2001 SUMMARY REPORT
of
LAKE NAOMI

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake Naomi, located in Ela Township, was created in 1948 and originally served as a test site for a fish tackle manufacturer. Construction of homes on the lake began approximately 20 years ago and continues today. The lake has a surface area of 12.9 acres and a mean depth of 6.1 feet. The lake is located entirely within the village limits of Hawthorn Woods and is used by White Birch Lake Association members for swimming and fishing, with a grassy launch on the west side of the lake.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature and water clarity were measured, and the plant community was assessed each month from May-September 2001. Phosphorus levels were high throughout the summer, resulting in high densities of filamentous algae. The source of phosphorus to the water column appears to be internal, as Lake Naomi stratifies for short periods of time, resulting in phosphorus release from the sediment. Phosphorus levels were not related to total suspended solids (TSS) or total volatile solids concentrations (TVS), but high TVS levels suggested that high levels of decomposition of filamentous algae were to blame for decreasing Secchi depths throughout the summer.

Chara and slender naiad dominated the plant community in 2001. Very small amounts of curly leaf pondweed, leafy pondweed, sago pondweed, and small pondweed were also observed. Filamentous algae was treated throughout the summer with Clearigate® and Cutrine Plus®, while Aquathol-K® and Reward® were used to treat curly leaf pondweed early in the summer. The plant management plan for Lake Naomi appears to be successfully treating the target plant species, while avoiding overuse of herbicides. However the lake association should attempt to replace chemical treatment of filamentous algae with manual removal. This would reduce the amount of decomposing algae in the water column, potentially increasing Secchi depth and encouraging plant growth

Although no erosion was occurring around Lake Naomi, buckthorn, purple loosestrife and reed canary grass were present along 50.3% of the shoreline. These are exotic plant species that out-compete native vegetation and provide poor habitat for wildlife. Additionally, very little wildlife habitat was present along this residential shoreline, dominated by rip rap, and few waterfowl and/or songbirds were observed over the course of the study.

Recommendations and options for lake management techniques to address these problems are described in the report.

LAKE IDENTIFICATION AND LOCATION

Lake Naomi is located in Ela Township, north of McHenry Road and west of Fairfield Road (T 43N, R 10E, S 9), and is entirely within the village limits of Hawthorn Woods. Lake Naomi has a surface area of 12.9 acres, with mean and maximum depths of 6.1 feet and 12.1 feet, respectively, and a calculated volume of 78.0 acre-feet. Lake Naomi receives its water input from Lake Leo and a small creek that drains a subdivision on the north side of the lake. The lake is located in the Indian Creek sub basin of the Des Plaines River watershed. Water exits the lake over a spillway on the northeast shore, flows through agricultural fields and eventually enters a wetland to the north.

BRIEF HISTORY OF LAKE NAOMI

Lake Naomi, located in Ela Township, was created in 1948 by building a six foot earthen dam and removing a large amount of dirt from the area. It originally served as a test site for a fish tackle manufacturer. Construction of homes on the lake began approximately 20 years ago and continues today. Currently, the lake is managed by the White Birch Lake Association which was formed more than 15 years ago.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Access to Lake Naomi via a grassy launch area on the west shore is open to Lake Association members only. The lake's main uses are swimming and fishing. No gas motors are permitted on the lake. The White Birch Lake Association meets once a year to discuss and address lake management issues, and each Association member is required to pay a fee of $400-500 per year. Currently, the biggest management concerns include continued control of filamentous algae and educating property owners with regard to lawn fertilizers.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples collected from Lake Naomi were analyzed for a variety of water quality parameters (See Appendix B for methodology). Samples were collected at 3 foot and 8-10 foot depths (depending on water level) from the deep hole location in the lake (Figure 1). Lake Naomi was thermally stratified only on the June and July 2001 sampling dates. Thermal stratification occurs when a lake divides into an upper, warm water layer (epilimnion) and a lower, cold water layer (hypolimnion). When stratified, the epilimnetic and hypolimnetic waters do not mix, and the hypolimnion typically becomes anoxic (dissolved oxygen= 0 mg/l) in nutrient-rich lakes by mid-summer. A lake that remains thermally stratified all summer is considered dimictic. Conversely, a polymictic lake stratifies and destratifies many times during the summer. Stratification may occur after several calm, hot days, but may be broken by a storm or high wind event and the

lower water layer will mix with the upper water layer. This may result in changes in phosphorus concentrations in the epilimnion that affect many aspects of water quality. In general, Lake Naomi is polymictic, but stratification occurs very low in the water column, isolating only the deepest water. Near-surface dissolved oxygen (DO) concentrations were always well above 5.0 mg/l (a level below which aquatic organisms become stressed) during the study period. Near-bottom DO concentrations fell below 5.0 mg/l during June and July, when hypoxic (DO<1.0 mg/l) conditions were observed (Table 1, Appendix A).

Phosphorus (P) is a nutrient that can enter lakes through runoff or be released from lake sediment, and high levels of phosphorus typically trigger algal blooms or produce high plant density. The average surface phosphorus concentration in Lake Naomi was 0.062 mg/l. This concentration was higher than most of the lakes in the County studied since 1995 (County median = 0.047 mg/l). Epilimnetic and hypolimnetic P concentrations were identical in May. However, in surface waters, the P concentration decreased from May to June and then doubled from June to July, where it remained high. In bottom waters, the P concentration increased from May to June and again from June to July, when levels were approximately 20% higher than the epilimnion (Table 1, Appendix A). Since the water entering Lake Naomi from Lake Leo was very low in P (average P = 0.026 mg/l), and rain data did not correlate with increases or decreases in P in Lake Naomi, the source of phosphorus to the water column appears to be internal. Although sampling was not frequent enough to prove it, it is plausible that the polymictic nature of Lake Naomi led to a release of phosphorus from the sediment during the summer. As mentioned above, a polymictic lake will stratify and de-stratify several times during the summer. During calm, hot periods, the lake will become weakly stratified and bottom waters will lose oxygen very quickly. As a result, phosphorus will be released from the sediment and build up in the hypolimnion. Stratification is then broken by air temperature changes or a wind or storm event and the phosphorus is distributed throughout the water column, often producing algae blooms. In May 2001, temperature, oxygen and phosphorus concentrations between the epilimnion and hypolimnion were very similar, indicating that the lake was still mixing. By the middle of June, the temperature and oxygen profiles indicated that the lake was stratified at 9 feet. The epilimnetic waters were isolated from P being released into the hypolimnion, causing the P concentration to decrease in the epilimnion and increase in the hypolimnion. In July, P concentrations had increased greatly in both the epilimnion and the hypolimnion and the lake was stratified at 10 feet. It is hypothesized that sometime between the June and July sampling dates, stratification was broken and P that had built up in the hypolimnion was distributed throughout the water column, resulting in an increase in epilimnetic P. By the time of the July sampling date, the lake had stratified again and P concentrations had increased even more in the hypolimnion (Table 1, Appendix A). In August, the lake was no longer stratified, but the stratification detected in July may have continued until just before the August sampling date, as epilimnetic and hypolimnetic P concentrations were still relatively different. Destratification continued through September, when P concentrations were, once again, similar between surface and bottom waters.

An aeration system is currently in place in Lake Naomi and was installed in order to reduce odors, nutrients and organic sediment by keeping the lake destratified. Five compressors and 14 diffusers run from March-November, while only 3 compressors and 6 diffusers run in the winter. The system is more than adequately sized, with placement of most of the diffusers at 7-10 foot depths, and the system appears to be properly monitored and controlled. Most of the diffusers form a ring around the deepest part of the lake and are suspended in the water column approximately 4-12 inches off of the bottom. The establishment of thermal stratification and the loss of oxygen in June and July occurred at approximately the 9-10 feet depths, which were level with or just below the deepest placement of the diffusers in the lake. The only way to prevent stratification in bottom waters is to place the diffusers directly on the sediment surface in the deepest area of the lake. However, this action is not recommended, as it would likely create more P and clarity problems through sediment resuspension. Additionally, because a bathymetric map is not available for Lake Naomi, it is not possible to determine the surface area over which the water column was losing oxygen and the sediment was releasing phosphorus in June and July. If this area was very small, internal phosphorus loading may be relatively insignificant as a source of P to the lake. Other potential sources could include release from decomposing algae or resuspended sediment, or some input from external sources.

The relatively high phosphorus concentrations that persisted throughout the summer resulted in the growth of filamentous and colonial algae, especially in areas of the lake where wave action was less intense. Filamentous mats were observed on the water surface, as well as on the lake bottom, while colonial algae (small green balls) were found only on the lake bottom. The mats were chemically treated almost every month from April through August, causing them to sink to the lake bottom, where they may have been releasing phosphorus during their decomposition. This phosphorus would have been available to the living filamentous algae resting on the sediment, which then floated to the water surface to create another mat of algae. This cycle may have continued through the summer each time that the surface algae was chemically treated and may have served as a source of P to the lake.

Total suspended solids (TSS) is a measure of the amount of suspended material, such as algae or sediment, in the water column. High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem such as the plant and fish communities. A large amount of material in the water column can inhibit successful predation by sight-feeding fish, such as bass and pike, or settle out and smother fish eggs. High turbidity caused by sediment or algae can shade out native aquatic plants, resulting in their reduction or disappearance from the littoral zone. This eliminates the benefits provided by plants, such as providing habitat for many fish species and stabilization of the lake bottom. Often, if filamentous algae is present in a lake, water clarity will be relatively high because filamentous algae will outcompete planktonic algae, which causes high TSS values and high turbidity. The average epilimnetic TSS concentration (5.0 mg/l) in Lake Naomi was slightly less than the County median (5.7 mg/l), but TSS increased progressively throughout the summer, reaching a high of 7.1 mg/l in August.

Elevated TSS concentrations can be caused by sediment in the water column. This sediment can enter from nonpoint sources, or be resuspended from the lake bottom. However, sediment does not appear to be the source of progressively increasing TSS in Lake Naomi. The average NVSS (nonvolatile suspended solids- a measure of inorganic material, such as clay particles, in the water column) concentration was very low (3.5 mg/l), indicating that a high amount of sediment was not present in the water column. Typically, if high TSS concentrations are the result of planktonic algae, TP and TSS will be strongly correlated. A strong correlation between TSS and total volatile solids (TVS, a measure of organic matter, such as algae, in the water column) would reinforce the relationship between TSS and planktonic algae. No planktonic algae blooms were observed in Lake Naomi and, not surprisingly, TSS was not strongly correlated with either TP (Figure 2) or TVS during the 2001 study. However, TVS concentrations were above the County average every month of the study, suggesting that an organic source was to blame for the rising TSS concentrations. This organic source is believed to be decomposing filamentous algae.

Filamentous algae was treated with an algaecide six times between April 24 and August 6. Each time the algae mats were treated, most of the algae was killed, which sank to the lake bottom and began decomposing. The decomposition resulted in the release of organic material into the water column. Additionally, the presence of filamentous algae (whether it is treated or not) can contribute to higher levels of decomposition than in a lake without filamentous algae. The algae mats that are formed on the water surface shade out algae mats resting on the lake bottom, as well as aquatic plants below the water surface. As a result, the bottom mats and plants die, adding to the amount of decomposing material in the lake and increasing TVS even more. Although the typical relationships between TSS, TVS and TP were not observed, the dark color of the water (which is observed in lakes dominated by decomposition) supported the hypothesis that decomposing organic matter was to blame for high TVS concentrations and decreasing Secchi depths.

The high amount of decomposition occurring in Lake Naomi was, likely, reducing DO at a relatively high rate. Although oxygen cannot enter the water column from the atmosphere fast enough to equally replace the DO being removed through decomposition, the aeration system in the lake helped maintain acceptable DO levels by preventing stratification of a large portion of the water column and increasing water movement throughout the lake. Without the aeration system, the lake might have experienced low DO levels at the water surface, odor problems or a fish kill, and it is recommended that the aeration system continue to be operated indefinitely, as long as current management strategies continue. Despite the benefits that the aeration system is providing, its operation is not resulting in low nutrient levels in the lake (which was one of the reasons for installing the aerator).

Secchi depth (water clarity) in Lake Naomi was highest in May, but decreased throughout the summer, ranging from a maximum of 6.92 feet to a minimum of 2.49 feet in September. Secchi depth was below the County average (5.1 feet) every month except May during the 2001 study. Decreases in Secchi depth coincided with increases in TSS

(Figures 3) and TVS, and were related to the decomposition of algae.

As mentioned above, lakes dominated by a healthy filamentous algae population (as opposed to planktonic algae) can experience relatively high Secchi depths because the algae mats shade out planktonic algae below them. However, once the algae is treated and begins to die and decompose, Secchi depth will likely fall for two reasons: the decomposing algae may release organic material into the water column, and/or the absence of competition by filamentous mats may allow planktonic algae to become dominant. With approximately biweekly treatment of the filamentous algae through June, Secchi depth fell dramatically between May and June. No treatments were conducted in July (a slight increase in Secchi depth was observed), but a treatment early in August resulted in another large decrease in Secchi depth.

One way to reduce the amount of decomposing algae in the water column is to manually remove filamentous algae mats. By replacing chemical treatment with manual removal, homeowners would be removing the source of organic material that is causing the reduction of water clarity during the summer. Manual removal would also reduce the amount of organic matter building up in the sediment and may decrease future phosphorus release from the sediment. Algaecide treatments for filamentous algae should be dramatically reduced or stopped in 2002 and lakeshore homeowners should attempt to manually remove filamentous algae along their shorelines throughout the summer. Algae rakes can be easily and cheaply constructed to rake algae from the shoreline, and larger rakes can be constructed and attached to the back of small boats to collect algae farther from shore. If Secchi depth increases as a result of manual algae removal, a larger number of plant species will have the opportunity to become established and may serve to increase water clarity even more.

As in Lake Leo, average conductivity in Lake Naomi (0.950 mS/cm) was above the County average (0.7557 mS/cm) in 2001 (Table 1, Appendix A). Conductivity is the measure of different chemical ions in solution. As the concentration of these ions increases, conductivity increases. The conductivity of a lake is dependent on the lake and watershed geology, the size of the watershed flowing into the lake, the land uses within that watershed, and evaporation and bacterial activity. Conductivity has been shown to be highly correlated (in urban areas) with chloride ions found in road salt mixtures. Epilimnetic total dissolved solids (TDS) concentrations, which have also been shown to be correlated with conductivity, were above the County average (452 mg/l) in Lake Naomi during every month of the study (Table 1, Appendix A). Conductivity changes can occur seasonally and even with depth, but over the long term, increased conductivity levels can be a good indicator of potential watershed or lake problems or an increase in pollutants entering the lake. High conductivity levels (which often indicate an increase in sodium chloride) can eventually change the plant community, as more salt tolerant plants take over. Sodium and chloride ions can bind substances in the sediment, preventing their uptake by plants and reducing native plant densities. Additionally, juvenile aquatic organisms may be more susceptible to high chloride concentrations. The high conductivity levels in Lake Naomi are most likely the result of increased residential development in the watershed of the lake and contribution of water with high conductivity from Lake Leo. More houses mean more impervious surfaces and more roads to be salted each winter. An overall increase in the amount of road salt deposited around Lake Naomi will continue to result in an increase in TDS and conductivity. Although the high conductivity levels in the lake are cause for concern, there may not be much that residents can do about it. Non-point runoff, such as that which picks up road salt and enters the lake during rain events, is very difficult to control. A potentially easy measure that lake shore residents can take to attempt to reduce the amount of road salt entering Lake Naomi is to convince the Village of Hawthorn Woods or Ela Township to reduce the amount of road salt laid down around both Lake Leo and Lake Naomi each winter. Often, excess road salt is laid down at the end of the winter season (when it is not really necessary) in order to use up left over stores. Residents should appeal to the appropriate government entity to use only the necessary amount of salt to keep roads safe each winter.

Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of these nutrients is in short supply relative to the other and that any addition of phosphorus or nitrogen to the lake might result in an increase of plant or algal growth. Other resources necessary for plant and algae growth include light or carbon, but these are typically not limiting. Most lakes in Lake County are phosphorus limited, but to compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting. Ratios greater than or equal to 15:1 indicate that phosphorus is limiting. Ratios greater than 10:1, but less than 15:1 indicate that there are enough of both nutrients to facilitate excess algal or plant growth. Lake Naomi had an average TN:TP ratio of 15:1. This indicates that the lake is very slightly phosphorus limited, but that both nutrients are already present in adequate amounts. Additional inputs of phosphorus or nitrogen to the lake may not have any observable effects until the inputs reach a very high level. Small increases in phosphorus may result in a slight increase in filamentous algae, but this may not be noticeable since filamentous algae tends to collect in specific parts of the lake. However, larger increases in phosphorus may lead to a significant increase in filamentous algae density throughout the lake, or may even result in a switch to planktonic algae dominance. This is common in nutrient-enriched lakes, such as Lake Naomi, where high phosphorus levels have reached the point where either very large increases or very large decreases in phosphorus may be necessary to trigger changes in algae density. On the other hand, less enriched lakes, such as Lake Leo are often more sensitive to increases or decreases in phosphorus. Regardless, care should be taken to ensure that no unnecessary sources of P are created around the lake.

Phosphorus concentrations can also be used to indicate the trophic state (productivity level) of a lake. The Trophic State Index (TSI) uses phosphorus, chlorophyll *a* (algae biomass) and Secchi depth to classify and compare lake trophic states using just one value. The TSI is set up so that an increase in phosphorus concentration is related to an increase in algal biomass and a corresponding decrease in Secchi depth. High TSI values indicate eutrophic (TSI=50-69) to hypereutrophic (TSI ≥70) lake conditions, typically characterized by high nutrient concentrations, high algal biomass, low DO levels, a rough fish population, and low water clarity. Lake Naomi had an average phosphorus TSI

(TSIp) value of 63.7, indicating eutrophic conditions. This means that the lake is a highly enriched system with relatively poor water quality. However, because the dominant species of algae in the lake were filamentous, water quality is not as poor as many other lakes with similar TSIp values. Lake Naomi ranks 52nd out of 102 lakes in Lake County (TSIp averaged over several years). Although this is not extremely unusual, as most man-made lakes in this geographical area fall into the eutrophic and hypereutrophic categories (Table 2, Appendix A), this ranking is in stark contrast to Lake Leo, which had a TSIp of 50.9 and ranked 20th on the same scale. Because the potential source of P to both lakes is internal loading from the sediment, this difference is likely the result of different P levels in the sediment and the different lengths of time that each lake was stratified in 2001. Naomi was stratified on two sampling dates, while Leo was only stratified on one sampling date, suggesting that Naomi was stratified for a longer period of time. A longer period of stratification would have meant a longer period of low oxygen levels in bottom waters and a longer period of phosphorus release from the sediment. Additionally, as a result of years of filamentous algae treatment, the sediment of Lake Naomi is probably more organic and much richer in P than the sediment of Lake Leo. Although the treatment of algae has also carried out for many years in Lake Leo, it has been the treatment of planktonic algae. Once dead, some planktonic algae may decompose in the water column, where dissolved phosphorus is released from the dead algae cells and taken up by new algae cells. Conversely, large mats of filamentous algae will sink to the lake bottom to decompose on the sediment surface, trapping much of the phosphorus contained in algae cells in the sediment, where it can later be released. The decomposing mats also add a larger amount of organic matter to the sediment. This can lead to a more rapid loss of DO over the sediment once the lake stratifies than in a lake with less organic sediment (Leo).

Most of the water quality parameters just discussed can be used to analyze the water quality of Lake Naomi based on use impairment indices established by the Illinois Environmental Protection Agency (IEPA). According to this index, Lake Naomi provides *Full* support of aquatic life and *Partial* support of swimming and recreation. The lake has *Partial* support of overall use.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (See Appendix B for methodology). Shoreline plants of interest were also recorded. However, no quantitative surveys were made of these shoreline plant species and these data are purely observational. Lake Naomi currently has a plant management plan in place to treat curly leaf pondweed. In 2001, spot treatments of Aquathol-K® and Reward® were applied to treat curly leaf pondweed once in April and twice in June. Aquathol-K® is a nonselective contact herbicide that is typically used to treat pondweeds. It is only effective on submersed plants and causes rapid plant death with dieback in about a week. However, since it is a contact herbicide and only affects the non-rooted portions of the plant, regrowth will occur and the herbicide must be applied repeatedly throughout the summer. Reward® is also a nonselective contact herbicide that is typically used on Eurasian watermilfoil and coontail and only provides short-term control. Repeat applications will always be necessary when using Reward®, especially in waters with high sediment turbidity, as the herbicide binds quickly to soil particles.

In 2001, *Chara* and slender naiad dominated the plant community. Very small amounts of curly leaf pondweed, leafy pondweed, sago pondweed, and small pondweed were observed throughout the summer (Tables 3 & 4). Despite its presence in Lake Leo, Eurasian watermilfoil (EWM) has not yet invaded Lake Naomi. This is likely because the plant is being successfully treated in Lake Leo and has not spread to a large area of the lake. The lack of a large number of boats on the lakes being transferred from Lake Leo to Lake Naomi and back again is also helping to prevent the spread of EWM.

During our study, light levels were measured at one-foot intervals from the water surface to the lake bottom. When the light level falls below 1% of the level at the water surface, plants are no longer able to grow. If a good bathymetric map is available, it can be determined how much of the lake has the potential to support aquatic plant growth. A bathymetric map is not currently available for Lake Naomi, so it cannot be accurately estimated how much of Lake Naomi could have supported plants. However, using percent light level and plant depth data, it was determined that plants did not grow to the maximum depth they should have as determined by 1% light, and only covered approximately 15% of the lake surface area during 2001. The inability of aquatic plants to grow in all areas as determined by percent light level may be explained by the presence of inadequate substrate in various parts of the lake, or the use of herbicides. The absence of a large number of different plants in Lake Naomi may be the result of shading by filamentous algae and is contributing to the relatively low Secchi depths observed. If the algae could be manually removed and Secchi depth maintained, a larger number of plant species may emerge over the course of the summer, providing fish habitat and clearer water.

The plant management plan for Lake Naomi appears to be successfully treating the target plant species of curly leaf pondweed, as very little was observed in the lake during the summer. It also appears that herbicide application is not being overused and that spot treatments of each herbicide have been adequate to treat the target areas. This responsible use of herbicides could be continued as needed in Lake Naomi.

All three emergent plant and trees species observed along the shoreline of Lake Naomi are invasive species that do not provide ideal wildlife habitat and have the potential to dominate the emergent plant community.

FQI (Floristic Quality Index) is a rapid assessment tool designed to evaluate the closeness of the flora of an area 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 (Nichols, 1999). Each floating or submersed aquatic plant is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). An FQI is calculated by multiplying the average of these numbers by the square root of the number of plant species found in the lake. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for 2000-2001 Lake County lakes is 14.0. Lake Naomi has an FQI of 11.2, slightly below the County average, as a result of low plant diversity and density in 2001.

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

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
Chara	*Chara* sp.
Slender Naiad	*Najas flexilis*
Curlyleaf Pondweed	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Small Pondweed	*Potamogeton pusillus*
Sago Pondweed	*Stuckenia pectinatus*
<u>*Shoreline Plants*</u>	
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Common Buckthorn	*Rhamnus cathartica*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Lake Naomi on July 19, 2001. The shoreline was assessed for a variety of criteria (See Appendix B for methods), and based on these assessments, several important generalizations could be made. Approximately 58% of Lake Naomi's shoreline is developed. The majority of the developed shoreline is comprised of rip rap (75.8%), while the remainder consists of woodland (7.9%), beach (7.9%), buffer (6.1%) and seawall (2.5%) (Figure 4). The undeveloped portion of the lake (located mostly along the eastern shore) consists entirely of woodland. Although rip rap is not an ideal shoreline type with regard to wildlife habitat, it does, typically, help to prevent shoreline erosion. As a result of the dominance by rip rap around Lake Naomi, none of the shoreline exhibited erosion.

While woodland is a desirable shoreline type for wildlife habitat, and rip rap and seawall are desirable for shoreline erosion control, buffer strips along a shoreline are ideal for both. The types of plants in a well-constructed buffer strip have deep roots that hold soil and prevent erosion, while, at the same time, providing food and shelter for many birds and small mammals. Homeowners who have rip rapped shorelines should consider planting at least 10 foot wide buffer strip behind the rip rap, and any new homes constructed on the lake should seriously consider installing buffer strips at least 10 feet wide along their shoreline to prevent erosion and provide additional wildlife habitat.

Buffer strips do not have to mean the end of a beautiful view of the lake, and, if done well, can add to the aesthetics of lakefront property.

Dramatic water level fluctuation can increase shoreline erosion, especially if the fluctuations occur over short periods of time. The water level in Lake Naomi fluctuated no more than one-half of a foot between May and September. Erosion occurs when water levels drop and newly exposed soil, which may not support emergent plant growth, is subjected to wave action. The low occurrence of water fluctuation in Lake Naomi reduced the likelihood of shoreline erosion, as evidenced by the absence of erosion around the lake.

Although very little erosion was occurring around Lake Naomi, invasive plant species, including reed canary grass, buckthorn and purple loosestrife were present along 50.3% of the shoreline. These plants are extremely invasive and exclude native plants from the areas they inhabit. Buckthorn provides very poor shoreline stabilization and may lead to increasing erosion problems in the future. Reed canary grass and purple loosestrife inhabit mostly wetland areas and can easily outcompete native plants. Additionally, they do not provide the quality wildlife habitat or shoreline stabilization that native plants provide. Steps to eliminate these plants around the lake (especially along the wooded shoreline) should be carried out before they become a nuisance.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

A 1964 fish survey by the Illinois Department of Natural Resources (IDNR) was the first to be performed on Lake Naomi. Largemouth bass (LMB), golden shiners (GO), fathead minnows (FH) and hybrid bluegill/pumpkinseed (HB) had been stocked in 1949-50. From 1964-1967, extensive trapping and removal of panfish was conducted in an attempt to reduce the number of these fish species in the lake. During fish surveys performed in 1964, 1966, 1968 and 1969, LMB dominated the fish community. The other fish found those years included bluegill (BG), HB, and green sunfish (GS), and it appeared that the panfish rehabilitation was working. More recently, fathead minnows have been stocked in Lake Naomi since 1996. In 1996, 800 pounds were stocked, in 1997, 1,600 pounds were stocked, and in 1998, 1000 pounds were stocked. Although no fish were stocked in 1999 and 2000, 1,500 fathead minnows were stocked in 2001. It is strongly recommended that a fish survey be conducted on Lake Naomi in order to determine the current condition of the fish community.

Wildlife observations were made on a monthly basis during water quality and plant sampling activities (See Appendix B for methodology). Because of the large amount of rip rap and seawall along the shoreline, which do not support large numbers of wildlife species, a very small number of waterfowl and song birds were observed around the lake all summer (Table 5). It is, therefore, very important that some of the woodland areas around the lake be maintained and that residents consider installing buffer strips to provide the appropriate habitat for bird species in the future. It is also important that any new homes being built on the lake keep their lots as wooded as possible and establish a buffer strip of native plants along their shorelines to provide additional habitat.

Table 5. Wildlife species observed at Lake Naomi, May-September 2001.

Birds	
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Great Egret	*Casmerodius albus*

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool in effective lake management, especially if the long term lake management plan includes intensive treatments, such as fish stocking, aeration, dredging, chemical application or alum application. Lake Naomi does not currently have a bathymetric map or morphometric data. Morphometric data obtained in the creation of a bathymetric map is necessary for calculation of equations for correct application of many types of treatments.

- *Lack of Participation in the Volunteer Lake Monitoring Program (VLMP)*

  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 establishment of a VLMP on Lakes Leo and Naomi would provide valuable historical data and enable lake managers to create baseline information and then track the improvement or decline of lake water quality after lake management techniques are employed.

- *Polymixis Leading to Internal Phosphorus Loading*

  Lake Naomi is a polymictic lake, meaning that it stratifies and destratifies several times during a summer. As a result of this stratification cycle, phosphorus was released from the sediment, built up in bottom waters during stratification and was then distributed throughout the water column during destratification. This resulted in an increase in available phosphorus to the surface waters, where it was utilized by filamentous algae. The algae is currently being treated with copper products, and an aeration system has been installed to prevent stratification. The aeration system is adequately sized and is successfully preventing stratification in a large portion of the water column. However, phosphorus concentrations in Lake Naomi continue to be higher than average, possibly as a result of sediment release or external phosphorus sources.

- *Lack of Aquatic Vegetation*

  One key to a healthy lake is a healthy plant community. *Chara* and slender naiad dominated the plant community throughout the summer, but were found in relatively small amounts. Curly leaf pondweed was being treated with a Reward® and

Aquathol-K®, nonselective herbicides which may also have affected native plants in the treated areas. The lake association could continue with the limited and responsible application of herbicides for the control of curly leaf pondweed but all attempts should be made to prevent treatment of non target plant species in the future.

- *Filamentous Algae Mats*

  Mats of filamentous algae were present along several areas of shoreline in 2001. When these mats are healthy, they serve to shade out planktonic algae below them (a desirable outcome), but they also serve to shade out submersed native plants below them (an undesirable outcome). The mats are currently being treated with algaecides, but the treatment is causing heavy decomposition of the dead algae material. The organic debris from this decomposition is being released back into the water column, increasing TVS and TSS, and decreasing water clarity. It has been recommended that manual removal of the filamentous algae mats be attempted. Manual removal will achieve the same aesthetic goal, but will improve upon chemical treatment by greatly reducing the organic matter in the water column, reducing oxygen demand from decomposition and possibly reducing the amount of phosphorus being released into the water column through decomposition and/or sediment loading.

- *Invasive Shoreline Plant 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. The outcome is a loss of plant and animal diversity. 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. Reed canary grass is another exotic plant found in wetland habitat. It spreads very quickly, does not provide adequate shoreline stabilization and is not well utilized by wildlife. 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. Purple loosestrife, reed canary grass and buckthorn are present along 50.3% of the shoreline of Lake Naomi and attempts should be made to control their spread before they become a large problem.

- *Limited Wildlife Habitat*

  Although much of the eastern shore of the lake is dominated by woodland, most of Leo Naomi’s shoreline is dominated by rip rap and seawall, which do not encourage diverse bird and animal populations. Several lots on the lake do have buffer strips. It is recommended that those residents that already have buffer consider widening of their strips and that those residents that do not have a buffer strip consider planting a

10-50 foot wide strip of native plants along their shoreline. This would not only increase wildlife habitat, but could reduce the amount of nutrients and soil particles entering the lake and could prevent future shoreline erosion.

POTENTIAL OBJECTIVES FOR THE LAKE NAOMI MANAGEMENT PLAN

I. Create a Bathymetric Map, Including a Morphometric Table
II. Participate in the Volunteer Lake Management Program
III. Eliminate or Control Invasive Species
IV. Enhance Wildlife Habitat Conditions
V. Conduct a Fisheries Assessment

OPTIONS FOR ACHIEVING THE LAKE MANEMENT PLAN OBJECTIVES

Objective I: Create a Bathymetric Map, Including a Morphometric Table

A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management treatments such as fish stocking, dredging, alum application or aeration were part of the overall lake management plan. Lake Naomi does not have a bathymetric map or morphometric data (which are pertinent for certain calculations). Maps can be created by the Lake County Health Department – Lake Management Unit or other agencies for costs that vary from $3,000-$10,000, depending on lake size.

Objective II: Participate in the 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:

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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 cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

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

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

<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 6, 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: Control by Hand

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

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

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

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

Option 3: Herbicide Treatment
Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant.   In some areas where individual spot treatments are prohibitive or unpractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option due to the fact that in order to chemically treat the area a broadcast application would be needed. Since many of the herbicides that are used are not selective, meaning they kill all plants they contact; this may be unacceptable if native plants are found in the proposed treatment area.

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

Pros

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

Cons

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

Costs

Two common herbicides, triclopyr (sold as Garlon™) and glyphosate (sold as Rodeo® or Round-up™), cost approximately $100 and $65 per gallon, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40.

Objective IV: Enhance Wildlife Habitat Conditions

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. 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 mix 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). Wildlife diversity and density around Lake Naomi was very poor in 2001. Taking steps to improve wildlife habitat around the lake will not only benefit songbirds and waterfowl, but will make living around the lake more enjoyable, as residents may observe many new and interesting animals.

Option 1: No Action

This option means that the current land use activities will continue. No additional techniques will be implemented. 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 may be 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 the table in 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 outcompete native plants and provide little value for wildlife.

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 place 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. Water quality may be improved by the filtering of nutrients, sediment, and pollutants in run-off. 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.

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. ft. would require 2.5, 1000 sq. ft. seed mix packages at $66-108 per package). This does not include labor that would be needed to prepare the site for planting and follow-up maintenance. 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.

<u>Option 3: Increase Natural Food Supply</u>

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 the table in Appendix A should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily (*Nuphar* spp. and *Nymphaea tuberosa*), sago pondweed (*Stuckenia pectinatus*), largeleaf pondweed (*Potamogeton amplifolius),* and wild celery (*Vallisneria americana*) 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 exacerbate 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 are 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.

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.

Objective V: 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.

TAXON	FISH LIFE STAGE	GEAR[a] STANDARD	GEAR[a] SUPPLEMENTAL
Trout, salmon, whitefish, char (except lake trout)	YOY	Electrofishing	Gill nets, trawls, seine
	Adult	Trap nets	Gill nets, electrofishing (F)
Lake trout	YOY	Electrofishing (F)	Seine (F), trawls
	Adult	Trap nets (F)	
Pike, pickerel, muskellange	YOY	Seine (Su)	
	Adult	Trap nets (S), gill nets (S,F)	
Catfish, bullheads	YOY	Seine	Baited traps
	Adult	Gill nets, trap nets[b]	Slat nets, angling
Bass, sunfish, crappie	YOY	Seine, electrofishing	
	Adult	Electrofishing	Trap nets, angling
Minnows, carp, dace, chub, shiners	YOY	Electrofishing	Seine
	Adult	Electrofishing	Seine
Yellow perch	YOY	Seine (Su), electrofishing	Trawls (S)
	Adult	Gill net, trap net	
Walleye	YOY	Seine (S), electrofishing	Trawls (S)
	Adult	Trap nets (S), gill nets (S, F), electrofishing (S, F)	

[a]Letter codes indicate seasonal restrictions on gear use to the spring (S), summer (Su), or fall (F).
[b]Bullheads only.