2002 SUMMARY REPORT
of
GRAY'S 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

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EXECUTIVE SUMMARY

Gray's Lake is a kettle shaped, 80-acre glacial lake, located in Avon Township just north of Route 120 in the Village of Grayslake. As with many residential lakes in the County, the shoreline of Gray's Lake is almost fully developed with residential housing encompassing the lake. The lake's main uses are recreational boating (no motors allowed), fishing, and swimming. There are five access points on the lake, three that are open to the residents of Grayslake and two that are only open to the surrounding subdivision . The Grayslake Park District along with the Gray's Lake Lake Management Committee have taken an active role in management of the lake including fish stocking, park maintenance, and aquatic plant management since 1989. Prior to this management was sporadic and on a "as necessary" basis.

Gray's Lake's water quality is *above average* in comparison to many other lakes in Lake County. Nutrient concentrations are low and with the assistance of healthy aquatic plant densities, keep nuisance algae blooms to a minimum. This has resulted in above average water clarity. Dissolved oxygen concentrations were also good (>5.0 mg/L) and a large majority of the lake (>88%) is able to support aquatic life. Other water quality parameters were also at or near acceptable levels during the 2002 study and have gone largely unchanged for over a decade.

Nuisance aquatic plant densities, which have been a problem in the past, have been kept to a minimum in the past decade. Currently, Eurasian water milfoil growth is at low densities maintained by periodic herbicide applications. Additionally, herbicide application rates have been lowered from a higher initial treatment rate in 1991 to much lower rates in recent treatments (2001). This was done in order to allow native plant species to become reestablished and then to maintain good densities. Future rates should remain low (5-6 ppb) and some improvements/fine adjustments could be made to plant management strategies to ensure that fewer native species are affected by these treatments. Milfoil densities should continue to be monitored to ensure that they do not once again increase and force out more beneficial, native vegetation.

The shoreline of Gray's Lake is fully developed and a vast majority is seawalled or rock rip rapped. While this can cause a variety of problems for the lake, it has kept Gray's Lake's shoreline somewhat protected from erosion. The highly invasive species purple loosestrife was found during shoreline assessment. Every effort should be made to eliminate this invasive plant from the shores of Gray's Lake. The Park District, as well as individual property owners, should promote and implement the use of naturalized shoreline types, such as buffer strips of native vegetation, when replacing existing structures. Additionally, emergent shoreline vegetation could be planted in near shore areas. This will benefit not only the water quality of Gray's Lake, but should also improve the wildlife habitat surrounding the lake. Some steps have been taken to improve sport fishing through fish stocking. However, there is more that could be done to the condition of the shoreline and to improve wildlife habitat on Gray's Lake. Despite a few areas for improvement, Gray's Lake is a good quality natural resource and if properly managed will remain in this state.

LAKE IDENTIFICATION AND LOCATION

Gray's Lake is located just north of Route 120 in Avon Township and is entirely within the limits of the Village of Grayslake (T45N, R10E, Sections 27 & 34). Gray's Lake is an oval shaped, 80 acre glacial lake with a current maximum depth of 20 feet and an average depth of 5.7 feet and lake volume is approximately 449.8 acre-feet (Lake County Health Department-Lakes Management Unit [LMU] morphometric data) (Figure 1). Gray's Lake is part of the Mill Creek drainage basin, which is part of the Des Plaines River watershed. There is a spillway on the west side of the lake, which controls the drainage from Gray's Lake into Mill Creek. Flow continues northward to Third Lake and eventually into the Des Plaines River. The lake's watershed is relatively small (approximately 230 acres) consisting of stormwater drainage from houses surrounding the lake. Watershed land-use is entirely residential, which is a change from past LMU studies that report the watershed still contained some agricultural and forested land.

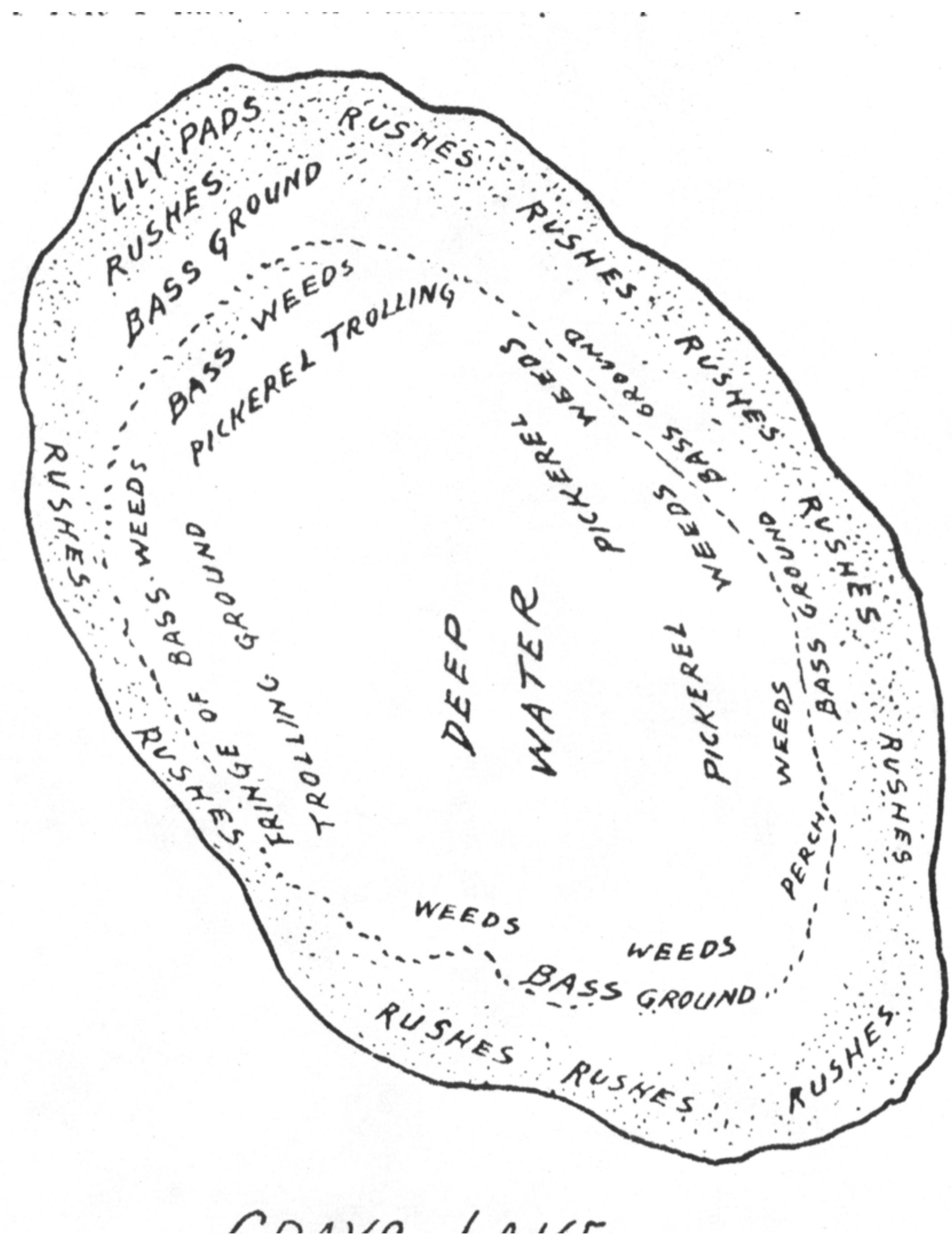
BRIEF HISTORY OF GRAY'S LAKE

In C.F. Johnson's 1896 book titled, *Angling in the Lakes of Northern Illinois,* he includes a brief chapter on Gray's Lake along with a hand drawn illustration of the lake (Figure 2). Johnson's details of the lake are almost nonexistent as he spends most of the chapter on anecdotal stories that have nothing to do with Gray's Lake. Although Johnson's writings are brief he does make note of large areas of rushes that encompassed the lake in addition to several areas of "bass weeds" which were probably large leaf pondweed ~*Potamogeton amplifolius* or Illinois pondweed~ *Potamogeton illinoensis*. Regretfully, these rush beds have been drastically reduced and now only occupy a small area in the northern part of the lake. However, the "bass weeds' are still present in the form of Illinois Pondweed, which can be found throughout the shallow areas of the lake. The Village of Grayslake and the Grayslake Park District (GLPD) along with the Gray's Lake Lake Management Committee oversee the management of the lake. The GLPD conducts such management activities as park maintenance, fish stocking, and aquatic plant management. The GLPD bought an aquatic weed harvester in 1992. Use was discontinued in 2000 due to the efficacy of herbicide treatments and was sold in 2002. The GLPD has been using aquatic herbicides to control nuisance plant growth since the mid 1970's but not on a regular basis until 1991 when the GLPD started using fluridone to successfully manage nuisance aquatic weeds. This has lead to a balanced native aquatic plant population.

SUMMARY OF CURRENT AND HISTROICAL LAKE USES

Access to Gray's Lake is open year round to all residents of the Village of Grayslake through several access points around the lake as well as private residences (Figure 3). Bottom ownership is split between the Village, subdivisions and about five dozen private owners. Launching of watercraft by non-residents and non-approved personnel at the access points is prohibited. Recreational opportunities on Gray's Lake have gone

Figure 2. C.F. Johnson depiction of Gray's Lake circa 1896.



unchanged for over the last 100 years and largely consist of boating (no motors of any kind allowed), swimming, and fishing. The no motor policy is enforced by the Village of Grayslake as it is a Village ordinance. There is an Illinois Department of Public Health licensed bathing beach at Jone's Park, which is monitored for *E. coli* bacteria levels by the Lake County Health Department on a bimonthly basis from early May through Labor Day. In the past five years, the beach at Jone's Island has only been closed once due to high bacteria levels. Four other access points on the lake offer fishing and boat launching areas but no beaches. There are two access points on the east side of the lake that are private (Grayslake Park and Moore's) and one that is public to Grayslake residents (George Street). On the west side of the lake, there is one access that is public to Grayslake residents (Bluff Street). Additionally, several residents on the lake have private beaches on their property. Wildlife viewing opportunities are limited due to a lack of quality habitat areas as is the case with most residential lakes in Lake County. However, some waterfowl do frequent the lake during certain times of the year (see *Limnological Data - Wildlife Assessment*).

LIMNOLOGICAL DATA - WATER QUALITY

Water samples collected from Gray's Lake were analyzed for a variety of water quality parameters. Samples were collected at three feet from the surface and three feet off the bottom (15-16 foot deep) at the deep hole location in the lake (Figure 3). Gray's Lake is thermally stratified, which means the lake divides into a warm upper water layer (epilimnion) and cool lower water layer (hypolimnion). This stratification is due to the deep lake morphology of Gray's Lake (see *Interpreting Your Lake's Water Quality* for further explanation). The lake did not become stratified until June and then remained stratified for the rest of the summer until September when fall turnover (mixing of the layers) had occurred. This separation of the lake into layers and mixing in September is reflected in the water quality data. Below is a discussion of the highlights from the complete data set for Gray's Lake (Table 1, Appendix A).

Dissolved oxygen (DO) concentrations in Gray's Lake were *good* during the entire study. The amount of the lake that had enough DO to support aquatic life (>5.0 mg/L) ranged between 88-100% of the total lake volume. Furthermore, DO profiles show that anoxic conditions (DO = 0 mg/L) only formed during July and August. Additionally, the volume of the lake that becomes anoxic is very small (<10%). When DO concentrations drop below 1.0 mg/L (hypoxia), biological and chemical processes release nutrients into the water, which are sequestered in the hypolimnion due to stratification. These nutrients are mixed into the lake during fall turnover. Due to the large oxic volume of Gray's Lake, the sequestered nutrients from the hypolimnion are diluted (0.006 mg/L increase) and seem to be having minimal impacts on nutrient concentrations after fall turnover (September).

Secchi disk depth is a direct indicator of clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. Based on Secchi depth, Gray's Lake has *above average* water quality. The 2002 average Secchi disk depth on Gray's Lake was 8.46 feet, which is greater than the Lake County median Secchi depth of 3.81 feet. Monthly readings varied slightly from each other, which can be related to suspended organic and inorganic particles in the water column. However, the June Secchi depth was much deeper (15.1 feet) than the other months (5.77 – 7.74 feet). This deeper Secchi depth might have been caused by the low concentrations of suspended solids, such as planktonic algae and sediment due to the extensive growth of curly leaf pondweed throughout the lake in May and June. Overall, the better than average Secchi depth is due to a variety of reasons including the lakes deep morphology, good aquatic plant densities, low nutrient concentrations, and the "no motor" policy. The 2002 average Secchi depth for Gray's Lake differed when compared to past Lakes Management Unit (LMU) and Volunteer Lake Monitoring Program (VLMP) measurements. The 2002 average Secchi depth on Gray's Lake is the deepest that it has been in past 14 years (Figure 4). Although limited data exists, seasonal average Secchi depth has been as shallow as 3.4 feet (1988) and as deep as 8.46 feet (2002). A possible explanation for these fluctuations could be changes in aquatic plant management activities. Herbicides are used to control nuisance aquatic vegetation, which compete with algae for available resources. After treatment, the algae can grow inhibited by plants, which could increase turbidity and decrease Secchi depth. In past treatments, higher concentrations of herbicides were used, which would have removed more vegetation and thus indirectly reduced clarity. However, since little data exists for Gray's Lake it is difficult to conclusively determine what causes these fluctuations.

Average total suspended solids (TSS), which is a measurement of suspended particles in the water such as silt, clay, algae and organic matter, was 2.3 mg/L, which is well below the County median of 6.0 mg/L. Additionally, average TSS in 2002 was much lower than the1988 and 1996 average concentration of 9.0 mg/L and 5.4 mg/L, respectively. This decrease in suspended solids is also evident in the increased average Secchi depth over past years. Calculated nonvolatile suspended solids (NVSS), which is the part of TSS that is inorganic particles (such as sediment) was also very low (1.7 mg/L). NVSS accounted for a large majority (74 %) of the TSS, which is reflected in the low occurrence of planktonic algal blooms on Gray's Lake. This can be attributed to several factors including good aquatic plant densities, low nutrient concentrations, deep morphology, and the no motor policy. Average total dissolved solids (TDS), total solids (TS), total volatile solids (TVS) were all at or below their respective County medians. Furthermore, other parameters such as conductivity, pH, and alkalinity were at normal levels for the County and remained fairly stable throughout the study.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. In 2002, Gray's Lake had a TN:TP ratio of 34:1, which means that the lake is highly phosphorus limited. Due to the highly phosphorus limited nature of Gray's

Lake, external inputs of phosphorus should be carefully monitored as even small increases could trigger algae blooms. The 2002 ratio was slightly lower than past studies, which showed Gray's Lake to be even more phosphorus limited (47:1 in 1996). This is due to an increase in the average TP concentration as well as a decrease in the nitrogen concentrations over the 1996 study. No comparisons can be made to the 1988 LMU study due to the lack of sufficient nutrient data.

The average total phosphorus (TP) concentration in Gray's Lake in 2002 was 0.030 mg/L, which is below the County median concentrations of 0.056 mg/L. The average phosphorus concentrations in 1996 and 1988 were slightly lower (0.023 mg/L and 0.02 mg/L, respectively). TP concentrations fluctuated slightly throughout the 2002 study and ranged from 0.018 - 0.066 mg/L. These fluctuations are similar to the Secchi disk data and could be related to variations in the amount of algae or sediment (TSS) in the water column (Figures 5 & 6). Additionally, the highest TP concentration was in May before the lake stratified, which also corresponds with elevated TSS concentrations and decreased Secchi depth. After stratification, TP concentrations remained fairly steady. In the hypolimnion, TP concentrations were similar to those of the epilimnion throughout the study. Average hypolimnetic TP concentrations were 0.039 mg/L, which is slightly higher than the epilimnetic concentration but is significantly lower than the median Lake County *hypolimnetic* TP concentration of 0.170 mg/L. Furthermore, hypolimnetic TP concentrations in Gray's Lake were lower than the median *epilimnetic* concentrations for the County. This could be due to the well-oxygenated conditions of the hypolimnion for most of the study. Additionally, the amount of the anoxic hypolimnion was very low (8%).

In lakes, phosphorus originates from two sources. One source is from within the lake (internal). This is a common source of phosphorus in lakes, which contain nutrient rich sediment. Biological and chemical processes release phosphorus from the anoxic sediment. Since Gray's Lake is stratified, released phosphorous is sequestered in the hypolimnion where it stays until fall turnover. Additionally, sediment bound phosphorus is also mixed into the water column by wind/wave action. On Gray's Lake, sediment resuspension may be a source of TP due to the lake's large shallow shelf (78% of the lake is 6 feet deep or less). Phosphorus from the hypolimnion seems to be a minor source since concentrations remained low throughout the study. These low hypolimnetic TP concentrations were also observed in previous LMU studies. The other main input of phosphorus is from sources outside of the lake (external). These external inputs consist of a variety of sources. They can include fertilizer runoff and erosion. TP concentrations did not correlate with rainfall data, which may indicate that a majority of Gray's Lake's TP may be from internal sources (Figure 7). However, since phosphorus concentrations in Gray's Lake are so low, the source of this phosphorus may be difficult to pinpoint.

Nitrogen concentrations (NO_3-N & NH_3-N) were below detectable concentrations in the epilimnion for the duration of the study. As compared to the 1996 study, 2002 concentrations were lower for NO_3-N and were unchanged for NH_3-N and total Kjeldahl nitrogen (TKN), which as mentioned previously had an impact on the TN:TP ratio. As with hypolimnetic TP, average TKN and NH_3-N remained fairly stable and were well

below their respective County median values (1.170 mg/L & 1.250 mg/L). Hypolimnetic NO_3-N concentrations were the same as the epilimnetic concentrations, below detection limits.

Another way to look at phosphorus concentrations and how they affect the productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus. TSI values are commonly used to classify and compare lake productivity (trophic state). The higher the phosphorus concentration the greater amount of algal biomass, which then results in a higher TSI and corresponding trophic state. Based on a TSI phosphorus (TSIp) value of 53.3, Gray's Lake is classified as *eutrophic* ($\geq$50, <70 TSI). A eutrophic lake is defined as a productive system that has above average nutrient concentrations and high algal biomass (growth). Gray's Lake is slightly eutrophic and did experience small planktonic algal blooms throughout the summer. The limited nature of these blooms was partially due to Gray's Lake's aquatic plant community and the many benefits they bring (such as competition with algae for available resources) along with low nutrient concentrations. Without an established aquatic plant population, algal blooms in Gray's Lake might be more widespread and of greater intensity. TSI can also be calculated based on Secchi disk depth. Based on Secchi depth, Gray's Lake has a TSI of 46.3, which classifies the lake as mesotrophic ($\geq$40 <50). TSI can also be used to compare lakes within the County. Based on the average TSI phosphorus, Gray's Lake ranks 30 out of 103 lakes studied by the LMU between 1998-2002 (Table 2, Appendix A).

TSI values along with other water quality parameters can be used to calculate use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most impairment assessments (P, NO_3-N, NH_3-N, pH, DO, TDS, NVSS, noxious aquatic plant growth) were listed as *None*. The only impairment assessment was for *Exotic Species* due to the presence of Eurasian water milfoil and curly leaf pondweed. IEPA impairment indices such as Aquatic Life Use, Swimming Use, and Overall Use impairment, Gray's Lake was ranked as providing *Full* support. Under the Recreational Use index Gray's Lake was ranked as providing *Partial* support due to the coverage of aquatic vegetation. However, the benefits of the aquatic vegetation far outweigh any negative impacts they may have on recreational opportunities on Gray's Lake.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization. Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). Shoreline plants of interest were also observed (Table 3). However, no surveys were made of these shoreline species and all data is purely observational. Based on a floristic quality index (FQI), aquatic plant *diversity* on Gray's Lake is slightly above average. The FQI 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

Table 3. Aquatic and shoreline plants on Gray's Lake, May – September 2002.

<u>*Aquatic Plants*</u>	
Chara	*Chara* sp.
Coontail	*Ceratophyllum demersum*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Curlyleaf Pondweed	*Potamogeton crispus*
Illinois Pondweed	*Potamogeton illinoensis*
Sago Pondweed	*Potamogeton pectinatus*
Slender Naiad	*Najas flexilis*
Spiny Naiad	*Najas marina*
White Water Lily	*Nymphaea tuberosa*
Spatterdock	*Nuphar variegatum*
Water Star Grass	*Heteranthera dubia*
Water Shield	*Brasenia schreberi*
<u>*Shoreline Plants*</u>	
Barnyard Grass	*Echinochloa crusgalli*
Blue Flag Iris	*Iris hexagona*
Bull Thistle	*Cirsium vulgare*
Burr Marigold	*Bidens mitis*
Canada Thistle	*Cirsium arvense*
Common Arrowhead	*Sagittaria latifolia*
Common Cattail	*Typha latifolia*
Common Milkweed	*Asclepias syriaca*
Cottonwood	*Populus deltoides*
Grass-leaved Arrowhead	*Sagittaria graminea*
Green Foxtail	*Setaria viridis*
Hardstem Bulrush	*Scirpus acutus*
Pickerelweed	*Pontederia cordata*
Purple Loosestrife	*Lythrum salicariajmk*
Swamp Loosestrife	*Decodon verticillatus*
Water Smartweed	*Polygonum amphibium*
Weeping Willow	*Salix alba tristis*
White Oak	*Quercus alba*

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). For this assessment, each submersed and floating aquatic plant species (emergent shoreline species were not counted) in the lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). Nonnative species were also counted in the FQI calculations for Lake County lakes. We then averaged these numbers and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. During the 2002 study, Gray's Lake had an FQI of 16.9. The Lake County average for 2000-2002 was 14.2 (86 lakes). This FQI indicates that Gray's Lake has slightly *above average* aquatic plant diversity.

During the 2002 study, twelve species of aquatic plants were found (including the macro alga *Chara* sp.). The months with the highest plant diversity were July and August, in which all twelve species were collected (Table 4, Appendix A). The most frequently occurring species during the study was *Chara*, which occurred at 41% of all sample sites (May-September). Although a desirable species, *Chara* does not provide the quality habitat that higher vascular macrophytes can provide. A possible reason for this average species diversity is the use of aquatic plant management techniques such as herbicides. During the past 30 years Gray's Lake has been using herbicides to control nuisance plant growth. A side effect of these treatments can be the loss of species diversity. This is often the case in lakes with intensive aquatic plant management programs. During past LMU studies, fifteen species of aquatic plants had been identified compared to twelve found in 2002. The use of aquatic herbicides (i.e., Sonar™ and Aquathol-K®) could also be an explanation for the dominance of *Chara*. Since *Chara* is an alga, it is unaffected by most herbicides (copper sulfate is only used as a spot treatment) and it can then grow uninhibited by other plant growth. Other plants that were commonly found during the 2002 study included sago pondweed (36%), water stargrass (34%), slender naiad (21%), and Illinois pondweed (10%). Other noteworthy plants that were found included water shield and hard stem bulrush.

Although aquatic plant *diversity* was average, aquatic plant *densities* on Gray's Lake were very good. 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, aquatic plant coverage (bottom coverage) of the lake could have been as high as 100% of the surface area (bottom coverage) and could have grown to a depth of 16 feet. We found during our 2002 study that plants did not grow to this depth and plants grew to a maximum depth of 13.0 feet, which is about 90% of the surface area of the lake. However, plant growth within this vegetated zone was sporadic and actual bottom coverage was about 50-60%. This can be attributed to variations in substrate types (overly sandy/rocky) that may be unable to support aquatic plant growth. This is also a possible explanation as to why plants were not found at depths greater than thirteen feet even though light levels were adequate. Additionally, herbicide treatments may have contributed to the sporadic growth. Since treatments are conducted every year densities are unable to reach problematic/dense levels. Despite these substrate limitations and herbicide usage, Gray's Lake has healthy plant densities. Furthermore, these healthy densities do not interfere with lake usage, as plants in the deeper water do not reach the surface. These healthy plant densities are one of the major reasons Gray's Lake has good water quality and is such good overall condition.

Sonar™(fluridone) was used at a higher rate (15 parts per billion {ppb}) initially in 1991 and 1992 to treat excessive stands of Eurasian water milfoil (EWM) and curly leaf pondweed. Since 1994 fluridone rates have been consistently lowered to adjust for changes in the aquatic plant population and to cause as little damage to the native plant community as possible. Now that the plant densities have been reduced to acceptable levels and EWM is no longer problematic, Sonar™ rates have been properly lowered to 6 ppb. These lower "maintenance" rates (and competition from natives) appear to be keeping the EWM at reduced densities. Eurasian water milfoil was only found at 4 out of 153 sites in 2002. Furthermore, Sonar™ applications have been properly spaced out with at least two years between treatments. This has allowed the native plant species to recover, which is beneficial for the water quality of Gray's Lake as well as the lake's fishery. In recent years native plants have become reestablished, which then helps to naturally control EWM densities. This can help to reduce the amount of herbicide needed for future treatments. The GLPD should make every effort to educate the homeowners and lake users about the perils of Eurasian water milfoil and how to prevent its spread in Gray's Lake. The use of FasTest™ to monitor fluridone concentrations should continue in order to ensure Sonar™ is being maintained at the desired concentration. Currently fluridone treatments are conducted every two years. In the future, the GLPD may want to consider treating every three years. This would provide an additional year for natives to become established before another whole lake treatment is conducted. The GLPD can continue to use Aquathol-K® and chelated copper products as spot treatments to control excessive curly leaf pondweed (CLP) and algae blooms in years when fluridone is not used. By keeping CLP densities under control more light and other resources are available to the more beneficial native plant species. Another alternative is to start spot treating the EWM since it now only grows in isolated patches. This would eliminate the need for whole lake treatments, which would be beneficial to the desirable native species. Additionally, there are alternative application methods for fluridone that might prove to be more effective for Gray's Lake such as late fall and winter treatments.

Now that EWM densities have been significantly reduced, CLP has now become problematic in the spring since competition from EWM is no longer present. CLP is an early season (cooler water) growing plant commonly reaching peak densities in early/mid June followed by a large dieback by the end of June. Studies have shown that if CLP is treated *before* the formation of turions (reproductive structures), densities can be reduced in subsequent years. This is due to the fact that the turions are only viable for two to three years. Since GLPD is treating every year (either with Sonar™ or Aquathol-K®), turion densities, and resulting CLP growth, may be reduced if the plants are treated **before** turion formation. However, treatment of the CLP did not take place this year until June 17, which is after turion formation. Furthermore, treatment this late may not be necessary since CLP naturally dies off usually by the end of June. Treatment of the CLP before turion formation has been suggested in the past by Marine Biochemists (the firm that treats the lake) and it is the recommendation of the LMU that this practice should be implemented by the GLPD.

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Gray's Lake on July 31 and August 1, 2002. The shoreline was assessed for a variety of criteria (*Appendix B* for methodology). At the time of the assessment, 96% of Gray's Lake's shoreline (10,173 feet) was developed. The majority of developed shoreline consists of rip rap (4,188 feet or 39%) and seawall (3,963 feet or 37%) shoreline (Figure 8). Both of these shoreline types are considered *undesirable*. Rip rap offers little habitat and can be prone to erosion if not installed properly. Seawalls are *undesirable* because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediment, which can lead to a variety of water quality problems. Several rock rip rapped and seawalled areas on Gray's Lake were in disrepair and could be at risk to erosion in the future. There was a lower occurrence of other types of *undesirable* shoreline, such as manicured lawn (the third most common), which made up 11% (1,196 feet) of the shoreline. Lawn at the land-water interface can create problems due to the poor root structure of turf grasses, which is unable to stabilize soils and may lead to erosion. The occurrence of *desirable* shoreline types such as buffered shoreline (8%) and woodlands (1%) was low. Shoreline that has established, *well-maintained* buffer strips are less likely to experience erosion and also provides improved habitat for wildlife. It is also our recommendation that GLPD should promote the use of well-maintained, naturalized shoreline and to minimize the use of rip rap, seawalls, and manicured lawns GLPD should also promote the use of buffer strips of deep rooted native vegetation around the entire lake regardless of shoreline type. This includes establishing buffer strips behind seawalls, rip rap, and beaches.

The overall occurrence of erosion on Gray's Lake is *moderate*. Based on the LMU assessment, 77% (8,237 feet) of shoreline on Gray's Lake was listed as having no erosion. This is largely due to the overwhelming dominance of rip rap and seawall shoreline, which are not normally prone to erosion. The occurrence of eroded shoreline was: *Slight* ~ 12%, *Moderat*e ~ 11%, with no shoreline assessed as having *Severe* erosion. (Figure 9). These eroded shorelines were made up of poorly maintained seawalls, rip rap, manicured lawns, buffer areas, and beach. Rehabilitating the *slight* and *moderate* erosion areas on the lake would not be overly difficult. In some cases it would involve minimal cost and effort for homeowners to retrofit or repair damaged seawall and rip rap areas, which would prevent future damage to these shorelines. Additionally, water levels in Gray's Lake fluctuated on a monthly basis during the 2002 study. Extreme water level fluctuations can have a negative impact on shoreline erosion. In the spring, the lake level increased 2.5 inches from May to June. After spring rains, the lake fell 5.25 inches but then remained stable (+/- 1.75 inches) the rest of the study. Total overall lake level fluctuation was a decrease of 2.75 inches from May through September.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Wildlife observations were made on a monthly basis during water quality and plant sampling actives (Table 5). All observations were visual. Wildlife habitat on Gray's Lake is above average for a residential lake. On many lots around the lake there are healthy populations of mature trees that provide good 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 several areas for habitat improvement on Gray's Lake. The invasive species purple loosestrife was observed along the shores of Gray's Lake on 43 different properties out of 123 that were assessed (Figure 10). This nuisance species should be controlled or eliminated before it spreads and becomes more established displacing more desirable native species such as pickerel weed and common arrowhead. These invasive plants are seldom used by wildlife for food or shelter. Additionally, shoreline habitat should be improved after their removal and should include native buffer strips and more naturalized shoreline areas.

The GLPD has had a fish-stocking program since 1994, which was started to improve the condition of the largemouth bass fishery. In 1994, 1995, 1996, and 1998, approximately 1,580, 4-inch largemouth bass per year were stocked in Gray's Lake. Since the implementation of the stocking program, IDNR fish surveys have shown fluctuations in the largemouth bass populations. Overall, there has been an improvement in the condition of the bass population. Additionally, GLPD has also stocked approximately 237 8-inch northern pike fingerlings per year in the same years that largemouth bass stockings have occurred. The GLPD should continue to monitor the fishery health with IDNR surveys and continue to follow their stocking and harvest recommendations. Additionally, the GLPD could further improve habitat by installing artificial structures such as fish cribs. Historically, the IDNR has reported that Gray's Lake contains the Black Chinned shiner, a State threatened minnow species.

Table 5. Wildlife species observed on Gray's Lake, May – September 2002.

<u>*Birds*</u>	
Mallard	*Anas platyrhnchos*
Ring-billed Gull	*Larus delawarensis*
Great Blue Heron	*Ardea herodias*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Zenaida macroura*
Eastern Pewee	*Contopus virens*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Blue Jay	*Cyanocitta cristata*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Scarlet Tanager	*Piranga olivacea*
House Sparrow	*Passer domesticus*
Palm Warbler	*Dendroica palmarum*
Wilson's Warbler	*Wilsonia pusilla*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Magnolia Warbler	*Dendroica magnolia*
Mourning Warbler	*Oporornis philadelphia*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
American Goldfinch	*Carduelis tristis*
Northern Cardinal	*Cardinalis cardinalis*

EXISTING LAKE QUALITY PROBLEMS

Gray's Lake currently has *good* water quality in comparison to many other lakes in Lake County. Water quality has remained fairly stable over the past 14 years and an increase in clarity has occurred. Successful control of Eurasian water milfoil and less aggressive management of native aquatic vegetation has helped maintain good plant densities and the overall quality of the lake. Recreational opportunities for boating, swimming, and fishing have been maintained and in some circumstances are being enhanced. The Village of Grayslake, the Grayslake Park District, and the Gray's Lake Lake Management Committee have used available resources to its advantage and should be complimented on the overall condition of Gray's Lake. However, there are a few areas for improvement.

- *Shoreline Condition*

  The majority of developed shoreline consists of rip rap (39%) and seawall (37%). Both of these shoreline types are considered *undesirable* because they offer little habitat and can reflect wave action back into the lake disturbing near shore sediment both of which negatively effect overall lake health. Additionally, *poorly* installed/maintained rip rap and seawalls can be prone to erosion. There are several seawalled and rip rapped properties on Gray's Lake that are in disrepair and may be prone to future erosion. The GLPD, as well as individual property owners should promote and implement the use of more naturalized shoreline types when replacing existing structures. The overall occurrence of erosion on Gray's Lake is moderate and the condition and/or physical type of this shoreline could be improved upon. Currently, 23% of the shoreline on Gray's Lake is experiencing either *Slight* (12%) or *Moderate* (11%) erosion. These eroded shorelines were made up of buffers, lawn, beach, seawall and rip rapped areas. The timely improvement of these eroded areas will prevent any further degradation. Another area of concern is the presence of invasive species such as purple loosestrife, which was found on 35% of the assessed parcels. This highly aggressive species should be eliminated before it spreads. Improvements in the condition of the shoreline could also better water quality, as well as benefit wildlife habitat.

POTENTIAL OBJECTIVES FOR GRAY'S LAKE MANAGEMENT PLAN

I. Shoreline Improvement and Erosion Control
II. Wildlife Habitat Improvement
III. Eliminate or Control Invasive Species

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Shoreline Improvement and Erosion Control

Some shoreline on Gray's Lake Eroding. 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 Gray's Lake a large majority of shoreline was found to be uneroded. However, approximately 23% (2,397 feet) of Gray's Lake shoreline had some form of erosion. These slightly and moderately eroded areas should be addressed as soon as possible in order to avoid further deterioration.

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

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 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* eroded shoreline, Gray's Lake would need approximately 1170 linear feet of rip rap. This would come to a cost of approximately $35,100 – $52,650. 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 Gray's 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 6 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 6 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, Gray's Lake would need approximately 1,227 linear feet of buffer strip. This would come to a cost of $18,405 – 24,540. It is advisable that buffer strips be planted on all appropriate shoreline areas on Gray's Lake including behind beach areas. This could be a cost sharing joint project between the lake front property owners and the Association. 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* eroded shorelines, Gray's Lake would need 180 linear feet of one of the above products on the moderate eroded areas of shoreline. This would cost approximately $29250 – 40,950. 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 Gray's 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*.

Option 1: No Action

This option means that the current land use activities will continue. No additional techniques will be implemented on Gray's 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 affects 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 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.

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 y the homewoner. 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 6 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 Gray's Lake.

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 Gray's 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.

Option 1: No Action

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

Pros

There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics when possible. Table 6 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 Gray's 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 Gray's 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 Gray's 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 7 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 7 for herbicide rates and prices. Total cost to treat the limited amount of purple loosestrife and other invasive species on Gray's Lake would be minimal and could be done by individual homeowners or the GLPD. 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. The GLPD more than likely has the equipment used in these types of applications so equipment costs could be drastically reduced for this option.