2001 SUMMARY REPORT
of
HIGHLAND LAKE

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Highland Lake is a kettle shaped 102 acre glacial lake in Avon Township near the intersection of Washington Street and Hainesville Road. As with many residential lakes in the County, Highland Lake's shoreline is fully developed with residential housing encompassing the lake. The main lake uses are recreational boating (no motors allowed), fishing, and swimming. There is no public access to the lake and the Highland Lake Property Owners Association oversees its management including fish stocking, park maintenance, and aquatic plant management.

The Association has taken an active role in maintaining/improving the overall quality of Highland Lake since its formation in 1959. Highland 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, which results in above average water clarity. Dissolved oxygen concentrations were also good (> 5.0mg/L) and a large majority of the lake is able to support aquatic life. Other water quality parameters were also at or near acceptable levels during the 2001 study.

Nuisance aquatic plant populations, which have been a problem in the past, have been kept to a minimum in the past decade. Currently, Eurasian water milfoil densities are being kept low by periodic herbicide applications. Additionally, herbicide application rates have been lowered from a higher initial treatment rate in 1990 to much lower rates in recent treatments (1997 and 2000). This was done in order to allow native plant species to become reestablished and maintain good densities. However, some improvements/fine adjustments could be made to plant management strategies to ensure that fewer native species are affected by these treatments. Future application rates should remain low (5-6 ppb). Milfoil densities should continue to be monitored to ensure that they do not become reestablished and force out more beneficial, native vegetation.

The shoreline of Highland Lake is fully developed and a vast majority have seawalls or rock rip rap. While this is problematic, and can cause a variety of problems for the lake, it has kept Highland Lake's shoreline protected from erosion. Shoreline development has also had a negative impact on wildlife habitat. Often, the only shoreline habitat consisted of invasive species (purple loosestrife, buckthorn, etc.), that offer little/poor quality habitat. Every effort should made to eliminate these invasive plants from the shores of Highland Lake. The Association, 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 Highland Lake, but should also improve the wildlife habitat surrounding the lake. Some steps have been taken to improve habitat, such as sinking fish cribs and creating a small wildlife refuge area on the lake. However, there is more that could be done to improve wildlife habitat on Highland Lake. Despite a few areas for improvement, Highland Lake is a good quality natural resource and if properly managed will remain in this state.

LAKE IDENTIFICATION AND LOCATION

Highland Lake is located at the intersection of Washington Street and Hainesville Road in Avon Township in unincorporated Lake County (T45N, R10E, Section 21, 22). Highland Lake is a round, 102 acre glacial kettle lake with a current maximum depth of 30+ feet and an average depth of 9.0 feet (Figure 1) (Lake County Health Department-Lakes Management Unit [LMU] morphometric data). Lake volume is approximately 926 acre-feet[1] (LMU, 1999 data). Highland Lake is part of the Long Lake/Squaw Creek drainage basin, which is part of the Fox River watershed. Highland Lake's watershed is relatively small (320 acres) consisting of drainage from Cranberry Lake and wetlands to the southeast and stormwater inputs from the houses surrounding the lake. There is a spillway on the north side of the lake, which controls the drainage from Highland to Round Lake. This drainage eventually flows into Long Lake and then into Fox Lake and the Fox River system. Watershed landuse is mainly residential with minor commercial. With the passing years, Highland Lake's watershed has become more developed. Recently, Softball City closed and the site is now being developed into residential housing. Additionally, the property across from Softball City on the southeast corner of Washington and Hainesville (adjacent to Cranberry Lake) is being developed into condominiums. These areas should be carefully monitored to ensure that their development is not negatively impacting the lake.

BRIEF HISTORY OF HIGHLAND LAKE

In C.F. Johnson's 1896 book titled, *Angling in the Lakes of Northern Illinois*, he refers to a lake that "is located one mile and a half from Gray's Lake Depot" which he calls Taylor's Lake (Figure 2). The lake Johnson was referring to was to become Highland Lake. In what year the lake took the name Highland is uncertain but it was after 1896. Johnson's writings on Highland Lake are limited, but he does note an ice house on the east shore. He also makes note of large areas of rushes that encompassed the lake in addition to several other areas of "bass weeds" (probably large leaf pondweed – *Potamogeton amplifolius*). Regretfully, these rush beds nor the "bass weeds" are present anymore. Management of the lake is overseen by the HLPOA, which was formed in October of 1959. The Association oversees management activities such as park maintenance, fish stocking, and aquatic plant management. Before the formation of the Association the lake was managed, but in no organized fashion.

SUMMARY OF CURRENT AND HISTROICAL LAKE USES

Access to Highland Lake is entirely private. The Highland Lake Property Owners Association (HLPOA) owns approximately 80% of the lake bottom. The remaining 20% is privately owned by 30 different residents. There are four HLPOA owned access points

[1] This lake volume was calculated at a time when the lake level was 4.5 inches below the spillway. Lake volume with the water at spillway level would be approximately 964 acre feet.

Figure 2. 1896 C.F. Johnson map of Taylor Lake (a.k.a. Highland Lake).

on the lake that are open year round to members (Figure 3). However, launching of watercraft by non-lake residents and non-approved personnel is prohibited. Recreational opportunities on Highland Lake have gone unchanged for over the last 100 years and largely consist of boating (no motors of any kind allowed), swimming, and fishing. In addition to the sandy swimming area located at Downey Park, several residents on the lake have private beaches on their property. Two other access points on the lake, Chic Park and Szontag Park offer picnic areas but no beach. The fourth access point on the lake is Hartnett Park, which is currently being rehabilitated into a small wildlife refuge area. For the rest of the lake, wildlife viewing opportunities are limited due to a lack of quality habitat 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*). In addition to these four points, there is a large swimming platform in the middle of the lake, which is owned by the HLPOA.

LIMNOLOGICAL DATA - WATER QUALITY

Water samples collected from Highland 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 (26-28 foot deep) at the deep hole location in the lake (Figure 3). Highland 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 Highland Lake (see *Interpreting Your Lake's Water Quality* for further explanation). However, during June, Highland mixed and then restratified in July (termed polymictic), and remained stratified for the rest of the study. This lapse in stratification was due to the change in weather, wind, and precipitation. This separation of the lake into layers (and mixing of the lake in June) is reflected in the water quality data. Below is a discussion of the highlights from the complete data set for Highland Lake (Table 1, Appendix A).

Secchi disk depth is a direct indicator of clarity as well as overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. Based on Secchi depth, Highland Lake has *above average* water quality. The 2001 average Secchi disk depth on Highland Lake was 6.58 feet, which is greater than the Lake County median Secchi disk depth of 4.18 feet. Monthly readings varied slightly from each other. These variations were related to suspended organic and inorganic particles in the water column. This 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. In 2001, the average Secchi depth for Highland Lake differed when compared to past Lakes Management Unit (LMU) and Volunteer Lake Monitoring Program (VLMP) measurements. Although limited data exists, seasonal average Secchi depth has been as shallow as 5.6 feet (1990) and as deep as 8.0 feet (1996) (Figure 4). This limited data shows that over the last 10 years Highland Lake has experienced slight fluctuations in Secchi disk depth. A possible explanation for these fluctuations might be due to Highland Lake's 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 uninhibited, which could increase turbidity and inhibit Secchi depth. However, since little data exists for Highland Lake it is difficult to conclusively determine what causes these fluctuations.

Dissolved oxygen (D.O.) concentrations in Highland Lake were *good* during the entire study. The amount of the lake that had enough D.O. to support aquatic life (>5.0 mg/L) ranged between 80-88% of the total lake volume. Average epilimnetic D.O. concentrations in September slightly decreased (6.81 mg/L) but were still above 5.0 mg/L. However, this is a natural phenomenon during fall turnover and is not an area of concern. Furthermore, D.O. profiles show that only 12-20% of the Highland Lake was hypoxic (D.O. <1.0mg/L). When D.O. concentrations drop below 1.0 mg/L, 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. However, this mixing of nutrients in the fall is not an area for concern since only a small portion of Highland Lake is hypoxic and thus a small volume of nutrient rich water is mixed.

Average total suspended solids (TSS), which is a measurement of suspended particles in the water such as silt, clay, algae and organic matter, was 3.3 mg/L, which was slightly higher than Highland Lake's 1996 average TSS of 2.4 mg/L. However, 2001 average TSS was still well below the County median of 5.7 mg/L. Calculated nonvolatile suspended solids (NVSS), which is the part of TSS that is nonorganic particles (such as sediment) was also very low (2.3 mg/L). NVSS accounted for a large majority (69.7%) of the TSS, which is reflected in the low occurrence of planktonic algal blooms on Highland Lake. This can be attributed to several factors including good aquatic plant densities, deep morphology, and no the motor policy. Average total dissolved solids (TDS), total solids (TS), total volatile solids (TVS) were all below their respective County medians. Furthermore, other parameters such as conductivity, pH, and alkalinity were at normal levels and remained fairly stable throughout the study.

Another very important measurement of water quality is nutrient concentrations. High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. 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. Highland Lake has a TN:TP ratio of 32:1, which means that the lake is highly phosphorus limited. *Due to the highly phosphorus limited nature of Highland Lake, external inputs of phosphorus should be carefully monitored as even small increases could trigger algae blooms.* The 2001 ratio was slightly lower than past studies, which showed Highland Lake to be even more phosphorus limited (48:1 in 1996) and is due to an increase in the average TP concentration.

The average phosphorus concentration in Highland Lake in 2001 was 0.030 mg/L. The average phosphorus concentration in 1996 was slightly lower (0.023 mg/L). However, the average phosphorus concentration in 1990 was 0.038 mg/L. These fluctuations are similar to the Secchi disk data and could similarly be related to variations in the amount of TSS (algae or sediment) in the water column. Another explanation could be periodic summer mixing of the epilimnion and hypolimnion, which had high TP concentrations. In the hypolimnion, TP concentrations increased during the course of the study. When the D.O. concentration drops below 1.0 mg/L biological and chemical processes release nutrients into the water. Average hypolimnetic TP concentrations were 0.079 mg/L, which is over double the epilimnetic concentration but is significantly lower than the median Lake County hypolimnetic TP concentration of 0.165 mg/L. Furthermore, hypolimnetic TP concentrations in Highland Lake were lower than the average *epilimnetic* concentrations for Lake County (0.087 mg/L).

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 Highland 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 where there is a lack of aquatic plants (which stabilize sediment). On Highland Lake, sediment resuspension may not be a major source of TP due to the lake's deep morphology and no motor policy. 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, failing septic systems and erosion. TP concentrations did not significantly correlate with rainfall data (Figure 5), which may indicate that a majority of Highland Lake's TP may be from internal sources.

Nitrogen concentrations (NO_3-N) were below detectable concentrations in the epilimnion for much of the study (May was the only month with detectable NO_3-N concentrations) in the epilimnion. As with hypolimnetic TP, total Kjeldahl nitrogen (TKN) and ammonia nitrogen (NH_3-N) had an increasing trend. As with TP, these elevated concentrations are due to hypoxia. However, in contrast to the TP concentrations, nitrogen concentrations in the hypolimnion were above their respective County averages. Average hypolimnetic TKN in Highland Lake was 3.06, which was higher than County median of 2.150 mg/L. Average NH_3-N concentrations in Highland Lake were 2.02 mg/L compared to the County median of 1.270 mg/L. However, the hypoxic volume for the lake is low and these elevated nitrogen concentrations are not of any real concern.

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 value of 53.3, Highland 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). Highland Lake is slightly eutrophic and did experience small planktonic algal blooms throughout the summer. The limited nature of these blooms was partially due to Highland Lake's aquatic plant community and the many benefits they bring (such as competition with algae for available resources). Without an established aquatic plant population, algal blooms in Highland Lake might be more widespread with greater intensity.

TSI can also be used to compare lakes within the County. Based on the average phosphorus TSI, Highland Lake ranks 30th out of 102 lakes studied by the LMU between 1988-2001 (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). All impairment assessments (P, NO_3-N, NH_3-N, pH, D.O., TDS, NVSS, noxious aquatic plant growth, exotic species) were listed as *None*. For all the IEPA impairment indices, such as Aquatic Life Use, Recreational Use, Swimming Use, and Overall Use impairment, Highland Lake was ranked as providing "Full" support.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

A healthy aquatic plant population is critical to good lake health. Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants 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 Highland Lake is *average* (Table 3). 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 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 2001 study, Highland Lake had an FQI of 14.5. The Lake County average for 2000-2001 was 14.0. This FQI indicates that Highland Lake has *average* aquatic plant diversity.

During the 2001 study, nine species of aquatic plants were found (including the macro alga *Chara* sp.). The month with the highest plant diversity was September, which included collection of all nine species. The most frequently occurring species during the study was *Chara*, which occurred at 40% 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 decade Highland 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 aquatic plant management programs. For comparison, nearby Round Lake and Cranberry Lake, which do not have aquatic plant management programs, have much higher species diversity with FQI's of 17 species/23.5 FQI and 27 species/37.2 FQI, respectively. The removal of aquatic plant species with herbicides (i.e.,Sonar™) is also the explanation for the dominance of *Chara*. Since *Chara* is an alga, it is unaffected by Sonar™ and can grow uninhibited by other plant growth. This allows for the expansion in *Chara* densities. Other plants that were commonly found during the 2001 study included sago pondweed (38% occurrence) and small pondweed (22 % occurrence).

Although aquatic plant *diversity* was average, aquatic plant *densities* on Highland Lake were *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 of the lake could have been as high as 83% of the surface area (bottom coverage) and could have grown to a depth of 18 feet. We found during our study that plants did not grow to this depth in 2001. Aquatic plants grew from a maximum depth of 9 feet (Table 4, Appendix A), which is about 72% of the surface area of the lake. However, plant growth within this vegetated zone was sporadic and actual bottom coverage was about 35-40%. This can be attributed to variations in substrate types 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 nine feet even though light levels were adequate. Despite these substrate limitations, Highland 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 densities are part of the reason Highland Lake has good water quality.

Sonar™ was used at a higher rate (16 parts per billion {ppb}) initially in 1990 to treat excessive stands of Eurasian water milfoil (EWM) and curly leaf pondweed. Now that the plant densities have been reduced to acceptable levels and EWM (and curly leaf pondweed) is no longer problematic, Sonar™ rates have been properly lowered. These lower "maintenance" rates (and competition from natives) appear to be keeping the EWM at reduced densities. Eurasian water milfoil and northern water milfoil were only found at a combined 13 out of 182 sites in 2001. Furthermore, Sonar™ applications have been properly spaced out with two to three years between treatments. This allows the native plant species to recover, which is beneficial for the water quality of Highland Lake as well as the lake's fishery. Additionally, native plants, once established, may out-compete the milfoil, which can naturally control the invasive plant and reduce the amount of herbicide needed for future treatments. The HLPOA should continue to educate the homeowners and lake users about the perils of Eurasian water milfoil and how to prevent its spread in Highland Lake. Curly leaf pondweed densities may continue to decrease with the passing years. Studies have shown that if curly leaf pondweed is treated before the formation of turions (reproductive structures), densities are reduced. This is due to the fact that the turions are only viable for two to three years. Since HLPOA is not

treating every year, (nor should they) turion densities may not be reduced. However, curly leaf pondweed was not problematic during the 2001 study.

The Sonar™ application rates were supposed to be 13 ppb in 1990, 8.7 ppb in 1993, 7.0 ppb in 1995, 5.5 ppb in 1997 and 6.5 ppb in 2000. However, the Sonar™ rates were based on an older lake volume (1143 acre-feet vs. 926 acre-feet) and the actual application rate was probably higher than intended. Based on the lake volume of 926 acre feet the treatments would actually have been closer to 16.0 ppb in 1990, 10.8 ppb in 1993, 8.8 ppb in 1995, 6.8 ppb in 1997 and 8.0 ppb in 2000. These over applications should no longer take place since the LMU has completed a bathymetric study of Highland Lake and has produced an accurate bathymetric map and morphometric data including the correct volume of Highland Lake. Furthermore, the application rate in 1996 (6.8 ppb) was successful but for no apparent reason the rate was increased for the 2000 treatment (8.0 ppb). All efforts should be made to keep Sonar application rates as low as possible (5.0-6.0 ppb, preferably). Additionally, future applications should take into account the current lake level and adjust the LMU volume accordingly. It is also recommended that FasTest be used during the next treatment of Highland Lake. FasTest is a bioassay offered by SePro (the manufacturer of Sonar™) that measures the concentration of fluridone in the lake after application. This will allow HPLOA to monitor fluridone concentrations and adjust future treatments accordingly. Furthermore, HLPOA could also use EffecTest, which is a bioassay that tests the sensitivity of Highland Lake's aquatic plants to Sonar™. This would allow HLPOA to select a concentration of Sonar™ specifically for Highland Lake that would still remove the milfoil but cause less damage to the native plant population. Additionally, there are alternative application methods for fluridone that might prove to be more effective for Highland Lake such as late fall and winter treatments. Another company, Griffin, now makes its own fluridone product called Avast™, which is the exact same product as Sonar™.

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

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Chara (macrophytic algae)	*Chara* sp.
Eurasian Water Milfoil	*Myriophyllum spicatum*
Northern Water Milfoil	*Myriophyllum sibiricum*
Curlyleaf Pondweed	*Potamogeton crispus*
Small Pondweed	*Potamogeton pusillus*
Sago Pondweed	*Stuckenia pectinatus*
Horned Pondweed	*Zannichellia palustris*
Vallisneria	*Vallisneria americana*
Shoreline Plants	
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Buckthorn	*Rhamnus cathartica*
Softstem Bulrush	*Scirpus validus*
Common Cattail	*Typha latifolia*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted at Highland Lake on July 12th, 2001. The shoreline was assessed for a variety of criteria (*Appendix B* for methodology). Based on this assessment, several important findings were made. At the time of the assessment, 98% of Highland Lake's shoreline (8,056 feet) was developed. This number has increased to 100% with the development of Hartnett Park. The majority of developed shoreline consists of rip rap (3,544 feet or 43 %) (Figure 6). Seawalled shoreline was the second most abundant type (2,635 feet or 32%). Both of these shoreline types are considered *undesirable*. Rip rap offers little habitat and can be prone to erosion if not installed properly. Several rock rip rapped areas on Highland Lake were in disrepair and could be at risk to erosion in the future. 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. There was a low occurrence of other types of *undesirable* shoreline, such as manicured lawn, which made up 5% (375 feet) of Highland Lake's 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* buffered shoreline was low and only accounted for 10% (840 feet) of total shoreline length. Shoreline that has established *well-maintained* buffer strips are less likely to experience erosion and also

provide improved habitat for wildlife. It is also our recommendation that HLPOA should promote the use of well-maintained, naturalized shoreline and to minimize the use of rip rap, seawalls, and manicured lawns to the shoreline edge. It is the recommendation of the LMU for HLPOA to 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 and rip rap.

The overall occurrence of erosion on Highland Lake is *low*. Based on the LMU assessment, 91.2% (7522 feet) of shoreline on Highland was listed as having no erosion. This is largely due to the overwhelming dominance of rip rap and seawall shoreline. Additionally, water levels in Highland Lake fluctuated very little over the summer. Extreme water level fluctuations can have a negative impact on shoreline. In the spring lake levels only changed 2.88 inches from May to June. After spring rains, the lake fell 6.7 inches but then remained stable (+/- 1.8 inches) the rest of the study. The occurrence of eroded shoreline was low: *Slight* ~ 4.3%, *Moderat*e ~ 2.2%, and *Severe* ~2.3% (Figure 7). These eroded shorelines were made up of poorly maintained seawalls, manicured lawns, and unmanaged shrub areas. The area of severe erosion (Hartnett park), which was at the inlet, is in the process of being rehabilitated. This area was the recipient of an Illinois First grant for $100,000. The project began in the fall of 2001 and will be completed in the spring of 2002. This area will now serve as a wildlife refuge. Rehabilitating the *slight* and *moderate* erosion areas on the lake would not be overly difficult. It would involve minimal cost and effort for homeowners to retrofit these areas and prevent future damage to these shorelines.

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 Highland Lake is minimal. On many lots around the lake there are healthy populations of mature trees that provide good habitat for a variety of bird species. During the September sampling, an Osprey, an Illinois endangered species, was observed soaring over the lake. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species. However, there are several areas for habitat improvement on Highland Lake. Two invasive species, purple loosestrife and buckthorn, were observed along the shores of Highland Lake on 20 different properties (Figure 8). These nuisance species should be controlled or eliminated before they spread and become more established displacing more desirable native species. These plants are seldom used by wildlife for food or shelter. Additionally, shoreline habitat should be improved after their removal and should include buffer strips and more naturalized shoreline areas (*see Objective VI: Wildlife Habitat Improvement*).

One area of concern on Highland Lake is the population of seagulls and resident Canada geese. Several times over the course of the summer, a number of gulls were observed. Additionally, Highland Lake may be a building number of Canada geese. These

sometimes nuisance birds produce a tremendous amount of waste, which was apparent on the swimming platform in the middle of the lake and at beaches along the shoreline. This waste is extremely high in phosphorus, which is an unwanted nutrient addition into Highland Lake. There are several techniques to control nuisance Canada geese that could easily be implemented on Highland Lake (see Management *Objective IV: Reduce Numbers of Canada Geese*). However, there is little that can be done to deter the gulls. *Absolutely no one should feed either of these birds*.

Highland Lake Property Owners Association has an active fish-stocking program that has been in place for decades. In 1995, largemouth bass, muskie, and walleye were stocked (muskie fishing is allowed on a catch and release basis only). In the spring of 2000, 875 pounds of largemouth bass were stocked. Additionally, channel catfish, and muskie have been stocked in the past. In addition to the stocking program, other fishery management techniques have been implemented. In the spring of 2001, fish cribs (habitat structures) were put into place in two locations in the lake. Placement of additional cribs is planned for the future. Additionally, with the reduced rates of Sonar™ and spacing of applications, not all of the plants are being eliminated every year from the lake. This allows for the remaining plants to provide fish habitat.

Table 5. Wildlife species observed on Highland Lake, May-September 2001.

Birds	
Canada Goose	*Branta canadensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Mallard	*Anas platyrhnchos*
Ring-billed Gull	*Larus delawarensis*
Osprey*****	*Pandion haliaetus*
Purple Martin	*Progne subis*
American Coot	*Fulica americana*
Barn Swallow	*Hirundo rustica*
American Crow	*Corvus brachyrhynchos*

*****Endangered in Illinois

EXISTING LAKE QUALITY PROBLEMS

Highland Lake currently has *good* water quality in comparison to many other lakes in Lake County. Water quality has remained fairly stable over the past 10 years. Successful control of Eurasian water milfoil and less aggressive management of other 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. Highland Lake Property Owners Association has used available resources to its advantage and should be complimented on the overall condition of Highland Lake. However, there are a few areas for improvement.

- *Shoreline condition*

  The overall occurrence of erosion on Highland Lake is very low. However, the condition and/or physical type of this uneroded shoreline could be improved upon. The majority of developed shoreline consists of rip rap (43%) and seawall (32%). 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 Highland Lake that are in disrepair and may be prone to future erosion. The HLPOA, as well as individual property owners should promote and implement the use of more naturalized shoreline types when replacing existing structures. This will benefit not only the water quality of Highland Lake, but may also improve the wildlife habitat surrounding the lake.

- *Wildlife Habitat*

  Overall, wildlife habitat on Highland Lake is sparse. The main problem is the lack of quality shoreline habitat. Almost all of Highland Lake's shoreline is developed and offers no/little habitat. This is a common problem on residential lakes with highly developed shorelines (rip rap, seawall, lawns, etc.). Often, the only shoreline habitat consisted of invasive species (purple loosestrife, buckthorn, etc.), that offer little/poor quality habitat. Every effort should be made by the HLPOA and individual homeowners to eliminate these invasives. Additionally, habitat could be greatly improved by simply incorporating buffer strips along shorelines and installing habitat structures. By increasing habitat, overall lake health as well as aesthetics will be enhanced.

- *Aquatic Plant Diversity*

  A key to a healthy lake is a healthy aquatic plant population. Highland Lake has adequate plant densities. To maintain a healthy lake, 20-40% surface area coverage

by aquatic plants is desirable. Highland Lake is within this range with 35-40% bottom coverage. However, the plants that make up this range are of low *diversity*. FQI calculations show that Highland Lake has *average* plant diversity (FQI of 14.5 on Highland vs. average FQI of 14.0 for Lake County). This is due to use of aquatic herbicides (Sonar™), which can lower the species *diversity* of a lake. Highland Lake has adjusted their herbicide treatments to allow for reestablishment of more beneficial native species and this has allowed densities to return to healthy levels after treatments. However, the HLPOA should take precautions to ensure that this returning population remains intact. The Sonar concentration used in 1996 was good (actual rate of 6.8 ppb). However, the HLPOA used a higher rate in 2000 (actual rate of 8.0 ppb), which was warranted. The Sonar rate should be kept as low as possible to ensure the well being of native pant populations/densities. These native plants, when given the proper chance, may out-compete invasive species such as Eurasian water milfoil, which will result in the need for less herbicide use. This could be accomplished by further spacing out Sonar™ treatments and reducing herbicide rates. Introductions of other desirable aquatic plants such as large leaf pondweed (*Potamogeton amplifolius*) or American pondweed (*Potamogeton nodosus*) would also be beneficial and help increase species diversity, habitat, and overall lake health.

- Canada Geese/Seagulls

  According to residents, Canada geese and seagulls were very abundant on Highland Lake in 2001. Several Highland Lake residents stated that these two bird species have become problematic in recent years. The gulls utilize the swimming platform in the middle of the lake. As a result, there is an extraordinary amount of gull feces on it. Goose feces are also fouling properties around the lake and is an increasing problem. Goose droppings plague several of the swimming areas along the shoreline. These feces pose both human and lake health problems such as high bacterial levels and unwanted nutrient inputs into the lake. High nutrient levels, particularly phosphorus, can contribute to algae growth. This will inhibit other recreational activities such as boating or swimming, as well as creating poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

- Lack of Historical Lake Data

  The lack of quality lake data is a common problem for many of the lakes in Lake County. This is either due to poor record keeping or noninvolvement on the part of the management entity. The HLPOA has been actively managing the lake since the late 1950s. However, there were no accurate records kept of any management practices until the 1980's. Highland Lake was formerly part of the IEPA Volunteer Lake Monitoring Program. It is unclear why participation in the VLMP was discontinued at Highland Lake. This program is worth the time and effort and provides valuable information about the lake. This data can be used to track changes (or lack of) in lake quality over many years. This data can be very useful to

management entities in making decisions on the management of the lake. Additionally, this data is very important to agencies, such as the LMU, when conducting studies of the lake and allows for a more complete analysis. It is the recommendation of the LMU that the HLPOA renews its participation in the VLMP.

POTENTIAL OBJECTIVES FOR HIGHLAND LAKE MANAGEMENT PLAN

I. Shoreline Improvement and Erosion Control
II. Wildlife Habitat Improvement
III. Eliminate or Control Invasive Species
IV. Reduce Number of Excessive Canada Geese
V. Illinois Volunteer Lake Monitoring Program

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Shoreline Improvement and Erosion Control

Erosion to shorelines on Highland Lake is a potential problem. Shoreline erosion occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses. During the 2001 survey of Highland Lake a large majority of shoreline was found to be uneroded. However, approximately 9% (724 feet) of Highland's shoreline had some form of erosion. Some of this erosion (*severe*) at Harnett Park has been addressed since the study (see *Limnological Data – Shoreline Assessment*). The slightly and moderately eroded areas should be addressed as soon as possible in order to avoid further deterioration.

Option 1: No Action

Pros

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

Cons

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

Costs

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if

the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Install Rock Rip Rap

Rip rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. *The use of rip rap should be viewed as a last resort* after other alternatives such as biologs have been tried or are inappropriate. Rip rap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip rap fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. *It is imperative that filter fabric be used under the rip rap to provide quality, long lasting results.* Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below). Rip rap is best used for areas of **moderate 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 ≤ 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, Highland Lake would need approximately 180 linear feet of rip rap. This would come to a cost of approximately $5,400 – $8,100. 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 Highland 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, Highland Lake would need approximately 350 linear feet of buffer strip. This would come to a cost of $3,500. It is advisable that buffer strips be planted on all appropriate shoreline areas on Highland Lake including behind beach areas (approximately 7,400 linear feet). 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, Highland Lake would need 180 linear feet of one of the above products on the moderate eroded areas of shoreline. This would cost approximately $4500-6300. 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 highland 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 Highland Lake. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

Pros

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

Cons

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

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

Costs

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

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see Table 6 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 Highland 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 Highland 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 Highland 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 Highland 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 Highland 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 Highland Lake would be minimal and could be done by individual homeowners or the Association. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. For other species, such as buckthorn, a device such as a Hydrohatchet®, a hatchet that injects herbicide through the bark (about $300) may be needed. Another injecting devise, E-Z Ject® is $450. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. A low cost alternative to specialized spray equipment is the use of household spray bottles (commonly used for window and bathroom cleaners). These bottles can be purchased at department stores for minimal costs. However, after there use for herbicide application they should not be used for anything else. Similarly, spray canisters like those used to apply lawn chemicals also provide lower costs alternatives to commercial spray equipment.

Objective IV: Reduce Excessive Numbers of Canada Geese

Canada geese are migratory waterfowl common throughout North America. Geese in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to goose feces. Large amounts of feces may end up in the water, either directly from geese on the water or rainwater runoff from lawns where feces have accumulated. Goose feces is high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth. This will inhibit other recreational activities such as boating or swimming, as well as creating poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Geese become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for goose populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security. Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of geese pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of geese. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds. Only one of the management options below can also be used with any effectiveness to control nuisance seagull populations (Dispersal/Repellent Techniques), which are becoming a problem on Highland Lake.

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

Pros

This option has no costs, however, increasing numbers of geese/gulls will most likely exasperate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

Cons

If current conditions continue and no action is taken, numbers of Canada Geese and problems associated with them will likely increase. An increase of goose/gull feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One

study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

Costs

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

Option 2: Removal

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction is an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700).

Hunting is one of the most effective techniques used in goose management. However, since many municipalities have ordinances prohibiting the discharge of firearms, reduction of goose numbers by hunting in urban areas (i.e., lakes, ponds, and parks) may not be an option. Hunting does occur on many lakes in the County, but certain regulations apply (e.g., 100 yard minimum distance from any residential property). Contact the Illinois Department of Natural Resources for dates and regulations regarding the waterfowl hunting seasons. Also, contact local and county law enforcement agencies regarding any ordinances concerning hunting within municipal boundaries.

Egg addling, or destroying the egg by shaking, piercing, or freezing, can be used to reduce or eliminate a successful clutch. Eggs should be returned to the nest so the hen goose does not re-lay another clutch. However, if no eggs hatch, she may still lay another clutch. Leaving one or two eggs unaltered and allowing them to hatch may prevent another clutch from being laid and reduces the total year's reproduction. Egg addling requires a state and federal permit.

The capture and relocation of geese is no longer a desirable option. First, relocated geese can return to the same location where they were captured. Second, there is a concern over potential disease transmission from relocated geese to other goose populations. Finally, since goose numbers in Illinois are already high there is no need to supplement other populations in the area.

Pros

Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. Reduction of feces on lawns and parks is beneficial to recreation users of all types. Less feces in the water means less phosphorus available for nuisance plant and algae growth. Thus, the overall water quality of the lake may be improved by this reduction in phosphorus.

Cons

If the habitat conditions still exists, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

Costs

An Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $33 for the 2000-2001 hunting season. For depredation permits, there is a $25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

Option 3: Dispersal/Repellent Techniques

Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten geese from an area using sounds or objects. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Other products emit noises, such as propane cannons, which can be set on a timer to go off at programmed intervals (e.g., every 20-30 seconds), or recorded goose distress calls which can be played back over a loudspeaker or tape player. Over time these techniques may be ineffective, since geese become acclimated to these devices. Most of these products are more effective when used in combination with other techniques. Harassment is one of the only techniques that can be effective in deterring seagulls. Typically, propane cannons are used. However, these create loud noises and may be unacceptable on a residential lake such as Highland Lake.

Another technique that has become popular is using dogs or swans to harass geese. Dogs can be used primarily in the spring and fall to keep birds from using an area by herding or chasing geese away from a particular area. Any dogs used for this purpose should be well trained and under the owners control at all times. Professional trainers can be contracted to use their dogs for this purpose. Dogs should not be used during the summer when geese are unable to fly due to molting. Swans are used because they are naturally

aggressive in defending their territory, including chasing other waterfowl away from their nesting area. Since wild swans cannot be used for this technique, non-native mute swans are used. However, mute swans are not as aggressive and in some case are permissive of geese. Again, using a combination of techniques would be most effective.

Chemical repellents can be used with some effectiveness on Canada geese only. New products are continually coming out that claim to rid an area of nuisance geese (they are ineffective on gulls). Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions or mowing frequency.

Pros

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less "food" available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

Cons

The effectiveness of harassment techniques is reduced over time since geese will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Use of dogs can be time consuming, since the dog must be trained and taken care of. Dogs must also be used frequently in the beginning of the season to be effective at deterring geese. This requires time of the dog owner as well. Dogs (frequently herding dogs, like border collies) that are effective at harassing or herding geese are typically not for the average homeowner. They are bred as working dogs and consequently have high levels of energy that requires the owner's attention.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

Costs

Costs for the propane cannons are approximately $660 ($360 for the cannon, $300 for a timer), not including the propane tank. The cost of ReJeX-iT® is $70/gallon,

GooseChase™ is $92/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 4: Exclusion

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

Pros

Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by geese may also be able to recover.

Cons

This technique will not be very effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus concentrations) will continue.

Costs

The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

Option 5: Habitat Alteration

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. Table 6 has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

Geese prefer ponds and lakes that have shorelines with gentle slopes to ones with steep slopes. While this alone will not prevent geese from using an area, steeper slopes used along with other techniques will be more effective. This option may not be practical for existing lake shorelines since any grading and/or filling would require permits and surveys, which would drive up the costs of redoing the shoreline considerably.

Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Pros

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife (see *Objective II: Wildlife Habitat Improvement*). A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. Finally, the more of the area that is in natural vegetation, the less turfgrass that needs to be constantly manicured and maintained.

Cons

Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

Costs

If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. 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. 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. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed. Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

Option 6: Do Not Feed Waterfowl!

There are few “good things”, if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the “foods” (i.e., white bread) given to geese and other waterfowl are quite low. Since geese/gulls are

physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese/gulls that are accustom to hand feeding may become aggressive toward other geese or even the people feeding the geese.

Costs

There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding.

Objective V: Illinois 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:

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