2000 SUMMARY REPORT
of
Waterford Lake

Lake County, Illinois

Prepared by the

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

Joseph Marencik
Michael Adam
Mark Colwell
Mark Pfister

July 2001

TABLE OF CONTENTS

LAKE IDENTIFICATION AND LOCATION

Waterford Lake, formerly known as Red Rock Lake and Walden Lake, is located south of Grass Lake Road in the Village of Lindenhurst in Lake Villa Township (T46N, R10E, Section 35, NE 1/4). Waterford Lake is a 67.2 acre man-made impoundment. The current maximum depth is 13 feet with an average depth of 5.6 feet (LCHD-LMU data). Lake volume is approximately 374.6 acre feet. Waterford is part of the Mill Creek drainage basin, which is part of the Des Plaines River watershed. Waterford Lake's direct water shed is small consisting of drainage from Potomac Lake to the north and storm sewers, which there were 29 (Figure 1). Waterford Lake drains into Spring Ledge Lake, a 5-acre water body to the southeast of Thunder Bay. This drainage eventually flows into Mill Creek. There is a drop box in Thunder Bay, which controls the drainage from Waterford to Spring Ledge Lake. Watershed usage is mainly residential with minor commercial inputs.

BRIEF HISTORY OF WATERFORD LAKE

Waterford is shaped like a lopsided dumbbell and was created in 1969. The main body of the lake is approximately 50 acres and the smaller portion, referred to as Thunder Bay, is approximately 17 acres. The lake was originally a peat mine that was further dredged and then flooded. This accounts for the erratic nature of the lake contour on certain parts of the lake. The northeast corner of the lake still has a peaty bottom. This peat bottom occasionally floats to or near the surface during summer months. The lake is surrounded by residential development with private ownership terminating at the water's edge. Bottom ownership completely lies with the Village of Lindenhurst. The Village's Lake Commission oversees management of the Village's lakes. In 1999, Waterford Lake underwent a complete fish rehabilitation. This included rotenone treatment for an excessive carp population and high dosage, whole lake herbicide treatments for excessive growth of coontail, curly leaf pondweed, and northern water milfoil (See *Limnological Data – Aquatic Plant Assessment*).

SUMMARY OF CURRENT AND HISTROICAL LAKE USES

Access to Waterford Lake is almost entirely private with the exception of two access points open to residents of Lindenhurst (Figure 1). The access point at the southwest corner of the lake has a boat ramp. However, at these two locations, launching of watercraft by non-lake residents and non-approved personal is prohibited. Recreational opportunities on Waterford Lake largely consist of boating (no gas powered motors allowed) and fishing as the lake has no public beach. However, several residents on the lake have private beaches on their property. Recreational usage of the lake has greatly improved since rehabilitation. Wildlife viewing opportunities on Waterford Lake are limited due to lack of quality habitat. However, some waterfowl do frequent the lake (see *Limnological Data - Wildlife Assessment*).

LIMNOLOGICAL DATA - WATER QUALITY

Water samples collected from Waterford Lake were analyzed for a variety of water quality parameters. Samples were collected at 3 feet from the surface and 3 feet off the bottom (8-9 feet deep) from the deep hole location in the lake (Figure 1). Waterford Lake is not thermally stratified, which means the lake does not divide into warm upper water (epilimnion) and cool lower water (hypolimnion) but instead the lake stays well mixed. This is due to the shallow lake morphology and long fetch (the longest distance which wind blows across a lake). This mixing of water is reflected in the water quality data. The concentrations of most parameters from shallow samples were very similar to the deeper sample data. Therefore, only the data from the epilimnetic samples will be discussed. The complete data set for Waterford Lake is in Table 1. Below is a discussion of highlights from the water quality data collected over the five-month study of Waterford Lake.

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. Secchi disk readings on Waterford Lake were *outstanding* especially considering that Waterford is a manmade lake. In three out of five months the Secchi disk was seen on the bottom (>10 feet). These deep Secchi disk readings were due in large part to the low amount of planktonic algal growth present in Waterford. Only in May was Secchi depth *poor* (3.7 feet). This was due to spring run off, which carries with it sediment and other debris that can cause high turbidity in the spring. The 2000 Secchi disk average depth (LMU 2000 average 8.9 feet*, VLMP 2000 average of 9.6 feet) was a substantial improvement over past measurements. In 1996, the last study by the LMU, average Secchi disk depth was 4.2 feet. In fact, this year's average (both LMU and VLMP) is the highest annual average Secchi disk depth since measurements have been taken on a regular basis starting in 1986 (Figure 2). In addition to limited algal growth, total suspended solids (TSS) are directly correlated with Secchi disk depth. As a result, average TSS on Waterford Lake during the study was 2.70 mg/L. This is three times lower than the County average. This is a striking improvement over the 1996 LMU study in which Waterford had an average TSS of 8.2 mg/L. Nonvolatile suspended solids (NVSS), which is the part of TSS that is nonorganic particles (such as sediment) was also very low (2.18 mg/L). NVSS accounted for almost all of the TSS, which reflects the lack of planktonic algal growth on Waterford Lake.

Total dissolved solids (TDS), total solids (TS), total volatile solids (TVS) and conductivity measurements were slightly elevated in May and June. These elevated levels were due to stormwater runoff containing high amounts of chlorides from road salts. These salts probably originated from near Grass Lake Rd. and surrounding residential streets. As the summer progressed these elevated levels declined as the road salts diminished. By July, TS, TDS, TVS, and conductivity levels were at levels near the County average.

- This average contains all measurements even if reading was inhibited by the bottom.

The pH (measure of hydrogen ion activity) of Waterford Lake was high (>9.0) during June and September. These high pH values are due to the tremendous amount of the macroalga *Chara* that was present in the lake. Plants (including *Chara*) use hydrogen ions (H^+) in their biological processes, such as photosynthesis. As these plants (*Chara*) strip H^+ from the water the pH is raised because there are less H^+ ions in the water (higher the H^+ concentration the lower the pH). Continually elevated pH (>9.0) can cause detrimental impacts to aquatic organisms. The elevated pH events on Waterford seem to be isolated and are of no real concern.

Another measurement of water quality is nutrient levels. 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. Waterford Lake has a TN:TP ratio of 40:1, which means that the lake is highly phosphorus limited. This concurs with past studies, which showed Waterford Lake to be highly phosphorus limited. Furthermore, average phosphorus in Waterford Lake has not appreciably changed from the 1996 **or** 1990 LMU studies. Average phosphorus levels in 1990 were 0.031 mg/L and in 1996 were 0.039 mg/L. Average phosphorus levels in Waterford Lake from May to September was 0.03 mg/L (Lake County average is 0.06 mg/L). Low levels of phosphorus in Waterford are due to a low internal concentration in addition to low external (watershed) inputs. These low levels of phosphorus, along with copper sulfate treatments, help keep algae growth to a minimum. Due to the highly phosphorus limited nature of Waterford Lake, external inputs of phosphorus should be carefully monitored as even small increases could trigger algae blooms. Nitrogen levels on Waterford were below detectable levels for much of the study. There was a slight peak in NO_3 in June and July, which was most likely due to influx from increased rains and associated stormwater runoff from surrounding lawns (Figure 3).

Another way to look at phosphorus levels and how they affect productivity of the lake is to use a Trophic State Index (TSI) based on phosphorus. TSI values are commonly used to classify and compare lake productivity (trophic state). The higher the phosphorus concentration the greater amount of algal biomass, which then results in a higher TSI and corresponding trophic state. Based on a TSI phosphorus value of 54.1, Waterford Lake is classified as eutrophic (>50, <70 TSI). A eutrophic lake is defined as an over productive system that has above average nutrient levels and high algal biomass (growth). However, this definition does not hold completely true for Waterford Lake because without the plants Waterford Lake would not have low TP. The eutrophic classification was due to slightly elevated phosphorus levels. These elevated levels did not cause high algal biomass, which phosphorus TSI trophic states are partially based on. This was due to the aquatic vegetation that is in the lake (even though there was little). Out of the 32 lakes studied in 2000, Waterford ranked 9th out of 32 based on a phosphorus TSI. Furthermore,

based on average phosphorus TSI, Waterford Lake ranks 29th out of 87 lakes studied by the LMU (Table 2).

TSI values along with other water quality parameters can be used to make other analysis of Waterford Lake based on use impairment indexes established by the Illinois Environmental Protection Agency (IEPA). Most impairment assessments were listed as *None*. However, pH impairment was listed as moderate for Waterford. This is due to high pH levels in June and September (see above). For all other important indices, such as aquatic life use, recreational use, swimming, and overall use impairment, Waterford Lake was ranked as providing "Full" support.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant surveys were conducted every month for the duration of the study (*Appendix A* for methodology). Shoreline plants of interest were also observed (Table 3). However, no surveys were made of these shoreline species and all data is purely observational. The extent to which aquatic plants grow is largely dictated by light availability. Aquatic plants need at least 1% of surface light levels in order to survive. Based on light penetration, aquatic plant coverage of the lake could have been as high as 100% (as it has been in the past). However, surveys show that plants did not completely grow at all depths (Table 4). Surveys showed that vegetation did not commonly occur below 8 feet.

Aquatic plant diversity on Waterford Lake was *poor* and consisted of only a few species (Table 3). During the 2000 study of Waterford, nine species of aquatic plants were found (including *Chara* sp.) with most of the species were found only in May. This is a decline from past aquatic plant densities (1994) in which 11 species were found. In the previous study, plant surveys were done in June and August and all 11 species were present. These same months in 2000 had the lowest plant diversity of the study, consisting of only four species per month.

The most frequent species during the study was the macroalga *Chara*, which occurred at 78% of all sample sites (May-September). Although a desirable species, *Chara* does not provide the quality habitat that high vascular macrophytes can provide. As compared to 1994 plant surveys, *Chara* sp. densities have greatly expanded. In 1994, *Chara* was only found at 20% of sample sites. The reason for this expansion in *Chara* is the over removal of all other aquatic plant species with herbicides, which *Chara* is not affected by. However, one welcome plant reduction has occurred. The occurrence of water milfoil (both Eurasian and northern). In 1994, water milfoil was found at 54% of sample sites and in 2000 it was not found at any site. This too can be attributed to the use of aquatic herbicides.

Other commonly occurring species include small pondweed and water stargrass (Table 4). The low occurrence of these plants in mainly due to the overuse the aquatic herbicide

fluridone (Sonar™). After May, and coincidentally after herbicide application, surveys show that species composition and number is drastically reduced. Species such as sago pondweed and *Vallisneria*, which were wide spread in May (33% and 10% of sample sites, respectively) were only sparsely present throughout the rest of the study. Even late in the study (August and September), many desirable populations had not rebounded to pretreatment levels. Sonar was used at high rates (12 parts per billion {ppb}) initially (1995-1999) to treat massive infestations of coontail, curly leaf pondweed and northern water milfoil. Now that the plant densities have been reduced to acceptable levels and coontail, curly leaf pondweed and northern water milfoil are no longer problematic, Sonar™ rates should be lowered. The application rate was 10 ppb at the recommendation of the LMU for the April 2000 application. However, the rate is going to be raised to 12 ppb for the April 2001 application. This trend is opposite of what should be occurring. Usually, after initial treatments with high dosages, rates are lowered to a "maintenance" rate once the excessive vegetation is knocked back to allowable levels. Rates should only be raised again if the vegetation returns to excessive levels in the future.

Lack of a healthy plant population can cause a variety of problems within the lake (see *Objective I: Better Management of Aquatic Vegetation*). Overuse of herbicides on Waterford Lake occurs due to pressure on the Lake Commission by an overwhelming, negative public viewpoint of aquatic vegetation. For the overall health of Waterford Lake it is imperative that a healthy, diversified population of aquatic vegetation is established. This can not be achieved until the public is educated on the benefits associated with aquatic vegetation.

Table 3. Aquatic and Shoreline Plants on Waterford Lake- 2000.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Chara	*Chara* sp.
American Elodea	*Elodea canadensis*
Water Stargrass	*Heteranthera dubia*
Curlyleaf Pondweed	*Potamogeton crispus*
Small Pondweed	*Potamogeton pusillus*
Sago Pondweed	*Stuckenia pectinatus*
Horned Pondweed	*Zannichellia palustris*
Vallisneria	*Vallisneria americana*

Table 3. Aquatic and Shoreline Plants on Waterford Lake- 2000. (cont)

Shoreline Plants	
Blunt Spikerush	*Eleocharis obtusa*
Blue Flag Iris	*Iris Hexagona*
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Buckthorn	*Rhamnus cathartica*
Common Cattail	*Typha latifolia*

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

Shoreline assessments were conducted at Waterford Lake on May 3rd and June 7th, 2000. Shorelines were assessed for a variety of criteria (*Appendix A* for methodology). Based on these assessments several important generalizations can be made. 100% of Waterford Lake's shoreline (9,476 feet) is developed. The majority of developed shoreline consists of rip-rap (4,169 feet or 44 %) (Figure 4). Seawalled shoreline was the second most abundant type (2,211 feet or 23%). Both of these shoreline types are considered *undesirable*. Rip-rap offers little habitat and can be prone to erosion if not installed properly, as is often the case. Seawalls are *undesirable* because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediments, which can lead to a variety of water quality problems. There was a low occurrence of other types of *undesirable* shoreline, such as manicured lawn, which made up 8% of Waterford's shoreline. Lawn at the land-water interface pose 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* buffer stripped shorelines was low and only accounted for 8% of the shoreline. Shorelines that have established well-maintained buffer strips are less likely to experience erosion and also provide improved habitat for wildlife. It is our recommendation that Lindenhurst Lake Commission 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.

The occurrence of erosion on Waterford is *low*. Based on LMU assessments, 82% (7,787 feet) of shoreline on Waterford was listed as having no form of erosion. This is largely due to overwhelming dominance by rip-rapped and seawalled shorelines. The occurrence of eroded shoreline was low: *Slig*ht – 7%, *Moderat*e – 8%, and *Severe* – 3% (Figure 5). These eroded shorelines were made up of poorly maintained buffer areas, manicured lawns, and unmanaged woody and shrub areas. Rehabilitating the slight and moderate

erosion would not be overly difficult. However, shorelines experiencing severe erosion can be difficult and costly to rehabilitate.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

In 1999, complete fishery rehabilitation was undertaken to eliminate the over abundance of common carp. This was accomplished through the use of rotenone. Fishery health on Waterford appears to be greatly improved since the rehabilitation. So far the results look promising with the apparent reduction/elimination of the carp. Several large bass (4 lb +) were observed during the study. In spring of 2000 several species of fish (bass, bluegill, and fathead minnows) were stocked to compliment already existing populations. In August of 2000, at the recommendation of the IDNR, channel catfish were stocked in order to expand the predator base.

Wildlife observations were made on a monthly basis during water quality and plant sampling actives. All observations were visual (Table 5). Wildlife habitat on Waterford Lake is almost nonexistent. In some areas of the lake, mainly Thunder Bay, there are healthy populations of mature trees that provide good habitat for a variety of bird species. Additionally, there are several shrub areas that provide habitat for smaller bird and mammal species. However, there are several areas for habitat improvement on Waterford. There are two invasive species that were observed and should be controlled or eliminated, purple loosestrife and buckthorn. These species have been noted in several areas around the lake (Figure 6). Purple loosestrife was found to occur at 17 lots on Waterford Lake and buckthorn was found at 3 lots. These plants are seldom used by wildlife for food or shelter. They should be eliminated before they spread and displace other native, more desirable plant species. Additionally, shoreline habitat should be improved and should include buffer strips and more naturalized shoreline areas (*see Objective VI: Wildlife Habitat Improvement*).

One area of concern on Waterford is the excessive number of Canada geese. Several times over the course of the summer, large number of geese were observed. These geese produce a tremendous amount of waste. This waste is extremely high in phosphorus, which is an unwanted nutrient addition into Waterford Lake (*see Limnological Data – Water Quality*). There are several techniques to control excessive numbers of geese that could easily be implemented on Waterford Lake (see *Management Objective IV: Alleviate Excessive Numbers of Canada Geese*).

Table 5: Observed Wildlife Species on Waterford Lake May-September 2000.

Amphibians	
Bull Frog	*Rana catesbeiana*
Birds	
Canada Goose	*Branta canadensis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Belted Kingfisher	*Megaceryle alcyon*
Birds (cont.)	
Mallard	*Anas platyrhnchos*
Ring-billed Gull	*Larus delawarensis*
Turkey Vulture	*Cathartes aura*
Reptiles	
Painted Turtle	*Chrysemys picta*
Snapping Turtle	*Chelydra serpentina*

EXISTING LAKE QUALITY PROBLEMS

Waterford Lake currently has *good* water quality in comparison to most other lakes in Lake County. Water quality has greatly improved over the previous 10 years (especially the last 5 years). Successful elimination of the common carp and more adept management of excess aquatic vegetation have brought about these positive changes. Recreational opportunities for boating, swimming, and fishing have been greatly enhanced. Lindenhurst has used available resources to its advantage and should be complimented on the condition of Waterford Lake. However, there are a few areas for improvement.

- *Poor Aquatic Plant Diversity*

  A key to a healthy lake is a healthy aquatic plant population. Waterford Lake has low plant densities as well as poor diversity (See *Limnological Data- Aquatic Plant Assessment*). This is due to overuse of the aquatic herbicide fluridone. The lack of quality aquatic vegetation can cause a variety of lake quality problems included the eventual decline of fishery health, and loss of water clarity. To maintain a healthy lake, 20-40% surface area coverage by aquatic plants is desirable (with 30-40% a better range). Taking into consideration Waterford's residential nature and attitude

towards aquatic vegetation 20-25% coverage is a more realistic goal. This does not include *Chara*, which remains near the bottom of Waterford and offers few of the benefits associated with a healthy *macrophytic* plant community. This coverage should consist of quality aquatic vegetation including small pondweed, *Vallisneria*, and water stargrass, which are already present in Waterford but are reduced due to higher than recommended herbicide rates (as per SePro). Introductions of other desirable aquatic plants such as large leaf pondweed or American pondweed would also be beneficial and help increase species diversity.

- *Poor Wildlife Habitat*

  Overall, wildlife habitat on Waterford Lake is sparse. The main problem is the lack of quality shoreline habitat. A large part of Waterford Lake's shoreline is developed and offers no/little habitat (see *Limnological Data – Shoreline Assessment*). 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. Habitat could be greatly improved by simply incorporating buffer strips along shorelines. By increasing habitat, overall lake health as well as aesthetics will be enhanced.

POTENTIAL OBJECTIVES FOR WATERFORD LAKE MANAGEMENT PLAN

I. Better Management of Aquatic Vegetation
II. Wildlife Habitat Improvement
III. Eliminate or Control Invasive Species
IV. Reduce Excessive Numbers of Canada Geese

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Better Management of Aquatic Vegetation

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. Plans should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow up is critical. Good aquatic plant management plans consider both the short and long-term needs of the lake.

In the past, Waterford Lake has had excessive growth of coontail, curly-leaf pondweed, and Northern water milfoil, which is now under control using herbicides. IDNR has recommended that the excessive vegetation be reduced in near shore areas to improve fishery habitat. Furthermore, total coverage by aquatic vegetation should be between 20-30%. Instead, Waterford Lake has eliminated almost all vegetation the lake. This was not the goal of the IDNR recommendations. However, due to overuse of herbicides (high rates), a healthy aquatic plant community is unable to become established. In 2000 fluridone was used at a rate of 10 ppb. This was an acceptable rate when trying to control excessive stands of curly-leaf pondweed and northern water milfoil but these nuisances are under control. Since these populations have been drastically reduced (no milfoil was found at any time in 2000 and only very limited curly-leaf in April), fluridone concentrations should be reduced to maintenance levels of 6-8 ppb. This will not only save the Village money but also allow for desirable native plant populations to thrive. Fluridone is not as damaging to native pant populations at these maintenance rates. However, fluridone is also damaging to native populations at higher rates. This was evident in the large reduction in native vegetation after herbicide treatments. These populations did not start to recover until August (see *Limnological Data – Aquatic Plant Assessment*).

<u>Option 1: Aquatic Herbicides</u>

Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products can not be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Aquatic herbicides are not allowed to be environmentally persistent, bioaccumulate, or have any bioavailability. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate

herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e. low wind speed, correct temp, etc.).

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat (Reward©). Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the upper portions of the plant as well as the root system. An example of a systemic herbicide is (fluridone or 2,4-D). Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water column in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom and slowly release the herbicide which is then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and dissolve as they come in contact with water. This is typical of herbicides/algicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60^0F. This is the time of year when the plants are most actively growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. The label is the law. There may be more than one herbicide for a given plant. The plants best controlled by a particular herbicide are in bold. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

Currently, fluridone (Sonar™) is used on Waterford Lake in the spring to treat curly-leaf pondweed and northern water milfoil. Application rate in 2000 was at 10 ppb, which is considered a high rate with no excessive vegetation present (see above). Fluridone is a nonselective herbicide, which means it kills both targeted and untargeted vegetation. If fluridone is used in future treatments, it is advisable to lower the rate to a maximum of 8 ppb. At lower rates fluridone has been shown to do less damage to native plants. A possible alternative to the use of fluridone is the use of diquat (Reward©). Diquat is also a nonselective contact herbicide. Due to its chemical nature, diquat is only effective on the plants that it comes into immediate contact with. This allows for a degree of selectivity based on treatment area whereas fluridone is applied as a whole lake treatment thereby providing no selectivity based on treatment area. Multiple treatments with diquat might be needed to treat new growth in areas where there is no/little tolerance of

vegetation. With proper planning and use of herbicides, native plant species that already exist in Waterford Lake, such as sago pondweed, small pondweed, and *Vallisneria* could return to healthy levels (20-30% surface area coverage).

Pros

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. A properly implemented plan can often provide season long control with minimal applications. Ecologically, herbicides can be a better management choice other than options such as mechanical harvesting or grass carp. When properly applied, aquatic herbicides may be selective for nuisance plants such as Eurasian watermilfoil but allow desirable plants, such as the pondweeds, to remain. This removes the problematic vegetation and allows native and more desirable plants to remain and flourish with minimal manipulation.

The fishery and waterfowl populations of the lake would greatly benefit due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed. Another environmental benefit of using aquatic herbicides over other management options is that they are organism specific. The metabolic pathways by which herbicides kill plants are plant specific which humans and other organisms do not carry out. Organisms such as fish, birds, mussels, and zooplankton are generally unaffected.

By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase. Activities such as boating and swimming would improve due to the removal of dense stand of vegetation. The quality of fishing may recover because of improved habitat. In addition to increased usage opportunities, the overall aesthetics of the lake would improve, potentially increasing property values on the lake.

Cons

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. This could drastically alter the biodiversity and ecological balance of the lake. Total removal or over-removal of plants can cause a variety of problems lake-wide. The fishery of the lake may decline and/or become stunted due predation issues related to decreased water clarity. Other wildlife, such as waterfowl, which commonly forage on aquatic plants, would also be negatively impacted by the decrease in vegetation.

Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will contribute to the overall nutrient load of the lake, which can lead to an increased frequency of noxious algal blooms. Furthermore, the removal of aquatic vegetation, which compete with algae for nutrients, can directly contribute to an increase in blooms.

After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian watermilfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation can lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fisheries can have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl and other wildlife. Additionally, some herbicides have use restrictions regarding their use in relation to fish, swimming, irrigation, etc.

Possible growth of nuisance algae that may follow could drastically impair recreational use of the lake. Swimming could be adversely affected due to the likelihood of increased algal blooms. Swimmers may become entangled in large mats of filamentous algae. Blooms of planktonic species, such as blue-green algae, can produce harmful toxins as well produce noxious odors. If regrowth of nuisance vegetation were to occur, motors could become entangled making boating difficult. Fishing would also be negatively impacted due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer due to an increase in unsightly algal blooms and massive stands of vegetation. This in turn could have an unwanted effect on property values. Studies have shown that problematic algal blooms can decrease property values by 15-20%.

Costs

Currently, Lindenhurst is using Sonar™ (fluridone) at a rate of 12 ppb. These rates need to be lowered to at least 10ppb (as in 2000) with 8-6 ppb being an ideal rate. Even SePro, the company that manufactures Sonar™, usually discusses typical applications as being 8-6 ppb and even 4 ppb applications in some situations. At these lower application rates Sonar is less damaging to the native plant population such as pondweeds and *Vallisneria*. This is beneficial for overall lake health.

Cost of Sonar™ treatments on Waterford Lake is hard to pin point because Lindenhurst pays for season long control. This price also includes copper sulfate applications. However, based on average costs, a 12 ppb treatment of Sonar™ on Waterford Lake should be approximately $4,400. Based on LMU recommendations of using 8 ppb, the approximate cost of would be $3,600. This

would not only lower costs but would also be beneficial to overall lake health. Furthermore, to reduce costs even further, there is now another fluridone product on the market called Avast™ that is much cheaper than Sonar but is the same formulation. Other herbicides that are possible alternatives to the use of fluridone include diquat (Reward) and 2,4-D (Navigate®, Aquaclear™). Both of these compounds can be used as spot treatments as needed and thus provide selectivity not possible with fluridone. Diquat in a general contact herbicide that kills any above ground portion of the plant it comes into contact with. 2,4-D is a systemic herbicide that is dicot (broad-leaved plant) specific. This allows beneficial plants such as pondweed and Vallisneria, which are monocots, to remain because the are unaffected by 2,4-D.

Option 2: Hand Removal

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

Waterford Lake could greatly benefit from the use of this management technique. Hand removal could be utilized around piers and beach areas. Hand removal of spring stands of curlyleaf pondweed could be used in areas that contain desirable vegetation. This might be a more acceptable way to control this weedy plant instead of over using aquatic herbicides such as fluridone, which is nonselective and also removes desirable vegetation. Hand removal might also be used in conjunction with other options such as proper use aquatic herbicides.

Pros

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem. Harvested plant material is often used as fertilizer and compost in gardens.

Cons

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of

vegetation can be quite tiresome. Additionally, convincing the residents of Waterford Lake to do the work them selves would probably prove to be very difficult. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. Another drawback is possible nonselective removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plants are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable vegetation and/or disrupt valuable habitat (fish spawning beds).

Costs

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

Option 3: Revegetation with Native Aquatic Plants

A healthy native plant population can reduce algal growth and prevent excessive nuisance plant growth. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis. If aquatic herbicides are being used to control what vegetation does exist there use should be scaled back or abandoned all together. This will allow the vegetation to grow back, which will help in controlling algae in addition to other positive impacts associated with a healthy plant population. Revegetation would not need to be widespread on Waterford; just enough to reach 20-30% surface area coverage would be needed to maintain a healthy fishery (30-35% would be the most desirable for overall lake health). This amounts to only 13-20 acres of the lake being vegetated by macrophytes. Revegetation could be divided up into multiple areas of the lake where residents are more receptive to aquatic vegetation. These areas have healthy native plant populations and should not be areas of nuisance growth.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the Waterford Lake would be allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance algae. Another technique utilizing existing plants is to transplant vegetation from one area to another. Waterford had several areas of plant growth that might act as transplant nurseries for revegetation. In August and September, Thunder Bay had a few nice stands of water stargrass and areas of *Vallisneria* that could be potential transplant stocks. However, if these areas are to be used for transplant stocks, herbicide treatments should be cut back so the plants are not damaged.

The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected

from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration as several factors would have to be taken into consideration. Table 3 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are aquatic shoreline vegetation (rushes, cattails, etc) and deeper water plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

If revegetation were to occur it would be advisable to notify the lake residents of the plan and find those who would not mind increased vegetation in front of their property. This may help with the negative public backlash that could be encountered in an anti-vegetation environment such as that on Waterford Lake.

Pros

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

Cons

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

Costs

If revegetation was undertaken using plants already in Waterford Lake then costs would be very low to nonexistent. Volunteers and village employees could do the labor, which would further reduce costs. If plants were brought in from an external source in order to increase species diversity then costs would vary on the extent and type of revegetation. An experienced aquatic nursery should design

and preferably carry out planting to ensure good results. See Table 6 for pricing on different species of aquatic plants suitable for revegetation.

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 nature and the love of manicured Kentucky bluegrass lawns, there is little wildlife habitat on Waterford Lake. 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: Reduce or eliminate exotic species*.

Option 1: No Action

This option means that the current land use activities will continue. No additional techniques will be implemented on Waterford. 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. On Waterford Lake this width of a buffer would not be widely accepted by resident. A more acceptable buffer area of even 5 feet would be a great improvement over what now exists on the shores of the lake. 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. Currently, there are few native emergent vegetation test areas around the lake. This is a good step in the right direction towards naturalizing Waterford's shoreline. This program should continue and be expanded.

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

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

Pros

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

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

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

Cons

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

Costs

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

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 Waterford 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. 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. 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 Waterford 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. Additionally, convincing residents of Waterford Lake to participate in such a program may prove to be difficult.

Costs

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

Option 3: Herbicide Treatment

Treatement with herbicides is the best option for controlling mature stands of pruple loosestrife on Waterford 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 Waterford Lake would be minimal and could be done by individual homeowners or the Village. 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. The Village more than likely owns many of these apparatuses already and therefore, costs of this option could be greatly reduced.

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.

Option 1: No Action

Pros

This option has no costs, however, increasing numbers of geese 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 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 boundries.

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.

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. New products are continually coming out that claim to rid an area of nuisance geese. 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™.

<u>Option 4: Exclusion</u>

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 levels) 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.

<u>Option 6: Do Not Feed Waterfowl!</u>

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 are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese 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.

Reference:

Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.