounts of goose feces. These feces are now cleaned up on a regular basis and closures have been greatly reduced/nonexistent. About eleven residents whose property lines extend out into the lake own the other half of the lake. Several of these residents have piers and watercraft.

## LIMNOLOGICAL DATA - WATER QUALITY

Water samples collected from Honey Lake were analyzed for a variety of water quality parameters. Samples were collected at 3 feet from the surface and 3 feet off the bottom (14-16 feet deep) from the deep hole location in the lake (Figure 1). Honey Lake is thermally stratified, which means the lake divides into warm upper water (epilimnion) and cool lower water (hypolimnion). This stratification is due to the deep lake morphology of Honey Lake (see *Interpreting Your Lake's Water Quality* for further explanation). This separation of the lake into layers is reflected in the 2001 water quality data. Below is a discussion of the highlights from the complete data set for Honey Lake (Table 1, Appendix A).

Secchi disk depth is a direct indicator of clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and the better the water quality. Based on average Secchi depth, Honey Lake has *good* water quality. The 2001 average Secchi disk depth on Honey Lake was 8.4 feet, which is double the Lake County median Secchi depth of 4.18 feet and is an increase of 47% over the 1998 LMU average Secchi depth (5.7 feet). May had the deepest Secchi depth (13.42 feet) with subsequent months significantly lower (6.26-7.81 feet) but still well above the County median (Figure 4). This decease in Secchi depth after May can be attributed to an increase in suspended particles such as tannins and organic matter (decaying plants/algae), that can reduce clarity. The 2001 average Secchi depth varied when compared to past LMU/ Illinois Volunteer Lake Monitoring Program (VLMP) measurements (Figure 5). These yearly fluctuations could be due to a variety of reasons including variations in plant densities and periodic algae blooms.

These fluctuations in Secchi depth/clarity appear to be cyclic and may be attributed to yearly fluctuations in phosphorus concentrations and resulting algae growth, which can drastically reduce Secchi depth. The 1998 LMU study found that average total phosphorus (TP) was higher than 2001 TP concentrations, which could lead to increased algal blooms and in turn to reduced Secchi depth. This is reinforced by visual observations from VLMP records that state there are fluctuations in algae growth from year to year on Honey Lake. Additionally, herbicide use (Sonar™) can reduce clarity. Aquatic plants stabilize sediment and compete with algae for available resources. Both of which enhance water clarity. By eliminating too much aquatic vegetation, the benefits that plants provide are lost. This is a common phenomenon in lakes with periodic whole lake herbicide treatments. Additionally, the 1995, 1996, 1997,1999, and 2000 Secchi data is from the VLMP monitoring program. The number of readings taken by volunteers on Honey Lake varied a great deal (from 3 –16 times a season). This varied sampling schedule can confound comparisons in Secchi depth averages from year to year.

Dissolved oxygen (D.O.) concentrations in Honey Lake were *good* during the entire 2001 study. The volume of the lake that had enough D.O. to support aquatic life ( $\geq$5.0 mg/L) ranged between 61-99% of the total volume. D.O. concentrations in September were jut above 5 mg/L (6.24 mg/L). However, this is a common phenomenon in the fall when the lake starts to cool, turnover and mix thus diluting D.O. concentrations. Besides being

a benefit for aquatic life, good D.O. concentrations are also beneficial for overall lake health. As the hypolimnion becomes hypoxic (<1.0 mg/L), nutrients are released due to biological and chemical processes. Due to stratification, these nutrients are sequestered in the hypolimnion and continue to build up during the course of the summer. When fall turnover, or a periodic summer mixing event, occurs these nutrients are then released into the lake and can cause a variety of problems including fall/winter algal blooms and D.O. crashes upon bloom death. However, this is not a concern since only a small percentage of the lake volume (1%-13%) was anoxic (0 mg/L) and nutrients would be diluted to much lower concentrations during turnover.

Average total suspended solids (TSS), which is a measurement of suspended particles in the water such as silts, clays, algae and organic matter, was 1.8 mg/L, which is significantly lower than the County median TSS of 5.7 mg/L. The 2001 average TSS was slightly lower than 1998 LMU TSS average (3.4 mg/L). Calculated nonvolatile suspended solids (NVSS), which is the part of TSS that is nonorganic particles (such as sediment) was also very low (1.3 mg/L). NVSS accounted for a large majority (72.2%) of the TSS, which is reflected, in the low occurrence of planktonic algal blooms on Honey Lake. Average total dissolved solids (TDS), total solids (TS), total volatile solids (TVS) were slightly above their respective County medians. These elevated TVS concentrations could be due in part to aquatic plant decomposition, which can cause an increase in organic matter in the water column. Above average TS and TDS concentrations are due to elevated levels of dissolved minerals (chloride). This is further reinforced by significantly elevated conductivity levels, which measures dissolved water born solids such as chlorides. In 2001, Honey Lake had an average conductivity of 1.113 milliSiemens/cm compared to the County average of 0.7557 milliSiemens/cm. High conductivity may be due to stormwater runoff containing high amounts of road salts. These salts could have originated from nearby roads, Routes 12, 22, and 59, all of which are in Honey Lake's watershed and had heavy winter road salt use.

Another very important measurement of water quality are nutrient concentrations. High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. This average phosphorus concentration in Honey Lake in 2001 was 0.038 mg/L. This average is without the July data, which was 77% higher (0.195 mg/L) than the next highest month. This peak in phosphorus may have been due to a periodic summer mixing of the epilimnion and hypolimnion due to climatic events (termed polymitic). This pulse in TP quickly dissipated and TP concentrations were substantially lower in August. Interestingly, this pulse was also present in the 1999 VLMP data but not in the 1998 LMU data. Since this seems to be an anomalous occurrence and may not represent the overall nutrient concentrations in Honey Lake this data was left out of the average. Average phosphorus concentrations in 1998 were 0.40 mg/L, which is not significantly different from the 2001 average TP concentration (without the July data) and TP concentrations remain stable in Honey Lake. These low phosphorus concentrations help keep planktonic algae blooms to a minimum and contribute to the above average clarity of Honey Lake. Nitrogen concentrations

(TKN, NH3, and $NO_3$) on Honey were below detectable concentrations for much of the study ($NH_3$ was only detectable in May). Hypolimnetic concentrations of nutrients (N&P) fluctuated slightly but were all within acceptable ranges and were near their respective County averages.

To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. In 2001, Honey Lake had a TN:TP ratio of 15:1which means that no nutrient limitation was occurring. If the anomalous July TP data is omitted, Honey Lake has a TN:TP ratio of 28:1, which means that the lake is phosphorus limited. The 2001 ratio (without the July data) was similar to the 1998 LMU study in which Honey Lake had a TN:TP ratio of 29:1. This stability in nutrient levels is encouraging and shows a stable state of low phosphorus concentrations.

In lakes, phosphorus originates from two sources. One source is from within the lake (internal). This is a common source of phosphorus in lakes, which by their nature contain rich sediment. However, in a lake that has highly organic sediment, such as Honey, this form of internal release may be a significant source. Additionally, biological and chemical processes release phosphorus from the anoxic sediments. Since Honey Lake is stratified, released phosphorous is sequestered in the hypolimnion where it remains until fall turnover. It seems that periodically, internal release events occur due to periodic mixing of the hypolimnion and epilimnion during the summer months. This causes a pulse of phosphorus to be released into the surface waters of the lake and this might be causing the periodic increase in planktonic algal blooms and decreases in Secchi depth seen in some years. However, by the next month TP concentrations had returned to much lower levels. Additionally, sediment bound phosphorus can be mixed into the water column by wind/wave action and lack of aquatic plants (which stabilize sediment). Since Honey Lake has a well-established aquatic macrophyte community and a no motor policy, suspension from these sources may not be a concern. The other main input of phosphorus is from outside of the lake (external). These external inputs consist of a variety of sources from the surrounding watershed. They can include fertilizer runoff, failing septic systems and erosion. Due to the size of its watershed, which is becoming more developed with the passing years, should be one of the main areas of concern for Honey Lake in the future. *Due to the phosphorus limited nature of Honey Lake, external inputs of phosphorus from the watershed should be carefully monitored as even small increases could trigger algae blooms.*

Another way to look at phosphorus concentrations and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus. TSI values are commonly used to classify and compare lake productivity (trophic state). The higher the phosphorus concentration the greater amount of algal biomass, which then results in a higher TSI and corresponding trophic state. Based on a TSI phosphorus value of 65.2[1], Honey Lake is classified as eutrophic (>50, <70 TSI). A eutrophic lake is defined as an

[1] TSI was calculated using the July TP data. The TSI of Honey Lake without the July data is 56.4, which is still classified as eutrophic.

over productive system that has above average nutrient concentrations and high algal biomass (growth). However, this definition does not hold completely true for Honey Lake. The eutrophic classification was due to slightly elevated phosphorus concentrations. These elevated concentrations did not cause high algal biomass, which phosphorus TSI trophic states are partially based on. However, some degree of planktonic growth did occur but was limited. The lack of algal blooms were due in part to the presence of aquatic vegetation and the many associated benefits (such as competition with algae). Without an established aquatic plant population, TP concentrations in Honey Lake might be higher and there could be more wide spread, higher intensity algae blooms. TSI can also be used to compare lakes within the County. Based on average phosphorus TSI from 1998 and 2001, Honey Lake ranks 44 out of 102 lakes studied by the LMU between 1988-2001 (Table 2, Appendix A). However, this ranking is based on calculations using the 2001 July TP data. If the July data were not used, Honey Lake would rank 37 out of 102 from 1988-2001. This is probably more representative of the true condition of Honey Lake and how it compares to other lakes in the County.

TSI values along with other water quality parameters can be used to make other analyses of Honey Lake based on use impairment assessments established by the Illinois Environmental Protection Agency (IEPA). Most impairment assessments (TP, $NO_3$-N, $NH_3$-N, pH, D.O., TDS, NVSS, exotic species) were listed as *None*. The only impairment assessment on Honey Lake was for noxious aquatic plant growth, which is listed as *Slight*. Additionally, IEPA has also established use impairment indices based on various water quality parameters. For the IEPA Aquatic Life Use and Swimming Use impairments, Honey Lake was ranked as providing *Full Support*. For Recreational Use impairment Honey Lake is listed as providing *Partial Support*. This ranking is due to an overabundance of aquatic vegetation. However, Honey Lake is not a high recreational use lake (water skiing, power boating, etc.) so this impairment is of no real consequence. The Overall Use impairment assessment is listed as *Full Support*.

## LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provided many water quality benefits such as sediment stabilization. Aquatic plant diversity on Honey Lake is slightly *below average* (Table 3). Floristic quality index (FQI) (Swink and Wilhelm 1994) is a rapid assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each submersed and floating aquatic plant species (emergent shoreline species were not counted) in the lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). Nonnative species were also counted in the FQI calculations for Lake County lakes. We then averaged these numbers and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. In 2001, Honey Lake has a FQI of 12.1. The average FQI of lakes studied by the LMU in 2000-2001 was 14.0. This FQI supports that Honey Lake has slightly *below average* aquatic plant diversity compared to other lakes in Lake County.

Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). Shoreline plants of interest were also observed (Table 3). However, no surveys were made of these shoreline species and all data is purely observational. The extent to which aquatic plants grow is largely dictated by light availability. Aquatic plants need at least 1% of surface light levels in order to survive. Based on light penetration, the extent of aquatic growth in Honey Lake could have been as high as 89% of the surface area (bottom coverage) and as deep as 14 feet. However, we found that plants did not completely grow in all of these areas or to this depth. Aquatic vegetation in Honey Lake occupied approximately 57% of the surface area, which is a bit excessive (30-40% is ideal), with a maximum growing depth of 8.0 feet (Table 4, Appendix A). However, these high densities helped maintain good water quality.

**Table 3. Aquatic and shoreline plants on Honey Lake, May-September 2001.**

| | |
|---|---|
| <u>*Aquatic Plants*</u> | |
| Coontail | *Ceratophyllum demersum* |
| Chara (macroalga) | *Chara* sp. |
| Common Duckweed | *Lemna minor* |
| Curlyleaf Pondweed | *Potamogeton crispus* |
| Sago Pondweed | *Stuckenia pectinatus* |
| Slender Naiad | *Najas flexilis* |
| Spiny Naiad | *Najas guadalupensis* |
| Water Stargrass | *Heteranthera dubia* |
| Yellow Pond Lily | *Nuphar advena* |
| White Water Lily | *Nymphaea tuberosa* |
| <u>*Shoreline Plants*</u> | |
| Purple Loosestrife | *Lythrum salicaria* |
| Reed Canary Grass | *Phalaris arundinacea* |
| Buckthorn | *Rhamnus cathartica* |
| Common Cattail | *Typha latifolia* |

During the 2001 study of Honey, only 10 species of aquatic plants were found (including the macroalga *Chara* sp.). The month with the highest plant diversity was September, in which all 10 species were sampled. The most frequent species during the study was

*Chara*, which occurred at 71% of all sample sites (May-September) (Table 4, Appendix A). Visual observation confirms that *Chara* is very abundant in Honey Lake. Although a desirable species, *Chara* does not provide the quality habitat that higher vascular aquatic macrophytes can provide. A possible reason for this below average species diversity is the use of aquatic plant management techniques such as aquatic herbicides. During the past decade Honey Lake has used herbicides (Sonar™) to control nuisance plant growth. A potential side effect of these treatments is loss of species diversity. Additionally, Grass carp have also been stocked in the lake. These herbivorous fish can be nonselective and may also contribute to a loss in species diversity. This is sometimes the case in lakes with aquatic plant management programs that utilize both grass carp and herbicides.. *Chara*, since it is an alga, is unaffected by Sonar™ and grows uninhibited and becomes the dominate plant in the lake. Additionally, *Chara* has been the dominant plant species in Honey Lake for at least a decade and these herbicide treatments just gave it more of an edge. Other plants that were commonly present included sago pondweed (46% of sample sites), coontail (50 % of sample sites), and water stargrass (7% of sample sites). Eurasian water milfoil (EWM) was not found at any of the sample sites in 2001. Furthermore, EWM was not seen anywhere in the lake. This is an encouraging change compared to the 1998 LMU study, which found EWM in the lake. Honey Lake should be monitored to ensure that EWM does not become reestablished.

There are several ways to reduce *Chara* densities to allow other plant populations to expand. The first is the use of copper sulfate. However, the amount of copper needed to appreciably reduce *Chara* densities is impractical. Continuous treatment of these areas would be needed in order to prevent the surrounding *Chara* from reinhabiting the site before other plants could become established. Additionally, the increased use of chemicals does not fit the current management strategy of Honey Lake. Another technique would be the use of mechanical harvesting in selected areas. Although, *Chara* reencroachment and regrowth would be a concern thus increasing the frequency/costs of harvesting. The most practical way for expansion of aquatic vegetation in Honey Lake is by reestablishment by native vegetation. Hopefully over time, these plants will continue to naturally expand into *Chara* dominated areas. Even though this method is slow, this the most ecologically sound approach for Honey Lake.

## LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

Shoreline assessment was conducted at Honey Lake on July 18, 2001. Shorelines were assessed for a variety of criteria (*Appendix B* for methodology). Based on this assessment several important generalizations can be made. About half (49%) of Honey Lake's shoreline is developed. A majority of the developed shoreline consisted of buffered areas (49%) (Figure 6). The high occurrence of buffered shoreline combined with the high occurrence of undeveloped shoreline on Honey Lake is encouraging, as they contain plants with deep root systems and are less prone to erosion and provide good wildlife habitat. Also noted during the assessment were other shoreline types such as lawn (16%), seawalls (21%), and rip rap (8%). These types of shoreline are often considered undesirable. Manicured lawn is a poor shoreline/water interface. This is due to the poor root structure of turf grasses, which are unable to stabilize soils and may lead to erosion. Seawalls (and rip rap to an extent) are undesirable because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediments, which can lead to a variety of water quality problems. Additionally, all four of these shoreline types: lawn, beach, rip rap and seawall provide poor wildlife habitat. The portion of the shoreline that was undeveloped was made up of cattail wetlands (49%) and woodlands (2%). The wetlands around Honey Lake help provide excellent wildlife habitat as well as protect against shoreline erosion due to wind and wave action as well as and water fluctuations. The largest change in lake level was from May to June with the lake rising 8.68 inches. The smallest decrease was from August to September when the lake level fell only 0.25 inches. These changes in lake level correlate well with rainfall data.

Shoreline was also analyzed for the presence of erosion. The occurrence of erosion on Honey Lake is *low*. None of the undeveloped shoreline was eroded. This can be attributed to the high percentage of cattails that makes up these areas. Of the developed shoreline, only 6 % was assessed as having *Slight* erosion. This slightly eroded shoreline was made up of only two shoreline types; buffered areas and manicured lawns. The buffer areas that have experienced erosion were found to be poorly maintained and as stated previously, manicured lawns are prone to erosion due to the lack of quality root structure. Individual homeowners could easily address these slightly eroded areas by establishing well-maintained buffer strips consisting of prairie grasses and wildflowers. Additionally, it would be beneficial to extend these buffers into lake by planting native emergent vegetation.

## LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling activities. All observations were visual. Several types of waterfowl were observed during the course of the study including the common tern and osprey, which are State of Illinois endangered species (Table 5). There are healthy populations of mature trees that provide good habitat for a variety of bird species. There are also a few large dead trees that provide excellent habitat for Double Crested Cormorants. Additionally, there are several shrub and woodland areas that provide habitat for smaller bird and mammal species. The majority of Honey's shoreline (51%) is undeveloped, which is encouraging especially for a lake in Lake County and provides excellent habitat. Additionally, 49% of the developed shoreline consisted of buffered areas, which can also provide good wildlife habitat. There are two invasive plant species (purple loosestrife and buckthorn) found along Honey Lake's shoreline that can have negative impacts on the habitat around the

**Table 5. Observed wildlife species on Honey Lake, May – September 2001.**

| | |
|---|---|
| ***Birds*** | |
| Pied Bill Grebe+ | *Podilymbus podiceps* |
| Double Breasted Cormorant | *Phalacrocorax auritus* |
| Canada Goose | *Branta canadensis* |
| Mallard | *Anas platyrhnchos* |
| Wood Duck | *Aix sponsa* |
| Ring-billed Gull | *Larus delawarensis* |
| Common Tern* | *Sterna hirundo* |
| Great Egret | *Casmerodius albus* |
| Great Blue Heron | *Ardea herodias* |
| Green Heron | *Butorides striatus* |
| Cooper's Hawk | *Accipiter copperii* |
| Sharpshinned Hawk | *Accipiter striatus* |
| Red-tailed Hawk | *Buteo jamaicensis* |
| Osprey* | *Pandion haliaetus* |
| Turkey Vulture | *Cathartes aura* |
| Belted King Fisher | *Megaceryle alcyon* |
| Common Flicker | *Colaptes auratus* |
| Barn Swallow | *Hirundo rustica* |
| American Crow | *Corvus brachyrhynchos* |
| Blue Jay | *Cyanocitta cristata* |
| Marsh Wren | *Cistothorus palustris* |
| American Robin | *Turdus migratorius* |
| Red Wing Black Bird | *Agelaius phoeniceus* |
| Northern Cardinal | *Cardinalis cardinalis* |
| ***Amphibians*** | |
| Bull Frog | *Rana catesbeiana* |
| Leopard Frog | *Rana pipiens* |
| ***Reptiles*** | |
| Painted Turtle | *Chrysemys picta* |

*Endangered in Illinois
+Threatened in Illinois

lake and should be controlled/eliminated. At least 48% of the shoreline parcels had some invasive species growth. This means that some portion of roughly 8,680 lineal feet (80% of total shoreline) of Honey Lake's shoreline is infested with one of these two species (Figure 7). These plants are seldom used by wildlife for food or shelter. They should be controlled/eliminated before they spread and displace other native and more desirable plant species (see *Objective I: Eliminate or Control Invasive Species*). Additionally, shoreline habitat should be further improved upon and should include buffer strips and more naturalized shoreline areas in place of manicured lawns.

Honey Lake has an ongoing fish-stocking program. Fish species that are regularly stocked include largemouth bass, northern pike, and hybrid bluegills. Conversations with resident fisherman reveal that there are also channel catfish, black and yellow bullhead, walleye, and carp present in the lake. As per IDNR recommendation in 1987, it would be advisable to start stocking channel catfish to compliment the existing/predator population of the lake. IDNR recommendations regarding take and size limits should also be followed. Another fish that has been stocked in Honey Lake are grass carp (*Ctenopharyngodon idella*), which were stocked approximately 10 years ago. ***They should not be stocked again***. It is **illegal** in the state of Illinois to stock grass carp in a glacial lake such as Honey. Grass carp rarely selectively remove nuisance aquatic vegetation. Instead they either totally denude a lake, which is very unhealthy, or they do not work at all. Additionally, grass carp have preferences in what plants they eat. Unfortunately, the plants they like the least are often the nuisance plants that are being targeted for removal (i.e., Eurasian water milfoil and coontail) and they prefer the more beneficial native plants, which they eat first.

# EXISTING LAKE QUALITY PROBLEMS

Overall, the quality of Honey Lake is of *above average*. This is evident in many aspects of water quality as well as wildlife populations. Listed below are a few *minor* issues that should be addressed. Some of these problems should be addressed immediately before they become bigger problems.

- *Aquatic Plant Diversity*

  A key to a healthy lake is a healthy aquatic plant population. Honey Lake has more than adequate plant densities but *below average* plant diversity. The lack of quality aquatic vegetation can cause a variety of lake quality problems including the eventual decline of fishery health, which other agencies such as the IDNR have pointed out on several occasions. To maintain a healthy lake, 20-40% surface area coverage by aquatic plants is desirable. The IDNR sometimes recommends 10-20% coverage but this is for sport fishery health not overall lake health. Honey Lake actually exceeds both of these ranges. Unfortunately, the plants that make up this population are of low diversity. This ma be partially due to past use of aquatic herbicides (Sonar™), which can lower species diversity. Biltmore has stopped the use of Sonar™ to allow for reestablishment of more beneficial native species. However, as a potential consequence of herbicide use, *Chara* (a macroalga) has become overabundant and is preventing/slowing the spread of other beneficial plants. Additionally, these more beneficial plants, when given the proper chance, may out-compete invasive species such as Eurasian water milfoil and coontail (both of which have been over abundant in the past). This will also help maintain Biltmore's efforts to keep chemical inputs into the lake to a minimum. Additionally, Biltmore only owns half the bottom and does not have the legal right to treat the whole lake without the other bottom owner's permission. Introductions of other desirable aquatic plants such as large leaf pondweed (*Potamogeton amplifolius*) or American pondweed (*Potamogeton nodosus*) would also be advantageous and help increase species diversity, habitat, and overall lake health.

- *Invasive Species Management*

  Two exotic invasive species that are found along Honey Lake's shoreline that are of concern are buckthorn and purple loosestrife. Both of these species provide minimal food or habitat benefit to wildlife. Furthermore, both species are extremely aggressive and will displace desirable, native vegetation, which will lead to further loss of food and habitat. The spread of these two aggressive species must be stopped before they become further established. Both of these noxious weeds can easily be controlled using several different management techniques. The cattail fringe is also of some concern. Yearly or alternate year burnings of the fringe would be beneficial in slowing its encroachment and further filling in of the lake. Additionally, these burnings would help control the spread of invasive species such purple loosestrife. Burning should be conducted as early in the year as possible to avoid any conflicts with migrating and/or nesting birds.

# POTENTIAL OBJECTIVES FOR HONEY LAKE MANAGEMENT PLAN

I. Eliminate or Control Invasive Species
II. Increase Aquatic Plant Diversity by Aquatic Plant Management

# OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

## Objective I: Eliminate or Control Exotic Species

Numerous exotic plant species have been introduced into our local ecosystems including Honey Lake. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

Purple loosestrife is responsible for the “sea of purple” seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants and is quick to become established on disturbed soils. Reed canary grass is an aggressive plant that if left unchecked will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

Presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself. However, problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

### Option 1: No Action

No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

***Pros***
There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 6 in Appendix A lists several native plants that can be planted along shorelines.

***Cons***
Native plant and wildlife diversity will be lost as stands of exotic species expand. Exotic species are not under the same stresses (particularly diseases and predators) as native plants and thus can out-compete the natives for nutrients, space, and light. Few wildlife species use areas where exotic plants dominate. This happens because many wildlife species either have not adapted with the plants and do not view them as a food resource, the plants are not digestible to the animal, or their primary food supply (i.e., insects) are not attracted to the plants. The result is a monoculture of exotic plants with limited biodiversity.

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be effected.

***Costs***
Costs with this option are zero initially, however, when control is eventually needed, costs will be substantially more than if action was taken immediately. Additionally, the eventual loss of ecological diversity is difficult to calculate financially.

## Option 2: Biological Control

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

Recently two beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils (*Hylobius transversovittatus* and *Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on either the leaves or juices of purple loosestrife, eventually weakening or killing the plant. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly retard plant densities. The insects are host specific, meaning that they will attack no other plant but purple loosestrife. Currently, the beetles have proven to be most effective and are available for purchase. There are no designated stocking rate recommendations, since using bio-control insects are seen as an inoculation and it may take 3-5 years for beetle populations to increase to levels that will cause significant damage. Depending on the size of the infested area, it may take 1,000 or more adult beetles per acre to cause significant damage.

***Pros***

Control of exotics by a natural mechanism if preferable to chemical treatments. Insects, being part of the same ecological system as the exotic (i.e., the beetles and weevils and the purple loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. This technique is beneficial to the ecosystem since it preserves, even promotes, biodiversity. As the exotic dies back, native vegetation can reestablish the area.

***Cons***

Few exotics can be controlled using biological means. Currently, there are no bio-control techniques for plants such as buckthorn, reed canary grass, or a host of other exotics. One of the major disadvantages of using bio-control is the costs and labor associated with it.

Use of biological mechanisms to control plants such as purple loosestrife is still under debate. Similar to purple loosestrife, the beetles and weevils that control it are not native to North America. Due to the poor historical record of introducing non-native species, even to control other non-native species, this technique has its critics.

***Costs***

The Ney York Department of Natural Resources at Cornell University (607-255-2821) sells overwintering adult beetles (which will lay eggs the year of release) for $2 per beetle and new generation beetles (which will lay eggs beginning the following year) at $0.25 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (217-333-6846).

**Option 3: Control by Hand**

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Due to the of the size of the infested areas on the individual private properties on the east side of Honey Lake, hand removal is probably the best technique for control in these areas. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

***Pros***

Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.

***Cons***

This option may be labor intensive or prohibitive if the exotic plant is already well established. Costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.

***Costs***

Cost for this option is primarily in tools, labor, and proper plant disposal.

## Option 4: Herbicide Treatment

Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or unpractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option due to the fact that in order to chemically treat the area a broadcast application would be needed. The small wetlands and cattail fringe along the north and west shore might be possible areas for localized broadcast treatment. The risk of damaging sensitive plants is low because of surrounding monoculture of cattails, which should be burned every so often anyway to prevent encroachment. Since many of the herbicides that are used are not selective, meaning they kill all plants they contact; this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using a herbicide soaked device. Trees are normally treated by cutting a ring in the bark (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

***Pros***

Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

***Cons***

Since most herbicides are non-selective, they are not suitable for broadcast application. Thus, chemical treatment of large stands of exotic species may not be practical. Native species are likely to be killed inadvertently and replaced by other non-native species. Off target injury/death may result from the improper use of herbicides. If herbicides are applied in windy conditions, chemicals may drift onto desirable vegetation. Care must also be taken when wicking herbicides as not to drip on to non-targeted vegetation such as native grasses and wildflowers. Another drawback to herbicide use relates to their ecological soundness and the public perception of them. Costs may also be prohibitive if plant stands are large. Depending on the device, cost of the application equipment can be high.

***Costs***

See Table 6, Appendix A for herbicide rates and prices. Total cost to treat the limited amount of purple loosestrife and other invasive species on Honey Lake would be minimal and could be done by individual homeowners or the country club. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. For other species, such as buckthorn, a device such as a Hydrohatchet®, a hatchet that injects herbicide through the bark (about $300) may be needed. Another injecting devise, E-Z Ject® is $450. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. Biltmore probably already owns this type of application equipment, which would reduce initial costs. Private lake property owners could use low cost alternatives to save on money. One such alternative to specialized spray equipment is the use of household spray bottles (commonly used for window and bathroom cleaners). These bottles can be purchased at department stores for minimal cost. However, after their use for herbicide application they should not be used for anything else. Similarly, spray canisters like those used to apply lawn chemicals/deck sealant also provide lower costs alternatives to commercial spray equipment.

**Objective II: Increase Aquatic Plant Diversity by Aquatic Plant Management**

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow up is critical. A good aquatic plant management plan considers both the short and long-term needs of the lake. The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. A quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management options covered below are commonly used techniques that are coming into wider acceptance and have been used in Lake County. There are other plant management options that are not covered below as they not are very effective, unreliable, or are too experimental to be widely used.

**Option 1: No Action**

If the lake is dominated by *native, non-invasive* species, the no action option could be ideal. Under these circumstances native plant populations could flourish and keep nuisance plants from becoming problematic. However, if a no action aquatic plant management plan in a lake with non-native, invasive species, nothing would be done to control the aquatic plant population of the lake regardless of the type and extent of the vegetation. Nuisance vegetation could continue to grow until epidemic proportions are reached. Growth limitations of the plant and the characteristics of the lake itself (light penetration, lake morphology, substrate type, etc.) will dictate the extent of infestation. Rooted plants, such as curly leaf pondweed (*Potamogeton crispus*) and elodea (*Elodea canadensis*), will be bound by physical factors such as substrate type and light availability. Plants such as Eurasian watermilfoil and coontail, which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

***Pros***

There are positive aspects associated with the no action option for plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical alteration, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. If the lake contains native, non-invasive plant species, expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep "weedy" plants under control.

An additional benefit of the no action option is the possible improvement in water quality. Turbidity could decrease and clarity should increase due to sediment stabilization by the plant's roots. Algal blooms could be reduced due to decreased resource availability and sediment stabilization. However, the occurrence of filamentous algae may increase/remain stable due to their surface growth habitat. The lake's fishery could improve due to habitat availability, which in turn would have numerous positive effects on the rest of the lake's ecosystem.

***Cons***

Under the no action option, if nuisance vegetation is dominant in the lake and were uninhibited and able to reach epidemic proportions, there will be many negative impacts on the lake. By their weedy nature, the nuisance plants would out-compete the more desirable native plants. This could eventually, drastically reduce or even eliminate the native plant population of the lake and reduce the lake's biodiversity. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. Predation will decrease due to the difficulty of finding prey in the dense stands of vegetation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive vegetation, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by these dense stands of vegetation. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the dense plant stands.

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could become more and more exasperating due in part to the thick vegetation and also because of the stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/algae problems have been shown to decrease by as much as 15-20%.

***Costs***
No cost will be incurred by implementing the no action management option. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

## Option 2: Mechanical Harvesting
Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. Plants are cut below the water at a level that will restore use of the lake. Typically, problematic areas are harvested and other areas are left alone. However, some management plans call for more widespread harvesting, especially when nuisance plants such as Eurasian watermilfoil become dominant. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

***Pros***
Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms. Some plant species such as curlyleaf pondweed, if harvested at the right time, do not grow back to nuisance proportions after harvesting. Plant clippings are high in nutrients and can be used as fertilizer or compost. Additionally, use of the lake is uninterrupted while harvesting is occurring.

By removing large quantities of plant biomass the overall quality of the lake may improve in many ways. The decrease in vegetative biomass will reduce the dissolved oxygen (D.O.) demand on the lake. This will cause increased dissolved oxygen levels. Some nuisance vegetation such as coontail have extremely high oxygen demands. Dense stands of these plants can quickly deplete a lake of D.O. during certain periods of the day. This can cause fish stress. Additionally, a decrease in plant density will improve the lake’s fishery by creating better opportunities for predation, which is essential in creating a balanced fish population. By removing nuisance vegetation, recreational uses of the lake will improve. The quality of activities such as boating, swimming, and fishing would greatly improve. By removing dense stands of vegetation the possibility of entanglement will decrease thereby increasing opportunities for boating and swimming. Paths cut by the harvester will open fishing areas especially if networks of fish “cruising lanes” are created.

***Cons***

Once widespread, mechanical harvesting is becoming a less attractive management technique for a variety of reasons. Many applicators that regularly employed mechanical harvesting no longer use or even offer this service due to low public demand. In addition, high initial investment, extensive maintenance, and high operational costs have also led to decreased use. Since many applicators no longer offer harvesting services, a lake association would have to purchase and maintain their own harvester. Many associations do not even have the financial resources to cover the maintenance and operational cost involved with owning a harvester. Harvester costs can range from $50,000-$150,000. Beside the financial limitations there are also physical limitations. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of the harvester) and can not maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process.

After the initial removal, there is a possibility for vegetation regrowth. Upon regrowth, weedy plants such as Eurasian watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation may lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fishery will have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl.

If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will also contribute to overall nutrient load of the lake, which can lead to increased frequency of algal blooms. Furthermore, the removal of aquatic vegetation, which competes with algae for resources with algae, can directly contribute to an increase in algal blooms. Removal of plants may lead to increased turbidity and decreased clarity. The fishery of the lake may decline and/or become stunted due changes in predation related to decreased water clarity. Other organisms, such as waterfowl, which commonly forage on native aquatic plants, would also be negatively impacted by the removal of these plants.

Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process. In the areas where harvesting is being conducted, one plant can not be removed and another left. All the plants are removed from that area. After the initial removal, regrowth of desirable plants does not typically occur in these harvested areas. Due to their weedy nature, plants such as Eurasian water milfoil, are able to grow more quickly than native plants and become more established in harvested areas. This will create a monoculture of nuisance vegetation. This causes an overall decrease in plant biodiversity, which can have detrimental effects to the entire ecosystem. Depending on the plant species, frequent harvesting might be required (typically 2-4 times per season). Along with this increased harvesting frequency come increased operational costs (labor, gas, maintenance, etc.). Nuisance plants such as coontail and Eurasian watermilfoil can spread by vegetative fragments that may escape collection during the harvesting process and spread to uninfested parts of the lake. In addition to the release of plant fragments, as the plants are cut, there is a possibility of plant associated nutrients being released into the lake. This could cause an increase is algal blooms whenever harvesting in conducted. Short-term turbidity may also be created by the harvester paddle wheels stirring up sediment in harvested area.

***Cost***

Depending on the type of the harvester (cutting width, payload capacity, hull material, HP of the motor, trailer options, etc) prices range from $50,000 to $150,000. Operational and maintenance cost typically range from $161.00-$445.00/acre.

**Option 3: Hand Removal**

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. These are easily obtainable through many outdoor supply catalogs or over the internet. Some rakes are equipped with tines as well as cutting edges. Tools can also be hand made by drilling a hole in the handle of a heavy-duty garden rake and tying it to a length of rope. Weights may be needed in order to provide forceful contact with the plants. In many instances, homeowners on lakes with near shore vegetation problems simply cut swaths through the weeds to create pathways to open water. Due to the limited amount of biomass removed, harvested plant material is often used as fertilizer and compost in gardens.

***Pros***

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

***Cons***

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. However, individual homeowners would be removing limited quantities of plant material so there would not be much to dispose of. Another drawback is possible nonselective removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plants are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable vegetation and/or disrupt valuable habitat (fish spawning beds). Over removal could also be a problem but is not normally a concern with hand removal.

***Costs***

Plant removal rakes can range in price from $50-150 and cutting tools commonly range in price from $50-200. Both are available from numerous catalogs and from the internet.. A homemade rake would cost about $20-40.

## Option 4: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 7, Appendix A lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

***Pros***

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth can be less expensive in the long run than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

***Cons***

There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant is used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

***Costs***

See Table 7, Appendix A for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.