2002 SUMMARY REPORT
of
HIDDEN LAKE

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT
3010 Grand Avenue
Waukegan, Illinois 60085

Joseph Marencik
Michael Adam
Christina Brant
Mary Colwell
Mark Pfister

January 2003

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Hidden Lake is a 19.1-acre, manmade lake located within the Saddlebrook Farms development. The lake is northeast of the intersection of Route 60 and Peterson Road in Fremont Township in the Village of Round Lake Park. Access to Hidden Lake is private with bottom ownership belonging to Saddlebrook Farms. However, Saddlebrook Farms does not take an active role in managing the lake except for the occasional fish stocking by the Saddlebrook Farms fishing club. The main uses of the lake are fishing and boating (canoe, rowboat, paddleboat).

Overall, Hidden Lake has very poor water quality when compared to other Lake County lakes. Dissolved oxygen concentrations are low with concentrations below5.0 mg/L for much of the summer (June, July, August). Secchi disk transparency readings, a measurement of water clarity, was also poor. Average Secchi depth for Hidden Lake in 2002 was 0.60 feet and July's Secchi reading of 0.380 feet was the single worst reading taken by our unit in the last 5 years. The two main factors contributing to the poor clarity are high nutrient concentrations (algae blooms) and suspended sediment. In 2002, the average total phosphorus concentration in Hidden Lake was 0.224 mg/L, which is four times higher than the Lake County median value of 0.056 mg/L. These high phosphorus concentrations, which cause summer long algae blooms, are directly related to internal phosphorus loading from sources such as sediment resuspension and living/decaying algae. The average total suspended solids concentration in Hidden Lake was 74.0 mg/L. TSS was as high as 106.0 mg/L, which is almost eighteen times the Lake County median concentration of 6.0 mg/L. These high concentrations of suspended sediment are greatly reducing clarity and contributing to the internal loading of nutrients in Hidden Lake.

Aquatic plant assessments revealed that were no plants in Hidden Lake for the entire study. Since a healthy aquatic plant population is critical to good lake health. The absence of aquatic plants has negatively impacted many aspects of lake quality. Aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources. Additionally, aquatic vegetation is an important source of habitat and food for wildlife such as fish and waterfowl.

Our shoreline assessment revealed that a majority of Hidden Lake's shoreline is developed (96%). The majority of this developed shoreline is made up of manicured lawn (43%) buffered areas (30%) and rip rap (24%). This high percentage of lawn and rip rap is discouraging as these are considered undesirable shoreline types for several reasons including poor root structure (lawn) and poor habitat (lawn and rip rap). Assessments also found that erosion on Hidden Lake is problematic, with 53% of the shoreline with some erosion. A majority of the eroded shoreline was assessed as *Slightly* eroded (29%) with some assessed as *Moderate* (15%) and *Severe* (9%). The most affected shoreline type regardless of development was lawn, which accounted for 36% of total erosion. This can be attributed to poor soil stabilization provided by turf grass. However, due to lack of maintenance, the buffer areas (a desirable shoreline type) on the lake were also found to be eroding.

LAKE IDENTIFICATION AND LOCATION

Hidden Lake is located in the Saddlebrook Farms residential community near the intersection of Route 60 and Peterson Road in Fremont Township within the Village of Round Lake Park (T44N, R10E, Section 4). Hidden Lake is a 19.1-acre manmade lake with a current maximum depth of 6 feet, and estimated average depth of 3 feet and volume of 57.3 acre-feet (Lake County Health Department – Lakes Management Unit [LMU] data). Hidden Lake is part of the Squaw Lake drainage basin of the Fox River Watershed. The current outlet structure is in disrepair and has been blocked by Saddlebrook Farms until it can be repaired. However, this control structure is above current lake level by over a foot and a half. If this control structure was functional, and water levels were high enough, Hidden Lake would drain into Squaw Creek, eventually into Long Lake, and then into the Fox River. There are two large pipes that enter the lake (Figure 1). These pipes carry stormwater drainage from the surrounding community. It appears that improper sediment control measures were in place when developing the surrounding property, as there are large deltas of sediment in front of each pipe. Previous to the Saddlebrook Farms development, land usage was agricultural.

CURRENT AND HISTORICAL USES OF HIDDEN LAKE

There is little current or historical information that exists for Hidden Lake. Past Illinois Department of Conservation (IDOC) reports list the lake as Lakefield Farm Lake. These same IDOC reports state that the lake was 12 feet deep. A bathymetric map made by residents of Saddlebrook Farms has the maximum depth of the lake at 9 feet. However, LMU staff found the deepest point in the lake to be 6 feet. These differences in depth may be related to many factors including recent development, condition of the spillway, and past human error. Past IDOC fishery surveys report that the lake was overrun by carp and bullhead and was stocked with largemouth bass sometime prior to 1972. In 2002, LMU staff found the lake to be overrun by carp, which was confirmed by local fisherman. Small size and shallow depth limit the use of Hidden Lake to recreational boating (paddle boat, row boat, and canoes), fishing, and aesthetic enjoyment. Although Saddlebrook Farms management was never reached for comment on the lake, locals report that the only management of the lake in recent years has been the removal of garbage from the lake.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Hidden Lake were analyzed for a variety of water quality parameters. Since Hidden Lake is so shallow, samples were collected from a depth of 3 feet in May and June and at the surface from July through September at the deep hole location in the lake (Figure 1). Hidden Lake does not thermally stratify, which means the lake does not divide into a warm upper water layer (epilimnion) and cool lower water layer (hypolimnion) but instead stays well mixed. This is due to the shallow lake

1

morphology and lack of aquatic plant growth. This mixing of water is reflected in the dissolved oxygen (DO) levels as well as other water quality data such as water temperature and nutrient concentrations. The complete data set for Hidden Lake can be found in Table 1, Appendix A and the Multiparameter data in Appendix C.

Dissolved oxygen concentrations in Hidden Lake are *poor*. In order to support aquatic life, DO concentrations should remain above 5.0 mg/L. If DO concentrations drop below this level for a prolonged period of time negative impacts to lake health, such as fish kills, can occur. In 2002, the average DO concentration in Hidden Lake was 7.21 mg/L. However, DO concentrations during much of the study (June, July, and August) were below 5.0 mg/L. DO concentrations in May and September were much higher (12.2 and 10.2, respectively) than the other months, which causes the average to be misleading. One of the main contributors to Hidden Lake's DO problems are the widespread planktonic algae blooms during the summer months, which were especially problematic during the mid summer months of June, July, and August. Although algae produce oxygen during biological processes (photosynthesis), they also consume oxygen (during respiration). This along with other factors, such as decomposition of dying algae (an oxygen consuming process), is creating a high biological oxygen demand (BOD) that is lowering the DO concentrations in the water column.

Secchi disk transparency is a direct indicator of water clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. Based on Secchi depth, Hidden Lake has very poor water quality. The 2002 average Secchi disk depth on Hidden Lake is 0.56 feet, which is substantially lower than the Lake County median Secchi disk depth of 3.81 feet. Monthly readings varied from 0.82 feet (May) to 0.36 feet (July), which was the shallowest (worst) reading taken by the LMU from 1998-2002. Additionally, three of the ten worst monthly readings from 1998-2002 have been taken at Hidden Lake in 2002. The extremely poor water clarity of Hidden Lake is caused by high concentrations of suspended organic and inorganic particles in the water column.

Total suspended solids (TSS) are a measurement of suspended solids such as algae and other organic matter as well as inorganic particles (silt and clay). In 2002, the average TSS for Hidden Lake was 74.0 mg/L, which is *twelve* times higher than the County median value of 6.0 mg/L. TSS increased from 52.0 mg/L in May to as high as 106.0 mg/L in July, which is almost *eighteen* times higher than the County median value and the second worst TSS concentration recorded by the LMU from 1998-2002 (506 samples). These high concentrations of suspended solids had a direct impact on water clarity (Secchi depth) (Figure 2). Calculated nonvolatile suspended solids (NVSS), which are the portion of the TSS that can be attributed to inorganic (soil particles) was 54.3 mg/L. This means that 73% of TSS (turbidity) was caused by suspended inorganic particles such as silt and clay. The other 27% can be attributed to organic particles such as algae. Monthly variations in NVSS correspond to changes in TSS, which further reinforces that a majority of Hidden Lake's clarity problems are from suspended soil particles (Figure 2).

2

These high concentrations of suspended soil particles can be directly attributed to carp, which appear to be overly abundant in Hidden Lake. Due to their feeding and spawning habits, carp disrupt sediment. Additionally, carp can disrupt aquatic plant growth, which stabilize sediment and compete with algae for available resources thus improving water clarity/quality. Furthermore, total volatile solids (TVS) concentrations, which are a measurement of suspended organic matter (such as algae), did not correlate with changes in TSS.

The other major contributors to poor water clarity/quality on Hidden Lake are nuisance algae blooms. 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 two nutrients (N&P) are usually the limiting factors in algal growth. 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. Most lakes in the County are phosphorus limited. In these phosphorus-limited lakes even a small addition of P can trigger algae blooms. In 2002, Hidden Lake had an average TN: TP ratio of 13:1, which means that Hidden Lake has sufficient amounts of both nutrients to support algae growth. This is evident in the season long planktonic algae blooms observed on Hidden Lake during the 2002 study. However, as with other parameters, there were fluctuations in nutrient concentrations. There were large fluctuations in nitrogen concentrations while phosphorous concentrations remained fairly stable, which caused shifts in the nutrient limitations of the lake. During most of the study (May, July, and September) Hidden Lake was nitrogen limited with a N:P of about 10:1. However, June's ratio was significantly higher at 35:1 (phosphorus limited). This shift is due to a substantial increase in the nitrogen concentrations during June, while phosphorus concentrations remained stable. This can be attributed to lake-wide, blue-green algae blooms, which is a type of algae that can fix atmospheric nitrogen into a usable form. With adequate concentrations of nitrogen, and more than enough phosphorus, the conditions were right for a large algae bloom. While algae blooms were present all season long, field observations confirm that Hidden Lake did experience a more intense bloom in June. The blooms can be triggered by a variety of factors including changes in temperature and rainfall. As these blooms subsided, the nitrogen concentrations dropped (less nitrogen was fixed by the blue-green algae) and the N:P ratio shifted back to nitrogen limited (10:1).

The phosphorus concentrations in Hidden Lake are *high*. The average TP concentration in 2002 was 0.223 mg/L, which is over four times the median TP concentration for Lake County lakes (0.056 mg/L). High TP concentrations are causing nuisance algae blooms but the majority of TP is probably adsorbed to the suspended soil particles, which are also contributing to the poor water clarity (Figure 3). Additionally, there were also above average concentrations of soluble reactive phosphorus (SRP), which is a form of phosphorus that is easily utilized by algae. SRP is normally not present in the surface waters of a lake in detectable concentrations because the algae utilize it. However, since Hidden Lake is nitrogen limited for most of the summer, which limits the growth of

3

algae, SRP builds up once released into the water column. Another input of phosphorus maybe from sources outside of the lake (external). These external inputs consist of a variety of sources including fertilizer runoff, geese feces, and erosion. However, water elevation measurements indicate that very little water flows into Hidden Lake over the course of the summer with the lake experiencing an overall decrease of 2.6 inches in elevation. Peak TP concentrations were in July and August, which does not correlate with monthly rainfall data from the same time period (Figure 4). This indicates that a majority of Hidden Lake's TP may be from internal sources.

Nitrate (NO_3-N) and ammonia-nitrogen (NH_3-N) concentrations were below detectable concentrations for much of the study with June and July the only months with detectable NO_3-N concentrations and June and August the only months with NH_3-N. However, even though the NO_3-N concentrations were below detectable limits for most of the study, the average June and July concentration (1.14 mg/L) was double the County median concentrations (0.084 mg/L). This can be attributed to nutrient release from dying algae in addition to the nitrogen being fixed by the blue-green blooms. This is supported by total Kjeldahl nitrogen concentrations (TKN), an organically associated form of nitrogen, which were significantly higher in June and July than other months of the study. Additionally, average TKN concentrations were 2.99 mg/L, which was over double that of the County median concentration of 1.17 mg/L.

Another way to look at nutrient concentrations and how they affect the productivity of a lake is the use of a Trophic State Index (TSI) based on average phosphorus concentrations. The TSI can be based on phosphorus concentration, chlorophyll *a*, and Secchi depth to classify and compare lake productivity levels (trophic state). The phosphorus TSI is setup so that the higher the phosphorus concentration, the greater amount of algal biomass and as a result, a higher trophic state. Based on a TSI phosphorus value of 82.2, Hidden Lake is classified as *hypereutropic* ($\geq$70 TSI). This means that the lake is a highly productive system that has excessive nutrient levels and high algal biomass (growth). Field observations and water quality data reinforce that Hidden Lake is *hypereutrophic* and does have high nutrient levels as well as high algal biomass. For comparison, most lakes in the County are eutrophic (TSI values $\geq$50 <70). Out of all of the lakes in Lake Country studied by the LMU since 1998, Hidden Lake ranks 98 out of 103 lakes based on phosphorus TSI (Table 2, Appendix A). Additionally, the Secchi TSI, which is normally lower (better) than phosphorus based TSI, was 85.6 (*hypereutrophic)* due to the extremely poor Secchi readings on Hidden Lake.

TSI values along with other water quality parameters can be used to compare to water quality standards as well as to compute use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). These indexes rate a given lake based on several water quality parameters. Based on above average phosphorus concentrations, Hidden Lake was listed as having a *Moderate* violation of Illinois water quality standards. Additionally, there were violations for high nitrogen and nitrate concentrations as well as high pH and TSS. Based on IEPA Swimming Use Index, Hidden Lake is categorized as *Nonsupport*. This is due to poor Secchi disk readings and

4

high phosphorus concentrations, which lead to high algal biomass (increased turbidity) and decreased visibility. Hidden Lake's average Secchi disk was only 6.6 inches, which is well below the IDPH's recommendation of 48 inches. Based on the Recreational Use Index, Hidden Lake was also categorized as *Nonsupport*. This is due to a high TSI value and high levels of suspended solids, which result in poor visibility and contribute to an overall reduction in use of the lake. Hidden Lake provides *Partial* support based on the Aquatic Life Use index despite the fact that Hidden lake has no aquatic plant community. Finally, based on the average of all of the use impairment indices, Hidden Lake is listed as providing *Nonsupport* for Overall Use.

LIMNOLOGICAL DATA - AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). However, no surveys were made of these shoreline species and all data is purely observational (see *Wildlife Assessment* for a list of species). 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 measurements, aquatic plants on Hidden Lake could have grown to a depth of 2-3 feet. A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources. Aquatic plant growth on Hidden Lake is *nonexistent.* This was despite the fact that there was adequate light penetration along most of the shoreline areas around the lake. As a result, Hidden Lake is experiencing a variety of water quality problems including poor clarity, increased turbidity, nuisance algae blooms, and poor fishery health. Substrate type and carp activity may be possible explanations for the lack of aquatic plant growth. Our visual observations noted that the substrate may be too rocky in some areas to support aquatic plant growth. However, even the parts of the lake with a more suitable substrate did not have any plant growth. Due to their disruptive feeding habits, carp uproot aquatic vegetation preventing establishment.

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. These numbers are then averaged 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. A low FQI indicates that there are a low number of species and possibly lower quality species present in the lake. In 2002, Hidden Lake had a FQI of zero since there were no aquatic plants found in the lake. The average FQI of lakes studied by the LMU in 2000-2002 was 14.2. Additionally, out of the 86 lakes analyzed by the LMU between 2000 - 2002 only 3 have an FQI of zero.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

Shoreline assessment was conducted at Hidden Lake on July 10, 2002. The shoreline was assessed for a variety of criteria (*Appendix B* for methodology). A large majority (96%) of Hidden Lake's shoreline is developed. A majority of the developed shoreline consisted of lawn (43%), buffered areas (30%), and rip rap (24%) (Figure 5). Buffered shoreline is normally desirable, as they contain plants with deep root systems that are less prone to erosion and provide good wildlife habitat. However, the buffered areas on Hidden Lake are made up of undesirable species such as reed canary grass. We also noted a low occurrence of seawalls. 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 exacerbate water quality problems. However, manicured lawn, which accounted for a large majority (43%) of the shoreline, is also a poor shoreline/water interface. This is due to the poor root structure of turf grasses, which are unable to adequately stabilize soil, which may lead to erosion. Additionally, manicured lawn provides poor wildlife habitat.

Shoreline was also analyzed for the presence of erosion. The occurrence of erosion on Hidden Lake is *high*. Overall, 53% (2,659 feet) of the shoreline on Hidden Lake had erosion (Figure 6). A majority of the eroded shoreline was assessed as *Slightly* eroded (29%) with some assessed as *Moderately* (15%) and *Severely* (9%) eroded. The most affected shoreline type regardless of development was lawn, which accounted for 36% of total erosion. This can be attributed to the poor soil stabilization characteristics of turf grass. Furthermore, manicured lawn made up the majority of shoreline that was assessed as having *Moderate* or *Severe* erosion. The buffer areas that have experienced erosion were found to be poorly maintained and as stated previously, are prone to erosion due to the lack of quality root structure. Saddlebrook Farms could easily address these *Slightly* eroded areas by establishing well-maintained buffer strips consisting of deep rooted, native prairie grasses and wildflowers. Additionally, it would be beneficial to extend these buffers into lake by planting native emergent vegetation such as arrowhead and pickerel weed. Improving the *Moderate* and *Severely* eroded areas would involve more labor-intensive measures such as regrading, bioengineering techniques, and possibly properly installed rip rap.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling actives (Table 3). Additionally, shoreline plants were also noted. All observations were visual. Wildlife habitat on Hidden Lake is poor, even for a manmade residential lake. There are a few mature trees that provide habitat for a variety of bird species. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species. However, there are many areas for habitat improvement on Hidden Lake. The invasive species reed canary grass was observed along 98% of the shores of Hidden Lake. The only places that reed canary grass was not found was where it had been mowed. This nuisance species should be controlled or eliminated in order to improve habitat (as well as overall shoreline condition). These plants are seldom used by wildlife for food or shelter. Removing such established stands of reed canary grass will be labor intensive but is crucial in improving the overall quality of Hidden Lake. Additionally, shoreline habitat should be improved after removal and should include the use of naturalized shorelines (i.e., buffer strips) and should include emergent species such as arrowhead and pickerel weed.

Table 3. Wildlife and plant species observed on Hidden Lake, May-Sept. 2002.

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Great Blue Heron	*Ardea herodias*
Killdeer	*Charadrius vociferus*
Red-tailed Hawk	*Buteo jamaicensis*
Barn Swallow	*Hirundo rustica*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Tree Swallow	*Iridoprocne bicolor*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*

Table 3. Wildlife and plant species observed on Hidden Lake, May-Sept. 2002.

Birds (cont'd)	
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*
Mammals	
Eastern Chipmunk	*Tamias striatus*
Amphibians	
Western Chorus Frog	*Pseudacris triseriata*
American Toad	*Bufo americanus*
Green Frog	*Rana clamitans melanota*
Reptiles	
Painted Turtle	*Chrysemys picta*
Snapping Turtle	*Chelydra serpentina*
Shoreline Plants	
Weeping Willow	*Salix alba tristis*
Reed Canary Grass	*Phalaris arundinacea*
Cottonwood	*Populus deltoides*
Barnyard Grass	*Echinochloa crusgalli*
Henbit	*Lamium amplexicaule*
Ground Ivy	*Glechmona hederacea*
Giant Foxtail	*Seteria faberi*
Blue Vervain	*Verbena hastata*
Chicory	*Cichorium intybus*
Common Buckthorn	*Rhamnus cathartica*

EXISTING LAKE QUALITY PROBLEMS

The overall quality of Hidden Lake is very poor due to a variety of problems such as high nutrient and suspended sediment concentrations, low DO, and no aquatic plant community. These are common problems throughout Lake County especially in shallow manmade lakes. However, due to lack of management, these problems have been ignored at Hidden Lake, resulting in some of the poorest water quality in the County. The solution for these problems is multifaceted and will involve time and money. Listed below are some of the major problems on Hidden Lake.

- *Shoreline Erosion*

  The overall occurrence of erosion on Hidden Lake was *high*. As stated previously, Hidden Lake has erosion on 53% of its shoreline. The main cause of this erosion is lack of suitable shoreline vegetation. The most eroded shoreline type was found to be manicured lawn, which is also the dominant shoreline type. Lawn is considered undesirable as it contains shallow rooted vegetation (turf grass), which is unable to adequately stabilize the soil. This lack of stabilization has lead to erosion, which is contributing to water quality problems such as sedimentation, nutrient enrichment and nuisance algae blooms. If left unattended, the erosion will continue to worsen, further aggravating related water quality issues. For this reason, shoreline erosion on Hidden Lake should be addressed immediately. Depending on the severity of erosion, these techniques on Hidden Lake include the use of regrading, rip rap, biologs, and buffer strips. Saddlebrook Farms should promote and implement the use of naturalized shoreline types such as buffer strips of native vegetation when improving degraded areas. Furthermore, these buffers should extend into the lake by utilizing emergent, native vegetation, which will help to dissipate wave action. This will benefit not only the water quality of Hidden Lake, but also improve wildlife habitat.

- *Low Dissolved Oxygen*

  Hidden Lake has low DO concentrations for much of the summer. DO concentrations were below 5.0 mg/L in June and July, which is the minimum concentration needed to support a healthy aquatic ecosystem. Furthermore, these DO measurements were taken during the day when concentration are at their highest. DO concentrations may be dangerously low during the evening/early morning hours, when oxygen concentrations are at there lowest. Historically, Hidden Lake has experienced periodic fish kills due to low DO conditions. Three main factors, respiring algae, decaying organic matter, and the shallow nature of the lake, are the major factors affecting DO conditions. A possible solution to the low D.O conditions would be to reduce the amount of algae in the lake. This could be accomplished by lowering the phosphorus concentration in the lake utilizing aluminum sulfate (alum), which binds the phosphorus out of the water column making is unavailable to algae. This should also be accompanied by a fishery rehabilitation program to eliminate the carp population, which is another major source of phosphorus (nutrient resuspension).

- *Lack of a Aquatic Plant Community*

  One key to a healthy lake is a healthy aquatic plant population. Hidden Lake has no aquatic plant population (submergent or emergent). The negative impacts associated with the absence of a aquatic plant community are wide spread and include those on water quality and fishery health. The lack of aquatic plants is more than likely the result of carp activity and substrate type since there is adequate light available in the shallow areas of the lake for plant growth. Establishment of a healthy aquatic plant community is essential in improving the overall quality of Hidden Lake. Establishing aquatic vegetation will stabilize sediment and help to reduce algae blooms, which will improve clarity. Additionally, these vegetated areas will provide valuable fish and wildlife habitat. This is a long-term process and involves other management practices as well such as the elimination of carp, which are possibly the biggest limiting factor in plant growth for Hidden Lake.

- *Wildlife Habitat*

  Overall, wildlife habitat on Hidden Lake is *fair* at best. The main problem is the lack of quality shoreline vegetation. Almost all (96%) of Hidden Lake's shoreline is developed and offers no/little habitat. This is a common problem on residential lakes with highly developed shorelines (rip rap, lawns, etc.). Often, the only shoreline habitat consisted of invasive species, which offer little/poor quality habitat. The wildlife habitat of Hidden Lake can be greatly improved by the use of other management techniques, such as the use of buffer strips for erosion control, and removal of invasive species (i.e., reed canary grass). Past IDNR (IDOC) surveys have found that the fishery of Hidden Lake is in poor health due to the lack of habitat (aquatic vegetation) and overabundance of carp. The rehabilitation of the lake's fishery can be an intensive process involving removal of the carp and establishment of habitat but is necessary to see any improvements in the overall quality of Hidden Lake. This process should begin with a fishery assessment to determine species composition and condition, which can then be used to formulate a management plant (stocking rates and/or rotenone treatments).

- Invasive Species Management

  One of the most common plants (besides turf grass) found along the shores of Hidden Lake was the exotic and highly invasive reed canary grass. This nuisance grass species is extremely aggressive and has displaced native vegetation, which has lead to loss of food and habitat. Additionally, due to the poor root systems, this invasive plant has led to increased erosion in several areas around the lake. There are several different management techniques that can be used in removal but considering the extent of infestation at Hidden lake, the best method of control may be the use of herbicides. Additionally, these areas should be replanted with deep-rooted native vegetation with continued monitoring to ensure it does not return.

- *Lake Data*

  The lack of quality lake data is a common problem for many of the lakes in Lake County. This is either due to poor record keeping or lack of involvement on the part of the management entity/residents. Saddlebrook Farms has not been actually managing the lake and accurate historical records may not be available. Additionally, data such as Secchi depth, water fluctuations, and DO profiles are not collected/monitored. Collection of this type of lake data can be very important in making decisions on the management of the lake. This data can be used to track changes (or lack of) in lake quality over many years. Additionally, this data is very important to agencies, such as the LMU, when conducting studies of the lake and allows for a more complete analysis. It is the recommendation of the LMU that Saddlebrook Farms becomes involved in the IEPA's Volunteer Lake Monitoring Program (VLMP). This program uses volunteers to collect bimonthly lake data for the IEPA. This program is worth the time and effort and provides valuable information about the lake.

- *Bathymetric Map*

  The current bathymetric (contour) map of Hidden Lake is inaccurate. If any management of Hidden Lake, such as rotenone treatments (a fish toxicant), were conducted it is critical to have an accurate bathymetric map and accompanying morphometric (volume) data. Additionally, these maps can be of great use to fishermen as well as lake managers. Bathymetric data can also show where possible problematic areas may be located (i.e., shallow areas). These maps can be easily made using different methods. All lakes in the County should have a current, good quality bathymetric map and Hidden Lake is no exception.

POTENTIAL OBJECTIVES FOR HIDDEN LAKE MANAGEMENT PLAN

I. Shoreline Improvement and Erosion Control
II. Wildlife Habitat Improvement
III. Eliminate/Control Invasive Species
IV. Fishery Rehabilitation
V. Nutrient Inactivation
VI. Volunteer Lake Monitoring Program
VII. Create a Bathymetric Map with Morphometric Table

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Shoreline Improvement and Erosion Control

Erosion to shorelines on Hidden Lake is a problem. Shoreline erosion occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses. During the 2002 survey of Hidden Lake the majority of shoreline was found to be eroded. Approximately 53% (2,659 feet) of Hidden Lake's shoreline had some form of erosion. These areas should be addressed as soon as possible in order to avoid further deterioration.

Option 1: No Action

Pros
There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future. Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g. kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

Cons
Taking no action will most likely cause erosion to continue and subsequently may cause poor water quality due to high levels of sediment or nutrients entering a lake. This in turn may retard plant growth and provide additional nutrients for algal growth. A continual loss of shoreline is both aesthetically unpleasing and may potentially reduce property values. Since a shoreline is easier to protect than it is to rehabilitate, it is in the interest of the property owner to address the erosion issue immediately.

Costs
In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Install Rock Rip Rap

Rip rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. *The use of rip rap should be viewed as a last resort* after other alternatives such as biologs have been tried or are inappropriate. Rip rap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip rap fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. *It is imperative that filter fabric be used under the rip rap to provide quality, long lasting results.* Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below). Rip rap is best used for areas of **moderate and severe erosion** and gentle to moderately sloped shores (<2:1). If rip rap is to be used on shorelines steeper than 2:1, then grading must be done in order to reduce grade to $\leq$ 2:1, preferably 3:1. *Every effort should be made to use more natural, less intrusive methods of shoreline stabilization (buffer strips and biologs).* However, the site must be prepared (grading, etc.) accordingly.

Pros

Rip rap can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip rap will last for many years. Maintenance is relatively low; however, undercutting of the bank can cause sloughing of the rip rap and subsequent shoreline. Areas with slight to moderate erosion problems may benefit from using rip rap. In all cases, a filter fabric should be installed under the rocks to maximize its effectiveness.

Fish and wildlife habitat can be provided if large boulders are used. Crevices and spaces between the rocks can be used by a variety of animals and their prey. Small mammals, like shrews can inhabit these spaces and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure created by large boulders for foraging and hiding from predators.

Cons

A major disadvantage of rip rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip rap and must be acquired prior to work beginning. If any fill material is placed in the floodplain along the shoreline; compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. While rip rap absorb wave energy more effectively than seawalls, there is still some wave deflection that may cause resuspension of sediment and nutrients into the water column.

Small rock rip rap is poor habitat for many fish and wildlife species, since it provides limited structure for fish and cover for wildlife. As noted earlier, some small fish and other animals will inhabit the rocks if boulders are used. Smaller rip rap is more likely to wash way due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

Rip rap may be a concern in areas of high public usage since it is difficult and possibly dangerous to walk on due to the jagged and uneven rock edges. This may be a liability concern to property owners.

Costs

Cost and type of rip rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. Based on assessed *moderately* and *severely* eroded shoreline, Hidden Lake would need approximately 1193 linear feet of rip rap. This would come to a cost of approximately $35,790 – $53,685. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,000-2,000 for installation of rip rap, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

Option 3: Buffer Strips

Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

Stabilizing the shoreline with vegetation is most effective on shorelines with **slight erosion** and slopes no less than 2:1 to 3:1, horizontal to vertical or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with more severe erosion problems. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as Biologs or rip rap. Furthermore, it is the recommendation of the LMU that buffer strips be established along all applicable shorelines of Hidden Lake regardless of shoreline type (including beach and seawalls).

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. Table 4 gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., muskrats) by placing a wire cage over the plants for at least one year.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is more highly eroded, willow posts may have to be used in conjunction with another erosion control technique such as biologs or rip rap. The use of buffer strips in conjunction with other methods such as rip rap and seawalls is highly recommended.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in Table 4 should be considered for native plantings.

Pros

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Occasional high mowing (1-2 times per year) for specific plants or physically removing other weedy species may be needed.

The buffer strip will stabilize the soil with its deep root structure and help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae and "weedy" aquatic plants. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff.

Another benefit of a buffer strip is potential flood control protection. Buffer strips may slow the velocity of flood waters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. Many plants can survive after being under water for several days, even weeks, while turfgrass is intolerant of wet conditions and usually dies after several days under water. This contributes to increased maintenance costs, since the turfgrass has to be either replanted or replaced with sod. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil. Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people but also benefits wildlife and the overall health of the lake's ecosystem.

Cons

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Costs
If minimal amount of site preparation is needed, costs can be approximately $10 per linear foot, plus labor. Cost of installing willow posts is approximately $15-20 per linear foot. Based on assessment *slightly* eroded shoreline, Hidden Lake would need approximately 1467 linear feet of buffer strip. This would come to a cost of $14,670. It is advisable that buffer strips be planted on all appropriate shoreline areas on Hidden Lake. However, some of this shoreline would be better suited for use of biologs incorporated with buffer vegetation (see *Option 4* below), which includes the use of buffer strips. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Option 4: Install Biolog, Fiber Roll, or Straw Blanket with Plantings
These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. These products are best used in areas on more **moderately** eroded shorelines or areas with highly erodable soil types. Many times biologs are used in conjunction with vegetated buffer strips as an alternative to rip rap.

Pros
Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

Cons
These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or 3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

Costs

Costs range from $25 to $35 per linear foot of shoreline, including plantings. Based on *moderately* and *severely* eroded shorelines, Hidden Lake would need 761 linear feet of one of the above products on the moderate eroded areas of shoreline. This would cost approximately $19,025 – 26,635. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

Objective II: Wildlife Habitat Improvement

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Due to its residential, developed nature the preservation/development of wildlife habitat on hidden lake has been neglected. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a variety of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

It is important to understand that the natural world is constantly changing. Habitats change or naturally succeed to other types of habitats. For example, grasses may be succeeded by shrub or shade intolerant tree species (e.g., willows, locust, and cottonwood). The point at which one habitat changes to another is rarely clear, since these changes usually occur over long periods of time, except in the case of dramatic events such as fire or flood.

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999). More information about non-native (exotic) plants can be found in the section *Objective III: Eliminate or control invasive species***.**

<u>Option 1: No Action</u>

This option means that the current land use activities will continue. No additional techniques will be implemented on Hidden Lake. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

Pros

Taking no action may maintain the current habitat conditions and wildlife species present, depending on environmental conditions and pending land use actions. If all things remain constant there will be little to no effect on lake water quality and other lake uses.

Cons
If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

Conditions in the lake (i.e., siltation or nutrient loading) may also change the composition of aquatic plant and invertebrate communities and thus influence biodiversity. Siltation and nutrient loading will likely decrease water clarity, increase turbidity, increase algal growth (due to nutrient availability), and decrease habitat for fish and wildlife.

Costs
The financial cost of this option is zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat effects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover
This option can be incorporated with *Option 3* (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Table 6, Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species out compete native plants and provide little value for wildlife. Currently, there are a few native emergent vegetation test areas around the lake. This is a good step in the right direction towards naturalizing Hidden Lake's shoreline. This program should continue and be expanded.

Occasionally high mowing (with the mower set at its highest setting) may have to be done for specific plants, particularly if the area is newly established, since competition from weedy and exotic species is highest in the first couple years. If mowing, do not mow the buffer strip until after July 15 of each year. This will allow nesting birds to complete their breeding cycle.

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be placed at least 10 feet away from the shoreline to prevent any debris from washing into the lake. Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets. Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

Pros

Increased cover will lead to increased use by wildlife. Since cover is one of the most important elements required by most species, providing cover will increase the chances of wildlife using the shoreline. Once cover is established, wildlife usually have little problem finding food, since many of the same plants that provide cover also supply the food the wildlife eat, either directly (seeds, fruit, roots, or leaves) or indirectly (prey attracted to the plants).

Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. Additionally, buffer strips help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff. This has a "domino effect" since less run-off flowing into a lake means less nutrient availability for nuisance algae, and less sediment means less turbidity, which leads to better water quality. All this is beneficial for fish and wildlife, such as sight-feeders like bass and herons, as well as people who use the lake for recreation.

Finally, a buffer strip along the shoreline can serve as a deterrent to Canada geese from using a shoreline. Canada geese like flat, open areas with a wide field of vision. Ideal habitat for them are areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Cons

There are few disadvantages to this option. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline. Composition and density of aquatic and shoreline vegetation are important. If vegetation consists of non-native species such as or Eurasian water milfoil or purple loosestrife, or in excess amounts, undesirable conditions may result. A shoreline with excess exotic plant growth may result in a poor fishery (exhibited by stunted fish) and poor recreation opportunities (i.e., boating, swimming, or wildlife viewing).

Costs

The cost of this option would be minimal. The purchase of native plants can vary depending upon species and quantity. Based upon 100 feet of shoreline, a 25-foot buffer planted with a native forb and grass seed mix would cost between $165-270 (2500 sq. feet would require 2.5, 1000 sq. feet seed mix packages at $66-108 per package). This could be a cost share project between the Association and individual homeowners in order to offset costs. This price does not include labor that would be needed to prepare the site for planting and follow-up maintenance, which could be done by the homeowner. This cost can be reduced or minimized if native plants are allowed to grow. However, additional time and labor may be needed to insure other exotic species, such as buckthorn, reed canary grass, and purple loosestrife, do not become established.

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with *Option 2*. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 4 (Appendix A) should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily, sago pondweed, largeleaf pondweed, and wild celery to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, “people food” such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks.

Pros

Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical “bug zappers” that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

Cons
Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks. Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake’s nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exasperate a lake’s excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

Costs
The costs of this option is minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense. See *Option 2: Increase Habitat Cover* above for prices.

Option 4: Increase Nest Availability

Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to *Options 2 and 3*). Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks, flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

Bat houses are also recommended for any area close to water. Bats are voracious predators of insects and are naturally attracted to bodies of water. They can be enticed into roosting in the area by the placement of bat boxes. Boxes should be constructed of rough non-treated lumber and placed >10 feet high in a sunny location.

Pros

Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old. The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric "bug zappers" for pest control. Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

Cons

Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks. Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

Costs

The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation. This is an excellent option for the residents to become actively involved with improving wildlife opportunities on Hidden Lake.

<u>Option 4: Revegetation With Native Aquatic Plants</u>

A healthy native plant population can reduce algal growth. Many lakes with long-standing algal problems have a very sparse plant population or none at all. This is due to reduction in light penetration brought about by years of excessive algal blooms and/or mats. Revegetation should only be done when existing nuisance algal blooms 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. If aquatic herbicides are being used to control what vegetation does exist there use should be scaled back or abandoned all together. This will allow the vegetation to grow back, which will help in controlling the algae in addition to other positive impacts associated with a healthy plant population.

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 algae. 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 4 (*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 algae by shading and competition for resources. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth is less expensive 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 improve 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 were used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 4 (*Appendix A*) for pricing.

Objective III: Eliminate or Control Invasive Species

Numerous exotic plant species have been introduced into our local ecosystems. 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 athartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. These exotic and invasive plants have made their way onto the shores of Hidden Lake. 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 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.

<u>Option 1: No Action</u>

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 4 (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: Hand Removal

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. This is probably the best method (combined with herbicides) for removal of invasive species on Hidden Lake. 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 excavated. This is probably the most effective method of removal on Hidden Lake for purple loosestrife. 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 3: Herbicide Treatment

Treatment with herbicides is one of the best options for controlling **mature stands** of invasive species on Hidden Lake. 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. 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. The label is the law. Table 5 (Appendix A) contains herbicides that are approved for use near water for control of nuisance vegetation. Included in this table are rates, costs, and restrictions on use.

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 5 (Appendix A) for herbicide rates and prices. 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. A low cost 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 costs. However, after there use for herbicide application they should not be used for anything else. Similarly, spray canisters like those used to apply lawn chemicals also provide lower costs alternatives to commercial spray equipment.

Objective IV: Fishery Rehabilitation

Option 1: Conduct a Fisheries Assessment

Many lakes in Lake County have a fish stocking program in which fish are stocked every year or two to supplement fish species already occurring in the lake or to introduce additional fish species into the system. However, very few lakes that participate in stocking check the progress or success of these programs with regular fish surveys. Lake managers should have information about whether or not funds delegated to fish stocking are being well spent, and it is very difficult to determine how well stocked fish species are surviving and reproducing or how they are affecting the rest of the fish community without a comprehensive fish assessment.

A simple, inexpensive way to derive direct information on the status of a fishery is to sample anglers and evaluate the types, numbers and sizes of fish caught by anglers actively involved in recreational fishing on the lake. Such information provides insight on the status of fish populations in the lake, as well as a direct measure of the quality of fishing and the fishing experience. However, the numbers and types of fish sampled by anglers are limited, focusing on game and large, catchable-sized fish. Thus, in order to obtain a comprehensive assessment of the fish community status, including non-game fish species, more quantitative methods must be employed. These include gill netting, trap netting, seining, trawling, angling (hook and line fishing) and electroshocking. Each method has its advantages and limitations, and frequently multiple gear and approaches are employed. The best gear and sampling methods depend on the target fish species and life stage, the types of information desired and the environment to be sampled. The table below lists examples of suitable sampling gear for collecting adults and young of the year (YOY) of selected fish species in lakes.

Typically, fish populations are monitored at least annually. The best time of year depends on the sampling method, the target fish species and the types of data to be collected. In many lakes and regions, the best time to sample fish is during the fall turnover period after thermal stratification breaks down and the lake is completely mixed because (1) YOY and age 1+ (one year or older) fish of most target species should be present and vulnerable to most standard collection gear, including seines, trap nets and electroshockers; (2) species that dwell in the hypolimnion during the summer may be more vulnerable to capture during fall overturn; and (3) lower water temperatures in the fall can help reduce sampling-related mortality. Sampling locations are also species-, life stage-, and gear-dependent. As with sampling methods and time, locations should be selected to maximize capture efficiency for the target species of interest and provide the greatest gain in information for the least amount of sampling effort.

The Illinois Department of Natural Resources (IDNR) will perform a fish survey at no charge on most public and some private water bodies. In order to determine if your lake is eligible for a survey by the IDNR, contact Frank Jakubecik, Fisheries Biologist at (815) 675-2319. If a lake is not eligible for an IDNR fish survey, or if a more comprehensive survey is desired, two known consulting firms have previously conducted fish surveys in Lake County: EA Engineering, Deerfield, IL, (847) 945-8010 and Richmond Fisheries, Richmond, IL, (815) 675-6545.

Option 2: Carp Removal

A frequent problem that plagues many of the lakes in the County is the presence of common carp (*Cyprinus carpio*). Common carp were first introduced into the United States from Europe in the early 1870's, and were first introduced into Illinois river systems in 1885 to improve commercial fishing. The carp eventually made their way into many inland lakes and are now so wide spread that many people do not realize that they are not native to the U.S.

Carp prefer warm waters in lakes, streams, ponds, and sloughs that contain high levels of organic matter. This is indicative of many lakes in Lake County. Carp feed on insect larvae, crustaceans, mollusks, and even small fish by rooting through the sediment. Immature carp feed mainly on small crustaceans. Because their feeding habits cause a variety of water quality problems, carp are very undesirable in lakes. Rooting around for food causes resuspension of sediment and nutrients, which can both lead to increased turbidity. Additionally, spawning, which occurs near shore in shallow water, can occur from late April until June. The spawning activities of carp can be violent, further contributing to turbidity problems. Adult carp can lay between 100,000 –500,000 eggs, which hatch in 5-8 days. Initial growth is rapid with young growing 4 ¾" to 5" in the first year. Adults normally range in size from 1-10 lbs., with some as large as 60 lbs. Average carp lifespan is 7-10 years, but they may live up to 15 years.

There are several techniques to remove carp from a lake. However, rarely does any technique completely eradicate carp from a lake. Commonly, once a lake has carp, it has carp forever. However, it is up to the management entity to dictate how big the problem is allowed to become. Rotenone is the only reliable piscicide (fish poison) on the market at this time, but it kills all fish that is comes into contact with. Currently, there is a rotenone laced baiting system that can selectively remove carp. While the process is a step in the right direction, several factors still need to be worked out in order for it to be a viable alternative to the whole lake treatment. Until this baiting technique is further developed and produces consistent results, it is not being recommended by the LMU at this time.

Rotenone is a piscicide that is naturally derived from the stems and roots of several tropical plants. Rotenone is approved for use as a piscicide by the USEPA and has been used in the U.S. since the 1930's. It is biodegradable (breaks down into CO_2 and H_2O) and there is no bioaccumulation. Because rotenone kills fish by chemically inhibiting the use of oxygen in biochemical pathways, adult fish are much more susceptible than fish eggs (carp eggs are 50 times more resistant). Other aquatic organisms are less sensitive to rotenone. However, some organisms are effected enough to reduce populations for several months. In the aquatic environment, fish come into contact with the rotenone by a different method than other organisms. With fish, the rotenone comes into direct contact with the exposed respiratory surfaces (gills), which is the route of entry. In other organisms this type of contact is minimal. More sensitive nonfish species include frogs and mollusks but these organisms typically recover to pretreatment levels within a few months. Rotenone has low mammalian and avian toxicity. For example, if a human consumed fish treated with normal concentrations of rotenone, approximately 8,816 lbs. of fish would need to be eaten at one sitting in order to produce toxic effects. Furthermore, due to its unstable nature, it is unlikely that the rotenone would still be active at the time of consumption. Additionally, warm-blooded mammals have natural enzymes that would break down the toxin before it had any effects.

Rotenone is available in 5% and 2.5% concentrations. Both concentrations are available as synergized formulations. The synergist (piperonal butoxide) is an additive that inhibits fish detoxification of rotenone, making the rotenone more effective. Rotenone has varying levels of toxicity on different fish species. Some species of fish can detoxify rotenone quicker than it can build up in their systems. Unfortunately, concentrations to remove undesirable fish, such as carp, bullhead and green sunfish, are high enough to kill more desirable species such as bass, bluegill, crappie, walleye, and northern pike. Therefore, it is difficult to selectively remove undesirable fish while leaving desirable ones. Typically, rotenone is used at concentrations from 2 ppm (parts per million) – 12 ppm. For removal of undesirable fish (carp, bullhead and green sunfish) in lakes with alkalinities in the range found in Lake County, the target concentration should be 6 ppm. Sometimes concentrations will need to be increased based on high alkalinity and/or high turbidity. Rotenone is most effectively used when waters are cooling down (fall) not warming up (spring) and is most effective when water temperatures are $<50^{o}$F. Under these conditions, rotenone is not as toxic as in warmer waters but it breaks down slower and provides a longer exposure time. If treatments are done in warmer weather they should be done before spawn or after hatch as fish eggs are highly tolerant to rotenone.

Rotenone rarely kills every fish (normally 99-100% effective). Some fish can escape removal and rotenone retreatment needs to occur about every 10 years. At this point in time, carp populations will have become reestablished due to reintroduction and reproduction by fish that were not removed during previous treatment. To ensure the best results, precautions can be taken to assure a higher longevity. These precautions include banning live bait fishing (minnows bought from bait stores can contain carp) and making sure every part of the lake is treated (i.e., cattails, inlets, and harbored shallow areas). Restocking of desirable fish species may occur about 30-50 days after treatment when the rotenone concentrations have dropped to sub-lethal levels. Since it is best to treat in the fall, restocking may not be possible until the following spring. To use rotenone in a body of water over 6 acres a *Permit to Remove Undesirable Fish* must be obtained from the Illinois Department of Natural Resources (IDNR), Natural Heritage Division, Endangered and Threatened Species Program. Furthermore, only an IDNR fisheries biologist licensed to apply aquatic pesticides can apply rotenone in the state of Illinois, as it is a restricted use pesticide.

Pros

Rotenone is one of the only ways to effectively remove undesirable fish species. This allows for rehabilitation of the lake's fishery, which will allow for improvement of the aquatic plant community, and overall water quality. By removing carp, sediment will be left largely undisturbed. This will allow aquatic plants to grow and help further stabilize the sediment. As a result of decreased carp activity and increased aquatic plant coverage, fewer nutrients will be resuspended, greatly reducing the likelihood of nuisance algae blooms and associated dissolved oxygen problems. Additionally, reestablishment of aquatic plants will have other positive effects on lake health and water quality, increases in fish habitat and food source availability for wildlife such as waterfowl.

Cons

There are no negative impacts associated with removing excessive numbers of carp from a lake. However, in the process of removing carp with rotenone, other desirable fish species will also be removed. The fishery can be replenished with restocking and quality sport fishing normally returns within 2-3 years. Other aquatic organisms, such as mollusks, frogs, and invertebrates (insects, zooplankton, etc.), are also negatively impacted. However, this disruption is temporary and studies show that recovery occurs within a few months. Furthermore, the IDNR will not approve application of rotenone to waters known to contain threatened and endangered fish species. Another drawback to rotenone is the cost. Since the whole lake is treated and costs per gallon range from $50.00 - $75.00, total costs can quickly add up. This can be off-set with lake draw down to reduce treatment volume. Unfortunately, draw down is not an option on all lakes.

Costs

As with most intensive lake management techniques, a good bathymetric map is needed so that an accurate lake volume can be determined (for costs see *Objective VI: Create Bathymetric Map with Morphometric Table*). To achieve a concentration of 6 ppm, which is the rate needed for most total rehabilitation projects (remove carp, bullhead and green sunfish), approximately 115 gallons of rotenone would be needed based on the approximate volume of Hidden Lake. This would come to a total cost of between $5,750 – 8,625. In waters with high turbidity and/or planktonic algae blooms such as Hidden Lake, the ppm may have to be higher which will further increase costs. A IDNR fisheries biologist will be able to determine if higher concentrations will be needed. To reduce costs the lake could be drawn down to reduce the volume that is being treated.

Objective VI: Nutrient inactivation

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ration (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

Pros

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in Secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

Cons

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long-term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

Costs

In order to determine costs and corresponding rates for an aluminum sulfate treatment, current morphometric data is required to make proper calculations. Since no morphometric data exists for Hidden Lake, a bathymetric study must be conducted (see *Objective VI: Create a Bathymetric Map and Morphometric Table*).

Objective VI: Create a Bathymetric Map and Morphometric Table

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some lakes in Lake County do have a bathymetric map, but they are frequently old, outdated and do not accurately represent the current features of the lake. Hidden Lake does not have an accurate bathymetric map. The map that was made in 2000 is inaccurate and lacks necessary morphometric data. If management activities intensify, Saddlebrook Farms should consider having a detailed bathymetric map made. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size.

Objective VII: Volunteer Lake Monitoring Program

In 1981, the Illinois Volunteer Lake Monitoring Program (VLMP) was established by the Illinois Environmental Protection agency (Illinois EPA) to gather fundamental information on Illinois inland lakes, and to provide an educational program for citizens. Annually, 150-200 lakes (out of 3,041 lakes in Illinois) are sampled by approximately 250 citizen volunteers. The volunteers are primarily lake shore residents, lake owners/managers, members of environmental groups, public water supply personnel, and citizens with interest in a particular lake.

The VLMP relies on volunteers to gather a variety of information on their chosen lake. The primary measurement is Secchi disk transparency or Secchi depth. Analysis of the Secchi disk measurement provides an indication of the general water quality condition of the lake, as well as the amount of usable habitat available for fish and other aquatic life.

Microscopic plants and animals, water color, and suspended sediments are factors that interfere with light penetration through the water column and lessen the Secchi disk depth. As a rule, one to three times the Secchi depth is considered the lighted or euphotic zone of the lake. In this region of the lake there is enough light to allow plants to survive and produce oxygen. Water below the lighted zone can be expected to have little or no dissolved oxygen. Other observations such as water color, suspended algae and sediment, aquatic plants, and odor are also recorded. The sampling season is May through October with volunteer measurements taken twice a month. After volunteers have completed one year of the basic monitoring program, they are qualified to participate in the Expanded Monitoring Program. In the expanded program, selected volunteers are trained to collect water samples that are shipped to the Illinois EPA laboratory for analysis of total and volatile suspended solids, total phosphorus, nitrate-nitrite nitrogen and ammonia nitrogen. Other parameters that are part of the expanded program include dissolved oxygen, temperature, and zebra mussel monitoring. Additionally, chlorophyll *a* monitoring has been added to the regiment of selected lakes. These water quality parameters are routinely measured by lake scientists to help determine the general health of the lake ecosystem.

For more information about the VLMP contact the VLMP Regional Coordinator:

Holly Hudson
Northeast Illinois Planning Commission
222 S. Riverside Plaza, Suite 1800
Chicago, IL 60606
(312) 454-0400