

**2001 SUMMARY REPORT  
of  
DUCK LAKE**

**Lake County, Illinois**

*Prepared by the*

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## EXECUTIVE SUMMARY

Duck Lake is a 110-acre natural slough pothole lake located near the Village of Fox Lake, Illinois. The northern third of the lake is within Fox Lake village boundaries, with the remainder of the lake in unincorporated Lake County. This is a shallow lake, with a maximum depth of 9 feet.

The water clarity in Duck Lake in 2001 was poor, averaging 2.01 feet. The water clarity is affected by algae growth and sediment resuspension which increased after aquatic plant herbicide treatments. Sediment may enter the lake via stormwater runoff or may be resuspended by motorboat, wind, wave and carp action.

In 2001, Duck Lake has excessive concentrations of total phosphorus, total Kjeldahl nitrogen, and total suspended solids. The near surface samples averaged 0.100 mg/L for total phosphorus, 2.828 mg/L for total Kjeldahl nitrogen, and 20.6 mg/L for total suspended solids. These concentrations are all over twice the county median, and are more than double of these same parameters measured in Duck Lake in 1997.

The shallow nature of the lake allows aquatic plants to grow across much of the surface. In 2001, prior to aquatic herbicide use, plant growth covered approximately 61% of the lake bottom. After the herbicide treatment, remaining aquatic plants covered about 29% of the lake bottom. This value is within the range of plant coverage recommended by the Illinois Department of Natural Resources to maintain a healthy fishery. However, once the plant coverage had reached this lower density, algae blooms and concentrations of total phosphorus, total Kjeldahl nitrogen, and total suspended solids increased, while water clarity decreased.

The two most common types of shoreline are wetland and riprap. Approximately 30% (11,850 feet) of the shoreline is eroding to some degree, but only 5% of the shoreline is classified as moderately or severely eroding (1,323 feet and 653 feet, respectfully). The severely eroding areas should be addressed immediately, before more sediment is washed into the lake. The shoreline is host to aggressive, exotic plant species such as purple loosestrife and buckthorn. These aggressive plants can crowd out native, beneficial plants and should be removed. The 16,930 feet (44%) of undeveloped shoreline around Duck Lake offers good wildlife habitat such as wetlands, woodlands, fallen trees (deadfall) and shrubby areas.

## **LAKE IDENTIFICATION AND LOCATION**

Duck Lake is a 110-acre natural slough pothole lake located near the Village of Fox Lake, Illinois (T45N, R9E, Sections 14, 15). A small spillway, about one foot high, was constructed in the 1950's within the outflow channel. The northern third of the lake is within Fox Lake village boundaries, with the remainder of the lake in unincorporated Lake County. This is a shallow lake, with a maximum depth of 9 feet. The estimated average depth is 4.5 feet deep, which is calculated at half of the maximum depth. The estimated lake volume is 495 acre-feet<sup>1</sup>, or 161.3 million gallons. The shoreline length including the channels, is 7.5 miles. Duck Lake receives inflow from Wooster Lake, which enters at the southeast corner. The Fish Lake Drain flows through Fish Lake, Fischer Lake and then Wooster Lake before entering Duck Lake. Water exits Duck Lake along the east side, as Squaw Creek continues to Fox Lake, within the Fox River Chain O'Lakes. During 1997, the Lake County Health Department's (LCHD) Lakes Management Unit collected water quality samples from Duck Lake. These data will be discussed within the water quality section of this report.

## **BRIEF HISTORY OF DUCK LAKE**

In the 1920's, Duck Lake was used as a fishing and recreational area. Year round homes were built beginning in the 1930's. In the late 1940's and early 1950's Duck Lake was dredged, but records of dredge locations within the lake and the amount of sediment removed are unavailable. In the late 1950's, the Duck Lake Woods Association purchased a weed cutter to curtail the growth of milfoil, coontail and "other lake grasses."<sup>2</sup> It is unclear if the milfoil was Eurasian water milfoil or northern water milfoil. Residents began using herbicides for aquatic plants in 1973. In 1979, Lake Management Consultants, Inc. collected water quality samples and aquatic plant information from Duck Lake. Their findings are discussed in the appropriate sections of this report.

## **SUMMARY OF CURRENT AND HISTORICAL LAKE USES**

Residents living around Duck Lake use the lake for motorized and nonmotorized boating, fishing, swimming and aesthetics. Because of the multiple uses, user conflicts are a concern for the residents. There is no public access to Duck Lake. The Duck Lake Waterway Association is an umbrella organization consisting of five homeowner associations that surround Duck Lake: Knollwood Park Subdivision, Duck Lake Woods Subdivision, Devlin Subdivision, Longwood Subdivision and Chris Larkin Subdivision. The associations treat the lake annually with aquatic herbicides to control plant beds in the lake. There are ten major parcels of lake bottom. The Duck Lake Woods subdivision owns a portion of the lake at the southern end. Knollwood Park Improvement Association owns the northwestern corner of the lake, including the channels in that area.

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<sup>1</sup> One acre-foot is one acre filled with one foot of water, or 325,900 gallons.

<sup>2</sup> Text from 1978 community block grant application, under section "History of Efforts to Improve Duck Lake."

Private individuals own four major parcels. Neal Construction, Duck Lake Crossing LLC, County of Lake, and an unknown owner own other major parcels. A volunteer has participated in the Illinois Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program (VLMP) measuring water clarity in Duck Lake since 1986 and collected water samples in 1999 and 2000.

## LIMNOLOGICAL DATA - WATER QUALITY

Water samples were collected a month, from May through September 2001, at the deep hole location (See Figure 1). Samples were collected at three and six feet and analyzed for a variety of parameters (Table 1, Appendix A). The 2001 water quality data can be found in Table 1, Appendix A. The document, "Interpreting Your Water Quality Data" explains these parameters in detail. See Appendix B for water quality sampling and laboratory methods.

The water clarity in Duck Lake during 2001 (LCHD) averaged 2.01 feet deep for the season. Fifty percent of Lake County lakes had a water clarity reading of at least 4.18 feet<sup>3</sup>. The best clarity in Duck Lake was seen in May, with a depth of 4.6 feet. Clarity decreased after the plants began to die back in June as a result of aquatic herbicide treatments. The water clarity in June was 2.6 feet deep. From July through September, the water clarity fluctuated from 0.72 feet to 1.15 feet deep. During 1979, Lake Management Consultants, Inc. determined that Duck Lake had a seasonal water clarity average of 3.2 feet. Duck Lake has also been measured through the VLMP since 1986. Table 2 in Appendix A lists the Secchi Disk readings for each year, including LCHD averages for 1997 and 2001. The seasonal clarity averages have ranged from 1.8 feet deep (2001, VLMP) to 4.2 feet deep (1996, VLMP) since 1986. Several lake residents have expressed concerns over the poor clarity seen in 2001.

Concentrations of total suspended solids (TSS) increased dramatically after May. The near surface sample seasonal average of TSS in Duck Lake during 2001 was 20.6 mg/L, which was nearly four times higher than the Lake County median concentration, which is 5.7 mg/L<sup>4</sup>. TSS concentrations peaked in August when 31.0 mg/L was found in the near surface sample. The VLMP found average TSS concentrations at the surface was 22.0 mg/L in 1999 and 14 mg/L in 2000. In 1997, LCHD found TSS concentrations averaged 8.5 mg/L in the near surface sample. By contrast, Wooster Lake, which is immediately upstream from Duck Lake, had low average TSS concentrations in the near surface sample (4.1 mg/L, 1999 LCHD data). Several factors may be influencing the results in Duck Lake. Aquatic plant coverage likely varies from year to year partly due to natural fluctuations but more likely due to variations in herbicide application rates and treatment timing.

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<sup>3</sup> This is the median value, or the point at which half of the lake samples have data less than this value, and the other half have greater values. Median and average values were calculated using results of lakes sampled by the LCHD from 1995 through 2001.

Figure 1.

Other possible explanations of the increase could be large storm events or watershed inputs.

Another parameter, non-volatile suspended solids (NVSS) can be calculated to show the amount of inorganic solids present in the water. In Duck Lake, the seasonal average for NVSS was 13.5 mg/L, with a range of 4.1 mg/L in May to 19.9 mg/L in August. On average, 65% of the TSS is NVSS which indicates high sediment resuspension. Sediment resuspension can be attributed to several factors including wind, wave and carp action. Because Duck Lake is small and shallow, motorboat activity also contributes to poor water clarity by resuspending sediment.

During 2001, total phosphorus (TP) in the near surface samples averaged 0.100 mg/L, which is over twice the Lake County median of 0.047 mg/L. Deeper water samples had an average TP concentration of 0.105 mg/L. Duck Lake ranked #49 out of 103 Lake County lakes based on average total phosphorus concentrations (See Table 2 in Appendix A). During 1997, TP concentrations were lower, with a seasonal average of 0.047 mg/L near the surface and 0.051 mg/L in the deeper water samples. In 1999 and 2000, the VLMP found average TP concentrations at the surface to be 0.032 mg/L and 0.026 mg/L, respectively. TP concentrations in Fish Lake and Fischer Lake, which are upstream from Duck Lake, are also high. Fish Lake averaged 0.134 mg/L in the near surface sample (1997 LCHD data), while Fischer Lake averaged 0.198 mg/L for the near surface sample (2001 LCHD data). Wooster Lake, which receives water from Fish Lake and Fischer Lake, had relatively low TP concentrations in the near surface sample (0.027 mg/L), but high concentrations in the deep water sample (0.509 mg/L). Wooster Lake is deeper (approximately 28 feet) than any of the other aforementioned lakes and strongly stratifies in the summer. This stratification traps nutrients like TP in the deeper water. Thus, Wooster Lake is acting as a sink for incoming phosphorus, preventing potentially larger phosphorus loading into Duck Lake. Duck Lake TP concentrations are likely the result of several factors including internal loading from sediment resuspension, storm events, or other watershed sources.

The trophic condition of a lake indicates the overall level of nutrient enrichment. The trophic state is calculated using total phosphorus concentrations, chlorophyll a concentrations and/or Secchi disk readings. On a point scale (Trophic State Index) after calculations, a lake with eutrophic status has at least 50 points. Most lakes in Lake County are eutrophic or nutrient rich, and are productive lakes in terms of aquatic plants and/or algae and fish. In 1979, TP concentrations in Duck Lake were indicative of a eutrophic lake, with a trophic state index of 60. Hypereutrophic lakes are those that have excessive nutrients, and have a trophic state index of at least 70 points. Lakes with nuisance algae growth reminiscent of “pea soup” are usually labeled hypereutrophic, and have poor water clarity. The condition of Duck Lake in terms of its phosphorus concentrations during 2001 was hypereutrophic with a trophic state index of 70.5 points.

The concentrations of total Kjeldahl nitrogen (TKN) in Duck Lake were higher in 2001 in comparison to the concentrations in 1997. During 2001, TKN near the surface increased from 0.73 mg/L in May to 4.52 mg/L in August, with a drop in concentration to 3.77



mg/L in September. Like total phosphorus concentrations, TKN concentrations can follow the seasonal dynamics of algal populations. The deeper water samples had TKN concentrations similar to those near the surface in 2001. During 1997, TKN concentrations did not increase as dramatically. Near the surface, results were 1.13 mg/L in May, increasing only to 1.5 mg/L in September. Concentrations near the bottom were similar to those near the surface in 1997. The Lake County TKN average is 1.26 mg/L. In 1999, Wooster Lake had a TKN average of 1.18 mg/L near the surface. This again illustrates that Wooster Lake is not the source of Duck Lake's nutrient problems.

The ratio of total nitrogen to total phosphorus (TN:TP) indicates if phosphorus or nitrogen limits the algae growth in the lake. 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. Although Duck Lake has high phosphorus concentrations, the TN:TP ratio is 28:1, indicating a lake limited by phosphorus. The TN:TP ratio in 1997 was similar, at 29:1. Most lakes throughout Lake County are phosphorus limited.

The dissolved oxygen (D.O.) concentrations and temperature throughout the water column of Duck Lake were measured from the surface to the bottom in one-foot increments. In 2001, the water column had D.O. concentrations > 1 mg/L from the surface to the bottom each month except June, in which anoxic conditions existed just off the bottom. In June, the water column was weakly stratified, creating this small anoxic zone. During the other months, the water column was able to mix, and did not sustain a thermocline. In 1997, the D.O. situation was similar, with concentrations > 1mg/L from the surface down to the bottom in all months except July when a small anoxic zone existed at one foot above the bottom.

The Illinois Environmental Protection Agency has assessment indices to classify Illinois lakes for their ability to support aquatic life, swimming, or recreational uses. The guidelines consider several aspects, such as water clarity, phosphorus concentrations and aquatic plant coverage. Duck Lake fully supports aquatic life according to these guidelines. Duck Lake is impaired for swimming uses because of the high phosphorus concentrations and low water clarity. This, with its hypereutrophic condition, allows only partial support of swimming uses. The lake was placed in the nonsupport category for recreational uses because of the large plant beds and high phosphorus concentrations. The overall use support category for Duck Lake is partial support.

During 2001 LCHD measured the change in the water elevation of Duck Lake. The largest change occurred between the months of June and July, when the water elevation dropped by 4.8 inches. Elevation fluctuations for the most part were minimal, from 0.35 inches to 2.7 inches between months.

## LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Staff randomly sampled locations in Duck Lake each month for aquatic plants, and identified 12 species. Table 4 lists the plant species identified during 2001. Table 5 in Appendix A lists the plant species and the frequency that they were found. Before the use of aquatic herbicides in 2001, aquatic plants covered approximately 61% of the lake bottom. The three plants most commonly found were Eurasian water milfoil (in 64% of the sample sites in May), curlyleaf pondweed (55% occurrence in May) and white waterlily (41% occurrence in May). Over the 2001 season, the Duck Lake Waterway Association contracted an applicator to apply a total of 2,400 pounds of 2,4-D pellets (Navigate®) across 12 acres to control aquatic vegetation. After the initial treatment, the plant coverage across Duck Lake was estimated at 29%. From June through September, the most commonly found aquatic plant was white waterlily, with occurrences ranging from 54% to 82% of samples collected in those months. The second most common plants in June were curlyleaf pondweed and coontail, both with similar occurrences (46% and 43%, respectively). From July through August, curlyleaf pondweed was not collected due to natural senescence. Coontail was collected most often in July and August with occurrences of 15% and 37%, respectively. In September, Duck Lake experienced a resurgence of Eurasian water milfoil, when it was collected at 23% of the sample locations. Eurasian water milfoil is an aggressive, exotic species that is known for its dense, nuisance plant beds. It isn't clear when Eurasian water milfoil first began growing in the lake. Information from the 1950's mentions milfoil, but does not specify the species as Eurasian or the native northern milfoil. The 1979 study by Lake Management Consultants does identify Eurasian water milfoil in their aquatic plant collection from Duck Lake. The two most abundant plants that were identified in Duck Lake in 1979 were spatterdock (referred to as yellow water lily; *Nuphar variegata*) and curlyleaf pondweed. This team sampled in water depths up to 1.5 meters (approximately 5 feet), and found that 75% of this depth zone did not have plants. Duck Lake may have had less plant coverage in 1979 than in 2001, but it is difficult to state this since the sampling methodologies and sampling frequencies differed.

Since Duck Lake has boat launches, it is recommended that signage be erected at each launch notifying users of the presence of EWM in the lake, so this species is not introduced into other lakes which do not already have it. The Exotic Species Advisory signs are available for \$13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site <http://www.iisgcp.org/outrch/br/sign.htm> or by calling 217-333-0240.

**Table 4. Aquatic and shoreline plants on Duck Lake, May – September, 2001.**

<u>Aquatic Plants</u>	
Coontail	<i>Ceratophyllum demersum</i>
Chara	<i>Chara</i>
Duckweed	<i>Lemna spp.</i>
Eurasian water milfoil	<i>Myriophyllum spicatum</i>
Largeleaf Pondweed	<i>Potamogeton amplifolius</i>
Curlyleaf Pondweed	<i>Potamogeton crispus</i>
Small Pondweed	<i>Potamogeton pusillus</i>
Sago Pondweed	<i>Stuckenia pectinatus</i>
Common Bladderwort	<i>Utricularia vulgaris</i>
Watermeal	<i>Wolffia spp.</i>
White Water Lily	<i>Nymphaea tuberosa</i>
Spatterdock	<i>Nuphar variegata</i>
<u>Shoreline Plants</u>	
Purple Loosestrife	<i>Lythrum salicaria</i>
Reed Canary Grass	<i>Phalaris arundinacea</i>
Buckthorn	<i>Rhamnus spp.</i>

Aquatic plants will not photosynthesize in water depths with less than 1% of the available sunlight. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow in a specific lake. In the case of Duck Lake, the 1% light level was down to the bottom in May, when approximately 60% of the lake had evident plant growth. Plants were found at a maximum depth of 6.7 feet (June). However, the potential plant coverage is 100%, since light was available down to the bottom. After the use of aquatic herbicides, the water clarity dropped, resulting in available light down to 6 feet by the June sampling date. Light availability was less in July and August, when light was less than 1% below 3 feet deep, although plants were found at a maximum depth of 4.9 feet and 5.5 feet, respectively. In September, the 1% light level was at 4 feet, with the maximum plant depth at 5.3 feet. During these months, plant growth was estimated at 29% coverage, with much of it white water lily plants along the northern shore. Because lily leaves reach the surface early in the season, though, light extinction down in the water column later in the season is not a hindrance to these plants.

To maintain a healthy fishery, the Illinois Department of Natural Resources suggests plant coverage of 20% to 40% across the lake bottom. The estimated 29% plant coverage after the aquatic herbicide treatment in 2001 fits this range. However, in plant free areas, the lake also experienced poor water clarity because of algae blooms, wind, wave and carp action.

Floristic quality index is a measurement designed to evaluate the closeness of the flora (plants species) of an area to that with undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long term floristic trends, and 4) monitor habitat restoration efforts. Each floating and submersed aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). These numbers are then used to calculate the floristic quality index (FQI). A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake, and better plant diversity. Nonnative species are included in the FQI calculations for Lake County lakes. The FQI scores of 64 lakes measured in 2000 and 2001 ranges from 0 to 37.2, with an average of 14. Duck Lake has a floristic quality of 17.1, indicating a better than average aquatic plant diversity based on the 64 lakes studied to date.

## LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

In June 2001, LCHD staff assessed the shoreline of Duck Lake. See Appendix B for a discussion of the methods used, and Figure 2 for a shoreline erosion map. The two most common types of shoreline were wetland (nearly 30% of the entire shoreline), and riprap (26%). Approximately 56% of the shoreline surrounding the lake is developed. This includes riprap (26%; 10,170 feet), seawall (9%; 3,598 feet) to mowed turfgrass (9%; 3,422 feet), unmowed buffer areas (7%; 2,676 feet) and beach (2%; 668 feet). The 16,930 feet (44%) of undeveloped shoreline provides good wildlife habitat, with wetlands, woodlands, fallen trees (deadfall) and shrubby areas. Approximately 30% (11,850 feet) of the shoreline is eroding in some degree. About 26% (9,874 feet) of the shoreline is slightly eroding, 3% (1,323 feet) is moderately eroding, and 2% (653 feet) is severely eroding. Most of the erosion occurs along shrub shorelines (33% of the eroding shoreline) or mowed lawn (19% of the eroding shoreline). However, most of these shorelines are either slightly or moderately eroding. The severely eroding shorelines are classified as woodland, shrub and beach. These shorelines will continue to erode as a result of wind induced wave action 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 in **Objective IV: Shoreline Erosion Control**.

Staff also noted the presence of invasive, aggressive plant species, along much of the shoreline. Purple loosestrife (*Lythrum salicaria*) was noted most often, followed by two shrub species - buckthorn (*Rhamnus spp.*) and honeysuckle (*Lonicera spp.*). Reed canary grass (*Phalaris arundinacea*) was also recorded periodically. These aggressive plants can crowd out native, beneficial plants. The removal of these species is recommended. Alternatives for their removal can be found within **Objective V: Eliminate or Control Exotic Species**.

Figure 2.

Figure 3.

## LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Duck Lake. See Appendix B for methods. Several of the species listed in Table 6 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

Good habitat exists around portions of Duck Lake, particularly the undeveloped area along the north and southwestern shorelines. A mix of woodland, wetland, and shrub habitats along with some deadfall along the shoreline provided areas for different types of wildlife to utilize. The poorest habitats were along developed shorelines where manicured lawns, riprap and seawalls were found. These habitats were favored by Canada geese, which were seen throughout the 2001 season. Geese feces is high in nutrients, particularly phosphorus, and may contribute to the overall nutrient load to the lake.

Historically, Duck Lake experienced a moderate winter fishkill in 1951. In the fall of 1968 the lake was partially rehabilitated with fish toxicant (rotenone) and restocked. LCHD did not conduct any fishery studies of Duck Lake in 2001.

**Table 6. Wildlife species observed on Duck Lake, May – September, 2001.**

*Birds*

Canada Goose	<i>Branta canadensis</i>
Mallard	<i>Anas platyrhynchos</i>
Wood Duck	<i>Aix sponsa</i>
Great Egret	<i>Casmerodius albus</i>
Great Blue Heron	<i>Ardea herodias</i>
Green Heron	<i>Butorides striatus</i>
Killdeer	<i>Charadrius vociferus</i>
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>
Common Flicker	<i>Colaptes auratus</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Eastern Kingbird	<i>Tyrannus tyrannus</i>
Great Crested Flycatcher	<i>Myiarchus crinitus</i>
Purple Martin	<i>Progne subis</i>
Barn Swallow	<i>Hirundo rustica</i>
Tree Swallow	<i>Iridoprocne bicolor</i>
Chimney Swift	<i>Chaetura pelagica</i>
American Crow	<i>Corvus brachyrhynchos</i>
Blue Jay	<i>Cyanocitta cristata</i>
Black-capped Chickadee	<i>Poecile atricapillus</i>
White-breasted Nuthatch	<i>Sitta carolinensis</i>
House Wren	<i>Troglodytes aedon</i>
American Robin	<i>Turdus migratorius</i>

**Table 6. Wildlife species observed on Duck Lake, May – September, 2001 (cont'd).**

Red-eyed Vireo	<i>Vireo olivaceus</i>
Warbling Vireo	<i>Vireo gilvus</i>
Yellow Warbler	<i>Dendroica petechia</i>
Common Yellowthroat	<i>Geothlypis trichas</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Common Grackle	<i>Quiscalus quiscula</i>
Starling	<i>Sturnus vulgaris</i>
Scarlet Tanager	<i>Piranga olivacea</i>
House Sparrow	<i>Passer domesticus</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
House Finch	<i>Carpodacus mexicanus</i>
American Goldfinch	<i>Carduelis tristis</i>
Swamp Sparrow	<i>Melospiza georgiana</i>
Song Sparrow	<i>Melospiza melodia</i>

Mammals and Reptiles

None noted.

Amphibians

Bull Frog

*Rana catesbeiana*

Green Frog

*Rana clamitans melanota*

Insects

Cicadas

Dragonfly

Damselfly

\* **Endangered in Illinois**

+ **Threatened in Illinois**



## EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality 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 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. Duck Lake does not have a recent bathymetric map. The old one created at an unknown date is outdated. 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.

- *Excessive Aquatic Vegetation*

During 2001, the estimated plant coverage on Duck Lake was approximately 61% of the lake bottom before the use of aquatic herbicides. The plant found most often was Eurasian water milfoil, an aggressive exotic species. After the aquatic herbicide use, the plant coverage decreased to about 29% of the lake bottom. This coverage is within the range suggested by the Illinois Department of Natural Resources for the maintenance of a balanced fishery. However, the drawback is that the water clarity was directly affected by the loss of plants, resulting in poor clarity readings.

Since Duck Lake has boat launches, it is recommended that signage be erected at each launch notifying users of the presence of EWM in the lake, so this species is not introduced into other lakes which do not already have it. The Exotic Species Advisory signs are available for \$13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site <http://www.iisgcp.org/outrch/br/sign.htm> or by calling 217-333-0240.

- *High Nutrient Concentrations*

In 2001, Duck Lake had excessive concentrations of total phosphorus, total Kjeldahl nitrogen, and total suspended solids. The near surface samples averaged 0.100 mg/L for total phosphorus, 2.828 mg/L for total Kjeldahl nitrogen, and 20.6 mg/L for total suspended solids. These concentrations are all over twice the county median, and show a more than doubling of these same parameters from 1997. Duck Lake has high phosphorus concentrations that have increased since 1997. Resuspended sediment and algae blooms are the cause of these high concentrations.

- *Excessive Algae Blooms*

The excessive phosphorus concentrations in Duck Lake result in severe algae blooms after the plants died back from the initial aquatic herbicide treatment. Blooms resulted in poor water clarity and high concentrations of some nutrients measured.

- *Poor Water Clarity*

The water clarity in Duck Lake was poor, averaging 2.01 feet deep for the 2001 season. Resuspended sediment and algae are the main culprits causing the turbidity in the water. High phosphorus concentrations support a large algae population after the aquatic plants died from the aquatic herbicide treatment. Due to the lake's shallow morphometry, motorboat, wind, wave and carp action resuspend sediment into the water column. The water clarity has remained fairly stable since it was initially measured in 1979.

- *Invasive Shoreline Plant Species*

Aggressive, exotic shoreline plants around much of the Duck Lake shoreline. Purple loosestrife was most prolific, followed by two shrub species: buckthorn and honeysuckle. Reed canary grass was also noted. It is recommended that these plants be removed and replanted with native vegetation.

- *Shoreline Erosion*

Approximately 30% of the total shoreline is eroding in some degree. The severely eroding shorelines are classified as woodland, shrub and beach. These shorelines will continue to erode as a result of wind induced wave action if protective measures are not taken. This can add sediment to the lake and result in a loss of shoreline property. The severely eroded areas should be addressed immediately.

- *User Conflicts*

Residents have expressed concern over lake user conflicts, e.g., power boaters and non-motorized boaters. Although the lake has a "gentleman's" agreement (no motors before 9 a.m.) for the power boaters, conflict still exists.

## **POTENTIAL OBJECTIVES FOR DUCK LAKE MANAGEMENT PLAN**

- I. Bathymetric Map
- II. Aquatic Plant Management Options
- III. Nuisance Algae Management Options
- IV. Shoreline Erosion Control
- V. Eliminate or Control Exotic Species
- VII. Enhance Wildlife Habitat Conditions
- VIII: User Conflicts

## **OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES**

### **Objective I: Bathymetric Map**

A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Currently, only an old bathymetric map of Duck Lake exists.

Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from \$3,000-10,000 depending on lake size.

## **Objective II: Aquatic Plant Management Options**

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 are not very effective, unreliable, 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. However, if a no action aquatic plant management plan in a lake with non-native, invasive 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 water milfoil 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.

#### ***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 alteration, 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. If the

lake contains native, non-invasive plant species, 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.

An additional benefit of the no action option is the possible improvement in water quality. Turbidity could decrease and clarity should increase due to sediment stabilization by the plant’s roots. Algal blooms could be reduced due to decreased resource availability and sediment stabilization. However, the occurrence of filamentous algae may increase/remain stable due to their surface growth habitat. The lake’s fishery could improve due to habitat availability, which in turn would have numerous positive effects on the rest of the lake’s ecosystem.

### ***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. The fishery of the lake may become stunted due to the 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.

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake’s ecosystem.

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 stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could

become more and more exasperating due in part to the thick vegetation and also because of stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/algae problems have been shown to decrease by as much as 15-20%.

### ***Costs***

No cost will be incurred by implementing the no action management option. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

### **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, D.O. concentration, temperature).

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 above ground portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. 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. Some granular products 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°F. 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. There may be more than one herbicide for a given plant. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

In Duck Lake, an aquatic plant management plan may be necessary since the aquatic plant communities have the potential to cover 100% of the lake bottom. Treatments should occur early in the spring (April or May). If herbicides are used in Duck Lake, systemic herbicides like 2,4-D granular (Aquacide®, Aqua-Kleen®, Navigate®, or Weedar 64®) or fluridone (Sonar™ or Avast™) could be used. The herbicide 2,4-D may be more selective than fluridone and is effective on dicots such as EWM and white water lily, which are common in Duck Lake. Spot treatments may minimize the impact to the native pondweeds.

### ***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. Ecologically, herbicides can be a better management option than using mechanical harvesting or grass carp. When properly applied, aquatic herbicides may be selective for nuisance plants such as Eurasian water milfoil but allow desirable plants such as American pondweed (*Potamogeton nodosus*) 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 benefit greatly 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 stands of vegetation. The quality of fishing may improve 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 biodiversity and ecological. Total 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 to 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 food supply.

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

Over-removal, 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***

Granular 2,4-D spot treatments cost approximately \$350-425/surface acre. Fluridone is applied based on the volume of the lake (acre-feet [AF]). A current bathymetric map should be used to accurately calculate this value. The cost for fluridone is \$9.75/AF at a concentration of 8 part per billion (ppb) and \$11.75/AF at 10 ppb.

### **Option 3: Hand Removal**

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and 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 swaths through the weeds to create pathways to open water. Due to the limited amount of biomass removed, harvested plant material is often used as fertilizer and compost in gardens.

This technique could be used in Duck Lake to eliminate small patches of nuisance vegetation, such as around piers or beaches.

### ***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. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

### ***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. However, individual homeowners would be removing limited quantities of plant material so there would not be much to dispose of. 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). Over removal could also be a problem but is not normally a concern with hand removal.

### ***Costs***

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

## **Option 4: Reestablishing Native Aquatic Vegetation**

This option is strongly recommended for Duck Lake.

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 7 in Appendix A lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

In Duck Lake, native emergent plants could be planted along the shoreline, particularly along the areas where erosion is occurring. Submersed aquatic plants could be planted as well, however, success will be somewhat dependent on water clarity. If water clarity can be improved, submersed plants will have a higher chance of success.

### ***Pros***

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This

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

### ***Cons***

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

### ***Costs***

See Table 7 for plant pricing. Additional costs will be incurred if a consultant/nursery is contracted for design and labor.

### **Option III: Nuisance Algae Management Options**

The growth of nuisance or excessive algae can cause a number of problems. Excessive algal growth can cause decreases in water clarity and light penetration. This can lead to several major problems such as loss of aquatic plants, decline in fishery health, and interference with recreational activities. Health hazards, such as swimmer's itch and other skin irritations have been linked to nuisance algae growth. Normally, excessive/nuisance algae growth is a sign of larger problems such excessive nutrients and/or lack of aquatic plants. Some treatment methods, such as copper sulfate, are only quick remedies to the problem. Solving the problem of nuisance algal growth involves treating the factors that cause the growth not the algae it self. Long-term solutions typically include an integrated approach such as alum treatments, revegetation with aquatic plants, and limiting external sources of nutrients. Interestingly enough, these long-term management strategies are seldom used, typically because of their high initial costs. Instead, the cheap, quick fix of using copper sulfate, though temporary, is much more widely used. However, the costs of continually applying copper sulfate over years, even decades, can eventually far exceed the costs of a slower acting, eventually more effective, integrated approach.

As with aquatic plant management techniques, algae management practices have both positive and negative characteristics. If used properly, they can 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 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 (beaches, boat ramps, etc.), habitat maintenance/restoration issues, and nutrient levels. For an algal management plan to achieve long term success, follow up is critical. The management of the lake's algae problem does not end once the blooms and/or mats have been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and treat as necessary. An association or property owner should not always expect immediate results. A quick fix of the algal problem may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly address the problem. The management options covered below are commonly used techniques and those that are coming into wider acceptance, and have been used in Lake County. There are other algae management options that are not covered below as they are not very effective, unproven, unfounded, or are too experimental to be widely used.

#### **Option 1: No Action**

With a no action management plan nothing would be done to control the nuisance algae regardless of type and extent. Nuisance algae, planktonic and/or filamentous, could continue to grow until epidemic proportions are reached. Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels.) will dictate the extent of growth. Unlike aquatic plants, algae are not normally bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by wind and wave action if strong enough. However, under normal conditions, with no action, both filamentous and planktonic algal

blooms can spread to cover 100% of the surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

### ***Pros***

There are positive aspects associated with the no action option for nuisance algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for algae control were eventually needed, the cost would be substantially higher than if the no action plan had been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, chemicals or introduction of any organisms would not take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks. Other problems such as strong odors (blue-green algae) might also increase in frequency.

### ***Cons***

Under the no action option, if nuisance algae becomes wide spread and able to reach epidemic proportions, there will be many negative impacts on the lake. The fishery of the lake may become stunted due to lack of quality forage fish habitat and reduced predation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species such as some blue-green algae. Blue-green algae can also produce toxins that are harmful to other algae. This allows blue-green algae to quickly dominate a body of water. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive algae growth, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by dense growths of algae. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, are poor sources of food for zooplankton and fish.

Water quality could also be negatively impacted with the implementation of a no action option. Decomposition of organic matter and release of nutrients upon algal death is a probable outcome. Large nutrient release with algae die back could lead to lake-wide increases of internal nutrient load. This could in turn, could increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae, filamentous and planktonic, will lead to a depletion of dissolved oxygen in the lake. This can cause fish stress, and eventually, if stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic

blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

### *Costs*

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

### **Option 2: Algicides**

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate (CuSO<sub>4</sub>) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. They all work the same and act as contact killers. This means that the product has to come into contact with the algae to be effective. Algicides come in two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides are enhanced when mixed with an algicide. When applying an algicide it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur. This may cause fish kills due to decomposition of treated algae. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake. Larger lakes will need to be divided into more sections. Then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather (>90°F) or when D.O. concentrations are low. This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible when temperature and D.O. concentrations are adequate. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

### *Pros*

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides are their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the

lake. Newly established stands of plants would 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*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae. Health risks associated with excessive algae growth (toxins, reduced visibility, etc.) The quality of fishing may recover due to improved habitat and feeding opportunities. In addition to increased usage opportunities, overall aesthetics of the lake would improve, potentially increasing property values.

### ***Cons***

The most obvious drawback of using algicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are filling the empty gap. These species that fill the gap can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

### ***Costs***

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. Chelated copper products costs about \$35-45 per gallon. Treatment applications vary but generally are recommended at 1-5 gallons per acre foot, depending on the product.

### **Option 3: Alum Treatment**

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum



has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio are good candidates. This encompasses many lakes within Lake County. Lakes that are thermally stratified experience longer inactivation than non-stratified lakes due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

### ***Pros***

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

### ***Cons***

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

*Costs*

Morphometric data is required to make proper calculations. However, based on the estimated volume of Duck Lake (495 acre-feet) an alum treatment would cost approximately \$22,400 – 38,400.

**Option 4: Revegetation With Native Aquatic Plants**

This option is identical to Option 4 in **Objective III: Aquatic Plant Management Options**.

## **Objective IV: Shoreline Erosion Control**

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 exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses.

### **Option 1: No Action**

#### ***Pros***

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future.

Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g. kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

#### ***Cons***

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

#### ***Costs***

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

### **Option 2: Install a Steel or Vinyl Seawall**

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave

action requiring routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time as steel will.

### ***Pros***

If installed properly and in the appropriate areas (i.e. shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last numerous years and have relatively low maintenance.

### ***Cons***

Seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Any repair costs tend to be expensive as well. 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. Permits and surveys are needed whether replacing and old seawall or installing a new one (see costs below).

Wave deflection is another disadvantage to seawalls. Wave energy not absorbed by the shoreline is deflected back into the lake, potentially causing sediment disturbance and resuspension, which in turn may cause poor water clarity and problems with nuisance algae, which use the resuspended nutrients for growth. If seawalls are installed in areas near channels, velocity of run-off water or channel flow may be accelerated. This may lead to flooding during times of high rainfall and run-off, shoreline erosion in other areas of the lake, or a resuspension of sediment due to the agitation of the increased wave action or channel flow, all of which may contribute to poor water quality conditions throughout the lake. Plant growth may be limited due to poor water clarity, since the photosynthetic zone where light can penetrate, and thus utilized by plants, is reduced. Healthy plants are important to the lake's overall water clarity since they can help filter some of the incoming sediment, prevent resuspension of bottom sediment, and compete with algae for nutrients. However, excessive sediment in the water and high turbidity may overwhelm these benefits.

Finally, seawalls provide no habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e. bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e. stunted fish populations).

### ***Costs***

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from \$65-80 per linear foot for steel and \$70-100 per linear foot for vinyl. A licensed contractor installs both types of seawall. On Duck Lake to install a seawall along the moderately eroded shorelines (1,323 feet) would cost \$86,000 – 105,840 for steel and approximately \$92,610 – 132,300 for vinyl. For the severely eroded areas (653 feet), a steel seawall would cost approximately \$42,445 – 52,240 and a vinyl seawall would cost approximately \$45,710 – 65,300. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be \$1,000-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

### **Option 3: Install Rock Rip-Rap or Gabions**

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. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes. Both rip-rap and gabions can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip-rap or gabions, 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***

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions 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 rip-rap or gabions. 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 in the rock above water and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure underwater created by large boulders for foraging and hiding from predators.

### *Cons*

A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap 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 rip-rap and gabions 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 away due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

Rip-rap may be a concern in areas of high public usage since it is difficult and possibly dangerous to walk on due to the jagged and uneven rock edges. This may be a liability concern to property owners.

### *Costs*

Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately \$30-45 per linear foot. Costs for gabions are approximately \$20-30 per linear foot, and approximately \$60-100 per linear foot when filled with rocks. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. On Duck Lake, the approximate costs to install rip-rap along the moderately eroded shorelines (1,323 feet) would be \$39,690 – 59,535, and for the severely eroded shoreline (653 feet) approximately \$19,590 – 29,385. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be \$1,000-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

### **Option 4: 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 rip-rap.

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. A table in Appendix A 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., geese and 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 rip-rap.

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 a table in Appendix A should be considered for native plantings.

On Duck Lake, the installation of buffer strips is strongly recommended. The areas that are currently lawn, rip-rap and even seawall would benefit from a buffer strip. When possible, emergent plants could be incorporated at the land/water interface.

### ***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. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper overwintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have



suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

### *Cons*

There are few disadvantages to native shoreline vegetation. Certain species (i.e. cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

### *Costs*

If minimal amount of site preparation is needed, costs can be approximately \$10 per linear foot, plus labor. Cost of installing willow posts is approximately \$15-20 per linear foot. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as \$1,000-2,000 depending on the types of permits needed.

## **Option 5: Install A-Jacks®**

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a child's playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.

### *Pros*

The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® can not be seen. They provide many of the advantages that both rip-rap and buffer strips have. Specifically, they absorb some of the wave energy and protect the existing shoreline from additional erosion. The added benefit of a buffer strip gives the A-Jacks® a more natural appearance, which may provide wildlife habitat and help filter run-off nutrients, sediment, and pollutants. Less run-off entering a lake may have a positive effect on water quality.

### ***Cons***

The disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site. These assemblies are not as common as rip-rap, thus only a limited number of contractors may be willing to do the installation.

### ***Costs***

The cost of installation is approximately \$40-75 per linear foot, but does not include permits and surveys, which can cost \$1,000-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed. For Duck Lake, the estimated costs for installation would be \$52,920 – 99,225 for the moderately eroded shoreline (1,323 feet) and \$26,120 – 48,975 for the severely eroded shoreline (653 feet).

## **Option 6: 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.

### ***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 is being done. Additional costs may be incurred if compensatory storage is needed.

## **Objective V: Eliminate or Control Exotic Species**

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

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

Since Duck Lake has boat launches, it is recommended that signage be erected at each launch notifying users of the presence of exotic species (in this case, EWM) in the lake, so this species is not introduced into other lakes which do not already have it. The Exotic Species Advisory signs are available for \$13.50 each to homeowner associations from the Illinois-Indiana Sea Grant Program at their internet site <http://www.iisgcp.org/outrch/br/sign.htm> or by calling 217-333-0240.

### **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. A table in Appendix A lists several native plants that can be planted along shorelines.

### ***Cons***

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

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

### ***Costs***

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

## **Option 2: Biological Control**

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

Recently two beetles (*Galerucella pusilla* and *G. californiensis*) and two weevils (*Hylobius transversovittatus* and *Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on either the leaves or juices of purple loosestrife, eventually weakening or killing the plant. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly retard plant densities. The insects are host specific, meaning that they will

attack no other plant but purple loosestrife. Currently, the beetles have proven to be most effective and are available for purchase. There are no designated stocking rate recommendations, since using bio-control insects are seen as an inoculation and it may take 3-5 years for beetle populations to increase to levels that will cause significant damage. Depending on the size of the infested area, it may take 1,000 or more adult beetles per acre to cause significant damage.

### ***Pros***

Control of exotics by a natural mechanism is preferable to chemical treatments. Insects, being part of the same ecological system as the exotic (i.e., the beetles and weevils and the purple loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. This technique is beneficial to the ecosystem since it preserves, even promotes, biodiversity. As the exotic dies back, native vegetation can reestablish the area.

### ***Cons***

Few exotics can be controlled using biological means. Currently, there are no bio-control techniques for plants such as buckthorn, reed canary grass, or a host of other exotics. One of the major disadvantages of using bio-control is the costs and labor associated with it.

Use of biological mechanisms to control plants such as purple loosestrife is still under debate. Similar to purple loosestrife, the beetles and weevils that control it are not native to North America. Due to the poor historical record of introducing non-native species, even to control other non-native species, this technique has its critics.

### ***Costs***

The New York Department of Natural Resources at Cornell University (607-255-2821) sells overwintering adult beetles (which will lay eggs the year of release) for \$2 per beetle and new generation beetles (which will lay eggs beginning the following year) at \$0.25 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (217-333-6846).

## **Option 3: Control by Hand**

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

Around Duck Lake, this option may only be practical for small areas of infestation such as small patches of purple loosestrife, honeysuckle, or buckthorn. Other sections of the shoreline consist of extensive stands of exotic plants and may be best removed by another technique.

***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 4: Herbicide Treatment**

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

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using a herbicide soaked device. Trees are normally treated by cutting a ring in the bark (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early

summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

### ***Pros***

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

### ***Cons***

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

### ***Costs***

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

## **Objective VI: Enhance Wildlife Habitat Conditions**

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a mix of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

It is important to understand that the natural world is constantly changing. Habitats change or naturally succeed to other types of habitats. For example, grasses may be succeeded by shrub or shade intolerant tree species (e.g., willows, locust, and cottonwood). The point at which one habitat changes to another is rarely clear, since these changes usually occur over long periods of time, except in the case of dramatic events such as fire or flood.

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999).

### **Option 1: No Action**

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

#### ***Pros***

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

#### ***Cons***

If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing



development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

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

### ***Costs***

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

### **Option 2: Increase Habitat Cover**

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25 foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see the table in Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

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

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be placed at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

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

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

### ***Pros***

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

Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. 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 the table in Appendix A should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily (*Nuphar* spp. and *Nymphaea tuberosa*), sago pondweed (*Stuckenia pectinatus*), largeleaf pondweed (*Potamogeton amplifolius*), and wild celery (*Vallisneria americana*) to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, “people food” such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks.

#### ***Pros***

Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical “bug zappers” that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

#### ***Cons***

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks.

Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exacerbate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

#### ***Costs***

The costs of this option are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

#### **Option 4: Increase Nest Availability**

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

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

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

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

### ***Pros***

Providing places where 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.

## **Option 5: Limit Disturbance**

Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances will be beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a “no wake” area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

### ***Pros***

Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

This option also can benefit the lake in other ways. Limited boat traffic may lead to less wave action to batter shorelines and cause erosion, which results in suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth.

Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

### ***Cons***

One of the strongest oppositions to this option would probably be from the powerboat users and water skiers. However, this problem may be solved if a significant portion of the daylight hours and the use of the middle part of the lake (assuming the lake is deep enough) are allowed for powerboating. For example, powerboating could be allowed between 9 AM and 6 PM within the boundaries established by “no wake” restricted area buoys.

### ***Costs***

The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Off-duty law enforcement officers usually charge \$25/hour to enforce boating laws or local ordinances.

### **Objective VIII: User Conflicts**

Duck Lake residents have expressed concern about how different individuals or groups of people use the lake. Problems can occur if different users want to use the lake at the same time for recreational activities that inherently conflict. For example, people who fish may feel their quality of fishing experience is greatly diminished when powerboats are using the lake. On some lakes, certain areas of the lake are designated as no wake or have restricted boat access. Other lakes have certain times of the day when various activities are not allowed. For example, no jetskies or waterskiing is allowed in the early morning and evening hours. Duck Lake has no wake buoys around the northern and southern shorelines of the lake and a no wake before 9 a.m. “gentleman’s” agreement on the entire lake. However, some residents feel this leaves little time for nonmotorized activities. A user’s survey is suggested as a way to help understand how the residents and users of the lake feel. A good example is from Lake Ripley, Wisconsin, where a comprehensive questionnaire was mailed to all area residents. The results helped Lake Ripley’s management entity to clarify the uses on the lake and assisted in the development of management plan. LCHD has a copy of this questionnaire for review.