2000 SUMMARY REPORT
of
LAKE OF THE HOLLOW

Lake County, Illinois

Prepared by the

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LAKE IDENTIFICATION AND LOCATION

Lake of the Hollow, formerly known as Brandenburg Lake, is a 77-acre glacial lake. It is located just south of the Village of Fox Lake, and southwest of the intersection of Route 134 and Illinois Route12/59 (T45N, R9E, S21, 22). Five private individuals and the Illinois Department of Natural Resources (IDNR) own the lake bottom. One individual owns approximately 71.5 acres. About 3 acres of the lake bottom belongs to the IDNR. A wetland adjacent to the northwest shore flows into Lake of the Hollow. A spillway, which was installed in 1970 at the northeast corner, allows water to flow to a small channel that enters Redhead Lake, which is about 870 feet to the north. Redhead Lake is connected to the Fox River Chain O'Lakes. Lake of the Hollow has a maximum depth of 15 feet, and an average depth of 7.5 feet, which is estimated at half of the maximum depth. The estimated volume of the lake is 577.5 acre-feet[1], or about 188 million gallons. The volume and average depth can only be estimated because a recent, accurate bathymetric map is not available. The shoreline length is 3.3 miles.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

The Lake of the Hollow Property Owners Association is open to people who live around the lake. An easement for the association members is located at the south end of the lake. The owners of another piece of property[2] located on the east side of the peninsula have allowed residents of the Woo Sung Haven of Rest subdivision to access the lake at this location. Some people who live in the Woo Sung Haven of Rest subdivision are also members of the Lake of the Hollow Property Owner's Association. People use the lake for swimming, fishing, aesthetics and non-motorized boating. The residents have used aquatic herbicides to treat nuisance aquatic plant populations. No public access exists on the IDNR property. The IDNR has assisted the residents by performing fisheries assessments and making recommendations for fisheries management. A detailed timetable of IDNR assessments and recommendations is on page 11.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were taken once a month, from May through September 2000, at the deep hole location (See Figure 1). See Appendix A for water quality sampling methods. Samples were collected at three feet and twelve feet deep and analyzed for a variety of parameters. The document, "Interpreting Your Water Quality Data" explains these parameters in detail.

[1] One acre-foot is one acre filled with one foot of water, or 325,900 gallons.
[2] The PIN for this lot is 0521401007.

Insert Figure 1, Sample location map

The water clarity in Lake of the Hollow was good during the 2000 sampling season, averaging 9.28 feet deep. The average clarity reading for Lake County lakes is only 5

feet deep[3]. The clarity is good in Lake of the Hollow because minimal suspended solids exist in the water column near the surface. Total suspended solids (TSS) such as algae and sediment cause turbidity in the water, reducing the water clarity. The seasonal average for TSS near the surface in Lake of the Hollow was 1.8 mg/L, well below the Lake County median of 5.2 mg/L. All other solid parameters except total volatile solids were below the Lake County averages. The amounts of total volatile solids in Lake of the Hollow were similar to the Lake County average.

The trophic condition of a lake indicates the overall level of nutrient enrichment. Most lakes in Lake County are eutrophic or nutrient-rich, and are productive lakes in terms of aquatic plants and/or algae and fish. These lakes frequently have heavy algae blooms that result in low water clarity or dense plant beds. Most lakes in Lake County are classified as eutrophic lakes. Mesotrophic lakes are less nutrient rich and are usually high quality lakes in terms of water clarity and the large variety of aquatic plant and animal species. The condition of Lake of the Hollow in terms of its phosphorus concentrations and clarity was mesotrophic, although the lake does have large plant beds. Nutrient concentrations in the water column were low. Nutrients are usually released from lake sediment under oxygen poor conditions at the bottom. Oxygen depletion near the bottom occurs in thermally stratified lakes. However, concentrations of nutrients in the bottom waters of Lake of the Hollow were very low or were below laboratory instrument detection limits. Total phosphorus (TP) near the surface was two times lower than the Lake County median, and in samples near the bottom, TP was five times lower than the Lake County median. Although soluble reactive phosphorus (SRP) usually increases in the bottom water samples of stratified lakes, SRP was not detected in any sample from Lake of the Hollow. Plants may have been removing SRP as soon as it was made available. All forms of nitrogen were lower than the Lake County medians. Although the concentrations of nutrients in the water are low, nutrient concentrations in the sediment are enough to sustain a productive system, as evidenced by the amount of aquatic plant growth. The ratio of total nitrogen[4] (TN) to total phosphorus (TP) in the lake indicates if the lake is in shorter supply of nitrogen or phosphorus. Lakes with TN:TP ratios of more than 15:1 are usually limited by phosphorus. Those with ratios less than 10:1 are usually limited by nitrogen. The TN:TP ratio of Lake of the Hollow during 2000 was 56:1, which indicates it is phosphorus limited, like most lakes in this area. In a ranking of 87 Lake County lakes in terms of their phosphorus concentrations, Lake of the Hollow is ranked number 8 out of 87. This lake may have low nutrient concentrations because its small, relatively undeveloped watershed. Lakes with larger watersheds normally have great inputs of nutrients over time. Another reason may be its peaty sediment, which does not offer as many nutrients as more organic substrates.

Dissolved oxygen (D.O.) and temperature were measured from the surface down to the bottom at one-foot increments. Lake of the Hollow was thermally stratified and had anoxic conditions below 8 feet deep from May to August, 2000. The D.O. concentrations

[3] Medians and averages were calculated with LCHD water quality data collected from 72 lakes from 1995 – 2000.

[4] Total nitrogen consists of the organic forms of nitrogen plus nitrate nitrogen.

were sufficient at least from the surface down to eight feet deep for the 2000 season. This should support a bluegill/bass fishery (at least 3.0 mg/L). However, accurate calculations of the volume of oxygenated water cannot be made without the data from a recent accurate bathymetric map. A bathymetric map was created in 1964, but is inaccurate and outdated.

The Illinois Environmental Protection Agency has guidelines to classify Illinois lakes for their ability to support aquatic life or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations and aquatic plant coverage. Lake of the Hollow fully supports aquatic life and swimming uses according to these guidelines. The lake has some impairment for recreational uses because of the excessive plant growth.

The water level of Lake of the Hollow was measured each month at the spillway throughout the 2000 sampling season. During all month except June, the water was two inches or less above the spillway. During the June sampling date, the water level was much higher, at 8.1 inches above the spillway. Fluctuating water levels can aggravate shoreline erosion. Interestingly, the closest rain gauge (Wauconda) recorded less rain in June than in May or July. The recorded rain data was 6.46 inches in May, 5.56 inches in June, and 6.2 inches in July.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Eighteen species of aquatic plants were recorded in Lake of the Hollow during the 2000 sampling season (see Table 1). This is a good diversity of plant species, although one plant, probably a hybrid of Eurasian water milfoil and northern water milfoil, dominated the lake, appearing in 92% of the samples over the season (See Appendix C for occurrences of plant species). Individual plants of Eurasian water milfoil and northern water milfoil were found occasionally within these large milfoil beds. White water lily and common bladderwort were the next two most commonly found plants, appearing in 54% and 33% of all samples, respectively. Staff also located several individual plants of whorled water milfoil, which is considered rare in Illinois. With the excellent water clarity, aquatic plants were prolific in the lake, covering about 97% of the lake bottom.

Aquatic plants will not photosynthesize in water depths where less than 1% of the sunlight reaches the bottom. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. In the case of Lake of the Hollow, a 1% light level still existed down to approximately 12 feet deep from May through July. To support this data, the deepest water in which a plant was found was 12.5 feet in June. Light was less than 1% below 9.2 feet in August and September. Much of the lake can accommodate plant growth since it has an estimated average depth of 7.5 feet, and the availability of light to reach a minimum of 9 feet deep. This is why approximately 97% (75 acres) of the lake bottom supported plant growth in 2000. From a fisheries perspective, the Illinois Department of Natural Resources (IDNR) would

recommend that Lake of the Hollow has plant coverage from 20% to 40% of the lake's surface acreage, or between 15 and 31 acres of plant coverage. The lake has been treated twice with the aquatic herbicide Sonar™. In 1997, to control the milfoil and curlyleaf pondweed, the pellet form of Sonar™ was applied at a rate of 15 parts per billion (ppb) in late April and May. FasTEST results in July from five different locations in the lake ranged from 6.55 ppb to 8.9 ppb. After treatment, it was noted that American pondweed, a beneficial, native plant, grew in areas that previously grew milfoil. The herbicide 2,4-D was also used in 1997 to control white water lily in the channel. In October 2000, liquid Sonar™ was applied at a rate of 15 ppb, to control milfoil growth for the 2001 season. FasTEST results were between 10 ppb and 20.5 ppb in two sample locations. Another FasTEST will be done in the spring of 2001 2.2 ppb. Because milfoil grows (slowly) throughout the winter, it may have absorbed the majority of the herbicide. The plant coverage in 2001 should be estimated to see if this latest treatment leaves 15 to 31 acres of plants in the lake. Native plants that return in areas that were previously milfoil beds should also be noted.

An important discovery in Lake of the Hollow during 2001 was the presence of the water milfoil weevil *[Euhrychiopsis lecontei* (*E. lecontei*)], which is a biological control organism used to control Eurasian water milfoil (EWM). *E. lecontei* is a native weevil, which feeds almost exclusively on milfoil species. It was originally discovered while investigating declines of EWM in a Vermont lake in the early 1990s. It was discovered in northeastern Illinois lakes in 1995. Another weevil, *Phytobius leucogaster*, also feeds on EWM but does not cause as much damage as *E. lecontei*. Therefore, *E. lecontei* is the insect that is stocked as a biocontrol and is commonly referred to as the water milfoil weevil. Currently, the LCHD-Lakes Management Unit has documented weevils (*E. lecontei* and/or *P. leucogaster*) in 16 Lake County lakes. Many of these lakes have seen declines in EWM populations in recent years. It is highly likely that *E. lecontei* and/or *P. leucogaster* occurs in all lakes in Lake County that have excessive EWM growth. Lake of the Hollow could benefit from a plant management plan that leaves an area of milfoil plants as a refuge for these insects to see if they begin to affect the milfoil populations. Shoreline plants in the areas with buffer strips or naturalized shorelines offer winter refuge for these insects.

Another part of the plant management plan would be to create a new bathymetric map. An accurate bathymetric map complete with volume calculations is a critical lake management tool, especially for the correct application of aquatic herbicides and algicides. Because the old bathymetric map is inaccurate and outdated, the creation of a new bathymetric map is recommended.

Table 1. Aquatic Plant Species in Lake of the Hollow, May – September, 2000.

Aquatic Plants

Coontail	*Ceratophyllum demersum*
Small Duckweed	*Lemna minor*
Eurasian water milfoil	*Myriophyllum spicatum*
Northern water milfoil	*Myriophyllum sibiricum*
*Whorled water milfoil	*Myriophyllum verticillatum*
Slender Naiad	*Najas flexilis*
Spiny Naiad	*Najas marina*
White Water Lily	*Nymphaea tuberosa*
Yellow Pond Lily	*Nuphar variegata*
American Pondweed	*Potamogeton americanus*
Curlyleaf Pondweed	*Potamogeton crispus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Leafy Pondweed	*Potamogeton foliosus*
Small Pondweed	*Potamogeton pusillus*
Threadleaf Pondweed	*Potamogeton filiformus*
Sago Pondweed	*Stuckenia pectinatus*
Common Bladderwort	*Utricularia vulgaris*
Wild Celery	*Valisneria americana*
Macroalgae	
Chara/Nitella	*Chara/Nitella*

*Rare in Illinois

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

In early May 2000, Lake County Health Department (LCHD) staff assessed the shoreline of Lake of the Hollow. See Appendix A for a discussion of the methods used. Of the 16,048 feet of shoreline that surrounds Lake of the Hollow, 7100 feet, or 44 % of the shoreline, is classified as being developed. This includes 3124 feet of unmowed buffer areas (44%), 2582 feet of riprap (36%), 979 feet of mowed turfgrass (14%), 263 feet (4%) of private beach and 151 feet of seawall (2%). The 8948 feet (56%) of undeveloped shoreline offers good wildlife habitat such as fallen trees (deadfall) and shrubby areas. Approximately 2053 feet of the developed shoreline is not eroding, with 1905.6 feet

armored with riprap or seawall. A total of 9716 feet, or 60%, of the total shoreline is eroding, with 647 feet (4%) severely eroding and 4262 feet (27%) moderately eroding (See Figure 2). Thirty seven percent (3595 feet) of the eroding shoreline is developed, including 828 feet of riprap. Eroding shorelines along the channel, especially around the island, were probably caused by ice damage. Wave action aggravates the eroding shoreline along the peninsula. Because of its short root system, the turfgrass mowed to the water's edge at the tip of the peninsula offers no protection from erosion. In addition, the water level fluctuated, increasing approximately 6 inches between May and June, and then decreasing 6 inches in July. All three of these factors, wave action, fluctuations in water level and ice damage play a part in aggravating shoreline erosion at Lake of the Hollow. These shorelines will continue to erode as a result of these factors if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property. Erosion control alternatives can be found within Objective III, "Mitigate Shoreline Erosion."

Staff also noted buckthorn (*Rhamnus spp*.), an invasive, non-native tree species along the island shoreline and along the western shore of the peninsula (See Figure 3). The removal of these trees is recommended. Alternatives for their removal can be found within Objective IV: "Remove Invasive Shoreline Plant Species." Some of the shoreline on which these trees grow is steep and moderately eroding. If the trees are removed, a plan needs to be in place to address shoreline protection. If possible, the shoreline should be planted as soon as the buckthorn is cut down. Because the shoreline around the island is steep and not easily accessible to heavy equipment for grading (which would be necessary for many erosion mitigation methods), willow posts may be the most feasible option to protect this area. Other invasive species, such as purple loosestrife and reed canary grass were noted. Purple loosestrife was commonly found along the east shore of the channel. Only one lot, which was also in the channel, had reed canary grass.

Figure 2

INSERT SHORELINE EROSION MAP

INSERT FIGURE 3, INVASIVE SHORELINE PLANTS

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

LCHD staff observed wildlife species during sampling visits to Lake of the Hollow. Methodology is discussed in Appendix A. A listing of the wildlife can be found in Table 2. The Illinois Department of Natural Resources (IDNR) owns several parcels of undeveloped property adjacent to the west shore of the lake in addition to three acres of lake bottom. This undeveloped wooded area around the lake provides excellent habitat for wildlife. Staff noted a juvenile pied-billed grebe, which is listed as a threatened species in Illinois. A nest for this species was not located, but it is possible that the grebes nested on this lake. Some residential areas offered good habitat with mature trees and naturalized areas. Residences with manicured lawns mowed to the water's edge offered the least habitat on the lake. Downed trees (deadfall) in the water offer good habitat for fish, turtles and wading birds. Deadfall should be left in the water.

The IDNR has surveyed the fishery in Lake of the Hollow in the past, with the last population count completed in 1981. A written report with recommendations of this last survey was unavailable. Residents may want to contact the IDNR about the possibility of a new fisheries survey and management recommendations. A tabulated history of IDNR's involvement with Lake of the Hollow is listed in Table 3.

Staff discovered that Lake of the Hollow had been stocked with grass carp in the past. Residents who were aware of this do not know the year or the number of grass carp that were stocked. In Illinois, grass carp are illegal to stock in a glacial lake such as Lake of the Hollow, and they are also illegal to stock in any lake with an outlet to another body of water. The outlet in Lake of the Hollow flows to the Chain O'Lakes. These fish probably escaped through this outlet to the Chain O'Lakes.

Staff also noted the presence of many Canada Geese on lots with mowed turfgrass. A buffer strip consisting of taller plants approximately 10-20 feet wide between the shoreline and any mowed lawn can discourage the geese from exiting the water at these locations and fouling the lot with their feces. Their feces also add phosphorus to the water column, which is a food source for algae and plants.

Table 2. Wildlife Species Present, May – September, 2000.

Birds

Pied-billed Grebe+	*Podilymbus podiceps*
Double Crested Cormorant	*Phalacrocorax auritus*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Ring-billed Gull	*Larus delawarensis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Red-tailed Hawk	*Buteo jamaicensis*
Turkey Vulture	*Cathartes aura*
Belted Kingfisher	*Megaceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Great Crested Flycatcher	*Myiarchus crinitus*
Eastern Phoebe	*Sayornis phoebe*
Eastern Pewee	*Contopus virens*
Least Flycatcher	*Empidonax minimus*
Purple Martin	*Progne subis*
Barn Swallow	*Hirundo rustica*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee	*Poecile atricapillus*
White-breasted Nuthatch	*Sitta carolinensis*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Wood Thrush	*Hylocichla mustelina*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo	*Vireo olivaceus*
Warbling Vireo	*Vireo gilvus*
Wilson's Warbler	*Wilsonia pusilla*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Brown-headed Cowbird	*Molothrus ater*
Common Grackle	*Quiscalus quiscula*

Table 2., con't. Wildlife Species Present

Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Chipping Sparrow	*Spizella passerina*
Song Sparrow	*Melospiza melodia*

+Threatened in Illinois

Mammals

Chipmunk	*Tamias striatus*
Gray Squirrel	*Sciurus carolinesis*

Table 3. Historical Fisheries Information

Year	Activity
1964	Fish population analysis
1969	Fish population analysis
1970	Winterkill
1971	Supplemental survey after winterkill
1972	Fish population analysis
1981	Fish population analysis

EXISTING LAKE QUALITY PROBLEMS

- *A recent accurate bathymetric map of Lake of the Hollow does not exist.*

  A bathymetric (depth contour) map is an essential tool in effective lake management since it provides information on the morphometric features of the lake, such as depth, surface area, volume, etc. The knowledge of this morphometric information would be necessary if lake management practices such as aquatic herbicide use, fish stocking, dredging, or aeration were part of the overall lake management plan.

- *Aquatic plants cover approximately 97% of the lake bottom as a result of shallow depths and good water clarity.*

  Eighteen species of aquatic plants were recorded in Lake of the Hollow during the 2000 sampling season (see Table 1). This is a good variety of plant species, although one plant, a possible hybrid of Eurasian water milfoil and northern water milfoil, dominates the lake. With the good water clarity, aquatic plants were prolific in the lake, covering about 97% of the lake bottom.

- *Approximately 60% of the shoreline is eroding.*

  A total of 9716 feet, or 60%, of the total shoreline is eroding, with 647 feet (4%) severely eroding and 4262 feet (27%) moderately eroding. These shorelines will continue to erode if protective measures are not taken. This can add sediment to the water and result in a loss of shoreline property.

POTENTIAL OBJECTIVES FOR LAKE OF THE HOLLOW LAKE MANAGEMENT PLAN

I. Create a Bathymetric Map.
II. Formulate an Aquatic Plant Management Plan.
III. Mitigate Shoreline Erosion.
IV. Remove Invasive Shoreline Plant Species.
V. Maintain or Enhance Areas for Wildlife.
VI. Alleviate Excessive Numbers of Canada Geese

ALTERNATIVES FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES FOR LAKE OF THE HOLLOW

Objective I: Create a bathymetric map.

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

Objective II: Formulate an Aquatic Plant Management Plan.

Lake of the Hollow supports plant growth across approximately 97% (73 acres)of lake bottom. From a fisheries perspective, the Illinois Department of Natural Resources (IDNR) would recommend that Lake of the Hollow has plant coverage from 20% to 40% of the lake's surface acreage, or 15 and 31 acres of plant coverage, respectively. The Association should keep accurate records of names and amounts of aquatic herbicides and algicides each year they are used. Part of the plan should include monitoring the size of both nuisance and beneficial plant beds each year to see if changes are needed in controlling the nuisance milfoil beds or encouraging the growth of healthy native plants. Lake of the Hollow could benefit from a plant management plan that leaves an area of milfoil plants as a refuge for these insects to see if they begin to affect the milfoil populations.

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. The plan 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. A good aquatic plant management plan considers both the short and long-term needs of the lake. The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. A quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management options covered below are commonly used techniques that are coming into wider

acceptance and have been used in Lake County. There are other plant management options that are not covered below as they not are very effective, or are too experimental to be widely used.

Option 1: No Action

If the lake is dominated by native, non-invasive species, the no action option could be ideal. Under these circumstances native plant populations could flourish and keep nuisance plants from becoming problematic. With a no action aquatic plant management plan in a lake with non-native nuisance species, nothing would be done to control the aquatic plant population of the lake regardless of the type and extent of the vegetation. Nuisance vegetation could continue to grow until epidemic proportions are reached. Growth limitations of the plant and the characteristics of the lake itself (light penetration, lake morphology, substrate type, etc.) will dictate the extent of infestation. Rooted plants, such as curly leaf pondweed (*Potamogeton crispus*) and elodea (*Elodea canadensis*), will be bound by physical factors such as substrate type and light availability. Plants such as Eurasian watermilfoil and coontail, which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely. The plant beds in Lake of the Hollow cover approximately 97% of the lake bottom at this time. The No Action option would leave the lake at status quo. The remainder of the lake bottom without plant growth was in the deepest water, and was rather peaty, a substrate that is not conducive to milfoil growth.

Pros

There are positive aspects associated with the no action option for plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical altercation, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. Expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep "weedy" plants under control.

Another positive aspect of the No Action option for Lake of the Hollow is that the water clarity would continue to be very good. The plant beds are stabilizing the sediment, and competing with algae for sunlight and nutrients, which allows the lake to maintain this level of water clarity.

Cons

Under the no action option, if nuisance vegetation is dominant in the lake and were uninhibited and able to reach epidemic proportions, there will be many negative impacts on the lake. By their weedy nature, the nuisance plants would out-compete the more desirable native plants. This could eventually, drastically reduce or even eliminate the native plant population of the lake and reduce the lake's biodiversity. This will also impact fish populations. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. Predation will decrease due to the difficulty of finding prey in the dense stands of vegetation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive vegetation, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by these dense stands of vegetation. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the dense plant stands.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of plants. Fishing could become more and more exasperating due in part to the thick vegetation and also because of stunted fish population.

Costs

No cost will be incurred by implementing the no action management option.

Option 2: Aquatic Herbicides

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).

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. 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 (Sonar™, Avast). 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 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 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. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

In 1997, Lake of the Hollow was treated with Sonar™ at a rate of 15 ppb with subsequent FasTEST results ranging from 6.55 ppb – 8.9 ppb approximately 2 months after the last treatment. The lake did have a native, beneficial aquatic plant, American pondweed, (*Potamogeton americanus*) the fall of 2000. The FasTest results indicated the lake had 10 ppb in one location, and 20.5 ppb in another. In the spring of 2001, another FasTest had results of 2.2 ppb. The milfoil, which still lives over winter, probably absorbed the herbicide since the fall. In the approaching summer season, the results of this treatment should be noted. For example, the size of the plant beds could be estimated by simply drawing the extent of the plant beds on a map of the lake during the middle of summer. A notation of the name and amount or concentration should be included so the Association knows how the lake reacted to the treatment. Decisions can then be made about changing the amount or type of herbicide if herbicide use is desired. This should be done yearly to compare how the plant beds are changing from year to year.

Pros

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, 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. 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 fisheries 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 (*Potamogeton amplifolius*). 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. Lake of the Hollow has very good water clarity, which would decrease if too many plants were removed. Lake of the Hollow is one of the few lakes in Lake County that are classified as mesotrophic, which means nutrients are in low concentrations in the water column. These lakes are usually high quality lakes. A situation that would cause algae blooms to increase would cause the quality of this lake to decline. The removal of aquatic vegetation, which competes with algae for resources, 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.

Overremoval, and possible regrowth of nuisance vegetation that may follow will 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[5]

In case the Association wants to lessen the concentration of Sonar™ in Lake of the Hollow, the cost for at a 10 ppb concentration is about $12 per acre-foot.

Option 3: Water Milfoil Weevil

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian water milfoil (EWM). *E. lecontei* is a native weevil, which feeds almost exclusively on milfoil species. It was originally discovered while investigating declines of EWM in a Vermont lake in the early 1990s. It was discovered in northeastern Illinois lakes in 1995. Another weevil, *Phytobius leucogaster*, also feeds on EWM but does not cause as much damage as *E. lecontei*. Therefore, *E. lecontei* is the insect that is stocked as a biocontrol and is commonly referred to as the Eurasian water milfoil weevil. Currently, the LCHD-Lakes Management Unit has documented weevils (*E. lecontei* and/or *P. leucogaster*) in 16 Lake County lakes. Many of these lakes have seen declines in EWM populations in recent years. It is highly likely that *E. lecontei* and/or *P. leucogaster* occurs in all lakes in Lake County that have excessive EWM growth. The Lakes Management Unit did find a weevil in Lake of the Hollow. The plant beds of the Eurasian/Northern water milfoil hybrid are not being controlled at this time by these

[5] Costs were quoted during 2000.

weevils. However, a area of milfoil plants could be left as a refuge for these insects to see if they begin to affect the milfoil populations.

Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations do not feed on any other aquatic plants and die back. When EWM starts to grow in the spring, so do weevil populations thus keeping the milfoil under control before it becomes a problem. Once the weevil is established, EWM does not have the opportunity to reach nuisance proportions and in some cases becomes very sparse. Best results are achieved in lakes that have shallow EWM infestations and in areas that milfoil is undisturbed by recreational and management actives. Weevils need proper overwintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Additionally, water temperatures need to be 68-70^{o}F for maximum weevil activity. For this reason weevils are typically stocked in late spring/early summer. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil™ process). The program includes evaluation of EWM densities and initial weevil populations, stocking, monitoring, and restocking as needed.

Pros

The use of the milfoil weevil can provide long-term control of EWM. Typically by the end of June EWM stands are starting to decline due to weevil damage. In many situations, EWM beds might not reach the surface before weevil damage causes declines. *E. lecontei* is also a selective means to control EWM. Studies have shown that *E. lecontei* has a strong preference for EWM and the only other plant it possibly will feed on is northern water milfoil. Since milfoil weevils are found to naturally occur in several lakes in Lake County, stocking of weevils would be an augmentation rather than an introduction thus making it a more natural control option.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could then start to re-colonize. Fisheries of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Recreational activities such as fishing, swimming, and boating would increase due to removal of inhibiting mats of EWM.

Cons

Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. Substantial reductions have been seen in EWM one year, only to be unaffected the next. Reasons for these inconsistencies are under investigation. One possible explanation is lack of suitable overwintering habitat. Highly developed, manicured lawn shorelines of many lakes in the County are not suitable habitat for weevil overwintering. Another possible explanation is cooler than normal summer water temperatures. Studies have

shown that cooler water temperatures reduce weevil feeding as well as egg production.

Milfoil control using weevils may not work well on plants in deep water. Plants are able to compensate for weevil damage on upper portions of the plant by increasing growth on lower portions where weevil does not feed. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats and swimming. In addition, weevils do not work well in areas disturbed by other management techniques such as harvesting or herbicide use. In areas where weevils are to be stocked, activity should be as reduced as much as possible. This may either limit the extent to which the weevils can be used or limit recreational use of the lake.
One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre. At a cost of $1 per weevil plus labor, a EWM management program using weevils can be expensive. Additionally, there is no guarantee that weevils will provide long term control or even produce any results at all.

Costs

Weevils are sold in units. One unit is 1000 bugs. Stocking rates must be at least 1 unit/area. Normally there is a minimum purchase of 5-10 units. $1/weevil with 500-3000 weevils/acre of EWM. The rate is dependent on whether weevils are naturally present. This does not including labor involved in initial surveys, stocking, and monitoring.

EnviroScience, Inc.
3781 Darrow Road
Stow, Ohio 44224
1(800) 940-4025

Option 4: 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 hand made 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.

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. 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.

Objective III: Mitigate Shoreline Erosion.

Erosion is a potentially serious problem to lake shorelines and 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 worsen the problem. Erosion not only results in loss of shoreline property, but negatively influences the lake's overall water quality by contributing nutrients and sediment 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.

At Lake of the Hollow, a total of 9716 feet, or 60%, of the total shoreline is eroding, with 647 feet (4%) severely eroding and 4262 feet (27%) moderately eroding (See Figure 2). Thirty seven percent of the eroding shoreline is developed. These shorelines will

continue to erode if protective measures are not taken. Because majority of the lakeshore (56%) has naturalized shoreline, erosion control methods employing the use of plantings would keep the undeveloped eroding shorelines in their natural state, and increase habitat along the developed eroding shorelines. Eroding areas with turfgrass mowed to the edge can benefit with the use of taller plants by discouraging Canada Geese from exiting the water at these locations. The homeowner should monitor shorelines that are slightly eroding. Homeowners with slightly eroding shorelines that consist of mowed turfgrass may want to consider planting a buffer strip of native plants along their shore.

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: Create a Buffer Strip

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 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 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, A-Jacks®, or riprap.

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

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or riprap. However, because of the need for heavy equipment to install A-Jacks and riprap, these two methods could not be used on the island.

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

All eroding areas could benefit from vegetative plantings, but depending on the severity of erosion, another technique in conjunction with plants may be necessary. One method would be to use willow posts in conjunction with a biolog, which would protect the

shoreline until the willows become established. The plantings on the biolog would add further protection.

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. 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. 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. For example, the cost for mitigating the severely eroding shoreline along the private property used by residents of the Woo Sung Haven of Rest subdivision with this method would be about $6,460 or $9,700- 12,934 if willow posts are installed. Willow posts along this same shoreline may be the best option to stabilize these severely eroding shorelines. The labor that is needed can be completed by the shoreline 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.

Table 4. Costs for Native Plants

Terrestrial-Dry soil	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Big Bluestem Grass (*Andropogon gerardii*)	10-25b lbs/acre	$20/lb	NA	$4-5
Bluejoint Grass (*Calamagrostis canadensis*)	2 lbs/acre	$2-4/oz	NA	$4-5
Little Bluestem Grass (*Andropogon scoparius*)	10-25 lbs/acre	$20/lb	NA	$4-5
Prairie Cord Grass (*Spartina pectinata*)	0.25-1.0 lbs/acre	$2-3/oz	250-500/acre	$2-4
Switch Grass (*Panicum virgatum*)	0.5-2.0 lbs./acre	$6-7/oz	NA	$1-5
Terrestrial-Wet Soil	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Blue Flag (*Iris versicolor*)	NA	$10/oz	1000/acre	$0.60-1.50
Blue Vervain (*Verbena hastata*)	NA	$6/oz	500-1000/acre	$0.80-1.00
Blunt Spike Rush (*Eleocharis obtusa*)	NA	$30/oz	500-1000/acre	$0.50-1.00
Boneset (*Eupatorium perfoliatum*)	0.006-0.25 lbs./acre	$6-7/oz	500-700/acre	$1.00
Water Horsetail (*Equisetum fluviatile*)	NA	NA	1000/acre	$0.50
Joe-Pye-Weed (*Eupatorium maculatum*)	NA	$8/oz	500-700/acre	$0.50-1.00
Sweet Flag (*Acorus calamus*)	NA	$10/oz	250/acre	$0.50-1.00
Wild Rice (*Zizania aquatica*)	NA	$5.00/lb	1000/acre	$0.50-0.20
Trees and Shrubs	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Bur Oak (*Quercus macrocarpa*)	NA	NA	NA	$5-6
Buttonbush (*Cephalanthus occidentalis*)	NA	NA	NA	$6-7
Red Osier Dogwood (*Cornus stolonifera*)	NA	$9/oz	NA	$2-5
White Oak (*Quercus alba*)	NA	$5-8/oz	NA	$6-7
Seed Mixes	**Seeding Rate**	**Seed Price**	**Planting Rate**	**Price/Plant**
Forb and Grass Seed Mix	500 square ft	$20-60	NA	NA
Forb and Grass Seed Mix	1000 square ft	$66-108	NA	NA

Option 3: 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. In areas of severe erosion, other techniques may need to be employed or incorporated with these products.

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. This would not be the best option around the island because of the highly erodible shoreline.

Costs

Costs range from $25 to $35 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,000 – 2,000 depending on the type of earthmoving that would be needed. Additional costs may be incurred if compensatory storage is needed.

Option 4. 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. Riprap can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the riprap, fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below).

Pros

Riprap 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, riprap 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 severe erosion problems may benefit from using riprap. 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. This would not be an option for the shorelines that could not be accessible by heavy equipment, such as the island. Permits are required if replacing existing or installing new riprap or gabions 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 riprap 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 riprap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $30-45 per linear foot. 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 riprap, 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.

Objective IV: Remove Invasive Shoreline Plant Species.

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus athartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. All three of these plants can be found growing along the shorelines at Lake of the Hollow. Buckthorn trees were found most often around the island. Buckthorn trees exude a chemical that discourages plant growth beneath. This may have aggravated the shoreline erosion along the island, since the trees are close to the shoreline and few understory plants are present to stabilize the soil. The removal of buckthorn trees is always recommended. Removal of a few buckthorn trees at a time could be done on the island instead of attempting to remove all of them at once.
The purple loosestrife was commonly found along the east shore of the channel. Only one lot, which was also in the channel, had reed canary grass. The outcome of a large number of these invasive species 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. 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 4 in Objective III: "Mitigate Shoreline Erosion" lists several native plants that can be planted along shorelines.

Cons

Native plant and wildlife diversity will be lost as stands of exotic species expand. Exotic species are not under the same stresses (particularly diseases and predators) as native plants and thus can out-compete the natives for nutrients, space, and light. Few wildlife species use areas where exotic plants dominate. This happens because many wildlife species either have not adapted with the plants and do not view them as a food resource, the plants are not digestible to the animal, or their primary food supply (i.e., insects) are not attracted to the plants. The result is a monoculture of exotic plants with limited biodiversity.

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be effected.

Costs

Costs with this option are zero initially, however, when control is eventually needed, costs will be substantially more than if action was taken immediately. Additionally, the eventual loss of ecological diversity is difficult to calculate financially.

Option 2: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is

excavated. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. The numbers of purple loosestrife found along the east side of the channel are small enough that this option is feasible. 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. Girdling could control large buckthorn trees, which is done by removing a ring of bark around the trunk. However, the tree could resprout from the base of the trunk.

Pros

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

Cons

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

Costs

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

Option 3: Herbicide Treatment

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

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems.

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

Because the buckthorn trees by Lake of the Hollow are near water, only the use of the herbicide Rodeo® (active ingredient, glyphosphate) can be used if the Association or private landowner wishes to use herbicides. The trees would need to be cut down, and their exposed stumps would need to be wicked with Rodeo®.

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

The cost for one gallon of Rodeo® is $65. Wicking devices are $30-40. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively.

Objective V: Maintain or Enhance Areas for Wildlife.

Lake of the Hollow has some excellent habitat, especially along the western and southern shores. The aquatic plant variety is very good, offering several food sources for a variety of animals. The island also offers good wildlife habitat. The residential lots with buffer strips and mature trees offer more habitat than those lots with mowed lawn to the water's edge. Maintaining the naturalized areas as they are would be of best interest for this ecosystem. The limited wildlife habitat on the lots with manicured lawns could be enhanced by the use of the options below.

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a 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 IV, Remove Invasive Shoreline Species.

Option 1: No Action

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

Pros

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

Cons

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

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

Costs

The financial cost of this option 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 4 for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

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

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They

should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets.

Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

Pros

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

Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. Water quality may be improved by the filtering of nutrients, sediment, and pollutants in run-off. This has a “domino effect” since less run-off flowing into a lake means less nutrient availability for nuisance algae, and less sediment means less turbidity, which leads to better water quality. All this is beneficial for fish and wildlife, such as sight-feeders like bass and herons, as well as people who use the lake for recreation. Finally, a buffer strip along the shoreline can serve as a deterrent to Canada geese from using a shoreline. Canada geese like flat, open areas with a wide field of vision. Ideal habitat for them are areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere.

Cons

There are few disadvantages to this option. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline. Composition and density of aquatic and shoreline vegetation are important. If vegetation consists of non-native species such as or Eurasian water milfoil or purple loosestrife, or in excess amounts, undesirable conditions may result. A shoreline with excess exotic plant growth may result in a

poor fishery (exhibited by stunted fish) and poor recreation opportunities (i.e. boating, swimming, or wildlife viewing).

Costs

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

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in Table 4 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 are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

Option 4: Increase Nest Availability

Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3).

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, species like tree swallows or chickadees will, in subsequent years use a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common

flicker) in one year. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

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

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

Pros

Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric “bug zappers” for pest control.

Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

Cons

Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks.

Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

Costs

The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation.

Objective VI: Alleviate 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 aggravate 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 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

A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $33.00 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™.

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 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 4 in Objective III, "Mitigate Shoreline Erosion" lists seeding rates and approximate costs for native plants 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 ObjectiveV: Maintain or Enhance Areas for Wildlife). 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 (see Objective III: Mitigate Shoreline Erosion). 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.

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 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.

Table 5. 2000 Lake of the Hollow Water Quality Data

Epilimnion

DATE	DEPTH	ALK	TKN	NH3	NO3	TN	TP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
05/17/00	3	194	1.17	<0.1	<0.05	1.17	0.015	336	1.8	342	155	8.53	0.5001	8.72	9.94
06/21/00	3	184	1.16	<0.1	0.055	1.22	0.027	302	1.2	314	92	10.76	0.4567	8.24	7.60
07/19/00	3	198	1.0	<0.1	0.064	1.06	0.019	314	2.0	311	120	9.25	0.4721	8.03	6.11
08/23/00	3	191	1.0	<0.1	0.058	1.06	0.023	338	2.4	331	125	9.29	0.4832	8.27	7.69
09/20/00	3	188	1.1	<0.1	<0.05	1.10	0.016	282	1.7	296	123	8.56	0.4848	8.35	8.22
Average		191	1.086	<0.1	0.059[k]	1.09	0.02	314	1.82	319	123	9.28	0.479	8.32	7.91

Hypolimnion

DATE	DEPTH	ALK	TKN	NH3	NO3	TN	TP	TDS	TSS	TS	TVS	SECCHI	COND	pH	DO
05/17/00	12	206	1.23	<0.1	<0.05	1.23	0.021	333	3.3	356	137	NA	0.5447	7.73	3.17
06/21/00	13	200	1.2	<0.1	0.059	1.26	0.035	300	3.6	343	107	NA	0.501	7.34	0.18
07/19/00	12	207	1.2	<0.1	0.069	1.27	0.041	315	5.9	323	105	NA	0.497	7.38	0.05
08/23/00	12	201	1.2	0.182	0.064	1.26	0.043	320	5.6	357	153	NA	0.5084	7.41	0.08
09/20/00	11	191	1.17	<0.1	<0.05	1.17	0.024	284	2.5	309	126	NA	0.4927	7.91	5.54
Average		201	1.2	0.182[k]	0.064[k]	1.20	0.033	310	4.18	338	126	NA	0.509	7.55	1.80

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, milligrams per liter (mg/L)
NH3-N = Ammonia nitrogen, mg/L
NO3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L

TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi Disk Depth, ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L
pH units are equal to the -Log of (H) ion activity.

Note: "k" denotes that the actual value is known to be less than the value presented.
NA = Not Applicable

Appendix A. Methods for Field Data Collection and Laboratory Analyses

Water Sampling and Laboratory Analyses

Two water samples were collected once a month from May through September. Sample locations were generally at the deepest point in the lake (see sample site map), three feet below the surface, and approximately two feet off the bottom. Samples were collected with a horizontal or vertical Van Dorn water sampler. Approximately three liters of water were collected for each sample for all lab analyses. After collection, all samples were placed in a cooler with ice until delivered to the Lake County Health Department lab, where they were refrigerated. TestAmerica Incorporated, an environmental services lab, analyzed samples collected for total Kjeldahl nitrogen (TKN). The Health Department lab analyzed all other samples. Analytical methods for the parameters are listed in Table 1. Except nitrate nitrogen, all methods are from the Eighteenth Edition of Standard Methods, (eds. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1992). Methodology for nitrate nitrogen was taken from the 14th edition of Standard Methods. Total Kjeldahl nitrogen was analyzed by method 351.2 from the Methods for Chemical Analyses of Water and Wastes (EPA 600 Series). Dissolved oxygen, temperature, conductivity and pH were measured at the deep hole with a Hydrolab DataSonde® 4a. Photosynthetic Active Radiation (PAR) was recorded using a LI-COR® 192 Spherical Sensor attached to the Hydrolab DataSonde® 4a. Readings were taken at the surface and then every foot until reaching the bottom in lakes $\leq$ 15 feet deep, and every two feet in lakes >15 feet.

Plant Sampling

Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At random locations in the littoral zone, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, any plants on the rake were identified and recorded. Plants that were not found on the rake but were seen in the immediate vicinity

of the boat at the time of sampling, were also recorded. Plants difficult to identify in the field were placed in plastic bags and identified with plant keys after returning to the office. The depth of each sampling location was measured either by a hand-held depth meter, or by pushing the rake straight down and measuring the depth along the rope or rake handle. One-foot increments were marked along the rope and rake handle to aid in depth estimation. Approximate locations of each point were drawn on an aerial photo of the lake. Locations of the plant edge were also identified and marked on the aerial photo. The plant edge was defined as the area where aquatic plants presence dissipated, typically toward the deeper portions of the lake. The number of sample locations was contingent upon lake surface area, area of littoral zone, and presence and distribution of plants.

Shoreline Assessment

To assess the current condition of each lake's shoreline, a shoreline assessment was completed in 2000. This survey was conducted with the use of a boat, aerial photos, and county parcel maps. The shoreline along the land/water interface on each parcel was observed from a boat and various parameters were assessed (Table 2). Shorelines were first identified as developed or undeveloped. The type of shoreline was then determined and length of each type was recorded based on the parcel map or was estimated. In addition, several other parameters were measured including: the extent of shoreline vegetation, the degree of slope and erosion, and the presence of inlets, recreational structures (including boats, canoes, jetskis, boat ramps, piers, boat lifts, swimming platforms, etc.), aerators, irrigation pumps, water control structures, invasive vegetation, beaver activity, and deadfall (trees or shrubs lying in the water).

Frequently a parcel consisted of several shoreline types. For example, a parcel may have a beach, a steel seawall, and rip-rap along the its shore. In this case, the parcel was subdivided into three separate sections.

Data was entered and analyzed in ArcView 3.2 © Geographic Information System (GIS) software. Total shoreline lengths and percentages for each category were determined using Excel software.

Wildlife Assessment

Species of wildlife were noted during visits to each lake. When possible, wildlife was identified to species by sight or sound. However, due to time constraints, collection of quantitative information was not possible. Thus, all data should be considered anecdotal. Some of the species on the list may have only been seen once, or were spotted during their migration through the area.

Table A1. Analytical Methods Used for Water Quality Parameters.

Parameter	***Method***
Temperature	Hydrolab DataSonde® 4a
Dissolved oxygen	Hydrolab DataSonde ®4a
Nitrate nitrogen	Brucine method
Ammonia nitrogen	Electrode method, #4500F
Total Kjeldahl nitrogen	EPA 600 Series, Method 351.2
pH	Hydrolab DataSonde® 4a, Electrometric method
Total solids	Method #2540B
Total suspended solids	Method #2540D
Total dissolved solids	Method #2540C
Total volatile solids	Method #2540E, from total solids
Alkalinity	Method #2320B, titration method
Conductivity	Hydrolab DataSonde® 4a
Total phosphorus	Methods #4500-P B 5 and #4500-P E
Soluble reactive phosphorus	Methods #4500- P E and #4500-P B1
Clarity	Secchi disk
Color	Illinois EPA Volunteer Lake Monitoring Color Chart
Photosynthetic Active Radiation (PAR)	Hydrolab DataSonde® 4a, LI-COR® 192 Spherical Sensor

Table A2. Shoreline Type Categories and Assessment.

Category	*Assessment*
Developed	Yes, No
Inlets	None, Culvert, Creek, Farm Tiles, Storm Water Outlet, Swale, Sump
Shoreline Vegetation	None, Light, Moderate, Heavy
Type	Prairie, Shrub, Wetland, Woodland, Beach, Buffer, Canopy, Lawn, Riprap, Seawall, Vacant
Slope	Flat, Gentle, Steep
Erosion	None, Slight, Moderate, Severe
Water Control Structures	None, Culvert, Dam, Spillway
Recreational Structures	Yes, No
Irrigation Present	Yes, No
Aerator Present	Yes, No
Invasive Vegetation	Yes, No
Beaver Activity	Yes, No
Deadfall	Yes, No

APPENDIX B. MULTIPARAMETER DATA

Appendix C. Plant Species and Their Occurrences in Lake of the Hollow

5/16/00 - 9/19/00	American Pondweed	Bladderwort	Chara	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Nitella	Northern Watermilfoil	Sago Pondweed
Num. of Sites	10	94	8	81	10	262	11	16	19	36
% Occurance	4%	33%	3%	29%	4%	92%	4%	6%	7%	13%

5/16/00	American Pondweed	Bladderwort	Chara	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Nitella	Northern Watermilfoil	Sago Pondweed
Num. of Sites	1	20	0	25	2	62	8	1	2	2
% Occurance	1%	29%	0%	36%	3%	89%	11%	1%	3%	3%

6/20/00	American Pondweed	Bladderwort	Chara	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Nitella	Northern Watermilfoil	Sago Pondweed
Num. of Sites	0	26	0	37	4	71	3	10	11	5
% Occurance	0%	34%	0%	48%	5%	92%	4%	13%	14%	6%

7/18/00	American Pondweed	Bladderwort	Chara	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Nitella	Northern Watermilfoil	Sago Pondweed
Num. of Sites	6	34	7	16	3	74	0	4	5	15
% Occurance	8%	44%	9%	21%	4%	96%	0%	5%	6%	19%

8/22/00	American Pondweed	Bladderwort	Chara	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Leafy Pondweed	Nitella	Northern Watermilfoil	Sago Pondweed
Num. of Sites	7%	30%	0%	7%	0%	100%	0%	3%	3%	30%

9/19/00	American	Bladderwort	Chara	Curlyleaf	Duckweed	Eurasian	Leafy	Nitella	Northern	Sago

	Pondweed			Pondweed		Watermilfoil	Pondweed		Watermilfoil	Pondweed
Num. of Sites	1	5	1	1	1	25	0	0	0	5
% Occurance	3%	17%	3%	3%	3%	83%	0%	0%	0%	17%

Appendix C., con't.

5/16/00 - 9/19/00	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
Num. of Sites	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	
% Occurance	5	26	1	1	5	2	152	31	1
	2%	9%	0%	0%	2%	1%	54%	11%	0%

5/16/00	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
Num. of Sites	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	
% Occurance	0	0	0	0	0	0	21	2	1
	0%	0%	0%	0%	0%	0%	30%	3%	1%

6/20/00	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
Num. of Sites	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	
% Occurance	0	8	0	0	0	1	40	12	0
	0%	10%	0%	0%	0%	1%	52%	16%	0%

7/18/00	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
Num. of Sites	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	
% Occurance	4	7	0	1	3	1	50	11	0
	5%	9%	0%	1%	4%	1%	65%	14%	0%

8/22/00	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
Num. of Sites	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	

% Occurance	3%	20%	0%	0%	3%	0%	70%	13%	0%

	Slender	Small	Spiny	Threadleaf	Wild	Whorled	White	Yellow	Unknown
9/19/00	Naiad	Pondweed	Naiad	Pondweed	Celery	Watermilfoil	Waterlily	Pondlily	
Num. of Sites	0	5	1	0	1	0	20	2	0
% Occurance	0%	17%	3%	0%	3%	0%	67%	7%	0%